Drawn by D. Wiest.

Bowen & Co lith. Philada.

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FIRST ANNUAL REPORT

ON THE

Noxious,

BENEFICIAL AND OTHER

INSECTS,

OF THE

STATE OF MISSOURI,

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

BY CHARLES V. RILEY,
STATE ENTOMOLOGIST.

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INTRODUCTORY.

To the Members of the Missouri State Board of Agriculture:

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

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

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

With this view of the matter, we might materially check the increase of some insects, by anticipating Nature in her operations, and

cutting down such trees as have been injured from whatsoever cause, so that they shall not remain from year to year as a hiding place for noxious insects, or as a hot-bed for equally injurious funguses.

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

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

anxious deliberation in the closet. Hence, the wisdom of having a State officer who can devote his whole time to the work.

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

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

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

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

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

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

Many letters were addressed to me, during the summer, inquiring as to the value of the new carbolic acid, which has been so much spoken of. Having fully experimented with it during the summer, I am well pleased with it as an insect destroyer. But a word of warning in its use is necessary. It is also known by the name of cresylic

acid, the difference between the two being one of purity only. Many, having seen it recommended, ordered the crude acid, and, using it—no matter how much diluted—they found to their sorrow that it killed their plants. *Carbolic acid mixes well with alkalies, but not with water, and it can only be used as a saponaceous compound.* This fact must be borne in mind by those who wish to use it.

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

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

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

Respectfully submitted,

CHARLES V. RILEY,

ST. LOUIS, MO., Dec. 2d, 1868. *State Entomologist.*

NOXIOUS INSECTS.

THE BARK-LICE OF THE APPLE-TREE.

(Homoptera, Coccidæ.)

[Fig. 1.]

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

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

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

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

[Fig. 2.]

The fruit-growers of Southern Missouri, have therefore little to fear from this Oyster-shell Bark-louse, and it is not unlikely that it would die out in the country considerably north of St. Louis, if imported there; but, as it exists and flourishes near the southern border of Iowa, and extends, in Illinois, below our northern boundary, there is every reason to believe that it will flourish in the extreme northern counties of our State if once introduced there. Now, up to the present time, it has not made its appearance, as far as I can learn, in any of the orchards in that part of Missouri, and it seems that, as a State, we are entirely exempt from this most grievous orchard pest. In or-

der to definitely decide this matter I took particular pains, while at Hannibal during the summer, to inquire of the old fruit men there on this point, and even John Fry, one of the oldest settlers, has never heard of its appearance in that vicinity. The responses from numerous letters that were sent, with the same query, to men living in other northern parts of the State, are to the same effect. Believing therefore, that this insect *can* flourish in our extreme northern counties if once introduced there, and that at present the fruit-growers of that region are exempt from it, I cannot too strongly urge them to hold the vantage ground they now have. *Let every man therefore who reads this report, and who contemplates planting an apple orchard in North Missouri, in duty to himself and to his neighbors, subject every young tree which he receives from northern or eastern nurseries, to a rigorous inspection; and if any be found infested, let them be thoroughly cleansed before planting. By this means alone, can we hope to retain that immunity, which we have so far enjoyed!*

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

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

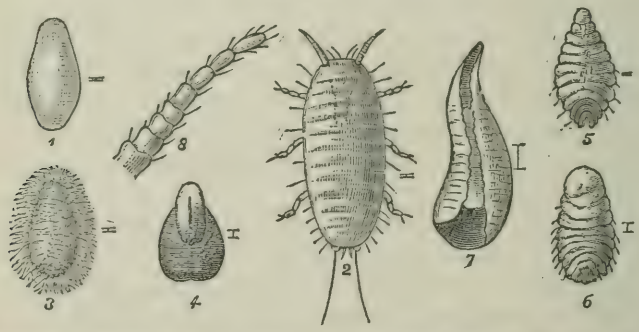
The gist of Dr. Shimer's observations which were recorded in a paper published in the Transactions of the American Entomological Society, (Vol. 1, No. 4) are, 1st—that he discovered that the tarsal joint of the newly hatched larva, which is very small, possesses no claw, but is furnished at the extremity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

represented at Figure 3, 3, to the motionless and memberless forms shown at 5 and 6 of the same figure, is an evidence of the degeneration or degradation in this insect as it approaches the imago state.

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

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

[Fig. 3*.]



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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

August 28th.—The eggs are now, apparently, all deposited, and I have watched with interest, as the deposition went on, the body of the parent louse shrinking day by day, instead of extending and becoming

gravid, until it is now a mere atom at the anterior or narrow end of the scale, in a few days scarcely to be noticed at all.

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

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

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

fragrans, shows how in that species the "scale" is not formed of the lifeless body of the female, but is a distinct integument, constructed by the female to protect herself and her eggs, and probably *secreted from the general surface of the body.*

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

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

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

By carefully lifting one of these scales during the months of July

and August, any of you may find the true louse underneath, occupying but a portion of, and being quite separate from it.

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

The observations of both, Mr. Shimer, Mr. Walsh, and myself agreed as to the time of hatching; as to the mode of growth of the scale, and as to finding no females; but as to the process by which the scale was formed there was difference of opinion. The reason, it seems to me, is obvious enough: in attempting to elucidate the problem we reach beyond the limits of our power of perception into the realms of conjecture. It is easy enough to watch the mode of growth of an oak-apple, but it is not such an easy matter to ascertain the reason why the kind which occurs on the red oak (produced by *Cynips quercus-inanis*) should form inside with radiating spokes from a common central cell; while that on the black oak (produced by *Cynips*[1] *quercus-spongifica*) should form inside with a dense spongy substance around a similar central cell. Mr. Shimer may, in part, be right in stating that the larval scale is formed by the young louse shedding its skin; but the extremely fine skin alone would not form such a scale, and he strangely overlooks the wax-like filaments secreted from the general surface of the body as well as the peculiar distinction in the growth of the "medial" and "anal" sacks. That these

two last scales are *constructed* by the louse, of its own cast skins and some excrementitious secretion, as he suggests, is also made *extremely* doubtful, from the simple fact that you may raise them every day of their growth and find the louse underneath, entirely free and separate. But after all, though of great scientific interest this matter is of no practical importance whatever, for as we shall see hereafter the great point to be borne in mind, in a practical light, is the time of hatching of the egg.

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

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

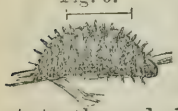
F. Starr, of Alton, Illinois, covered with a species, which, if not the same, is exceedingly like it.

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

Fig. 4.

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

Fig. 5.



Artificial Remedies.—These may be summed up in a very few words, and consist, for the most part, in prevention, and I again urge a strict examination of every young tree before it is planted. If an orchard is once attacked before its owner is aware of it, much could be done on young tress by scraping the scales off in winter, but on large trees where it is difficult to reach all the terminal twigs, this method becomes altogether impracticable, and it will avail but little

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

Mr. A. R. Whitney, of Franklin Grove, Lee county, Illinois, whose apple trees have been troubled more or less with bark-lice, found that an application of sheep manure around the trees, had a beneficial effect in checking the pests, and he attributes the result to the ammonia arising from the manure. With regard to washes, to be used with a syringe, the late Dr. Jno. A. Kennicott used 1 lb. of sal soda to one gallon of water with good effect; it is best used by heating to

redness in an iron pot and then dissolving it in the water. Mr. E. G. Mygatt, of Richmond, McHenry county, Illinois, has experimented with this insect for over 20 years with the following result: Brine (2 quarts salt to 8 of water) kills the lice, but also the foliage and fruit. Tobacco water (strong decoction) neither injures the foliage nor affects the lice. A solution of cobalt kills the lice, but takes the foliage also. Weak lye kills the lice, but also somewhat affects the leaves. Lime water kills about half the lice, and affects the leaves a little. Finally, quassia, boiled in proportion of 1 pound to 3 gallons of water, though well known to be effectual for the common plant-lice, has no effect on these coccids. In short, we have abundant proof that neither tobacco-water nor strong alkaline washes have any effect on these young lice, though a strong solution of soap *will* kill them, and my experience the past season, with cresylic acid soap in other directions, leads me to strongly recommend it for this purpose. It will sometimes be necessary to repeat the wash, as the lice do not all hatch out the same day, though the period of hatching seldom extends over three days.

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

THE PERIODICAL CICADA.

(Homoptera Cicadidæ.)

SEVENTEEN AND THIRTEEN YEAR BROODS.

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

The metamorphoses of insects, their instructive industry, their quarrels and their instincts, afford abundant food for our love of the marvelous; but few of them can claim such a singular history as can our Periodical Cicada. We are moved to admiration in contemplating the fact that an insect, after living for 17 long years in the bowels of the earth, should at last change its sluggish, creeping and worm-like form, and, endowed with the power of flight, ascend from its earthy retreat to become a denizen of the air and to enjoy the full glory of the Sun. But our wonder increases when we reflect that this

same insect has appeared in some part or other of the United States at regular intervals of 17 years, for centuries, aye! for ages in the past. Long ere Columbus trod on American soil this lowly insect must have appeared regularly at its appointed time. It must have filled the woods with its rattling song, when none but wild beasts and savages were present to hear it. To me there is something beautiful in the idea that through its periodicity we are enabled with tolerable certainty to go back in thought, for centuries in the past, to a particular month of a particular year, when the woods resounded with its song in the same manner as they did last summer; for so regularly do the different broods appear, that one is perfectly warranted in the assumption, that in the month of June, in the year 1738, for instance, 130 years ago—they appeared in the southern part of Missouri, and that 6 years previously they had appeared in the northwestern corner of the same State.

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

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

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

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

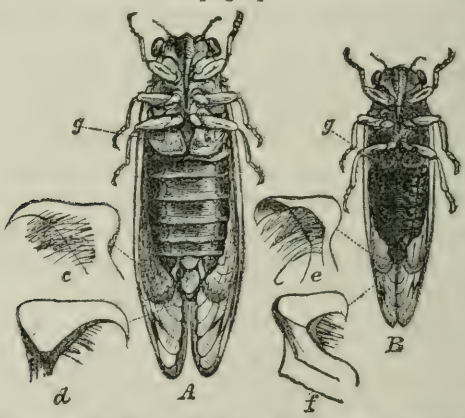
* See *Journal of Agriculture*, St. Louis, June 13, 1868, in which appeared the first account ever published of such a brood.

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

TWO DISTINCT FORMS.

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

[Fig 6.]



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

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

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

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

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

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

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

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

The large species has been observed to make its appearance from eight to ten days earlier than the small species (*cassinii*), and there is not a single specimen of the latter, among a number of the 13-year

brood (*tredecim*) that I captured in May, though I took a few specimens afterwards.

THE SEASON OF THEIR APPEARANCE AND DISAPPEARANCE

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

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

THEIR NATURAL HISTORY AND TRANSFORMATIONS

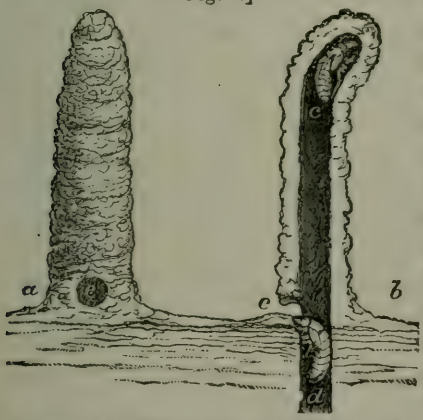
have been sufficiently described in the standard works of both Harris and Fitch, and it is only necessary to mention a few facts not recorded by them.

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

[Fig. 7.]

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

Fig. 8.]



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

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

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

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

[Fig. 9.]

[Fig. 10.]

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

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

[Fig. 11.]

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

*There is frequently a ninth joint partly developed.

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

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

ENEMIES OF THE CICADA.

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

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

THE STING OF THE PERIODICAL CICADA.

It is astonishing what a wide-spread fear exists of the Cicada on account of its stinging powers. There is scarcely a paper in the United States but published some account of a "locust" sting last summer, while unpublished accounts were equally numerous. One of the editors of the St. Louis *Republican* was kind enough to clip out for me all accounts of such stings, which he found in their numerous exchanges, and the number which had accumulated,

before the end of the "Locust" season, was truly surprising. Some people even denied themselves the pleasure of eating blackberries, raspberries and other fruits, because they feared these fruits had been poisoned by the eggs of Cicadas; while others believed that they poisoned water. I have endeavored to trace up a number of these reports, but have invariably found that they were either false or greatly exaggerated, and there is no doubt whatever that the great majority of such accounts owe their origin to the fertile imaginations of newspaper reporters, who are ever ready to create a sensation. Yet, to use a common metaphor, it is strange there should be so much smoke and no fire, and I will briefly review the only three methods by which such stinging can possibly be produced. At the same time, I give it as my conviction that there is but little cause for fear, as I have handled hundreds of them, and know hundreds of persons, including children, who have done the same, and yet have never been able myself to witness a single case of *bona fide* stinging,

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

[Fig. 12.]

By the Ovipositor.—The ovipositor of the female (Fig. 13, *b*) is certainly capable of inflicting a wound, but the Cicada is anything but pugnacious, and when not in the act of ovipositing, this instrument is securely enclosed in its sheath. That this is the stinging instrument is rendered extremely doubtful, for the following reasons: 1st. All the stinging we hear of has been done suddenly, while the

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

[Fig. 13.]

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

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

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

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

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

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

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

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

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

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

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

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

It also appears that in some instances they injure trees by the

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

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

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

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

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

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

While the discovery of the thirteen year broods, dispelled much of the fog in which this chronology had hitherto been wrapped, it at the same time, rendered a complete and lucid exposition of that chronology extremely difficult. The northern boundary line of the thirteen year broods is about latitude ~~37°~~, but in Illinois one of them ascends between two and three degrees above this line, while the seventeen year broods descend below it in several places, the two broods sometimes occupying the same territory. Two broods of the same kind, appearing in different years may also overlap one another, as in the instance given in the account of brood XXII in Virginia, where the "locusts" appear every eighth and ninth year. In order to make the subject as clear as possible, and to facilitate references, I have numbered the different broods of this insect in accordance with the date of their future appearance from and after the present year. 38°

BROOD I.—*Septemdecim*—1852, 1869.

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

BROOD II.—*Tredecim*—1856, 1869.

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

BROOD III.—*Septemdecim*—1853, 1870.

In the year 1870, and at intervals of seventeen years thereafter, they will in all probability appear in what is known as the "Kreitz Creek Valley" in York county, Pa., and possibly in Vinton county, Ohio, and Jo. Daviess county, Ills. Mr. S. S. Rathvon, of Lancaster, Pa., speaking of this brood, says: "Lancaster county is bounded on the southwest by the Susquehanna river, dividing it from the county

of York, along the northeastern margin of which there is a mountain range, sloping down to the river. Along that slope Cicadas were abundant the present season (1868—Brood XXII). But on the southwest side of the range, in what is known as the Kreitz Creek Valley, there were none. They appeared last in this valley in 1853, and previous to that year at intervals of seventeen years from time immemorial." Dr. Smith records their appearance in 1853, both in Vinton county, Ohio, and Jo. Daviess county, Illinois.

BROOD IV.—*Tredecim*—1857, 1870.

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

BROOD V.—*Septemdecim*—1854, 1871.

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

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

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

BROOD VI.—*Tredecim*—1858, 1871.

In the year 1871, being the same year as the preceding, and at intervals of 13 years thereafter, they will in all probability appear in

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

BROOD VII.—*Tredecim*—1859, 1872.

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

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

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

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

BROOD VIII.—*Septemdecim*—1855, 1872.

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

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

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

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

BROOD IX—*Septemdecim*—1857, 1874.

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

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

BROOD X—*Tredecim*—1862, 1875.

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

BROOD XI—*Septemdecim*—1859, 1876.

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

BROOD XII—*Septemdecim*—1860, 1877.

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

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

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

counties, North Carolina, in 1792, 1809, 1826 and 1843. In Dearborn county, Indiana, in 1843 and in 1860, and in Kalamazoo, Michigan, during the same years.

BROOD XIII.—*Septemdecim*—1861, 1878.

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

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

BROOD XIV.—*Septemdecim*—1862, 1879.

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

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

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

BROOD XV.—*Septemdecim*—1863, 1880.

In the year 1880, and at intervals of 17 years thereafter, they will, in all probability, appear from western Pennsylvania to Sciota river,

east, and down the valley of the Ohio river as far as Lewis county, in Virginia.

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

BROOD XVI.—*Tredecim*—1867, 1880.

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

BROOD XVII.—*Septemdecim*—1864, 1881.

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

There is abundant evidence that they appeared in the counties named in Wisconsin in 1864, and fair evidence that they appeared that year in Summit county, Northeast Ohio, while straggling specimens were found in the same year, by Mr. S. S. Rathvon, in Lancaster county, Pa., and by Mr. James Angus, in Westchester county, N. Y. Dr. Fitch also records their appearance in 1847, or 17 years previously, in

the western part of North Carolina, and Dr. Smith, in Wheeling, Virginia, in 1830, '47 and '64. The distance between the localities given is very great, and it is doubtful whether all these records belong to one and the same brood.

BROOD XVIII.—*Tredecim*—1868, 1881.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

BROOD XIX.—*Septemdecim*—1865, 1882.

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

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

BROOD XX.—*Septemdecim*—1866, 1883.

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

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

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

BROOD XXI.—*Septemdecim*—1867, 1884.

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

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

BROOD XXII.—*Septemdecim*—1868, 1885.

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

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

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

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

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

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

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

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

From the above synoptical view it results that there will, during the next 17 years, be broods of the Periodical Cicada somewhere or

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

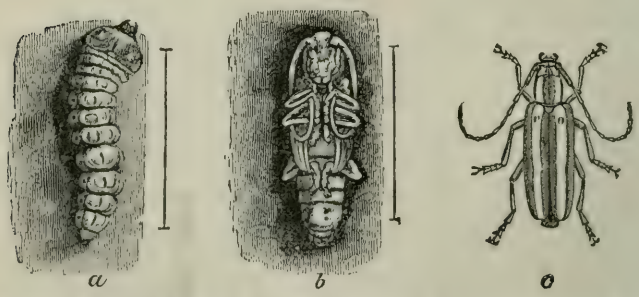
* The broods marked (*) belong to the 13-year or tredecim race of the Periodical Cicada.

APPLE-TREE BORERS.

(Coleoptera, Cerambicidæ.)

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

[Fig. 14.]



a *b* *c*

It is a fact which has not been disputed by any one whom I have queried on the subject, that apple trees on our ridges are shorter lived than those grown on our lower lands. Hitherto no particular reason has been given for this occurrence, but I think it is mainly attributable to the workings of the borer now under consideration. I

have invariably found it more plentiful in trees growing on high land than in those growing on low land, and it has also been my experience that it is worse in ploughed orchards than in those which are seeded down to grass. Fifty years ago, large, thrifty, long-lived trees were exceedingly common, and were obtained with comparatively little effort on the part of our ancestors. They had not the vast army of insect enemies to contend with, which at the present day make successful fruit-growing a scientific pursuit. This Apple-tree borer was entirely unknown until Thomas Say described it in the year 1824; and, according to Dr. Fitch, it was not till the year following that its destructive character became known in the vicinity of Albany, N. Y., for the first time. Yet it is a native American insect, and has for ages inhabited our indigenous crabs, from which trees my friend, Mr. A. Bolter, took numerous specimens, in the vicinity of Chicago, ten years ago. It also attacks the quince, mountain ash, hawthorn, pear and the June-berry. Few persons are aware to what an alarming extent this insect is infesting the orchards in St. Louis, Jefferson and adjacent counties, and, for aught I know, throughout the State. A tree becomes unhealthy and eventually dwindles and dies, often without the owner having the least suspicion of the true cause—the gnawing worm within. Even in the orchard of the most worthy president of our State Horticultural Society, I found one or more large worms at the base of almost every tree that I examined, notwithstanding he had been of the opinion that there was not a borer of this kind on his place.

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

The average length of the larva, when full-grown, is about one inch, and the width of the first segment is not quite ¼ of an inch. Its color is light yellow, with a tawny yellow spot of a more horny consistency on the first segment, which, under a lens, is found to be formed of a mass of light brown spots. The head is chestnut-brown, polished and horny, and the jaws are deep black. The pupa is of rather lighter color than the larva, and has transverse rows of minute teeth on the back, and a few at the extremity of the body; and the perfect beetle has two longitudinal white stripes between three of a light cinnamon-brown color. The Two-striped Saperda makes its appearance in the beetle state during the months of May and June, and is seldom seen by any but the entomologist who makes a point of hunting for it—from the fact that it remains quietly hidden by day and flies and moves only by night. The female deposits her eggs during the month of June, mostly at the foot of the tree, and the young worms hatch and commence boring into the bark within a fortnight

afterwards. These young worms differ in no essential from the full grown specimens, except in their very minute size; and they invariably live, for the first year of their lives, on the sap-wood and inner bark, excavating shallow, flat cavities which are found stuffed full of their sawdust-like castings. The hole by which the newly hatched worm penetrated is so very minute that it frequently fills up, though not till a few grains of castings have fallen from it; but the presence of the worms may be generally detected, especially in young trees, from the bark, under which they lie, becoming darkened, and sufficiently dry and dead to contract and form cracks. Through these cracks, some of the castings of the worm generally protrude, and fall to the ground in a little heap, and this occurs more especially in the spring of the year, when, with the rising sap and frequent rains, such castings become swollen and augment in bulk. Some authors have supposed that the worm makes these holes to push out its own excrement, and that it is forced to do this to make room for itself; but, though it may sometimes gnaw a hole for this purpose, such an instance has never come to my knowledge, and that it is necessary to the life of the worm is simply a delusion, for there are hundreds of boring insects which never have recourse to such a procedure, and this one is frequently found below the ground, where it cannot possibly thus get rid of its castings. It is currently supposed that this borer penetrates into the heart wood of the tree after the first year of its existence, whereas the Flat-headed species is supposed to remain for the most part immediately under the bark; but I find that on these points no rules can be given, for the Flat-headed species also frequently penetrates into the solid heart wood, while the species under consideration is frequently found in a full grown state just under the inner bark, or in the sap-wood. The usual course of its life, however, runs as follows:

As winter approaches, the young borer descends as near the ground as its burrow will allow, and doubtless remain inactive till the following spring. On approach of the second winter it is about one-half grown and still living on the sap-wood; and it is at this time that these borers do the most damage, for where there are 4 or 5 in a single tree, they almost completely girdle it. In the course of the next summer when it has become about three-fourths grown, it generally commences to cut a cylindrical passage upward into the solid wood, and before having finished its larval growth, it invariably extends this passage right to the bark, sometimes cutting entirely through a tree to the opposite side from which it commenced; sometime turning back at different angles. It then stuffs the upper end of the passage with sawdust-like powder, and the lower part with curly fibres of wood, after which it rests from its labors. It thus finishes its gnawing work during the commencement of the 3d winter, but remains motionless in the larval state till the following spring when it casts off its skin once more and becomes a pupa. After resting three

weeks in the pupa state it becomes a beetle, with all it members and parts at first soft and weak. These gradually harden and in a fortnight more it cuts its way through its sawdust-like castings, and issues from the tree through a perfectly smooth and round hole. Thus it is in the tree a few days less than three years, and not merely two years as Dr. Fitch suggests. I have come to this conclusion from having frequently found, during the past summer, worms of three distinct sizes in the same orchard, and Mr. D. B. Wier of Lacon, Ills., had previously published the fact*, while a correspondent to the *Country Gentleman* of Albany, N. Y.† who says he has large experience with this borer, sent to the editors specimens of all three sizes, which he calls "this years, two and three year old worms." The individual from which I drew my figures, and which was taken from a crab apple tree, went into the pupa state on the 14th day of March and became a beetle on the 15th of April; but was doubtless forced into rapid development by being kept throughout the winter in a warm room.

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

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

Prairie Farmer, Chicago, April 20, 1867.

†*Country Gentleman*, Sept. 12, 1867.

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

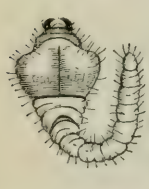
"I will suppose that I have a young orchard of any number of trees, say a thousand, the second season after planting, about the last of July, or during the first half of August, with a common hoe, I take all the weeds and other trash, and about an inch of soil, from the crown of the trees; then, any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

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

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

(Coleoptera, Buprestidæ.)

[Fig. 15.]



[Fig. 16.]

This borer which is represented in the larva state at Figure 15, may at once be recognized by its anterior end being enormously enlarged and flattened. It is paler than the preceding, and makes an entirely different burrow. In consequence of its immensely broad and flattened head, it bores a hole of an oval shape and twice as wide as high. It never acquires much more than half the size of the other species, and is almost always found with its tail curled completely round towards the head. It lives but one year in the tree and

produces the beetle, represented at Figure 16, which is of a greenish black color with brassy lines and spots above, the underside appearing like burnished copper. This beetle flies by day instead of by night, and may often be found on different trees basking in the sunshine. It attacks not only the apple, but the soft maple, oak, peach, and is said to attack a variety of other forest trees; though, since the larvæ of the family (BUPRESTIDÆ) to which it belongs all bear a striking resemblance to each other, it is possible that this particular species has been accused of more than it deserves.

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

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

THE PEACH BORER—*Ægeria exitiosa*, Say.

(Lepidoptera, Ægeridæ.)

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

From the Round-headed Apple-tree borer, to which it bears some resemblance both in its mode of work and general appearance, it is

at once distinguished by having six scaly and ten fleshy legs. It works also more generally under the surface of the ground, and goes through its transformations within a year, though worms of two or three sizes may be found at almost any season. When full grown the worm spins for itself a follicle of silk, mixed with gum and excrement, and in due time issues as a moth. As it is not so well known in this last state, I annex (Fig. 17) figures of both male (2) and female (1) moths. As will be seen from these figures, the two sexes differ very materially from each other, the general color in both being glossy steel-blue. Some specimens which were received from Mr. W. S. Jewett, of Pevely, Jefferson county, commenced issuing as moths on the 20th of July, but I found empty follicles the latter part of May in trees which had been thoroughly wormed the year before, and from which the moths has consequently left at that early date. This borer likewise attacks the plum-tree, though singularly enough it causes no exudation of gum in this as it does in the peach tree.

[Fig. 17.]

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

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

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

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

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

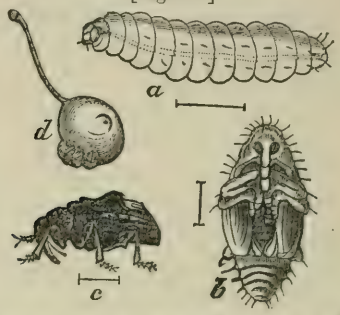
The application of soap does not appear to prevent the moth from depositing her eggs, as in the case of apple tree borers. Hot water is very efficient in killing the young borers, after the earth has been removed, and it should be applied copiously, and *hot* nigh unto the boiling point, for there is no danger of its injuring the tree. Those

who grow tobacco will also find it profitable to throw the stems around the butts of their trees, as there is good evidence of its being obnoxious to the moth.

THE PLUM CURCULIO—*Conotrachelus nenuphar*, Herbst.

(Coleoptera, Curculionidæ).

[Fig. 18.]



I regret to have to state that Missouri is none the less exempt from the ruinous work of this persistent "Little Turk," than are her sister States, though I have not heard of a single instance where they have been so numerous as they were last summer in Southern Illinois; for Parker Earle, of South Pass, captured 6,500 from 100 peach trees, during the first six days of May. In every locality which I have visited, this beetle is considered *the* enemy to stone fruit, and though so much has been written about it, I find it necessary to devote a few pages to its consideration, since some of the points in its natural history are not entirely and satisfactorily settled, even yet. There is in fact conflicting evidence from different authors, as to whether it is single or double brooded each year, and as to whether it hybernates principally in the perfect beetle state, above ground, or in the preparatory states, below ground; the very earliest accounts that we have of the Plum Curculio, in this country, differing on these points. Thus, it was believed by Dr. James Tilton, of Wilmington, Deleware, who wrote at the very beginning of the present century, and by Dr. Joel Burnett, of Southborough, and M. H. Simpson, of Saxonville, Massachusetts, who both wrote interesting articles on the subject, about fifty years afterwards; that it passed the winter in the larval or grub state, under ground, and Harris seems to have held the same opinion. But Dr. E. Sanborn, of Andover, Massachusetts, in some interesting articles published in 1849 and 1850, gave as his conviction that it hybernates in the beetle state above ground. Dr. Fitch, of New York, came to the conclusion that it is two-brooded, the second brood wintering in the larva state in the twigs of pear trees; while Dr. Trimble, of New Jersey, who devoted the greater part of a large

and expensive work to its consideration, decided that it is single-brooded, and that it hybernates in the beetle form above ground. Since the writings of Harris and Fitch, and since the publication of Dr. Trimble's work there have been other papers published on the subject. The first of these was a tolerably exhaustive article, by Mr. Walsh, which appeared in the *Practical Entomologist* (Vol. II, No. 7), in which he takes the grounds that the Curculio is single-brooded; though subsequently he came to the very different conclusion that it was double-brooded, (First Annual Rep., p. 67). In the summer of 1867 I spent between two and three weeks in Southern Illinois, during the height of the Curculio season, and closely watched its manœuverings. From the fact that there was a short period about the middle of July, when scarcely any could be caught from the trees, and that after a warm shower they were quite numerous, having evidently just come out of the ground,* I concluded that it was double-brooded and communicated to the *Prairie Farmer* of July 27th, 1867, the passage to that effect, under the signature of "V," which is quoted by Mr. Walsh (Rep., p. 67), as corroborative of its two-brooded character. Subsequent calculation induced me to change my mind, and I afterwards gave it as my opinion that there was but one main brood during the year, and that where a second generation was produced it was the exception, (Trans. Ills. State Hort. Soc., 1867, p. 113). Finally Dr. E. S. Hull, of Alton, Illinois, who has had vast personal experience with this insect, read a most valuable essay on the subject, before the meeting of the Alton (Ills.), Horticultural Society of March, 1868, in which he evidently concludes they are single-brooded, and that they pass the winter, for the most part, in the preparatory states, underground.

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

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

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

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

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

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

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

4—That by its punctures it causes the dreaded peach-rot to spread, whenever that disease is prevalent, though it cannot possibly be the first cause of the disease. The peach-rot is now pretty generally acknowledged to be a contagious disease of a fungoid nature, and I believe that the spores of this fungus, "a million of which might be put upon the point of a stick whittled down to nothing," attach themselves more readily to fruit which has the skin abraded, and from which the gum issues, than to whole or unpunctured fruit. With this belief I made some effort to procure, for the benefit of my readers, a synopsis of the growth of this fungus; but, alas! I find that nothing

but confusion exists with regard to it. Upon applying to my friend, Dr. T. C. Hilgard, of St. Louis—a recognized authority on such subjects—he furnished me with the article which may be found in the *Journal of Agriculture* of January 16th, 1869. I most respectfully declined publishing it in these pages, knowing that the reader would not be likely to understand what was either too *profound* or too befogged for my own comprehension, and those who require a *synopsis* of this fungus, are referred to that article. Verily, we must conclude that Peach-rot is not yet much understood, if a more clear exposition of it cannot be given!

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

22—That most of those which hatch after the first of July, either fail to hatch, or the young larvæ die soon after hatching, owing perhaps to the more ripe and juicy state of the fruit, being less congenial to them; and that what few do mature, which hatch after this date,

undergo their transformations more slowly than the rest and pass the winter in the ground.

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

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

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

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

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

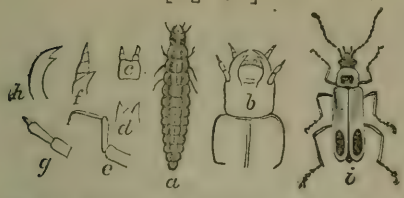
larva, pupa or beetle state, to be found among the sand in the vase on November 29th; which was, perhaps, due to the contents having kept much moister than those of the first vase, though on July 25th I had, as I thought, moistened the sand in the first vase quite sufficiently."

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

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

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

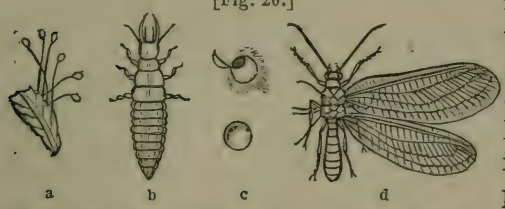
[Fig. 19*.]



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

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

[Fig. 20.]



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

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

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

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

[Fig. 21.]

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

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

[Fig. 22.*]

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

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

[Fig. 23.]

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

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

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

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

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

"To make a curculio catcher we first obtain a light wheel, not to exceed three feet in diameter, the axletree of which should be about ten inches long. We next construct a pair of handles, similar to those of a wheelbarrow, but much more depressed at the point designed to receive the bearings of the axletree, and extending forward of the wheel just far enough to admit a crossbeam to connect the handles at this point; one-and-a-half inches in the rear of the wheel a second cross beam is framed into the handles, and eighteen to twenty-four inches further back, a third. The two last named cross-beams have framed to their under-sides a fourth piece, centrally, between the handles, and pointing in the direction of the wheel. To the handles and to the three last named pieces, the arms or ribs to support the canvass are to be fastened. To the front part of the beam connecting the handles in front of the wheel, the ram is attached, this should be covered with

leather stuffed with furniture moss, a dozen or more thicknesses of old hat, leather or other substance, being careful to use no more than necessary to protect the tree from bruising. Ascertain the elevation the handles should have in driving, and support them in that position. We now put in place the stretchers or arms, six for each side, which are to receive and support the canvas. We put the front arms in position. These extend back to near the centre of the wheel on each side, and in front of the wheel (for large machines) say six feet, and are far enough apart to receive the largest tree between them on which it is intended to operate. The remaining arms are supported on the handles, and fastened to them and to the two cross and parallel pieces in the rear of the wheel. These are so placed as to divide the space at their outer ends equally between them and the first mentioned stretchers and fastened to the ends of the handles. Next we have ready a strip of half-inch board two an a half wide. One end of this is secured to the forward end of one of the front arms, and in like manner to all the others on one side of the machine, and fastened to the handles. Both sides are made alike. The office of these strips is to hold the outside ends of the arms in position; they also hold the front arms from closing. These outside strips also receive the outside edge of the canvas, which is fastened to them as well as the several arm supports.

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

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

To run this machine successfully three things are necessary: 1st, that the land be decently clean, and not overgrown with rank weeds; 2d, that the orchard be sufficiently large to pay the interest on the prime cost of the machine—about $30; 3d, that the trees have a clean trunk of some three or four feet. I find various modifications of this machine, both in our own State and in Southern Illinois; and in some

instances they have been abandoned entirely on account of the injury caused to the trees from the repeated blows given to the trunk. In small orchards it will be found most profitable to drive a spike into the trunk of each tree and to use two sheets stretched on frames, which can both be dragged or carried and placed in position by one man, while a second person gently taps the iron spike with a mallet. To bring the Curculio down, it requires a light, *sudden* tap which jars, rather than a blow which shakes, and if the frames are each made so as to fold in the middle, it will facilitate disposing of those which fall upon it.

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

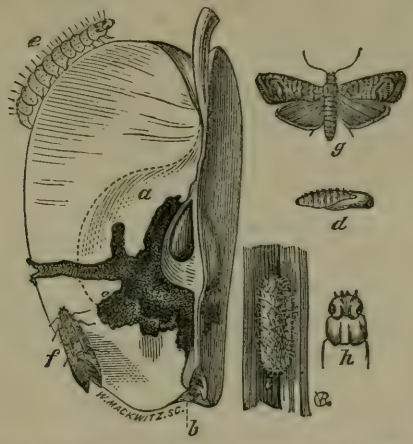
THE CODLING MOTH OR APPLE-WORM—*Carpocapsa pomonella*, Linn.

(Lepidoptera, Tortricidæ.)

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

the burrowings and channel of exit to the left; *b*, the point at which the egg was laid and at which the young worm entered; *e*, the full

[Fig. 24]



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

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

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

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

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

Though the Codling moth prefers the apple to the pear, it nevertheless breeds freely in the [illegible] fruit, for I have myself raised the

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

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

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

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

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

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

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

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

The philosophy of the hay-band system is simply that the worms, in quitting the fruit, whether while it is on the tree or on the ground, in their search for a cozy nook, in which to spin up, find the shelter given by the hay-band just the thing, and in ninety-nine cases out of a hundred, they will accept of the lure, if no other more enticing be in their way. I have thoroughly tested this remedy the past summer, and have found it far more effectual than I had anticipated, wherever

the above rules were recognized. Under two hay-bands which were kept around a single old isolated tree, through the months of June, July and August, I found every week of the last two months an average of fifty cocoons.

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

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

CUT-WORMS.

(Lepidoptera Noctuidæ.)

THE NATURAL HISTORY OF TWELVE DISTINCT SPECIES.

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

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

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

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

[Fig. 25].

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

CLIMBING CUT-WORMS.

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

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

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

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

"They destroy low branched fruit trees of all kinds, except the peach, feeding on the fruit buds first, the wood buds as a second

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

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

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

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

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

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

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

The subject is all important to the orchardist, and to those especially who have young and newly planted trees on a light soil; for there are many who have had their trees injured by the buds being devoured in this manner, who never dreamed of preventing such an

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

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

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

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

About the time these worms were completing their growth, they having most likely developed earlier than usual, in the unnatural heat of the frames, I received from J. M. Shaffer, Secretary of the Iowa State Agricultural Society, some eggs which he found on a cherry twig. These eggs were quite small, of a pink color, with ribs radiating from a common centre, and were deposited in a batch. Exactly similar eggs, found on an apple twig, were presented to the Alton Horticultural Society, at its June meeting, by Mr. L. W. Lyon, of Bethalto, Ills.; while I subsequently found a batch of the very same eggs on a White mulberry LEAF, taken from a tree growing near St. Louis. Between the 24th and 30th of May, the young hatched from these eggs, in the shape of minute, thread-like worms of a dirty yellow color, and covered with the spots, already spoken of as occurring on all cut-worms, which are at this time in this species quite dark and conspicuous. In this early stage of their growth, they did not hide themselves

in the ground, and had, furthermore, the peculiarity of looping up the back when in motion, in the same manner as does the Canker-worm, and as do all other geometers or span worms. After the first moult, which took place six days after hatching, the dark spots became almost obliterated, the characteristic markings of this same Variegated cut-worm which I had received from Mr. Bush, began to appear, and they lost their looping habit. At this time they grew at an incredible rate, becoming thicker in proportion to their length as they grew older, and by the 15th of June, those which hatched on the 24th of May, had shed their skins four times, and gone into the ground, where they formed oval cocoons of earth, and in two days more were changed into chrysalids. By the 20th of June the moths began issuing, thus requiring but 35 days to go through all their transformations.

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

The moth produced from this cut-worm is represented at Plate 1, Figure 1. Its general color is a dark brownish-gray, some specimens being almost black along the front edge of the upper wings, while others have this edge of a dull golden-buff color. The NOCTUIDÆ, to which our cut-worm moths belong, have not yet been worked up by any one in this country, and as they are all of sombre colors, and as the species, in many instances, very closely resemble each other, it is not an easy matter to properly determine them. The species under

consideration, is apparently quite common here, and yet Mr. A. Grote of New York, who made a trip to Europe last year, for the purpose of comparing our American moths with those in the British museum, and in other European collections, took a specimen with him and brought it back unnamed. In the collection of Mr. A. Bolter, of Chicago, it is marked *Agrotis saucia*, Treitschke, while Mr. Cresson informs me that in the collection of the American Entomological Society, at Philadelphia, it is named *æqua*, but without authority. Harris's description of *inermis* (Inj. Insects, p. 444), brief and insufficient as it is, agrees with some of the individuals, and, as it is said to be the counterpart of *æqua* which is an European species, I have concluded, rather than to create more synonyms, to redescribe it below, under this name. Individuals among the numerous specimens which I bred from the same batch of eggs, differ greatly from one another, and I find this to be the case with all owlet moths. Indeed, with the present species, a description taken from any single specimen would scarcely suffice for any of the others, and it is not at all unlikely that this species has received different names from different authors.

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

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

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

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

Described from 25 bred specimens.

THE DARK-SIDED CUT-WORM.

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

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

[Fig. 26.]

a *b*

The general color is dingy ash-gray, but it is characterized more especially by the sides being darker than the rest of the body. When young, it is much darker, and the white, which is below the dark lateral band, is then cream-colored, and very distinct. It produces

a moth which may be known as the Cochran Rustic, and was first described in the *Prairie Farmer* of June 22, 1867. Speaking of the depredations of this worm, Mr Cochran says:

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

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

Agrotis Cochranii, Riley—*Imago.*—Fore wings of a light warm cinereous, shaded with vandyke brown and umber, the terminal space, except at apex, being darker and smoky. Basal, middle and limbal areas of almost equal width, the middle exceeding somewhat the others. A geminate dark basal half-line, usually quite distinct. Transverse anterior geminate, dark, somewhat irregularly undulate, and slightly obliquing outwards from costa to interior margin. Transverse posterior geminate, the inner line being dark, distinct and regularly undulate between the

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

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

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

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

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

Described from numerous bred specimens.

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

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

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

interesting letter accompanied those which were received from the last named gentleman:

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

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

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

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

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

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

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

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

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

Perfect Insect.—Average length 0.70; alar expanse 1.50. General color of fore wings very light pearly bluish-gray, with a perceptible deepening posteriorly. Quite variable, sometimes of a more decided blue, at others inclining to buff as in *Leucania unipunctata*, Haw. Markings, when distinct, as in Plate 1, Figures 5 and 6. With the exception of the reniform spot and subterminal line, however, they are usually distinct only on costa, being either indistinct or entirely obsolete on the rest of the wing. The subterminal line is light, with a more or less dark diffuse shade each side, which, in some instances, forms into sagittate spots. A black stain at the lower part of reniform spot forms a most distinctive character. Hind wings very pale and lacking the bluish cast of

fore wings; lunule distinct, and a dark shade, enclosing a lighter mark, as in *Heliothis*, along posterior margin. Eyes dark; head and thorax same as fore wings; abdomen same as hind wings. The whole under surface the same as hind wings above, the lunules and arcuated bands faintly traced, the fore wings having a darker shade in the middle.

Described from 30 bred specimens.

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

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

[Fig. 27.]

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

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

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

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

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

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

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

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

[Fig. 28.]

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

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

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

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

THE WESTERN STRIPED CUT-WORM.

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

Dr. Fitch, in his Second Report, on noxious insects of the State of New York, describes a cut-worm by the name of the "Striped cut-worm," (p. 313), In his 9th Report, (pp. 245–8), this worm was very fully re-described, together with the moth which it produces. This worm seems to have done great injury to the corn crop in the East, and the moth is a variety of the Corn Rustic (*Agrotis nigricans*, Linn,) which Dr. Fitch named *maizi*. It will be referred to on page 87. From worms, found in an orchard, and answering entirely to that description. I have bred numerous specimens of one of our most common owlet moths, namely, the Gothic Dart (*Agrotis subgothica*, Haworth.) As the worms are so similar in appearance, I have called the one under consideration, the "Western Striped Cut-worm," as no other name would better characterize it, though it is evidently as common in the East as it is in the West. Its general appearance is not

greatly unlike that of the "Greasy Cut-worm" already described, but its average size is but 1¼ inches. The ground color is dirty white or ash-gray and it has three broad dark lines, and two light narrow ones along the sides, and a light one, edged on each side with a dark one, along the middle of the back. This species remains longer in the ground than any of the others, and the moth does not appear till August and September. The moth is represented at Figure 29, *a*, with the wings expanded, and at *b* with the wings closed. Its markings are so conspicuous and characteristic that it suffices to say that the light parts are of grayish flesh-color, and the dark parts of a deep brown. It was first described in the year 1810 by Mr. Haworth, and is supposed to be an English insect; but as it is quite rare in England, and very common in this country, Dr. Fitch concludes, and I think rightly, that it is an American insect, the eggs or larvæ of which have accidentally been carried to England.

[Fig. 29.]

a *b*

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

THE DINGY CUT-WORM—Pl. 1, Fig. 11.

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

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

On the 27th of last June, I received several of these cut-worms from Mr. Horace Starkey, of Rockford, Illinois, with a statement that they were proving quite destructive in the gardens of that vicinity, but without specifying what particular plants they attacked. They entered the ground soon after being received, and by the 7th of July, had all changed to chrysalids. The chrysalis differs from most of the others, in being of a very light honey-yellow, shaded with brown, with the eyes dark brown, and two sub-quadrate spots of the same color on the wing-sheaths, just above the antennæ. It measures 0.65 of an inch in length. The moths began to issue on the 2d of September, and proved to be a species very closely allied to the preceding. Indeed the markings on the wings are almost exactly the same; but it

is a smaller species, seldom expanding more than 1.25 inches and differs materially upon a strict comparison, and especially in the ground color being lighter and more silvery. It is faithfully represented at Plate 1, Figure 11. This species, as I am kindly informed by Mr. Cresson, is marked *Agrotis jaculifera* in the collection of the American Entomological Society, but without authorship; and as the name seems appropriate I have retained it.

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

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

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

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

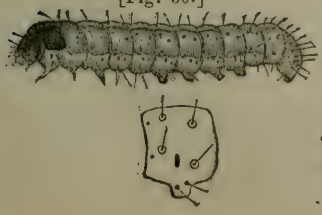
Described from three bred specimens.

THE GLASSY CUT-WORM.

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

In the year 1819, in a short article upon the cut-worm, published in the first volume of Silliman's Journal, p. 157, Mr. Brace, of Litchfield, Connecticut, gave an account of this moth, which he bred from pupæ that were found a few inches under the ground, in a cabbage patch. He did not describe the worm which produced the pupæ, as he evidently supposed there was but one kind of cut-worm in existence. Consequently, up to the present day the larva of this common Devastating Dart moth has been unknown. It was my good fortune to breed this moth from the larva state. The cut-worm from which it was produced, was found on the 12th of May under a wild endive plant, upon the leaves of which it had evidently been feeding. It was but half grown, and, being placed in a jar half filled with earth, that contained growing grass, it burrowed into the earth and after once casting its skin, fed entirely

[Fig. 30.]



on the roots of the grass, though other food was thrown into the jar. On the 7th of June it measured 1.80 inches when crawling, and on the 19th of the same month had changed to a chrysalis from which the moth emerged on the 7th of July. The worm is represented at Figure 30, and may at once be distinguished from all others of its tribe, that are known, by its translucent glassy green body, in contrast with a very distinct hard, polished, dark-brown shield on the first segment, and a bright venetian-red head. The usual spots on the body are quite distinct, and placed in the positions given at the lower outline of Figure 30, which represents the side of one of the middle segments.

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

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

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

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

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

Those which I bred, fed voraciously on cabbage leaves during the night and lay concealed and motionless during the day. Before

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

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

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

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

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

THE SMALL WHITE BRISTLY CUT-WORM.

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

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

[Fig. 31.]

a *b*

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

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

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

Imago.—Expanse 1.10 inches. Fore wings brownish-gray, with a more or less determined carneous or lilaceous hue. Orbicular spot sub-obsolete; sometimes entirely obsolete. Reniform spot of normal shape, moss-green, with a snow-white annulation, indistinct above; broad and distinct below. Ordinary lines lighter. Basal half-line distinct only on costa, and below posterior median nerve. Transverse anterior single, obliquing but slightly, and bordered posteriorly with a very thin broken darker line; it is moss-green in the middle, and there is a green shade running from it to the basal half-line, dividing the sub-basal space. Opposite this green in the median space, is a dark subquadrate almost black spot, and between the stigma the wings are also quite dark. Transverse posterior single, posteriorly oblique a little more than ½ of breadth of wing, then parallel with posterior margin, forming at the second nerve a roundish spot which extends to the anal angle, and is dark below and moss-green above. Subterminal line usually very indistinct—merely indicated by a few dots. A median arcuated band is perceptible, being broader and darker between the stigma and interrupted in the middle by lower portion of reniform spot. A minute light spot on each vein at posterior margin. Costa with a light spot at terminus of sub-basal line, of transverse anterior, and above reniform spots—dark each side of these and at terminus of median band; concolorous with wing at subterminal space, having four very minute light spots, one at ends of subterminal and transverse posterior lines, and two between them. Fringes concolorous with the wings, having a very fine darker edge.

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

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

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

OTHER CUT-WORMS.

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

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

THE WHEAT CUT-WORM.

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

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

they seem to feed on the volunteer oats in the same field, but entirely destroy the young wheat."

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

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

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

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

REMEDIES AGAINST CUT WORMS.

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

[Fig. 32.]

1

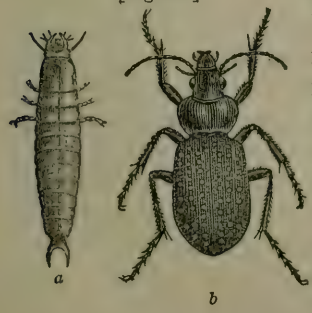
There is also a large yellowish-brown four-winged Ichneumon fly (the *Paniscus geminatus* of Say), which I have bred from cut-worms. The parent fly deposits a single egg within the body of a worm, but the maggot hatching from this egg does not cause the worm to die, till after the latter has entered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

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

[Fig. 33.]

a *b*

[Fig. 34.]



a *b*

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

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

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

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

as in sand, and they are all the more exposed to their numerous midnight enemies which are ever watching for them.

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

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

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

INSECTS INFESTING THE POTATO.

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

We often see paragraphs in the papers, stating that "THE Potato Bug" has been very abundant and destructive in such a month and a

such and such a place. Accompanying these statements, remarks are frequently added, that "THE Potato Bug" is preyed upon by such and such insects, so that we may soon expect to see it swept from off the face of the earth; and that, even if this desirable event should not take place, "THE Potato Bug" may be checked and controlled by such and such remedies.

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

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

(Lepidoptera, Noctuidæ.)

[Fig. 35.]

2

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

[Fig. 36.]

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

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

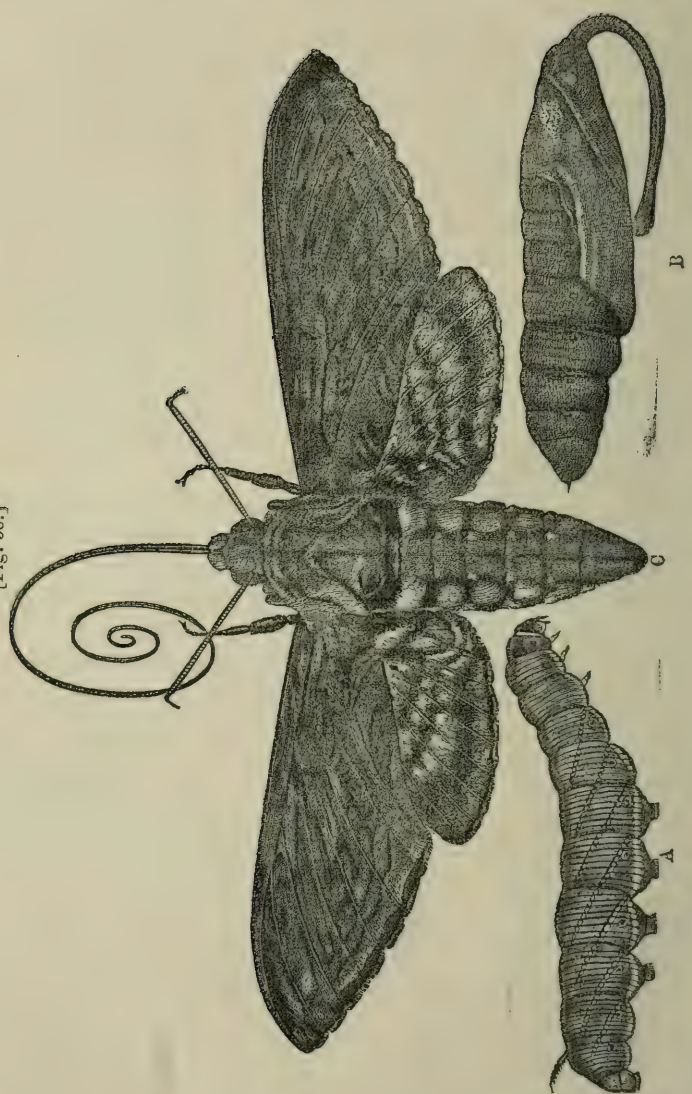
REMEDY—*Prevention.*—The careful florist, by an occasional close inspection of his plants about the beginning of July, may detect the point at which the borer entered, which is generally quite a distance from the ground, and can then cut him out without injury to the plant. As this is not feasible in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

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

(Coleoptera, Curculionidæ.)

[Fig. 37.]

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



[Fig. 38.]

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

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

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

(Lepidoptera, Sphingidæ.)

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

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

The moth itself (Fig. 38, C) was formerly confounded with the To-

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

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

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

(Coleoptera Meloïdæ.)

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

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

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

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

[Fig. 39.]

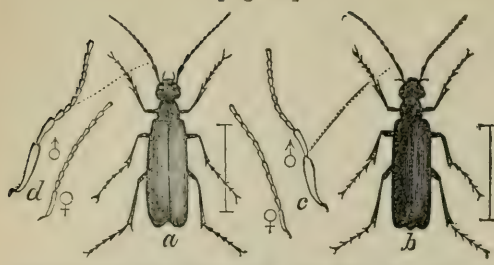
The late Samuel P. Boardman, of Lincoln, Illinois, discovered that this Striped Blister-beetle, like the Colorado beetle, eats all other potato tops in preference to Peach-blows. (See *N. Y. Sem. Tribune*, July 13, 1868.) This is certainly a new fact, so far as regards the former species, though it has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

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

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

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

[Fig. 40.]



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

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

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

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

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

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

[Fig. 41.]

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

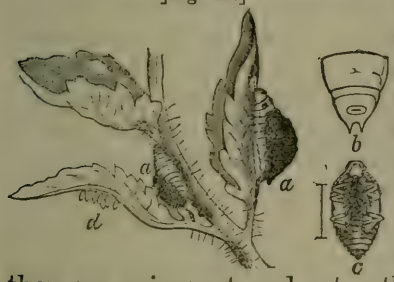
* This is the name formerly given by almost all entomologists to this species; and a most appropriate one it is, in view of the remarkable ash-gray margin of its black wing-cases (*elytra*). But of late years it has been discovered, that, as long ago as the middle of the last century, and several

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

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

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

]Fig. 42.]



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

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

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

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

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

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

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

[Fig. 43.]

[Fig. 44.]

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

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

(Coleoptera, Chrysomelidæ.)

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

[Fig. 45.]

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

(Coleoptera, Chrysomelidæ.)

ITS PAST HISTORY AND FUTURE PROGRESS.

[Fig. 46.]

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

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

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

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

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

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

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

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

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

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

stance the larvæ of both the true and the bogus species occurred in company. Thus it appears to inhabit at least five southerly regions, namely South Illinois, Missouri, Kentucky, Georgia and Alabama.

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

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

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

At Figure 46, the true Colorado Potato-beetle is represented in all

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

[Fig. 47].

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

I subjoin a more full description of *Doryphora juncta*. That of the larva of *Doryphora* 10-*lineata* will be found in Dr. Fitch's *N. Y. Reports*, Vol. III, pp. 231–2. According to Dr. Fitch, the ground color of this last larva is "pale-yellow" in the mature state; according to Dr. Shimer, in his excellent article on the preparatory stages of this insect, it is "orange." In the immature larvæ it is almost always of a dull Venetian-red, though in the mature larvæ the color becomes

lighter. Indeed in some instances it becomes almost as pale as that of *D. juncta.* I saw a number of such pale individuals among the late broods of last summer, though I had never seen them so pale before, notwithstanding I have witnessed great numbers of them every year, since 1863.

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

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

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

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

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

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

Unlike many other noxious insects, this larva is not a general feeder, but is confined to plants belonging to the potato family (*Solanaceæ*), and especially to the genus to which the potato belongs (*Solanum*). Occasionally it feeds on the tomato, on the ground-cherry (*Physalis*), and on the imported Jamestown-weed, or gympson-weed (*Datura*). It prefers the horse-nettle (*Solanum carolinense*) to some varieties of the potato, and were it not that the nettle is considered a nuisance, on account of the difficulty of eradicating it when

once introduced, it would be a good plan to encircle a potato field with a row of nettles, so as to concentrate the insects, and thus more readily destroy them. It is also even more destructive to the egg-plant than to the potato. Now, the egg-plant, the horse-nettle, and the potato, all three of them belong to the same genus (*Solanum*), as the wild plant upon which the larva originally fed in the Rocky Mountain region; but the egg-plant and the horse-nettle are botanically more closely related to the last than is the potato; being, like the Rocky Mountain potato, covered with thorny prickles, while the cultivated potato is perfectly smooth. On the other hand, the cultivated potato is much more nearly related to the Rocky Mountain species than is the tomato; which last has, by modern botanists, been removed from the genus to which the other two appertain, and placed in a genus by itself. It would seem, therefore, that the closer a plant comes to the natural food-plant of the insect, the better the insect likes it.

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

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

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

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

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

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

To illustrate the decrease in its numbers which took place in the State of Iowa from 1867–8, I will state that Mr. Henry Tilden, of Da-

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

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

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

this as the fate of the potato bug for the present, and I will write you again in a month, or as soon as I get additional news from him.

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

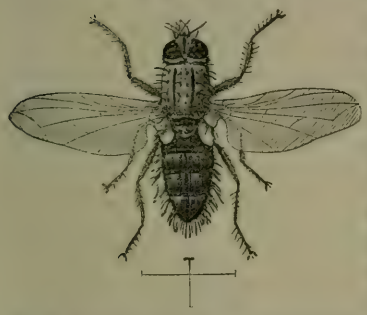
"Those plowing old potato ground where these creatures operated extensively last year, find the ground full of the dormant wretches. We, at Muscatine, Iowa, will lend them our Benson's Horse Power Potato Bug Killer, but we can't spare our lady bugs."

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

THE COLORADO POTATO-BEETLE PARASITE—*Lydella doryphoræ*, N. Sp.
(Diptera Tachinidæ.)

This fly (Fig. 48) has probably been more efficient in checking it than any one other insect, at least in our own State. Until last year no parasitic insect whatever was known to prey internally upon it, but this fly destroyed fully ten per cent. of the second brood and fifty per cent. of the third brood of potato-beetles that were in my garden. It bears a very close resemblance, both in color and size, to the common house fly, but is readily distinguished from the latter by its extremely brilliant silver-white face. It may be seen throughout the summer months flying swiftly from place to place, and deftly alighting on fence or wall, where, basking in the sun, its silvery face shows to good advantage. As with the rest of the family to which it belongs, the habit of the female is to attach a single egg externally to the body of the Potato-beetle larva. This egg subsequently hatches into a little footless maggot, which burrows into the body of its living victim, and eventually destroys it, but not until it has gone underground in the usual manner. The victimized larva instead of becoming a pupa, and eventually a beetle, as it would have done had it not been attacked, begins to shrink as soon as it enters the ground, and gradually dies; while inside its shriveled skin the parasitic maggot contracts into a hard brown pupa, and in due time issues forth in the shape of the fly which I have figured. I am indebted to Mr. Wm. LeBaron, of Geneva, Illinois, for the generic determination of this fly. It belongs to the genus (or sub-genus *Lydella* Macquart, and is very closely allied to *Tachina* proper, with which it could properly be united, did not the great number of species require a division as a matter of necessity. I subjoin a more detailed description of the fly:

[Fig. 48.]



LYDELLA DORYPHORÆ, New Species.—Length 0.25. Alar expanse 0.48. Antennæ black. Palpi fulvous. Face silvery white. Front silvery, tinted with pale golden-brown, with a broad middle stripe black. Thorax cinereous with imperfect black stripes. Abdomen black and silvery-

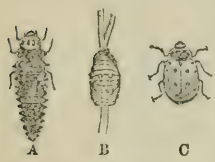
ash, changing into each other when viewed from different angles. When viewed from above: first segment deep black with a posterior border of silver-ash very narrow in the middle, much widened laterally, but abreviated at the sides of the abdomen. The other segments with the basal half silvery-ash, terminal half black. Legs black. Fourth longitudinal vein of the wings straight after the angle. Posterior transverse vein arcuate.

Described from numerous bred specimens.

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

[Fig. 49.] [Fig. 50.] [Fig. 51.]

[Fig. 52.]



[Fig. 53.]

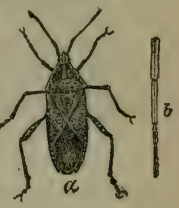
The eggs of ladybirds greatly resemble those of the Colorado Potato-beetle, and are scarcely distinguishable except by

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

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

[Fig. 54.]

[Fig. 55.]



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

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

[Fig. 56.]

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

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

[Fig. 57.]

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

[Fig. 58].

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

[Fig. 59.]

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

[Fig. 60.]

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

[Fig. 61.]

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

[Fig 62.]

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

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

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

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

Neither ducks, geese, turkeys nor barn-door fowls will touch the larva of the Colorado-beetle when it is offered to them; and there are

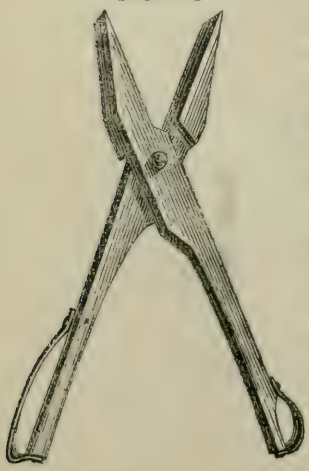
numerous authentic cases on record, where persons who have scalded to death quantities of these larvæ, and inhaled the fumes from their bodies have been taken seriously ill, and even been confined to their beds for many days in consequence.

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

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

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

[Fig. 63.]



In parts of Iowa, the ravages of this insect were so serious in 1866, that a horse-machine was invented for their destruction

by Mr. Benson, of Muscatine in that State. As this machine, or some improvement on it, may prove advantageous where potato-growing is carried on extensively, I subjoin an account of it.

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

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

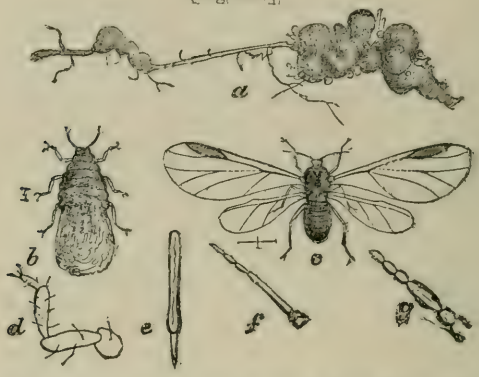
Much may be done by a proper choice of varieties, the Peach-blow having the same immunity from the attacks of this Colorado Potato-beetle, as from those of the Blister-beetles. I have known several instances where Neshannocks, raised side by side with Peach-blows, have been entirely destroyed, while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

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

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

(Homoptera, Aphidæ.)

[Fig. 64.]



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

In a paper read by Dr. Hull, before the Illinois State Horticultural Society, at its 13th annual meeting, a communication was quoted from Judge A. M. Brown, of Villa Ridge, in which the latter gave it as his firm belief that rotten apple tree roots were never caused by root-lice, but by this particular fungus. With due deference to Judge Brown's opinion, I have to differ with him most emphatically, for I am convinced that this Root louse *does cause the roots to rot.* I examined on the 15th of May last, hundreds of young apple trees on the nursery of Mr. J. M. Jordan, of St. Louis. Mr. J. had been greatly troubled with root-lice on his young apple stock during the year 18 7, and had dug up and thrown thousands of young trees into a heap, by which means he expected to kill the lice and prevent their spreading onto new stock. He covered this heap with earth a foot deep, and had the gratification of finding that nearly all the lice had died by

the next spring. Many rows of trees—mostly one year grafted—had been left in the ground, however, and on examining these, I found that wherever the previous year the lice had been numerous enough to cover and deform the whole root, there that root had invariably rotted. In many instances all trace of the knots and deformities which the lice cause, had disappeared, while, in some few instances they were yet traceable. In every case where rot had ensued the lice had entirely left, so that not a trace of them could be found. From these, and subsequent observations made during the summer, I conclude that the rot does not ensue till the roots have been completely deformed by the lice, and while on a young tree a colony of lice will multiply sufficiently to entirely cover it in a single season, and thus cause it to rot the next year; on larger trees they may be at work for years before this result is accomplished. This rot from root-lice may, I think, be distinguished from both the other kinds by its being more porous and soft, approximating the brown mould of a rotting log. The unusual swellings and knots caused by the lice, though hard originally, seem to loose their substance, and very frequently the finer roots, and almost always the fibrous roots waste entirely away.

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

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

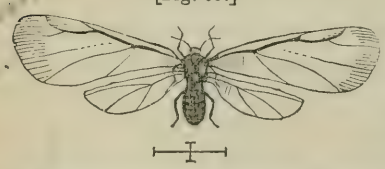
Although this insect usually confines itself to the roots of the tree, yet a few may occasionally be found on the suckers that spring up

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

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

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

[Fig. 65.]



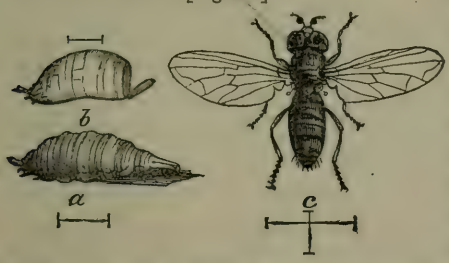
On comparing Figure 64 *c* with Figure 65, which represents a Plant-louse that inhabits a large gall on the Cottonwood, it will be observed at once that the veining of the front wing is very different. In Figure 64, *c*, the third branch-vein is very distinctly forked; in Figure 65 it is simple. Nor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

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

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

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

[Fig. 66.]



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

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

with longer white hairs, rufo-piceous above on the middle ½ of joint 1; venter with joint 1 piceous. *Legs* with all the 6 knees, and in the 4 front legs the entire tibia except a spot on the exterior middle, and also all the 6 tarsi except their extreme tips, and except in the hind legs the bassal ⅔ of the first tarsal joint, all dull pale rufous. *Wings* hyaline; veins black. Length ♀ 0.25 inch; alar expanse 0.48 inch.

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

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

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

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

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

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

surface of the ground, so that it is possible that this ladybird only attacks them when it can get at them above ground; though, judging from analogy, I strongly suspect it also seeks them out in their underground quarters.

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

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

(Homoptera Aphidæ.)

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

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

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

INSECTS INJURIOUS TO THE GRAPE-VINE.

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

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

(Coleoptera, Prionidæ.)

[Fig. 67.]

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

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

Respectfully, &c.,

ALFRED BARTER.

VIRGIL CITY, Mo., August 21, 1868.

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

Very respectfully,

JOHN H. HOGAN.

September 3, 1868.

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

Very respectfully,

SIMMONS & TILLSON.

SULPHUR SPRINGS, September 10, 1868.

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

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

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

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

[Fig. 68.]

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

[Fig. 69.]

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

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

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

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

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

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

THE GRAPE CURCULIO—*Cœliodes inæqualis*, Say.

(Celeoptera, Curculionidæ.)

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

[Fig. 70.]

[Fig. 71.]

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

[Fig. 72.]

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

THE GRAPE-SEED CURCULIO.

(Coleoptera, Curculionidæ.)

A minute maggot was discovered last August infesting the seeds of the Grape in certain parts of Canada, by Mr. Wm. Saunders, of London. It causes the berries to shrivel up and utterly ruins them. Specimens which had been received from Canada, were sent to me by my friend A. S. Fuller, of New Jersey, and the annexed Figure 73 shows a highly magnified view of the maggot, its natural size being represented underneath. The head is of the same translucent, milk-white color as the body, but the jaws, which are finely pointed, are light brown, and there is a patch of brown at their base. It has exactly thirteen segments exclusive of the head, and every segment has a few white, fleshy hairs, these hairs being thickest near the head and longest on the under part of the first three segments, thus imitating feet, as is often the case with footless larvæ of this character.

[Fig. 73.]

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

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

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

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

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

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

"In the case of the shriveled berries, where one seed only is af-

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

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

(Coleoptera, Curculionidæ.)

The canes of the Concord vine are frequently found to have galls on the last year's growth, in the shape of an elongated knot or swelling which is generally situated immediately above or below a joint. This gall was formed the previous fall while the tender cane was growing, and has almost invariably a longitudinal slit or depression on one side, dividing that side into two cheeks, which generally have a rosy tint. The gall is caused by a little footless, white cylindrical larva which measures 0.28 of an inch, and has a yellowish head, and somewhat darker tawny jaws. It is minutely wrinkled transversely, and sparsely covered with minute white bristles; the three segments next to the head being prominently swollen underneath and the bristles attached to them look very much like legs, and doubtless to some extent perform the functions of legs. This larva indeed bears a very close general resemblance to that of the Potato Stalk-weevil, illustrated at page 93, Figure 37 *a*, and when taken out of its gall immediately curls up as in that figure. During the latter part of June this larva transforms within the cane to a pupa, also greatly resembling that figured at *b*, on page 93, with the exception that it is much smaller, and that the wings and legs reach down three-fourths the length of the body instead of but one-half as in that species. Two weeks after it has thus transformed it becomes a beetle belonging to the great Curculio family. Before this insect had ever been bred to the perfect state I predicted that it would produce a Curculio, as may be seen by referring to page 117 of the Transactions of the Illinois State Horticultural Society for 1867. This beetle is represented enlarged at Figure 74, its natural length being 0.10. It is of a uniform light yellowish-brown without any markings whatever. It is closely allied to the Potato Stalk-weevil, but belongs to the genus *Madarus* which differs from *Baridius* in the peculiar undulating appearance of the wing-cases, and more especially in their being highly polished, the word *Madarus* meaning glossy or polished. This little

[Fig. 74.]

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

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

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

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

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

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

(Coleoptera, Chrysomelidæ.)

[Fig. 75.]

One of the worst foes to the grape-vine that we have in Missouri is the Grape-vine Fidia which is represented in the annexed Figure 75. It is of a chestnut-brown color, and is densly covered with short and dense whitish hairs which give it a hoary appearance. I have found it very thick in most of the vineyards which I visited, and it is almost universally miscalled the "Rose-bug," which is, however, a very different insect. The Grape-vine Fidia was first described by Mr. Walsh in the May, 1867, number of the *Practical Entomologist*. It is found in the woods on the wild grape-vine and also on the leaves of the *Cercis Canadensis;* but of the tame vines it seems to prefer the Norton's Virginia and Concord. It makes its appearance during the month of June, and by the end of July has generally disappeared, from which fact we may infer that there is but one brood each year. The

manner in which it injures the vine is by cutting straight elongated holes of about ⅛ inch in diameter in the leaves, and when numerous it so riddles the leaves as to reduce them to mere shreds. The preparatory stages of this beetle are not yet known.

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

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

(Lepidoptera, Tortricidæ.)

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

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

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

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

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

[Fig. 76.]

a *b*

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

and I therefore subjoin a more detailed description of it in its different stages:

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

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

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

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

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

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

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

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

(Lepidoptera, Zygænidæ.)

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

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

There are two other caterpillars very much resembling this, which also feed on the vine; but they produce very different looking moths, the one known as *Eudryas grata*, Fabr., and the other as *Eudryas unio*, Hübner. Dr. Fitch in his 3d Report §123 states that the larva of *E. grata* differs only from that of *A. octomaculata* in lacking a white spot on each side of every segment, and in being slightly humped at its hind end. The specimen from which my figure was

made may prove to be *E. grata*, for it had no such white spots and *was* humped; but it differs essentially from the most excellent description of this last larva which A. S. Packard, Jr., has given in his "notes on the family Zygænidæ, pp. 27–29, and sufficiently resembles those from which I actually bred the 8-spotted Forester.

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

(Lepidoptera, Alucitidæ.)

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

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

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

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

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

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

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

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

(Orthoptera, Achetidæ.)

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

[Fig. 77.]

[Fig. 78.]

But by far the worst habit of the Tree-cricket is that of severing grapes from the bunches just as they are beginning to ripen, and it sometimes cuts off an entire bunch, or so thoroughly excoriates the stem that it fails to ripen its berries. I have seen the ground under some vines covered with grapes which had been thus severed, but should never have accused the Tree-cricket, had I not found it in the very act, and received specimens with accounts of this same habit, both from Mr. B. L. Kingsbury, of Alton, Illinois, and from J. H. Tice, of St. Louis. This cricket is aided in this destructive work by another species which has the same habit, namely the Jumping Tree-cricket (*Orocharis saltator*, Uhler.) This last insect is more robustly built than the former, and is at once distinguished by its uniform light-

brown color, and I have good reason to believe that it deposits its eggs in the grape-vine in a row of punctures, each of which is about one-third of an inch apart, and each of which leads to from ten to twelve narrow eggs, about a tenth of an inch long, and deposited on either side of the puncture, length-wise in the pith.

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

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

(Lepidoptera Geometridæ.)

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

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

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

Described from one ♀ specimen.

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

(Lepidoptera, Phycidæ).

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

[Fig. 79.]

a b

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

As soon as gooseberries and currants are well formed, this worm begins to make its presence known by causing the berries which it infests to prematurely turn red or dull whitish. After eating the inside of one berry, leaving a hole for the passage of the excrement, it enters another berry, making a passage way of silk, until it draws together a bunch of currants, or two or three gooseberries as the case may be. The berries thus attacked sometimes drop, but more gener-

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

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

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

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

Described from 10 specimens.

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

Perfect insect.—Length, including palpi, 0.40; alar expanse, 0.80. Color pale-gray. Front wings with a dark transverse diffuse band on the inner third, enclosing a zig-zag white line not reaching the costa. A dark discal spot, constricted in the middle, the upper and lower edges con-

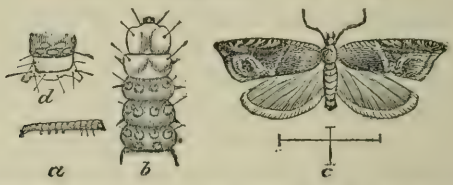
tinued basally in the shape of two faint lines to the transverse band already mentioned, where they almost converge, the space enclosed by them being whiter than the rest of the wing, with a darker line along the middle. Beyond this discal spot, at about the outer fourth of the wing is another dark but less distinct diffuse transverse band, nearly parallel with posterior margin and with a white zig-zag line produced into an acute angle, basally, on the internal margin, the space between this band and the discal spot being also quite light. A row of marginal black dots, with the apex light. Fringes concolorous. Hind wings somewhat more dusky with darker margins and veins and lighter fringes. Head, thorax, abdomen, antennæ, palpi and legs all pale gray, being more silvery on the under than on the upper side.

One specimen from Wm. Saunders.

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

Lepidoptera, Tortricidæ

[Fig. 80.]



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

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

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

of this little pest in conjunction with the White-grub, he has had to abandon strawberry culture.

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

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

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

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

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

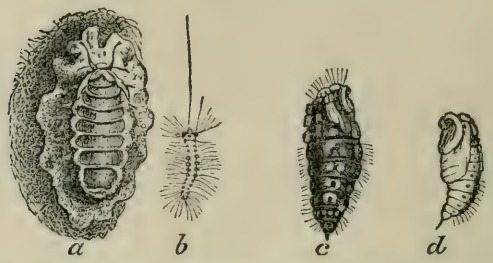
ANCHYLOPERA FRAGARIÆ, New species—Head and thorax reddish-brown. Palpi and legs paler. Antennæ dusky. Tarsal joints tipped with dusky. Front wings reddish-brown, streaked and spotted with black and white as in the figure. Hind wings and abdomen dusky. Alar expanse 0.40–0.45 inch. Described from nine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

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

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

(Lepidoptera, Arctiidæ.)

[Fig. 81.]



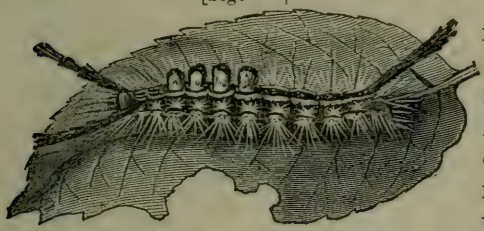
During the winter little bunches of dead leaves are sometimes found to be quite numerous on our apple trees. They are generally fastened to the twigs, and upon examination are found to contain gray cocoons. The greater portion of these cocoons have an egg-mass glued to them, which is composed of numerous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

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

smaller, whiter, and the fourth frequently obsolete; a transverse row of four yellow warts becomes conspicuous on segments 2 and 3; a subdorsal yellowish line appears, starting from segment 8 and running and diminishing posteriorly; the upper sides become of a dark bluish-gray, while the yellow line along the lower sides becomes more distinct. Six days after the second moult the third moult takes place with but little change in the appearance of the caterpillar, further than that the different colors become still more bright and distinct and the different tufts still larger.

Up to this time all the individuals of a brood have been alike, and of a size, so that it was impossible to distinguish the sexes. Six days from the third moult, however, the males measure not quite ¾ of an inch, and begin to spin their cocoons; while the females undergo a fourth moult about this time, and in about six days more they also spin up, having acquired twice the size of the male when he spun up.

[Fig. 82.]



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

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

It may puzzle some persons to divine how such a hairy and tufted caterpillar can possibly cast off its skin and yet retain these pretty appendages. After having remained stationary without food for about two days, the old skin becomes dry and somewhat loose. If at this time this old skin be carefully removed, it will be found that an entirely new set of these appendages has been forming underneath it; the two long plumes curled over the head, down by the feet and up again to near the scaly collar; the four white brushes folded close together inwardly crossing each other; the anal plume folded below the anus, and all the other hairs laid in thread-like bunches close to the body in a posterior direction. In due time the old skin splits on the back, near the head, and the caterpillar gradually works it off posteriorly. The moment they are exposed the appendages which had been compressed, as described, to the body, commence to straighten

out, and in a few minutes the new dress is displayed in all its beauty and freshness. The long plumes at the head do not straighten out of their own accord, however, for the caterpillar by a curious curling of the body, while resting on a few of its abdominal prolegs, cunningly brushes them with its tail end, first on one side, then on the other. It furthermore presses them, for the same end, one after the other against any surface on which it is at the time walking, and having once thoroughly straightened out its toilet it rests a few minutes from its efforts and then commences to feed with surprising vigor, apparently determined to make up for its two day's fast.

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

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

Fig. 83.

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

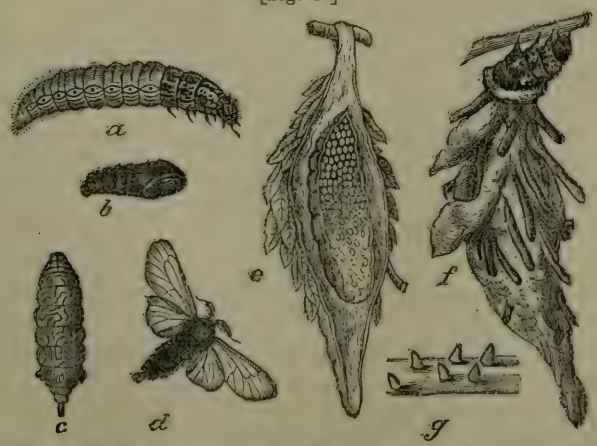
This insect seems to occur more or less over the whole country, and I have repeatedly received its egg-masses during the past two winters. It is, however, as we might expect from its nature, often confined like the Canker-worm, to particular orchards in a particular neighborhood. It feeds upon different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

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

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

(Lepidoptera, Psychidæ.

[Fig. 84]



Our shade and ornamental trees are often defoliated by various insects, and I will give brief accounts of three which have attracted

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

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

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

Thoughout the winter the weather-beaten bags may be seen hanging from almost every kind of tree. Upon plucking them many will be found empty, but the greater proportion of them will, on being cut open, present the appearance given at Figure 84, *e*; they are in fact full of soft yellow eggs. Those which do not contain eggs are the male bags and his empty chrysalis skin is generally found protruding from the lower end About the middle of next May these eggs will hatch into active little worms, which, from the first moment of their lives, commence to form for themselves little bags. They crawl on to a tender leaf, and, attached to their anterior feet with their tails hoisted in the air, they each spin around themselves a ring of silk, to which they soon fasten bits of leaf. They continue adding to the lower edge of the ring, pushing it up as it increases in width, till it reaches the tail and forms a sort of cone, as represented at Figure 84, *g*. As the worms grow, they continue to increase their bags from the bottom, until the latter become so large and heavy that the worms let

them hang instead of holding them upright, as they did while they were young. By the end of July they have become full grown, when they present the appearance of Figure 84, *f*. The worm on being pulled out, appearing as at Figure 84, *a*. This full grown condition is not attained, however, without critical periods. At four different times during their growth these worms close up the mouths of their bags and retire for two days to cast their skins or moult, as is the nature of their kind, and they push their old skins through a passage which is always left open at the extremity of the bag, and which also allows the passage of the excrement.

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

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

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

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

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

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

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

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

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

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

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

(Lepidoptera, Tineidæ.)

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

This worm is slender and of a very dark olive-brown color, with white longitudinal lines. During the months of August and September it may be found of all sizes, living in communities of from five to thirty individuals within a slight silken web. Did they but feed on the leaves their injury to the tree would be slight, but they have the miserable habit of gnawing the leaf stalk in two, and of severing the leaf, and causing it to turn black; thus marring the looks of large trees and killing many seedlings outright. When the worm is full grown it suspends itself in the middle of the loose web and changes to a chrysalis about ½ inch long and of a dull smoky-brown color. The chrysalis skin is so very fine, that as the future moth develops

within, the colors of its wings show distinctly through it. The chrysalis state lasts on an average about two weeks, at the end of which time the moth bursts forth. In this state it is one of the neatest and most beautiful little moths that can well be imagined. At Plate 2, Figure 22, it is represented of the natural size, expanded, and at Figure 23 with the wings closed. The fore wings are of a bright metallic golden-orange, crossed transversely with bands of very pale chrome-yellow, marbled with black; while the underwings are smoky black, and almost transparent in the middle. The first moths begin to appear during the first days of September, and continue issuing from the crysalids till the last of October. From the fact that I could get none of them to deposit eggs, I infer that they pass the winter in the moth state—the more readily since I have had them escape from the crysalis even in November. They are very fond of flitting over and clinging to the flowers of the Golden rod and of the *Eupatorium serotinum.*

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

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

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

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

The young worm is pale and void of markings.

Chrysalis.—Average length 0.53. Not polished, but with the markings of the larva still apparent through the thin skin. General color dull smoky-brown, with a distinct broad dorsal band of a

light rust-brown color along the abdomen, and a perfectly round spot of the same color on the top of the thorax, this spot generally giving forth a narrow orange line posteriorly.

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

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

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

(Lepidoptera, Tortricidæ.)

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

[Fig. 85.]

a *b*

This moth is represented at Plate 2, Figure 3, with the wings expanded, and at Figure 4 with wings closed. It is prettily marked, the fore wings being of an ochreous color with a golden tint, and darker spots, and the hind wings of a deep golden color. It was first described by Mr. Grote, of New York, in the Transactions of the American Entomological Society, Vol. II, p. 121. It was quite common in 1868 along the Iron Mountain road, and seems to be peculiar to Missouri. It also seems to prefer the young Hickories and Walnuts to the older or larger trees, as I found few nests that were out of reach.

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

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

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

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

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

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

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

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

(Diptera Muscidæ.)

DESTROYING THE SEED AFTER IT IS PLANTED.

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

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

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

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

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

[Fig. 86.]

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

[Fig. 87.]

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

It is difficult to suggest a remedy for this pest, as its presence is not observed till the mischief is done. Hot water has been found effectual in killing the Onion maggot, without injuring the onions, and would doubtless prove as effectual for this Corn maggot, where a few hills of some choice variety are attacked, which it is very desirable to save. But its application in a large field, even if one knew where to apply it, would be impracticable, and I can only suggest soaking the

seed, before planting, in gas-tar or copperas, and hope that the experiment will be tried next spring by those of our Eastern friends who have suffered from this maggot.

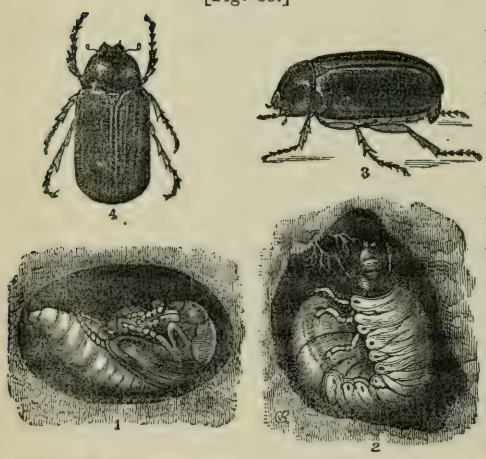
The larvæ of the genus *Anthomyia* live, for the most part, on vegetable matter, and seem to prefer it in a state of decay. Some, however, breed in excrement. Besides this corn species and the onion maggot already spoken of, there is one in this country that attacks radishes, and another that attacks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

THE WHITE GRUB.

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

(Coleoptera, Melolonthidæ.)

[Fig. 88.]



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

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

"CAMERON, MISSOURI, Sept. 21, 1868.

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

raise a crop on the land that is now full of them. They have ruined all the meadow in this vicinity."

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

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

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

the summer following, will naturally conclude his application was effectual, when in reality the insects left of their own accord in the beetle state.

During their periodical visits as beetles, they should be shaken from the trees, gathered up, scalded and fed to hogs. As an illustration of what may be done in the way of hand-picking, I will state that under the efforts of M. Jules Reiset, the incredible amount of 160,000 kilogrammes, or about eighty millions of similar White grubs were collected and destroyed in a portion of the Seine-Inferieure of France, during the autumn of 1866.

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

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

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

[Fig. 89.]

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

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

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

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

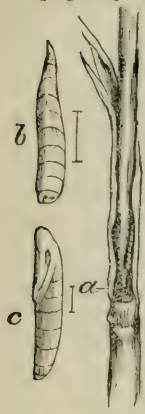
(Diptera Muscidæ.)

ATTACKING WHEAT.

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

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

[Fig. 90.]



This fly is represented, magnified, at Plate 2, Figure 28, and belongs to the genus *Meromyza* in the family MUSCIDÆ of the order DIPTERA. It appears to be the very same species which Dr. Fitch found flying about wheat fields in New York State, and which he described and named as the American Meromyza (*Meromyza Americana*), on page 299 of his 1st and 2d Reports.* He did not ascertain the habits of the larva, however, and they have ever since remained unknown. The fly measures, on an average, 0.17 to the tip of the abdomen, and expands about 0.20. It is of a pale yellowish-green, the head being more inclined to straw color. The eyes are black and there is a round black spot between them on the top of the head. There are three broad black stripes, with a bluish-gray cast, on the thorax, the middle one straight and extending anteriorly to the pedicel of the neck, the outer ones slightly rounded outwardly, not extending so far anteriorly, but extending around the scutel and joining the middle one posteriorly. The abdomen also has, above, three broad blackish stripes, which are confluent posteriorly and interrupted at each of the sutures. Wings prismatic, hyaline and greenish anteriorly, their veins and the tips of the feet being dusky.

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

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

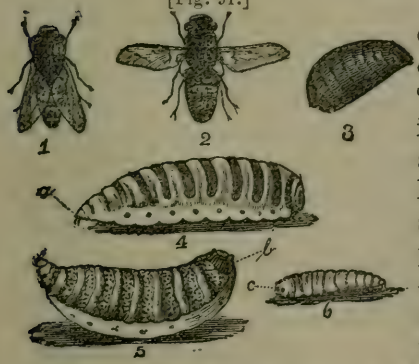
"Farm Insects," and one of them—the *Oscinis vastator*—though a very different fly, seems to have almost precisely the same habit as our insect. It is quite probable, also, that in this country as in Europe, there are two broods during the year, the second brood of larvæ attacking grain sown in the fall,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

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

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

(Diptera, Œstridæ.)

[Fig. 91.]



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

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

The flies make their appearance in June and July, and deposit living maggots in the nostrils of the sheep. As soon as they are deposited they ascend the nostrils, causing great irritation on their way, until they reach the frontal sinuses; there they attach themselves by

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

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

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

It has lately become the fashion with many members of the Agricultural press, to ridicule the idea that sheep die at all from grub in

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

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

If grub in the head is not productive of inconvenience or disease, as the disciples of Youatt have it, whence the suffering condition, the loss of appetite, the slow, weak gait, the frequent coughing, the slimy and purulent matter, sometimes so profusely secreted as at times to almost prevent the animal breathing? Whence the tossing and lowering of the head, and the fits of frenzy, to which so naturally quiet and gentle an animal as the sheep is subject? All these symptoms result from grub in the head, and the animal frequently gets too weak to rise, and finally dies. These effects of the grub were well recognized and understood by such old writers and close observers as Reaumur and Kollar; while Mr. Dan'l Kelly, of Wheaton, Illinois; Towne Bros., of Geneva, Illinois; M. L. Cockrill, of Tennessee, and other well known flock-masters with whom I have either conversed or corresponded, are unanimous in ascribing these symptoms to the true cause; and the late S. P. Boardman, of Lincoln, Illinois, coincided with them in this respect. For my part, I would as soon believe that those parasites were beneficial, which are so injurious to man, either internally or externally, or those which prey upon our caterpillars and other insects, and invariably destroy them; for although, when there are but few grubs in the head, the injury they inflict is not perceptible, *they can never be beneficial*, and when numerous enough will undoubtedly cause death. They cannot live in the head of the sheep without causing great irritation by the spines with which the ventral region is covered and the hooks with which they cling to such a sensitive membrane as that which lines the sinuses. Moreover, when numerous enough to absorb more mucous than the sheep secretes, the grubs will feed on the membrane itself, and (according to the evidence of some practical sheep men) will even enter to the brain through the natural perforation of the ethmoid bone, through which pass the olfactory nerves; in either of which cases, they must cause the most excruciating pain. The natural fear

also, which sheep have of the fly, and the pains they take to prevent its access to the nose, is of itself proof enough that it is obnoxious to them. The rabbit is subject to the attack of a very large gad-fly (the *Cuterebra caniculi* of Clark). I saw a half grown rabbit the past summer with an enormous swelling each side of its neck. On examination these swellings were found to be caused by the grubs of this fly, and the rabbit was so weakened and emaciated that it could scarcely move. No one could witness such a sight without being convinced that the parasite was injurious.

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

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

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

forth in every new edition of the '*Practical Shepherd*,' the same old exploded (or should be) notion of the fly depositing *an egg*. I presume it is altogether likely that all modern English writers on sheep keep up the same thing—by copying from Youatt."

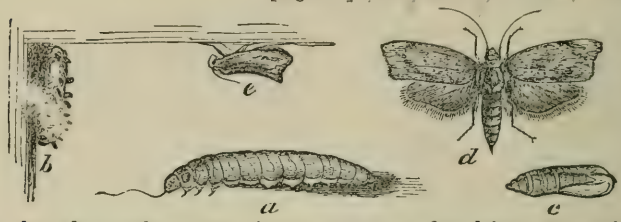
On one occasion in 1866, I myself obtained living maggots from one fly and Mr. Cockrill has since obtained over 300 living, moving worms from one that was caught while she was after the sheep. Many flesh-flies, if they cannot find suitable meat or carrion on which to lay their eggs, retain these egg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

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

INSECT ENEMIES OF THE HONEY-BEE.

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

[Fig. 92.] Lepidoptera, Tineida.



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

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

The Bee-moth was first introduced into this county from Europe, about the commencement of the present century, and it was in all probability imported with the common bee-hive. There are two broods of the moth each year, the first brood appearing in May and June, and the second, which is the most numerous, in August. During the day time, these moths remain quietly ensconced in some angle of the hive, but as night approaches, they become active, and the female uses her best endeavors to get into the hive, her object being to deposit her eggs in as favorable a place as possible. Wire-gauze contrivances are of no avail to keep her out, as she frequently commences flying before all the bees have ceased their work. But even if she were entirely prevented from entering the hive, she could yet

deposit her eggs on the outside, or by means of her extensile ovipositor, thrust them in between the slightest joint or crack, and the young worms hatching from them, would readily make their way into the hive. The moment the worm is hatched, it commences spinning a silken tube for its protection, and this tube is enlarged as it increases in size. This worm cuts its channels right through the comb, feeding on the wax, and destroying the young bees on its way. When full-grown, it creeps into a corner of the hive or under some ledge at the bottom, and forms a tough white cocoon, of silk intermingled with its own black excrement as in figure 92, *b*. In due time the moth emerges from this cocoon.

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

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

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

(Diptera, Asilidæ.)

[Fig. 93.]

In the last chapter of his 9th Report, Dr. Fitch describes a fly by the name of the "Nebraska Bee-killer," which he received from Mr. R. O. Thompson, of Nursery Hill, Otoe county Nebraska, and which the latter named gentleman had found preying upon the bee in North Nebraska in the summer of 1864. Mr. Thompson has since removed from Nebraska to North Missouri, and in conversation with him last summer he informed me that he had met with this Bee-killer each year since 1864, and that it seemed to be increasing. At a later day, in a communication to the *Rural World* of September 12, 1868, he states that it made its appearance in such numbers in North Missouri last summer, that it to a great extent prevented the bees from swarming. I present above at Figure 93 a life-size portrait of this voracious insect, its general color being yellowish-brown or yellowish-gray. This figure will enable its ready recognition, and those who wish a very full and detailed description of it will find it in the Report of Dr. Fitch above referred to. It belongs to the *Asilus* family of two-winged flies which have been very aptly termed the hawks of the insect world. Last July I found thse flies quite common in Mr. Shaw's beautiful gardens in St. Louis, and I watched them by the hour and found to my amazement that though other insects were flying all around, as well as other species of bees, yet they never seized any other species but the common Honey-bee. They capture the bee on the wing, pouncing upon it with lightning-like rapidity; then grasping it securely with their fore legs, they alight upon some plant or even upon the ground, and rapidly suck out the inside of the bee, with the stout and powerful proboscis which is shown in the figure, leaving the empty shell when they get through. Mr. Thompson says that beneath some favorable perch that is near the apiary, hundreds of these bee-shells may be found accumulated in a single day; while he has watched and found that a single fly on one of these perches destroyed no less than 141 bees in that period of time.

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

BENEFICIAL INSECTS.

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

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

(Orthoptera Mantidæ.)

[Fig. 94.]

This peculiar and predatory insect which is variously known by either of the above names in different localities, is very fortunately quite common in the central and southern parts of Missouri, as well as in most of the Southern States. Its food consists mainly of flies, though it is a most voracious cannibal and will devour its own kind as well as any other living insect that comes within its grasp. I have known it to attack various kinds of butterflies, including the male Bag-worm, grasshoppers, and caterpillars of various kinds, and in one instance a single female devoured eleven living Colorado Potato-beetles during one night, leaving only the wing-cases and parts of the legs. It disdains all dead food, and never makes chase for the living, but warily, patiently and motionless, it watches till its victim is within reach of its fore-arms, and then clutches it with a sudden and rapid

motion. Its appearance is really formidable, and its attitude while watching for its prey quite menacing, and on this account it is held in very general and superstitious dread. It is, however, utterly incapable of harming any one; and, as one of our best friends should be cherished and protected.

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

[Fig. 95.]

The manner in which these eggs are deposited has never been described, and though I have never myself witnessed the operation, I have found the mass while it was yet quite soft and freshly laid, and have dissected the female just before she was about to deposit; and incline to believe that it is gradually protruded in a soft mucilaginous state, being covered at the time

with a white, frothy, spittle-like substance which soon hardens and becomes brittle upon exposure to the air. Mr. Parker Earle informs me that he has witnessed the operation. and that he judges it to require about an hour, the eggs being "pumped out, and the entire mass elaborately shaped, with a fine instinct of construction as the process continues."

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

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

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

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

INNOXIOUS INSECTS.

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

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

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

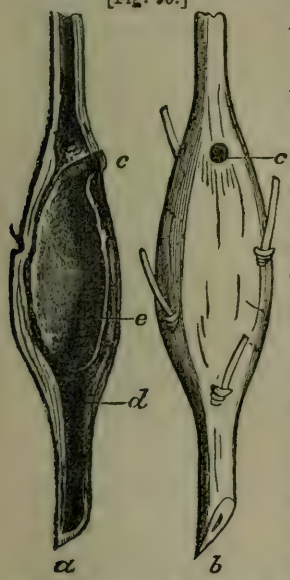
Day by day science is becoming more and more popularized, and before long the necessity of devoting more attention to natural history in our schools and colleges will become apparent. There are few things, for instance, so well calculated to train the minds of children, and at the same time entertain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

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

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

The gall which I am now about to speak of, occurs on the same species of Solidago, and in almost equal abundance with the former, though its architect has never hitherto been described. This gall which is represented at Figure 96, *b*, is of a very different form from the preceding, being altogether more elongate and narrower, and upon cutting it open it is found to be hollow, and to contain, instead of a white footless maggot, a gray 16-footed caterpillar (*e*), which in time develops into the little moth which is represented with the wings expanded at Plate 2, Figure 1, and with the wings closed at Figure 2. The history of this insect may be thus briefly told:

[Fig. 96.]



The moths winter over and may be seen flying in the month of May, in which month I have myself captured a specimen. When the young plants of the Golden-rod are about six inches high the female moth deposits an egg either in the terminal bud, or at the side of the stalk just below it, and the worm hatching from the egg works into the stalk, and causes it to swell by gnawing and thus inducing the secretions towards it. By the beginning of June the gall has just begun to form and at this time upon cutting it open the worm is found to be about ⅓ grown, and its excrement is as yet all at the upper portion of the gall. As the plant grows, so the gall increases in size, remaining, however, at the same altitude from the ground. By the middle of July both the gall and its maker have attained their full size, and upon opening the former at this season of the year the excrement will be found packed closely at both its ends, and from the small quantity of such excrement (*d*) to be found, it would appear that all but the more solid parts had been absorbed by the plant, ~~it~~ probably acting as a manure to stimulate the growth of the gall. When full grown, the worm measures rather more than half an inch, and it now prepares for changing into the

chrysalis state by eating a perfectly round passage-way entirely through the wall of the gall at its upper end. It then protects the orifice with a secretion of liquid silk which hardens and forms a perfect little plug (Fig. 96, *c*,) about 0 04 thick and 0.08 in diameter, and which is so constructed that it cannot be readily displaced from without, as it has a rim on its outer edge. The inner edge, however, is not so rimmed, and the plug can be pushed away from the inside with the slightest effort, for the little tenant when it shall have become fitted to leave its dark and secluded tenement and soar into the air, must needs make its exit through this orifice. Well may we wonder at Nature's handiwork, for what consummate skill, and wonderful instinct—I had almost said forethought—is here exhibited! Can this action be but a blind instinct, or has the larva a premonition of its future etherial imago state and its wants? Who can answer? Our little host, not satisfied with having thus protected the entrance to his home, now lines its passage way, and the walls, with a delicate silken tissue, after which he rests from his labors, and commences to undergo those mysterious transformations, so characteristic of his class. A gall cut in two at this stage of its growth presents the appearance of Figure 96, *b*. In two days' time the little worm has changed to a chrysalis, just ½ inch in length, rather slender and of a shiny mahogany-brown. At the end of about three weeks more the chrysalis grows very dark, and finally the inclosed moth bursts the skin and escapes from the gall.

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

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

The gall-making insects belonging to the same order (Lepidoptera) as our little moth, are by no means common, and the only other gall of this character with which I am acquainted, at all resembling the one just described, occurs on the stems of *Artemisia compestris* in France, and is produced by the larva of a very different little moth with pale yellow wings shaded with orange, first described by Herrich-Schæffer by the name of *Cochylis hilarana*. This last gall is figured on Plate 1, of the "Annales de la Société Entomologique de France" for 1856, and its history is detailed by M. E. Perris, at pages 33–38 of the same volume. The gall is similar in form, but narrower, with the walls thicker than that of my insect, while the larva is yellowish-white.

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

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

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

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

Described from numerous bred specimens.

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

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

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

are as applicable to our gall-maker as to most other insects. There are indeed no less than six parasites which attack it, and from many hundreds of galls examined, I estimate that one worm out of every

five is thus destroyed. As four of these parasites are new to science, and are all probably confined to this one species of insect, I will briefly describe them.

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

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

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

Annexed will be found a full description of this parasite:

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

[Fig. 97.]

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

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

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

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

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

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

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

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

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

(Lepidoptera Geometridæ.)

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

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

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

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

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

(Lepidoptera Alucitidæ.)

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

During the month of May the heads of the above named thistle may frequently be found drawn together by silken threads, with some of the leaves frequently dead. On pulling this webbed mass apart from eight to a dozen thick smooth worms may be found, which are of a light straw color with rows of black spots, and the head and tail marked as in the accompanying figure. These worms are found of different sizes in the same head, which would indicate that the parent moth either deposits her eggs at different intervals in the same place or that the eggs hatch out irregularly. Towards the end of May they change to pupæ within the burrow which the worm inhabited; these pupæ being of a dull yellow color, without polish, and resembling the pupæ of some long-legged Crane fly (*Tipula*) rather than a moth—see Pl. 2, Fig. 14. In just one week after they have thus changed, the moths escape. This moth, which is represented at Plate 2, Figure 13, is of a tawny yellow color, with a prominent triangular dark spot on the outer third of the front wing, running from the front edge. As it differs from all hitherto described North American species, it may appropriately be called the Thistle Plume.

[Fig. 98.]

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

Described from 12 specimens.

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

Perfect insect.—Length 0.45; alar expanse 0.80. Front wings bifid, the cleft reaching not much more than ¼ of wing; tawny yellow, with a distinct dark brown triangular spot running from costa to the base of cleft—sometimes a little below it—its posterior margin with a slight concave curve. Three dusky, diffuse longitudinal spots, one placed on the basal third of the wing at costa and frequently reaching along the costa to the triangular spot; one near the interior margin, a little nearer to the base of wing than the last, and one on the outer third of the interior margin. Two light-colored transverse lines across the end of wing, one very near and parallel with posterior margin, the other bordering the triangular spot behind, and curving across the lower lobe towards posterior angle. The space between these two light lines usually darker than the ground-color. Fringes dark with a light margin. Hind wings trifid, the upper cleft reaching a little beyond the

middle, the lower one to the base of wing. Color ashy-brown, the lower lobe produced into a dark angular spot about their middle posteriorly. Antennæ, palpi, head, thorax, and body, tawny yellow; legs of the same color with the exception of the tarsi, which are almost white, with alternate dark brown spots, the spines being black, with dusky tips.

× (Pterophorus) cardui, Zeller, V. Z. B. G. Platyptilia. Wien, 1873. p. 318.

ERRATA.

Page 8, line 21, for "being" read "were."
Page 10, line 1, for "Figure 3, 3" read "Figure 3, 2."
Page 12, line 20, for "last" read "1866."
Page 12, line 3 from bottom, after "February," add "(1867)."
Page 31, line 15, for "370" read "380."
Page 47, line 16, for "far" read "for."
Page 114, line 1, after "insect" read "(*Strietrus frimbriatus*, Say)."
Page 129, line 30, after "Cottonwood" read "(*Pemphigus vagabundus*, Walsh)."
Page 133, line 24 from bottom, for "preceding insect" read "Grape curculio."
Page 134, line 3 from bottom, for "Part V" read "Part VI."
Page 142, under the heading, add "(Lepidoptera, Tortricidæ)."
Page 166, under the heading, add "(Lepidoptera, Tineidæ)."

INDEX.

SECOND ANNUAL REPORT

ON THE

Noxious,

BENEFICIAL AND OTHER

INSECTS,

OF THE

STATE OF MISSOURI,

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

BY CHARLES V. RILEY,

STATE ENTOMOLOGIST.

JEFFERSON CITY:
Horace Wilcox, Public Printer.
1870.

PREFACE.

To the Members of the Missouri State Board of Agriculture:

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

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

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

The cause of Economic Entomology lost one of its greatest champions, and the farmers and fruit-growers of the West, and especially of our sister State, Illinois, suffered an irreparable loss, in the sudden death, on November 18th, 1869, of Mr. Benj. D. Walsh, of Rock Island. At the time of his death, he was State Entomologist of Illinois, and my Associate in the Editorship of the *American Entomologist*, published at St. Louis; and I hardly need say that this sad and unexpected fate of my friend has very much increased my own labors. When I add to this the fact that Mr. Walsh was prostrated for over three months last spring and summer, and that Mr. Wilcox, our State Printer, was ready for this Report at an earlier day than I had

anticipated; you will not be surprised to learn that several subjects which I had contemplated treating of, have been unavoidably deferred another year.

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

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

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

All which is respectfully submitted by

CHARLES V. RILEY,
State Entomologist.

St. Louis, Mo., Dec. 2, 1869.

NOXIOUS INSECTS.

REPORT OF THE COMMITTEE ON ENTOMOLOGY.

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

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

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

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

been disseminated among those who have to deal with them, or to the more potent and unalterable workings of Nature.

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

Owing to the severe drouth of 1868, which was unfavorable to its successful transformations, that dreaded foe of the fruit-grower, the Plum Curculio, was scarce in the early part of the season, and our plum and peach trees set a fuller crop than they had done before for years; but the subsequent moist weather was favorable to the underground evolutions of this little pest, and the new brood appeared in great numbers about the end of June and beginning of July, when they did much damage to stone-fruit and some damage to pip-fruit by the gougings which they made for food. As stated in an essay read before the State meeting of our Illinois horticultural friends, I have discovered a little cannibal in the shape of a minute yellow species of *Thrips*, which destroys vast numbers of the "Little Turk's" eggs; and let us hope, that by attacking the Curculio in its most vulnerable point, this *Thrips* may in the course of a few years reduce the numbers of the Curculio, as the ladybirds have done with the Colorado Potato-bug, or as the minute mite (*Acarus mali*) is known to have done with the common Oyster-shell Bark-louse of the Apple. The eggs of the Apple-tree Plant-louse (*Aphis mali*) which last winter so thickly covered the twigs of the apple trees in many orchards, hatched and produced a prodigious number of lice as soon as the buds commenced to burst. In this immediate neighborhood they were soon swept away, however, by their cannibal insect foes, and by insectivorous birds, such as the warblers, etc.; but a physiological

fact connected with this insect has been developed this year by Dr. E. S. Hull, the able Illinois State Horticulturist, which is of such importance that I cannot pass it over even in this brief report. He has ascertained that we suffer from the injurious punctures of their little beaks long after the lice themselves have disappeared. In fact, he has proved to his own satisfaction that the so-called "scab" in apples, which prevailed to such an alarming extent last year, and rendered thousands and thousands of bushels valueless for market purposes, is actually caused by the punctures of these lice. I said that the doctor had proved this matter "to his own satisfaction," because I believe that caution requires that we should not consider it as an established fact until all objections to it can be dispelled. Personally I have made no observations on this matter, but the facts in the case all add weight to Dr. Hull's theory, if such it can be called. Hitherto the cause of the "scab" on apples has been involved in mystery. It was supposed to have a fungoid origin; yet an examination will show that the scabby appearance is not caused by any live fungus, but by arrested growth of the cells which have become corky and cicatrized. The importance of this discovery of Dr. Hull's, should it once be firmly established, cannot well be estimated; for when we have once ascertained the cause of a disease, it need scarcely exist any longer. By destroying the lice we shall prevent scabby apples, and experience teaches that they can be destroyed by a good syringing of tobacco-water. We may expect, in this immediate vicinity, an almost total exemption from "scab" next year, for the apple trees are remarkably free from the minute black bead-like eggs of the Plant-louse with which they were so thoroughly peppered a year ago.

The Tent Caterpillar (*Clisiocampa Americana*) was more abundant than usual in our orchards, and the Tent Caterpillar of the Forest (*Clisiocampa sylvatica*) also appeared in great numbers both on our orchard and forest trees.

A worm which I have called the Pickle Worm, (*Phacellura nitidalis*, Cram.) and which had never been publicly noticed before, appeared in immense numbers, and did great damage to our cucumbers and melons by boring into the fruit, but as this insect, with others, will be fully treated of in my forthcoming Report, I will pass on to a more general subject.

> "The pebble in the streamlet scant,
> May turn the course of many a river;
> The dew-drop on the infant plant,
> May warp the giant oak forever."

In no department of science does the old proverb "prevention is better than cure," apply with such force as in that of Economic Entomology. In my studies and observations I have often been struck with the fact that many of our very worst insect enemies have been introduced from abroad, and that if this subject of Economic Entomology had been better understood and appreciated fifty years ago,

and the proper measures had been taken to prevent the introduction of these pests, we should at present be free from the curse of the great majority of them. We have, indeed, plenty of Native American insects, which have become great pests to the cultivator of the soil, on account of the artificial state of things which he induces. In a state of Nature, a given species of plant, in its struggle for existence, is scattered promiscuously over a certain extent of country, and the particular insect or insects which feed upon that plant, have to search for it over a comparatively extensive surface, and their multiplication is consequently restricted. But the pursuit of horticulture, for instance—which may be succinctly defined as the assembling in tracts of greater or less extent, of one species of plant at the expense and exclusion of others—causes the particular insects which feed upon that plant, to multiply unduly, and we have to use that same intelligence in subduing these insects, which we employ in producing the artificial results which caused their increase. In the normal state of things insects never increase unduly; but, on the contrary, always act as Nature's most faithful servants, and accomplish a most important work in her economy. Yet, for reasons explained above, they naturally become our enemies, and we should suffer from the depredations of our indigenous species, even though no foreign ones had been imported. But we have altogether more than our share of these insect depredators, and so truly is this the case, that insects which attract universal attention, and are considered as very serious evils in Europe, would not be deemed worthy of notice in this country. There, if they lose one-fifth of a given crop, the whole community becomes alarmed; but here the cultivator sometimes considers himself fortunate if he secures the half of his crop from insect ravages, and each State loses annually from fifty to sixty million dollars from this cause alone, though but four States have as yet made any attempt to prevent this serious loss. In order to bring this fact home to you, and to show why we suffer more than do our foreign brethren, I will read a paper, which I have prepared for the *American Entomologist*, on

IMPORTED INSECTS AND NATIVE AMERICAN INSECTS.

If we examine into the history, as detailed in a recent number of our Magazine, (pp. 15–22) of the imported Currant Worm and the Native Currant Worm, we shall find a very curious state of things. These two insects both produce Sawflies, which are so closely allied to each other, that although they are referred to distinct genera by Entomologists, it may be doubted whether the genus (*Pristiphora*) under which the native species is classified be not a mere subgenus of that under which the imported species is classified. Reasoning *a priori*, therefore, we should expect to find a very great similarity in the destructive powers of these two worms, especially as each of them infests the leaves both of the Red Currant and of the Gooseberry. But

what are the actual facts? On the one hand we see a Native American species—which must have existed here from time immemorial, feeding on our wild Gooseberries and perhaps on our wild Red Currant, and which yet has troubled our tame Gooseberries and tame Red Currants so very slightly, that it cannot be proved with absolute certainty to have ever done so at all, except in Rock Island county, Ills., and in Scott county, Iowa.*

On the other hand we see a species, only introduced into this country, from Europe, some twelve years ago, which has already almost put a stop to the cultivation of the Gooseberry and Red Currant throughout a large part of the State of New York, the northern borders of Pennsylvania, and the whole of Canada West, and is slowly but surely extending itself in all directions from the point where it was originally imported. What can be the reason of such a wide difference in the noxious powers of two such closely allied insects, feeding on exactly the same plants, but one of them indigenous to America and the other imported into America from Europe? Nor is this the only case of the kind. We can point out at least three other such cases. The Imported Onion-fly (*Anthomyia ceparum*), is a terrible pest to the onion-grower in the East, though it has not yet made its way out West. On the other hand, the Native American Onion-fly (*Ortalis arcuata*, Walker), which is a closely allied species and has almost exactly the same habits, has only been heard of in one or two circumscribed localities in the West, and even there does comparatively but little damage. Again, the Imported Oyster-shell Bark-louse (*Aspidiotus conchiformis*) is a far worse foe to the Apple and certain other fruit trees than our indigenous Harris's Bark-louse, (*Asp. Harrisii*), though each of them infests the same species. Finally, the imported Meal-worm beetle (*Tenebrio molitor*) swarms throughout the whole United States, and is a great pest; while the Native American species (*Tenebrio obscurus*), which has almost exactly the same habits, belongs to the same genus, and is of very nearly the same size, shape and color, is comparatively quite rare among us, and is scarcely known to our millers and flour-dealers.

On a careful and close examination, it will be found that almost all our worst insect foes have been imported among us from the

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*In Volume 15 of the *Prairie Farmer*, page 504, a correspondent from Jefferson county, Iowa, states that as early as June 11th, in the year 1865, "a small green worm had taken the lion's share of his currants and gooseberries." This may possibly refer to the Native Currant Worm, which feeds upon gooseberry and currant leaves, but it more probably means the Gooseberry Fruit-worm (*Pempelia grossulariæ*, Packard,) which feeds upon the gooseberries and currants themselves, and which may be found figured and described in our First Missouri Report, page 140. What a vast fund of information is scientifically unavailable, simply because correspondents are so stingy with their pen, ink and paper. Again the editor of the *Farmers' Union*, published at Minneapolis, Minn., says in a recent number of that paper, that several gardens in that vicinity have been for the past few years infested with the Currant worm, and that last year they visited his own garden for the second time, having, the previous year, made sad havoc with the foliage before they were discovered. Now, as there are three perfectly distict worms which attack the leaves of currant bushes, and as the editor contents himself with referring to "THE Currant Worm," the information he imparts is perfectly valueless to the Entomologist, and the practical man may be led astray by the remedies suggested.

other side of the Atlantic. The Hessian Fly* was imported almost ninety years ago; the Wheat Midge about half as long ago; the Bee Moth at the beginning of the present century; the Codling Moth, the Cabbage Tinea, the Borer of the Red Currant, the Oyster-shell Bark-louse, the Grain Plant-louse, the Cabbage Plant-louse, the Currant Plant-louse, the Apple-tree Plant-louse, the Pear-tree Flea-louse, the Cheese-maggot, the common Meal-worm, the Grain Weevil, the House Fly, the Leaf-beetle of the Elm, the Cockroach, the Croton Bug, and the different Carpet, Clothes and Fur Moths, at periods which cannot be definitely fixed. Even within the last few years the Asparagus-beetle has become naturalized in New York and New Jersey, whence it will no doubt spread gradually westward through the whole United States, while the Rape Butterfly was introduced about a dozen years ago, and is rapidly spreading over some of the Eastern States. And only a year ago the larva of a certain Owlet-moth (*Hypogymna dispar*), which is a great pest in Europe, both to fruit-trees and forest-trees, was accidentally introduced by a Massachusetts entomologist into New England, where it is spreading with great rapidity. It is just the same thing with Plants as with Insects. We have looked carefully through Gray's *Manual of Botany*, and we find that—excluding from consideration all cryptogams, and all doubtful cases, and all cases where the same plant is supposed to be indigenous on both sides of the Atlantic—no less than TWO HUNDRED AND THIRTY-THREE distinct species of plants have been imported among us from the Old World, all of which have now run wild here, and many of which are the worst and most pernicious weeds that we have to contend against. In the United States *Agricultural Report* for 1865 (pp. 510–519) will be found a list of ninety-nine of the principal "Weeds of American Agriculture," by the late Dr. Wm. Darlington. Of this whole number no less than forty-three, or nearly one-half, are species that have been introduced among us from the Old World. Among these we may enumerate here, as the best known and the most pernicious, Butter-cups (two species), Shepherd's Purse, St. John's Wort, Cow-cockle, May-weed or Dog-fennel, Ox-eye Daisy, Common Thistle, Canada Thistle, Burdock, Plantain, Mullein, Toad-flax, Bind-weed, Jamestown (Jimson) weed, Lamb's Quarter, Smart-weed, Field Garlic, Fox-tail Grass and the notorious Cheat or Chess. And to these we may add the common Purslane, which, through some strange oversight, has been omitted in Dr. Darlington's catalogue.

It will be supposed, perhaps, since there are about as many voyages made from America to Europe as from Europe to America, that we have fully reciprocated to our transatlantic brethren the favors

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*For the sake of the scientific reader, we subjoin here, in their regular order, the scientific names of the Insects catalogued by their English names in the text of this paragraph: *Cecidomyia destructor, Diplosis tritici, Galleria cereana, Carpocapsa pomonella, Plutella cruciferarum, Ægeria tipuliformis, Aspidiotus conchiformis, Aphis avenæ, A. brassicæ, A. ribis, A. mali, Psylla pyri, Piophila casei, Tenebrio molitor, Sitophilus granarius, Musca domestica, Galeruca calmariensis, Blatta orientalis, Ectobia germanica, Tinea tapetzella, vestianella, pellionella, &c.; Crioceris asparagi, Pieris rapæ and Hypogymna dispar.*

which they have conferred upon us, in the way of Noxious Insects and Noxious Weeds. It is no such thing. There are but very few American insects that have become naturalized in Europe, and even these do not appear for the most part to do any serious amount of damage there. For example, on one or two occasions single specimens of our Army-worm Moth (*Leucania unipuncta*) have been captured in England; but the insect has never spread and become ruinously common there, as it continually, in particular seasons, does in America. Our destructive Pea-bug (*Bruchus pisi*) has also found its way to Europe; but although it is met with in England, and according to Curtis has become naturalized in the warmer departments of France, Kirby and Spence expressly state that it does not occur in England "to any very injurious extent," and Curtis seems to doubt the fact of its being naturalized in England at all.* Again, the only species of White Ant that exists within the limits of the United States, (*Termes frontalis*), has been known for a long time to be a guest at the Plant-houses of Schönbrunn, in Germany; but is not recorded to have ever as yet spread into the surrounding country. As to our American Meal-worm (*Tenebrio obscurus*), Curtis states that it has been introduced into England along with American flour, and that it is sometimes abundant in London and the provinces;† but Kirby and Spence say not one word about it, and it seems to be confined to the English sea-ports and the places where American flour is stored, without spreading into the adjacent districts.

A very minute yellow ant, however, (*Myrmica molesta*), which is often very troublesome with us in houses, has, according to Frederick Smith, "become generally distributed and naturalized" in houses in England; and Kirby and Spence state more specifically, that "it has become a great pest in many houses in Brighton, London and Liverpool, in some cases to so great an extent as to cause the occupants to leave them."‡ As to our Chinch Bug, our Curculio, our Plum Gouger, our two principal Apple-tree Borers, our Canker-worm, our Apple-tree Tent-caterpillar, our Fall Web-worm, our Peach-tree Borer, and our other indigenous pests among the great Army of Bad Bugs, nobody ever yet found a single one of them alive and kicking on the other side of the Atlantic. And with regard to Plants, the only two American plants that we know to have become so firmly established in Europe as to be a nuisance there, are an American aquatic plant, the common Water-weed (*Anacharis canadensis*), which has choked up many of the canals in England, and our common Horse-weed, or Mare's tail as it is called in the West, (*Erigeron canadense*), which has spread from America nearly over the whole world.

Since then, it can be demonstrated by hard, dry facts, that American plants and insects do not become naturalized in the Old World

*Kirby & Spence *Introd.* Letter 6th; Curtis *Farm insects*, p. 358.

†*Farm insects*, p 334.

‡Smith in Stainton's *Entom. Annual* 1862, p. 70, and 1863 pp. 59-62; Kirby & Spence *Introd.*, Letter 8th.

with anything like the facility with which the plants and insects of the Old World are every day being naturalized in America, there must be some cause or other for this singular state of things. What is that cause? It is, as we believe, a simple fact which is pretty generally recognized now as true by modern naturalists, namely, that the plants and animals of America belong, as a general rule, to an old-fashioned creation, not so highly improved and developed as the more modernized creation which exists in Europe. In other words, although this is popularly known as the New World, it is in reality a much older world than that which we are accustomed to call the Old World. Consequently, our plants and animals can no more stand their ground against European competitors imported from abroad, than the Red Indian has been able to stand his ground against the White Caucasian Race. On the other hand, if by chance an American plant or an American animal finds its way into Europe, it can, as a general rule, no more stand its ground there against its European competitors, than a colony of Red Indians could stand their ground in England, even if you gave them a whole county of land and an ample supply of stock, tools, and provisions to begin with. For throughout Animated Nature, as has been conclusively shown by Charles Darwin, there is a continual struggle for existence, the stronger and more favorably organized species overpowering and starving out from time to time their less vigorous and less favorably organized competitors. Hence, it is as hopeless a task for a poor puny, old-fashioned American bug to contend against a strong energetic, highly-developed, European bug, as it would be for a fleet of old-fashioned wooden ships to fight against a fleet of our modern iron-clads.

Let not "Young America," however, be altogether discouraged and disgusted at hearing, that our Animal and Vegetable Creation is more old-fashioned than that of what is commonly known as the Old World. The oldest geological formations, in which the remains of Mammals occur, contain the remains of such mammals exclusively (*Marsupialea*) as bring forth their young only partially developed, and carry those young about with them in a pouch, till the day of complete development and physical "second birth" arrives. In America we have a single genus—the Opossums—that belongs to this antediluvian type. In the three ancient continents they have absolutely none at all. But if in this respect America is more old-fashioned than Europe, Australia is still more old-fashioned than America; for there almost all their mammals possess this remarkable peculiarity; so that if the American creation is somewhat old-fogyish, that of Australia is the very concentrated essence of old-fogyism itself. Consequently, if Europe crows over us as altogether "behind the times," "Young America" can take its revenge by crowing over Australia, as the land of the Kangaroo and the Wombat and other such exploded absurdities of the Mesozoic epoch.

The theory advanced in the above paper, may meet with some objectors, although I confidently believe in the inference there stated of the relative advancement and improvement of the flora and fauna of the two continents. But there is another reason why the insects which are imported into this country multiply at a prodigious rate, and soon acquire herculean power of doing harm, though they may never have stepped beyond the limits of propriety in their own native home—a reason too palpable and evident to savor of the theoretical. It is, that whenever an injurious insect is introduced in our midst, as a general rule the particular parasite or parasites which kept it in check abroad, are not introduced with it. In consequence, the foreigners, unaccompanied by the usual *gens d'armes*, throw off all restraint and play the deuce with our crops; just as the rats and mice will take possession of, and overrun a house, if not restrained by human or by feline agencies.

Sometimes, as in the case of the Imported Currant-worm, the noxious insects introduced from the old world are attacked by native American parasites, but as I believe the parasites of European nativity to be, as a rule, more energetic and vigorous than our indigenous ones, it would be advisable even in such a case, to import in addition such species as prey upon it in Europe. But in the case of the Wheat Midge which has actually flourished among us for almost half a century without a single parasite of any kind whatever infesting it from one end of the country to the other, it is sheer folly and cupable shiftlessness not to import among us from the other side of the Atlantic some one or all of the three different *Chalcis* flies which are known to check it throughout all Europe. And so with other insects which are known to be unaccompanied with the parasites which attack them abroad. Years and years ago Dr. Fitch demonstrated in print the policy of such a step; but bugs and bug-hunters are so very generally the subject of festive ridicule among the high and low vulgar, that hitherto the recommendation of the State Entomologist of New York has met with no practical response.

Now no one will fail to understand the force of the old proverb already quoted, after listening to these facts. Let us profit by the experience of the past, and while battling with those foes which are already in our midst, let us keep a watchful eye, and be on our guard ready to crush any new plague that may threaten us, before it gets beyond control. Yes, but say you, how is this to be accomplished? Can it be done by the government? Yes, in some cases; as for instance in the importation of parasites, government aid should be solicited. If, in 1860, when the Asparagus Beetle (*Crioceris asparagi*, Linn.) was first introduced on to Long Island, the Legislature of the State of New York had taken proper action in the matter, the insect might have been stamped out of the island at the trivial expense of a few hundred dollars, instead of being allowed to multiply, as it did, to such an extent as to occasion a dead loss of some fifty thousand

dollars in a single county, and of spreading from the island into the adjoining country. Quite recently a weevil (*Bruchus granarius*) which does immense damage to peas and beans and some other plants in Europe, was introduced into New York in some pods which a certain gentleman presented to the New York Farmers' Club, and if the proper steps are at once taken, it may yet be prevented from spreading through the country.

In Europe vast sums have been expended in founding professorships of Economic Entomology in the various agricultural colleges, and in conducting elaborate experiments on the best means of checking and controlling these tiny foes. But the entire sum expended by Congress or by our various State Legislatures for this purpose, from the Declaration of Independence to the year of our Lord 1869, cannot exceed ninety or one hundred thousand dollars, or about one thousand dollars a year. Yet the annual damage done by insects within the limits of the United States cannot be less than three hundred million dollars. Indeed, it is but quite recently that the people, from necessity, have awakened to the importance of the subject. We now have an Entomologist connected with the Department of Agriculture at Washington, and, with proper care, he can be of inestimable service to the country, in preventing the introduction of noxious insects. It is not noxious weeds alone, such as the Canada thistle, which are sent broadcast over the land by the distribution of uninspected seeds; but noxious insects are very frequently distributed in the same way. We have the highest authority, Dr. J. L. LeConte, of Philadelphia, for the statement, that before the Entomologist received his appointment, a noxious beetle, *Rhizopertha pusilla*, which has now become naturalized here, was originally introduced into this country in wheat from the Patent Office.

Therefore, there can be no doubt that much may be done at headquarters. That government aid cannot be of any avail in the great majority of instances, however, is equally apparent to those who have studied this question; and we must trust to a more thorough dissemination of such information as will enable each individual to protect himself. Much is being done in this direction by means of State Reports, through the *American Entomologist*, and through our various agricultural and horticultural journals; but much yet remains to be done. We must bear in mind that by enlightening our neighbors, we are helping ourselves, and, as horticulturists, we should urge that more attention be paid in our colleges, and especially in those of an Industrial nature, to the study of the Natural Sciences.

In my First Report, I have shown how the Oyster-shell Bark-louse, though perfectly able to live in the northern part of this State, is yet unknown there; and I tremble, lest some one in carelessness or ignorance should, introduce this dreaded plague of the apple grower into that section, from some Eastern or Northern nursery. Every

tree received from a distance should be examined from "top to stern," as the sailors say, before it is planted, and all insects, in whatever state they may be, destroyed. There can be do doubt that many of our worst insect foes may be guarded against by these precautions. The Canker-worm, the different Tussock-moths or Vaporer-moths, the Bark-lice of the Apple and of the Pine, and all other scale insects (*Coccidæ*), the Apple-tree Root-louse, etc., are continually being transported from one place to another, either in earth, on scions, or on the roots, branches, and leaves of young trees; and they are all possessed of such limited powers of locomotion, that unless transported in some such manner, they would scarcely spread a dozen miles in a century.

In the Pacific States, fruit-growing is a most profitable business, because they are yet free from many of the fruit insects which so increase our labors here. In the language of our late lamented Walsh, "although in California the Blest, the Chinese immigrants have already erected their joss houses, where they can worship Buddha without fear of interruption, yet no 'Little Turk' has imprinted the crescent symbol of Mahometanism upon the ~~the~~ Californian plums and the Californian peaches." But how long the Californians will retain this immunity, now that they have such direct communication with infested States, will depend very much on how soon they are warned of their danger. I suggest to our Pacific friends that they had better "take the bull by the horns," and endeavor to retain the vantage ground they now enjoy. I also sincerely hope that the day will soon come when there shall be a sufficient knowledge of this subject throughout the land, to enable the nation to guard against foreign insect plagues; the State against those of other States, and the individual against those of his neighbors.

THE CHINCH BUG—*Micropus leucopterus*, Say.

(Heteroptera, Lygæidæ.)

[Fig. 1.]

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Few persons will need to be introduced to this unsavory little scamp, but, lest perchance, an occasional reader may not yet have a clear and correct idea of the meaning of the word Chinch Bug, I represent herewith (Fig. 1) a magnified view of the gentleman. The hair-line at the bottom shows the natural size of the little imp, and his colors are coal-black and snow-white. He belongs to the order of Half-winged Bugs (HETEROPTERA), the same order to which the well known Bed Bug belongs, and he exhales the same loathsome smell as does that bed-pest of the human race. He subsists by sucking, with his sharp-pointed

beak, the juices of our cereals, thereby causing them to shrink and wither, and not by gnawing or biting their substance, as many persons suppose. Insignificant as is the minute puncture of a single individual, yet these insects often appear in such countless numbers as to bleed to death whole fields of grain by their myriad beaks.

If the Western Fruit-grower is asked, what particular insect is the most difficult for him to combat, and the most destructive to his crops, he will probably answer "The Curculio." If the same question is put to the Western Grain-grower, he will infallibly reply "The Chinch Bug." And he will be in the right. The Wheat-midge—popularly known in the West as the "Weevil" or the "Red Weevil"—does a considerable amount of damage, in particular years and in particular localities, by its little legless orange-colored lava sucking away the sap from the growing kernel of wheat. The Hessian Fly—often called simply "the Fly"—injures the wheat by the maggot that produces it living between the stem and the sheath of the blade, and intercepting the sap before that sap can reach the ear. The Grain Plant-louse, easily distinguished from the above two little pests by its long sprawling legs, has in certain years somewhat injured the small grain in the West by accumulating, first on the growing stem and afterwards on the ear, and abstracting the sap with its long pointed beak. There are also, in all probability, several minute Two-winged Flies, which do more or less injury to the growing grain by their larvæ breeding in the stem, the natural history of one of which, the American Meromyza, was given for the first time in my First Report (pp. 159–61). The larva of an unknown moth, which burrows upwards and downwards in the stem of oats, and probably of wheat also, causing the ear to become prematurely white and the kernel to be entirely blasted, also in some years does considerable damage. The White Grub, the Wire-worm, and certain Cut-worms take a certain per centage of the young grain, almost as soon as it peeps out of the ground. But undoubtedly the meanest bug, out of the whole crowd of the multifarious insect-foes of the grain-growing farmer, is the Chinch Bug. He is not satisfied with taking a field here and a field there, and sparing the remainder. But when his time comes—and in mercy to the Western Farmer we are not cursed every year with this little savage—he sweeps the whole country with the besom of destruction. The Wheat-midge, the Hessian Fly, and the Grain Plant-louse, destructive as they are to small grain, yet spare our corn. If they take the good white wheaten bread out of our mouths, they yet leave us an ample supply of corn-dodgers. But the Chinch Bug makes a clean sweep, whenever he gets the upper hand of us. He "goes the entire hog." Nothing in the way of grain comes amiss to him. He is not dainty, not he! Whenever he gets a chance to spread himself, he first of all at one fell swoop destroys the small grain, and then fastens his liquorish beak upon the corn and takes that also.

PAST HISTORY OF THE CHINCH BUG.

The first record we have of the prevalence of the Chinch Bug was in the old Revolutionary times in North Carolina, where it was confounded with the Hessian Fly, an insect just then imported from Europe into the United States. Ever since those times it has been an epidemic pest, in particular years, in North and South Carolina and in Virginia. The great American entomologist, Thomas Say, in 1831, when he had been residing in Indiana for six years, was the first to name and describe it scientifically. He states that he "took a single specimen on the Eastern shore of Virginia;" whence we may reasonably infer that it was then either unknown or very rare in Indiana, and probably also in the other Western States. In Missouri it did considerable damage as early as 1854, for Jas. Pleasant of Fox Creek, St. Louis county, informed me that he had known it since that year, and that he had been previously acquainted with it in Virginia. Wm. M. Beal of Edina, Knox county, writes that it has existed and done more or less damage there since 1856, though it has scarcely been heard of since 1865. Mr. A. H. Roberts of Gray's Summit, Franklin county, informs me that it has not been in that neighborhood more than eight or ten years, and Mr. C. S. Jeffries, of Boles' post office in the same county, never heard of it till about fifteen years ago, though he has lived there for the last fifty years.

If proper records existed, we should doubtless find that it attracted attention in Missouri at a much earlier day, for in Illinois it was noticed as long back as 1840, in Hancock county, where it was absurdly supposed to have been introduced by the Mormons of Nauvoo, and was called the "Mormon louse"

In 1868, owing to the great drouth, this insect, as I have stated elsewhere, was quite injurious in many sections of our own State, and especially in the southwest. In the extreme northern portion they began to attract attention about the first of May, but the wet weather that occurred about that time caused them to disappear. In the more central counties the earliest sown wheat suffered but little from their depredations, though that which was sown later, was reduced about one-third. The conditions being favorable, they rapidly increased during the Summer, and in the fall, the second brood was so numerous that great fears were entertained for the safety of the crops of 1869. Let us be thankful, however, that the excessive rains of last spring and summer, though deplored and regretted by many, had the effect to so thoroughly drown out these little pests, as to make them comparatively harmless; for the only place in which I heard of their doing serious harm was at Tinney's Grove in Ray county. Seeming misfortune is often a blessing in disguise, and though the corn crop was lessened by the heavy rains, the wheat crop in all probability would have suffered far worse, had the season

been dry and favorable to the increase of this, the greatest insect foe of the wheat-grower.

We may safely conclude that the Chinch Bug has always existed in Missouri, in small numbers; but that it did not multiply to an injurious extent until the grains began to be cultivated on an extensive scale. At all events, we know from the evidence of Dr. Harris and Dr. Fitch, that it existed long ago in exceedingly small numbers in New York, and even in Massachusetts. What the causes may have been, that thinned out the numbers of this insect in former times in the West, is another question. In former times, the great bulk of these bugs were probably destroyed every winter by the prairie fires, and, as cultivation has extended in consequence of the country being gradually settled up, and less and less prairie has been annually burnt over, the number that has survived through the winter to start the next year's broods has annually become greater. If these views be correct, we may expect them, unless more pains be taken to counterwork and destroy them, to become, on the average of years, still more abundant than they now are, whenever prairie fires shall have become an obsolete institution; until at last Western farmers will be compelled, as those of North Carolina have already several times been compelled, to quit growing wheat altogether for a term of years.

It may be very reasonably asked, why the Chinch Bug does not increase and multiply in Massachusetts and New York, seeing that it existed there long ago, and that there are, of course, no prairie fires in those States to keep it in check. The answer is, that the Chinch Bug is a Southern, not a Northern species; and that hundreds of Southern species of insects, which on the Atlantic seaboard only occur in southerly latitudes, are found in profusion in quite a high latitude in the Valley of the Mississippi. The same law, as has been observed by Professor Baird, holds good both with Birds and with Fishes.*

NATURAL HISTORY OF THE CHINCH BUG.

In the four great and extensive Orders of Insects, namely, the Beetles (*Coleoptera*), the Clear-winged Flies (*Hymenoptera*), the Scaly-winged Flies (*Lepidoptera*), and the Two-winged Flies (*Diptera*), and in one of the four small Orders in its restricted sense, namely, the Net-winged Flies (*Neuroptera*), the insect usually lies still throughout the pupa state, and is always so far from being able to eat or to evacuate, that both mouth and anus are closed up by membrane. In the remaining three small Orders, on the contrary, namely, that of the Straight-winged Flies in its most extensive sense (*Orthoptera* including *Pseudo-neuroptera*), the Half-winged Bugs (*Heteroptera*) and the Whole-winged Bugs (*Homoptera*), the pupa is just as active and just as ravenous as either the larva or the perfect

* Silliman's Journal, xli, p. 87.

insect, and the little creature never quits eating as long as the warm weather lasts, except for a day or so while it is accomplishing each of its successive three, four or five moults. As the Chinch Bug belongs to the Half-winged Bugs, it therefore continues to take food, with a few short intermissions, from the day when it hatches out from the egg to the day of its unlamented death.

Most insects—irrespective of the Order to which they belong—require 12 months to go through the complete circle of their changes, from the day that the egg is laid to the day when the perfect insect perishes of old age and decrepitude. A few require 3 years, as for example the Round-headed Apple-tree Borer (*Saperda bivittata*, Say) and the White Grub which produces the May-beetle (*Lachnosterna quercina*, Knoch.) One species, the Thirteen-year Locust (*Cicada tredecim*, Riley), actually requires 13 years to pass from the egg to the winged state; and another, the Seventeen-year Locust (*Cicada septemdecim*, Linn.) the still longer period of 17 years. On the other hand there are not a few that pass through all their three states in a few months, or even in a few weeks; so that in one and the same year there may be 2, 3 or even 4 or 5 broods, one generated by the other and one succeeding another. For example, the Hessian Fly (*Cecidomyia destructor*, Say), the common Slug-worm of the Pear (*Selandria cerasi*, Peck), the Slug-worm of the Rose (*Selandria rosæ* Harris), the Apple-worm and a few others, produce exactly two generations in one year, and hence may be termed "two-brooded." Again, the Colorado Potato-beetle in Central Missouri is three-brooded, and not improbably in more southerly regions is four-brooded. Lastly, the common House-fly, the Cheese-fly, the various species of Blow-flies and Meat-flies, and the multifarious species of Plant-lice (*Aphis*) produce an indefinite number of successive broods in a single year, sometimes amounting in the case of the last-named genus, as has been proved by actual experiment, to as many as nine.

As long ago as March, 1866, I published the fact that the Chinch Bug is two-brooded in North Illinois (*Practical Entomologist*, I, p. 48), and I find that it is likewise two-brooded in this State. and most probably in all the Middle States. Yet it is quite agreeable to analogy that in the more Southern States, it may be three-brooded. For instance, the large Polyphemus Moth is single-brooded in the Northern and Middle States, and yet, two broods are sometimes produced in this State, while in the South it is habitually two-brooded. Again, the moth known as the Poplar Spinner, (*Clostera Americana*, Harris), is stated by Dr. Harris and Dr. Fitch to be only single-brooded in Massachusetts and New York, the insect spinning up in September or October, passing the winter in the pupa state, and coming out in the winged form in the following June. But Dr. Harris—no doubt on the authority of Abbott—states that "in Georgia this insect breeds twice a year;"* and I have proved that it does so breed in Missouri, having

*Injurious Insects, p. 434.

now (Dec. '69) a number of cocoons which were formed by a second brood of larvæ. It is quite reasonable, therefore, to infer that the Chinch Bug may produce even more than two broods in the more Southern States.

It is these two peculiarities in the habits of the Chinch Bug, namely, first, its continuing to take food from the day of its birth to the day of its death, and secondly, its being either two-brooded or many-brooded, that renders it so destructive and so difficult to combat. Such as survive the autumn, when the plants on the sap of which they feed are mostly dried up so as to afford them little or no nourishment, pass the winter in the usual torpid state, and always in the perfect or winged form, under dead leaves, under sticks of wood, under flat stones, in moss, in bunches of old dead grass or weeds or straw, and often in corn-stalks and corn-shucks. In the fall and winter of 1868, I repeatedly received corn-stalks that were crowded with them, and it was difficult to find a stalk in any field that did not reveal some of them, upon stripping off the leaves. I have even found them wintering in the gall made by the Solidago Gall-moth (*Gelechia gallæsolidaginis*), described in the First Report.

In the winter all kinds of insect-devouring animals, such as birds, shrew-mice, etc., are hard put to it for food, and have to search every hole and corner for their appropriate prey. But no matter how closely they may thin out the Chinch Bugs, or how generally these insects may have been starved out by the autumnal droughts, there will always be a few left for seed next year. Suppose that there are only 2,000 Chinch Bugs remaining in the spring in a certain field, and that each female of the 2,000, as vegetation starts, raises a family of only 200, which is a low calculation. Then—allowing the sexes to be equal in number, whereas in reality the females are always far more numerous than the males—the first or spring brood will consist of 200,000, of which number 100,000 will be females. Here, if the species were single-brooded, the process would stop for the current year; and 200,000 Chinch Bugs in one field would be thought nothing of by the Western farmer. But the species is NOT single-brooded and the process does NOT stop here. Each successive brood increases in numbers in Geometrical Progression, unless there be something to check their increase; until the second brood amounts to twenty millions, and the third brood to two thousand millions. We may form some idea of the meaning of two thousand millions of Chinch Bugs, when it is stated that that number of them, placed in a straight line head and tail together, would just about reach from the surface of the earth to its central point—a distance of four thousand miles.

According to the reasoning of Dr. Henry Shimer, of Mr. Carroll, Illinois, who published an interesting paper on this insect in the proceedings of the Academy of Natural Science of Philadelphia for May, 1867, the Chinch Bug takes wing only at its love seasons, which occur in his locality in May and in August. His views on this subject are

well set forth in the following paragraph taken from the paper above alluded to:

May 16, 1865, was a delightful, mild, bright, sunny, summer-like day: and I again, for the last time, observed the same highly interesting phenomena, which I have noticed above as occurring after the harvest of 1864—the atmosphere swarming with Chinch Bugs on the wing. This is their spring; that was their autumnal nuptial season—their season of love. These remarkable little creatures prefer to conduct their courtships under the searching gaze of the noonday sun, instead of at the midnight hour. They were so numerous, alighting on the pavements in the village, that scarcely a step could be taken without crushing many of them under foot. In a few days, they had all disappeared; their breeding grounds were chosen, where they could be found in great numbers, often in pairs. I first noticed this disposition of the Chinch Bug to take wing under the promptings of the love passion, about six years ago, in their autumnal love season. At no other time save their love season, twice a year, have I ever seen one Chinch Bug flying. It is quite remarkable that the winged imago, under no other circumstances will even attempt to use its ample wings. No threatening danger, however imminent, whether of being driven over by grain reapers, wagons, or of being trodden under foot, etc., will prompt it to use its wings to escape. I have tried all imaginable ways to induce them to fly, as by threshing among them with bundles of rods or grass, by gathering them up and letting them fall from a height, etc., but they invariably refuse entirely to attempt to use their wings in escaping from danger. The love emotion alone makes them conscious that they are in possession of wings.

I agree entirely with Dr. Shimer as to the facts mentioned in the paragraph, but not as to the conclusions which he deduces. There are many objections to his theory, some of which may be found in the *American Entomologist*, (Vol. I, pp. 172–3).

It is a notorious fact that Chinch Bugs do not all mature at once, and if they took wing only when making their courtships, some of them would be flying during a period of several weeks; and as will be shown presently, there exists a dimorphous short-winged form of the Chinch Bug, which cannot possibly make any such ærial love trips. It seems more agreeable to analogy that they take wing only when they have become so unduly numerous that they are instinctively aware that they must either emigrate or starve. Be this however as it may, the fact of their being as a general rule unwilling to use their wings is well known to every practical farmer.

It has long been known that the Chinch Bug deposits its eggs underground and upon the roots of the plants which it infests, and that the young larvæ remain underground for some considerable time after they hatch out, sucking the sap from the roots. If, in the spring of the year, you pull up a wheat plant in a field badly infested by this insect, you will find hundreds of the eggs attached to the roots; and at a somewhat later period the young larvæ may be found clustering upon the roots and looking like so many moving little red atoms. The egg is so small as to be scarcely visible to the naked eye, of an oval shape, about four times as long as wide, of a pale amber white

color when first laid, but subsequently assuming a reddish color from the young larva showing through the transparent shell.* As the mother Chinch Bug has to work her way underground in the spring of the year, in order to get at the roots upon which she proposes to lay her eggs, it becomes evident at once, that the looser the soil is at this time of the year the greater the facilities which are offered for the operation. Hence the great advantage of ploughing land for spring grain in the preceding autumn, or, if ploughed in the spring, rolling it repeatedly with a heavy roller after seeding. And hence the remark frequently made by farmers, that wheat harrowed in upon old corn-ground, without any ploughing at all, is far less infested by Chinch Bug than wheat put in upon land that has been ploughed. There is another fact which has been repeatedly noticed by practical men. This insect cannot live and thrive and multiply in land that is sopping with water; and it generally commences its operations in early spring upon those particular parts of every field where the soil is the loosest and the driest.

The female occupies about three weeks in depositing her eggs, and, according to Dr. Shimer's estimate, she deposits about 500. The egg requires about two weeks to hatch, and the bug becomes full grown and acquires its wings in from 40 to 50 days after hatching.

[Fig. 2.]

There are, as is well known to Entomologists, many genera of the Half-winged Bugs, which in Europe occur in two distinct or "dimorphous" forms, with no intermediate grades between the two; namely, a short-winged or sometimes even a completely wingless type and a long-winged type. Frequently the two occur promiscuously together, and are found promiscuously copulating so that they cannot possibly be distinct species. Sometimes the long-winged type occurs in particular seasons and especially in very hot seasons. More rarely the short-winged type occurs in a different locality from the long-winged type, and usually in that case in a more northerly locality. We have a good illustration of this latter peculiarity in the case of the Chinch Bug, for a dimorphous short-winged form (Fig. 2.) occurs in Canada, and Dr. Fitch describes it from specimens received from the States, as a variety, under the name of *apterus*.

DESTRUCTIVE POWERS OF THE CHINCH BUG.

Few persons in the more Northern States can form a just conception of the prodigious numbers and redoubtable armies in which this insect is sometimes seen in the South and Southwestern States,

*In Dr. Shimer's Paper the dimensions of the egg, as "determined with fine mathematical instruments," are said to be "0.04 inch long and 0.01 inch wide," (p. 99.) This is either a clerical or a typographical error for "0.004 inch long and 0.001 inch wide." Otherwise the egg would be nearly one-third as long as the insect itself; and as Dr. Shimer thinks that every female lays about 500 eggs, this would be something like getting a bushel of wheat out of a quart measure.

marching from one field to another. The following extracts—the first one written in June, 1865, by Dan. F. Rogers to the New York Farmers' Club, and the second from an old number of the *Prairie Farmer*—may seem a little far-fetched, but I have no doubt that both accounts are substantially correct:

There never was a better "show" for wheat and barley than we had here the 10th of June, and no more paltry crop has been harvested since we were a town. Many farmers did not get their seed. In passing by a field of barley where the Chinch Bugs had been at work for a week, I found them moving in solid column across the road to a corn field on the opposite side, in such numbers that I felt almost afraid to ride my horse among them. The road and fences were alive with them. Some teams were at work mending the road at this spot, and the bugs covered men, horses and scrapers till they were forced to quit work for the day. The bugs took ten acres of that corn, clean to the ground, before its hardening stalks—being too much for their tools—checked their progress. Another lot of them came from a wheat field adjoining my farm into a piece of corn, stopping now and then for a bite, but not long. Then they crossed a meadow 30 rods into a 16 acre lot of sorgo, and swept it like a fire, though the cane was then scarce in tassel. From wheat to sorgo was at least sixty rods. Their march was governed by no discoverable law, except that they were infernally hungry, and went where there was most to eat. *Helping a neighbor harvest* one of the few fortunate fields, early sown—and so lucky!—we found them moving across his premises in such numbers that they bid fair to drive out the family. House, crib, stable, well-curb, trees, garden fences—one *creeping* mass of stinking life. In the house as well as outside, like the lice of Egypt, they were everywhere; but in a single day they were gone.

If any Western rustics are verdant enough to suppose that Chinch Bugs cannot be out-flanked, headed off and conquered, they are entirely behind the times. The thing has been effectually done during the past season, by Mr. Davis, Supervisor of the town of Scott, Ogle county, Ills. This gentleman had a cornfield of a hundred acres, growing alongside of an extensive field of small grain. The bugs had finished up the latter and were preparing to attack the former, when the owner, being of an ingenious turn, hit upon a happy plan for circumventing them. He surrounding the corn with a barrier of pine boards set up edgewise, and partly buried in the ground, to keep them in position. Outside of this fence deep holes were dug, about ten feet apart. The upper edge of the board was kept constantly moist with a coat of coal tar, which was renewed every day.

The bugs, according to their regular tactics, advanced to the assault in solid columns, swarming by millions, and hiding the ground. They easily ascended the boards, but were unable to cross the belt of the coal tar. Sometimes they crowded upon one another so as to bridge over the barrier, but such places were immediately covered with a new coating. The invaders were in a worse quandary than that of Butler and Weitzel at Fort Fisher, and, in that state of mind crept backward and forward until they tumbled into the deep hole aforesaid. These were soon filled, and the swarming myriads were shoveled out of them literally by wagon loads, at the rate of thirty or forty bushels a day—and buried up in other holes, dug for the purpose, as required. This may seem incredible to persons unacquainted with this little pest, but no one who has seen the countless myriads which cover the earth as harvest approaches, will feel

inclined to dispute the statement. It is an unimpeachable fact. The process was repeated till only three or four bushels could be shovelled out of the holes, when it was abandoned. The corn was completely protected, and yielded bountifully.

HEAVY RAINS DESTRUCTIVE TO THE CHINCH BUG.

As the Chinch Bug, unlike most other true Bugs, deposits its eggs underground, and as the young larvæ live there for a considerable time, it must be manifest that heavy soaking rains will have a tendency to drown them out. The simple fact, long ago observed and recorded by practical men, such as Mr. B. E. Fleharty of North Prairie, Knox county, Ills., that this insect scrupulously avoids wet land, proves that moisture is naturally injurious to its constitution. Hence it was many years ago remarked by intelligent farmers, and we had an illustration of it the present year (1869), that very often when the spring opens dry, Chinch Bugs will begin to increase and multiply in an alarming manner; but that the very first heavy shower checks them up immediately, and repeated heavy rains put an almost entire stop to their operations. It is very true that nearly all insects will bear immersion under water for many hours, and frequently for a whole day, without suffering death therefrom; for although animation is apparently suspended in such cases, they yet, as the phase is, "come to life again." But no insect, except the few that are provided with gills like fishes and extract the air out of the water, instead of breathing it at first hand, can stand a prolonged immersion in water without drowning. And it must be obvious to the meanest capacity, that an insect, such as the Chinch Bug, whose natural home is the driest soil it can find, will have its health injuriously affected by a prolonged residence in a wet soil.

In fact the whole history of the Chinch Bug, from the very earliest records which we have of it, points unmistakably to the fact that a wet season affects it injuriously, and often almost annihilates it.

arolina and Virginia, during the dry years which preceded 1840, it had become so numerous that the total destruction of the crops was threatened; but fortunately, unlike its predecessors, the summer 1840 was quite wet and the ravages of the bug were at once arrested. In Illinois and in this State it had increased to an alarming extent during the latter part of the late Rebellion; but the excessive wet summer of 1865 swept them away to such an extent that it was difficult to find any in the fall of that year. So it was again in 1869–70, and so it always has been, and doubtless always will be. It will be well therefore for farmers to bear in mind, that *in a hot, dry season Chinch Bugs are always the worst, and that in a wet season it is impossible for them to do any considerable amount of damage.*

Dr. Shimer, however, is not satisfied with this simple theory. He has gotten up and expounded to the world a new and recondite theory of his own, namely, that in the terrible wet season of 1865, when the Chinch Bug, although in early spring it had appeared in

very great numbers, was almost annihilated in the course of the summer, it perished, not as others had foolishly supposed, from the direct operation of the rain, but indirectly through a certain mysterious epidemic disease analogous to the Cholera or the Yellow Fever among human beings. He fully allows that the mortality among the Chinch Bugs was contemporaneous with the wet weather; but he will have it that it was not the wet weather that killed the Bug, as we common folks have always hitherto believed, but that it was his newly-discovered Epidemic Disease. But as in the conjoint article in the *American Entomologist* (I, pp. 174–6) this Epidemic theory was fully considered by my late associate, Mr. Walsh, in his own peculiar style, I shall not dwell upon it here.

CANNIBAL FOES OF THE CHINCH BUG.

As long ago as 1861, Mr. Walsh, in his *Essay upon the Injurious Insects of Illinois*, published facts which tended to show that four distinct species of Ladybirds preyed upon the Chinch Bug.* The first of these four is the Spotted Ladybird (*Hippodamia maculata*, DeGeer, Fig. 3), which also preys upon a great variety of other insects, attacking both the eggs of the Colorado Potato Bug and those of certain Bark-lice; and which is further remarkable for being one of the few insects found both in Europe and in North America.

[Fig. 3.]

[Fig. 4.]

In corroboration of the fact of its preying on the Chinch Bug, I may state, that the Rev. Chas. Peabody, of Sulphur Springs, informs me that he has repeatedly found it so feeding on his farm. The second species is the Trim Ladybird (*Coccinella munda*, Say, Fig. 4), which is distinguishable at once from a great variety of its brethren by having no black spots upon its red wing-cases. The other two are much smaller insects, belonging to a genus (*Scymnus*) of Ladybirds, most of the species of which are quite small and of obscure brown colors, and hard to be distinguished by the popular eye from other beetles, the structure of which is very different, and which therefore belong to very different groups and have very different habits.

In the autumn of 1864 Dr. Shimer ascertained that the Spotted Ladybird which has been sketched above, preys extensively upon the Chinch Bug. In a particular field of corn, which had been sown thick for fodder, and which was swarming with Chinch Bugs, he found, as he says, that this Ladybird, "could be counted by hundreds upon every square yard of ground after shaking the corn; but the Chinch Bugs were so numerous that these hosts of enemies made very little perceptible impression among them."

In the same autumn Dr. Shimer made the additional discovery, that in the very same field of fodder-corn the Chinch Bugs were preyed upon by a very common species of Lacewing-fly, which he

*See *Trans. Ill. St. Agric. Society*, IV, pp. 346–9.

described in January, 1865,* as the Illinois Lacewing (*Chrysopa Illinoiensis*). The description was republished, together with the substance of Mr. Shimer's observations in the *Prairie Farmer*, of Chicago, Ill., accompanied with a non-characteristic wood-cut of the larva, cocoon and imago. At this time Mr. Shimer favored me with two specimens of the perfect insect, and he likewise furnished Mr. Walsh with additional specimens. From these specimens, it is evident that the species is the same as that described long before, by Dr. Fitch, as the Weeping Lacewing (*Chrysopa plorabunda*). In 1868, I found the same species quite numerous in a wheat field belonging to Mr. T. R. Allen, of Allenton, where its larvæ were perhaps feeding on the Chinch Bugs, as they were found to do in North Illinois, by Dr. Shimer.

[Fig. 5.]

The Lacewing flies all bear a striking resemblance to one another, both in size, shape and color; and to convey a correct idea of their appearance, it is only necessary to repeat the annexed drawing (Fig 5.) from my First Report, where a sketch of their natural history will be found (pp. 57–8).† They almost all of them, in the fly state, have a characteristic and disagreeable odor, resembling nothing so much as human ordure.

According to Dr. Shimer, the Weeping Lacewing-fly was not quite as abundant as the Spotted Ladybird among the fodder-corn, but still there were so many of them, that he thought that "there was one or more of them for every stalk of that thickly sown corn." "Every stroke of the cutter," he adds, "would raise three or four dozen of them, presenting quite an interesting spectacle as they staggered along in their awkward, unsteady flight." And he not only actually observed the larvæ preying very voraciously on the Chinch Bugs in the field, but he reared great numbers of them to the mature Fly by feeding them upon Chinch Bugs. His account of the operations of the larva when in captivity is so interesting that I quote it in full:

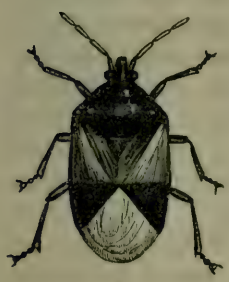
I placed one of the larvæ in a vial, after having captured it in the field in the very act of devouring Chinch Bugs of all sizes, and subsequently introduced into the vial a number of Chinch Bugs. They had hardly reached the bottom before it seized one of the largest ones, pierced it with its long jaws, held it almost motionless for about a minute while it was sucking the juices from the body of its victim, and then threw down the lifeless shell. In this way, I saw it destroy in quick succession, about a dozen bugs. Towards the last, as its appetite was becoming satiated, it spent five or more minutes in sucking the juices from the body of one bug. After this bountiful repast, it remained motionless for an hour or more, as if asleep. Never for

*Proc. Ent. Soc. Phil., IV, pp. 208–12.

†In that account I stated as a fact which, so far as I was aware, had not been recorded by any previous writer, that the insect issues from the small cocoon in an active sub-imago state, from which, after a few hours, the winged fly emerges, leaving behind it a fine silvery-white transparent skin. I have since found that Dr. Shimer, in the scientific paper already referred to, had previously recorded the very same fact.

a single moment, during the feast, did it pause in the work. When not in possession of a bug, it was on the search for, or in the pursuit of others. It manifested much eagerness in the pursuit of its prey, yet not with a lion-like boldness; for on several occasions I observed a manifest timorousness, a halting in the attack, as if conscious of danger in its hunting expeditions, although here there was none. Sometimes, when two or more bugs were approaching rapidly, it would shrink back from the attack, and turning aside go in the pursuit of others. At length, awakening, it would renew the assault as before. On one occasion, when it was on the side of the vial, two inches up, with a large bug in its mouth, I jarred the vial, so that it fell to the bottom and rolled over and over across the bottom, but holding on to its prey, it regained its footing and mounted up to its former position. Occasionally the Chinch Bugs would hasten to escape when pursued, as if in some degree conscious of danger.

Fig. 6.



I

The Insidious Flower Bug, (*Anthocoris insidiosus*, Say), of which I represent herewith a highly magnified figure, (Fig. 6), may often be found in company with the Chinch Bug, under the husks of ears of corn. It is quite common in Missouri, where I have found it in several different galls, and especially in the Grape-vine Leaf gall, where it was preying on the lice (*Phylloxera vitifoliæ*), which are the architects of the gall. It has often been mistaken for the Chinch Bug, and was upon one occasion sent to Dr. Fitch, by one of his correspondents, for that veritable Bug. Yet it undoubtedly preys upon the Chinch Bug, as well as upon a variety of other plant-feeding insects, and it therefore becomes very necessary that the farmer should learn to recognize it and distinguish it from the true culprit. It is very true that, practically, it will be found almost impossible to separate the sheep from the goats, and spare the lives of the former while condemning to destruction the unsavory little carcasses of the latter. Still, it will be some comfort to the grain-grower, when at some future day he may discover his small grain or his corn to be alive with Chinch Bugs, to perceive the bright orange-colored larvæ of the Insidious Flower-Bug dodging about among the blood-red or blood-brown larvæ of his bitter foes, and sucking out their life-blood with ravenous avidity; or to discover the little slow-going larvæ of the *Scymnus* group of Ladybirds, with such dense and evenly-shorn masses of short milk-white cottony threads growing out of their entire bodies that they look like little animated flakes of cotton wool, crawling about among the stinking crowd and making many a hearty meal off them, stink they never so badly; or, finally, to watch the lizard-like black and yellow larvæ of the Spotted Ladybird, and the Trim Ladybird, with their short, robust jaws, or the greenish-brown larvæ of the Lacewing-fly, with their long slender sickle-shaped jaws, running rapidly about among the hosts of their enemies, and smiting them hip and thigh without any more mercy than the Amale-

kites of old experienced at the hands of avenging Israel. He will then know that, even if he is himself powerless to make head against a host of minute foes, as numerous as the sand on the seashore, and as destructive and irresistible as the waves of the great ocean itself, Providence has provided a check upon the unlimited increase of his enemies; and that a Power which is above us all and provides for us all, and which alloweth not even a sparrow to fall to the ground unless by His especial permission, has said to every vegetable-feeding insect, through the mouths of the various Cannibal and Parasitic species which He has appointed to do His work: "Thus far shalt thou go, and no farther; and here shall thy proud hosts be stayed."

The common Quail of the Middle and Western States (*Ortyx Virginiana*) otherwise known as the Partridge in the Northern States has long since been known as a most efficient destroyer of Chinch Bugs, and the fact was some time ago published by myself in the *Prairie Farmer*, and by others in various Agricultural Journals and Reports. We also have the corroborative testimony of Dr. Shimer, who is a good ornithologist. In the winter time, when hard pushed for food, this bird must devour immense numbers of the little pests which winter in just such situations as are frequented by the Quail; and this bird should be protected from the gun of the sportsman in every State where the Chinch Bug is known to run riot.

AMOUNT OF DAMAGE DONE BY THE CHINCH BUG.

According to Dr. Shimer's estimate, which may be considered a reasonable one, in the year 1864 "three-fourths of the wheat and one-half of the corn crop were destroyed by the Chinch Bug throughout many extensive districts, comprising almost the entire Northwest." At the average annual rate of increase, according to the United States Census, in the State of Illinois, the wheat crop of 1864 ought to have been about thirty millions of bushels, and the corn-crop about one hundred and thirty-eight million bushels. Putting the cash value of wheat at $1.25 and that of corn at 50 cents, the cash value of the corn and wheat destroyed by this insignificant little bug, no bigger than a grain of rice, in one single State and in one single year, will therefore, according to the above figures, foot up to the astounding total of OVER SEVENTY-THREE MILLIONS OF DOLLARS! Put it as low as we choose, it is still a "big thing;" and it is unnecessary to argue a question any further, when facts and figures speak so plainly.

REMEDIES AGAINST THE CHINCH BUG.

It has long been noticed that the Chinch Bug commences its ravages in the spring from the edges of a piece of grain, or occasionally from one or more small patches, scattered at random in the more central portions of it, and usually drier than the rest of the field. From these particular parts it subsequently spreads by degrees over the whole field, multiplying as it goes and finally taking the entire crop unless checked up by seasonable rains. In newly-broken land,

where the fences are new and consequently no old stuff has had time to accumulate along them, the Chinch Bug is never heard of. These facts indicate that the mother insects must very generally pass the winter in the old dead stuff that usually gathers along fences. Hence, by way of precaution, it is advisable, whenever possible, to burn up such dead stuff in the winter or early in the spring, and particularly to rake together and burn up the old corn-stalks, instead of plowing them in, or allowing them, as is often done, to lie littering about on some piece of waste ground. It is true, agriculturally speaking, this is bad farming; but it is better to lose the manure contained in the corn-stalks than to have one's crop destroyed by insects. Whenever such small infected patches in a grain field are noticed early in the season, the rest of the field may often be saved by carting dry straw on to them and burning the straw on the spot, Chinch Bugs, green wheat and all; and this will be still easier to do when the bugs start along the edge of the field. If, as frequently happens, a piece of small grain is found about harvest-time to be so badly shrunken up by the bug as not to be worth cutting, the owner of it ought always to set fire to it and burn it up along with its ill-savored inhabitants. Thus, not only will the insect be prevented from migrating on to the adjacent corn-fields, but its future multiplication will be considerably checked.

A very simple, cheap and easy method of prevention was recommended in the *Prairie Farmer* of April 19th, 1862, by Mr. Wilson Phelps, of Crete, Illinois. It may very probably be effectual when the bugs are not too numerous, and certainly can do no harm:

With twelve bushels of spring wheat mix one bushel of winter rye, and sow in the usual manner. The rye not heading out, but spreading out close to the ground, the bugs will content themselves with eating it, until the wheat is too far advanced to be injured by them. There will, of course, be no danger of the winter rye mixing with the spring wheat.

When Chinch Bugs are likely to march, as they often do, after the fashion of Army-worms, from an infected to an uninfected field, Mr. H. J. Everest, of Stoughton, Dane county, Wisconsin, recommends the following plan, which is stated to have been tried by several persons and found to be perfectly effectual, and which is substantially the same as that referred to on page 23:

Take common fence-boards, six inches or less wide, and run them around the piece, set edgewise, and so that the bugs cannot get under them or between the joints, and then spread either pine or coal tar on the upper edge, and they will not cross it. The tar needs renewing till the edge gets saturated, so that it will keep wet and not dry in any more, and either kind of tar is effectual. Then dig holes close to the boards, about like a post-hole, once in four or five rods, and run a strip of tar from the top of the board to the bottom on the outside opposite the hole, and they will leave the board, and in trying to get around the tarred stripe will slide into the hole, where they will be obliged to remain till they can be buried at leisure, and new holes opened for more victims. It is seldom one has to fence more than

one side of a field, but wherever the fence is, it is a sure stop.—*Prov. New York Farmers' Club.*

Finally, when the Chinch Bugs are already in the field which it is proposed to rescue from their clutches, Mr. Michael Hopps, of Lyonsville, Cook county, Illinois, says that he saved a piece of wheat by sowing gas-lime broadcast over it, at the rate of six or seven bushels to the acre; and that the effect was that the bugs immediately left his field, and his crop was saved, while the wheat of his neighbors was nearly ruined by them. He further states that "a neighbor had a field of wheat adjoining his (Mr. Hopps's) cornfield, in which the bugs worked badly. Thinking that, as soon as the wheat was cut, they would emigrate to his corn, he dropped a handful of the gas-lime upon each hill of corn, in the same manner as plaster is often dropped upon corn in the East. The consequence was that the bugs did not attack the corn in the least."—(*Prairie Farmer.*)

But, if gas lime keeps off Chinch Bugs, which may or may not be the case, it appears that coal-tar most certainly will not do so, as the following experiment of Dr. Shimer's proves:

May 26th, 1864.—I saturated some saw-dust with coal-tar, and mixed some quick-lime among it, so that it might be in a good condition for handling, and sowed it thickly broadcast over a portion of my wheat field, where the bugs were very numerous.

May 27th–29th, 1864.—The bugs refuse to leave the part of the field where I sowed the tarred saw-dust, so there is but little hope of driving them from their once chosen grounds, by the seasonable application of strong smelling drugs.

I have known farmers to follow the plan of going through a wheat field badly infested with Chinch Bugs, and with a sickle to cut, here and there, small patches of the wheat which they threw on the ground in the form of a loose irregular shock. The bugs would gather under these cut stalks in great numbers from the standing grain, and could then be destroyed either by crushing or by burning them with straw.

The above remedies are selected as the most likely to prove practically successful, from a mass floating round in the various Agricultural Journals, some of them utterly absurd and irrational, and others of very doubtful use. As to the ridiculous proposal put forth in the Waukegan (Ills.) *Gazette*, in 1865, with a great flourish of trumpets, by one D. H. Sherman of that town; namely, to destroy the Chinch Bugs in the egg state by pickling all the seed wheat; it is sufficient to observe that this insect *never* deposits its eggs upon the kernel of the ripe wheat. Consequently, to attempt to kill Chinch Bug eggs, by doctoring the seed wheat, would be pretty much like trying to kill the nits in a boy's head by applying a piece of sticking-plaster to his great toe. In the old *Practical Entomologist* (I, p. 48), I showed that there were no such eggs in the wheat kernels, which Mr. Sherman himself had sent me, and which he had supposed to be thus infested.

BOGUS CHINCH BUGS.

Few things are more astonishing than the acuteness of perception superinduced by being constantly conversant with some one particular subject. I have often been surprised at the readiness with which nurserymen will distinguish between different varieties of Apple, even in the dead of the year, when there are no leaves, and of course no fruit on their nursery trees. In the same way old practiced shepherds can recognize every individual sheep out of a large flock, though, to the eyes of a common observer, all the sheep look alike. Experienced grain-growers, again, can distinguish at a glance between twenty different varieties of wheat, which the best botanist in the country would fail to tell one from the other; and I have been informed that a miller of many years' standing, as soon as he has shouldered a sack of wheat, knows at once whether it is spring grain or fall grain; while ninety-nine entomologists out of every hundred would probably be unable, on the most careful inspection, to tell the difference between the two, and some might even mistake wheat for rye.

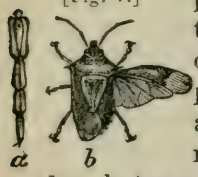
It is not surprising, therefore, that persons who have paid no particular attention to the study of insects, often confound together insects which, in the eyes of the professed entomologist, look as different from each other as a horse does from a cow or a hog. It would, indeed, be little short of miraculous if this were not so; for there are about thirty thousand distinct species of insects to be found within the limits of the United States, and of course in such a vast multiplicity, there must be many strong resemblances.

I will therefore conclude this article on the Chinch Bug, by briefly mentioning several true Bugs, belonging to the same Order of Half-winged Bugs (*Heteroptera*), as that pestilent little foe of the farmer, and which I know to be frequently mistaken for it. The reader will then, by comparing the different figures, see at once how widely they all differ, and by a very little practice, his eyes will become so well educated that he will soon, without any artificial assistance from glasses, be able to distinguish the creatures one from the other, as they crawl or fly about in the almost microscopic dimensions assigned to them by their Great Creator.

One reason, perhaps, why so many different bugs are popularly confounded with the Chinch Bug, is the similarity of their smell. Everybody is aware that Chinch Bugs possess the same peculiarly unsavory odor as the common Bed Bug; and hence when a person finds a small insect that has this obnoxious smell, he is very apt to jump to the conclusion that it must be a Chinch Bug. No mode of reasoning, however, can be more unsafe or unsound. There are hundreds of different species of Half-winged Bugs—the common brown Squash Bug (*Coreus tristis*) for example—that possess this peculiar smell; and what is stranger still, although this smell is more usually

met with among the plant-feeders, there are a few of the true Cannibals that possess it to perfection. Among these I may mention the Spined Soldier-bug (*Arma spinosa*, Dallas) whose portrait I here reproduce from my First Report (Fig. 7 *b*); for, as the bitterest enemy of the Colorado Potato Bug, and consequently one of our best friends, he cannot too often be presented, or become too well known. We can well afford to endure his unpleasant odor, when we duly reflect on his kind services. Just think of it, you bitter bug-haters—this little soldier has, beyond all doubt, saved thousands of dollars to the State of Missouri in the last few years, by heroically stabbing and slaying countless hosts of one of your worst enemies! That he should have the bed-buggy odor is not very surprising, since he appertains to a large and extensive group, (the *Scutellera* family) most of the other species belonging to which are plant-feeders. Indeed it is a very general rule, to which I know of but one exception* that the insect in the great *Reduvius* family among the Half-winged Bugs, every one of which is of carnivorous propensities, never have this peculiarly nauseous aroma; and that it is bestowed only upon certain plant-feeding bugs, to protect them no doubt from their insect foes, in the same manner as the skunk is protected from the eagle by his odoriferous tail. Yet while many of the plant-feeding Bugs do have this odor, a good many of them are entirely free from it, and some few of them really smell so agreeably that the fact has been thought worthy to be recorded by entomological writers. Even that detestable pest, already referred to, the common Squash Bug, sometimes emits a pleasant aroma, altogether different from that which it normally gives out; for I have kept this winter, in a separate box, one which emits a most pungent but agreeable smell, very much resembling that of a very ripe, rich pear. But perhaps the most suggestive fact of all is that, notwithstanding the close alliance between the two Orders of Half-winged and Whole-winged Bugs, there is not a single known species of the latter that has ever been known to exhale the bedbuggy effluvium, which is met with in so many species belonging to the former.

[Fig. 7.]



a *b*

THE INSIDIOUS FLOWER-BUG.—First among the insects frequently mistaken for the Chinch Bug, may be mentioned the Insidious Flower-bug (*Anthocoris insidious*, Say) already referred to under the head of "Cannibal Foes of the Chinch Bug." This little Flower-bug has been usually referred by entomologists to the same extensive group (*Lyœus* family) as the true Chinch Bug, though more recent authors have placed it in a distinct group on account of its short three-jointed beak.

THE ASH-GRAY LEAF-BUG.—Second among the Bogus Chinch Bugs may be mentioned the Ash-gray Leaf-bug (*Piesma cinerea*, Say) a

* A shiny black species of *Nabis* (*Nabis marginatus*, Uhler, MS) smells as much like a Bed Bug as the most peaceable Plant-feeder.

small greenish-gray bug of which I present herewith a highly magnified figure (Fig. 8), its true size being about the same as that of the Chinch Bug for which it has been mistaken, though it lacks altogether the conspicuous black and white markings which characterize that little grain pest, and really resembles it in nothing but the unpleasant odor which it emits. In the summer of 1868, Col. F. Hecker, of St. Clair county, Illinois (See *Am. Entomologist*, I, p. 19), found an insect, which he mistook for the Chinch Bug, destroying the blossom buds of his grape-vines. Now as the Ash-gray Leaf-bug is known to work in this way on the Grape-vine, and as I found it abundant in Col. Foster's vineyard, on the Iron Mountain Railroad in this State, it was doubtless this species which injured Col. Hecker's vines; for the true Chinch Bug has never hitherto been observed to attack woody plants like the Grape-vine, but confines itself exclusively to herbaceous plants, such as wheat, oats, Indian corn, etc. The Ash-gray Leaf-bug belongs to an entirely different group from the Chinch Bug (*Tingis* family) all the species of which have a short 3-jointed beak, which however differs from that of the 3-jointed beak of the Flower-bugs (*Anthocoris*) by being encased in a groove when not in use. They mostly live on green leaves in all their three stages, after the fashion of plant lice. Like the Chinch Bug, the Ash-gray Leaf-bug hybernates in the perfect state, and may be found in the winter in considerable numbers under the loose bark of standing trees and especially under that of the Shag-bark Hickory.

[Fig. 8.]

I

With the exception of the Ash-gray Leaf-bug, there is no North American species belonging to the genus, that is known to attack fruit trees or fruit-bearing bushes or vines; though there are several that infest forest trees—each species generally confining itself to a particular genus of trees. But in Europe there is a species, the Pear-tree Leaf-bug (*Tingis pyri*) which is so injurious to the Pear, that the French gardeners have given it the name of "the Tiger." It is to be hoped that it may never, like another European pest of pear-growers, the Pear-tree Flea-louse (*Psylla pyri*)—which has already been introduced into the New England States, and will perhaps make its way out West—traverse the Atlantic ocean and take out its naturalization papers in this country.

THE FLEA-LIKE NEGRO-BUG.—Third among the bogus Chinch Bugs may be mentioned the Flea-like Negro-bug (*Corimelæna pulicaria*, Germar), of which I here present a magnified outline (Fig. 9). Its color is black with a white stripe each side. This insect resembles the Chinch Bug in having an ordinary 4-jointed beak, but differs from it in belonging to a very distinct and well marked group (*Scutellera* family), which is characterized by the enormous size of the "scutel" or shield.

[Fig. 9.]

In the most numerously represented division of this family the scutel forms a large triangle, extending along the back about half-way to the tip of the abdomen, as may be seen in the figure of the Spined Soldier-bug (Fig. 7), referred to on a previous page. But in another division of this family which does not contain nearly so many species, the scutel, instead of being angular, is rounded at top and covers more or less the entire upper surface of the abdomen. It is to this last division that the Flea-like Negro-bug belongs, and the dirty yellow or white stripes at its sides are really nothing but the thickened anterior edge of the front wings, all the remaining part of the front wings, as well as the entire hind wings, being, in repose, completely hidden under this enormously extended shield. In the Bordered Soldier-bug, as the reader will perceive from the annexed drawing (Fig. 10), which I reproduce from my First Report, the scutel is indeed rounded, and also extends a considerable distance over the abdomen; but as it otherwise agrees with the other Soldier-bugs in the rest of its organization, it is classified with them, and not with our Negro-bug.

[Fig. 10.]

The Flea-like Negro-bug has been known to injure various plants for two or three years back. I found it exceedingly abundant last summer in all parts of the State which I visited. It has a great passion for the fruit of the Raspberry, and is sometimes so plentiful as to render the berries perfectly unsaleable by the bed-bug aroma which it communicates to them, as well as by sucking out their juices. Wherever it occurs, the nauseous flavor which it imparts to every berry which it touches, will soon make its presence manifest, though the little scamp may elude ocular detection. It is really too bad that such a little black varmint should so mar the exceeding pleasure which a lover of this delicious fruit always experiences when in the midst of a raspberry plantation in the fruit season. It is also quite injurious to the Strawberry, puncturing the stem with its little beak, and thus causing either blossom or fruit to wilt; and the following extract, taken from a communication to the *Western Rural* by Mr. B. Pullen, of Centralia, Ills., undoubtedly refers to the same Bug, and would indicate that it made its first appearance in that neighborhood last summer:

"A new insect, to us here, has appeared on our strawberries for the first time the past season, damaging the crop very much. It resembles somewhat the Chinch Bug, so destructive to our wheat and corn, and, judging from the peculiar odor they emit on being mashed, should think them very nearly related. Some claim that they are of a different species altogether. Whether this be so or not those interested in the cultivation of the strawberry are anxiously looking forward to another season to see if they are to continue their depredations."

It likewise attacks the Strawberry in Canada, as an account of its attacking that plant, is given by my friend, C. J. S. Bethune, in the

Canada Farmer for August 1st, 1867; and it was under this very same serious charge that it was apprehended and brought up for trial at the last May meeting of the Alton (Ills.) Horticultural Society. It also attacks both Cherry and Quince, occurring on these trees in very large numbers, and puncturing the blossoms and leaves, but especially the fruit stems, which in consequence shrivel and die. It is also quite injurious to garden flowers and especially to the Coreopsis, and abounds on certain weeds, among which may be mentioned the Red-root or New Jersey Tea-plant (*Ceanothus Americanus*), and Neckweed or Purslane-speedwell (*Veronica peregrina*). In the month of June under these two last named plants, they may be found in countless numbers of all sizes and ages, from the small light brown wingless, newly hatched individuals, to the full fledged jet black ones. In fact they breed on these weeds, and there is no more effectual method of checking their increase and thus preventing their injuries to our cultivated fruits, than by sprinkling these weeds, and the ground underneath them, with a good strong solution of Cresylic soap. I should advise the propagation of a small patch of either one of these weeds near a strawberry patch, as a decoy for the Bugs, which may thus be, to some extent, enticed away from the strawberry plants, and killed more readily.

There are two other species of Negro-bug which are common in this State, though they never swarm in such injurious profusion as does the Flea-like Negro-bug. The first of these (*Corimelœna lateralis*, Fabr.) is absolutely undistinguishable from it however, except in being fully one-half longer and wider. The shape, sculpturing and coloring are exactly the same, even down to the lateral white stripe; so that, but for the fact of no intermediate grades in size occurring, the two would be certainly considered as mere varieties of one and the same species. The other Negro-bug (*Cor. unicolor*, Beauv.) is fully twice as long and wide as our insect; but though resembling it closely in every other respect, yet differs very notably in lacking the white anterior edging to the front wings. It might indeed be said, that the biggest Negro dresses entirely in black, while the two other smaller sized darkies relieve the sombre monotony of their sable suits, by wearing a conspicuously white shirt-collar.

To these three bogus Chinch Bugs, might be added one or two other species of small stinking Bugs which have been, by some persons, mistaken for the true Chinch Bug. But enough has been already said to show, that insects which in reality are shaped and fashioned as differently as are cows and deer, are yet often confounded together in the popular eye, principally, no doubt, because they have the same peculiar bed-bug aroma. Should the ignorance of the popular judgment in confounding these tiny creatures which seem to the Entomologist so very, very different from each other, therefore, be despised and ridiculed? Far be it from me to display such intolerant stupidity! As well might the nurseryman ridicule the grain-grower,

because the grain-grower cannot distinguish a Baldwin Seedling from a High top apple; or the grain-grower the nurseryman because the nurseryman cannot tell Mediterranean from Tea wheat, or Club from Fife. I do, however, entertain an abiding hope that by the present very general and praiseworthy movement towards the popularization of Natural History, and by the dissemination of Entomological Reports, a better knowledge of this practically important subject will soon exist in the community. Our farmers will then, not so often wage a war of extermination against their best friends, the cannibal and parasitic insects, while they overlook and neglect the very plant-feeders which are doing all the damage, and upon which the others are feeding in the very manner in which a Wise Providence has appointed them to adopt.

RECAPITULATION.

The following important points in the history of the Chinch Bug, may be considered as firmly established:

1st. Chinch Bugs hybernate in the perfect or winged state in any old dry rubbish, under dead leaves, in old straw, in corn-shucks and corn-stalks, among weeds in fence-corners, etc., etc. Therefore all such substances should be burned up, as far as possible, in the spring.

2nd. The earlier small grain can be sowed in the spring, the more likely it is to escape the Chinch Bug; for it will then get ripe before the spring brood of bugs has had time to become fully developed at the expense of the grain.

3d. The harder the ground is where the grain is sowed, the less chance there is for the Chinch Bug to penetrate to the roots of the grain and lay its eggs thereon. Hence the importance of fall-ploughing and using the roller upon land that is loose and friable. And hence, if old corn-ground is sufficiently clean, it is a good plan to harrow in a crop of small grain upon it without ploughing it at all. Moreover this rolling plan should always be adopted, as the best wheat-growers both in this country and in Europe attest that the heavier the ground for wheat is rolled, the better will be the crop.

4th. A single heavy rain immediately checks up the propagation of the Chinch Bugs. Continued heavy rains diminish their numbers most materially. A long-continued wet season, such as that of 1865, almost sweeps the whole brood of them from off the face of the earth; but from the rapid rate at which they multiply there will always be enough left for seed for another year. It may be laid down, not only as a general, but universal rule, that this insect is never ruinously destructive, except in those sections of country where there is continued hot dry weather; and that if, in two adjoining districts, there has been a dry summer in one and much wet weather during the summer season in the other, however plentiful and destructive the bug may be in the first district, it will scarcely be heard of in the second. Certainly this state of facts is not exactly that from which any reasonable man would infer, that the paucity of Chinch Bugs in a wet

season is caused by an Epidemic Disease taking them off. We might as well maintain that, although there was no Epidemic Disease among the children of Israel that had just crossed the Red Sea, or among the Egyptians that staid at home, it was simply and solely an Epidemic Disease that slew the pursuing hosts of the Egyptians and covered the bottom of the Red Sea with their carcasses.

THE ARMY-WORM—*Leucania unipuncta*, Haw.

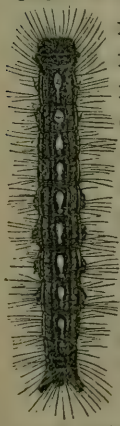
[Lepidoptera Noctuidæ.]

Among those insects which attract especial attention, either from the peculiarity of their habits, or the vast amount of damage which they inflict, the notorious Army-worm holds a conspicuous place. The mode in which these worms travel in vast armies when in search of food, the great value of the cereals and the grasses to which they for the most part confine their ravages, their sudden appearance in such incomputable numbers, and their equally sudden disappearance, all tend to arouse the curiosity and interest of even the most indifferent observer.

Before giving a history of this insect, it will be necessary to state that there are four distinct caterpillars, producing four perfectly distinct moths, which have been designated as Army-worms in various parts of the United States.

First—The Tent-caterpillar of the Forest (*Clisiocampa sylvatica*, Harr.) has been erroneously known by the name of "Army-worm" in the northwest corner of the State of New York. A back view of this caterpillar is given in the accompanying sketch (Fig. 11) by which it will at once be recognized by the reader. For a number of days, last June, this worm might have been seen marching "single file" up the railroad track on Pilot Knob, in the scorching rays of the noonday sun; and it is often found crawling along roads in very considerable numbers. Yet it cannot with propriety be called an Army-worm, and our Eastern friends had best drop the title and avoid confusion in the future.

[Fig. 11.]

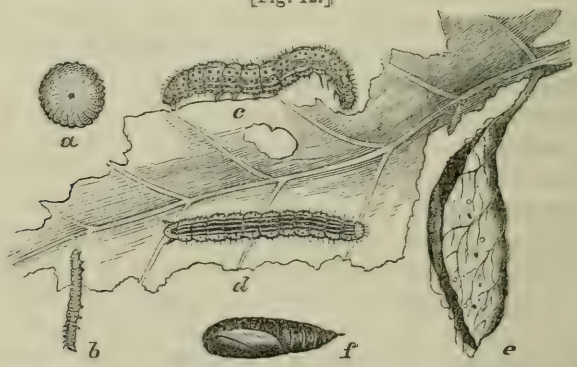


Second—The Cotton-worm (*Anomis xylina*, Say), is very generally known by the name of "the Cotton Army-worm," in the South. The term as applied to this species is not altogether inappropriate, as the worm frequently appears in immense armies, and when moved by necessity will travel over the ground in "solid phalanx;" and so long as the word "Cotton" is attached—its ravages being strictly confined to this plant—there is no danger of its being confounded with the true Army-worm. The term has furthermore received the sanction of custom in the Southern States, and of Mr. Glover in his Department Reports.

As various attempts have been made, with more or less success, to grow the cotton plant in the southern parts of this State, a description of this insect will not be inappropriate, the more especially, since it will teach the reader the difference between it and the true Army-worm.

The Cotton-worm was first scientifically described by Mr. Thomas Say, in the year 1827. According to Dr. D. L. Phares, of Woodville, Miss., it destroyed at a low estimate, 200 tons of cotton in the Bahamas as long ago as 1788; while in Georgia it completely destroyed the crop in 1793. According to Dr. Capers* its injuries were noticed in 1800, and it likewise proved very destructive in 1804, 1825 and 1826. Since the last date, as we may learn from old volumes of the *American Farmer*, of Baltimore, Md., and from the Patent Office Reports, it has done more or less damage to the crop almost annually, in some part or other of the cotton-growing district. As with the real grass-feeding Army-worm of the Middle States, it swarms in particular years to such an extent as to utterly ruin the crop, while in other years it is scarcely noticed. This fact has led many to infer that there is a stated periodicity in its returns in such immense numbers; but the natural history of the worm confutes such an idea, while the records give no foundation for the inference. The sudden increase or decrease of this, as of other species of noxious insects, depends on climatic, as well as on other equally potent influences.

[Fig. 12.]



The egg, (Fig. 12, *a*), according to Dr. Phares is shaped "precisely like a scull-cap, with rows of pinheads from base to apex as thickly set as possible," appearing as if moulded in a very deep saucer. These eggs are of a translucent green color, and are deposited upon the under side of the leaves, and from their small size, are naturally difficult of detection. Each female moth deposits from 400 to 600, and according to the late Thomas Affleck, of Brenham, Texas, they hatch two days after being deposited, if the weather be moist and warm. The worms (Fig. 12 *b*, $\frac{1}{3}$ grown) at first feed upon the parenchyma or soft fleshy parts of the leaves, but afterwards devour in-

*Patent Office Rep., 1855, p. 74.

differently, not only any portion of the leaves, but also the blossom-bud and blossom, together with the calyx leaves at the base of the boll, thus causing the lobes which hold the cotton, to fall entirely back and allow the cotton to drop at the slightest touch. While young these worms readily let themselves down by a web when disturbed, but when older they make less use of this web, and jerk themselves away to a considerable distance when suddenly touched. They cast their skins at five successive periods, and come to their growth in the incredibly short space of fifteen or twenty days. Mr. Affleck even states that they usually enter the chrysalis state on the eleventh day after hatching; but I incline to believe that such a brief larval existence is extremely exceptional, and the length of time required for them to mature will not only differ in different individuals of the same brood, but will vary with the state of the atmosphere. At Figure 12 *c* is given a side view, and at *d* a back view of a full-grown worm. It has the normal complement of legs—namely 16—but the two foremost pair of false legs, or those under segments 6 and 7, are so reduced in size that they are scarcely used in motion, and it consequently loops when walking.

I have upon two occasions received full-grown specimens of this worm, and they differ materially, both in depth of shade, coloration and markings, as indeed do almost all the larvæ of moths belonging to the same (*Noctua*) family. The most common color is light green, though they are frequently quite dark with a purplish hue at the sides, and with black backs. Whether light or dark colored, however, they are more or less distinctly marked with pale longitudinal lines and black spots, as in the above figures.

Mr. Lyman, in his "Cotton Culture," says of this insect: "The first moths that visit a crop deposit their eggs and die. These eggs in ten days become little worms, which fall to eating the leaf on which they were hatched, and as they grow, consume the plant and pass to another. But age comes on apace with these ephemeral creatures; the worm presently grows weary of devouring, selects a leaf, rolls himself in a little cocoon and *dies*." Of course this is a serious mistake to think that the worm dies, else how could it produce the moth which, as Mr. Lyman himself shows, afterwards issues from the cocoon. It is astonishing to find such gross errors creeping into our popular works, but then, the study of these contemptible little Bugs, even if they do sometimes totally destroy the crop, is of course beneath the dignity of the man who can write a work on cotton culture!! The truth of the matter is that, when they have completed their growth, the worms fold over the edge of a leaf (Fig. 12 *e*), and, after lining the inside with silk, change to chrysalids (Fig. 12 *f*), which are at first green, but soon acquire a chestnut-brown color; after remaining in this last state (in which, though the insect is inactive, it is yet full of life, and undergoing wonderful development) from seven to fourteen days, or even longer, the moth escapes, the chrysalis being held fast

within the cocoon by means of several very minute hooks with which the tail is furnished.

[Fig. 13.]

At Figure 13 *a*, this moth is represented with the wings expanded, and at *b*, with the wings closed. The general color of the upper surface is a golden-yellow inclining to buff, with a faint olive tint near the outer or posterior margin. The fore wings are crossed, as in the above figures, by more or less distinct, irregular lilac-colored lines. But the chief characteristic is a dark slate-colored, or black spot on the front wings, in which spot there are paler scales forming almost a double pupil as represented in the figures, while between this spot and the base of the wings there is a much smaller pure white dot. In general color and in the position of the larger spot, this moth bears a remarkable resemblance to that of the true Army-worm of the Northern and Middle States.

Mr. Affleck, who certainly had abundant opportunities for observing the fact, assured me that this moth rests in the position shown in Figure 13, *b*, namely, with the head downwards. He wrote on August 22d, 1868: "The Cotton moth (*Ophinsa xylina* of Harris in his correspondence with myself) never alights in any other position, or if by accident it first assumes another position, it instantly wheels around *head down*."

According to the best authority, there are three different broods of worms during the year, the first appearing in June or July, and the last, which does the most damage, appearing in August or September, or even later. Mr. Lyman, in the little work already referred to, says: "That nature has made no provision by which either the fly, the worm, the chrysalis or the eggs, can survive the winter or exist for any length of time where the cotton plant is not a perennial." But this is surely an error, which Mr. Lyman would never have made, had he possessed a better knowledge of insect-life; and as Mr. Glover found that the chrysalis was killed by the slightest frost, the insect evidently winters over in the moth state, as do many others belonging to the same tribe. Mr. W. B. Seabrook gives strong evidence that this is the case, in a "Memoir on the Cotton Plant," read in 1843, before the State Agricultural Society of South Carolina, wherein he says: "That the Cotton Moth survives the winter is nearly certain. An examination of the neighboring woods, especially after a mild winter, has often been successfully made for that purpose." And Dr. Phares states positively that the moth hybernates in piles of cotton seed under shelter, under bark and in crevices of trees in dense forests and other secluded places, and that it may often be seen on pleasant days in winter.

The two principal remedies which have hitherto been relied upon are, 1st, hand-picking; 2d, destroying the moths by fires, to which they are naturally attracted. The first method is sure, but tedious and somewhat impracticable on a very large scale. The second is most effectual if carried out when the first moths appear, in May and June. If these two methods were persistently carried out in the early part of the season throughout any given cotton-growing county, they would of themselves be sufficient to save the crop; but the efforts of individuals are of no avail, where there are slovenly neighbors who neglect to perform these labors. It would therefore be of incalculable advantage, if something could be applied to the plants which would prevent the moths from depositing their eggs upon them, as the industrious planter could then set at defiance his more slovenly neighbor. Mr. Affleck was enthusiastic in his praise of cresylic soap as such a plant-protector, and I received a long letter, written a few weeks previous to his death, and showing how he had found that no cotton moth had ever deposited an egg on any plant that had been sprinkled with a solution of this soap. But Dr. Phares states that it was pretty thoroughly tried last year, and proved a failure, though he does not give the reason why.

It is some little consolation to know that the character of the season determines their numbers, and that if none make their appearance in any stage by the first of July, there is little to be feared from them the rest of that year.

Third—There is in the South another insect (*Laphrygma frugiperda*, Sm. & Abb.?) which is frequently known by the ominous name of "Army worm;" an insect which also will attack cotton, though it prefers grasses and weeds. This species in its habits resembles the true Army-worm of the Middle States, more closely perhaps than does the Cotton Army-worm, and Mr. Joseph B. Lyman, in his recent work on "Cotton culture"* (p. 92), calls it *the* "Army-worm;" yet to prevent confusion, the cognomen should be discontinued, and the term "Southern Grass-worm" (by which it is already very generally known) should be strictly applied to this third bogus Army-worm. We now come to the veritable Army-worm of the Northern and Middle States —the insect which is the subject of this article, and we will dwell for a few moments on the

PAST HISTORY OF THE TRUE ARMY-WORM.

If we trace back the history of the Army-worm in this country, we find that inaccuracy and confusion characterize most of the records concerning it previous to the year 1861. In that year, however, by the contemporaneous observations and experiments of several entomologists, in different sections of the United States, its natural history was first made known to the world, and the parent moth identified.

* Cotton Culture, by J. B. Lyman, late of Louisiana. Orange Judd & Co., New York.

The very earliest record which we find of its appearance in this country is in Flint's 2nd Report on the Agriculture of Massachusetts, where it is stated that in 1743 "there were millions of devouring worms in armies, threatening to cut off every green thing."

In 1770 it spread over New England in alarming numbers. Dr. Fitch in his 6th Report quotes the following full and interesting account from the Rev. Grant Powers's Historical Sketches of the Coös Country in the Northern part of New Hampshire. "In the summer of 1770 an army of worms extended from Lancaster, the shire town of Coös County, N. H,, to Northfield, Mass., almost the whole length of the Granite State. They began to appear the latter part of July, and continued their ravages until September. They were then called the 'Northern Army,' as they seemed to advance from the north or northwest to the south. It was not known that they passed the highlands between the rivers Connecticut and Merrimack. Dr. Burton, of Thetford, Vermont, informed the author that he had seen the pastures so covered with them, that he could not put down his finger without touching a worm, remarking that 'he had seen more than ten bushels in a heap.' They were unlike anything that generation had ever seen. There was a stripe upon the back like black velvet, and on each side a stripe of yellow from end to end, and the rest of the body was brown. They were seen not larger than a pin, but in maturity were as long as a man's finger and of proportionate thickness. They appeared to be in great haste, except when they halted to feed. They entered the houses of the people and came up into the kneading troughs as did the frogs in Egypt. They went up the sides of the houses and over them in such compact columns that nothing of the boards or shingles could be seen. Pumpkin-vines, peas, potatoes and flax escaped their ravages. But wheat and corn disappeared before them as by magic. Fields of corn in the Haverhill and Newbury meadows, so thick that a man could hardly be seen a rod distant, were in ten days entirely defoliated by the 'Northern Army.' Trenches were dug around fields a foot deep, as a defence, but they were soon filled and the millions in the rear passed on and took possession of the interdicted feed. Another expedient was resorted to: Trenches were cut, and thin sticks, six inches in diameter, were sharpened and used to make holes in the bottom of the trenches within two or three feet of one another, to the depth of two or three feet in the bottom lands, and when these holes were filled with worms, the stick was plunged into the holes, thus destroying the vermin. In this way some corn was saved. About the first of September the worms suddenly disappeared. Where or how they terminated their career is unknown, for not the carcass of a worm was seen. Had it not been for pumpkins, which were exceedingly abundant, and potatoes, the people would have greatly suffered for food. As it was, great privation was felt on account of the loss of grass and grain."

The same writer adds that "in 1781, eleven years after, the same kind of worm appeared again, and the fears of the people were greatly excited, but this time they were few in number."

In 1790 their ravages are again recorded in Connecticut, where they were very destructive to the grass and corn, but their existence was short, all dying in a few weeks (Webster on Pestilence, I, 272.)

Their next appearance in the Eastern States was in 1817, after an interval of twenty-seven years, according to Fitch, who quotes the following paragraph from the Albany (N. Y.) *Argus:*

Worcester, Mass., May 22nd, 1817.—"We learn that the black worm is making great ravages on some farms in this town, and in many other places in this part of the country. Their march is a 'displayed column,' and their progress is as distinctly marked as the course of a fire which has overrun the herbage in a dry pasture. Not a blade of grass is left standing in their rear. From the appearance of the worm it is supposed to be the same which usually infests gardens, and is commonly called the *cut worm.* * * * This same worm is also destroying the vegetation in the northern towns of Rensselaer and eastern section of Saratoga, New York. Many meadows and pastures have been rendered by their depredations as barren as a heath. It appears to be the same species of worm that has created so much alarm in Worcester county, but we suspect it is different from the cut worm, whose ravages appear to be confined to corn."

It was not until after a lapse of forty-four years from the last mentioned date, namely, in the summer of 1861, that this worm again spread over the meadows and grain fields of the Eastern States. During the interval, however, it had from time to time attracted attention in the Western States, where it often proved quite destructive. Thus, in Illinois, it is recorded as having appeared in 1818, 1820, 1825, 1826, 1834, 1841, 1842, 1845 and 1856, and according to Mr. B. F. Wiley, of Makanda, Ill., it was quite numerous and destructive in the southern part of the State in 1849, and appeared there also in 1857, though it was confined that year to limited localities.* Mr. J. Kirkpatrick, of Ohio, mentions its appearance in the northern part of that State in 1855. He says: "Last season (1855), in consequence of the heavy rains in the early part of June, the flats of the Cuyahoga, near Cleveland, were flooded. After the subsidence of the water, and while the grass was yet coated with the muddy deposit, myriads of small blackish caterpillars appeared; almost every blade had its inhabitant; no animal could feed upon it without, at every bite, swallowing several; if a new blade sprung up, it was immediately devoured, but what was most remarkable, the insects did not attempt to remove to land a foot or two higher but that had not been covered by the water."†

Prairie Farmer, July 18th, 1861.

†Ohio Agricultural Report, 1855, p. 350.

The year 1861 will long be remembered as a remarkable Army-worm year, for this insect was observed in particular localities throughout the whole northern and middle portion of the United States from New England to Kansas. It was first noticed in numbers sufficient to cause alarm, in Tennessee and Kentucky during the month of April; and toward the close of the same month it appeared in the southern counties of Illinois. By the end of June it had visited nearly all portions of the latter State, proving more or less destructive to grass, wheat, oats, rye, sorghum and corn.

Its advent in Missouri was simultaneous with that in Illinois, and judging from what facts I have accumulated, it occurred very generally over this State, though recorded only in St. Louis, Jefferson, Warren, Boone, Howard and Pike counties. No mention is made of its occurrence, at this time, in any of the States or Territories west of Missouri, but to the East, scarcely a single State escaped its ravages. In many portions of Ohio it entirely destroyed the hay and grain crops, and in the eastern part of Massachusetts the damage done was reported to exceed a half million of dollars.

Singularly enough, I can find no trace of the occurrence of this insect in Missouri prior to the year 1861, and the first intelligible account of it from the pen of a Missourian, is that by Dr. Wislizenus of St. Louis, published in the Transactions of the St. Louis Academy of Science (Vol. II, No. 1, pp. 159-60). My good friend Wislizenus then erroneously supposed it to be identical with the *Bombyx graminis* of Northern Europe—an insect which commits similar devastations on the grasses and cereals in that country. But I believe he is now well aware that it is an entirely distinct species.

Since 1861 the Army-worm has never spread so generally over such a vast extent of country, though in 1865 it appeared in considerable numbers around St. Joseph in this State, and in 1866 did some damage near Quincy, Ills., as we learn from the Quincy *Whig*.

Last year it made its appearance again in vast numbers in many portions of this State, especially in St. Louis, Jefferson, Cooper, Callaway, Henry, St. Clair, Marion, Ralls, and Lafayette counties, and in some counties in Illinois and Indiana. The first intimation I received of its appearance in Missouri was the following letter sent to me by Mr. A. E. Trabue of Hannibal, under date of June 8th:

I inclose a match-box with grass and two worms, which we think are Army-worms. They are here in myriads destroying the grass. Destroyed a hundred acres of blue grass meadow in five days, and are now advancing on me. What are they and their habits?

Carbolic acid (one part acid, 20 parts water) kills them if they get a good drench with it, but is too expensive at that rate. They will cross a trail of it without injury, though they evidently dislike the smell. Have sent to town for coal tar to see if they will cross it when the ground is soaked with it. The advancing column is a half mile wide.

The hogs are very fond of them; will not notice corn when they

can get Army-worms, but we have more of the latter than they can dispose of.

A. E. TRABUE.

Upon receipt of this letter, I visited Hannibal and ascertained that the worm was even more numerous around New London, and especially on the farm of Mr. A. McPike.

ITS SUDDEN APPEARANCE AND DISAPPEARANCE.

The popular idea about the sudden appearance of an insect has always been an erroneous one. The "blows" or "gentiles" in meat, "skippers" and mites in cheese, plant-lice on plants, etc., etc., are very generally supposed to have a spontaneous origin, and our sudden Army-worm invasions have very generally been accounted for in the same way, by those who know nothing of Nature's workings. Yes, and so-called *savans*—will it be credited !—have been anxious to so far tickle the popular fancy as to conceive and give birth to theories (such as that of larval reproduction) which were not one whit more sensible or tenable.

It is well known to entomologists, and the reader, by perusing the article on "Cut-worms" in my First Report, will soon become aware of the fact, that most of the larvæ of our Owlet Moths (family *Noctuidæ*) rest hidden during the day and feed in the morning and evening, or at night. They are all smooth, tender-skinned worms, and cannot endure the scorching rays of the sun. Consequently many of them live almost habitually, just under the surface of the soil, while others shelter themselves under vegetable substances during the day. Our Army-worm forms no exception to the rule, for upon closely watching the habits of the hosts I witnessed last summer in the field, and of hundreds which I had confined in breeding cages, I ascertained that they frequently hide themselves Cut-worm fashion, just under the surface of the ground, or under the plants upon which they feed. The Army-worm delights, in fact, in cool, moist and shady situations, and from the passage already quoted, from Mr. Kirkpatrick, where it is shown that the worms which swarmed on the Cuyahogo flats, did not attempt to remove to land a foot or so higher: and from further facts recorded by Dr. Fitch, it becomes evident that its natural abode is in the wild grass of our swamps, or on low lands. During an excessive dry summer these swampy places dry out, and the insect, having a wider range where the conditions for its successful development are favorable, becomes greatly multiplied. The eggs are consequently deposited over a greater area of territory, and if the succeeding year prove wet and favorable to the growth of the worms we shall have the abnormal condition of their appearing on our higher and drier lands, and of their marching from one field to another. For just so soon as the green grass is devoured, in any particular field in which they may have hatched, these worms are forced, both from hunger and from their sensibility to the sun's rays, to leave the denuded field.

Thus the fact becomes at once significant and explicable, that almost all great Army-worm years have been unusually wet, with the preceding year unusually dry, as Dr. Fitch has proved by record. The appearance of this insect last summer in the West forms no exception, for the summer of 1868 was unusually dry and hot, while that of 1869 was decidedly wet. I may remark here, in further corroboration of these views, that, as might have been expected, no Army-worms were noticed last year in the Eastern States; for though in the summer of 1868 we of the West suffered so severely from drouth, yet in the East they were blessed with the usual amount of rain-fall, and in some sections had even more than the average amount.

There is in reality nothing in the least mysterious in the sudden appearance and disappearance of the Army-worm, for the truth of the matter is, that there are a few of these insects in some part or other of the country every year, and I have for the past four or five years captured one or more specimens of the moth every fall. The eggs hatch during the early part of May, in the latitude of South Illinois and South Missouri, and the young worms may feed by millions in a meadow without attracting attention; but when they have become nearly full grown and have stripped bare the fields in which they were born, and commence to march as described above, they necessarily attract attention, for they are then exceedingly voracious, devouring more during the last three or four days of their worm-life, than they had done during the whole of their previous existence. As soon as they are full grown they burrow into the earth, and, of course, are never seen again as worms.

Their increase and decrease is dependent on even more potent influences than those of a climatic nature. The worms are attacked by at least eight different parasites, and when we understand how persistent these last are, and how thoroughly they accomplish their murderous work, we cease to wonder at the almost total annihilation of the Army-worm the year following its appearance in such hosts. In the words of the late J. Kirkpatrick "their undue increase but combines the assaults of their enemies and thus brings them within bounds again."

We must also bear in mind, that besides these parasitic insects, there are some cannibal insects, such as the Fiery Ground-beetle (*Calosoma calidum*, Fabr.) and its larva,* which prey unmercifully upon the worms, while the "Mosquito Hawks" (*Libellulæ*) and bats, doubtless destroy many of the moths. Hogs, chickens and turkeys revel in the juicy carcasses of the worms, and sometimes to such an extent that, as I am informed by Mr. T. R. Allen, of Allenton, the former occasionally die in consequence, and the latter have been known to lay eggs in which the parts naturally white, would be green when cooked. Small birds, of various kinds, and toads and frogs also,

*First Report, Fig. 34.

come in for their share of this dainty food; while the worms, when hard pushed, will even devour each other.

NATURAL HISTORY OF THE ARMY-WORM.

Previous to the year 1861, but very little accurate knowledge had been acquired respecting the habits of the Army-worm, and nothing whatever of a scientific nature had been published.

A few very observing farmers ventured to predict its appearance during very wet summers succeeding very dry ones. They did not know why this was the case, but it was a fact that they had learned from experience. It was also known that the worm attacked only the grasses and cereals, that it was gregarious in its habits, and that it disappeared suddenly, in a manner as seemingly mysterious as that in which its advent was supposed to have been made.

These few facts were about the only ones of real value, respecting the habits of this insect, that could be gleaned from the statements of those who had suffered most from its ravages; while the subject seems to have been, up to that time, entirely ignored by entomological writers.

In 1861, however, its very general appearance, and the vast amount of damage it did, attracted the attention, not only of farmers, but of several well-known entomologists, among whom may be mentioned our late friends, Walsh, of Illinois, and Kirkpatrick, of Ohio; and Cyrus Thomas, of Illinois, Dr. Fitch, of New York, and J. H. Klippart, of Ohio.

As might have been expected, diverse conclusions were arrived at, and various theories entertained by these writers, and some very spirited correspondence between Messrs. Walsh and Thomas and Walsh and Klippart may be found in old files of both the *Ohio Farmer* and the *Prairie Farmer*.

The principal point of dispute was, whether the Army-worm wintered in the egg or chrysalis state, and, as a consequence, whether it was single or double-brooded.

It is needless to follow these gentlemen in their discussions, which were frequently caustic and pungent; but sometimes partook more of the character of personal wrangling than of a calm and conscientious search after truth. Two of the five parties mentioned above, are now in their graves, and while one of those yet living—Mr. Cyrus Thomas—believed in the two-brooded character of the insect; the other two evade the question entirely. Mr. Walsh took the ground that it was single-brooded, and the experience of the past year has convinced me that he was correct.

The Army-worm, like all other insects, hatches from an egg, and this egg is evidently deposited by the parent moth at the base of perennial grass-stalks. In Southern Missouri it hatches out about the middle of April; in the central part of the State about the first, and in the northern part about the middle of May; in Massachusetts,

about the middle of June, and in Maine about the middle of July. In every locality the worm goes underground about a month afterwards to assume the pupa or chrysalis state, and stays underground between two and three weeks. Hence, in the southern part of this State the moth appears about the fore part of June, and a month later in each successive locality as we go north, till in Maine, the period becomes the fore part of September. Of course, these dates will vary somewhat with the character of the seasons, and sometimes from local causes; but, broadly speaking, they will hold good.

The moths soon pair, and sometime during the summer and fall months, deposit their eggs in the positions already indicated. Many eggs are thus deposited in tame meadows, but there is little doubt in my mind that the great bulk of these eggs are deposited in low, damp situations, and if the fall should prove wet, instead of dry, many of them would perhaps get drowned out, and we should thus have another potent influence at work to decrease the numbers of the worm the succeeding year. I make this suggestion with all due consideration, for I have long since concluded that the instincts of insects, as of some of the higher animals, are not always sufficient to guard against all contingencies. It has been demonstrated beyond the possibility of a doubt, that the Plum Curculio deposits its eggs in fruit that overhangs water, and in other positions where the grub must inevitably perish; and certain flesh-flies are well known to deposit their eggs, by mistake, on flowers which have a putrescent smell. Darwin has remarked that a small South American bird (*Furnarius cunicularius*) which builds its nest at the bottom of a narrow, cylindrical hole, which extends horizontally several feet underground, is so incapable of acquiring any notion of thickness, that, although he saw specimens constantly flitting over a low clay wall, they continued vainly to bore through it, thinking it an excellent bank for their nests.* Many such instances of misdirected instinct might be cited, and they all lead me to believe that the female Army-worm moth would be just as likely to lay her eggs in situations where they would drown out, as in situations more favorable.

The above may be considered as the normal habit of the Army-worm; but exceptional individuals occur, perhaps one in a hundred, but demonstrably not as many as one in twenty, which lie in the chrysalis state all through the winter and do not come out in the moth state till the following spring. The proportion of those which lie over till spring is doubtless greater in the more northern States than it is with us. The great fault which Mr. Walsh made in his excellent paper on this insect, published in the Illinois State Agricultural Transactions for 1861, was, that he drew his lines too rigidly, and allowed of no exceptions to the rule which he laid down, of its single-broodedness. He also fell into an error in roughly estimating

*Voyage Round the World, p. 95.

the average life of the moth at from three to five weeks. I have often caught the moths, both in the fall and spring months, even in years when the worms themselves were unnoticed by farmers; and Dr. Levi Bartlett, formerly of Pesotum, Ills., informed me while he was practising in Chicago, that he had himself ascertained that they would sometimes live at least three months, and that he had often found them as late as October. We must also bear in mind that they do not all mature and issue from the ground together, even in the same locality; but that an interval of from six to eight weeks may intervene between the issuing of the first and last moths. With these facts before us it is easy to comprehend how some of the moths live long enough to deposit their eggs on newly sown fall grain, though grass meadows are more favorite resorts. It also becomes clear that the moths may sometimes lay their eggs before harvest upon growing grain, sufficiently high from the ground, for the egg to be carried off with the straw; and this accounts for several well authenticated instances of the Army-worm starting from stack-yards.

The Army-worm larva varies but little in appearance from the time it hatches to the time when it is full grown. Some specimens are a shade darker than others, but on many thousands examined, I have found the markings very uniform as represented in the annexed cut (Fig. 14). The general color is dingy black, and it is striped longitudinally as follows: On the back a broad dusky stripe; then a narrow black line; then a narrow white line; then a yellowish stripe; then a narrow sub-obsolete white line; then a dusky stripe; then a narrow white line; then a yellowish stripe; then a sub-obsolete white line; belly obscure green. Those who are more particular will find a detailed description at the end of this article.

[Fig. 14.]

The chrysalis (Fig. 15) is of a shiny mahogany-brown color, with two stiff converging thorns at the extremity, having two fine curled hooks each side of them. The general color of the moth is light reddish-brown or fawn color, and it is principally characterized by, and receives its name from, a white spot near the center of its front wings, there being also a dusky oblique line running inwardly from their tips. The accompanying illustration (Fig. 16), though darker than it should be, will show wherein it differs from the Southern Cotton Army-worm, notwithstanding the colors of the two moths are nearly alike. Our Army-worm moth was first described by the English Entomologist Haworth in the year 1810, in his *Lepidoptera Brittanica*, page 174, as *Noctua unipuncta*. Subsequently the French Entomologist Guenée

[Fig. 15.]

[Fig. 16.]

(*Noctuelites* I, p. 77) overlooking the former's description, and regarding it as a new species, named it *Leucania extranea*. Of course Haworth's name takes the precedence. It is considered a common species even in European collections, and Guenée mentions it as occurring in Brazil. A variety without the white spot occurs in Java and India, and still another, lacking the white spot, and having a dark border on the hind wings, occurs in Australia; while an occasional specimen has been captured in England. A figure is given in Stainton's Entomologist's Annual for 1860, of one captured there in 1859, but if the figure be a correct one, the specimen is much lighter than ours, and the characteristic white spot is not nearly so conspicuous.

PARASITES OF THE ARMY-WORM.

THE RED-TAILED TACHINA FLY—*Exorista leucaniæ*, Kirk.—To one who has never before seen the Army-worm in its might, the sight of the myriads as they return thwarted in their endeavors to cross, or of the living, moving and twisting mass which sometimes fills a ditch to the depth of several inches; is truly interesting. At Hannibal I was much surprised to find that fully nine worms out of every ten had upon the thoracic segments, just behind the head, from one to four minute, narrow, oval white eggs, about 0.04 inch long, attached firmly to the skin; and my companions were equally surprised when I informed them that these were the eggs of a parasite, and that every one of the worms which had such eggs attached to it, would eventually succumb to one of the maggots these eggs produced. The eggs are no doubt deposited by the mother fly just behind the head, so that the worm may not reach the young maggots when they hatch, and be enabled to destroy them with its jaws. I have found several different kinds of cut-worms with just such eggs attached invariably on the back just behind the head. They are glued so strongly to the skin of the worm that they cannot be removed without tearing the flesh.

The large two-winged parasitic flies which deposited these eggs, were wonderfully numerous, buzzing around us and about the worms like so many bees, and the moment one was caught, I recognized it as the Red-tailed Tachina Fly. This is one of the most common and abundant of the Army-worm parasites, and attacks it in widely different parts of the country. I have also bred the same fly from the Varigated cut-worm (larva of *Agrotis inermis**), and a variety of it from our common large Cecropia worm, which is often found on apple and other fruit trees. It was first very briefly and imperfectly described as *Exorista leuca*[*i*]*æ*, by the late J. Kirkpatrick, in the Ohio Agricultural Report for 1860, page 358, and was subsequently much more fully described as *Senometopia* [*Exorista*] *militaris* by Mr. Walsh, in his Army-worm paper already referred to. Of course Mr. Kirkpatrick's

*First Report, p. 72.

name has the priority, but I introduce Mr. Walsh's original description of the fly and likewise the very same figure (Fig. 17) which he used to illustrate it.

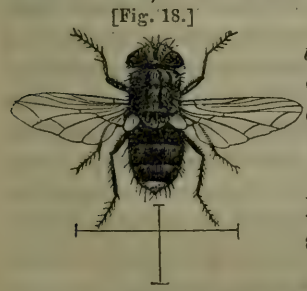
[Fig. 17.]

Exorista leucaniæ—Length, .25 to .40 inches, or from 6 to 10 millimetres, the females not exceeding .30 inch. Face silvery, with lateral black hairs only on the cheeks, at the top of which is a black bristle. Front, golden-olive, with a black central stripe, and lateral black convergent hairs. Occiput, dusky. Labium, brown, with yellowish hair. Maxipalps, rufous. Eyes, cinnamon-brown, covered with very short dense whitish hair. Antennæ, two basal joints, black, with black hairs; third joint, flattened, dusky, and from two and a half to three times the length of the second joint; seta, black. The entire hinder part of the head covered with dense whitish hair. Thorax glabrous, bluish-gray, lighter at the side, with four irregular black vittæ, and black hairs and bristles. Scutel, reddish-brown, whitish behind, glabrous, with black hairs and bristles. Pectus, black, glabrous, with hairs and lateral bristles. Legs, black, hairy; thighs, dark cinereous beneath; pulvilli, cinereous. Wings, hyaline; nervures, brownish; alulæ, opaque greenish-white. Abdomen, first joint black; second and third, opalescent in the middle with black and gray, and at the sides with rufous and gray; last joint, rufous, slightly opalescent at the base with gray; all with black hairs and lateral bristles. Beneath, the first joint is black, the others black, margined with rufous, all with black hairs. In the male the space between the eyes at the occiput is one-seventh of the transverse diameter of the head; in the female it is one-fourth. The colors of the abdomen sometimes "grease" and fade in the dried specimen.

Bred fifty-four specimens from about the same number of Army-worms. Described from eight males and six females. Two species, similarly marked with rufous, but generally distinct, occur at Rock Island.

Mr. Kirkpatrick also described on the same page of the Ohio Report for 1860, another species (?) to which he gave the name of *Osten Sackenii*. But upon the very face of it, this proves to be but a smaller specimen of his *leucaniæ;* for the characters on which he would build this other species, are none of them constant. He says it differs from *leucaniæ* in its smaller size; in the gray bands on the abdomen not being so distinct; in some little variation in the position of the brown, and in the *pulvill*[*i*]*æ* being more distinctly gray. Now *leucaniæ* varies from 0.25 to 0.40 inch in length; the brown on the abdomen is opalescent and varies; the pulvilli and gray abdominal markings vary far more in depth of shade than there set forth, and the abdomen in fact, if the least greasy, often loses all trace of gray.

[Fig. 18.]



THE YELLOW-TAILED TACHINA FLY, (*Exorista flavicauda*, N. Sp.)—We have another species in Missouri however, which may be called the Yellow-tailed Tachina Fly, and which differs so notably from the Red-tailed species that it may be recognized even on the wing. It is almost twice as large, and the head instead of being narrower than the thorax as in *leucaniæ* is broader. Its flight is also more vigorous and its buzz twice as loud, I represent this species at Figure 18, and draw up the following description for the scientific reader:

Exorista flavicauda, N. Sp.—Length, 0.35 to 0.50 inch. *Head* broader than thorax; face, silvery-white, the cheeks inclining to yellow, with lateral black hairs extending to near the base of

antennæ, and one stiffer and longer bristle at top of cheeks; front, dusky, ferruginous, with two rows of black converging bristles; divided by a broad depressed stripe of a brighter ferruginous color and without bristles; occiput bright ferruginous; labium ferruginous with hairs of same color; maxipalps rufous; eyes dark mahogony-brown, and *perfectly smooth;* antennæ, two basal joints rufous, with black hairs, third joint flattened, dusky,, and thrice as long as second; seta, black; entire hinder part of head covered with dense white hairs. *Thorax,* more decidedly blue than in *leucaniæ, broader* (instead of narrower) in front than behind; the vittæ less distinct; scute of same color as thorax. *Abdomen,* stout and more cylindrical than in *leucaniæ;* first joint dark bluish-gray; second, light bluish-gray, becoming darker along the middle, at sides and at lower border; third joint, like second above, but golden-gray at sides (no rufous); last joint *entirely* yellow or pale orange, with no other color and but few black bristles around anus. *Wings* more dusky than in *leucaniæ;* alulæ, opaque bluish-white. *Legs,* black; pulvilli pale yellow.

Described from one captured, 4 bred ♀. Space between eyes at occiput fully one-third the width of head.

[Fig. 19.]

To give an idea of the other parasites which attack the Army-worm, I will briefly allude to them, and transmit descriptions for the scientific reader.

THE GLASSY MESOCHORUS—*Mesochorus vitreus,* Walsh. (Fig. 19.)—Length of body .08 inch, (two millimetres,) to .13 inch, (three millimetres); the small specimens being parasitic on the Army-worm and the large ones captured in Rock Island county. Male, general color light rufous. Eyes and ocelli, black; antennæ fuscous, except toward the base. Upper surface of thorax in the larger specimen fuscous; intermediate and posterior tibiæ with spurs equal to one-fourth of their length; posterior knees slightly dusky; tips of posterior tibiæ distinctly dusky. Wings hyaline; nervures and stigma, dusky. Abdomen, a translucent yellowish-white in its central one-third; the remaining two-thirds piceous-black, with a distinct narrow yellowish annulus at the base of the third joint. In the larger specimen, which seems to be immature, the basal abdominal joint, and the articulations of the terminal joints are light rufous. Appendiculum of the abdomen composed of two extremely fine setæ, thickened at their base, whose length slightly exceeds the extreme width of the abdomen.

The female differs from the male, in the head from the mouth upwards being piceous. The thorax and pectus, in all three specimens, are also piceous-black. Abdomen as in the smaller male. Ovipositor, which is dusky, slightly exceeds in length the width of the abdomen.

THE DIMINISHED PEZOMACHUS—*Pezomachus minimus,* Walsh, (Fig. 20.).—Length of the body .07 to .10 inch., (2 to 2½ millimetres). Male, general color, piceous. Eyes black; antennæ black, except toward the base, where they are light rufous. Legs rufous; hind legs a little dusky. Abdomen narrowed; second and sometimes the third joint annulate with rufous at tip. The female differs from the male in the thorax being almost invariably rufous, and in the first three abdominal joints being generally entirely rufous, with a piceous annulus at the base of the third, which is sometimes absent. The abdomen is also fuller and wider. Ovipositor dusky, equal in length to the width of the abdomen. No vestige of wings in either sex, and the thorax contracted and divided as in *Formica.*

[Fig. 20.]

[Fig. 21.]

Fig. 22.]

The larvæ of this species issue from the body of the Army-worm, and spin on its skin, small cocoons symmetrically arranged side by side, and enveloped in floss (Fig. 21). It belongs to a genus of wingless Ichneumons, and in its turn is preyed upon by a small *Chalcis* fly (*Chalcis albifrons,* Walsh) which is represented at Figure 22.

THE MILITARY MICROGASTER—*Microgaster militaris,* Walsh, (Fig. 23).—Length 0.07 inch. Head black; palpi whitish; antennæ fuscous above, light brown beneath towards the base. Thorax black, polished, with very minute punctures. Wings hyaline; nervures and stigma fuscous; lower nervure of marginal, and exterior nervure of second submarginal cellule entirely obsolete. Lower nervule of third and terminal submarginal cellule, hyaline. Legs light rufous, posterior pair, with knees and tips of tibiæ fuscous. Abdomen black, glabrous, highly polished. Ovipositor not exserted.

[Fig. 23.]

The cocoons of this little parasite are spun in irregu-

lar masses, and are so completely covered with loose white silk that as a whole they look like little pieces of fine wool attached to the back of the Army-worms. They were very numerous last year in this State, and were sent to me by several correspondents, under the supposition that they were the eggs of the Army-worm. Nothing could be more unsafe and erroneous than such a conclusion; for instead of giving birth to new generations of the Army-worm they produce the little flies which are its most deadly foes. All the numerous specimens which I bred accord exactly with the above named species. This parasite is also in its turn infested by two parasites (*Glyphe viridascens* (Fig. 24) and *Hockeria perpulcra*, Walsh), but while over 90 per cent. of Army-worms are killed by primary parasites, only about 18 per cent. of these primary parasites are destroyed by the secondary parasites.

[Fig. 24.]

THE PURGED OPHION—*Ophion purgatus*, Say*.—Body pale honey-yellow, somewhat sericeous; antennæ rather longer than the body; orbits yellow, dilated before, so as to occupy the greater part of the hypostoma; ocelli large, prominent; wings hyaline; stigma slender; first cubital cellule with two opaque, subtriangular spots; no areolet; metathorax with a single, raised, rectilinear, transverse line, near the base. Length, seven-tenths of an inch.

[Fig. 25.]

This large Ichneumon Fly (Fig. 25) has been bred from the Army-worm. The ovipositor is very short, and instead of piercing the skin of her victim as do all the other Ichneumons that have been described, the female Ophion simply attaches her egg, which is bean-shaped, by a pedicle to the skin. The footless grub which hatches from this egg does not entirely leave the egg-case, but the last joints of its body remain attached to the shell, while it reaches over, and with its sharp jaws gnaws into the side of the worm (Packard). This Ophion has been taken in Maine, New York, Massachusetts, Indiana, Illinois, Missouri and Carolina and doubtless occurs all over the United States.

THE ARMY-WORM ICHNEUMON FLY—*Ichneumon lucaniæ*, Fitch.—Dr. Fitch* has briefly described another true Ichneumon Fly under the above name, which he bred from the Army-worm.

Thus we have seven distinct and true parasites which attack this worm, and besides these, two others, undescribed, are figured in Harris's Injurious Insects (last edition p. 630), swelling the number to nine. Can we longer wonder that this dreaded foe to the farmer, never molests his crops for two successive years?

HABITS OF THE ARMY-WORM, AND SUGGESTIONS FOR ITS DESTRUCTION.

Since the great bulk of the eggs of the Army-worm are deposited in the summer and fall months in grass swamps and grass mead-

* *Ophion purgatus*, Say.=*O. lateralis*, Brullé.

*N. Y. Reports, Vol. III, p. 126.

ows, and the eggs do not hatch out till the following spring, it becomes obvious that burning over grass meadows in the winter or very early in the spring, must destroy most of the eggs. Many instances might be given where, in past years, burnt grass escaped the worm, while all the unburnt grass in the neighborhood was badly infested, and in one instance part of a meadow having been accidentally burnt and part remaining unburnt, the burnt portion in the following summer, had no Army-worms on it, and the unburnt portion swarmed with them. Thus, if you burn your meadows over annually you will seldom be troubled with this pest, and if you get your neighbors to do the same thing, and in addition will also burn all the wild grass around you, the Army-worm will never do you any damage. The remedy is so simple that all can apply it. The best time to do this burning, is, as all practical men well know, in the dead of the year, when the ground is frozen; the roots of the grass are then unharmed by the fire. Of course, ploughing the land late in the fall or late in the spring, will have the same effect as burning it, for if the eggs are turned two or three inches underground they will surely rot and fail to hatch. Here we see, as in the case of the Canker-worm, which I shall presently treat of, and as in the case of almost every other noxious insect, it is necessary accurately to investigate the habits and puculiarities of each one before we can effectually counterwork it.

During my visit to Hannibal last June, I ascertained that the worms orignated in a large 100-acre field of very rich blue-grass, belonging to Mr. W. R. Flowerree. This gentleman makes a business of fattening cattle, and intended feeding off the grass in the fall; but that same blue-grass field *had neither been pastured nor plowed the year before;* and this was the very reason why the worms originated there, as the reader will readily perceive from the foregoing account of the insect's habits.

The Army-worm when traveling will scarcely turn aside for anything but water, and even shallow water-courses will not always check its progress; for the advance columns will often continue to rush head-long into the water until they have sufficiently choked it up with their dead and dying bodies, to enable the rear guard to cross safely over. I have noticed that after crossing a bare field or bare road where they were subjected to the sun's rays, they would congregate in immense numbers under the first shade they reached. In one instance I recollect their collecting and covering the ground five or six deep all along the shady side of a fence for about a mile, while scarcely one was seen to cross on the sunny side of the same fence. Though they will nibble at clover, they evidently do not relish it, and almost always pass it by untouched. They will eat any of the grasses, and are fond of oats, rye, sorghum, corn and wheat, though they seldom devour any other part but the succulent leaves. They often cut off the ears of wheat and oats and allow them to fall to the ground, and

they are perhaps led to perform this wanton trick, by the succulency of the stem immediately below the ear. South of latitude 40° they generally appear before the wheat stalks get too hard, or early enough to materially injure it; but north of that line, wheat is generally too much ripened for their tastes, and is sometimes even harvested before the full grown worms make their advent.

I have heard of the Army-worm, sometimes passing through a wheat field when the wheat was nearly ripe, and doing good service by devouring all the chess and leaving untouched the wheat; but the following item from Collinsville, Illinois, which appeared in the *Missouri Democrat*, contains still more startling facts, and would indicate that even a foe to the farmer as determined as this, may sometimes prove to be his friend.

"HARVEST AND CROPS.—Notwithstanding the unfavorable weather, many farmers have commenced the wheat harvest. The yield in this immediate vicinity will be superabundant. Some fields were struck with rust a few days since, but the Amry-worm making its appearance simultaneously, stripped the straw entirely bare of blades and saved the berry from injury. These disgusting pests have saved thousands of dollars to farmers in this neighborhood. A few fields of corn and grass have been partially destroyed, but by ditching around fields, the worm's ravages have been confined within comparatively narrow limits."

The worms may be prevented from passing from one field to another by judicious ditching. Mr. Trabue has large meadows, separated only by a road from the blue-grass field of Mr. Flowerree; and he thought he could keep out the worms by simply making a V-shaped ditch; believing that they could not crawl over, so long as the earth crumbled. The first evening after it was dug, this ditch seemed to be effectual, and the bottom was covered with one seething, twisting mass of the worms; but a heavy rain came on in the night following, after which they crossed without difficulty. Mr. Jas. Dimmitt however, who had 80 acres of wheat adjoining the fatal blue-grass field, effectually protected it by surrounding it with a ditch which had the inner side slanting under, towards the field it was intended to protect. It was indeed most fortunate that Mr. Dimmitt had hit upon the true method in the beginning, for his wheat was yet in that soft state, in which many of the ears would have been devoured or cut off; and friend Trabue was not long in profiting by his example.

A good plan to destroy the worms which accumulate in the furrow or ditch is to burn straw in it; for the fire not only kills the worms, but makes the earth in the ditch friable and more efficient in preventing their ascent. A heavy roller passed over a field will kill almost every worm, and I have already stated that hogs and poultry will devour great numbers of them. But it is always better and easier to prevent than to cure.

LEUCANIA UNIPUNCTA, Haw.—*Larva*—General color dingy black, with the piliferous spots, placed in the normal position, but scarcely visible, though the soft hairs arising from them are easily seen with a lens. Four lateral light lines, of almost equal thickness, and at about equal

distance from each other, the two uppermost white, the two lowermost yellow; a much less distinct dorsal white line, frequently obsolete in middle of segment, and always most distinct at the divisions: a jet black line immediately above the first lateral white one, the dorsum near it, thickly mottled with dull yellow, but becoming darker as it approaches the fine dorsal white line, along each side of which it is perfectly black. Space between lateral light lines 1 and 2, dull yellow, the white lines being relieved by a darker edge; that between lines 2 and 3 almost black, being but slightly mottled along the middle; that between 3 and 4 yellow, mottled with pink-brown, and appearing lighter than that between 1 and 2. Venter greenish-glaucous, mottled and speckled with neutral color, especially near the edge of the 4th lateral line. Legs glassy and of same color as venter, those on thoracic segments with black claws, those on abdomen with a large shiny black spot on the outside. Stigmata oval, black, and placed in the 3d lateral light line. Head pale grayish-yellow, speckled with confluent fuscous dots; marked longitudinally by two dark lines that commence at the corners of the mouth, approach each other towards the centre, and again recede behind; on each side are four minute polished black eyelets, placed on a light crescent-shaped ridge, and from each side of this light ridge a dark mark extends more or less among the confluent spots above. Described from numerous average living specimens.

Imago—Front wings: general color tarnished yellowish-drab, inclining to russet; sprinkled with blackish atoms, the basal half of the costal margin being lighter than the rest. Ordinary spots brighter than rest of wing, being either fulvous or rust-red, each having ordinarily a tarnished centre, the reniform or "kidney-shaped" spot, having at its lower border a conspicuous white point, indistinctly surrounded by blackish, from which point the moth takes its name; between this point and the terminal border a transverse row of black dots (one on each vein) much arcuated above; and inside and parallel with it a less distinct row, the dots forming which, are between the nerves; an oblique dark streak, shaded off gradually posteriorly, but relieved anteriorly by the same bright color as the ordinary "spots" runs from the head of this row of dots to the apex of the wing; nerves more or less marked with white, especially towards their tips; posterior or terminal border with a row of black spots between the nerves; fringes same color as wing, with a narrow dusky line inside their middle. Hind wings partly transparent, smoky-brown, with a slight purplish lustre, the veins, lunule, and terminal border more dusky; fringes pale yellow with a dusky middle line.

Under surfaces opalescent yellowish-white, the front wings shaded with smoky-gray, the costa narrowly, and the terminal margin broadly freckled with dusky specks, the fringes and a shade near the apex flesh-color, and a distinct dusky band across their outer one-fourth, narrower but darker on the costa than in the middle of the wing: the hind wings with the lunule distinct and also speckled anteriorly and posteriorly, the basal edge of the posterior portion well defined by a series of black dots on the nerves.

Head and shoulders of same color as basal part of costa; thorax same as front wings; abdomen same as hind wings; beneath all more uniformly gray.

INSECTS INFESTING THE SWEET-POTATO.

TORTOISE-BEETLES.

(Coleoptera, Cassidæ.)

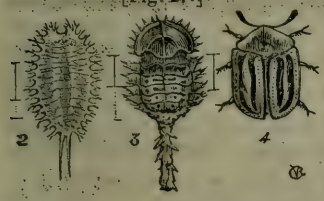
In my First Report I described eleven different and distinct insects which habitually prey on the common Irish Potato (*Salanum tuberosum*). I will now give an account of the worst insect enemies of the Sweet-Potato (*Ipomea batatus*), all of which attack that plant in this State. Before doing so, however, it will be as well to remark, that one species belonging to the same family as those which feed on the Sweet-Potato, and which is quite frequently met with in Missouri, namely, the Clubbed Tortoise-beetle (*Deloyala clavata*, Oliv. Fig. 26,)

[Fig. 26.]

feeds in reality on the common Irish Potato, thus swelling the number of insects which injuriously affect that most valuable esculent, to a round dozen. The larva of the Clubbed Tortoise-beetle is not yet known, and it is the perfect insect which has been found to attack the Potato. This is doubtless the species which Mr. Huron Burt of Williamsburg, Callaway county, referred to in the *Journal of Agriculture* of June 6th, 1868, as "a scale-like, terrapin-shaped hard insect, spread out like a flying-squirrel," that adhered tenaciously to the leaves of his potato plants. By referring to Figure 26 the reader will not be slow to learn why these beetles are called Tortoise-beetles, for the patches of dark opaque color which extend on the thin projecting semi-transparent shell of that species, remind one very forcibly of the paws of a mud-turtle. The true legs however, which, as in all other insects, are six in number, and which in this species, are so short that they scarcely reach beyond the thin shield-like crust that extends from the body, may readily be seen when the insect is turned upside down.

The insects which attack the Sweet-Potato are few in species, and belong almost entirely to this group of Tortoise-beetles. With the exception of the Cucumber Flea beetle (*Haltica cucumeris*, Harr.), figured and described on page 101 of the First Report, and a few solitary caterpillars, I have never found any other insects on this plant; but these Tortoise-beetles are of themselves sufficiently numerous in individuals and species to often entirely destroy whole fields of this esculent, and they are especially severe on the plants when newly transferred from the hot-bed.

[Fig. 27.]



These insects are at present included in the great CHRYSOMELA family of beetles, though they were formerly placed in a separate family (CASSIDIDÆ) by themselves, and there certainly are few groups more strongly characterized. They are almost all of a broad subdepressed form, either oval or orbicular, with the thorax and wing-covers so thoroughly dilated at the sides into a broad and flat margin, as to forcibly recall the appearance of a turtle, whence the popular name. Many have the singular power, in a greater or less degree, of changing their color when alive, and as I shall show further on, some of them shine at will with the most brilliant metallic tints.

Insects, as with the higher animals, usually void their excrement in such a manner that they effectually get rid of it, and in some cases they take pains to fling it as far from them as possible, by means of their hind legs. I have especially noticed this cleanly habit in the Oblong-winged Katydid (*Phylloptera oblongifolia*, DeGeer), of which I have had numbers breeding in confinement during the past two summers. They almost always fling their excrement straight

from them, so that if they are in a horizontal position, it adheres to the sides of their cages instead of falling to the bottom. In the great majority of insects the anus is situated at, or near the last ring, and usually on the ventral side, so that the fæces are easily left behind; but the larvæ of several species of beetles that have the peculiar habit of covering themselves with their own excrement, have the anus not on their bellies, but on their backs. The Three-lined Leaf-beetle* (*Lema trilineata*) has this habit, and is enabled to cover itself by the singular position of the anal vent which is on the back of the last segment. A closely allied European species, but belonging to a different genus (*Crioceris merdigera*) has the same habit. In this country there is also another yellowish oval jumping beetle (*Blepharida rhois*, Forster), which in the larva state covers itself with its excrement. In this instance the anus is at the end of the last segment, but it is sufficiently extensile at the will of the insect to allow of the accomplishment of the feat. This last larva is a disgusting looking thing, and I found it last year very abundant along the line of the Iron Mountain Railroad, on all three of the Sumachs—*Rhus aromatica*, *glabra* and *copalina*—preferring them in the order of their naming.

But the larvæ of the Tortoise-beetles are *par excellence* the true dung carriers, for they excel all others in this medigerous art. In the instances related above, the load is carried immediately on the back, but our Tortoise-beetles are altogether more refined in their tastes, and do not allow the dung to rest on the body, but simply shade themselves with a sort of stercoraceous parasol.

The larvæ of all the species that have been observed to feed on the Sweet-Potato are broad and flattened like the beetles, and have the margin of the body furnished with spines which are often barbed, (Fig. 27, 2). They all belong to the genera *Cassida* and *Coptocycla*, and there are thirty-two of these spines, or sixteen on each side of the body. Four of these are situated on the prothorax, which forms two anterior projections beyond the common margin; four of them—the two anterior ones longer than the others—are on each of the two following thoracic segments, and each of the abdominal segments is furnished with but two. There are nine elevated spiracles each side superiorly, namely, one immediately behind the prothorax and eight on the abdominal segments. The fore part of the body is projected shield-like over the head, which is retractile and small.

[Fig. 28.]

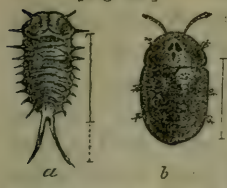
In a closely allied genus (*Chelymorpha*) to which belongs a brick-red insect with black spots (*Ch. cribraria*, Fabr., Fig. 28, pupa; 29 beetle) found upon Milkweed (*Asclepias*), and which has the body greatly rounded above, with scarcely any lateral flange, the larva, as observed by Dr. Packard, has the prickles smooth and not

[Fig. 29.]

*First Rep., p. 100.

sprangling. In another genus also (*Physonota*) to which belongs the Five-dotted Tortoise-beetle (*Ph. quinquepunctata*, Walsh & Riley, Fig. 30, *b*), and which is intermediate in form between the last named genus (*Chelymorpha*) and those with the body greatly flattened (*Cassida*, *Coptocycla*, *Deloyala*) the prickles of the larva are also smooth and only 20 in number, i. e., 10 on each side, as may be seen by referring to Figure 30, *a*. Mr. Walsh found this insect in Northern Illinois, and though we do not know upon what particular plant it feeds, yet from analogy we may infer that it subsists on some Composite flower, as other species belonging to the same genus are known to do.

[Fig. 30.]



a *b*

Almost all the larvæ of the beetles belonging to the great CHRYSOMELA family, of which the Colorado Potato Bug may serve as an example, have, besides the six legs at the anterior end of the body, an additional proleg, or protuberance which serves as such, at the posterior end; but the larvæ of our Tortoise-beetles have no such proleg, and the six anterior legs are short, thick and fleshy, and with the retractile head, give these larvæ, from a side view, as great a resemblance to a turtle as have the beetles.

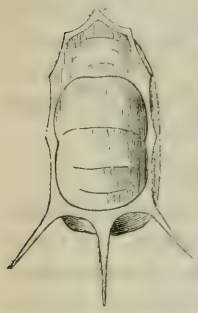
Though lacking an anal proleg, however, they are characterized by having a movable forked tail, in the shape of two long prong-like horny filaments which both spring from a broad neck situated immediately above the anus. The anus projects and curves over the back at the will of the insect, and by the aid of this fork and of some of the lateral spines, it forms the parasol of dung which so nicely protects it.

When we read of those Hottentots who cover different portions of their bodies with the uncleaned intestines of sheep and oxen, we feel shocked at such barbarism, and can scarcely comprehend how human beings can defile themselves with the like disgusting materials. Such men must be pitiable indeed, for they can have no other object than the gratification of their filthy and beastly pleasures. There is nothing so repulsive about our insect Hottentots, for the dung parasol of our Tortoise-beetles has neither offensive odor or appearance, and its true character is generally sufficiently disguised by being intermixed with the cast-off skin and prickly spines; and though those species, first referred to, which directly cover their backs, often look sufficiently unclean, we know that they thus act at Nature's bidding and for a useful purpose.

All the Tortoise-beetle larvæ which I have bred to the perfect beetle state, have come to their growth in about three weeks after hatching. They cast their skins at three successive periods, and these skins are slipped on to the fork, where in most instances they remain. On carefully detaching from a full grown larva the dung with which these skins are mixed, these three successive skins are easily recognized, the smallest being at the extremity and the largest at the base

of the fork. They are especially recognizable in the Mottled Tortoise beetle (*Cassida guttata*, Oliv., Fig. 36,) mentioned below, which removes most of its dung before each moult.

Fig. 31.



The eggs from which these larvæ hatch, are deposited singly upon the leaves, to which they are fastened by some adhesive substance. They are of irregular angular form; flat, and somewhat narrower at one end than the other; ridged above and at the sides, but smooth and obovate below. They are usually furnished with spine-like appendages, which however are sometimes entirely lacking. They look, in fact, very much like miniature specimens of those curious skate-barrows or Mermaid's purses, which are found so commonly along the sea-shore, and which are the empty egg-shells of certain kinds of Ray-fish or Skate. Those of the common Golden Tortoise-beetle (Fig. 31,) are 0.04 inch long, and of a dull, dirty white color.

The Tortoise-beetle larvæ, when full grown, fasten the last two or three joints of the body to the underside of a leaf, by means of a sticky secretion, and in about two days change to pupæ. The pupa of those species which have 32 barbed spines, is flat with usually four or five broad but thin and transparent serrated leaf-like appendages on each side of the abdomen, and the prothorax, which is greatly dilated and covers the head, is furnished around the edge with smaller barbed spines. The broad leaf-like spines at the edges of the body are bent under while the transformation is being effected, but are soon afterwards stretched stiffly out with a forward slant. The pupa loses the pronged tail, but as the old larval skin is left adhering to the terminal segments the prong of dung still protects it in most cases. The legs and antennæ are not free in this, as in the pupæ of most other beetles, but are soldered together as in the chrysalis of a butterfly, and yet it has the power of raising itself up perpendicularly upon the tail end by which it is fastened. The pupa state lasts about a week.

Having thus spoken in general terms of this anomalous group of beetles, I shall now refer more particularly to a few of the species. Most of those mentioned below infest the Sweet-Potato both in the larva and perfect beetle states. They gnaw irregular holes and when sufficiently numerous entirely riddle the leaves. They usually dwell on the underside of the leaves, and are found most abundant during the months of May and June. There must be several broods during the year, and the same species is often found in all stages, and of all sizes at one and the same time. In all probability they hybernate in the beetle state.

I have proved by experiment that Paris green—one part of the green to two of flour—when sprinkled under the vines, will kill these insects, though not near so readily as it does the Colorado Potato

Bug. Moreover, as these Tortoise beetles usually hide on the under side of the leaves, and as the vines trail on the ground, it is very difficult to apply the powder without running some risk from its poisonous qualities. I therefore strongly recommend vigilance when the plants are first planted, and by the figures and descriptions given below the reader will be enabled to recognize and kill the few beetles which at that time make their appearance, and thus nip the evil in the bud. The Bermuda and Brazilian Sweet-Potato plants are more vigorous than the Nansemond, and less liable to be attacked.

THE TWO-STRIPED SWEET-POTATO BEETLE—*Cassida bivittata*,, Say.

This is the most common species found upon the Sweet-Potato, and seems to be confined to that plant, as I have never found it on any other kind. Its transformations were first described by myself in the *Prairie Farmer Annual*, for 1868, (p. 53.) The larva (Fig, 27, 2 enlarged; Fig. 32, natural size), is dirty white or yellowish-white, with a more or less intense neutral-colored longitudinal line along the back, usually relieved by an extra light band each side. It differs from the larvæ of all other known species in not using its fork for merdigerous purposes. Indeed, this fork is rendered useless as a shield to the body, by being ever enveloped, after the first moult, in the cast-off prickly skins, which are kept free from excrement. Moreover, this fork is seldom held close down to the back, as in the other species, but more usually at an angle of 45° over or from the body, thus suggesting the idea of a handle. In Kirby & Spence's Introduction (p. 426), may be found the following passage in reference to the positions in which the fork of the larvæ of these Tortoise-beetles is carried: "The instrument by which they effect this is an anal fork, upon which they deposit their excrement, and which in some is turned up and lies flat upon their backs; and in others forms different angles, from very acute to very obtuse, with their body; and occasionally is unbent and in the same direction with it." Reaumur is referred to as authority for these statements, and the language would lead us to suppose that the forks were thus variously carried by different species; but Reaumur never said anything of the sort. His language has been poorly rendered, for he distinctly referred to the different positions which the same insect could give to the fork, and I believe that the peculiarity mentioned above has never been observed in the larvæ of any other species of the genus.

[Fig. 32.]

When full fed, this larva attaches itself to the underside of the leaf, and in two days the skin bursts open on the back, and is worked down towards the tail; when the pupa, at first pale, soon acquires a dull brownish color, the narrow whitish tail, which still adheres posteriorly, being significant of the species. See (Fig. 27, 3.)

The beetle (Fig, 27, 4) is of a pale yellow, striped with black, and though broader and vastly different scientifically, still bears a gen-

eral resemblance to the common Cucumber-beetle (*Diabrotica vittata*, Fabr.)

These beetles may be seen quite thick around young peach and apple trees quite early in the season, and a little later they venture into the trees and pair off; but as soon as the Sweet-Potato plants are set, they leave everything else for them.

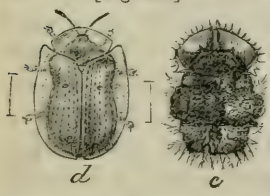
THE GOLDEN TORTOISE-BEETLE—*Cassida aurichalcea*, Fabr.

Next to the preceding species, the Golden Tortoise-beetle is the most numerous on our sweet-potatoes; but it does not confine its injuries to that plant, for it is found in equal abundance on the leaves of the Bitter-Sweet and on the different kinds of Convolvulus or Morning Glory. The lava (Fig. 33, *a*, natural size *b*, enlarged with the dung taken on the fork), is of a dark brown with a pale shade upon the back. It carries its fæcifork directly over the back, and the excrement is arranged in a more or less regular trilobed pattern. The loaded fork still lies close to the back in the pupa, which is brown like the larva, and chiefly characterized by three dark shades on the transparent prothorax, one being in the middle and one at each side, as represented at Figure 34, *c*.

[Fig. 33.]

The perfect beetle (Fig. 34, *d*), when seen in all its splendor, is one of the most beautiful objects that can well be imagined. It exactly resembles a piece of golden tinsel, and with its legs withdrawn and body lying flat to a leaf, the uninitiated would scarcely suppose it to be an insect, did it not suddenly take wing while being observed. At first these beetles are of a dull deep orange color, which strongly relieves the transparent edges of the wing-covers and helmet, and gives conspicuousness to six black spots, two (indicated in the figure) above, and two on each side. But in about a week after they have left the pupa shell, or as soon as they begin to copulate, they shine in all their splendor, and these black spots are scarcely noticed.

[Fig. 34.]

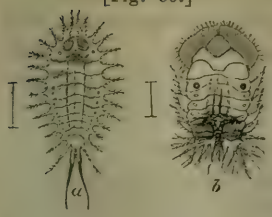


THE PALE-THIGHED TORTOISE-BEETLE—*Cassida pallida*, Herbst.

This species can scarcely be distinguished from the preceding. It is of a somewhat broader, rounder form, and differs in partially lacking the black spots on the wing-covers, and in having the thighs entirely pale yellow, while in *aurichalcea* they are black at the base. It likewise feeds upon the Sweet-Potato, and its larva differs only from that of the former, in its spines being brighter and lighter colored, and in having a dull orange head, and a halo of the same color on the anterior portion of the body.

THE MOTTLED TORTOISE-BEETLE—*Cassida guttata*,* Oliv.

[Fig. 35.]



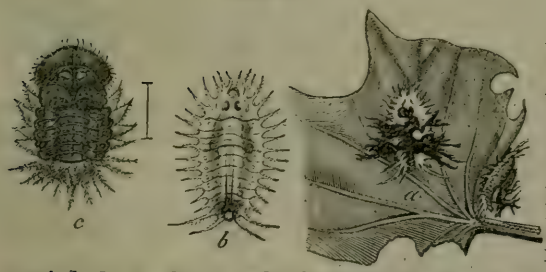
[Fig. 36.]

This species (Fig. 36) which is the next most common of those found on the Sweet-Potato in the latitude of St. Louis, is at once distinguished from all the others here described, by being usually black, with the shoulders black to the extreme edge of the transparent wing-covers. It is a very variable species, and is frequently more or less speckled or mottled with gold, while more rarely it has a uniform golden appearance.†

The larva, which is represented enlarged and with the dung removed at Figure 35, *a*, is of a uniform green color, with a bluish shade along the back, which shade disappears however whenever the insect has fasted for a few hours. It carries its dung in irregular broad masses, often branching as in the species next to be described. The pupa (Fig. 35, *b*,) is also of a uniform green color, with a conspicuous black ring around the base of the first abdominal pair of spiracles. Before changing to pupa and previous to each moult, this larva is in the habit of removing the dung from its fork.

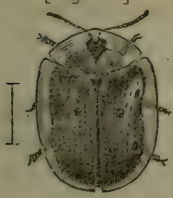
THE BLACK-LEGGED TORTOISE-BEETLE—*Cassida nigripes*, Oliv.

[Fig. 37.]



This species, which is likewise found on the Sweet-Potato, is a little the largest of those heretofore mentioned. The beetle (Fig. 38) has the power, when alive, of putting on a golden hue, but is not so brilliant as *C. aurichalcea*, from which species it is at once distinguished by its larger size and by its black legs and three large conspicuous black spots on each wing-cover. The larva (Fig. 37, *b*,) is of a pale straw color with the spines, which are long, tipped with black; and besides a dusky shade along each side of the back, it has two dusky spots immediately behind the head, and below these last, two larger crescent marks of the same color. The dung is spread in a characteristic manner, extending laterally in long shreds or ramifications. (See Fig. 37, *a*.) The pupa

[Fig. 38.]



* This insect is referred by Boheman to the genus *Cortocycla*, which differs from *Cassida* by more slender, not distinctly clavate and nearly filiform antennæ.

† This species has very probably been described under different names. It is *C. cruciata*, Fabr.; *C. signifer*, Herbst, and from larvæ found on the same batch of plants, and differing in no respect whatever, I have bred specimens which were determined by Le Conte as *C. trabeata*, Lec.

(Fig. 37, *c*.) is dark brown, variegated with paler brown as in the figure, while the spines around the edges are transparent and white.

THE PICKLE WORM—*Phacellura nitidalis*, Cramer.

(Lepidoptera, Margarodidæ.)

As long ago as the year 1828, Dr. T. W. Harris described and named the common Squash Borer (*Ægeria* [*Trochilium*] *cucurbitæ*). This borer is a true caterpillar, having sixteen legs, and very much resembling the common Peach Borer. It is hatched in the early part of summer, from eggs placed by the parent moth on the stems of the vine, close to the root. It penetrates the stem, and by devouring the pith, frequently causes the death of the vine. When full fed it retreats a short distance into the ground and forms a cocoon of a gummy substance covered with particles of earth. Within this cocoon it passes the winter, and early the next summer issues as a moth. This moth is very beautiful, with a conspicuous orange colored body spotted with black; with the front wings blue-black and with the hind wings perfectly transparent.

Ever since the day when it was first described by Harris, this insect has been known as the Squash Borer. It seems to be confined, however, to a few of the more Eastern States, and although Mr. Wm. Klussman, of Pine Bluff, Arkansas, thinks he is troubled with this species, and has given up the growing of all winter squashes in consequence of its ravages (*Country Gentleman*, Nov. 11, 1869, page 378), yet it certainly is not of common occurrence in the Valley of the Mississippi, or we should more often hear of it.

There is, however, another borer which attacks the roots of cucurbitaceous vines, and which is but too common all over the country. I refer to that ubiquitous little pest the Striped Cucumber-beetle (*Diabrotica vittata*, Fabr.) an insect which annually destroys thousands of dollars' worth of vines in the United States, and for which remedies innumerable—some sensible, but the greater portion not worth the paper on which they are printed—are published every year in our different agricultural papers.

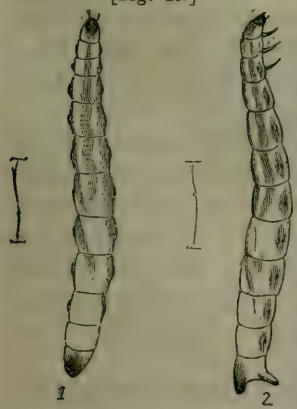
The natural history of this "Striped Bug," as it is more commonly called, was first made known in the West by Dr. Henry Shimer, of Mt. Carroll, in the *Prairie Farmer*, for August 12, 1865. But as everything pertaining to such a very common and destructive insect, cannot be too often repeated, I will here relate its habits in the briefest manner..

The parent beetles (Fig. 39) make their appearance quite early in the season, when they immediately commence their work of destruction. They frequently penetrate through the cracks that are made by the swelling and sprouting of the seeds of melons, cucumbers, or squashes, and by nipping off the young sprouts, destroy the plant before it is even out of the ground.

[Fig. 39]

Their subsequent work when the vines have once pushed forth their leaves, is too well known to need description. Yet notwithstanding the great numbers and the persistency of these beetles, we finally succeed, with the proper perseverance and vigilance, in nursing and protecting our vines, till we think they are large enough to withstand all attacks. Besides, by this time, the beetles actually begin to diminish in numbers, and we congratulate ourselves on our success. But lo! All of a sudden, many of our vines commence to wilt, and they finally die outright. No wound or injury is to be found on the vine above ground, and we are led to examine the roots. Here we soon discover the true cause of death, for the roots are found to be pierced here and there with small holes, and excoriated to such an extent, that they present a corroded appearance. Upon a closer examination the authors of this mischief are easily detected, either imbedded in the root, or lurking in some of the corroded furrows. They are little whitish worms, rather more than a third of an inch long, and as thick as a good sized pin; the head is blackish-brown and horny, and there is a plate of the same color and consistency on the last segment. These worms are in fact the young of the same Striped Bug which had been so troublesome on the leaves earlier in the season; and that the insect may be as well known in this, its masked form, as it is in the beetle state, I present the annexed highly magnified figures of the worm (Fig. 40), No. 1 showing a back view and No. 2 a side view. The beetles, while feasting themselves on the tender leaves of the vine, were also pairing, and these worms hatched from the eggs which were deposited near the roots by the female. When the worms have become full-grown, which is in about a month after they hatch, they forsake the roots and retire into the adjoining earth, where each one, by continually turning around and around, and compacting the earth on all sides forms for itself a little cavity and in a few days throws off its larva skin and becomes a pupa. This pupa is much shorter than was the worm, and is represented enlarged in the annexed Figure 41, No. 1 ventral view, and No. 2 back view, the hair lines at the sides showing the natural size. This pupa state lasts about two weeks, at the end of which time the skin is again moulted, and the perfect beetle form assumed. All the parts of this newly developed beetle are at first soft, but after remaining motionless in its cell, till these soft parts have acquired solidity and strength, it breaks through the walls of its prison and works itself up to the light of day.

[Fig. 40.]



[Fig. 41.]

There are from two to three generations each year, the number varying according to the latitude, or the length of the winter. To

show however, how the different broods run into one another, and to prove how difficult it is to separate them by distinct lines, I will state that at Kirkwood, Mo., I found this insect abundant in its three stages of larva, pupa, and beetle, during the first days of October last. And in a large jar partly filled with earth, in which I placed a number of infested roots about that time, I to-day (Nov. 8, 1869) find both pupæ and beetles. The soil in this jar was kept as nearly as possible in the same condition as that out of doors, and as I noticed the beetles around the vines even after the first frosts, I am led to infer that, in this latitude at least, the insect often hybernates as a beetle, and not always as a pupa, as intimated by Dr. Shimer.

Of all the multifarious remedies proposed against the attacks of this insect, there are none so effectual or so cheap in the end, as inclosing the young vines in boxes which are open at the bottom, and covered with millinet on the top. Such boxes are made at a trivial cost, and if properly stored away each season after use, will last for many years. Whenever other remedies must from necessity be resorted to, there is nothing better than sprinkling the vines, early in the morning with Paris-green and flour, (one part of the green to four or five of flour) or with white hellebore. It of course follows, that if the beetles are effectually kept off, there will afterwards be no worms at the roots.

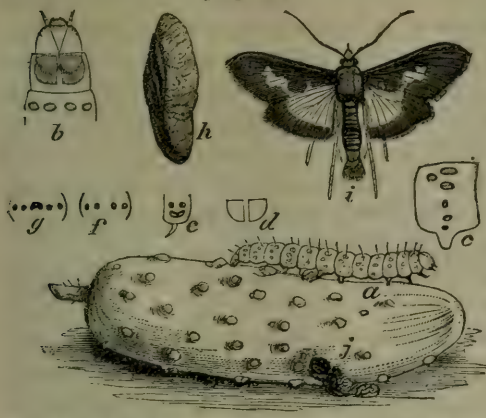
Much complaint was made last summer, in various parts of the country, of the sudden death of cucurbitaceous vines, from some unknown cause, and Henry Ward Beecher seems to have suffered in this manner, like the rest of us, but could find no worms in the roots of his vines. I know from experience that such vines are subject to a species of rot in the root—a rot not caused by insects, and for that reason the more serious, since we cannot tell how to prevent it. I have seen whole melon patches destroyed by this rotting of the roots, but in the great majority of instances where I have examined vines that had died from "some unknown cause," I have had no difficulty in either finding the worms of the "Striped Bug" yet at work on the roots, or else the unmistakable marks of their having been there. Indeed, by the time a vine dies from the effects of their gnawings and burrowings, the worms have generally become fully grown, and have hidden themselves in their little pupal cavities.

So much for the two borers which have heretofore been known to attack plants belonging to the Gourd family. We have seen how they both bore into the roots of these plants, and how one of them in the perfect state attacks the leaves. No other borers have been known to attack these plants, though the 12-Spotted Diabrotica (*D. 12-punctata*, Fig. 42), may often be found embedded in the rind of both melons, cucumbers and squashes. But we now come to a third insect which attacks plants of this same Gourd family. It neither bores into the root, nor devours the foliage, however, but seems to confine itself to the fruit; and I have

[Fig. 42]

called it the Pickle Worm, from the fact of its often being found in cucumbers that have been pickled.

[Fig. 43]



At Figure 43, *a*, I represent one of these worms of the natual size. They vary much in appearance, some being of a yellowish-white, and very much resembling the inside of an unripe melon, while others are tinged more or less with green. They are all quite soft and translucent, and there is a transverse row of eight shiny, slightly elevated spots on each segment, and an additional two behind the others on the back. (See Fig. 43, *c*.) Along the back and towards the head, these spots are larger than at the sides, and each spot gives rise to a fine hair. The specimen from which I obtained my first moth last summer was very light colored, and these spots were so nearly the color of the body as to be scarcely visible. The head was honey-yellow bordered with a brown line and with three black confluent spots at the palpi.

The cervical shield or horny plate on the first segment was of the same color as the body, and so transparent that the brown border of the head when retracted shone distinctly through it as at Figure 43, *b*. The breathing-holes or stigmata are small, oval, and of the same color as the body, with a fulvous ring around them. In some of the young worms the shiny spots are quite black and conspicuous. My late associate, Mr. Walsh, communicated to me the following description of such a marked specimen, from which he bred the very same species of moth as from the paler individuals: The description was taken when the worm was but half grown.

Length $\frac{1}{3}$ inch. Color pale greenish-yellow; 16 legs. Head pale rufous, the Y-shaped sutures and the mouth black. Cervical shield as in Figure 43, *d*, each half edged with black, center rufous. Marked under shield on each side as at *e*, and the same lateral marking on joints, 2 and 3. Above on joints 2 and 3 as at *f*. On joints 4–11, eight (including 2 lateral) spots transversely arranged, and behind these, two dorsal spots. Of the eight spots the two lateral ones on each side are substigmatal. Stigmata edged with dusky. Anal joint with five spots as in *g*, the middle one large and transverse. Body with some sparse long dusky hairs, 6–8 times as long as wide, a little tapered toward the head. Spins a thread. Legs and prolegs nearly immaculate.

The worms commenced to appear in the latitude of St. Louis, about the middle of July, and they continued their destructive work till the end of September. They bore cylindrical holes into the fruit and feed on its fleshy parts. They are gross feeders and produce a

large amount of soft excrement. I have found as many as four in a medium-sized cucumber, and a single worm will often cause the fruit to rot. They develop very rapidly and come to their growth in from three to four weeks. When about to transform they forsake the fruit in which they had burrowed, and drawing together portions of some leaf that lies on or near the ground, spin a slight cocoon of white silk. Within this cocoon they soon become slender brown chrysalids with the head parts prolonged, and with a very long ventral sheath which encloses the legs. If it is not too late in the season the moths issue in from eight to ten days afterwards. The late individuals, however, pass the winter within their cocoons; though, from the fact that some moths come out as late as November, I infer that they may also winter over in the moth state.

The moth produced by this worm (of which Figure 43, *i*, represents the male) is very strikingly marked. It is of a yellowish-brown color, with an iris-purple reflection, the front wings having an irregular, semi-transparent, dull golden-yellow spot, not reaching their front edge, and constricted at their lower edge; and the hind wings having their inner two-thirds of this same semi-transparent yellow. The under surfaces have a more decided pearly lustre. The thighs, the breast, and the abdomen below, are all of a beautiful silvery-white, and the other joints of the long legs are of the same tawny or golden-yellow as the semi-transparent parts of the wings. The abdomen of the female terminates in a small flattened black brush, squarely trimmed, and the segment directly preceding this brush is of a rust-brown color above. The corresponding segment in the male is, on the contrary, whitish anteriorly and of the same color as the rest of the body posteriorly, and he is, moreover, at once distinguished from the female, by the immense brush at his tail, which is generally much larger than represented in the above figure, and is composed of narrow, lengthened (*ligulate*) scales, which remind one of the petals of the common English daisy, some of these scales being whitish, some orange, and others brown. This moth was described nearly a century ago by Cramer, under the scientific name of *Phak*[*c*]*ellura nitidalis*, and it may be known in English as the Neat Cucumber Moth. The genus to which it belongs is characterized chiefly by the partly transparent wings, and by the immense scaly brush of the males. The antennæ are long, fine and thread-like, those of the male being very finely ciliated; the abdomen extends beyond the wings, and the legs are very long and slender. The species are for the most part exotic, and the larvæ of all of them, so far as known, feed on cucurbitaceous plants.

The following item, taken from a St. Louis paper, though somewhat facetious, will give an idea of the extent of the injuries caused by this insect in that vicinity:

What's the matter with the cucumbers? A lady of our acquaintance, the other day, sent to market to purchase some cucumbers for

pickling purposes. They were placed in a vessel to be washed, previous to being put in the brine. It was then observed that small, singular looking worms clung in the 'wrinkles' on the outside of some of the cucumbers. These were washed off, when accident led to the discovery that inside every one of the cucumbers was secreted a white, corrugated, creeping thing, from half an inch to over an inch in length, resembling in miniature a rattlesnake's rattles, and not a very pretty object to look upon. It turns out that nearly, if not all the cucumbers brought to this market this season are affected the same way. These worms certainly do not look very good to eat, in the unpickled form; but we are told that they are entirely harmless in the natural state, and probably add to the pungency and crispness of the gherkin when forming part of the chow-chow, and other relishes which grace every well regulated square meal. Like the mites in the cheese, which with some are supposed to testify to the good quality and healthfulness of the article, we suppose worms in the pickles may fairly be considered a question of taste; but, if it is not obtrusive, we will add that we do not believe they are to *our* taste or digestion, and, if it is all the same to the cucumber merchants, we would rather not take any in our'n.

In Missouri, I have myself found this insect quite abundant in various parts of St. Louis and Jefferson counties, and the cucumbers seem to have fared worse than the melons. That it was not confined to these two counties, is also proved by the following communication which appeared in the *Journal of Agriculture*, of September 10, 1869:

Pleasant Hill, Mo., September 2, 1869.—Last winter, seeing many glowing accounts of the "Alton Large Nutmeg Melon," I sent to Mr. Barler and procured some, paying thirty cents an ounce for them; planted and worked well; during August, had some melons. The first few tasted right well, but soon my "Green Citron" cantelope ripening, the difference in the taste of the two was found to be so great that we could not eat the Alton Nutmeg. Furthermore, the latter had worms in them—the larvæ of some insect—eating into nearly every one. The Green Citron was rarely attacked by them. I have raised this variety of Green Citron for several years, and would not give one of the melons for a dozen Alton Nutmegs. It is sweet, juicy and very rich in taste. When a boy, I can remember a cantelope that was raised by my father, called "Persian." I think the Green Citron probably derived from it.

Yours, G. C. Broadhead.

In Illinois, it was very destructive around Alton, during the month of August; for, on July 19th, I received specimens from G. W. Copley, of that place, and found (Sept. 2, 1869), on visiting Mr. O. L. Barler's large melon fields, that fully three-fourths of his melons had been injured by it. Since then, several other Alton men have assured me that it was equally destructive with them. It also occurred around Springfield, for Mr. P. M. Springer sent to me, the last of October, a specimen of the moth which he had bred from a cucumber-boring worm; while Mr. Walsh also found it abundant at Rock Island, in the northern part of that State.

In Michigan, as I learned from Mr. W. B. Ransom, of St. Joseph,

it greatly injured the cucumbers and melons around that place; and Mr. Glover, of the Department of Agriculture, informs me that he has found the worm on Squash, in Florida, in July. Thus it appears that this Pickle Worm has a wide range, and that last summer it simultaneously fell upon the cucumbers and melons in widely different parts of the country. Of course, in making pickles, the worm is pickled with the cucumber, and we shall consequently continue to hear startling stories about the worms in the pickles.

This insect, so far as I can ascertain, has never before been figgured or described in this country; nor can I find any mention made of its destructive work in past years. I am, therefore, led to the conclusion that it was never numerous or destructive enough in the past, to attract attention. This fact becomes the more astonishing, when we consider how wide-spread and general its injuries were the past summer; and it furnishes another illustration of the sudden and enormous increase, in some particular year, of an insect which had scarcely ever before been noticed.

The system of Nature is so complicated, and every animal organism is subject to so many influences that affect its increase or decrease, that we are not surprised at the fluctuation in the relative numbers of any particular species. The "Struggle for Life," as expounded by Darwin, is no where more effectual in bringing about changes than in insect life. We are at first a little puzzled to account for the sudden advent, and the equally sudden departure of such insects as the Army-worm, Chinch Bug, Wheat Midge, etc., but when we once acquire a just conception of the tangled web in which every insect is involved, we wonder rather that the balance is so well kept.

Our Pickle-worm is an indigenous species, and has, doubtless, existed in some part or other of the country from time immemorial; and now that its habits are recorded and its history made known, I should not be at all surprised to learn that individuals have suffered from it in years gone by. The French Entomologist, Guenée, gives as its food-plant, a species of potato, and it is just possible that it may not always have fed upon the same plants on which it was found last summer. At all events, let us hope that it will disappear as suddenly as it appeared; but should it occur in great numbers again next year, the foregoing account will enable those who grow melons, cucumbers or squashes, to understand their enemy, and to nip the evil in the bud, by carefully overhauling their vines early in the summer, and destroying the first worms that appear, either by feeding the infested fruit to hogs or cattle, or by killing the worms on the spot. I know from experience that this worm when pickled with the cucumber, does not in the least affect its taste, and is not in the least injurious to the human system; but as it is not very desirable food, pickles should always be halved, before being brought to the table, especially if they were gathered from a field or garden known to be infested.

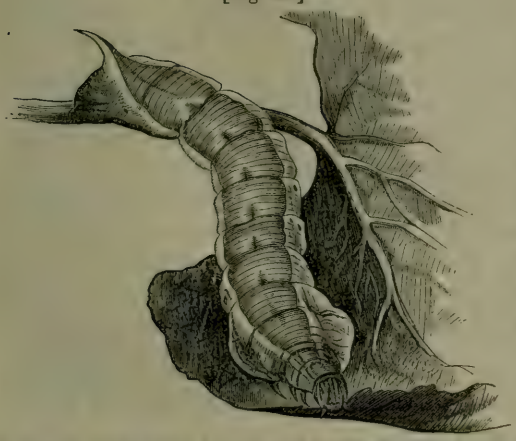
INSECTS INJURIOUS TO THE GRAPE-VINE.

Under this head, I shall continue the series of articles begun in my First Report, in order to give the grape-growers of our State a thorough understanding of their insect enemies, and thus lessen the hindrances and drawbacks to viticulture—that most important and pleasant part of rural industry, which is increasing with such unprecedented rapidity.

THE HOG-CATERPILLAR OF THE VINE—*Chœrocampa pampinatrix*, Sm. & Abb.*

[Lepidoptera, Sphingidæ.]

[Fig. 44.]



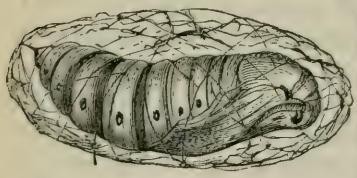
Of the large solitary caterpillars that attack the Grape-vine, this is by far the most common and injurious in the Mississippi Valley. I have frequently found the egg of this insect glued singly to the underside of a leaf. It is 0.05 inch in diameter, perfectly round and of a uniform delicate yellowish-green color. The young worm which hatches from it, is pale green, with a long straight horn at its tail; and after feeding from four to five weeks it acquires its full growth, when it presents the appearance of Figure 44, the horn having become comparatively shorter and acquired a posterior curve.

This worm is readily distinguished from other grape-feeding species by having the third and fourth rings immensely swollen, while the first and second rings are quite small and retractile. It is from this peculiar appearance of the fore part of the body, which strikingly suggests the fat cheeks and shoulders and small head of a blooded hog, that it may best be known as the Hog-caterpillar of the vine. The color of this worm when full grown is pea-green, and it is wrinkled transversely and covered with numerous pale-yellow dots, placed

*Synonyms, *Sphinx*, [*Darapsa*] *myron*, Cramer; *Otus cnotus*, Huebner. Of the four different generic names under which this species has been classified, "*Sphinx*" is a general term for all the Hawk-moths and refers to the sphinx-like attitude often assumed by their larvæ; "*Chœrocampa*" is derived from two Greek words which mean "Hog-caterpillar;" and "*Darapsa*" and "*Otus*" are gibberish. Of the three different specific names, "*Myron*" refers to an ancient Greek who bore this appellation, "*cnotus*" is pure unadulterated gibberish, and "*pampinatrix*" is from the Latin and signifies "a female vine-pruner." Both Harris and Fitch describe this insect under the name of *Chœrocampa pampinatrix;* and this, as the appellation best known to our grape-growers, and the most characteristic of the habits of the species, I should prefer to retain, although no doubt, according to the strict Law of Priority, the specific name of *Myron* ought to be employed. Mr. Walker, Dr. Clemens and Dr. Morris call this species "*Darapsa Myron*," and Mr. Grote calls it "*Otus Myron*." By ringing the changes with sufficient ingenuity upon the four generic and the three specific names, we may obtain no less than twelve different names for this one insect!

in irregular transverse rows. An oblique cream-colored lateral band, bordered below with a darker green, and most distinct on the middle segments, connects with a cream-colored subdorsal line, which is bordered above with darker green, and which extends from the head to the horn at the tail. There are five and often six somewhat pale yellow triangular patches along the back, each containing a lozenge-shaped lilac-colored spot. The head is small, with yellow granulations, and four perpendicular yellow lines, and the spiracles or breathing holes are orange-brown. When about to transform, the color of this worm usually changes to a pinkish-brown, the darker parts being of a beautiful mixture of crimson and brown. Previous to this change of color Mr. J. A. Lintner, of Schoharie, New York, has observed the worm to pass its mouth over the entire surface of its body, even to the tip of its horn, covering it with a coating of apparently glutinous matter—the operation lasting about two hours.* Before transforming into the pupa or chrysalis state, it descends from the vine, and within some fallen leaf or under any other rubbish that may be lying on the ground, forms a mesh of strong brown silk, within which it soon changes to a chrysalis (Fig. 45.) of a pale, warm yellow, speckled and spotted with brown, but characterized chiefly by the conspicuous dark brown spiracles and broad brown incisures of the three larger abdominal segments.

[Fig. 45.]



[Fig. 46.]

The moth (Fig. 46) which in time bursts from this chrysalis, has the body and front wings of a fleshy-gray, marked and shaded with olive-green as in the figure, while the hind wings are of a deep rust-color, with a small shade of gray near their inner angle.

This insect is, in northerly regions, one-brooded, but toward the south two-brooded, the first worms appearing, in the latitude of St. Louis, during June and July, and giving out the moths about two weeks after they become chrysalids, or from the middle of July to the first of August. The worms of the second brood are full grown in September, and passing the winter in the chrysalis state, give out the moths the following May. On one occasion I found at South Pass, Illinois, a worm but one-half grown and still feeding as late as October 20th, a circumstance which would lead to the belief that at

*Proc. Ent. Soc.. Phil., III, p. 663.

points where the winters are mild, they may even hybernate in the larva state.

This worm is a most voracious feeder, and a single one will sometimes strip a small vine of its leaves in a few nights. According to Harris it does not even confine its attacks to the leaves, but in its progress from leaf to leaf, stops at every cluster of fruit, and either from stupidity or disappointment, nips off the stalks of the half-grown grapes and allows them to fall to the ground untasted. It is fortunate for the grape-grower, therefore, that Nature has furnished the ready means to prevent its ever becoming excessively numerous, for I have never known it to swarm in very great numbers. The obvious reason is, that it is so freely attacked by a small parasitic Ichneumon fly—belonging to a genus (*Microgaster*) exceedingly numerous in species—that three out of every four worms that we meet with will generally be found to be thus victimized. The eggs of the parasite are deposited within the body of the worm, while it is yet young, and the young maggots hatching from them feed on the fatty parts of their victim. After the last moult of a worm that has been thus attacked, numerous little heads may be seen gradually pushing through different parts of its body; and as soon as they have worked themselves so far out that they are held only by the last joint of the body, they commence forming their small snow-white cocoons, which stand on ends and present the appearance of Figure 47. In about a week the fly (Fig. 48, *a*, magnified; *b*, natural size) pushes open a little lid which it had previously cut with its jaws, and soars away to fulfil its mission. It is one of those remarkable and not easily explained facts, which often confront the student of Nature, that, while one of these Hog-caterpillars in its normal and healthy condition may be starved to death in two or three days, another, that is writhing with its body full of parasites will live without food for as many weeks. Indeed, I have known one to rest for three weeks without food in a semi-paralyzed condition, and after the parasitic flies had all escaped from their cocoons, it would rouse itself and make a desperate effort to regain strength by nibbling at a leaf which was offered to it. But all worms thus attacked succumb in the end, and I cannot conclude this article to better advantage than by reminding the Grape-grower, that he should let alone all such as are found to be covered with the white cocoons above illustrated, and not, as has been often done, destroy them under the false impression that the cocoons are the eggs of the worm. Numbers of these little white cocoons are sent to me every year under the supposition that they are eggs, and no doubt many of them get destroyed by the very persons who ought to cherish them.

[Fig. 47.]

[Fig. 48.]

THE ACHEMON SPHINX—*Philampelus achemon*, Drury.*

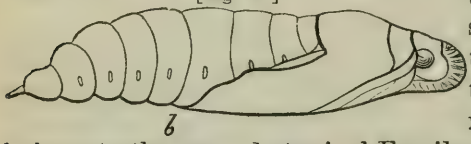
(Lepidoptera, Sphingidæ.)

[Fig. 49.]

a

This is another of the large Grape-vine-feeding insects, belonging to the great *Sphinx* family, and which may be popularly known as the Achemon Sphinx. It has been found in almost every State where the Grape is cultivated, and also occurs in Canada. It feeds on the American Ivy (*Ampelopsis quinquefolia*, with as much relish as on the Grape-vine, and seems to show no preference for any of the different varieties of the latter. It is, however, worthy of remark, that both its food-plants belong to the same botanical Family.

[Fig. 50.]



b

The full grown larva (Fig. 49.) is usually found during the latter part of August and fore part of September. It measures about 3½ inches when crawling, which operation is effected by a series of sud-

[Fig. 51.]

c

den jerks. The third segment is the largest, the second but half its size and the first still smaller, and when at rest the two last mentioned segments are partly withdrawn into the third as shown in the figure. The young larva is green, with a long slender reddish horn rising from the eleventh segment and curving over the back, and

*The synonyms for this insect are *Sphinx Crantor*, Cramer, and *Pholus crantor*, Huebner. The genus *Philampelus*—meaning literally "fond of the vine"—was erected by Harris to include this and the next species.

though I have found full grown specimens that were equally as green as the younger ones, they more generally assume a pale straw or reddish-brown color, and the long recurved horn is invariably replaced by a highly polished lenticular tubercle. The descriptions extant of this worm are quite brief and incomplete. The specimen from which my drawing was made, was of a pale straw color which deepened at the sides and finally merged into a rich vandyke-brown. A line of a *feuille-morte* brown, deep and distinct on the anterior part, but indistinct and almost effaced on the posterior part of each segment, ran along the back, and another line of the same color, continuous, and with its upper edge fading gradually, extended along each side. The six scalloped spots were cream-colored; the head, thoracic segments and breathing-holes inclined to flesh-color, and the prolegs and caudal plate were deep brown. The worm is covered more or less with minute spots which are dark on the back but light and annulated at the sides, while there are from six to eight transverse wrinkles on all but the thoracic and caudal segments.

The color of the worm, when about to transform, is often of a most beautiful pink or crimson. The chrysalis (Fig. 50) is formed within a smooth cavity under ground. It is of a dark shiny mahogany-brown color, shagreened or roughened, especially at the anterior edge of the segments on the back.

Unlike the Hog-caterpillar of the Vine, just described, this insect is everywhere single-brooded, the chrysalis remaining in the ground through the fall, winter and spring months, and producing the moth towards the latter part of June. I rather incline to believe however that there may be exceptions to the rule in southerly latitudes, and that in such latitudes it may sometimes be double-brooded; for I have known the moth to issue near St. Louis during the first days of August, and have this very year found two worms in the same locality as late as the 25th of October, neither of which was quite full grown, though the leaves on the vines upon which they were found had almost all fallen. Apparently such premature development of *Sphinx* moths is a well-known occurrence among the different European species; for Chas. Darwin remarks that "a number of moths, especially *Sphinx* moths, when hatched in the autumn out of their proper season, are completely barren; though the fact of their barrenness is still involved in some obscurity.*

The moth (Fig. 51), is of a brown-gray color variegated with light brown, and with the dark spots, shown in the figure, deep brown. The hind wings are pink with a dark shade across the middle, still darker spots below this shade, and a broad gray border behind. I once had an excellent opportunity of observing how it burst open the chrysalis shell, for while examining a chrysalis, the moth emerged. By a few sudden jerks of the head, but more especially by friction

*See *Variation of Animals and Plants, etc.*, II, pp. 157–8, English Edition, and the references there given in the foot-note.

with the knees of the middle pair of legs, it severed and ruptured the thin chrysalis shell, and the very moment the anus touched the ruptured end, the creamy fluid usually voided by newly-hatched moths was discharged.

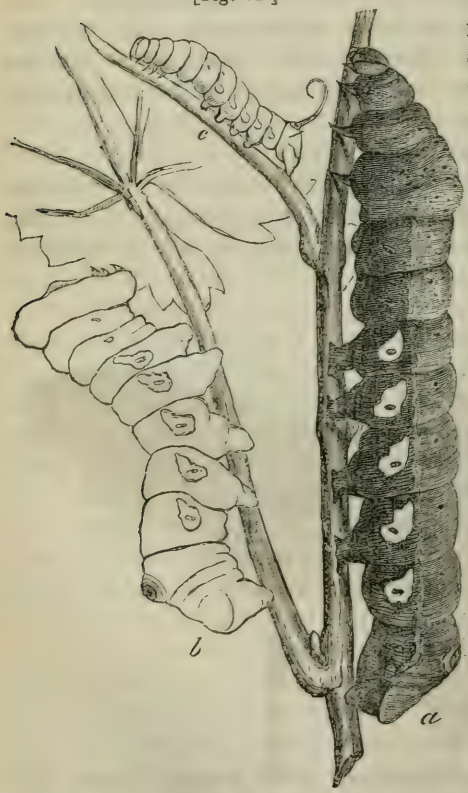
I have never found any parasite attacking this species, but its solitary habit and large size make it a conspicuous object, and it is easily controlled by hand, whenever it becomes unduly numerous upon the Grape-vine.

THE SATELLITE SPHINX—*Philampelus satellitia*, Linn.*

(Lepidoptera Sphingidæ.)

Like the preceding insect this one occurs in almost every State in the Union. It also bears a strong resemblance to the Achemon Sphinx, and likewise feeds upon the *Ampelopsis* as well as upon the Grape-vine; but the worm may readily be distinguished from the former by having five cream-colored spots each side, instead of six, and by the spots themselves being less scalloped.

[Fig. 52]



In the latitude of St. Louis, this worm is found full grown throughout the month of September, and a few specimens may even be found as late as the last of October. The eggs of this species, as of all other Hawk-moths (*Sphinx* family) known to me, are glued singly to the leaf of the plant which is to furnish the future worm with food. When first hatched, and for sometime afterwards, the larva is green, with a tinge of pink along the sides, and with an immensely long straight pink horn at the tail. This horn soon begins to shorten, and finally

*The synonyms for this insect are *Sphinx lycaon*, Cramer; *Pholus lycaon*, Huebner, and *Daphni pandorus*, Huebner. Mr. A. Grote (Proc. Ent. Soc. Phil., I, p. 60), believes that the *Sphinx lycaon* of the authors above quoted, is distinct from *S. Satellitia*, Linn., and would fain "*eliminate*" a third species (*posticatus*). For reasons which it would be tedious to give here, I prefer to regard *lycaon* as a variety of *satellitia*.

curls round like a dog's tail, as at Figure 52, *c*. As the worm grows older it changes to a reddish-brown, and by the third moult it entirely loses the caudal horn.

When full grown, it measures nearly four inches in length, and when crawling, appears as at Figure 52, *a*. It crawls by a series of sudden jerks, and will often fling its head savagely from side to side when alarmed. Dr. Morris* describes the mature larva as being green, with six side patches; but though I have happened across many specimens of this worm during the last seven years, I never once found one that was green after the third moult; nor do I believe that there are ever any more than five full-sized yellow spots each side, even in the young individuals. The specimen from which the above figure was made, occurred in 1867, at Hermann, Missouri, in Mr. Geo. Husmann's vineyard. The back was pinkish, inclining to flesh-color; the sides gradually became darker and darker, and the five patches on segments 6—10 inclusive, were cream-yellow with a black annulation, and shaped as in the figure. On segments 2, 3, 4, 5 and 6, were numerous small black dots, but on each of the following five segments there were but two such dots. A pale longitudinal line ran above the yellow patches, and the head and first joint were uniformly dull reddish-brown.

The most common general color of the full-grown worm is a rich velvety vinous-brown. When at rest, it draws back the fore part of the body, and retracts the head and first two joints into the third (see Fig. 52, *b*), and in this motionless position it no doubt manages to

[Fig. 53.]

escape from the clutches of many a hungry insectivorous bird. Dr. Morris, copying perhaps after Harris, erroneously states that the three anterior joints, together with the head, are retracted into the *fourth*, and Mr. J. A. Lintner† makes the same false assertion. It is

*Synopsis of N. A. *Lepidoptera*, p. 178.

†Proc. Ent. Soc. Phil., III, p. 659.

the *third* segment in this species, as well as in the Achemon Sphinx, which is so much swollen, and into which the head and first two segments are retracted.

When about to transform, the larva of our Satellite Sphinx enters a short distance into the ground, and soon works off its caterpillar-skin and becomes a chrysalis of a deep chestnut-brown, and very much of the same form as that of the Achemon Sphinx, figured on page 74. The moth (Fig. 53), makes its appearance in June of the following year, though it has been known to issue the same year that it had existed as larva. In this last event, it doubtless becomes barren, like others under similar circumstances, as was shown on page 75. The colors of the moth are light olive-gray, variegated as in the figure with dark olive-green. The worms are easily subdued by hand-picking.

THE ABBOT SPHINX—*Thyreus Abbotii*, Swainson.

(Lepidoptera, Sphingidæ.)

This is another of the large Grape-feeding insects, occurring on the cultivated and indigenous vines and on the Virginia Creeper, and having in the full-grown larva state, a polished tubercle instead of a horn at the tail. Its habitat is given by Dr. Clemens, as New York, Pennsylvania, Georgia, Massachusetts, and Ohio; but though not so common as the Sphinx moths previously described, yet it is often met with both in Illinois and Missouri. The larva which is represented in the upper part of Figure 54, varies considerably in appearance. Indeed, the ground-color seems to depend in a measure on the sex, for Dr. Morris describes this larva as reddish-brown with numerous patches of light-green, and expressly states that the *female* is of a uniform reddish-brown, with an interrupted dark brown dorsal line and transverse striæ. I have reared two individuals which came to their growth about the last of July, at which time they were both without a vestige of green. The ground-color was dirty yellowish, especially at the sides. Each segment was marked transversely with six or seven slightly impressed fine black lines, and longitudinally with wider

[Fig. 54.]

non-impressed dark brown patches, alternating with each other, and giving the worm a checkered appearance. These patches become more dense along the subdorsal region, where they form two irregular dark lines, which on the thoracic segments become single, with a similar line between them. There was also a dark stigmatal line with a lighter shade above it, and a dark stripe running obliquely downwards from the posterior to the anterior portion of each segment. The belly was yellow, with a tinge of pink between the prolegs, and the shiny tubercle at the tail was black, with a yellowish ring around the base. The head, which is characteristically marked, and by which this worm can always be distinguished from its allies—no matter what the ground-color of the body may be—is slightly roughened and dark, with a lighter broad band each side, and a central mark down the middle which often takes the form of an x. This worm does not assume the common Sphinx attitude of holding up the head, but rests stretched at full length, though if disturbed it will throw its head from side to side, thereby producing a crepitating noise.

The chrysalis is formed in a superficial cell on the ground; its surface is black and roughened by confluent punctures, but between the joints it is smooth and inclines to brown; the head-case is broad and rounded, and the tongue-case is level with the breast; the tail terminates in a rough flattened wedge-shaped point, which gives out two extremely small thorns from the end.

The moth (Fig. 54, below) appears in the following March or April, there being but one brood each year. It is of a dull chocolate or grayish-brown color, the front wings becoming lighter beyond the middle, and being variegated with dark brown as in the figure; the hind wings are sulphur-yellow, with a broad dark brown border breaking into a series of short lines on a flesh-colored ground, near the body. The wings are deeply scalloped, especially the front ones, and the body is furnished with lateral tufts. When at rest, the abdomen is curiously curved up in the air.

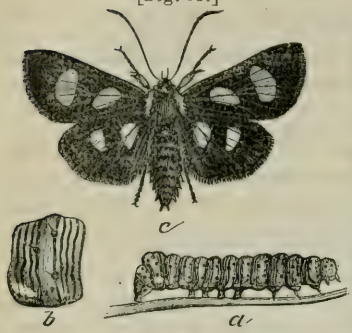
THE BLUE CATERPILLARS OF THE VINE.

Besides these large Sphinx caterpillars, every grape-grower must have observed certain so-called "Blue Caterpillars," which, though far from being uncommon, are yet very rarely sufficiently numerous to cause alarm, though in some few cases they have been known to strip certain vines. There are three distinct species of these blue caterpillars, which bear a sufficiently close resemblance to one another, to cause them to be easily confounded. The first and by far the most common with us is the larva of

THE EIGHT-SPOTTED FORESTER—*Alypia octomaculata*, Fabr.

(Lepidoptera, Zygænidæ.)

[Fig. 55.]



At Plate I, Figure 18 of my First Report, the male of this moth is illustrated by the side of its supposed larva, Figure 19 of the same Plate. In the text (pp. 136–7) I expressed some doubts as to whether this last was the rightful larva of the Eight-spotted Forester, and as I have since reared several moths from the larva state, and ascertained that the worm there figured does not belong to the Eight-spotted Forester, but in all probability to the Pearl Wood Nymph, I will now give the characters of these three different blue caterpillars, so that they may readily be distinguished hereafter.

The larva of the Eight-spotted Forester may often be found in the latitude of St. Louis as early as the beginning of May, and more abundantly in June, while scattering individuals (probably of a second brood) are even met with, but half-grown, in the month of September. The young larvæ are whitish with brown transverse lines, the colors not contrasting so strongly as in the full-grown specimens, though the black spots are more conspicuous. They feed beneath the leaves and can let themselves down by a web. The full-grown larva often conceals itself within a folded leaf. It is of the form of Figure 55, *a*, and is marked transversely with white and black lines, each segment having about eight light and eight dark ones. The bluish appearance of this caterpillar is owing to an optical phenomenon from the contrast of these white and black stripes. The head and the shield on the first segment are of a shiny bright deep orange color, marked with black dots, and there is a prominent transverse orange-red band, faint on segments 2 and 3; conspicuous on 4 and 11 and uniform in the middle of each of the other segments. In the middle segments of the body each orange band contains eight black conical elevated spots or tubercles, each spot giving rise to a white hair. These spots are arranged as in the enlarged section shown in the engraving (Fig. 55, *b*), namely, four on each side as follows: the upper one on the anterior border of the orange band, the second on its posterior border, the third just above spiracles on its anterior border—each of the three interrupting one of the transverse black lines—and the fourth, which is smaller, just behind the spiracles. The venter is black, slightly variegated with bluish-white, and with the orange band extending on the legless segments. The legs are black, and the false-legs have two black spots on an orange ground, at their outer base; but the characteristic feature, which especially distinguishes it from the other two species, is a lateral white wavy band—

obsolete on the thoracic segments, and most conspicuous on 10 and 11—running just below the spiracles, and interrupted by the transverse orange band.

I quote here Harris's full description of this larva (*Correspondence*, p. 286), as it agrees with mine, except in giving the number of transverse black lines as 6 on each segment, instead of 8, from the fact that he does not include the two which border the orange band, on account of their being interrupted. I have preferred to consider each segment of this worm as 8-banded, to distinguish it more readily from the other two species, which have respectively only six and four. "Length, when at rest, one inch and two-tenths, very pale blue, transversely banded with orange on the middle of each segment, the bands dotted with small black points, producing hairs, and surmounted by black lines, and between each of the bands six transverse black lines. A large, irregular, white spot on the side of the tenth and eleventh segments, and a series of smaller white spots on each of the other segments except the first three. Head orange dotted with black. Legs blackish externally. The full-grown, have a decidedly bluish tinge, entirely owing, however, to an optical phenomenon from the contrast of the white with the transverse black lines. The head is of a pale dirty orange or rusty yellow, with about eight black dots on each side; [about 10 large and 14 small dots in all,] a semicircular plate on the top of the first segment and the anal valves are pale orange dotted with black. There is a transverse series of black dots on the second and third segments, without an orange band. Each of the other segments is transversely banded with orange and dotted with black; the dots being in two alternate rows, and all of them emitting distinct, long whitish hairs. [The anterior dots on the back of segments 4, 5 and 6 and the posterior ones on 11, are considerably larger than the rest]. Between each of the bands there are six slender, continuous, black transverse lines. The points are also connected by interrupted black lines. Legs at base orange, black externally and at tip, except the anal pair which are orange, dotted with black. The large white lateral spot is common to the side of the tenth and eleventh segments. The other lateral white spots are situated immediately behind the bands on the fourth, fifth, sixth, seventh, eighth and ninth segments, the anterior spots being largest; and thence they diminish to the ninth, while again the posterior spot is very large and very distinct. The orange bands are interrupted on the top of the seventh, eighth and ninth segments."

This larva transforms to chysalis within a very slight cocoon formed without silk, upon, or just below the surface of the earth, and issues soon after, as a very beautiful moth of a deep blue-black color, with orange shanks, yellow shoulder-pieces, each of the front wings with two large light yellow spots, and each of the hind wings with two white ones. The illustration (Fig. 55, *c*) represents the female, and the male differs from her in having the wing spots larger, and in having a conspicuous white mark along the top of his narrower abdomen.

I have on one or two occasions known vines to be partly defoliated by this species, but never knew it to be quite so destructive as it is represented in the following communication from Mr. W. V. Andrews, of New York city, which I take from the February (1869) nummer of the *American Naturalist:*

"That a man should desire to raise his own Isabellas is laudable and praiseworthy; and I see no reason why such desire should exist exclusively in the breasts of our bucolic friends. The inhabitants of New York, as a general thing, clearly are of the same opinion, as is evidenced by the number of grape-vines ornamenting the doors and trellis-work of the houses of our citizens; not, of course, in the benighted regions of Wall street, but up-town; say from Sixteenth street northward. A friend of mine residing on Thirty-fourth street, showed me, in March last, a very fine vine, which he calculated would produce him sundry pounds of choice grapes, and in the pride of his

heart he invited me to "call along" occasionally, and feast my eyes on the gradual development of the incipient bunches. Thinking that August would be a good month for my visit, I "called along," wondering in my mind whether my friend would, when the time of ripe grapes came, desire me to help myself out of his abundance; or whether he intended to surprise me with a little basket of nice bunches, garnished with crisp, green leaves. The first glance at the grape-vine banished all doubts on this point. There were an abundance of bunches on the vine, in a rather immature condition, of course, but of foliage there was not a trace. Of course I expressed my surprise, though, for certain reasons, I felt none; and asked my friend why he selected a species of vine for shelter, ornament, and use, which produced no foliage. He rebuked my ignorance pretty sharply, and told me that a few weeks before, the vine was covered with leaves; but, for some inexplicable reason, they had all disappeared—eaten, he guessed, by something. He guessed right. There were at least a hundred of the larvæ of *A. octomaculata*, the rear guard of a mighty host, wandering about the branches, apparently for the purpose of making sure that no little particle of a leaf was left undevoured. Pretty little things they were, with harmoniously blended colors of black, yellow and blue, but so terribly destructive! I had the curiosity to walk through all the streets to the east of Third avenue, as low as Twenty-third street, and every vine was in the same predicament. If grape leaves, instead of fig leaves, had been in request for making aprons, and one *Alypia* had been in existence at the time, I doubt if in the whole Garden of Eden enough material would have been found to make a garment of decent size. The destruction of the crop for 1868 was complete.

"This was bad. But it was not half so bad as the helpless ignorance which possessed nearly all of the unfortunate owners of vines. Scarcely one that I conversed with had the remotest idea of the cause of the disaster, and when I explained that it was the caterpillar of a beautiful little black moth, with eight whitish-yellow spots on its wings, which had eaten up the foliage, my assertion was received with such a smile of incredulity, as convinced me that there is no use in trying to humbug such very sharp fellows as are the New York grape-growers.

"It is a little remarkable, however, that the destruction was confined to the eastern part of the city. I saw several luxuriant vines on the western side; and across the river at Hoboken, and at Hudson City, not a trace of *A. octomaculata* was discernible.

"The insect, then, is very local in its habits, and it is a day-flyer; and, from these facts, I infer that its ravages may be very materially checked. A little poisoned molasses, exposed in the neighborhood of the vine, would operate on the perfect insect [extremely doubtful]; while a good syringing with *soft soap* and water would bring down the caterpillars effectually."

THE BEAUTIFUL WOOD NYMPH—*Eudryas grata*, Fabr.

(Lepidoptera, Zygænidæ.)

Here is another moth (Fig. 56), surpassing in real beauty, though not in high contrast, the species just described. The front wings are milk-white, broadly bordered and marked, as in the figure, with rusty-brown, the band on the outer margin being shaded on the inner side with olive-green, and marked towards the edge with a slender wavy white line: under surface yellow, with two dusky spots near the middle. The hind wings are nankin-yellow, with a deep brown border, which does not extend to the outer angle, and which also contains a wavy white line: under surface yellow with a single black spot.

[Fig. 56.]

Surely these two moths are as unlike in general appearance as two moths well can be; and yet their caterpillars bear such a close resemblance to each other, and both feed upon the Grape-vine! The larva of the Beautiful Wood Nymph is, in fact, so very similar to that of the Eight-spotted Forester, that it is entirely unnecessary to figure it. It differs more especially from that species by invariably lacking the white patches along the sides, by the hairs arising from the black spots being less conspicuous, and by the hump on the eleventh segment being more prominent. The light parts of the body have really a slight bluish tint, and in specimens which I have found, I have only noticed six transverse black stripes to each segment. This larva, when at rest, depresses the head and raises the third and fourth segments, Sphinx-fashion. It is found on the vines in the central portion of the State as early as May and as late as September, and it devours all portions of the leaf, even to the midrid. It descends to the ground, and without making any cocoon, transforms to a chrysalis, which is dark colored, rough, with the tip of the abdomen obtusely conical, ending in four tubercles, the pair above, long and truncate, those below broad and short (Packard). Some of them give out the moth the same summer, but most of them pass the winter and do not issue as moths till the following spring.

THE PEARL WOOD NYMPH—*Eudryas unio*, Huebner.

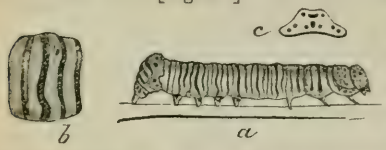
(Lepidoptera, Zygænidæ.)

This is another pretty little moth, so closely allied to, and so much resembling the preceding species, that it is not necessary to produce its picture. It is a smaller species, and differs from the Beautiful Wood Nymph in having the outer border of the front wings paler and of a tawny color, with the inner edge wavy instead of straight;

and in that of the hind wings being less distinct, more double, and extending to the outer angle.

The larva is said by Dr. Fitch to so much resemble that of the preceding species that "we as yet know not whether there are any marks whereby they can be distinguished from each other." (Report 3, § 124.) The moth is more common with us than its larger ally, and though I have never bred it from the larva, yet I have often met with a worm (Fig 57, *a*,) which there is every reason to believe, belongs to this species, and which is easily recognized from the preceding. It never grows to be quite so large as the other, and may readily be distinguished by its more decided bluish cast; by having but four light and four dark stripes to each segment (Fig. 57, *b*,); by having no orange band across the middle segments, and by the spots, with the exception of two on the back placed in the middle light band, being almost obsolete. The head, shield on the 1st segment, hump on the 11th, and a band on the 12th, are orange, spotted with black, the hump being marked as at Figure 57, *c*. Venter orange, becoming dusky towards head; feet and legs also orange, with blackish extremities, and with spots on their outside at base.

[Fig. 57.]



The worm works for the most part in the terminal buds of the vine, drawing the leaves together by a weak silken thread, and cankering them. It forms a simple earthen cocoon, or frequently bores into a piece of old wood, and changes to chrysalis, which averages but 0.36 inch in length; this chrysalis is reddish-brown, covered on the back with rows of very minute teeth, with the tip of the abdomen truncated, and terminating above in a thick blunt spine each side.

From the above accounts it is hoped that the reader will have no difficulty in distinguishing between these three blue caterpillars of the Grape-vine. But, says the practical grape-grower, "what does it concern me to know whether the little blue varmints that are defoliating my vines, belong to this species or to that? All I wish to know is how to get rid of them, and as they are all three so nearly alike, the remedy applied to one must be equally effectual with the others." Gently, dear reader; it *may* prove of considerable importance that you know which particular species infests your vines! If, for instance, a person living in the West should find the larvæ of the Beautiful Wood Nymph, then he need feel no alarm; while if a person living in the East should find that of the Pearl Wood Nymph, he may in like manner put his hands in his pockets and go his way with an easy mind; for neither of these species are likely to become troublesome in those respective sections of the country, since heretofore they have always been quite rare in those parts. Again, the larvæ of the two Wood Nymphs have a fondness for boring into old pieces of wood, to transform to the chrysalis state, and Mr. T. B. Ashton, of White Creek,

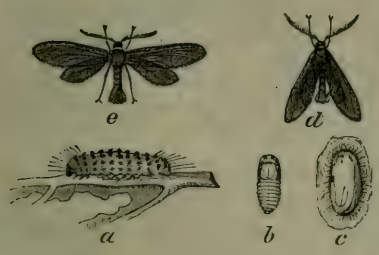
New York, found that they would even bore into corn cobs for this purpose in preference to entering the ground, wherever such cobs were accessible.* The Eight-spotted Forester, on the contrary, has no such habit, and while the only mode of combating it, is to pick the larvæ off and burn them, the Wood Nymphs may be more easily subdued by scattering a few corn cobs under the vines in the summer, to be raked up and burned in the winter.

THE AMERICAN PROCRIS—*Procris* [*Acoloithus*] *Americana*† Boisd.

(Lepidoptera, Ctenuchidæ.)

During the months of July and August, the leaves of the Grape-vine may often be found denuded of their softer parts, with nothing but the veins, and sometimes only a few of the larger ribs left skeleton-like, to tell of the mischief that has been done. Very frequently, only portions of the leaf will be thus denuded, and in that event, if we examine such a leaf closely, we shall find the authors of the mischief drawn up in line upon the yet leafy tissue with their heads all towards the margin, cutting away with their little jaws and retreating as they feed.

[Fig. 58.]



[Fig. 59.]

These little soldier-like files are formed by worms in black and yellow uniforms which produce a moth popularly known as the American Procris. The eggs from which they hatch, are laid in small clusters on the underside of the leaves, and while the worms are small, they leave untouched the most delicate veins of the leaf, which then presents a delicate net-work appearance as shown at the right of Figure 59; but when they become older and stronger they devour all but the larger ribs, as at the left of the figure.

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*Fitch's Rep. III, p. 82.

†This is the *Aglaope Americana* of Clemens, *Procris Americana* of Boisduval and Harris, and *Ctenucha Americana* of Walker.

The full grown larva (Figure 58, *a*) measures rather more than half an inch, and tapers a little towards each end. It is of a sulphur-yellow color, with a transverse row of six velvety-black, prickly tufts on each of the principle segments, the lower tufts being less distinct than those on the back. The first segment is entirely black with a yellow edge, while the spots on segments 11 and 12 usually run into one another. Head small, brown, and retractile, being usually hidden in the first segment. Fine scattering hairs anteriorly, laterally and posteriorly. The young worm is of a very pale yellow, covered with numerous fine white hairs, with a slight grayish-brown tint on the head, and with the fifth and seventh segments paler than the rest, and having the black spots scarcely visible.

When full grown these worms disperse over the vines or forsake them entirely, and each spins for itself a small, tough, whitish, flattened cocoon (Fig. 58, *c*) within which, in about three days, it changes to a chrysalis (Fig. 58, *b*), 0.30 inch long, broad, flattened and of a light shiny yellowish-brown color. In about ten days afterwards the moths (Fig. 58, *e* and *d*) begin to issue. This little moth is the American representative of the European *Procris vitis;* it is wholly of a black color, except the collar, which is of a deep orange, and the body ends in a broad fan-like notched tuft, especially in the male. The wings are of a delicate texture, reminding one of crape, and when the insect is at rest they generally form a perfect cross with the body, the hind wings being completely hidden by the front ones, which are stretched out straight at right angles, as in the genus *Pterophorus*, to which belongs the Grape-vine Plume.* I have, however, on one or two occasions found the American Procris resting in the manner shown at Figure 58, *d*.

This is the only Grape-vine feeding caterpillar which has a gregarious habit, and as gregarious insects are always more easily subdued than those of a solitary nature, the American Procris need never become very destructive. Its natural food is undoubtedly the wild grape-vines of our forests, and the Virginia Creeper, and Mr. Jordon, of St. Louis, has noticed that while it very commonly attacks the foliage of the Concord, yet it never touches the Clinton and Taylor in his vineyard—a taste which is remarkable and not easily accounted for, since the foliage of the latter kinds is more tender and generally more subject to insect depredations than that of the former.

There are two broods of this insect each year with us, some of the moths from the second brood of worms issuing in the fall, but the greater part not leaving their cocoons till the following summer. During the month of June they may be seen in pairs about the vines, and I have also frequently observed around Hermann, a very closely allied but smaller and different moth (*Acoloithus falsarius*, Clem.) about the same season of the year. This last, though so closely resembling the other, may be distinguished by being scarcely more than half as large; by the body lacking the anal tuft and being comparatively much thicker and shorter; by the hind wings being comparatively larger, and by the collar being of a paler orange and divided on the top by a black point.

*First Rep., Pl. II, Fig. 15.

The American Procris, though the fact is not mentioned by other authors, is subject to the attack of at least one parasite, with us; for I have bred from it a very peculiar little four-winged black fly belonging to the great *Chalcis* family, and which Mr. Cresson of Philadelphia refers doubtingly to *Perilampus platygaster*, Say.

THE NEW GRAPE-ROOT BORER.

Under this head I published last year* an account of a gigantic Grape-root borer which had at that time not been bred, and of which, in consequence, the perfect insect was not with certainly known. In order that the reader may get well familiarized with its appearance, the figure is here reproduced (Fig. 60). For reasons then given I inferred that this borer belonged to the *Prionus* family of the Long-horned beetles, and that it would perhaps produce the Cylindrical Orthosoma (*Orthosoma cylindricum*, Fabr.), a large flattened bay-colored beetle which is common throughout the country, and especially so in the Mississippi Valley, and which I illustrated at the time. I expressed the hope to be able another year to settle this matter, and am glad to be able to do so.

[Fig. 60.]

Last July I bred from worms that had been sent to me the year before, as occurring in Grape root, a different, though very closely allied species to that which I had inferred they would produce, namely,

THE BROAD-NECKED PRIONUS—*Prionus laticollis*, Drury.

(Coleoptera, Prionidæ.)

[Fig. 61.]

This species is usually of a darker color than the Cylindrical Orthosoma, and differs materially from that species by its larger size and broader form. The female, which is represented at Figure 61, differs from the male in having shorter and narrower antennæ, though her body is usually larger.

In all probability this insect lives nearly three years in the larva state, for three distinct sizes may be found. Those I have bred, left the roots they were inhabiting when about to become pupæ, and formed for themselves smooth oval chambers in the earth wherein they eventually cast their larval skins, and

*First Rep., pp. 124–8.

[Fig. 62.]

assumed the pupa form represented at Figure 62, but in all probability they transform within the root, when in more natural conditions. This change takes place towards the end of June, and the perfect beetle appears in about three weeks afterwards.

Soon after breeding this beetle from Grape-feeding borers, I bred a female of the same species from a very large borer which I had found the same spring, in an apple root, it having entirely killed a young apple tree, by hollowing out nearly all the roots, and by finally severing the tap root near the butt of the tree.

Thus it results that the Broad-necked Prionus bores in the larva state indiscriminately in the roots of the Grape-vine and Apple, and perhaps in those of the closely allied Pear. According to Harris it also infests the roots of different kinds of poplars, and it is consequently a pretty general feeder.

Few persons are really aware of the amount of damage these gigantic borers are capable of causing. Last March I received a long letter from Mr. Robert S. Munford, of Munfordsville, Ky., minutely describing this borer, and the manner in which it destroyed three hundred dollars' worth of his apple trees; while Mr. C. R. Edwards, of Bowling Green, Ky., writes that they have been quite injurious to his grape-vines of all varieties, though his Ionas suffered most from their attacks. Mr. Emory S. Foster, of Bushburg, sent me a specimen in May with the statement that it cut off a vine, after the fall of the leaf, and then went some six inches further down, and entered the main root, making for itself a comfortable residence where it spent the winter. Messrs. Bush and Spaulding inform me that they are continually losing vines from this borer, and that they consider it one of the worst enemies they have to contend against.

Little can be done to prevent the ravages of these underground borers after they are once in a vine, the death of which is usually the only manifestation of their presence. Still, every vine-grower should make it a rule to search for them whenever he finds vines suddenly dying from any unknown cause, and upon finding such a borer should at once put an end to its existence. The beetles, which may often be found during the summer and fall months, and which not unfrequently rush with heavy, noisy flight, into our lighted rooms, should also be ruthlessly sacrificed whenever met with. As I shall presently show, however, much may be done by judicious management to prevent their getting into the vines.

THE TILE-HORNED PRIONUS—*Prionus imbricornis*, Linn.

(Coleoptera Prionidæ.)

There is another species, the Tile-horned Prionus (*Prionus imbricornis*, Linn., Fig. 63 ♂)—so called from the joints of the male antennæ lapping over one another like the tiles or shingles of a roof—which very closely resembles the Broad-necked Prionus, and is with us much commoner. It may be distinguished at once from this last by the antennæ of the male being about 19-jointed, and those of the female about 16-jointed;* whereas both sexes of the Broad-necked Prionus have 12-jointed antennæ. In other respects, these two beetles are almost exactly alike, so that, if the antennæ happen to be broken, it is not very easy to tell one from another.

[Fig. 63.]

♂

Hitherto it has not been known upon what kind of tree this species fed, but I was fortunate enough last summer to ascertain that it also infests grape-roots. On the first of July last, Mr. Isidor Bush, of Bushburg, brought me quite a number of full-grown larvæ which he had taken from the roots of his grape vines. These were so very similar in appearance to those which produced the Broad-necked species, that I had not a suspicion they would produce anything else, and I was consequently greatly surprised when I bred from them a number of the Tile-horned species under consideration. By collecting together fibres and chips of the roots, they form a loose sort of cocoon, and transform, either inside or outside of the root, to pupæ, which resemble so closely that shown in Figure 62, that they can scarcely be distinguished from it.

We have, therefore, two distinct insects which bore into the roots of the Grape-vine, and which, though distinct, are so closely allied, that the females can only be distinguished by the number of joints in their antennæ. One of these is known to attack, besides the Grape, the Apple, the Lombardy poplar and the Balm of Gilead, and the other is very likely equally indifferent as to its choice of diet.

The accounts given in my former article, of the immense borers found in Osage Orange roots, and even in the roots of corn-stalks, undoubtedly refer to one or the other of these insects, and probably to the Tile-horned species, as that is the most common.

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* Having examined nearly 20 males of this species, I have found the antennal joints to vary in number from 18 to 20, the same specimen often having a different number of joints in the right and left antenna. In one ♀ the antennæ are both of them 16-jointed, in another ♀ they are both of them 17-jointed. The typical number of joints in the Coleopterous antenna is only 11; and the number being so variable in these many-jointed antennæ is in accordance with the general rule, that multiple parts are often variable.

Several persons who have recognized this immense borer from the figure and description which I published last year, have informed me that they have found it on prairie land, and Mr. Wm. C. Holmes, nurseryman, of Plattsburg, writes: "The Borer described on page 124 of your Report is destroying a good many of our apple grafts, set last spring. The root not being large enough for them to work inside, they eat out about one-third of the bark, and hollow out the rest of the root. Our nursery is on prairie, broke in the fall of 1867 and spring of 1868." Now the fact of these large root-feeding borers occurring in such numbers in recently turned-up prairie land where no large roots exist, would have been perfectly inexplicable had I not been cognizant of other facts which threw light on the subject.

There is a small dimorphous male form of the Tile-horned Prionus not more than half the normal size, and of a much paler yellowish color, which is quite common in the West, and which I have found even more common around St. Louis, than the true type. I know that this form is often found in prairie regions, and my entomological friend Chas. Sonne, of Chicago, Illinois, informs me that a relation of his, Mr. F. Jæger, of Siegel, Illinois, in digging a cellar, once found immense numbers of these large grubs near the surface of the ground. A whole lot of them were sent to Mr. Sonne, and he bred from them numerous specimens of this small form of the Tile-horned Prionus, every one of them males, and every one with nineteen joints to the antennæ. On another occasion, at the same place, Mr. Sonne, having placed a lamp on a grind-stone, found that these beetles swarmed around the light, and next day upon examining a number which he captured, they all proved to be, in like manner, the small yellow form, and all males. Now, Mr. Jæger's house is remote from any timber whatever, there being but a few scrub willows here and there near by; and, from these facts, and those mentioned by Mr. Holmes, we are forced to the belief that these grubs (at least those of the small ♂ dimorphous form) are able, not only to subsist on the roots of small shrubs and very young trees, but also upon those of herbaceous plants. Mr. H. A. Mungor, of Lone Cedar, Martin county, Minnesota, has had a similar experience; for he often ploughs up these grubs in prairie land, and has captured the beetles a full mile away from any trees or shrubs, except a few specimens of a suffruticose plant known as the Lead-plant (*Amorpha Canescens*), which very seldom grows a root there, of over one-half inch diameter. He has also actually bred the beetle from pupæ found in such prairie ground. Therefore, some of the accounts—such as their occurring full grown in the roots of annuals like corn and cabbage, and in those of grape-vines but one year planted—which were not easily explained before; become perfectly clear, now that we have a better understanding of the facts in the case.

Now then comes the point of practical importance. It may with reason be argued, that it matters little to the Grape-grower to which

particular species these borers belong, so they have the habit in common, of infesting the roots of his vines. But a more important question presents itself to the thinking mind. Is any danger to be apprehended from these borers, from growing grape-vines and fruit trees among decaying oak stumps? In my former article, from the testimony of practical vineyardists, I have hinted that there is, and have advised not to plant on land covered with such stumps, or even to use oak stakes, where those made of cedar can be had; and I am glad to be able to say that this advice is well founded.

As a general rule, the larvæ of the Long-horned Boring Beetles either inhabit green and living wood or else decaying and dead wood, the same species never attacking both kinds of wood indiscriminately; and as I knew that the larva of the Cylindrical Orthosoma fed on rotten pine wood, I thought it very probable that it also fed on rotten oak stumps, and had been confounded by practical men with those of the Broad-necked and Tile-horned species, which it so much resembles. This opinion was supported by the fact that it occurred abundantly in Union county, South Illinois, in 1861, where there are no pine trees growing, and where, at that period, the so called "poplar" or white-wood was universally used in buildings, in place of pine imported from the North; and I last summer ascertained that it really does breed in rotten oak stumps, as well as in decaying pine, for I found it in the former wood, both in the larva, pupa, and fresh beetle state. But what is still more important I also find that the Broad-necked Prionus, is an exception to the rule above mentioned, and that it breeds as freely in decaying oak stumps as in living roots. For this fact I am indebted to Mrs. Mary Treat of Vineland, N. J., who has sent me specimens of the beetle bred from larvæ that are found abundant in the oak stumps in that vicinity.

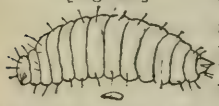
Summary.—To sum up the whole matter in a few words, it is obvious that we have in Missouri three large boring grubs, which so closely resemble each other, that they cannot be distinguished by any marks which we are yet acquainted with—that the Broad-necked Prionus feeds indiscriminately on the living roots of Apple, Grape-vine, Poplar (and perhaps of several other trees), and on decaying oak stumps, and will travel through the ground from one place to another—that the Tile-horned Prionus not only attacks the Grape-vine, but can subsist on the roots of herbaceous plants, and in all probability will also feed on decaying oak, like the former species; and finally, that the Cylindrical Orthosoma feeds on decaying pine and oak, but has not yet been found in living roots. From these facts we may deduce the important corollary, that it will not do to leave oak stumps to rot on ground which is intended for a vineyard or orchard—which was the thing to be proved.

THE GRAPE SEED-MAGGOT—*Isosoma vitis*, Saunders.

(Hymenoptera, Chalcididæ.)

In my First Report (pp. 125–31), I gave an account of a minute maggot (Fig. 64) which had been found by Mr. Wm. Saunders, of London, C. W., to infest the seeds of growing grapes, and to occasion much damage around London and Paris, by causing the berries of the Clinton, Delaware, Rogers' No. 4, and some of Mr. Arnold's Seedlings, to shrivel up without maturing. There are so many noxious insects, common in Missouri, that occur also in the southern portions of Canada West, that it was deemed necessary to give the grape-growers of the State a diagnosis of its work, in case it should at any day make its appearance in our vineyards.

[Fig. 64.]



From the appearance of this maggot, I inferred, with every one else who gave an opinion, that it would most likely produce some small species of snout-beetle (*Curculio* family). Now mark how dangerous a thing it is, for even an entomologist to guess at the character of some insects, when in this masked form. We flatter ourselves that there are but very few insects among the half million different species that are estimated to exist in the whole extent of this terrestrial globe of ours, that we cannot place at a glance in its proper Order, even when in the larva state; but let us humbly acknowledge that there are some few larval forms among the more minute Four-winged Flies (order *Hymenoptera*) and Beetles (order *Coleoptera*) which it is almost, if not absolutely, impossible to distinguish the one from the other.

Last August I had the pleasure of spending a few hours with Mr. Saunders, at his place in London, and I was gratified to learn that he had bred the perfect insect from this seed-maggot. It proved to be a little Four-winged fly (*Chalcis* family), and upon my return home, I found a few specimens of the very same species of fly, in a bottle in which were placed some infested grapes received the year before from Mr. A. S. Fuller of New Jersey, and obtained by him from Canada.

[Fig. 65.]

This fly so closely resembles the notorious Joint-worm Fly (*Isosoma hordei*, Harris) that the accompanying highly magnified sketch (Fig. 65) of that insect—*a* representing the female, *b* the male, *c* the ♀ antenna, *d* the ♂ do., *e* the ♀ abdomen and *f* the ♂ do.—will afford a very correct idea of its appearance.

The Grape Seed-maggot Fly differs principally from the Joint-worm Fly in its somewhat smaller size, in the legs being marked

with black on the thighs and shanks, in the ♂ abdomen being comparatively shorter, and in its third ring conspicuously overhanging the fourth. The following account and description from Mr. Saunders himself, is taken from the November number of the *Canadian Entomologist:*

"In October I detached a larva from the inside of the seed, and placed it in a small glass cell between two plates of glass, in which state it remained until early in January, when it became a pupa, having first attached itself to the sides of the cell by a few short silky threads. It had now contracted in length, become nearly oval, and assumed a yellowish tint, with a few short loose silky threads adhering to different parts of its surface. On the 11th of February I examined some seeds and found the larva within, still alive and active, just as it appeared in the fall. On the 7th of July further specimens were opened and the inmates found soft and motionless; these appeared to be in the pupa state, but I did not examine them with sufficient care to enable me to be positive. During the remaining part of July, I looked many times into the bottles in which the grapes were enclosed but could not discover anything. On the 9th of August, feeling sure that the time for the appearance of the insect must be fully come, if not already past, I resolved on a thorough search for it. As soon as the contents of the bottles had been emptied on a piece of white paper, I observed a number of small four-winged flies among the dried-up grapes. They were all dead and stiff, some of them more brittle than others. From the observations made, I should judge that they made their escape from the middle to the end of July."

ISOSOMA VITIS, Saunders, ♀—*Head* large, flattened in front, black, thickly punctured, and covered with many short whitish hairs; mandibles pale brown at base, tipped with black; antennæ (scape and 8 joints), 9-jointed, black, thickly covered with whitish hairs inserted in deep sockets; the scape pale brown, slender, nearly as long as the three following joints together; the second short; third to eighth inclusive nearly equal in length; the terminal joint longer, tapering slightly towards the tip. *Thorax* black, punctured and covered with whitish hairs. *Legs*, front pair pale brown, trochanters nearly black; second and third pairs, trochanters black, femora and tibiæ nearly black along the middle, pale brown at tips; tarsi pale brown. *Abdomen*, long, black, straight, smooth, with a polished surface; placed on a short pedicel; a little contracted at base, thickest on third joint, tapering gradually to fifth, and then suddenly to extremity; the basal joint very short, second and third each somewhat longer, fourth as long as the three preceding, fifth less than half as long as fourth, sixth a little shorter, terminal joint rather longer.

♂ differs from ♀ in having the antennæ somewhat longer and more thickly covered with hairs. His abdomen is short, thick and blunt, placed on a moderately stout pedicel nearly its own length. The abdominal rings have about the same relative size as in the female, but the posterior edge of third overhangs the fourth, the latter appearing as if partially drawn within the projecting edge of the third ring.

Length ♀ 0.10, ♂, 0.06 inch.

"Having kept the grapes in bottles, only occasionally opened for ventilation, in a dry room, they had become quite hard, dry and shrivelled. In consequence of this, many of the flies were unable to make their way out, the seed having become too hard for their jaws to eat through. On opening some of these the flies were found dead with wings fully developed and surrounded by small fragments of the interior coating of the seed which they had evidently gnawed off while

endeavoring to escape. Those which had found their way out had eaten a small nearly round irregular hole through seed and skin. In many similar cases where the larva feeds within a hard substance it provides for the escape of the perfect insect by eating away the hard enclosure until it is reduced so thin as to appear almost transparent, then a very little effort is sufficient to remove the obstruction to the outward passage of the imago. In this instance I have been unable to detect any such preparation, and believe that the whole work of escape is accomplished by the perfect fly.

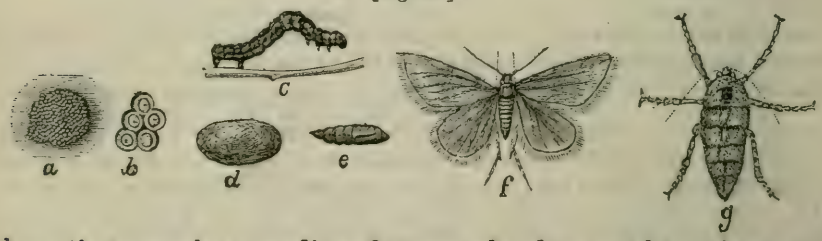
"Notwithstanding the abundance of this insect last year, I have as yet been unable to detect their presence or any evidence of their work during the present season; probably the cold and wet character of the summer has been unfavorable to their operations."

THE CANKER-WORM—*Anisopteryx vernata*, Peck.

[Lepidoptera Phalænidæ.]

This word CANKER-WORM has formed the heading of so many articles in our various Agricultural and Horticultural journals during the last ten or twelve years, and its natural history has been so fully given in the standard work of Dr. Harris, that one almost wonders

[Fig. 66.]



where there can be a reading farmer who does not know how properly to fight it. But then, new generations are ever replacing those which pass away, so that the same stories will doubtless have to be repeated to the end of time. Facts in Nature will always bear repeating, and as it may be laid down as a maxim that no injurious insect can be successfully combated without a thorough knowledge of its habits and transformations, I will first recount those of the Canker-worm, and afterwards state the proper remedy.

The eggs of this insect are very minute, measuring about 0.03 inch in length and 0.02 in diameter. In form they are not unlike a miniature hen's egg, minutely roughened and with longitudinal irregular depressions. They reflect prismatic colors, and are deposited close together in rows, forming batches such as that shown in the above Figure 66, *a* representing them of the natural size, and *b* rep-

resenting them magnified. They are glued together by a grayish varnish which the mother moth secretes, and they are attached to the trunk, or to some one or other of the twigs of the tree, and may often be found on the inside of loose scales of bark, each batch consisting of upwards of a hundred eggs.

As the leaves begin to form, these eggs hatch into minute, thread-like span-worms, which in from three to four weeks afterwards acquire their full size, when they appear as at Figure 66 *c*. The Canker-worm is distinguished from most other caterpillars that attack the Apple, by having but four prolegs at the end of the body. The normal number of such prolegs in caterpillars, is ten; and it is the lack of the foremost six which obliges our insect to span or loop, from which habit the characteristic name GEOMETRIDÆ has been given to the group to which it belongs.

When full-grown this worm measures scarcely an inch in length, and is commonly ash-gray on the back, darker at the side and yellowish beneath. It varies greatly in the intensity of its markings however, ash-gray, green, and yellow ones occurring in the same brood, and the most constant character by which it may be distinguished from other span-worms of the same size, is the pattern of the head, which, no matter what the general hue of the body may be, is usually shaded and marked as in the annexed Figure 67. The markings of the worm vary indeed so much, that, without this criterion I could hardly venture to determine a Canker-worm larva myself.

[Fig. 67.]

I subjoin a very full description of this worm from numerous average specimens, as it is of considerable importance, that an orchardist may be able to ascertain definitely whether he is troubled with the true Canker-worm or not. For if he mistakes some other span-worm which produces winged females as well as winged males, for the genuine Canker-worm which is apterous in the female moth state, it becomes very obvious that all his efforts to try and prevent the ravages of the spurious Canker-worm by the most approved and well-tried methods, will not only fail most absolutely, but he will lose all faith in such remedies, and may perchance, if he is given to the use of the quill, vent his wrath and disappointment by sending to some one of the horticultural journals of the land, a pithy article "based upon FACTS [?] and EXPERIENCE" showing up the utter worthlessness of the Canker-worm remedies!

It is from such lack of true knowledge that the City Fathers of Baltimore, Maryland, went to the useless expense of furnishing oil troughs for all their large elm trees which were being defoliated, under the delusive idea that the insect committing the ravage was the Canker-worm; whereas it turned out to be the larva of a little imported Beetle (*Galeruca calmariensis*, Fabr.), the female of which has ample wings, and can fly as readily as a bird from tree to tree; and it is

from such oversights, that paragraphs like the following take their rise. This one may be found in the *Boston Journal* for may 23d, 1866:

ORIGIN OF CANKER-WORMS.—A Medford correspondent says that last fall he applied to his trees protectors which were pronounced the best in the neighborhood, and notwithstanding not a single grub passed over them, the trees, like others in the vicinity, are this season covered with worms which are now pursuing their devastating work. In his opinion the Canker-worms do not originate from the grub, and he challenges proof that they do. The subject is one worthy of investigation!

Whe-e-e-e-ou! It needs no comments in this Report.

When first hatched the young Canker-worms are of a dark olive-green or brown hue, with a shiny black head and thoracic legs, with a whitish lateral and dorsal band, the latter having a darker central line along it. After the first moult, the head becomes lighter and mottled, and the light bands less conspicuous. After the second moult the bands are almost obliterated and the body becomes more uniformly mottled and speckled with livid-brown; the head becomes still lighter and the prolegs being now large, spread out at almost a level with the venter. After the third (and I believe last) moult the appearance changes but little. The full grown larva averages 0.90 inch in length with an average diameter of 0.10 inch, being broadest on joint 11. It varies from light fleshy-gray to almost black. Head mottled as in Figure 67. Ends of body somewhat darker than middle. Joint 1 with a yellowish dorsal shield, the hinder margin in form of a rounded W. Viewed under a lens the body has a series of eight fine light yellowish, irregular, somewhat broken lines, running the whole length of the body, each one relieved by a darker shade each side of it. The two along middle of dorsum are close together, with the space between them usually dark, and occupied at anterior edge and middle of joints 5, 6, 7 and 11 by black marks somewhat in form of x, these marks being represented by simple black dots on the other joints. Space between these dorsal lines and the next lowest, lighter, and containing four black piliferous spots to each joint, the posterior ones rather further apart than the anterior ones which on joint 11 form two larger elevated shiny black spots. Space between lines 2 and 3 darker than any other part of the body. That between lines 3 and 4 lighter than any other part of body and containing the stigmata which are perfectly round and black with a light centre, with a small piliferous spot anteriorly above and below them, and another behind them, this last becoming large on joints 5, 6, 7 and 8. Venter dark and livid at borders, with a pale greenish band along the middle, which has a pinkish patch in it on joints 5, 6, 7 and 8. Legs greenish at base, color of body at extremity. The markings are most distinct on the light specimens.

The Canker-worm is by no means confined, in its destructive work, to the Apple, for it likewise attacks the Plum, the Cherry, the Elm, and a variety of other trees. Mr. R. J. Mendenhall, of Minneapolis, Minn., even informs me, in a recent letter, that "the Currant worm" spoken of in a late number of the *Farmer's Union* as infesting the currant bushes in the gardens around that city, were really Canker-worms, but he is most assuredly mistaken. The Canker-worm is seldom ever noticed on our trees till the riddled and seared appearance of the foliage tell of its presence; for, like most other span-worms, it has the habit of resting in a stiff straight posture, either at an angle of about 45° from, or flat and parallel with the twig which it occupies—thus eluding detection.

After it has attained its full size it either crawls down the tree or lets itself down by means of a silken thread, and burrows into the ground. Here, at a depth of two or three inches, it forms a rude cocoon of particles of earth intermixed with silk (Fig. 66, *d*). Within two days after completing the cocoon the worm becomes a chrysalis

of a light brown color. The sexes are now distinguishable, the male chrysalis (Fig. 66, *e*) being slender, pointed in front, and showing the wing-sheaths; while that of the female is larger and destitute of wing-sheaths.

In the latitude of St. Louis, the worms have generally descended from the trees and entered the ground by the middle of May, though some remain till about the first of June. As I have amply proved during the past two summers, there is but one brood each year in this State, just as there is but one brood in Maine, and whether the worms enter the ground the first or the last of May, they remain there as chrysalids all through the summer and fall months, and the great majority of them till the following spring. A frost seems to be necessary to their proper development. Some come out during the first mild weather that succeeds the first frosts in November; others issue all through the winter whenever the ground is thawed, and the great bulk issue as soon as the frost is entirely out of the ground in spring. Many which I bred this winter issued during the warm weather of January.

The moths (Fig. 66 *f* ♂, *g* ♀) show great disparity of sex, the male being fully winged while the female is entirely destitute of these appendages. The front wings of the male are pale ash-gray, crossed by three equidistant jagged, more or less defined, black lines, all curved inwardly, and most distinct on the front or costal border; and by a somewhat broader whitish line, which runs from the posterior angle to the apex; the inner and terminal borders also being marked with black. The hind wings are silvery-gray, and the under surfaces are of the same uniform silvery-gray color, each wing with a dusky discal spot, the front wings each with an additional spot on the costa. Such is the appearance of the more common perfect specimens found in the West, but the wings are very thin and silky, and the scales easily rub off, so that it is almost impossible to capture a perfect specimen at large. They vary considerably also—so much so that Dr. Harris ranks a smaller form as a distinct species (*A. pometaria*) which I have however bred promiscuously with the more typical specimens. The most common variation from the brief description above given, is found in such specimens which have the dark lines obsolete, and an additional white line inside the one described. The female is ash-gray, the thorax with a black spot, the body more or less marked with black along the back, and the legs alternately marked with black and white.

In Missouri the Canker-worm is not so injurious over broad tracts of country, as it is in some of the more eastern States. Yet it is sufficiently distributed in different parts, to require vigilance to keep it down. "R. P.," of Mexico, Mo., found it very injurious in the spring of 1868, and sent me many specimens, and they were the genuine article. Around Pevely, I have likewise found it common on the

farms of Dr. Varnum and Mr. Foster. Mr. Wm. M. Beal of Edina tells me that it is considered one of the very worst enemies in Knox county, and as I am informed by Mr. J. D. Dopf, editor of the *Journal*, Rockport, Atchison Co., it was exceedingly troublesome to the elms there in 1866. Where they have once become established, and are neglected, their ravages soon become very great; and they were so bad in certain parts of Michigan a few years ago, and especially in the Grand Traverse region in 1865, that, unless my memory fails me, a certain Eastern editor, in response to an appeal for a remedy from Mr. Sanford Howard, the Secretary of the Michigan State Board of Agriculture very foolishly urged the Wolverines to cut down their trees. May I hope that these Entomological Reports will be the means of protecting Missouri from the fearful ravages of this worm which has so often discouraged the orchardists in Massachusetts, Rhode Island, Connecticut, and some of the Middle States.

It is the apterous condition of the female moth which gives us such complete control of this enemy, and which indicates

THE PROPER REMEDY.

The sole object of the female, after she leaves the earth, seems to be to provide for the continuance of her kind, and she instinctively places the precious burden, which is to give birth to the young which she herself is destined never to behold, upon the tree whose leaves are to nourish those young. All her life-energy is centered in the accomplishment of this one object, and she immediately makes for the tree upon issuing from the ground. Consequently, anything that will prevent her ascending the trunk will, in a great measure (but as we shall presently see, not entirely) preserve the tree from the ravages of the worm.

Numerous indeed have been the devices—patented or unpatented—which have at different times and in different parts of the country been used to accomplish this desired end; and every year our Agricultural journals report individual experiments with some one or other of these devices—some favorable and others adverse. Tar, applied either directly around the body of the tree, or on strips of old canvas, on sheep-skin, or on stiff paper; refuse sorghum molasses, printers' ink, or slow-drying varnishes, or melted India rubber, which always retains its soft viscid state, applied in a similar manner; tin, lead, and rubber troughs to contain oil; belts of cotton-wool, etc., etc., have all been used, and with both good and bad results, very much according as they have been used intelligently or otherwise. Now, all these appliances, of whatsoever character, are divisible into two classes: first, those which prevent the ascension of the moth by entangling her feet, and trapping her fast, or by drowning her; and, second, those which accomplish the same end by preventing her from getting a foothold, and thus causing her repeatedly to fall to the ground until she becomes exhausted and dies.

The first class of remedies are thoroughly effectual when applied understandingly and persistently. And by this I mean, that the orchardist must know that many of the moths issue in the fall of the year, and that the applications must, in consequence, be made at least as early as the latter part of October, and that they must be kept sticky, through all but freezing weather, till the leaves have well put out, in the following spring. Furthermore he must know that many of the moths—frustrated in their efforts to climb the tree—will deposit their eggs near the ground or anywhere below the application, and that the young worms hatching from them are able to pass behind the slighest crevice or over the finest straw. Thus, if troughs are used, they must be fitted over a bandage of cotton-wool, so that when the trough is drawn tightly around the tree, it will do no injury, and will at the same time cause the cotton to fill up all inequalities of the bark; the joint must likewise be kept smeared either with tar or molasses, and then the worms will not be able to pass. In the neglect to thus fasten them, lies the secret of failure which many report who use such troughs. The second class of contrivances are of no avail whatever, for although the moth is unable to travel over a very smooth surface, I know from experience that the young worms can march over the smoothest glass by aid of the glutinous silken thread which they are able to spin from the very moment they are born. For these reasons, even the "Merritt's Patent Tree-Protector," which was so well advertised by Mr. Howard in his otherwise excellent article on the Canker-worm, in the Michigan Agricultural Report for 1865, must be classed with the worthless patents. This "Protector" consists of a ring of glass grooved below and hung from the tree by a tent of canvas, to which it is fastened by an iron clamp.

I might enumerate a number of such ingenious contrivances both of glass, wood, tin, and isinglass, for heading off the female moth *only*, and some few which are sufficiently thorough to head off the young larvæ also; but they are all so expensive, that I am perfectly convinced they will never be adopted in our large orchards; nor are they necessary, for some of the remedies already mentioned are altogether more simple and more effectual.

It cannot be denied that it requires a great deal of time, labor and expense to continually renew the applications of tar on every tree in a large orchard during so many months of the year; while its application directly to the bark is more or less injurious to the trees. For these reasons, refuse sorghum molasses will be found much better for the purpose, as it does not harden so rapidly, and is said not to be injurious to the tree. In neighborhoods where sorghum is grown, it is also much cheaper. That it will pay to do this work in orchards where the Canker-worm is known to be numerous, there cannot be the least doubt. The old adage, "What is worth doing at all is worth doing well," was never truer than in fighting this insect.

Apply the remedy thoroughly during two successive years, and you have utterly routed the enemy, and this is more especially the case where an orchard is not in too close proximity to the timber, or to slovenly neighbors. Fail to apply the remedy, and the enemy will, in all probability, rout you. The reason is simple. The female being wingless, the insect is very local in its attacks, sometimes swarming in one orchard and being unknown in another which is but a mile away. Thus, after it is once exterminated, a sudden invasion is not to be expected, as in the case of the Tent Caterpillar, and of many other orchard pests; but when it has once obtained a footing in an orchard, it multiplies the more rapidly, for the very reason that it does not spread fast.

If oil troughs are used, it will be found much safer, and surer to sink them in the ground close around the butt of the tree, instead of winding them around the trunk higher up. There will then be no chance for the young worms to get up between the trough and the tree. But it follows, that this plan can only be adopted in an orchard which is kept perfectly clean.

As for muriate of lime, which has been so earnestly recommended as a preventive, by interested parties, here is what Mr. Sanford Howard says of it in the *Western Rural* of August 18th, 1866, and Mr. Joseph Breck, editor of the old American *Journal of Horticulture*; G. C. Brackett, correspondent of the *Maine Farmer*, and several other persons with whom I am acquainted, all testify, after having thoroughly tried it, to its utter worthlessness for this purpose:

The editor of the *Farmer* says, there are statements to the effect, that a substance called Gould's Muriate of Lime, applied to the soil in autumn, had entirely prevented the subsequent appearance of Canker-worms on trees standing on the ground, although the trees had previously been much damaged by the insect. It is also stated that on other trees, not ten rods distant, where none of the so-called muriate of lime was applied, the worms were very destructive.

I cannot think that this amounts to any proof that the substance applied destroyed the worms, or had any effect on them. The non-appearance of the insect in the case alluded to, was probably due to other causes. If this substance will kill or injure the insect in any of its stages, it would be easy to prove it by a direct application to soil containing insects, in a box. Several years ago, I took pains to make a particular experiment with this so-called muriate of lime, the result of which was that the Canker-worm underwent its transformations naturally, and to all appearance healthfully, in a soil composed of nearly fifty per cent. of the articles of which it was said a small proportion only was necessary to totally destroy them? If the substance is the same in composition now that it was then, it is reasonable to suppose that the result of its application would be the same.

As to the "Plug Ugly Theory," which consists of filling an auger bore with sulphur and plugging it tight, and which originated, some years since, in the inventive brain of some *Prairie Farmer* correspondent; it is altogether too absurd to need consideration, for even if the mode of application were not so downright ridiculous, it is well

known to entomologists that many caterpillars will thrive exceedingly on leaves that have been thickly sprinkled with sulphur.

Vigilance is the price of reward, and as it is always easier to prevent than to cure, it were well for the owners of young orchards, in neighborhoods where the Canker-worm is known to exist, to keep a sharp look-out for it; so that upon its first appearance the evil may be nipped in the bud. In the same manner that it is exterminated in the individual orchard, in like manner, it may, by concert of action, be exterminated from any given locality. When once the worms are on a tree, a good jarring will suspend them all in mid-air, when the best way to kill them is by swinging a stick above them, which breaks the web, and causes them to fall to the ground; when they may be prevented from ascending the tree, by the methods already described, or by strewing straw on the ground and setting fire to it.

One word in commendation of late fall plowing and the use of hogs. A good deal has been said both for and against fall plowing, and the following discussion which took place at the November (1868) meeting of the Alton (Ills.) Horticultural Society, will afford a sample of the different opinions held by individuals:

Dr. Long took the ground that fall plowing was one of the best and surest means of eradicating those insects which stay in the ground over winter. He said, some five or six years ago my orchard was badly infested with the Canker-worm; by late cultivation, I almost, if not entirely, got rid of them.

Dr. Hull—I do not believe that fall plowing will destroy the larvæ of insects to any extent. I have dug up frozen lumps containing larvæ that were not affected by freezing. I think the Canker-worm will not spread here as in New England.

J. Huggins—I have been led to believe—contrary to Dr. Hull's statement—that they will spread, and feel that there is great danger of their spreading. I believe fall plowing a great aid in the extermination of them. Cites a case where they have been almost entirely destroyed by late plowing, in an orchard that was nearly ruined by them.

Dr. Hull—If it be true that they will spread, why is it that none of Dr. Long's neighbors have them? He says he was badly overrun with them, and the fact that his neighbors were not, I think confirmation of my statement that they will not spread.

Dr. Long—My brother's orchard, adjoining mine, had double as many as my own. He fall plowed, and has very few left. He also cites the case of an old orchard, in this section, that was almost destroyed by them, but fall plowing has almost, if not entirely, destroyed them.

The following item from the New York Weekly *Tribune* of February 26th, 1869, also bears on this point:

Canker-worms Destroyed by Plowing.—Mr. McNeil Witherton, in answer to W. V. Monroe's request: I will state that I think that the Canker-worm can be destroyed by plowing the ground where they are, late in the fall. The 28th of Nov., 1867, I was at my son David's in Wisconsin. He told me that the Canker-worms were in his orchard, and had injured his apple trees very much the past season; that a man who owns a nursery and keeps apple trees for sale, went into the orchard and examined the trees and worms, and said it was the Can-

ker-worm that was injuring his orchard. I told him that about fifty years ago they had been in my father's orchard some six years, and killed a large number of the trees; that we plowed it late in the fall, and have never seen the Canker-worm there since. I advised him to plow his orchard immediately. The next day he plowed it as far as the worms had been in it. I received a letter from him a few weeks ago, stating that the Canker-worms were not in his orchard this year, and those trees that were injured and not killed last year, revived some this year.

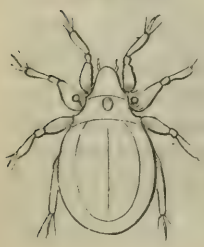
Now there is no doubt but late plowing will produce somewhat different effects, according to the character of the soil, and the depth of the plowing; but that it is more generally beneficial than otherwise I am perfectly convinced, and as for the assertion of Mr. Wm. P. Lippincott, of Vernon, Iowa, made some time ago, in the *Iowa Homestead*, namely, that it left the ground full of harbors for the next year's breeding, it suffices to say that the insect does not breed in the ground, and, holes or no holes, the worms will penetrate the soil whenever the time arrives to change to chrysalis. After the summer months the insect invariably lies in the chrysalis state snugly entombed in a little earthen cell very thinly lined with silk, from two to six inches below the surface. This cell, though frail, is a sufficient protection, so long as it is whole, from any excess of moisture, and at the same time prevents too much evaporation in case of summer drouth or dry winter freezing. Now I have proved by experiment that whenever this cell is disturbed or broken in cold weather, the chrysalis has not the power to penetrate the ground again, and in the great majority of instances, either rots, dries out, becomes mouldy, or, if on the surface, is devoured by birds. Even summer plowing, if performed after the first of July would work beneficially; and it is for this reason, that clean, well cultivated orchards are more free from the attacks of this insect, than slovenly and neglected ones. The only advantage of late fall plowing, lies in the facts, that the chrysalis is at that time too benumbed to work itself into the ground and form another cell, and that birds are then harder pushed for food, and more watchful for any such dainty morceau.

As to the efficiency of hogs, in rooting up and devouring the chrysalids, during the summer months, abundant favorable testimony might be cited; but the facts are too obvious to need argument.

ENEMIES OF THE CANKER-WORM.

Like most of our noxious insects, the Canker-worm is subject to the attacks of cannibal and parasitic insects. It is also devoured by very many different birds, some of which almost entirely live on it; and Dr. Packard, of Salem, Mass., has observed an elongated mite (*Nothrus ovivorus*, Fig. 68, enlarged) devouring its eggs. The most common parasite which I have yet discovered with us, is an undescribed small four-winged fly belonging to the genus *Microgaster*, of the same size, but differing from the Military Micro-

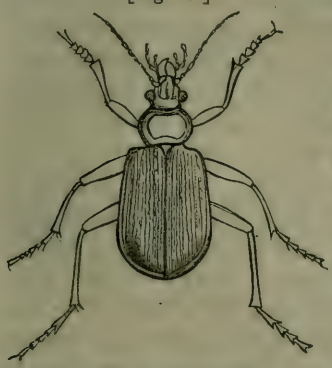
[Fig. 68.]



gaster (Fig. 23) which preys upon the Army-worm. It differs also from most other insects of the same genus, by each individual larva as it eats through the skin of the Canker-worm, spinning its pale greenish-white cocoon alone, and not in company. About ten per cent. of the worms which I have endeavored to breed, have been destroyed by this parasite. Harris mentions the larva of another four-winged fly, and that of a two-winged fly belonging to the genus *Tachina*, which also infest the worm, destroying about one-third of them in Massachusetts. There is also a very minute and undescribed species of *Platygaster* which pierces the egg of the Canker-worm, and drops one of her own into it, from which in due time the perfect fly develops.

Among the Cannibal insects, which prey upon it, may be mentioned the Ground-beetles, two of which I have found preying upon this worm, namely, the Rummaging Ground-beetle (*Calosoma scrutator*, Fabr. Fig. 69), a large and beautiful insect, with the wing-covers golden-green, and the rest of the body marked with violet-blue, gold, green, and copper; and the Fiery Ground-beetle (*Calosoma calidum*, Fabr. Fig. 70.), a black species of almost equal size, with copper colored spots on the wing-covers. These beetles are very active, and run over the ground in search of soft-bodied worms, and will even mount upon the trunks of trees for the same purpose.

[Fig. 69.]



[Fig. 70.]

The Fraternal Potter-wasp (*Eumenes fraterna*, Say), is stated by Harris, to store her cells with Canker-worms, often gathering eighteen or twenty of them for a single cell. This wasp (Fig. 71, *a*), is quite common in St. Louis county, and uses other species besides Canker-worms as food for its young. Its clay nest (Fig. 71 *b*, entire; *c*, the same cut open shortly after it was built, showing the manner in which it is compactly crowded with green worms), may often be found attached to the stems of the Goldenrod and of other plants in the open air, or cemented under the loose bark of some tree. It has even been found attached to the leaves of a deciduous plant, where it must necessarily fall to the ground in winter and lie there till the perfect insect issues in the following summer.

[Fig. 71.]

CABBAGE WORMS.

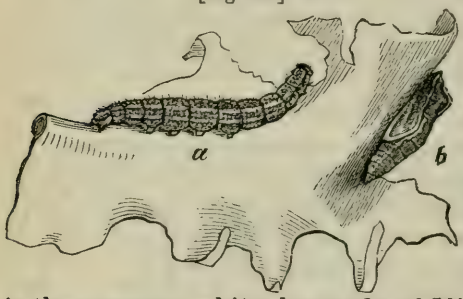
Of the various insects that affect this important esculent, the three following are among the most injurious in this State:

THE SOUTHERN CABBAGE BUTTERFLY—*Pieris protodice*, Boisd.

(Lepidoptera, Pieridæ.)

Mr. S. H. Scudder, of the Boston Society of Natural History, from an examination of a large number of specimens of this butterfly, found that it enjoys a wide geographical range, "extending from Texas on the southwest, Missouri on the west, and the mouth of the Red River of the North on the northwest, as far as Connecticut, and the Southern Alantic States on the east."* But while the species is scarce in the more northern States, it is the common white butterfly of Missouri, abounding in many parts of the State, and sometimes flitting so thickly around the truck gardens near large cities, as to remind one at a distance, of the falling of snow. It often proves exceedingly injurious, and I learn from a Mississippi exchange, that "there were last year thousands of dollars' worth of cabbages devastated and ruined by worms in the neighborhood of Corinth." The paragraph goes on to state, "that cabbages could not, in consequence, be had there even at ten cents per head." The "worm" referred to, was doubtless the species under consideration.

[Fig. 72.]



[Fig. 73.]

I have often passed through cabbage beds near St. Louis, and been unable to find a perfect head, though few of the gardeners had any suspicion that the gay butterflies which flitted so lazily from one plant to another, were the real parents of the mischievous worms which so riddled the leaves.

The larva (Fig. 72, *a*) may be summarily described as a soft worm, of a greenish-blue color, with four longitudinal yellow stripes, and covered with black dots. When newly hatched it is of a uniform orange color with a black head, but it becomes dull brown before the first moult, though the longitudinal stripes and black spots are only visible after said moult has taken place.

I subjoin a more complete description of it:

Average length when full grown 1.15 inches. Middle segments largest. Most common ground-color green verging onto blue; sometimes clear pale blue and at others deep indigo or

* See Proc. Bost. Soc. Nat. Hist., VIII, 1861, p. 180.

purplish-blue. Each segment with six transverse wrinkles, of which the first and fourth are somewhat wider than the others. Four longitudinal yellow lines, each equidistant from the other, and each interrupted by a pale blue spot on the aforementioned first and fourth transverse wrinkles. Traces of two additional longitudinal lines below, one on each side immediately above prolegs. On each transverse wrinkle is a row of various sized, round, polished black, slightly raised, piliferous spots; those on wrinkles one and four being largest and most regularly situated. Hairs arising from these spots, stiff and black. Venter rather lighter than ground-color above, and minutely speckled more or less with dull black. Head same color as body; covered with black piliferous spots, and usually with a yellow or orange patch each side—quite variable. The black piliferous spots frequently have a pale blue annulation around the base, especially in the darker specimens.

The chrysalis (Fig. 72, *b*), averages 0.65 inch in length, and is as variable in depth of ground-color, as the larva. The general color is light bluish-gray, more or less intensely speckled with black, with the ridges and prominences edged with buff or with flesh-color, and having larger black dots.

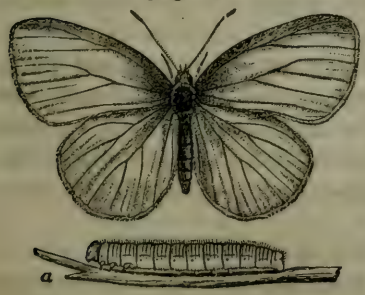
[Fig. 74.]

The female butterfly (Fig. 73) differs remarkably from the male which I represent at Figure 74. It will be seen, upon comparing these figures that the ♀ is altogether darker than the ♂. This sexual difference in appearance is purely colorational, however, and there should not be the difference in the form of the wings which the two figures would indicate, for the hind wings in the ♂ cut, are altogether too short and rounded.

This insect may be found in all its different stages through the months of July, August and September. It hybernates in the chrysalis state. I do not know that it feeds on anything but Cabbage, but I once found a ♂ chrysalis fastened to a stalk of the common nettle (*Solanum carolinense*), which was growing in a cemetery with no cabbages within at least a quarter of a mile: and Mr. J. R. Muhleman is reported as having stated at a late meeting of the Alton (Illinois) Horticultural Society, that it is injurious to turnips and other plants of the cabbage family. There are two broods of this insect each year.

As already stated, in the more northern and eastern States our Southern Cabbage Butterfly occurs in comparatively small numbers, but it is replaced by the Potherb Butterfly (*Pieris oleracea*, Boisd.), an indigenous species which does not occur with us. This last (Fig. 75, butterfly with the larva beneath) is in reality a northern species, for it rarely reaches as far south as Pennsylvania, but extends east to Nova Scotia, west to Lake Superior, and north as far as the Great Slave Lake in the Hudson's Bay Company's territory. It is readily distinguished

[Fig. 75



from our species by being perfectly plain, with no black spots on the wings. The body is black, and the front wings have a slight shade of this color at their base, front edge, and tips. Its larva is pale green [Fig. 76.] and feeds on various other cruciferous plants besides cabbages; its chryalis (Fig. 76) is also pale green or whitish, regularly and finely dotted with black.

This butterfly has existed from time immemorial on the American continent, within the geographical limits already given, and yet has never made its way into Missouri or any of the southwestern States. Nor is it likely to ever do so; and why? Because some insects are constitutionally incapacitated to live beyond certain geographical limits. The range of an insect is governed by various influences which I have not time to enumerate at present; but the principal influence is undoubtedly climate—temperature—heat. The "isothermal" lines, or the lines of equal heat, as all physical geographers are well aware, do not run parallel with the lines of latitude, as one might at first thought suppose; but if our isothermal maps are to be relied on, vary most astonishingly to points north and south of a given line. The same variation from a given line of latitude is noticeable in the distribution of insects, or—to coin a word—we have "isentomic," or iso-insect lines, which are as variable as the lines of equal heat, by which they are doubtless to a great extent governed. In Central Missouri we live on nearly the same latitude as that of Southern Pennsylvania, and in North Missouri, as that of Southern New York; yet we do not live on the same insect line, but nearly on that of Virginia and North Carolina, and even in the extreme northern part of the State, a number of insects are found, which on the Atlantic seaboard are never known to occur north of Virginia, and the same rule holds good with the birds and fishes of the United States. The same thing is true of our Central and Southern counties. In other words many of our insects are *southern*, not *northern* species, and as familiar examples, I might mention the Tarantula of Texas (*Mygale Hentzii*, Girard), and its large Digger-wasp enemy (*Pepsis formosa*, Say), which have been frequently found in St. Louis county during the past two years, though they were for a long time supposed to be confined to Texas.

Now, since the indigenous Potherb Butterfly has never, in the course of past ages, extended to any point South of Pennsylvania, although its cruciferous food-plants have always flourished South of that line, we are justified in concluding that it never will do so, and that though a brood of the worms were introduced directly on to some cabbage patch in the extreme Northern part of this State, they would soon die out there.

Consequently we have nothing to fear from this butterfly which has always troubled our northeastern friends. But the case is very different with another white cabbage butterfly which is now committing sad havoc to the cabbages in some parts of Canada, and some

of the Eastern States. The species I refer to is the Rape Butterfly (*Pieris rapæ*, Schrank), a recent importation from Europe, and while I have no fear of any evil results arising from the introduction of the Potherb Butterfly, I should hate to try the experiment of introducing a brood of worms of the Rape Butterfly into any portion of the State; because, for the reasons detailed in the paper read before the State Horticultural Society, and which is published at the beginning of this Report, I have not a doubt but they would flourish exceedingly, and become far more injurious than either of the indigenous species. Indeed, the history of this insect, since its introduction into this country, affords sufficient proof that such would be the result, for M. Provancher in a recent number of his journal, *Le Naturalista Canadien*, says that it alone, has caused more damage around Quebec, since its arrival there, than all other noxious butterflies put together, in the same space of time; and he estimates that it annually destroys $240,000 worth of cabbages around that town. In short, as this insect is rapidly spreading westward, there is every reason to fear that it may some day get a foothold in our midst, unless the proper measures are taken to prevent such an undesirable occurrence. It will be well therefore to familiarize the reader with its appearance, for "to be forewarned is to be forearmed!"

Little did I dream, when, many years ago, I watched this butterfly fluttering slowly along some green lane or over some cabbage patch in England, where it is THE butterfly; or when I found its chrysalis so abundantly in the winter time on old palings or even on the kitchen wall indoors—that I should some day be fearing its presence here. But just as little did our forefathers dream of the immense though gradual changes which have come over this broad land during the last two or three centuries! Coming events are said to cast their shadows before them, but verily we know not what the morrow will bring forth.

This Rape Butterfly is the bane of every cabbage grower, and its larva is the dread of every cook in many parts of Europe. Unlike the two indigenous N. A. species already alluded to, this worm is not content with riddling the outside leaves, but prefers to secrete itself in the heart, so that every cabbage has to be torn apart and examined before being cooked, and it is also necessary to keep a continual lookout, even after it is dished up, lest one gets such an admixture of animal and vegetable food as is not deemed palatable by the most of men. It is on account of this habit of boring into the heart of cabbages, that the French call it the "Ver du Cœur" or Heart-worm.

It was introduced about 1856 or 1857, having been first taken in Quebec in 1859. In 1864 Mr. G. J. Bowles, who published an account of it in the *Canadian Naturalist and Geologist*, for August, 1864, p. 258, estimated that it had not then extended more than forty miles from Quebec as a centre. In 1866 it was taken in the northern parts of New Hampshire and Vermont; in 1868 it had advanced as far

South as Lake Winnepesaugee. It having since been taken at Bangor, and at other points in Maine; in certain parts of New Jersey, and the past year around Boston and New York.

It was in all probability introduced into this country in the egg state, for the eggs are deposited on the underside of the leaves, and there is nothing more likely than that a batch may have been thrown with refuse leaves from some vessel, and that after hatching the young larvæ managed to find suitable food close by.

[Fig. 77.]

The larva (Fig. 77, *a*), is pale green, finely dotted with black, with a yellowish stripe down the back, and a row of yellow spots along each side in a line with the breathing holes. When about to transform, it leaves the plant upon which it fed, and shelters under the coping of some wall or fence, or on anything that may be conveniently at hand, and changes to a chrysalis (Fig. 76, *b*) which though variable in color, is usually pale green, speckled with minute black dots. The insect passes the winter in this state and as with the two indigenous species, there are two broods each year.

The butterflies have the bodies black above, with the wings white, and marked as in the accompanying cuts; the female (Fig. 78) being distinguished from the male (Fig. 79) by having two round spots (sometimes three) instead of only one on the front wings. Underneath, both sexes are alike, there being two spots on the front wings and none on the hind ones, which are yellowish, sometimes passing into green. The species varies very much, and there is a specimen in my collection in which all the spots are so nearly obsolete above, that if it were not for the characteristic under-surfaces, it could scarcely be distinguished from the Potherb Butterfly. There is also in England a variety of the male sex which has the ground-color canary yellow instead of white, and curiously enough, this same variety has been taken in this country.

[Fig. 78.]

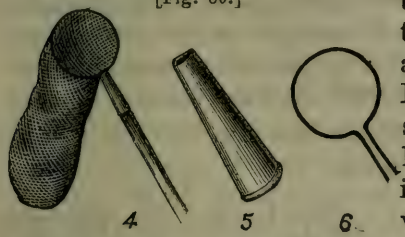
[Fig. 79.]

Although some caterpillars are polyphagous, feeding indiscriminately on a great variety of plants, yet most of them are confined to plants of the same botanical family, or at all events of the same natural order. Such is the case with the two indigenous cabbage butterflies above mentioned, for they are not known to go beyond cruciferous plants for food. The Rape Butterfly has a less epicurean palate however, and departs from this rule, inas-

much as it has been known to feed upon the weeping willow in England.

REMEDIES.—One way of counterworking the evil effects of these cabbage butterflies, is to search for the eggs at the proper season, and destroy them. These eggs are pear-shaped, yellowish and longitudinally ribbed, but as they are deposited singly or in clusters of not more than two or three, the operation becomes tedious and somewhat impracticable on a large scale. Still, children should be taught how to find them, and incited to search for them by the hope of a reward for a certain number. The butterflies are slow lumbering flyers and may easily be caught in a net and killed. A short handle, perhaps four feet long, with a wire hoop and bag-net of muslin or musquito netting, are the only things needed to make such a net, the total cost of which need not be more than fifty or seventy-five cents. Or a more durable one may be made, in the following manner: Get a tinsmith to make a hollow handle of brass or tin from six to seven inches in length and tapering at one end, as seen in Figure 80, 5; then procure a piece of stout wire, rather more than a yard long, and bend it in the manner shown in Figure 80, 6. Place the ends of the wire in the small end of the handle, solder it on, and then fill in one-third of the handle with molten lead, so as to make the wire doubly fast and solid. Now make a bag of some strong but light fabric, and fasten it well to the wire. The depth of the bag should be more than twice the diameter of the wire hoop. If a handle is required, a wooden one is easily made to fit into the hollow brass or tin, as at Figure 80, 4. Poultry, if allowed free range in the cabbage field, will soon clear off the worms of our indigenous species.

[Fig. 80.]



By laying pieces of board between the cabbage rows, and supporting them about two inches above the surface of the ground, the worms will resort to them to undergo their transformations, and may then be easily destroyed.

Either Paris green or white hellebore will kill the worms, if sprinkled on to them, but cannot be used on cabbages, as it is difficult to free the plants of these substances which are poisonous. The saponaceous compounds of cresylic acid are effectual, and without these objections.

In Europe there are many parasites which serve to check the increase of the Rape Butterfly, and Curtis enumerates at least four. But on this continent, but one such parasite has so far been found to attack it, and that was a two-winged fly—probably a *Tachina* fly—which M. Provancher bred from the chrysalis, in Quebec, Can.* M. Provancher, after remarking that he found a chrysalis which, from its blacken-

*(*Naturaliste Canadien* Vol. II, p. 18.)

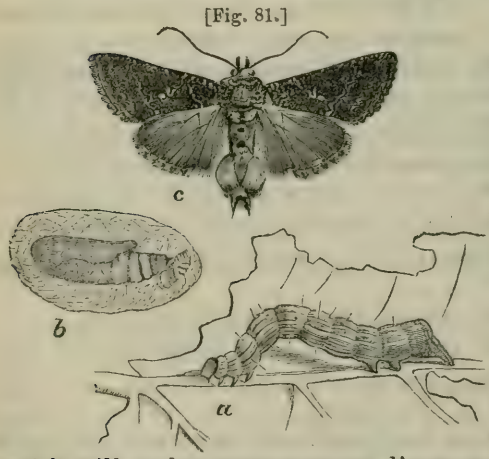
ing in the middle, he suspected would not develop into a butterfly, says of this parasite that he afterwards found a cocoon [pupa ?] by its side which was smooth blackish and oblong, and so large that he could scarcely believe it had escaped from the chrysalis, which was, however, now pierced in the middle and empty. M. Provancher goes on to say: "Ten days afterwards, we perceived one morning that the cocoon was open at one end, and there was buzzing about in the vial a fly, which we recognized as belonging to the genus *Sarcophaga* [flesh-flies], the larvæ of which are known to develop in meat. Here then, we exclaimed, when we saw this fly, is an enemy of the Rape Butterfly. But unfortunately the flesh-flies feed indiscriminately on almost any kind of flesh, and never being very numerous, cannot become very redoubtable enemies of this butterfly."

With all due respect to my friend Provancher, I incline to believe that he has mistaken a *Tachina* fly which is a true parasite, for a flesh-fly (*Sarcophaga*) which is only a scavenger. And if this be so, his reasoning falls to the ground, for, as we may see in the Army-worm article in this Report, there are no more efficient checks to the increase of injurious insects than these same *Tachina* flies.

THE CABBAGE PLUSIA—*Plusia brassicæ*, N. Sp.

(Lepidoptera, Plusidæ.)

[Fig. 81.]



This is the next most common insect which attacks the Cabbage with us, and curiously enough it has never yet been described. It is a moth, and not a butterfly, and flies by night instead of by day. In the months of August and September the larva (Fig. 81, *a*) may be found quite abundant on this plant, gnawing large, irregular holes in the leaves. It is a pale green translucent worm, marked longitudinally with still paler more opaque lines, and like all the known larvæ of the family to which it belongs, it has but two pair of abdominal prolegs, the two anterior segments which are usually furnished with such legs in ordinary caterpillars, not having the slightest trace of any. Consequently they have to loop the body in marching, as represented in the figure, and are true "Span-worms." Their bodies are very soft and tender, and as they live exposed on the outside of the plants, and often rest motionless, with the body arched, for hours at a time, they are espied and devoured by many of their enemies, such as birds, toads, etc. They are also subject to the attacks of at least two parasites and die very often from disease, especially in wet weather;

so that they are never likely to increase quite as badly as the butterflies just now described.

When full grown this worm weaves a very thin loose white cocoon, sometimes between the leaves of the plant on which it fed, but more often in some more sheltered situation; and changes to a chrysalis (Fig. 81, *b*) which varies from pale yellowish-green to brown, and has a considerable protruberance at the end of the wing and leg cases, caused by the long proboscis of the enclosed moth being bent back at that point. This chrysalis is soft, the skin being very thin, and it is furnished at the extremity with an obtuse roughened projection which emits two converging points, and several short curled bristles, by the aid of which it is enabled to cling to its cocoon.

The moth is of a dark smoky-gray inclining to brown, variegated with light grayish-brown, and marked in the middle of each front wing with a small oval spot and a somewhat U-shaped silvery white mark, as in the figure. The male (Fig. 81, *c*) is easily distinguished from the female by a large tuft of golden hairs covering a few black ones, which springs from each side of his abdomen towards the tip.

The suggestions given for destroying the larvæ of the Cabbage Butterflies, apply equally well to those of this Cabbage Plusia, and drenchings with a cresylic wash will be found even more effectual, as the worms drop to the ground with the slightest jar.

PLUSIA BRASSICÆ, N. Sp.—*Larva*—Pale yellowish translucent green, the dorsum made lighter and less translucent by longitudinal opaque lines of a whitish-green; these consist each side, of a rather dark vesicular dorsal line, and of two very fine light lines, with an intermediate broad one. Tapers gradually from segments 1–10, descending abruptly from 11 to extremity. Piliferous spots white, giving rise to hairs, sometimes black, sometimes light colored; and laterally a few scattering white specks in addition to these spots. A rather indistinct narrow, pale stigmatal line, with a darker shade above it. Head and legs translucent yellowish-green, the head having five minute black eyelets each side, which are not readily noticed with the naked eye. Some specimens are of a beautiful emerald-green, and lack entirely the pale longitudinal lines. Described from numerous specimens.

Crysalis—Of the normal *Plusia*-form, and varying from yellowish-green to brown.

Moth—Front wings dark gray inclining to brown, the basal half line, transverse anterior, transverse posterior, and subterminal lines pale yellow inclining to fulvous, irregularly undulate, and relieved more or less by deep brown margins; the undulations of the subterminal line more acuminate than in the others, and forming some dark sagittate points; the basal half-line, the transverse anterior near costa, and the transverse posterior its whole length, being sometimes obscurely double: four distinct equidistant costal spots on the terminal half of wing, the third from apex formed by the termination of the transverse posterior; posterior border undulate with a dark brown line which is sometimes marked with pale crescents; a series of similar crescents (often mere dots) just inside the terminal space; the small sub-cellulary silver spot oval, sometimes uniformly silvery-white but more often with a fulvous centre, sometimes free from, but more often attached to the larger one which has the shape of a constricted U, very generally with a fulvous mark inside, which extends basally to the transverse anterior at costa. Fringes dentate, of the color of the wing, and with a single undulating line parallel to that on the terminal border. *Hind wings* fuliginous, inclining to yellowish towards base, and with but a slight pearly lustre; fringes very pale with a darker inner line. Under surfaces pale fuliginous with a pearly lustre, the front wings with a distinct fulvous mark under the sub-cellulary spots, speckled more or less with the same color around the borders of the wing, the fringes being dentate with light and dark; the hind wings speckled with fulvous on their basal half, and with the fringes as above. *Thorax* variegated with the same color as front wings, the tufts being fulvous inclining to

pink. *Abdomen* ♀ gray, with a few pale hairs near the base, and scarcely extending beyond the margin of the hind wings; ♂ longer, covered with pale silky hairs, a distinct dorsal brown tuft on each of the three basal segments, and two large lateral either fawn-colored or golden-yellow brushes on the fifth segment, meeting on the back and partly covering two smaller brushes on the sixth, which are tipped with black; terminal segment flattened and with two lateral more dusky and smaller tufts: underside of thorax and abdomen gray, mixed with flesh-color. Alar expanse 1.55 inches. Described from numerous bred specimens. In a suite of specimens bred from the same brood of larvæ a considerable difference in the general depth of color is found, some being fully as dark again as others.

Closely resembles *Plusia ni*, Engr., which occurs in Italy, Sicily, France, and the northern parts of America. Mr. P. Zeller of Stettin, Prussia, to whom I sent specimens, considers it distinct however from the European *ni*, and I have consequently given it a name in accordance with its habits.

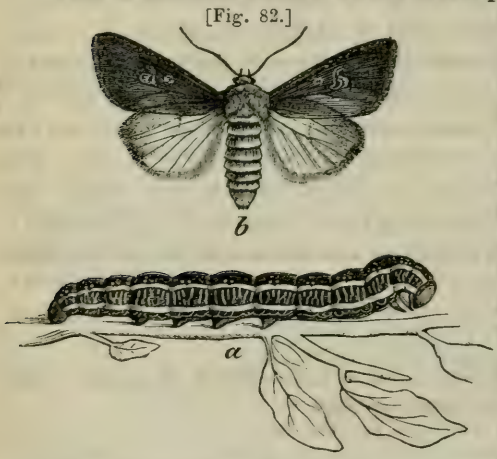
There is another worm which may be known as the Thistle Plusia, and which occurs on our common thistles, and cannot therefore be considered very injurious. It differs only from that of the Cabbage Plusia in having the sides of the head, the thoracic legs, a row of spots above the lateral light line, and a ring around the breathing pores, black. I have bred from it the *Plusia precationis** of Guenée—an insect whose larval history has not hitherto been known.

THE ZEBRA CATERPILLAR—*Mamestra picta*, Harr.

(Lepidoptera, Apamidæ.)

This is another insect which often proves injurious to our cauliflowers and cabbages, though it by no means confines itself to these two vegetables. Early in June the young worms which are first almost black, though they soon become pale and green, may be found in dense clusters on these plants, for they are at that time gregarious. As they grow older they disperse and are not so easily found, and in about four weeks from the time of hatching they come to their full growth. Each worm (Fig. 82. *a*,) then measures about two inches in length, and is velvety-black with a red head, red legs, and with two lateral yellow lines, between which are numerous transverse white, irregular, zebra-like finer lines, which induced Dr. Melsheimer to call this worm the "Zebra." Though it does not conceal itself, it invariably curls up cut-worm fashion, and rolls to the ground when disturbed.

[Fig. 82.]



It changes to chrysalis within a rude cocoon formed just under the surface of the ground, by interweaving a few grains of sand or a

* Some of these bred specimens approach very near to *Pl. iota*, Gn. and even to *Pl. u-brevis*, Gn.

few particles of whatever soil it happens on, with silken threads. The chrysalis is ¾ of an inch in length, deep shiny brown and thickly punctured except on the posterior border of the segments and especially of those three immediately below the wing-sheaths, where it is reddish and not polished; it terminates in a blunt point ornamented with two thorns. The moth (Fig. 82, *b*,) which is called the Painted Mamestra, appears during the latter part of July, and it is a prettily marked species, the front wings being of a beautiful and rich purple-brown, blending with a delicate lighter shade of brown in the middle; the ordinary spots in the middle of the wing, with a third oval spot more or less distinctly marked behind the round one, are edged and traversed by white lines so as to appear like delicate net-work; a transverse zigzag white line, like a sprawling W is also more or less visible near the terminal border, on which border there is a series of white specks; a few white atoms are also sprinkled in other places on the wing. The hind wings are white, faintly edged with brown on the upper and outer borders. The head and thorax are of the same color as the front wings, and the body has a more grayish cast. There are two broods of this insect each year, the second brood of worms appearing in the latitude of St. Louis from the middle of August along into October, and in all probability passing the winter in the chrysalis state, though a few may issue in the fall and hybernate as moths, or may even hybernate as worms; for Mr. J. H. Parsons, of N. Y., found that some of the worms which were on his Ruta Baga leaves, stood a frost hard enough to freeze potatoes in the hill, without being killed.* I have noticed that the spring brood confines itself more especially to young cruciferous plants, such as cabbages, beets, spinach, etc., but have found the fall brood collecting in hundreds on the heads and flower-buds of asters, on the White-berry or Snow-berry (*Symphoricarpus racemosus*); on different kinds of honey-suckle, on mignonette, and on asparagus: they are also said to occur on the flowers of clover, and are quite partial to the common Lamb's-quarter or Goosefoot (*Chenopodium album*).

On account of their gregarious habit when young, they are very easily destroyed at this stage of their growth.

THE TARNISHED PLANT-BUG—*Capsus oblineatus*, Say.†

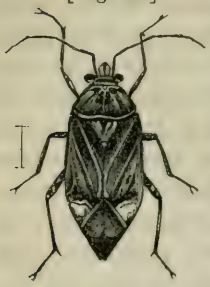
[Heteroptera Capsidæ.]

Quite early last spring while entomologizing in Southern Illinois,

* *Practical Entomologist*, II, p. 21.

† This bug was originally described by Beauvois as *Coreus linearis*, and subsequently as *Capsus oblineatus* by Say. Harris in speaking of it refers it to the sub-genus *Phytocoris* Fallen, and by mistake, changes Beauvois' specific name *linearis*, to *lineolaris*, which he translates into popular language as the "Little-lined Plant-bug." As Say's description is the only one I have access to, I have retained the name he gave it, as being eminently appropriate.

[Fig. 83.]



I spent a day with Mr. E. J. Ayres of Villa Ridge, and was surprised to learn that he had become quite discouraged in his efforts to grow young pear trees, on account of the injuries of a certain bug, which upon examination I found to be the Tarnished Plant-bug, represented enlarged at Figure 83, the hair line at its side showing the natural size. The family to which this bug belongs is the next in a natural arrangement to that which includes the notorious Chinch-bug, and the insect is, like that species, a veritable bug, and obtains its food by *sucking* and not *biting*. The *Capsus* family is a very large one, containing numerous species in this country, but among them, none but the species under consideration have thrust themselves upon public notice by their evil doings.

The Tarnished Plant-bug is a very general feeder, attacking very many kinds of herbaceous plants, such as dahlias, asters, marigolds, balsams, cabbages, potatoes, turnips, etc.; and several trees, such as apple, pear, plum, quince, cherry, etc. Its puncture seems to have a peculiarly poisonous effect, on which account, and from its great numbers, it often proves a really formidable foe. It is especially hard on young pear and quince trees, causing the tender leaves and the young shoots and twigs to turn black, as though they had been burned by fire. On old trees it is not so common, though it frequently congregates on such as are in bearing, and causes the young fruit to wither and drop. I have passed through potato fields along the Iron Mountain Railroad in May, and found almost every stalk blighted and black from the thrusts of its poisonous beak, and it is not at all surprising that this bug was some years ago actually accused of being the cause of the dreaded potato-rot.

This bug is a very variable species, the males being generally much darker than the females. The more common color of the dried cabinet specimens is a dirty yellow, variegated as in the figure with black and dark brown, and one of the most characteristic marks, is a yellow V, sometimes looking more like a Y, or indicated by three simple dots, on the scutel, (the little triangular piece on the middle of the back, behind the thorax). The color of the living specimens is much fresher, and frequently inclines to olive-green. The thorax, which is finely punctured, is always finely bordered and divided down the middle with yellow, and each of the divisions contains two broader logitudinal yellow lines, very frequently obsolete behind. The thighs always have two dark bands or rings near their tips.

As soon as vegetation starts in the spring, the mature bugs which winter over in all manner of sheltered places may be seen collecting on the various plants which have been mentioned. Early in the morning they may be found buried between the expanding leaves, and at this time they are sluggish and may be shaken down and destroyed; but as the sun gets warmer, they become more active, and

when approached, dodge from one side of the plant to the other, or else take wing and fly away. They deposit their eggs and breed on the plants, and the young and old bugs together may be noticed through most of the summer months. The young bugs are perfectly green, but in other respects do not differ from their parents except in lacking wings. They hide between the flower-petals, stems and leaves of different plants, and are not easily detected. Late in the fall, none but full grown and winged bugs are to be met with, but whether one or two generations are produced during the season I have not fully ascertained, though in all probability there are two.

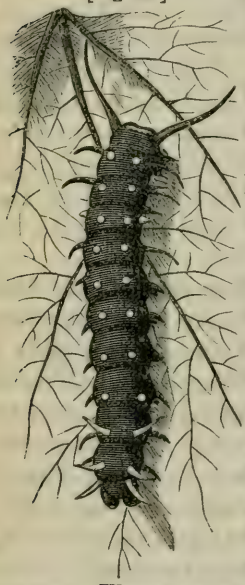
Remedies.—In the great majority of cases, we are enabled to counteract the injurious work of noxious insects, the moment we thoroughly comprehend their habits and peculiarities. But there are a few which almost defy our efforts. The Tarnished Plant-bug belongs to this last class, for we are almost powerless before it, from the fact that it breeds and abounds on such a great variety of plants and weeds, and that it flies so readily from one to the other. Its flight is however limited, and there can be no better prophylactic treatment than clean culture; for the principal damage is occasioned by the old bugs when they leave their winter quarters and congregate on the tender buds and leaves of young fruit stock; and the fewer weeds there are to nourish them during the summer and protect them during the winter, the fewer bugs there will be. The small birds must also be encouraged. Applications of air-slacked lime and sulphur, have been recommended to keep them off, but if any application of this kind is used, I incline to think that to be effectual, it must be of a fluid nature; and should recommend strong tobacco-water, quassia-water, vinegar, and cresylic soap. Some persons who have used the last compound have complained that it injures the plants, and every one using it should bear in mind, what was stated in the preface to my First Report, namely, that the pure acid, no matter how much diluted with water, will separate when sprinkled, and burn holes in, and discolor plant texture; while if properly used as a saponaceous wash it will have no such injurious effect. It must likewise be borne in mind, that the so-called "plant-protector" which is a soap made of this same acid, will bear very much diluting, (say one part of the soap to fifty or even one hundred parts of water) and that it will injure tender leaved plants if used too strong. I have noticed that the bugs are extremely fond of congregating upon the bright yellow flowers of the Cabbage, which, as every one knows, blooms very early in the season; and it would be advisable for persons who have been seriously troubled with this bug, and who live in a sufficiently southern latitude where the plant will not winter-kill, to let a patch of cabbages run wild and go to seed in some remote corner of the farm, in order that the bugs may be attracted thither and more readily destroyed, than when scattered over a larger area.

THE PHILENOR SWALLOW-TAIL—*Papilio philenor*, Drury.

(Lepidoptera Papilionidæ.)

There is a genus of climbing plants (the Aristolochias), which is peculiarly attractive on account of its large, rich tropical-looking foliage. The Aristolochias are represented in almost all parts of the world, and some of the tropical species bear beautiful and immense flowers. In this country we have three native species which produce but small, pipe-like flowers, but which make very pretty ornaments for covering walls and arbors or for ornamenting trellises and screens. The most common and best known species in this State is the so called Dutchman's Pipe (*Aristolochia sipho*), but the two other species (*A. serpentaria* and *A. tomentosa*) are also cultivated.

[Fig. 84.]



In the beautiful botanical grounds of Mr. Shaw, at St. Louis, there are some magnificent specimens of the Dutchman's Pipe, and about the end of last July, these had all been suddenly defoliated. I was invited to go and examine the cause and propose some remedy. I found the vines literally denuded, for there was not a whole leaf upon them, those that were not entirely eaten off down to the stem, being riddled with different sized holes. Upon a close examination, the authors of the mischief were soon found, in the shape of the peculiarly horned caterpillar, represented at Figure 84; but as there were few large specimens to be found, it was quite evident that the great bulk of them had acquired their growth, and had already left the vines for some more sheltered situation, in which to transform to the chrysalis state. There were, however, a sufficient number of smaller or more recently hatched individuals, had they remained undiscovered, to have soon taken every vestige of the few imperfect leaves remaining; while the beautiful butterflies which produced these worms were noticed flitting around the vines.

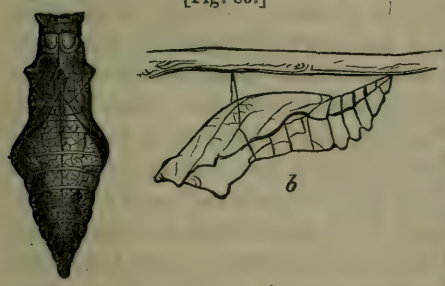
This insect is found on no other plants but the Aristolochias. The worms commence to hatch in this latitude by the beginning of July, from eggs deposited on the leaf; and individuals may be found as late as the last of August. They live in company, especially while young, and cover the leaves with zigzag lines of silk, which enable them the better to crawl about and hold on to the vines. The newly hatched worm is dark brown, with no spots, and with quite short tubercles. After the first month they become lighter colored, with the tubercles on the back of segments 6, 7, 8 and 9, of an orange color, and some of the other tubercles, especially the two on the first segment, proportionally longer than the rest. After the second

moult the color of the body becomes still lighter, some of the tubercles still proportionally longer and longer, and those on the back all begin to appear orange; while a distinct orange spot becomes visible between the long horns on the first segment, from which spot the soft, forked orange scent-organs are thrust. After the third moult but very little change takes place, and after the fourth moult, the worm loses in a great measure its shiny appearance, becomes more velvety and darker, and when full grown presents the appearance of Figure 84, and may be described as follows:

Length, two inches. Color velvety black, with a slight purplish or chesnut-brown hue. Covered with long fleshy tubercles of the same color as body, and shorter orange colored tubercles, as follows: Two, which are brown, long, tapering and feeler-like, springing anteriorly one from each side of joint 1, the two being movable, and alternately applied to the surface upon which the worm moves. Joint 2, with two brown tubercles, one springing from each side with a downward curve, and each about one-third as long as those on joint 1; also with two small dorsal, wart-like orange tubercles. Joints 3 and 5 exactly like joint 2, but on joint 4 the lateral brown tubercle is replaced by a wart-like orange one. Joints 6, 7, 8 and 9, each with two small dorsal orange tubercles, and each with a lateral, elongated, pointed, brown, downwardly curved one, arising from the base of prolegs. Joints 10 and 11 also with these lateral tubercles, but the orange dorsal ones replaced by longer pointed curved brown ones, which however often have an orange base. Joint 12 with two somewhat stouter dorsal brown tubercles, but none at sides. Joints 7, 8, 9 and 10, each with a lateral orange spot just before and above the spiracles, which are sunk into the flesh and scarcely perceptible. Head, legs, venter and cervical shield the same color as body, the venter with two tubercles on joint 5, which much resemble prolegs, the cervical shield, with an orange transverse spot on anterior edge, from which is thrust the osmaterium.

When full grown this tubercled worm fastens itself by its hind legs and by a silken loop drawn between joints 5 and 6, and in about two days changes to a chrysalis, of which Figure 85, *a*, gives a shaded back-view, and *b* a lateral outline. This chrysalis is at first yellowish-green, but soon becomes beautifully marked with gray and violet, and more or less with yellow on the back: and it is readily distinguished from all other chrysalides of North American butterflies belonging to the same genus (*Papilio*) by two trigonate prominences on the head which give it a square appearance; by a very prominent trigonate projection on the top, and a lesser one each side of thorax; by the wing-sheaths being much dilated and sharply edged above, and by six prominent, rounded, narrow-edged, longitudinal projections on the top of the three principal abdominal joints.

[Fig. 85.]



The butterfly which issues from this chrysalis in about three weeks, is such a delicate and elegant object, that it is next to impossible to give a just illustration of it. The front wings are black with a greenish metallic reflection on the nerves and along the front and hinder borders, and a row of white spots near the hinder border, which is very slightly undulate, with a narrow cream-colored mark on

the inner sinuses. The hind wings are of a brilliant steel-blue, with a greenish cast, with a carved row of white lunules and with the hinder border quite undulate and the inner sinuses cream-colored. The under surface of the front wings is more sombre than the upper surface, with the spots near the borders and the marginal lunules more distinct. The under surface of the hind wings, is on the con-

[Fig. 86.]

trary, with the exception of a large almost oval patch at base, of a very brilliant steel blue, with a curved row of seven rounded spots of a deep orange, bordered with black, and the four or five upper ones edged above with white ; there is a small yellow basal spot, about five small whitish spots around the lower borders of the large sombre oval patch, and the marginal lunules are much more distinct than on the upper surface. The male which I illustrate (Fig. 86) differs from the female in the more brilliant hue of the upper surface, and in either entirely lacking the row of white spots near the hinder border of the front wings, or in having but the faintest trace of them.

As these Aristolochia worms are semi-gregarious, and as when young, all the individuals of a batch may be found close together, they are easily destroyed, and those persons who cultivate the Aristolochias, need never be troubled with this insect, if they will examine the vines carefully during the first half of July. The worms invariably produce butterflies during the fall months, and the insect consequently hybernates in the perfect or butterfly state. As the worms feed only on the Aristolochias, scarcely a plant of the kind can be grown without sooner or later being attacked, and the gardener should always keep a watchful eye for the worms, about the time indicated.

THE COTTONWOOD DAGGER—*Acronycta populi*, N. Sp.

(Lepidoptera Acronyctadæ.)

[Fig. 87.]

The Cottonwood tree (*Populus monilifera*), though not very generally cultivated in the more thickly settled parts of the country, is yet a valuable tree, especially in the newly settled parts of the West, where by its rapid growth and large foliage, it soon furnishes both wood and shade on the bleak treeless prairies. Besides several borers which eat into the trunk and root, it is attacked in this State by a very curious lazy caterpillar, which devours the foliage, and not unfrequently strips the tree.

This caterpillar (Fig. 87) when full grown, rests curled round upon the leaf, and is easily recognized by its body being covered with long soft bright yellow hairs which grow immediately from the body, part on the back, and curl round on each side. It has a shiny black head, black spots on the top of joints 1 and 2, and a straight black brush on top of joints 4, 6, 7, 8 and 11. There are two broods of these worms each year, the first brood appearing during the month of June and producing moths by the last of July, the second brood appearing the last of August and throughout September, and passing the winter in the chrysalis state. The chrysalis is dark shiny brown, and ends in an obtuse point which is furnished with several hooked bristles. It is formed within a pale yellow cocoon of silk intermingled with the hairs of the caterpillar, and is generally built in some sheltered place, such as a chink in the bark of a tree, or under the cap of some fence.

[Fig. 88.]

The moth (Fig. 88, ♀) is of a pale gray, marked with black as in the figure. It belongs to a night-flying genus (*Acronycta*) of true Owlet-moths, very closely allied to our common cut-worm moths; and yet the larvæ belonging to this genus have none of them the cut-worm habit of concealing themselves under ground, and are exceedingly heterogeneous among themselves. Some are furnished with long soft hairs like the species under consideration; some with prominent hairy warts; some have protuberances on certain segments; some are furnished with brushes; others not, etc., etc. But notwithstanding this dissimilarity among the larvæ of the genus, the moths bear very close

resemblances to one another, and in some cases it is not easy to separate them without knowing the larvæ. Our Cottonwood species has never been described. It bears a strong resemblance to several European species, but as it would only weary the general reader to give the details wherein it differs from those already described, which closely resemble it, these details will be found to accompany the scientific description below.

This insect would undoubtedly become much more numerous and troublesome, were it not for the fact that it is pursued by three distinct parasites. Many of the worms when full grown will fasten themselves firmly to a leaf in the curled position, and from the body will issue from thirty to forty little maggots. These maggots are each of them 0.17 inch long, of a dull green color, tapering each way, with a dark dorsal mark, a lateral elevated ridge, and a row of shiny elevated spots of the same color as the body between this ridge and the back. Each one spins a mass of white silk around its body, and creeps out of it and commences spinning afresh, until at last a large aggregate amount of flossy silk is spun, into which the maggots work back to transform, though some transform while lying on the surface. These maggots eventually produce a little black Ichneumon-fly belonging to the genus *Microgaster*.* Another and larger undetermed Ichneumon-fly belonging to the genus *Ophion*, also attacks this Cottonwood worm, and it is also occasionally infested with a *Tachina*-fly larva.

These worms are most easily destroyed when young, for though not strictly gregarious, they do not then scatter much from the branch upon which they were born.

ACRONYCTA POPULI, N. Sp.—*Larva*—Length 1.50. Color yellowish-green, covered with long soft bright yellow hairs which spring immediately from the body, part on the back, and curl round on each side. On top of joints 4, 6, 7, 8 and 11, a long straight double tuft of black hairs, those on 7 and 8 the smallest. Head polished black with a few white bristles. Joint 1 with a black spot above, divided longitudinally by a pale yellow line, giving it the appearance of a pair of triangles. Joint 2 with two less distinct black spots. Thoracic legs black; prolegs black with brownish extremities. Venter greenish-brown. Described from many specimens. When young of a much lighter color, or almost white, with the black tufts short but more conspicuous, with a distinct black dorsal line, two lateral purplish-brown bands, and with hairs white, sparse and straight.

Individuals vary much: some have a black dorsal line, some have but three distinct black tufts; some have a 6th tuft of black hairs on joint 9, and others have a few black hairs on all but the thoracic joints. Just before spinning up, many of the hairs are frequently lost, and the body acquires a dull livid hue.

Moth.—♀, Front wings, white, finely powdered with dark atoms which give them a very pale gray appearance; marked with black spots as follows: a complete series of small spots on posterior border extending on the fringes, one between each nerve; near the anal angle between nerves 1 and 2 a large and conspicuous spot bearing a partial resemblance to a Greek *psi*, placed sidewise, and from this spot a somewhat zigzag line running parallel with posterior border, but somewhat more arcuated towards costa, least distinct between nerves 3 and 4, and forming a large distinct dart-like spot between nerves 5 and 6; space between this line and posterior border, slightly darker than the rest of the wing-surface on account of the dark atoms being more thickly sprinkled over it; four costal marks, one subobsolete in a transverse line with the reniform spot, one conspicuous about the middle, and in a line with reniform spot and anal angle, one about the same size as the last and looking like a blurred X about one-third the length of wing from base, and one subob-

Microgaster acronyctæ of my MS.

solet, near the base; orbicular spot flattened and well defined by a black annulation; reniform spot indicated by a blurred black mark running on the cross-vein and sometimes somewhat crescent-formed; a V-shaped spot pointing towards base half-way between costa and interior margin, in a transverse line with the large costal spot which looks like a blurred X; a blurred mark in middle at base, and lastly a narrow spot on the inferior margin, half-way between base and anal angle. Hind wings same color as front wings; somewhat more glossy, with the lunule, a band on posterior border one-fourth the width of wing, and sometimes a narrow coincident inner line, somewhat darker than the rest; the posterior border also with a series of spots one between each nerve. Under surface of front wings pearly-white with an arcuated brown band, most distinct towards costa, across the posterior one-third, all inside of this band of a faint yellowish-brown; lunule and fringe spots distinct, and with a faint trace of the *psi*-spot; hind wings uniform pearly-white with a distinct and well defined dark wavy line running parallel with posterior margin across the posterior one-third of wing, and with the lunule and fringe spots distinct. Antennæ simple and bristle-formed, gray above, brown beneath. Head thorax and body, both above and below, silvery-gray. Legs with the tarsi alternately dusky and gray. ♂ differs from ♀ by his somewhat stouter antennæ; much narrower body, and narrower wings and fringes, the front wings having the apex more acuminate, and the hind wings scarcely showing the darker hind border.

Described from 2 ♀, 2 ♂ all bred. In the ornamentation of the front wings this species bears some resemblance to the European species *tridens* and *psi*, but otherwise differs remarkably, and especially in its larval characters. It bears a still closer resemblance both in the larva and imago state to the pale variety of a common species known in England as the "Miller" (*A. leporina*), but judging from the figures and description in "Newman's Natural History of British Moths," it may be easily distinguished from *leporina* by the well defined orbicular spot, by the greater proximity of the two large costal spots, by lacking a round spot behind the disk, and by the more prolonged apex. It differs also in the larva state from *leporina* which feeds on the Birch. It likewise closely resembles *interrupta*, though the larvæ are remarkably different; and it also resembles *lepusculina*, the larva of which is unknown; but the specific differences will be readily perceived upon comparing Guenée's descriptions. How near it approaches to *Acronycta occidentalis*, Grote,* it is impossible to tell, as the author's description is exceedingly brief, considering the number of closely allied forms; but as that species has a bright testaceous tinge on the reniform spot, it evidently differs from mine. Harris's *Apatela* [*Acronycta*] *Americana*,† though very different in the imago, yet closely resembles *populi* in the larva state. I have on two occasions found the larva of *Americana* feeding on the Soft Maple, and it may be distinguished from *populi*, by its greater size; by the paler color of the body; by the hairs being paler, more numerous, shorter and pointing in all directions, especially anteriorly and posteriorly of each segment; by having on each of joints 4 and 6 two distinct long black pencils, one originating each side of dorsum, and on joints 11 one thicker one originating from the top of dorsum; by a substigmatal row of small black spots (three to each segment, the middle one lower than the others) and by a trapezoidal velvety black patch starting from anterior portion of joint 11 and widening to anus.

THE MISSOURI BEE-KILLER—*Asilus Missouriensis*, N. Sp.

(Diptera Asilidæ.)

On page 168 of my First Report an account is given, with a very poor figure, of a large two-winged fly which was first received by Dr.

*Proc. Ent. Soc. Phil., VI, p. 16.

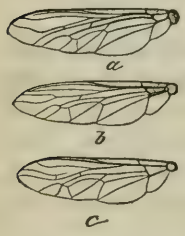
†I am surprised that Dr. Morris (*Harr. Inj. Insects*, p. 436, Note) refers this species to Guenée's *acericola*, when the larva of the latter, as described by Guenée himself, is so different and feeds withal on Birch and Alder, and not on either Maple, Elm, Linden or Chesnut.

[Fig. 89.]

Fitch, of New York, from Mr. R. O. Thompson of this State, who found that it had the pernicious habit of catching and sucking out the juices of the common honey-bee. Dr. Fitch referred this fly to the genus *Trupanea*, and called it the Nebraska bee-killer, from its having first been captured by Mr. Thompson in Nebraska, where he at that time resided. The great German Dipterist, H. Loew, as I am informed by Baron Osten Sacken of New York, ignores and has discontinued the genus *Trupanea*, substituting in its place that of *Promachus*; and Fitch's *Trupanea apivora* is the very same species previously described by Loew as *Promachus Bastardii*, and it is one of the most common species, occurring very generally over the United States.

I find that we have in Missouri a somewhat larger fly (Fig. 89) which has the same pernicious habit of seizing and destroying the honey-bee in preference to all other kinds of prey. It acts in exactly the same manner as the Nebraska Bee-killer, being, if anything, more inhuman and savage. It belongs to the typical genus *Asilus*, and I have called it the Missouri Bee-killer (*Asilus Missouriensis*). Though bearing a casual resemblance to the Nebraska Bee-killer, it may very readily be distinguished from that species, and especially by the different venation of the wings.

[Fig. 90.]



The three more common genera of these voracious *Asilus* flies, may easily be distinguished from each other by the character of these wing-nerves. In the typical genus *Asilus* to which belongs our Missouri Bee-killer, the *third* longitudinal vein is forked near the terminal *third* of the wing, and the vein itself is connected about the middle of the wing, with the fourth longitudinal, as in Figure 90, *b*. In the genus *Promachus*, to which the Nebraska Bee-killer belongs, it is the *second* (not the third) longitudinal vein which is forked near the *middle* of the wing, and the third branch of this fork is connected by a slender cross-vein to the third longitudinal, near the terminal third of the wing, as in Figure 90, *a*. In the genus *Erax*, which generally comprises smaller species, the venation is similar to that of *Asilus*, but the upper branch of the fork, instead of joining the third longitudinal vein, is abruptly broken off and connected only near its termination by a transverse vein, as in Figure 90, *c*.

ASILUS MISSOURIENSIS N. SP.—Alar expanse 1.85; length of body 1.30 inches. *Wings* transparent, with a smoky yellow tinge, more distinct around the veins, which are brown. *Head* pale yellow, sometimes brownish; moustache straw-yellow with a few stiff black hairs below; beard pale straw-yellow; crown very deeply excavated; base of the same pale yellow with short, stiff,

yellowish hairs, and a crown of black ones near the border; eyes large, prominent, finely reticulated and almost black; antennæ, first joint black tipped with brown, cylindrical and hairy; second joint black, short, thick and rounded at tip, with a few stiff hairs; third joint as long as first, tapering each way, smooth, black and terminating in a long, brown bristle; proboscis black and nearly as long as face; neck with pale and black hairs. *Thorax* leaden-black, slightly opalescent with reddish brown at sides, more or less pubescent with pale yellow, especially laterally and posteriorly and in three narrow longitudinal dorsal lines which gradually approach towards metathorax; bearded at sides and behind with a few decurved black bristles, those behind interspersed with a few smaller pale hairs; scutel of the same color, with upward-curving, black bristles; halteres brown. *Abdomen*, ♂, general color dull leaden-yellow, with darker transverse bands at insections; the light color produced by a yellowish pubescence and numerous short close-lying yellow hairs, the dark bands produced by the absence of this covering at the borders of each segment; basal segment broad, bilobed, and with lateral black bristles; segments 6, 7, 8 and anal valves with a decided pink tint, especially 7; 8 but one-third as long as 7 above. ♀, broader, flatter, more polished and brassy, with no transverse darker bands, segments 7 and 8 polished black, the latter narrow and longer than any of the others; anus with a few black bristles. *Legs*, dull purple-brown, with black bristles; thighs very stout, the hind pair rather darker than the others, the two front pair of trochanters with long, yellowish hairs; pulvilli, generally fulvous.

Described from two ♂, and two ♀, all captured while sucking honey-bees. I have not access to Loew's descriptions, and cannot therefore compare it with already described species; but specimens have been sent to Dr. Wm. LeBaron, of Geneva, Illinois, and to Baron Osten Sacken, of New York, and both these gentlemen are unacquainted with it, and believe it to be new. In the well marked ♂ specimens, the body bears a general resemblance to that of *Trupanea* [*Promachus*] *vertebrata*, Say.

Of course the apiarian will care very little to know which of these two Bee-killers is weakening his swarms. They should both be unmercifully destroyed, and though very strong and rapid flyers, they may be easily caught when they have settled on any little prominence with a bee in their grasp; for they are so greedy of the bee's juices that they are at this time less wary, and even when disturbed, will fly but a few yards away before settling again. A net such as that described in the article on "Cabbage worms" will be found useful in catching these mischievous flies.

The habits and preparatory stages of our *Asilus* flies are not very well known. They are all cannibals in the fly state, sucking out the juices of their victims with the strong proboscis with which they are furnished, and by which they are capable of inflicting a sharp sting on the human hand. The larvæ are footless, and live in the ground, and such as are known in this state are strangely enough, vegetable-feeders.

[Fig. 91.]

The only N. A. species that has heretofore been bred to the perfect state, is the Silky Asilus (*Asilus sericeus*, Say., Fig. 91) belonging to the typical genus *Asilus*. Its larva feeds upon the roots of the Rhubarb, and was bred to the perfect state by Dr. Harris (*Inj. Insects*, p. 605). I have succeeded in breeding to the fly state another species, belonging however to the genus *Erax*, and subjoin a description of the larva, as it is of considerable scientific interest. The fly is figured below (Fig. 93 *a*).

[Fig. 92.] ERAX BASTARDI (?)—*Larva*—(See Fig. 92.) Length 1.05 inches. Only twelve joints, the three anterior and the three posterior ones tapering gradually, the rest of equal width: slightly depressed; translucent yellowish-white, the chitinous covering tolerably firm however; a swollen lateral ridge; two rufous dorsal spiracles on joint 1 and two similar ones on joint 11. Head dark brown, very retractile, pointed, divided at tip into two mandibulate points, and having two unguiform appendages; anal segment with two depressed longitudinal lines above, ridged on anterior edge and with a central depressed line below. It makes use of its head in crawling.

Pupa—(Fig. 93 *b*). Stout, honey-yellow; the leg and wing-sheaths soldered together though separated from the abdomen; eyes large and dark; head with two large brown spines in front, and a lateral set of three rather smaller ones; thorax with two small thin rounded dorsal projections and a set of two small lateral spines just behind the head; abdomen, with each segment ridged in the middle and furnished on this ridge with a ring of brown blunt thorns sloping backwards; anal segment with a few rather stouter spines.

[Fig. 93.]

Two specimens, one found by Mr. G. C. Brodhead of Pleasant Hill, Mo., under a peach tree, the other by Mr. G. Pauls of Eureka, Mo., under a "creeping vine" of which he did not know the name. They were found full grown in May, and gave out the flies the fore part of July. Both produced ♀♀, on which account the species cannot be determined with absolute certainty. Osten Sacken informs me that it is allied to *tabescens* Loew, but is different. It is marked *lictor* in my MS., but from Macquart's description of *Bastardi*, and from ♂ and ♀ specimens of that species kindly furnished by Dr. Le Baron, I feel pretty confident that it is ♀ of that species, which is described as follows: *Abdominis segmentis tribus apicalibus niveus* ♂; *omnibus segmentis albido marginatis* ♀. *Pedibus nigris: tibiis rufis: alis flavidis. Long.* 7½ l. He then adds: "Face and front black with gray down; moustache with the upper half black and lower half white; as also the beard. The middle band of thorax divided. The first four segments of the abdomen with the posterior and lateral borders whitish. Extremities of the legs black. From North America. From 8 ♂, I have seen one which had the four terminal segments of the abdomen white." My females accord very well with this description so far as it goes, though I cannot see why Macquart restricts the whitish borders to the first four segments in the French description, when in the Latin it is stated that all the segments are so bordered, which is the case with my specimens.

INNOXIOUS INSECTS.

THE GOAT-WEED BUTTERFLY—*Paphia glycerium*, Doubleday.

[Lepidoptera, Nymphalidæ.)

[Fig. 94.]

There is is an interesting and rare butterfly known to entomologists by the name of *Paphia glycerium*, which occurs in Missouri, Texas and Illinois, and perhaps in other southwestern States. It is an interesting species on account of the dissimilarity of the sexes, and of the position it holds among the butterflies; and as its natural history was unknown till the present year, I will transcribe from the *American Entomologist*, the following account of it, which I was enabled to prepare from specimens kindly sent to me last September by Mr. J. R. Muhleman, of Woodburn, Ills., and from further facts communicated by Mr. L. K. Hayhurst, of Sedalia, Mo.

Dr. Morris, in his "Synopsis of the Lepidoptera of North America," places this butterfly with the *Nymphalis* family, of which the Disippus Butterfly (*Nymphalis disippus*, Godt.), is representative. The larva, however, has more the form and habits of that of the Tityrus Skipper (genus *Goniloba*), while singularly enough, the chrysalis resembles that of the Archippus Butterfly (genus *Danais*).

The larva feeds on an annual (*Croton capitatum*) which is tolerably common in Missouri, Illinois, Kentucky, and westward, where it is known by the name of Goat-weed, and as no value whatever is at-

tached to it, the insect which attacks it cannot be classed among the injurious species. The plant has a peculiar wooly or hairy whitish-green appearance, and in the month of September its leaves may frequently be found rolled up after the fashion shown at the left of Figure 94, with the larva inside. This roll of the leaf is generally quite uniform, and is made in the following manner: Extending itself on the midvein, with its head towards the base of the leaf, the larva attaches a thread to the edge, at about one-fourth the distance from the base to the point. By a tension on this thread, it draws this edge partly toward the opposite one, and fastens it there, being assisted in the operation by the natural tendency of the leaf to curl its edges inwards. Fastening a thread here, it repeats the operation until the edges meet, and then it proceeds to firmly join them nearly to the apex, leaving a small aperture through which to pass the excrement. During hot days the larva remains concealed in the leaf, and towards evening comes out to feed, though sometimes it feeds upon its house, eating the leaf down half way from base to point. It then abandons it and rolls up a new one. In the breeding cage, when placed in a cool shady room, the larva seldom rolls up the leaves, but feeds at random over the plant, and when at rest simply remains extended on a leaf. From this we may infer that its object in rolling the leaves is to shield itself from the rays of the hot August and September sun; for the plant invariably grows on high naked prairies.

[Fig. 95.]

The young larva has a large head, larger than the third segment, which is the largest in the body. The head preserves its general form through the successive moults; it is light bluish, thickly covered with papillæ of a dirty-white color, and there are also a number of light orange papillæ of a larger size scattered among them. The skin of the caterpillar is *green*, but the general hue is a dirty-white, owing to the entire surface being very closely studded with white or whitish papillæ with dark-brown ones interspersed. These prominences are hemispherical, hard, opaque, shining, and the larva feels rough and harsh to the touch.

At each moult some of these papillæ disappear, especially *all* the brown ones, the body increases in size so that the head is smaller than the third segment, the green color of the skin becomes more apparent, the body is softer to the touch, and the whole larva assumes a neater appearance.

Thus this larva has very much the same peculiar whitish glaucous-green color as the plant on which it feeds; and any one who has seen it upon the plant, cannot help concluding that it furnishes another instance of that mimickry in Nature, where an insect, by wearing the exact colors of the plant upon which it feeds, is enabled the better to escape the sharp eyes af its natural enemies. When full-grown, which is in about three weeks after hatching, this worm (Fig. 94, *a*) measures 1½ inches, and although, as above described, the little elevations frequently disappear so that it looks quite smooth, yet sometimes they remain until the transformation to chrysalis takes place, as was the case with two which I bred.

[Fig. 96.]

PAPHIA GLYCERIUM.—*Full-grown larva*—Length 1.50 inches. Cylindrical. General appearance shagreened, pale glaucous-green, lighter above stigmata than elsewhere. Ground-color, of body clear green. Thickly covered with white papillæ or granulations, which are often interspersed with minute black or dark-brown sunken dots. Head quite large, (rather more than ½ as large as the third segment), nutant, subquadrate, bilobed, granulated like the body, but with the black sunken dots more numerous, and having besides, several larger granulations above, some four of which are generally black and the rest fulvous; a row of three very distinct eye-spots at the base of palpi; the triangular V-shaped piece elongated and well defined by a fine black line, and divided longitudinally by a straight black line; palpi and labrum pale, the latter large and conspicuous; jaws black. Neck narrow, constricted, green, smooth, and retractile within first segment. Segments 1—3 gradually larger and larger; 3 to last gradually smaller. Stigmata fulvous. Venter less thickly granulated than tergum. Described from five full-grown specimens received from Mr. Muhleman.

Preparatory to transforming, it suspends itself by the hind legs to a little tuft of silk which it had previously spun, and after resting for about twenty-four hours with its head curled up to near the tail, it works off the larval skin and becomes a chrysalis, which in from two to three weeks afterwards gives out the butterfly. This chrysalis (Fig. 94, *b*) is short, thick, rounded, and of a light green; sometimes becoming light gray, and being finely speckled and banded with dark gray. The skin is so thin and delicate that the colors of the butterfly may be distinctly seen a few days before it makes its escape.

The male butterfly (Fig. 95), is of a deep coppery-red on the upper side, bordered and powdered and marked with dark purplish-brown, as shown in the figure. The under side is of a *feuille morte* brown with a greasy lustre, the scales being beautifully shingled transversely so as to remind one of that article of dry-goods which the ladies call rep; while the bands which commenced on the front wings above, may be traced further across the wing, and there is a transverse band on the hind wings, with an indistinct white spot near

the upper edge. The female (Fig. 96), is of a lighter color than the male, marked with purplish-brown as in the figure, the transverse bands being quite distinctly defined with very dark-brown. The under side is very much as in the male.

A few of the butterflies, in all probability, manage to live through the winter, and are thus enabled to perpetuate the race, by depositing their eggs, the following summer, on the leaves and stems of the Goat-weed, which is the only plant upon which the insect is yet known to subsist.

THE BLACK BREEZE-FLY—*Tabanus atratus*, Fabr.

(Diptera, Tabanidæ.)

[Fig. 97.]

There is a family of large Two-winged Flies, commonly called Breeze-flies in England, but more commonly known as Horse-flies in this country, the insects belonging to which are, in the perfect state, great nuisances, though there is every reason to believe that as larvæ they are beneficial to the husbandman, by devouring many noxious underground vegetable-feeding larvæ.

This family comprises some of the very largest flies, and they are all noted for the tormenting powers which the female has of piercing the skin and sucking the blood of different quadrupeds and even of man. They are widely distributed, and species occur in all parts of the world, torturing alike the huge elephant and fierce lion of the tropics, and the peaceful reindeer of the arctic region. It is during the hottest summer months that they "do most abound," and they frequent both our timbered and prairie regions. One of the most common species in the West is the so-called "Green-head Fly" (*Tabanus lineola*, Fabr.) and every farmer who has to work on the prairies, especially during the hay-making season, knows how blood-thirsty it is, and how absolutely necessary it is to cover the horses at this season of the year, in order that they may be able to work at all. Two other species of nearly the same size (*T. costalis*, Wied. and *T. cinctus*, Fabr.) are common with us, and I have found the striped

Chrysops (*Chrysops vittatus*, Wied.)—a smaller yellow species with black stripes, and a broad smoky band across the middle of each wing; to be very troublesome in our wooded regions, confining its attacks more especially to the horses' ears, from which habit it is frequently called the "Ear-fly."

It is only the female flies, as is the case also with our mosquitoes, which thus torment our animals by means of their sharp lances, the males living on the sweets of flowers, and their mouths being destitute of mandibles. The flight of these Breeze-flies is very strong and rapid, and is attended with a buzzing, tormenting noise. The males may often be seen with the wings vibrating so rapidly that they become invisible, resting motionless in one place, and then darting rapidly and resting suddenly again, generally turning the head in some other direction each time they dart; and St. Fargeau has ascertained that this manœuvering is performed in order to intercept and seize the females.

Although these flies swarm so prodigiously on our prairie and especially on our low swampy lands, yet hitherto very little has been known of their larval character and habits. De Geer very many years ago described the larva of the European Cattle Breeze-fly (*Tabanus bovinus*, Linn.), and up to 1864 this was the only larva of the kind known. In February of that year Mr. Walsh published the description of another Tabanide larva, but without being able to refer it to any particular species.* I had the good fortune last summer to breed to the perfect state the very same kind of larva which Mr. Walsh described. It proved to be one of our most common and largest species, namely The Black Breeze-fly (*Tabanus atratus*, Fabr.) This Fly (Fig. 97, *c*) is black, the back of the abdomen being covered with a bluish-white bloom like that on a plum; the eyes are large, and the wings are smoky dark brown or black.

The larva (Fig. 97, *a*) is a large 12-jointed, cylindrical affair, tapering at each end, of a transparent, highly polished, glassy, yellowish or greenish appearance, shaded with bluish-green and furnished above and below, as in the figure, with large roundish sponge-like tubercles which are retracted or exserted at the will of the insect. Though the external integument is so transparent, that the internal structure is readily visible, yet this integument is firm and the larva is most vigorous and active, burrowing with great strength either backwards or forwards in the earth, and between one's fingers while it is being held. Placed in water it will swim vigorously by suddenly curling round and lashing out its tail, but it is apparently not as much at home in this element as in the wet earth, for it is restless and remains near the surface, with the tip of the tail elevated in the air. When the water is foul it moves about actively near the surface, but when it is fresh it remains more

*Proc. Bost. Soc. Nat. Hist., Vol. IX, pp. 302-6.

quiet at the bottom. The specimen which I succeeded in breeding, was sent to me by Mr. Adolph Engelmann of Shiloh, St. Clair Co., Ills. It was found by Mr. Wm. Cooper of the same county, about ten feet from a small but permanent stream of water. Mr. C. at first took it to be a leech, and when he attempted to capture it, it immediately commenced burrowing in the ground.

Mr. Walsh's description of this larva is so full, and agrees so well with mine, that I cannot do better than transcribe it.

TABANUS ATRATUS.—*Larva*,—Length 2.25 inches when extended, 1.75 inches when contracted; diameter .25—.30 inch. Body cylindrical, 12-jointed, the three or four terminal joints much tapered at each end of the body, but more so anteriorly than posteriorly, and joints 1 and 11, each with a retractile membranous prolongation at tip. Joints 1 to 10 are subequal; 11 is about two-thirds as long as 10 and 12 about one-fourth as long, and .05 inch in diameter. [Joints 1 and 12 pear-shaped when extended]. Color a transparent greenish-white, paler beneath; an irregular dark-green or greenish-black annulus, paler beneath, on the anterior and posterior margins of joints 2 to 11, the anterior annulus laterally connected with the posterior by two to four dark-green lines. On the dorsum of 4 to 9, and more obscurely on 10, a dark-green basal triangle, extending half-way to the tip; joint 1 with paler markings, and with no dark annulus behind; joint 12 entirely fuscous. Head small, apparently fleshy, pale, truncate-conical, .03 inch wide, and about .04 inch long in repose, inserted in joint 1 without any shoulder. The trophi occupy two-thirds of its length, but it has a long cylindrical internal prolongation, extending to the middle of joint 2, which is sometimes partially exserted, so that the head becomes twice as long as before. All the trophi are pale and apparently fleshy, except the mandibles, which are dark-colored and evidently horny, and they have no perceptible motion in the living insect. The lubrum is slender, a little tapered, and three times as long as wide, on each side of and beneath which is a slender, thorn-like, decurved, brown-black mandible. The labium resembles the labrum, but is shorter, and on each side of it is a slender palpiform, but exarticulate maxilla, extending beyond the rest of the mouth in an oblique direction. No palpi. On the vertex are a pair of short, fleshy, exarticulate, filiform antennæ, and there are no distinct eyes or ocelli. In the cast larval integument the entire head, .25 inch long, is exserted, and is dark-colored and evidently horny, all the parts retaining their shape except the antennæ, labrum and labium. The whole head has here the appearance of the basal part of the leaf of a grass-plant, clasping the origin of the maxillæ on its posterior half, and bifurcating into the somewhat tapered cylindrical mandibles on its anterior half. The maxillæ are traceable to two-thirds of the distance from the tip to the base of the head, scarcely tapering, bent obliquely downwards at two-thirds of the way to their tip, and obliquely truncate at tip. On the anterior margin of ventral segments 4—10, in the living insect, is a row of six large, fleshy, roundish, tubercular, retractile pseudopods, the outside ones projecting laterally, and each at tip transversely striate and armed with short, bristly pubescence; on the anterior half of ventral joint 11 is a very large, transversely-oval, fleshy, whitish, retractile proleg, with a deeply impressed, longitudinal stria. On the anterior margin of dorsal joints 4—10, is a pair of smaller, transversely-elongate, retractile, fleshy tubercles, covering nearly their entire width, armed like the pseudopods, but not so much elevated as they are. No appearance of any spiracles. Anus terminal, vertically slit with a slender, retractile thorn .05 inch long, not visible in one specimen. Head, and first segment or two, retractile.

The larva reared by De Geer was terrestrial. This larva is semi-acquatic, for it is quite at home either in water or moist earth. My specimen was kept for over two weeks in a large earthen jar of moist earth well supplied with earth-worms. It manifested no desire to come to the surface, but burrowed in every direction below. I found several pale dead worms in the jar, though I cannot say positively whether they had been killed and sucked by this larva. Mr. Walsh in speaking of its haunts and of its food, says: "I have, on many different occasions, found this larva amongst floating rejectamenta. On one occasion I found six or seven specimens in the interior of a floating log, so soft and rotten that it could be cut like

cheese. Once I discovered a single specimen under a flat, submerged stone, in a little running brook. And finally, I once met with one alive, under a log, on a piece of dry land which had been submerged two or three weeks before, whence it appears that it can exist a long time out of the water. I had, on several previous occasions, failed to breed this larva to maturity, and the only imago I have, was obtained in 1861, from larvæ, which, suspecting them to be carnivorous from the very varied stations in which they had occurred, I had supplied with a number of fresh-water mollusks, but the habits of which, in consequence of having been away from home, I was unable to watch. On September 2d, 1863, I found a nearly full-grown larva amongst floating rejectamenta, and between that date and September 23d, he had devoured the mollusks of eleven univalves (*Gen. Planorbis*) from one-half to three-fourths of an inch in diameter; and on three separate occasions I have seen him work his way into the mouth of the shell. In this operation his pseudopods were energetically employed, and I found, on cracking the shells after he had withdrawn, that a small portion of the tail end of the animal was left untouched—no doubt in consequence of his being unable to penetrate to the small end of the whorl of the shell—and also the skin of the remaining part, and the horny-tongued membrane."

My larva transformed to pupa (Fig. 97, *b*) within the ground, during the fore part of July; it remained in this state but a few days, and the fly issued July 13th, and soon made its presence known by its loud buzzing inside the jar. It was a perfect ♀ specimen, and the pupal integument was sufficiently firm and polished, that by carefully washing off the earth, an excellent cabinet specimen was obtained, which retained almost the exact form and appearance of the living pupa. Before the escape of the fly which was effected through a longitudinal fissure on the back of the head and thorax, reminding one of the mode of escape of our Harvest-flies (*Cicadæ*), this pupa by means of the thorns with which it is furnished, had pushed itself up to the surface of the earth. My specimen being female, may account for the very slight difference between the following description and that of Mr. Walsh's.

Pupa, (described from pupal integument).—Cylindrical, lying curved as in the figure; rounded at the head, and tapering at the last two joints; pale semi-transparent yellowish-brown. *Head* with two transverse, narrow-edged, somewhat crescent-shaped dark-brown projections representing the mouth, two rounded tubercles above, on the front, of the same color, and each giving out a stiff bristle; and midway between these four, two much smaller, lighter, rounded tubercles, set closer together; on each side in a line with the upper tubercles, a wrinkled antenna, trigonate at base, appressed to the surface and pointing outwards; below these antennæ, on the eyes, two small bristled warts. *Thorax*, pronotum commencing behind antennæ, with a pair of small bristled brown tubercles* on its anterior dorsal submargin; mesonotum twice as long as pronotum, with a pair of large obliquely-placed, reniform, purple-brown tubercular spiracles, bordered on the outside above, with a distinct fine white line; between these spiracles are four small brown elevations the two middle ones quite small and close together; a short metanotal piece, about one-seventh as long

*Evidently not spiracles as Mr. Walsh supposed. The mesonotal spiracles are well defined, with the white border above mentioned, and the abdominal spiracles are each marked behind by a distinct white line; but these tubercles have no such annulus and are illy defined.

as pronotum and without spiracles. *Abdomen*, with 8 subequal segments, with two well defined lateral impressed lines, and all but the last bearing between these lines, a rounded brown tubercular spiracle, the posterior upper borders lined with white. The first segment is simple and extends to the tips of the wing-sheaths; the others are all furnished, on the posterior one-third, with an annulus of fine, yellowish bristles, depressed and directed backwards. Anal thorn robust, yellow, truncated, and furnished with six stout brown thorns, hexagonally arranged. Length 1.20 inches; greatest diameter 0.30 inch. One ♀ specimen.

This large Black Breeze-fly does not attack horses to any considerable extent that I am aware of, but is said to bite cattle. The smaller species of real Horse-flies mentioned above, and which occur in prodigious numbers on our Western prairies, away from any large streams of water, must evidently be terrestrial in the larva state, and not aquatic, and must just as surely live on other food than snails, which are quite rare on the prairies. They are certainly carnivorous however, and it is but natural to suppose that they feed on underground vegetable-feeding larvæ, such as the different kinds of white grubs, the larvæ of Crane-flies (*Tipulidæ*), etc. Thus, in all probability, they perform a most important part in the economy of Nature, by checking the increase of those underground larvæ which are the most unmanageable of the farmer's foes. They therefore partly atone for the savage and blood-thirsty character of the perfect females, and I prefer consequently to place them with the other Innoxious Insects.

GALLS MADE BY MOTHS.

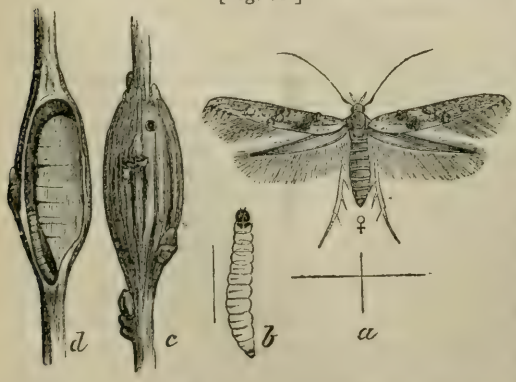
As a sequence to the article on the Solidago Gall Moth (*Gelechia gallæsolidaginis*, Riley) published in my former Report, I will here describe two other gall-making moths, with which I was not then acquainted, the first of which, as I have since ascertained, occurs in this State. The other I have never yet met with.

THE FALSE INDIGO GALL-MOTH—*Walshia amorphella*, Clemens.

(Lepidoptera; Tineidæ.)

On the leafless stems of the False Indigo (*Amorpha fruticosa*) may often be seen, during the fall, winter and spring months, an elongated swelling such as that shown at Figure 98, *c*, two of them often occurring one above the other. This swelling is a simple enlargement of the stem to five or six times its natural diameter, and measures from three-quarters of an inch to an inch in length. If cut open during any of the winter months, the interior will present a tough woody appearance, with an irregular brown channel, almost always

[Fig. 98.]



at one side of the gall, and communicating above with a small closed-up tubercle (See Fig. 98, *d*,). At the bottom of this channel the larva (Fig. 98, *b*, enlarged), which is whitish with a conspicuous black head and black collar, may always be found, and it does not transform to the chrysalis state till a few weeks before appearing as a moth. The tubercle near the top of the gall is evidently caused by the young larva penetrating the stem when it first hatches out; and this larva must, after it has burrowed the proper length down the stem, turn round and widen the burrow right up to the point of entrance; for it is from this point that the moth escapes in the spring. The moth, of which Figure 98, *a*, represents an enlarged female, is easily distinguished from most other small moths belonging to the same family (*Tineidæ*) by its beautifully tufted front wings, which are not easily represented in a wood-cut. It is of a yellowish-brown color, marked with darker brown, and the males are generally a little darker than the females. This little moth was first described by Clemens (Proc. Ent. Soc. Phil., Vol. II, p. 419), who named the genus in honor of Mr. Walsh, its first discoverer, and so far as I am aware it is the only representative of the genus.

The twigs invariably wither and dry up above this gall, but as the shrub has no particular value, the little gall-maker may be placed among the harmless insects.

WALSHIA AMORPHELLA—*Larva*—Length 0.35—0.40 inch. Cylindrical, tapering each way, but more especially towards anus. Yellowish-white, each segment with about two distinct transverse folds. Two dorsal rows of pale but polished piliferous spots, two to each segment; stigmata round, jet black with a white centre, with a pale piliferous spot above, and two contiguous ones on a lateral fold, below each; on joints 1 and 2 the folds are more numerous and the piliferous spots are larger and arranged in a transverse row. Head either black or dark brown, the trophi except the maxillæ white, and the eyelets, arranged in a crescent, also pale. Cervical shield same color as head, divided in the middle by a distinct pale line. Both have a few white hairs, arising from pale points. Anal shield small and brown. Thoracic legs pale but slightly horny, transparent, furnished with hairs, and with two basal semi-circular brown lines behind, the largest terminating on the inside, in a black thorn. Prolegs very small and scarcely distinguishable except by a faint brown circular rim at extremities, and a still fainter one at their base. Described from numerous specimens, all very uniform.

Pupa—Unknown.

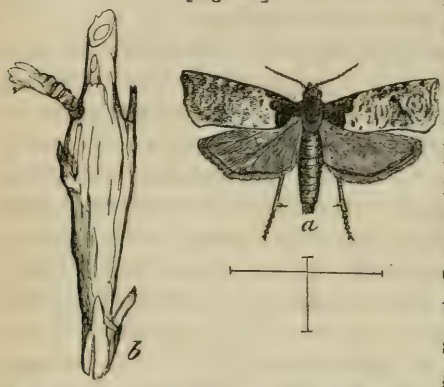
Moth—Front wings yellowish-fuscous, with a rather large blackish-brown patch at the base of the wing, somewhat varied with spots of the general hue, and a blackish-brown tuft, having the scales directed toward the tip of the wing, on the basal third of the fold, and a smaller one above it near the costa. Near the end of the fold is another small tuft of the general hue, having the ends of the scales tipped with dark brown, and in the middle of the wing nearly adjoining the latter is a large tuft of the general hue. Above the end of the fold is a small blackish-brown tuft, the scales of which are not so much erected as in the other tufts; between this and the central tufts is a blackish-brown patch which sends a streak of the same hue into the fold. The apical portion of the wing is somewhat discolored with brown, and along the inner margin, at the base of the cilia, are five or six black dots. Cilia dull testaceous. [Hind wings shiny yellowish-brown, long, narrow, lanceolate, with very long cilia] Antennæ fuscous [the basal joint long, smooth and clavate]. Head and thorax blackish-brown; labial palpi yellowish-fuscous. [Abdomen above dark brown, the joints bordered behind with gray, the terminal joint with a yellow tuft. Legs short, the tarsi only of hind pair reaching beyond abdomen; marked with gray and brown. Under surface uniform grayish-brown, the hind wings somewhat paler, and all the wings bordered with a paler line. Length 0.20; alar expanse 0.53 inch.] (After Clemens).

THE MISNAMED GALL-MOTH—*Euryptychia, saligneana*, Clemens.

(Lepidoptera, Tortricidæ.)

The only other gall-producing moth known in this country is the species illustrated herewith (Fig. 99, *a*), and there are some doubts in my mind as to whether it is a real gall-maker or an "inquiline" or intruder on my true Solidago Gall-maker (*Gelechia gallæsolidaginis.*) But two specimens of the moth have ever been found, one of which is in the cabinet of the late Brackenridge Clemens, at Philadelphia, and the other in my possession. They were both bred by Mr. Walsh from golden rod galls resembling those of my Solidago gall in being elongated and hollow; and from specimens kindly furnished to me before his death, I am enabled to give the above sketch of the dried gall, with the pupa-skin attached, and likewise that of the moth. The only description which exists of the larva is of a dead and somewhat shrunken specimen, in the following brief note taken from Mr. Walsh's journal: "Larva 16-footed, yellowish; spiracles (fuscous) on all but 2d, 3d and anal segments. Head and 2d [1st] segment horny and rufous. Length 0.40."

[Fig. 99.]



The moth is the only representative of its genus (*Euryptychia*) so far known. It was described in 1865 by Dr. Clemens * as *E. saligneana*, under the false impression that it was reared from a willow gall. But the scientific name of the insect must stand, however inappropriate.

EURYPTYCHIA SALIGNEANA—*Moth*—Front wings white, tinted with yellowish. The basal patch is dark brown. The wing beyond the basal patch is nearly white, varied with leaden-colored speckles and striped over the nervules with dull, leaden-gray, transverse stripes, two of which near the anal angle form a white ocelloid patch. Immediately interior to the ocelloid patch is a small black spot, having a line of black atoms running into it, from above and beneath. Below the apex, on the hind margin, is a triangular brown patch, which is varied with grayish and dotted with black in the middle and along the inner edge. The costa is geminated with white, and striped with brown. Hind wings dark fuscous. (After Clemens.)

Generic character—Hind wings broader than front wings. Costal and subcostal veins with a common origin; branches of subcostal connivent. Median vein 4-branched, three of which are aggregated, the two central ones from a common base. Front wings *with a broad fold*, extending to the middle of the costa, closely appressed; at least three times longer than broad; costa straight, tip moderately acute, apical margin rounded. The nervules given off from the posterior end of the cell are bent toward each other or are somewhat aggregated.

Head smooth, with ocelli at base of antennæ. Antennæ filiform, simple. Labial palpi, *do not exceed the face*, are curved, smooth, rather slender, expanded toward the tip, the apical joint scarcely perceptible, except in front. (Clemens.)

My reasons for thinking this insect an intruder on the rightful gall-maker, are: 1st, because if it were a true gall-maker we should

* Proc. Ent. Soc., Phil., V., p. 141.

naturally expect to find its gall more common; 2d, because on several occasions I have found within the *Gelechia* gall, a pale worm very different from the true gray gall-making larva. But until more decided proof can be obtained, and until the fact is settled by further experience and experiment, we must, from such evidence as we have, consider the Misnamed Gall-moth, a true gall-maker.

Thus we have three different and distinct gall-moths in this country, belonging to two distinct families and three distinct genera; while a fourth (*Cochylis hilarana*) belonging to still another genus is known to form a gall on the stems of *Artemisia* in Europe. It is very manifest that all of these galls are formed by the irritating gnawings of the larva after it is hatched, and not induced by any poisonous fluid injected with the egg by the ovipositor of the parent, as is demonstrably the case with those galls which are produced by gall-flies (*Cynips* family), and with such as are produced by some gall-making Saw-flies. It is not at all improbable, however, that these moth larvæ do in reality secrete from the mouth some peculiar fluid which tends to produce the gall; for we know that very many other moth larvæ burrow in the stems of different plants without producing any abnormal swelling.

ERRATA.

Page 13, line 25, for "cupable" read "culpable."
Page 16, line 13, for "lava" read "larva"
Page 23, line 6 from bottom, for "hole" read "holes."
Page 32, line 17, for "insect" read "insects."
Page 50, line 4 from bottom, for "*leucaiæ*" read "*leucaniæ*."

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THIRD ANNUAL REPORT

ON THE

NOXIOUS,

BENEFICIAL AND OTHER

INSECTS,

OF THE

STATE OF MISSOURI,

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

BY CHARLES V. RILEY,
State Entomologist.

JEFFERSON CITY, MO.:
HORACE WILCOX, PUBLIC PRINTER.

1871.

PREFACE.

To the Members of the Missouri State Board of Agriculture:

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

No particular action seems to have followed the suggestions thrown out in my last year's preface, as to the procuring of a better quality of paper and ink for these Reports. The impressions of the cuts which illustrate the text, are consequently quite inferior in my second Report, and fail to do justice to the engravings.

As will be seen from the following pages, many important discoveries in Economic Entomology have been made during the year, and some few insects have been very abundant. On the whole, however, we have enjoyed more than the usual immunity from insect depredations throughout the State. Complaints have been numerous, and articles giving extravagant accounts of the increase of noxious insects are continually appearing in our agricultural papers. But while some insects are on the increase, others are on the decrease, and the cause for alarm is in a great measure imaginary. More is now said and written about insects in the industrial journals of the State than formerly, because, through the agency of these Reports, the people have had their eyes opened to the importance of the subject; and the impression that insects generally are on the increase must be, in a great measure, attributed to this fact rather than to any real increase that has occurred.

The *American Entomologist*, in the columns of which some of the observations contained in this Report have already appeared, was continued during the year, and a botanical department, edited by Dr. George Vasey, of Normal, Illinois, was added to it. The charge of such a journal, together with my State duties, kept me too much confined, and for these and other reasons given, the magazine has been suspended during the coming year, 1871.

This suspension will enable me to spend more time in the field, and as these annual Reports have but a limited circulation, and as very many cultivators of the soil must in consequence, fail to get the

information contained in them, I have concluded to devote more time the coming year to lecturing; and have already prepared for that purpose a number of large, colored illustrations.

I am satisfied that by this means I can materially add to the good effected by these Reports, and I shall endeavor to fill any engagements which the officers of our county agricultural and horticultural societies may desire to make, providing they give me notification a sufficient time beforehand.

In the following pages the same rules are complied with as were laid down in my first Report. When the insects treated of are new, or the existing descriptions of them are imperfect, or in a foreign language, I have added a full description, which is, however, always printed in smaller type, so that it can be skipped by the non-interested reader. The popular name of each insect is accompanied by the scientific name, and the latter is always printed in *italics* and mostly in parenthesis, so that it may be skipped by the practical man without interfering with the text. The Order and Family to which each insect belongs, is also given under each heading. The dimensions are expressed in inches and the fractional parts of an inch, and the sign ♂ wherever used, is an abbreviation for the word "male," the sign ♀ for "female," and ~~the~~ the sign ⚲ for neuter. It must also be recollected that many of the figures are magnified, and that the hair line at the side of such gives the natural size.

The scientific reader will notice that some of the insects are referred to the old instead of the more modern genera, and this course has been pursued because the generic nomenclature is constantly changing, and because the old name has often become thoroughly associated with the insect in the mind of the practical man, who would be confused by, and is not interested in, the nice changes taking place in classification.

All the illustrations in this, as in the previous Reports, have been drawn from life by myself, or under my direct care, unless otherwise stated.

I have secured a pleasant office, connected with that of your Secretary, at Room 29, Insurance Building, Southeast corner of Fifth and Olive streets, St. Louis, and all letters sent to me should be thus addressed.

My acknowledgments are due to the Superintendents of the following railroads, for free passes over their respective routes: The Pacific Railroad of Missouri, Atlantic and Pacific, St. Louis and Iron Mountain, Hannibal and St. Joseph, North Missouri, Chicago and St. Louis, Illinois Central, and the Rockford, Rock Island and St. Louis.

All which is respectfully submitted by

CHARLES V. RILEY,
State Entomologist.

St. Louis, Mo., December 2, 1870.

NOXIOUS INSECTS.

SNOUT-BEETLES.

(Coleoptera Curculionidæ).

AN ACCOUNT OF SOME OF THOSE SPECIES WHICH ARE INJURIOUS TO FRUITS AND VEGETABLES.

In my First Annual Report I gave an account of the common Plum Curculio, which was as complete as our knowledge of the insect would then permit. Since the publication of that Report many new and most important facts, relating to this insect, have been brought to light, and I deem it wise in this review of some of our more injurious snout-beetles, to lay these facts before the reader. Many of them were embodied in an essay read by myself at the Fifteenth Annual Meeting of the Illinois State Horticultural Society, recently held at Galesburg, in that State, and therefore, with some important additions, I reproduce that essay, which embraces the first five insects here treated of.

Insects, like other animals, derive their nourishment from the vegetable and animal kingdoms; but a glance is sufficient to show that they possess a far greater field of operations than all the other animals combined. Indeed, the food of insects is a theme so large that I might occupy page after page by dwelling upon it alone. The other animals use as food but a very small portion of the inexhaustible treasures of the vegetable kingdom, and the remainder is unpalatable or even poisonous to them. Not so with insects, for, from the gigantic *Banyan* which covers acres with its shade, or the majestic Oak, to the invisible fungus, the vegetable creation is one vast banquet, to which they sit down as guests. The larger plant-feeding animals are also generally confined, in their diet, to the leaves, seeds or stalks, being either foliaceous or farinaceous; but insects make every possible part of a plant yield them valuable provender. We have an excellent illustration of this omnipresent character of insects in those species which are well known to attack the common apple tree. Thus, beginning at the root, we find it rendered knotty and unhealthy on the outside by the common Root-louse (*Eriosoma pyri*, Fitch), while the heart is often entirely destroyed by one or the other of two

gigantic Root-borers (*Prionus imbricornis*, Linn, and *P. laticollis*, Drury). The trunk is riddled by the larvæ of several Long-horn beetles, and pre-eminently by the Two-striped Saperda (*Saperda bivittata*, Say), as well as by other smaller beetles; the liber and alburnum are destroyed by the Flat-headed borer (*Chrysobothris femorata*, Fabr.), the outer bark eaten by bark beetles (*Scolytus* family) and sucked by Bark-lice peculiar to it. The branches and twigs are bored along the axis and pruned by the larvæ of the common Pruner (*Elaphidion villosum*, Fabr.), and by that of the Parallel Pruner (*E. parallelum*, Lec.), girdled by the Twig-girdler (*Oncideres cingulatus*, Say*), sawed and rasped by the Periodical Cicadas (*Cicada septemdecim*, Linn, and *C. tredecim*, Riley), otherwise known as Seventeen-year Locusts, by tree-hoppers and a dozen other Homopterous insects; bored into from the side by the Twig-borer (*Bostrichus bicaudatus*, Say), wounded by the bites of such beetles as the New York Weevil (*Ithycerus novæboracensis*, Forster), or pierced as by a red-hot wire by small boring beetles (*Scolytidæ*).

The buds before they expand are infested with the larvæ of the Apple Bud-moth (*Grapholitha oculana*, Harr.), or entirely devoured by voracious cut-worms (*Agrotis scandens*, Riley, etc.). The blossom has no sooner unfolded its delicate and beautiful petals than it is devoured entirely either by the Brazen Blister Beetle (*Lytta ænea*, Say), the Striped Cucumber Beetle (*Diabrotica vittata*, Fabr.), the Rose bug, or by a great many other insects that might be mentioned, some, as the different bees, confining themselves to the pollen or honey from the nectaries, while others again prefer other parts. The young fruit is either eaten partly or entirely by Snapping beetles (*Melanotus communis* and *M. incertus*), or punctured by either the Plum or Apple Curculios, and afterwards bored through and through by their larvæ, or by that ubiquitous Apple Worm (*Carpocapsa pomonella*); as it matures it is eaten into by the larvæ of the Plum Moth † (*Semasia prunivora*, Walsh), rendered putrid by the Apple Maggot (*Trypeta pomonella*, Walsh), and by the Apple Midge (*Molobrus mali*, Fitch); as it ripens it is gouged by the Flower Beetles (*Euryomia inda* and *E. melancholica*), and disfigured by a variety of other insects, while the skin is often gnawed off and corroded by the larvæ of the Rose Leaf-roller (*Loxotænia rosaceana*, Harr.); and even the seed, if it should be preserved, will be attacked by the Grain Sylvanus (*Silvanus surinamensis*, Linn.), the Dwarf Trogosita (*T. nana*, Melsh.) and the larvæ of one or two small moths. And as to the leaves, they are not only sapped and curled by the Apple Plant-louse (*Aphis mali*, Fabr.), and by leaf hoppers; rolled by several leaf-rollers; folded at the edges by a small pale, undescribed worm which I shall soon describe; blistered by the Rosa Hispa (*Uroplata rosa*, Weber);

*I have bred specimens of this insect from apple twigs.

†Inappropriately so called by Mr. Walsh, as I shall presently show.

crumpled by the Leaf Crumpler (*Phycita nebulo*, Walsh), mined by the Apple Micropteryx (*Micropteryx pomivorella*, Pack.); skeletonized and tied together by another undescribed worm, which I shall some day name *Acrobasis Hammondii;* but they are greedily devoured by a whole horde of caterpillars, from the tiny *Micropteryx* to the immense Cecropia worm, some of which confine themselves to the parenchyma, some to the epidermis, some to the tender parts, without touching the veins, while others bodily devour the whole leaf. The sap forms the sole food of some insects, and even when the poor apple tree dies, a host of different insects revel in its dead and decaying parts, and hasten its dissolution, so that it may the more quickly be resolved into the mold from which it had, while living, derived most of its support, and through which it is to give nourishment for the young trees which are to take its place.

Thus we perceive that there is not a single part of the apple tree which is not made to cradle, or to give nourishment to some particular insect, and the same might be said of almost every plant that grows on the face of the earth, even those which produce resinous or gummy substances, or which are pithy in the center, having special insects which feed upon these parts and on nothing else. There are insects— the gall makers, for instance—which, not satisfied with any existing part of the plants, as such, cause abnormal growths, in which their young are reared.

Nor are insects confined to vegetables in their recent state. The block of hickory wood, fifty years after it is made up into wagon wheels, is as palatable to the Banded Borer (*Cerasphorus cinctus*, Drury), which causes "powder-post," as it was to the Painted Borer (*Clytus pictus*, Drury) while green and growing; and a beam of oak, when it has supported the roof of a building for centuries, is as much to the taste of an *Anobium* as the same tree was while growing, to the American Timber Beetle (*Hylexctus Americanus*, Harr.) Some, to use the words of Spence, "would sooner feast on the herbarium of Brunfelsius, than on the greenest herbs that grow," and others, "to whom

> '——— a river and a sea
> Are a dish of tea,
> And a kingdom bread and butter,'

would prefer the geographical treasures of Saxton or Speed, in spite of their ink and alum, to the freshest rind of the flax plant."

Indeed, it would be difficult to mention a substance, whether animal or vegetable, on which insects do not subsist. They revel and grow fat on such innutritious substances as cork, hair, wool and feathers; and "with powers of stomach which the dyspeptic sufferer may envy, will live luxuriously on horn;" they insinuate themselves into the dead carcasses of their own class; they are at home in the hottest and strongest spices, in the foulest filth, in the most putrid carrion; they can live and thrive upon, or within the living bodies of the larger animals, or of those of their own class; they are at home in

the intestial heat of many large animals, reveling in the horse's stomach, in a bath of chyme of 102° Fahr., or in the bowels of man, in an equally high temperature. Some have even been supposed to feed on minerals, and, not to dwell upon Barchewitz's tale of East India ants, which eat iron, certain it is that the larvæ of our May flies (Ephemeræ) do eat earth, and I have known the larvæ of the common May Beetle to feed for three months upon nothing but pure soil; but in both these cases the insects undoubtedly derive nourishment from the vegetable matter which is extracted from the earth by the action of the stomach.

These facts will serve to show that, seek where we may, we cannot find a place or a substance in which or on which, some insect does not feed. They people the atmosphere around us, swim at ease in the water, and penetrate the solid earth beneath our feet; while some of them inhabit indifferently all three of these elements at different epochs of their lives.

Now when we reflect that there are at least half a million—if not a full million—distinct species of insects in this sublunary world of ours, and that their habits and habitations are so diversified, it would really seem as though entomology was a subject too vast for any one man to shoulder; and indeed it is in all conscience extensive enough. The science of entomology is, however, so perfect in itself, and its classification so beautiful and simple that a particular species is referred to its Order, its Family, its Genus, and finally separated from the other species of that genus, with the greatest ease, and with a feeling of true satisfaction and triumph, by those who have mastered the rudiments of the science. And, very fortunately, it is not necessary for the practical fruit-grower to enter into the minutiæ of species or even of genera in order to learn the habits of the insects which interest him in one way or another. These minutiæ must be left to the professed entomologist.

There is not an insect on the face of the globe which cannot be placed in one or the other of seven, or more properly speaking, eight great Orders; so that, unlike the botanist, the entomologist is not bewildered by an innumerable array of these Orders, though he has five times as many species to deal with. These Orders comprise about two hundred families, many of which may, for practical purposes, be grouped into one family—as, for instance, the seven families of Digger-wasps and the five large families which have all the same habits as the true or genuine Ichneumon-flies. Many more may be neglected as small, rare, or unimportant; so that practically there will remain about a hundred family types to be learned. Each family, as Agassiz, has well remarked, may, with a little practice, be distinguished at a glance by its general appearance, just as every child with a little practice, learns to distinguish the family of A's from the family of B's, and these from the family of C's in the alphabet. There is the old English A, the German text A, and a host of orna-

mental A's, both in the capital letter and the small or "lower-case" letter, as the printers call it; but the family likeness runs through all, and it is astonishing how quick a child learns to distinguish each family type. It is true there are a few abnormal or eccentric insects —there were some which deceived even Linnæus—which put on the habit of strange families, just as an eel, which is a true fish with fins, puts on the habit of a snake—a reptile without fins. But these are the exceptions and not the rule.

Now it is wisely ordained that every family, as a general rule, has not only a distinctive family appearance, but also distinct family manners. For example, nobody ever saw an Ichneumon-fly construct a nest and provision it with insects, as does a Digger-wasp; and nobody ever saw a Digger-wasp deposit its eggs in the body of a living insect at large in the woods as an Ichneumon-fly does. But each family maintains its peculiar family habits, and cannot be induced to deviate from them.

So universally is this the case, that if an insect is brought me which I never saw in my life, I will tell half its history at a glance. It is this "Unity of Habits," this beautiful provision of nature—definite family likeness, accompanied by definite family habits—which so simplifies the task of the practical man; for, instead of having to study the diversified habits of half a million species, he has but to acquaint himself with the appearance and characteristics of one hundred families; and if the rudiments of Entomology had been taught in the schools of this country, so that the farmer had become familiar with these hundred family types, he would now be much better able to cope with his insect enemies. When I think that it would take a child no longer to learn these one hundred family types than it does to learn the one hundred different types which compose the four alphabets—the Roman capital and small alphabet and the writing capital and small alphabet—I fully expect, and sincerely hope, that in the public schools of this country we shall soon have text-books introduced which will cover the ground as well, and occupy the same place as do those useful works of Leunis, and Troschel and Ruthe, in the public schools of Germany.

With these few remarks, which are intended to show that the practical man may easily obtain a general knowledge of his insect friends and enemies, notwithstanding the wide field of their operations and the immense number of species which exist, we will now dwell for a while on one of these families, which deeply interest us as fruit-growers, namely:

THE CURCULIONIDÆ OR SNOUT-BEETLES.

This is one of the very largest and most conspicuous families in the Order of Beetles (*Coleoptera*), comprising, as it does, over 10,000 distinct and described species. It is at once distinguished from all the

other families of beetles by the front of the head being produced into a more or less elongated snout or rostrum, at the extremity of which the mouth is situated. This snout is sometimes very long and as fine as a hair (genus *Balaninus*), and sometimes as broad as the head (genus *Brenthus*); but it always forms part and parcel of the head, and does not articulate on it as does the snout or proboscis of the true Bugs (*Hemiptera*), or the tongue of Moths and Butterflies. The other chief characteristics of the family are an apparently four jointed tarsus or foot (though in reality there are more generally five joints), an ovoid form narrowing in front, the sides pressed by the convex elytra or wing-covers, the antennæ or feelers attached to the snout, and either elbowed or straight, and composed of nine, ten, eleven or twelve joints—the first of which is always long, and the terminal three generally united in a club or knob; and finally stout legs with swollen thighs, sometimes bearing spines.

The larvæ of these snout-beetles are whitish or yellowish and fleshy grubs, usually without legs or having only in the place of them fleshy tubercles, which in a measure perform the functions of legs;* the body is oblong, with the back generally arched but sometimes straight. With these characteristics in mind, the farmer cannot fail to recognize a snout-beetle when he sees one. Now there is hardly one of the one hundred families that I have referred to from which so many injurious species can be enumerated, for with the exception of an European species (*Anthribus varius*) whose larva was found by Ratzeburg to destroy bark-lice, they are all vegetarians, the larvæ inhabiting either the roots, stems, leaves or fruits of plants; and the beetles feeding on the same. So whenever you find an insect with the characters just given, you may rest morally certain that it is injurious, and should be destroyed without mercy. This family is not only one of the most injurious, but, on account of the secretive habits of the larvæ, the insects comprising it are the most difficult to control. When a worm is openly and above board denuding our trees, we at least readily become aware of the fact, and can, if we choose, apply the remedy; but when it surreptitiously, and always under cover, gnaws away at the heart of our grains and fruits, we become in a measure helpless to defend ourselves. But even here where the enemy is so well ambushed and hidden, the proper tactics, based on thorough knowledge, will frequently enable us to penetrate the defenses and conquer the foe.

Before leaving this subject of families, let me impress upon the mind another important fact, namely, that the family is not peculiar to any one country, and that while species vary, the family has the same habits and characteristics all over the world. Thus in Europe

*It is generally unqualifiedly stated by authors that Curculionid larvæ are apodous; but there are exceptions to the rule, and I may cite as an example the larva of *Cratoparis lunatus*, Fabr., which I have found in fungi, and have bred to the perfect state, and which has six conspicuous thoracic legs.

we find the snout-beetles as injurious, and as difficult to manage—if not more so—than they are in this country. One species (*Rhynchites conicus*, Herbst.,) deposits eggs in the twigs of Pear, Plum, Cherry and Apricot, and girdles the twig to make it fall; another, (*Rhynchites bacchus*, Schœn.) infests the fruit, and still another (*Anthonomus pyri*, Schœn.) the flower bud of the Pear. One, (*Rhynchites betuleti*, F.,) rolls up grape leaves and partly cuts the stems, so that they perish, while another, (*Anthonomus pomorum*, Schœn.,) infests the blossom bud of the Apple, and renders it unfertile. Still another inhabits the blossom bud of the Cherry. *Balaninus nucum* is found in their common Hazel-nut, and *B. cerasorum* in Cherry pits; *Apion apricans* devours the seed of Clover; *Otiorhynchus sulcatus*, Schœn., infests the crown of strawberries and two different species (*Baris chlorizans*, Schœn., and *Ceutorhynchus napi*, Schœn.,) infest the stems of cabbages and turnips.

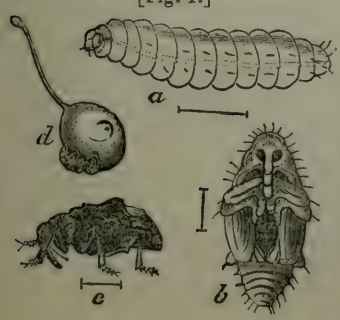
But after all, a single species—the "little Turk," for instance—sometimes causes more loss of fruit in this country than all the above enumerated species do to the European cultivator, and though much of this comparative incapacity for harm, on the part of their insects, may be in a measure due to the better knowledge of his foes which the transatlantic cultivator possesses; to the more careful culture which he pursues, and the usually limited extent of his orchard, compared with ours; yet it greatly depends on other causes, which it is not necessary now to dwell upon. So I will at once proceed to say a few words about those of our own Snout-beetles, which more particularly interest us.

THE COMMON PLUM CURCULIO—*Conotrachelus nenuphar*, Herbst.

IT IS SINGLE BROODED, AND HIBERNATES AS A BEETLE.

I shall not here repeat what has already been published about this insect; but shall confine my remarks principally to the unsettled and mooted points in its natural history, and to the new discoveries that have been made since the appearance of my first Report. I am glad to be able to say that I have forever settled the principal question, namely, as to its being single or double brooded. Authors have, from the beginning, held different views on this subject, and this fact should not surprise us, when we bear in mind that

[Fig. 1.]



they reasoned simply from conjecture; nor will it surprise us when we understand the facts in the case. The facts that fresh and soft Curculios are found in this latitude as early as the last of June, and that they still come out of the ground in August, or as late as September, and even October in more northerly latitudes, are well calculated to mislead; while it was difficult to imagine an insect living ten months before ovipositing, without dwindling away through the action of its enemies. But in the beetle state, the Curculio has few, if any enemies, and in my former writings on this subject, I have shown that the other facts do not in the least prove the insect to be double-brooded. Among those whose opinions commanded respect, from their profound entomological knowledge and general accuracy, was Mr. Walsh, who, during his last years, strenuously contended that this insect was double-brooded. For several years I have entertained a different opinion, believing that it was single brooded, as a rule, and only exceptionally double-brooded; and the facts so fully bear me out in this opinion, that were my late associate living to-day, I should bring forth the testimony with a feeling of triumph, for he was not often in the wrong! It is worthy of remark, however, that Mr. Walsh's first impression, as given by him in the year 1867*, was that this insect is single brooded; his first opinion thus coinciding with what I have now proved to be the facts in the case. In my first Report I have reviewed the experiments which led him to change his opinion, and have shown that they did not warrant his final conclusion.

The many words that have been penned in the discussion of this question would fill a volume; but one stern fact, one thorough experiment, is worth more than all the theories that were ever conceived, or the phrases that were ever written on the subject. At first it seems to be a very simple question to settle, but the fact that it remained unsettled so long would indicate the reverse. Judge A. M. Brown of Villa Ridge, at my suggestion, endeavored in the summer of 1869 to solve the problem by imprisoning the first bred beetles and furnishing them with plucked fruit. Dr. Hull partially performed a like experiment, and I did the same myself; but we were met by the advocates of the two-brooded theory with the objection that such a test was of no value, as the Curculio would not deposit on plucked fruit or in confinement; and to add weight to their argument they could cite us to numerous instances among butterflies to prove that many insects really will not deposit in confinement. But, as we shall see, they placed too much confidence in the instinct of Mrs. Turk when, from such premises, they made these deductions apply to her.

As I proved over and over again, the question could not be solved with any more certainty, by confining beetles to living boughs containing fruit, as the boughs could not well be covered with any sub-

* Practical Entomologist, Vol. II., No. 7.

stance through which the beetles would not gnaw their way out. So I determined last spring to build a frame over a large tree and entirely enclose it in stout gauze, that would neither let a flea in or out, much less a Curculio. Having accomplished this before the blossoms had fallen off the tree, I awaited with pleasurable interest the result from day to day, from week to week, and from month to month; engaging a competent person to watch, when, from necessity, I was obliged to be away. It were worse than waste of time to detail here the many interesting observations made on this tree which I had under control, or to enumerate the many other experiments which I conducted in other ways, or the innumerable facts obtained; and it will suffice to give in a summary manner the results—premising only that every precaution was taken, and no expense spared, to prevent failure; that the experiments were satisfactory beyond my expectations, the results conclusive beyond all peradventure, and that I can prove every statement I make. To sum up then:—*The Plum Curculio is single-brooded*, and I have a number now alive *which were bred during the latter part of June from the first stung peaches.* (At the time the printer is ready for this Report the beetles are still alive and flourishing—February 24th, 1871.) But, as there seem to be exceptions to all rules, so there are to this; yet the exceptions are only just about sufficient to prove the rule, for as far south as St. Louis not more than one per cent. of the beetles lay any eggs at all, until they have lived through one winter; or in other words, where one female will pair and deposit a few eggs the same summer she was bred, ninety-nine will live on for nearly ten months and not deposit till the following spring. In more northern latitudes I doubt if any exceptions to the rule will be found.

As to the other mooted point, namely, whether this insect ever hibernates under ground in the larva state, I am perfectly satisfied that it never does, but that it passes the winter invariably as a beetle, under all sorts of shelter in the woods; generally, however, near the surface of the ground. Indeed, it often makes for itself a hole in the ground, seldom however deep enough to more than barely cover its own body. In short, there is very little to alter or modify in the established facts in its natural history, which I have already published. The egg, instead of being "oval," as there stated, would be better described as "oblong-oval," measuring exactly 0.03 inch in length, and being nearly three times as long as wide. It should also be remarked here, that when depositing the eggs in apples, the female often neglects the usual symbol of Mohammedanism, which she so invariably inscribes upon stone fruit; and that where this mark is made on apples, it more easily becomes obliterated.

During their beetle life, these insects feed continually, just as long as the weather is mild enough to make them active. While fruit lasts, they gouge holes in it, and after peaches have gone, apples are

badly attacked. They also gnaw large holes in the leaves, and when nothing else presents, will feed on the bark of the tender twigs.

The beetles often make a peculiar creaking noise (a fact not mentioned before of this species) by rubbing the tip of the abdomen up and down against the wing-covers.*

Let us be thankful, therefore, that there can no longer reasonably be difference of opinion, or discussion on these questions, which, though of no very great practical importance, were yet of great interest to us all.

IT IS NOCTUNRAL RATHER THAN DIURNAL.

Before leaving this little Turk, however, I have some other facts to mention which were first brought to light the present year, and which have a most important practical bearing. The people of the West have been repeatedly told, and with so much assurance that they no doubt have all come to believe it as gospel, that Curculios fly only during the heat of the day, and that it is useless to endeavor to catch them after say 10 o'clock in the morning. What I am about to utter will no doubt astonish many, but I know whereof I speak. *The Curculio is a nocturnal rather than a diurnal insect; is far more active at night than at day, and flies readily at night into the bargain.* If any one doubts this assertion, let him go into his peach or plum orchard at midnight with a lantern and sheet, and he will catch more than he could during the day, and will also find, to his sorrow, that they are then much more nimble and much bolder—

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*A great many different beetles belonging to widely different families have the power of making a stridulating creaking noise, and though the instrument is found upon different parts of the body in different species, yet it is always made after one plan, namely, a file-like rasp and a scraper. In Darwin's new book (Descent of Man, pp. 366–73) an interesting account of the different methods employed will be found. Every entomologist knows how commonly this creaking noise occurs in the Long-horn beetles, and that the rasp is situated on the mesothorax and is rubbed against the prothorax. In the Burying beetles (NECROPHORIDÆ) these rasps are situated on the fifth abdominal joint, and are scraped by the posterior margin of the elytra. In the Dung-beetles again it is variously situated upon different portions of the body. Dr. Fitch (10th Ann. Rep. p. 12) has noticed the creaking noise made by the Three-lined Leaf-beetle (*Lema trilineata*) which is produced by the same motions as those witnessed in our Curculio; but in this instance, as in all other stridulating Chrysomelidæ, the rasp is situated on the dorsal apex of the abdomen known as the pygidium, and is scraped by the wing-covers; while in the closely allied Curculionidæ which have this power the parts are completely reversed in position. Any one who will take the trouble to carefully examine the wing-covers of our Plum Curculio will find on the lower apical edge of each, a horny, slightly raised plate, about a third as long as the whole wing-cover, and transversely and obliquely ribbed by numerous parallel ridges. There is also a longer cord or carina near the sutural edge which may help to intensify the noise. The dorsal apex of the abdomen or pygidium forms a yellowish and roughened plate, with the sides horny and emarginate, so that when the abdomen plays up and down, these horny edges grate or scrape at right angles against the rasp.

In some instances the stridulation is possessed principally by one sex and serves no doubt as a sexual call; but with our Curculio as with most other stridulating beetles, both sexes seem to share alike in the power, and it then no doubt serves as a mutual call, or is used under the influence of distress, fear, or even pleasure; for I have always more particularly noticed the noise of an evening when the Curculios were most active and preparing for their active night work.

scarcely feigning death at all. Indeed, with the exception of such females as are busily occupied in depositing eggs, most of the Curculios rest during the day, sheltered either by the foliage or branches of the tree, or by any extraneous substance on the ground near by. They are also more active in the evening than in the morning, and these facts lead us to the important question, whether the morning or the evening is the best time to jar the trees. My experiments so far are not conclusive, for I have some days caught more in the morning, and at others more in the evening. All other things being equal, the evening will prove preferable to the morning, from there being less dew at that time; and I particularly draw attention to this matter now, that the proper experiments may be instituted during the coming year by more than one individual.

THE RANSOM CHIP-TRAP PROCESS.

Another grand and successful mode of fighting the little Turk was also brought to light again, and to a great extent practiced the past summer. I allude to the Ransom chip process for entrapping this insect. About the middle of May the Horticultural world was startled by a somewhat sensational article, which was the burden of an extra to the St. Joseph (Michigan) *Herald*, headed:—"Great Discovery—Curculio Extermination Possible." The process consists in laying close around the butt of the tree pieces of chips or bark, under which, according to their instinct, a great many of the Curculios secrete themselves during the day, and may thus be easily destroyed. Now that we better understand this insect's habits, we also better comprehend the philosophy of this process. Being noctural in their habits, the beetles naturally seek shelter during the day, and especially is this the case early in the season, when the days are chilly, and before the females are too much engaged in egg depositing. Numerous opinions were expressed as to the value and efficiency of this method; but I will here repeat my own, as given to the readers of the *American Entomologist and Botanist;* first, because I endeavored to be candid and truthful, and secondly, because the opinions expressed have been so far fully corroborated by subsequent experience. Let it be distinctly understood that in recording what I believe to be the facts in the case, I have no wish to detract one particle from the credit due Mr. Ransom, for bringing this method prominently before the people, and demonstrating its practical applicability; for to him undoubtedly belongs the honor of the re-discovery and of the proper application of the method:

"We are really sorry to damp the ardor and enthusiasm of any person or persons, when enlisted in such a good cause, but truth obliges us to do so, nevertheless. Of course Curculio extermination is possible! but not by the above method alone, as our Michigan friends will find to their sorrow. For a short time, early in the season, when the days are sometimes warm and the nights cold, and before the

peach blossoms have withered away, we have succeeded in capturing Curculios under chips of wood and in other such sheltered situations; but we have never been able to do so after the fruit was as large as a hazlenut, and the little Turk had got fairly to work. Our Michigan friends will, we fear, find this to be too truly the case.

"This process, furthermore, cannot well be called a new discovery, because it was discovered several years ago, as the following item from Moore's *Rural New Yorker* of January 28th, 1865, will show:

"How to catch Curculio.—In May last we had occasion to use some lumber. It was laid down in the vicinity of the plum yard, and on taking up a piece of it one cold morning, we discovered a number of curculios huddled together on the under side. On examining other boards we found more, so we spread it out to see if we could catch more, and we continued to find more or less every day, for two weeks. We caught in all one hundred and sixty-one. So I think if people would take a little pains they might destroy a great many such pests. These were caught before the plum trees were in flower. What is most singular is, that we never found a curculio on a piece of old lumber, although we put several pieces down to try them. They seemed to come out of the ground, as we could find them several times a day by turning over the boards.

Johnsonville, New York. Mrs. H. Wier.

"But though Mr. Ransom cannot properly claim to have made a new discovery, and although this mode of fighting will not prove sufficient to *exterminate* the Curculio, yet we greatly admire the earnestness and perseverance which he has exhibited. In demonstrating that so great a number of the little pests can be entrapped in the manner described, Mr. R. has laid the fruit growers of the country under lasting obligations to him. It is a grand movement towards the defeat of the foe, and one which, from its simplicity, should be universally adopted early in the season. But we must not relinquish the other methods of jarring during the summer, and of destroying the fallen fruit; for we repeat that the Plum Curculio will breed in the forest."

I subsequently visited St. Joseph, for the express purpose of examining more closely into Mr. Ransom's Curculio remedy. I found that so few Curculios had been caught under the chips after the first week in June, that nearly everybody, except Mr. Ransom, had for some time abandoned the method, and were jarring their trees by one process or another. Mr. Ransom himself, by dint of unusual perseverance and great care in setting his traps, had much better success than I had expected he would. On the 15th June he caught 78; on the 16th, 97; and on the 17th, 71. For about a week after this he scarcely caught any, but from the 24th to the 27th inclusive, he caught about 300. On the 6th of July I accompanied him around the outside rows of his orchard and caught five under the traps. We had no opportunity to use the sheet, but I am satisfied that more could have been jarred down. Mr. R. had a very fair crop of peaches, and—forgetting that crops have often been grown before with very little care, and that others around him who did not bug so persistently had fruit also this year—is very sanguine of his new method, and too much inclined, perhaps, to attribute his crop solely to this remedy. Nevertheless, contrary to the impression made by his published views, he was candid enough to admit that it might be found necessary to resort to the jarring process, after a certain season of the year; and indeed the number of stung peaches on the ground showed too plainly that there is no hope of *extermination* by the chip plan alone. The soil around St. Joseph is, for the most part, a light sandy loam, never

packing, and very easily kept in good cultivation. To this character of the soil must be attributed much of the success with the Ransom method; for I am satisfied, after full experiment, that in the warmer climate and heavier soil of St. Louis, it is of no practical use after the middle of May, or at the farthest, after the first of June. The few specimens that I have captured by this method at St. Louis were found under small pieces of new shingle; and Mr. W. T. Durry, who has 2,300 trees in his orchard at St. Joseph, also found this the best kind of trap. Mr. Ransom, however, prefers small pieces of oak bark, which he places close around the tree, with the inner or concave side pressed to the ground. Stones do not answer well, and corn cobs are objectionable because it requires so much time to discover and destroy the Curculios, which hide in their deep cavities.

The best time of day to take the Curculios from under the chips is undoubtedly in the afternoon; but it must not be left too long, as they begin to leave and scatter over the trees as soon as the sun approaches the horizon. The chips should be laid around the trees as soon as the frost is out of the ground, or at least by the time the blossoms begin to expand; for more beetles will be caught under them during a few weeks thus early in the season than throughout the rest of the year.

Before concluding this branch of the subject, I earnestly urge upon fruit-growers throughout the State to give this process a good trial during the coming season, and to report the results to me. The observations of a hundred persons in as many different parts of the State must necessarily be of more value than those of a single individual in any one locality; and as the process was not prominently brought before the public last year, until it was too late to make thorough experiments, it is very desirable to have the true value of the method in Missouri definitely ascertained in 1871. To arrive at such definite knowledge of its value, I need the co-operation of intelligent fruit-growers, and for this reason I hope that notes and experiments will be made and sent to me at my office, any time during the summer. The number of trees experimented on, number of beetles captured, time of year, hour of day, character of soil, and all other facts connected with the experiments should be noted; as they all help us to a more thorough knowledge of the true value of the process

KEEPING IT IN CHECK BY THE OFFER OF PREMIUMS.

After visiting St. Joseph and vicinity, I passed into Ontario, where I found the trees overloaded with fine unblemished fruit. I found my friend, Mr. Wm. Saunders, of London, also much occupied with, and interested in, the Curculio question. He was, in fact, carefully counting different lots of this insect which had been received from different parts of the Dominion; for be it known, that the enterprising Fruit-Growers' Association of Ontario, in its praiseworthy efforts to check the increase of the Curculio, offered *a cent per head* for every one

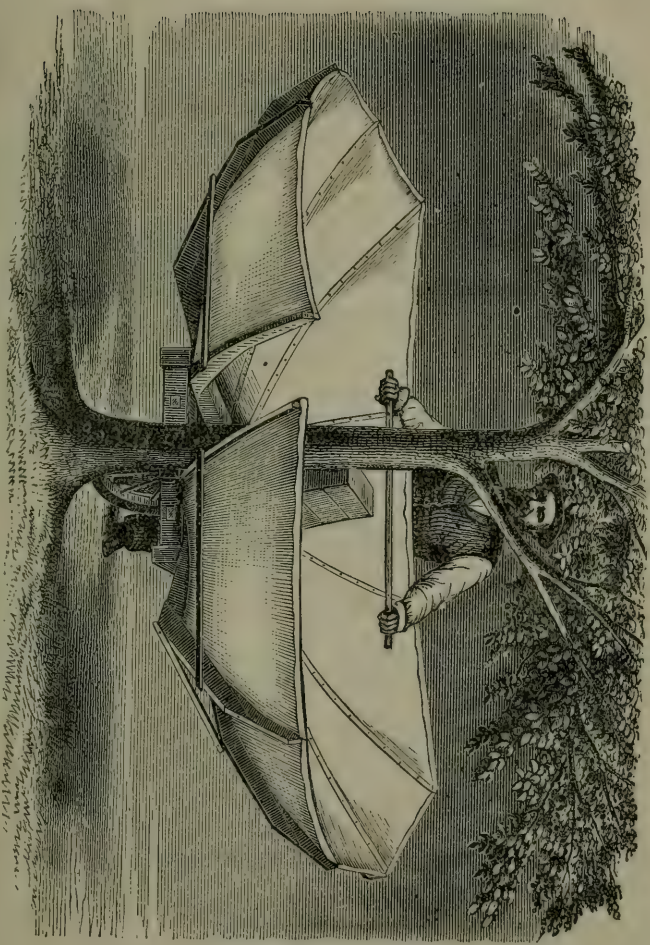
which should be sent to our friend, who happens to be secretary of that body. What would our own people think if the Legislature or the State Horticultural Society should offer an equally liberal premium *per capita* for every little Turk captured? Wouldn't they set about capturing them in earnest, though! The Legislature might stand it, and I am not sure but that some such inducement, held out by the State to its fruit-growing citizens, would pay, and prove the most effective way of subduing the enemy. But the Horticultural Society that should undertake it, would have to be pretty liberally endowed. Just think of it; ye who catch from three to five thousand per day. The bugs would pay a good deal better than the peaches. However, very fortunately for the Ontario Fruit-Growers' Association, their good offer did not get noised abroad as much as it might have been, and the little Turk occurs there in such comparatively small numbers, that up to the time I left only 10,731 had been received.

PARIS GREEN AS A REMEDY.

Mr. G. M. Smith, of Berlin, Wisconsin, in an article written last fall to the St. Joseph (Mich.) Horticultural Society, recommends Paris Green for the Plum Curculio. Even if the uniform application of such a poisonous drug on large trees were practicable, it would never succeed in killing one Curculio in a hundred. Paris Green kills the leaf-eating beetles by being taken internally with the leaves; but the Curculio, with its snout, prefers to gouge under the skin of the fruit, and only exceptionally devours the leaves. Yet, notwithstanding the palpable absurdity of the remedy, it has very generally passed from one journal to another without comment.

JARRING BY MACHINERY.

Of course there is no more expeditious way of jarring down the Curculio than by the Hull Curculio-catcher (Fig. 2.) Yet I confess that after extensive observations in many different parts of the country I am forced to the conclusion that this machine does not give the satisfaction one could wish. I have already shown that where it was constantly used the trees suffered serious injury from bruising, and it is a rather significant fact that in most orchards where it has been introduced, some modification has soon followed, or else it has been entirely abandoned; while in the East they still adhere to the improved stretchers and mallet. It seems to me that the machine, as made by Dr. Hull, two years ago, was not only too heavy and unwieldy, but incapable of giving the requisite sharp jarring rap to the branches of a large tree without causing too much injury to the trunk; and that if a modification of it could be made to satisfy the peach-grower, there would soon be a greater demand for such a machine.

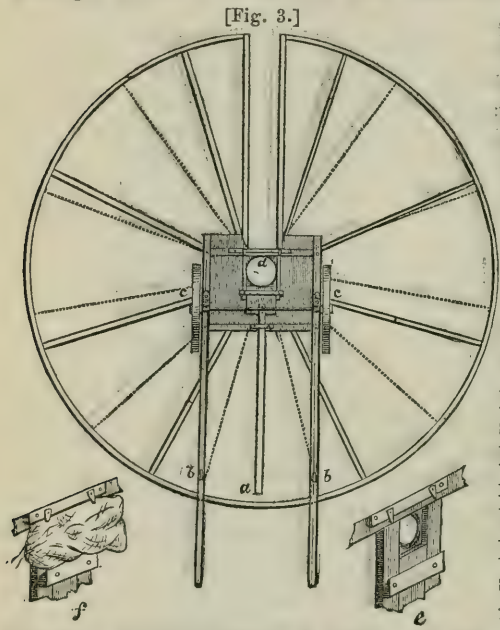


[Fig. 2.]

[A full description of this machine, without any figure, was given in my first Report, pp. 60-61.]

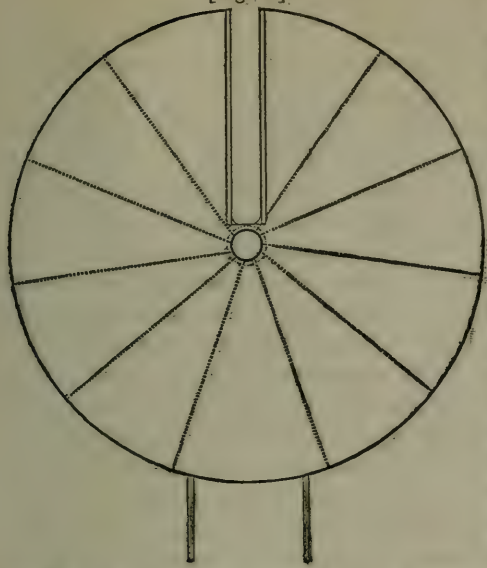
As a step in the right direction I will briefly describe a machine which I have herewith illustrated, (Fig. 3, back view; Fig. 4, front view), and which I found in quite general use around St. Joseph and Benton Harbor, Michigan. It was gotten up by Mr. L. M. Ward of the latter place, and proves, in the orchard, to have decided advantages over the Hull machine, of which it is a modification. It is a much lighter machine, and, as the diagrams indicate, instead of running on a single wheel it is carried and balanced by two, (Fig. 3, *c c*) and supported with legs on the handles, (Fig. 3, *b b*), when not running. The Curculios and stung fruit are brushed through a hole in the centre (Fig. 3, *d*), and as the operator passes from one tree to another he closes this hole, to prevent the beetles from escaping, by means of a slide, (Fig. 3, *a*), which he has under control. Bags previously prepared, by being fastened on a square piece of wood with a hole in the centre corresponding to a hole in the side of the bag, are snugly buttoned below (Fig. 3, *e* and *f*), so as to secure everything that falls through from above, and when one bag is full it is easily replaced by another, and its contents destroyed by scalding, or otherwise, and emptied out. In most of the orchards where this machine was being used, the jarring was performed by a separate mallet, which is easily hung, as is also the brush, on the shafts when the machine is being operated by one person, or, which I think a better way, where help is not scarce, it can, with the brush, be carried by a second person (an intelligent boy will answer,) who performs the jarring and brushing while the first person wheels the machine.

[Fig. 3.]



The machine is simple in construction, and any one with ordinary mechanical ability can build it—modifying, of course, the diameter of the wheels and the inclination of the sheet to suit the character of his trees or of his ground. Mr. Ward has taken no patent out for it, and the machine is, therefore, public property. The platform may be made narrower than shown in the illustration, for the nearer the wheels approach and the lighter the machine, the better. It has been argued in favor of the one-wheel machine, that it can be more easily

[Fig. 4.]



run on rough ground and more readily turned, which, in a great measure, is true; but the Ward machine might be so made that it could easily be tilted on one wheel in turning, and our Benton Harbor friends have so far found no difficulty in operating it. The two wheels have the additional advantage that the machine is not rendered unwieldy by strong wind. It also stands firm when left by the operator, who is thereby better enabled to use a mallet if he prefers it, the mallet being hung to the shafts, and taken down after the machine is wheeled into position. Either machine can be used with a bumper, or with a mallet, and there are certain rules which should be adopted in jarring for the Curculio, no matter whether a one-wheel or a two-wheel machine is used. These rules are: First. In jarring with a mallet, it is best to prepare each tree by squarely sawing off some particular limb, or else the mallet must be well protected with rubber to prevent bruising of the tender bark. The former custom is by far the best, as we are enabled to give the tree a sharp, vibrating rap with the bare, hard wood. Secondly. If the mallet is dispensed with, and the tree is bumped with the machine—a method which certainly has the advantage of expedition—it will be found altogether more profitable to drive a shouldered spike or to insert a shouldered screw in the trunk at the right distance from the ground, and the jarring can then always be done on this spike without injury to the tree.

If the trees are headed high enough to admit of a sufficient inclination of the canvas, the beetles will naturally roll to the centre and fall into whatever receptacle there may be for them below; but such an inclination is not often practicable, and the brush or broom is almost always needed.

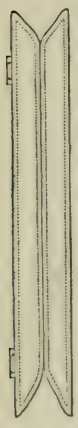
The orchardist must also be guided in his choice of machines by the character of his land, for the two-wheel machine doubtless owes much of its success around St. Joseph, Michigan, to the smoothness of their land. No machine will work well on rough, cloddy soil.

There are various improvements that might be made in the above machine by any ingenious person, and at my suggestion Mr. J. E. Porter of the Eagle Agricultural Works, Ottawa, Illinois, has commenced building these two-wheel machines with adjustable arms. The canvas also is to be so made that it can be fastened on and taken

off again so that the whole may be more compactly packed for shipping, and for storing away out of the wet. Exclusive of the canvas, the whole can be made ready for shipment for from $16,00 to $18,00, and the machine will no doubt be advertised the coming season.

It is gratifying to know also that the inventive genius of some of our Western men is being applied to the improvement of this implement. Thus Messrs. Claxton & Stevens of the Insane Asylum, St. Louis county, have just applied for a patent on a one-wheel machine, the principle feature of which is a bumper which works with a spring. I have seen the model, but am not favorably impressed with the machine as one having any great practical value. The spring bumper is an expensive and unnecessary addition, and in other respects the machine is inferior in utility to that I have just described. One good feature, however, is an arrangement for closing up the tree-way where the bumper touches the tree. It consists simply of two long strips of sheeting fastened to a light frame, each one of which is so attached to the sides of the tree-way that when dropped they form a roof as at Figure 5. The tree easily separates these two pieces when the machine is worked. The frame of this machine is quite flat with an upturned rim, but each half-circle is so arranged that it can be raised on hinges.

[Fig. 5.]

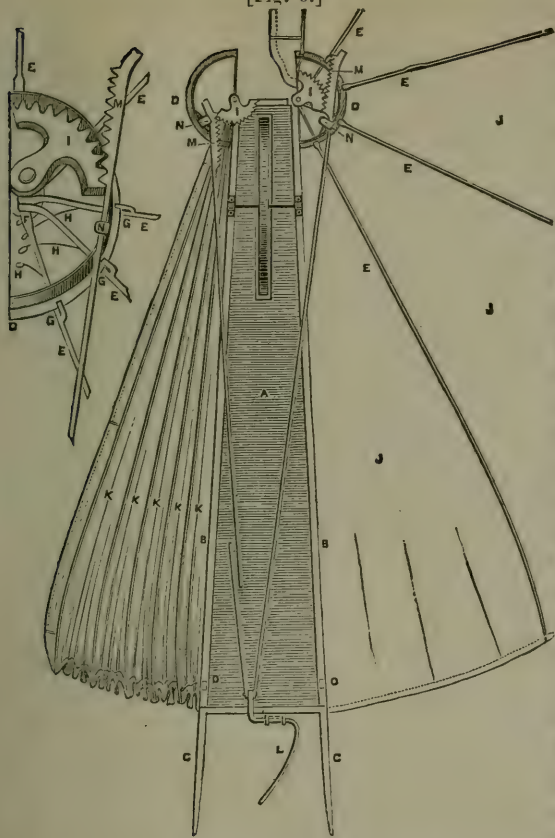


Dr. M. M. Hooten, of Centralia, Illinois, patented last summer a machine made very much after Dr. Hull's plan, but he has since made several improvements and changes and has made application for another patent for the improved machine which I herewith illustrate from a model with which he has kindly furnished me.

He first constructs a long narrow wheel-barrow with a level and smooth platform (Fig. 6, *a*,) made of ½ inch pine or other light material, firmly nailed down to two arms (*b*, *b*,) and covering them from the front end to within twenty inches of the rear end. These rear ends serve for handles (*c*, *c*). The anterior ends, at a point one foot from the extremity, rest upon the axles of the wheel, which is two feet in diameter. He then attaches a half circle (*d*, *d*) to each outer side of the forward ends of the arms of the platform. These half circles are ten inches in diameter, and are so placed as to be about two-thirds of their width in advance of the platform, which at the forward end is from ten to twelve inches wide. Thus enough room is left for the tree to be admitted between the flat sides of the half circles.

There are now to be five or six movable arms (*e*, *e*) placed on each side of these iron half circles, and a single half-inch bolt (*f*) passed through a hole in the inner ends of them, and through the straight bar next to the tree-way. The arms are now permitted to rest on the half circles, and are held down to the circle by a hook

[Fig. 6.]



which is attached to the lower side of the arm and curves over the outside of, and under, the circle (*g*, *g*).

These movable arms are now arranged at equal distances on the circles, and fastened with twine, while the canvas is being tacked on, beginning first by tacking it to the sides of the platform of the barrow and then to the arms. At the inner end of each of these movable arms is a raised finger (*h*, *h*), which holds the canvas up so as to keep any insects from being thrown over into the tree-way. A semi-circular cog-wheel (*i*, *i*), which works by its centre, is now placed on the lower end of the same bolt that passes through the inner ends of the movable arms. The forward arm on each side is firmly attached to this cog-wheel, which works under the canvas. When made to revolve backwards or forwards on the bolt, this cog-wheel carries the outside arm around on the iron half circle, and the sheet-covered frame is thus easily stretched and opened, as at *j*, *j*, or closed as at *k*, *k*.

This motion is quickly accomplished by means of a lever (*l*), which works on a hinge at the rear of the platform, and which moves a rod armed on one side at the forward end with cogs (*m*, *m*), which tread in the cogs of the semi-circular cog-wheel before described, to which it is held by a keeper (*n*). The handle of the lever lies on the platform when the machine is folded, and stands upright when it is extended; so that by a single motion of one hand of the operator, the machine may be folded into a very small compass, or as quickly extended. The hinder part of the machine is supported by two swinging legs (*o*, *o*). These may swing back to the handles, but cannot go forward beyond a right angle. The machine is very light, and works so easily that, according to the inventor, a boy of fourteen years can

easily run one of them. The whole machine does not weigh over forty pounds.

The above figure represents a back view of the machine, with one side open and the other closed. The principle advantage of the machine lies in this folding apparatus, which enables the operator to defy the wind which on some days renders the original Hull machine almost useless as it plays powerfully against the stretched canvas. This feature also enables the owner to store the machine away with less trouble. I have my doubts, however, whether the advantage gained sufficiently compensates for the extra machinery. Another advantage which Mr. Hooton claims for the machine is that it is so low that it will swing its broad folds under low-headed trees. That portion of the wheel which rises above the platform is protected by a circular box, and it is found that every time the canvass is expanded, there is a slight jerk, which casts everything that has fallen upon it to the centre, where the bugs and fruit consequently remain until removed. The raised fingers to which the canvas is attached at the centre, and similarly raised pieces along each side of the tree-way, prevent the insects and fallen fruit from escaping; and there is no receptacle below into which they can be brushed. The machine is therefore built with the idea that it is as easy to pick up and remove the fallen beetles and fruit as it is to brush them into a receptacle below.

In operating the machine it is wheeled up to the tree while closed, then expanded and drawn back a little so as to give the tree a jar, and then closed and wheeled away to the next tree. Mr. Hooton has had a full sized machine in operation, and it seems to give very good satisfaction. As there is considerable casting needed, the ordinary fruit-grower will not be able to manufacture it as easily as he can the Ward machine; but as all these machines will doubtless be put upon the market the coming season, the reader must choose for himself which he prefers.

I have been urged to take an interest in two of these machines, and even to take out a patent for certain improvements suggested; but as a public officer I have refused to do either. My object is to give a disinterested and candid account of what I conceive to be the merits or demerits of any machine that may appear, in the hope that ere long we shall have something in the market, so cheap and efficient that no peach-grower will have any excuse for not jarring his trees.

TWO TRUE PARASITES OF THE PLUM CURCULIO.

THE SIGALPHUS CURCULIO PARASITE.

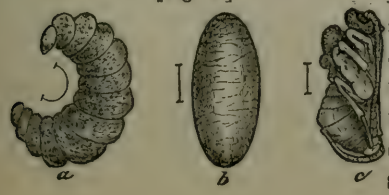
Just 10 years ago, in his "Address on the Curculio," delivered at the annual meeting of the N. Y. State Agricultural Society, Dr. Fitch gave an account, accompanied with a figure, of a small Ichneumon-

fly which he named *Sigalphus curculionis*, and which he believed was parasitic on the Curculio. Before that time no parasite had ever been known to attack this pestilent little weevil, and even up to the present time it is currently believed that no such parasite exists; for unfortunately the evidence given by Dr. Fitch was not sufficient to satisfy some of our most eminent entomologists. These parasites were in fact received by him from Mr. D. W. Beadle of St. Catherines, C. W., who had bred them from Black-knot, from which he bred at the same time a certain number of Curculios; but as other worms besides those of the Curculio are likewise found in Black-knot, we had no absolute proof that this fly was parasitic on the insect in question. Consequently we find that Mr. Walsh, in his Report as Acting State Entomologist of Illinois, rather ridicules the idea of its being a Curculio parasite and endeavors to prove that it is parasitic instead on the larva of his Plum Moth (*Semasia prunivora*). But I have this year not only proved that poor Walsh was himself wrong in this particular inference, but that he was equally wrong in supposing his little Plum-moth, so called, to be confined to plums; for I have bred it from Galls (*Quercus frondosa*, Bassett); from haws, from crab apples and abundantly from tame apples.

[Fig. 7.]

To be brief, Dr. Fitch's *Sigalphus* is a true parasite on the Plum Curculio and I have bred hundreds of the flies from Curculio larvæ. The first bred specimens gave me much pleasure, for as soon as I saw they belonged to the same genus as Dr. Fitch's fly, I felt assured that another disputed question was settled. But to make assurance doubly sure, I repeatedly half filled large jars with pure earth, finely sifted so that no living animal remained in it. Into these jars I placed Curculio larvæ from day to day as they issued from peaches that were thrown into another vessel, and in due time the parasitic flies began to issue from the ground along with the perfect Curculios. Nay more than this, I soon learned to distinguish such Curculio larvæ as were parasitised, and after they had worried themselves under the ground—seldom more than half an inch—I would uncover them, and on several occasions had the satisfaction of watching the gnawing worm within reduce its victim until finely nothing was left of him.

[Fig. 8.]



As soon as the Curculio larva is destroyed by the parasite, the latter (Fig. 8, *a*) encloses itself in a tough little yellowish cocoon of silk (Fig. 8, *b*), then gradually assumes the pupa state (Fig. 8, *c*) and at the end of about the same length of time that the Curculio

requires to undergo *its* transformations and issue as a beetle, this, its deadly foe, gnaws a hole through its cocoon and issues to the light of day as a black four-winged fly (Fig. 7, *a male ; b female*). In the vicinity of St. Louis, this fly was so common the past season that after very careful estimates, I am satisfied three-fourths of all the more early developed Curculio larvæ were destroyed by it. On the 17th and 18th of April, in that locality a severe frost killed the peach buds on all but a few of the young and most vigorous trees of Hale's Early and Crawford, so that instead of a large and abundant crop of peaches to depredate on, the little Turk had to concentrate its attacks on the few peaches that were left; and no one expected that any fruit would be saved. Yet the work of this little parasite was so effectual that, wherever fruit set, a fair crop was gathered even by those who made no effort at all to protect their trees!

While visiting Dr. Fitch last August, at his house in Salem, N. Y., I compared my bred specimens with his species, and found them identically the same; but a full description of it will be found below, and it is not necessary at present to dwell upon its characters.

As Mr. Walsh bred this same parasite from the larvæ of his little Plum Moth, it doubtless attacks other soft-bodied larvæ and does not confine itself to the Plum Curculio. This is the more likely as it would scarcely pass the winter in the fly state. The female, with that wonderful instinct which is exhibited in such a surpassing degree in the insect world, knows as well as we great Lords of Creation what the little crescent mark upon a peach or plum indicates; and can doubtless tell with more surity, though she never received a lesson from her parents, whether or not a Curculo larva is drilling its way through the fruit. When she has once ascertained the presence of such a larva by aid of her antennæ—which she deftly applies to different parts of the fruit, and which doubtless possess some occult and delicate sense of perception, which, with our comparatively dull senses, we are unable to comprehend—then she pierces the fruit, and with unerring precision, deposits a single egg in her victim, by means of her ovipositor.

Now there is, as I shall show in the description, a variety (*rufus*) of this parasite, with the ovipositor nearly one-fifth of an inch long, but in the normal form the ovipositor is only twelve-hundredths of an inch long, and the Curculio larva must therefore be reached soon after it hatches, or while yet very young. Consequently we find that the earliest Curculio larvæ, or those which hatch while the fruit is yet small, are the most subject to be parasitised, and while from larva obtained early in the season, I bred more parasites than Curculios, this order of things was reversed a little later in the year. Some persons will no doubt wonder how such a large fly can be developed from a Curculio larva which is stung while so young; but we do not know how long the parasitic egg remains unhatched, and it must be re-

membered that it is a rule, wisely ordained and long known to exist in insect life, that the parasitic larva does not at first kill outright, but subsists, without retarding growth, upon the fatty portions of its victim, until its own growth is attained. Thus the first worm derives its nourishment from the juicy fruit, and grows on regardless of the parasite which is consuming its adipose substance, until the latter is sufficiently developed, and the appointed time arrives for it to destroy its prey by attacking those parts more vital.

This parasite, which I will now proceed to describe, belongs to the second sub-family (*Braconides*) of the Ichneumon-flies (*Ichneumonidæ*), and the venation of its wings, and 3-jointed abdomen, place it in the genus *Sigalphus*. Westwood (Synopsis, p. 63) gives three cubital panes or areolets in the front wings as characteristic of the genus; but Brullé (p. 510) and, as Mr. Cresson informs me, Westmael in his *Braconides de Belgique*, give only two, which is the number in our insect.

SIGALPHUS CURCULIONIS, Fitch—*Imago*—(Fig. 7, *a* male; *b* female). *Head* black, sub-polished and sparsely covered on the face with short whitish hairs; ocelli touching each other; labrum and jaws brown; palpi pale yellow; antennæ (Fig. 7, *c*) 27-jointed, filiform, reaching, when turned back, to middle joint of abdomen or beyond, the bulbus and small second joint rufous and glabrous, the rest black or dark brown, though 3–10 in many specimens are more or less tinged with rufous; 3–14 very gradually diminishing in size; 14–27 sub-equal. *Thorax* black, polished, the metathorax distinctly and broadly punctate, and the rest more or less distinctly punctate or rugose, with the sides sparsely pubescent. *Abdomen* pitchy-black, flattened, the dorsum convex, the venter concave, and the sides narrow-edged and slightly carinated; the three joints distinctly separated and of about equal length; the first joint having two dorsal longitudinal carinæ down the middle; all densely marked with very fine longitudinally impressed lines, and sparsely pubescent; (Dr. Fitch in his description published in the *Country Gentleman*, under date of September, 1859, states that these lines leave "a smooth stripe along the middle of its second segment and a large smooth space on the base of the third;" which is true of a few specimens, but not of the majority, in which the impressed lines generally cover the whole abdomen.) Ovipositor longer than abdomen, but when stretched in a line with it, projecting backwards about the same length beyond; rufous, with the sheaths black. *Legs* pale rufous, with the upper part of hind tibiæ aud tarsi, and sometimes the hind femora, dusky. *Wings* subhyaline and iridescent, the veins pale rufous, and the stigma black. Length ♀, 0.15–0.16 inch, expanse 0.30; ♂ differs only in his somewhat smaller size and in lacking the ovipositor. In many specimens the mesothorax and the eyes are more or less distinctly rufous.

Described from 50 ♀♀, 10 ♂♂, bred June 23d–July 29th, 1870, from larvæ of *Conotrachelus nenuphar*, and 2 ♀♀ obtained from Dr. Fitch.

Larva (Fig. 8, *a*)—White, with translucent yellowish mottlings.

Pupa (Fig. 8, *c* ♀)—0.17 inch long; whitish, the members all distinct, the antennæ touching hind tarsi, the ovipositor curved round behind, reaching and touching with its tip the third abdominal joint, which afterwards forms the apical joint of imago; five ventral joints, which in the imago become much absorbed and hidden, being strongly developed.

Cocoon (Fig. *c*, *b*)—Composed of one layer of closely woven yellowish silk.

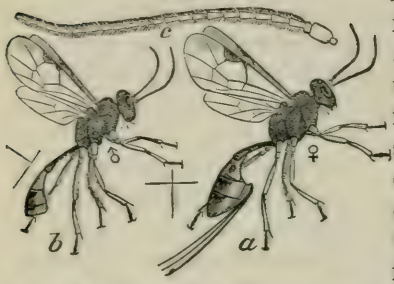
VARIETY RUFUS—Head, thorax and most of first abdominal joint entirely rufous, with the middle and hind tibiæ dusky, and the ovipositor three times as long as abdomen and projecting more than twice the length of the same beyond its tip.

Described from three ♀♀ bred promiscuously with the others. This variety is slightly larger and differs so remarkably from the normal form that, were it not for the absolute correspondence in all the sculpturing of the thorax and body, and in the venation of the wings, it might be considered distinct. The greater length of the ovipositor is very characteristic, and accompanies the other variation in all three of the specimens.

THE PORIZON CURCULIO PARASITE.

The other parasite works in very much the same manner, but instead of issuing the same summer as a fly, it remains in its somewhat tougher and more yellowish cocoon all through the fall and winter, and does not issue in the winged state till the following spring. This parasite was first discovered by Dr. Trimble, who sent me the cocoons from which I subsequently bred the perfect fly. It belongs to the first sub-family (*Ichneumonides*) of the Ichneumon-flies, and apparently to the genus *Porizon** of which it forms a new species. It is only necessary here to state that it differs from the other species in its reddish-brown abdomen, as well as in form, as may be readily seen by referring to the figures (Fig. 9, *a* female; *b* male; *c* antenna).

[Fig. 9.]



PORIZON CONOTRACHELI, N. SP.—*Head* pitchy-black, opaque, the ocelli triangularly placed and close together; eyes oval, polished, and black; face covered with a silvery-white pubescence; labrum rufous, with yellowish hairs; mandibles and palpi, pale yellowish-brown; antennæ inserted in depressions between the eyes, reaching to metathorax when turned back, filiform, 24-jointed; black with basal joints 6–1 becoming more and more rufous, the bulbus always distinctly rufous; bulbus rather longer and twice as thick as joint 3; joint 2 about one-third as long. *Thorax* pitchy-black, opaque, the sides slightly pubescent with whitish hairs, the mesothorax rounded and bulging anteriorly, the scutellum slightly excavated and sharply defined by a carina each side; metathorax with the elevated lines well defined and running parallel and close together from scutellum to about one-fourth their length, then suddenly diverging and each forking about the middle. *Abdomen* glabrous, polished, very slender at base, gradually broader and much compressed from the sides at the apex which is truncated; peduncle uniform in diameter and as long as joints 2 and 3 together; joints 2–5 subequal in length; color rufous with the peduncle wholly, dorsum of joint 2, a lateral shade on joint 3, and more or less of the two apical joints superiorly, especially at their anterior edges, black; venter more yellowish: ovipositor about as long as abdomen, porrect when in use, curved upwards when at rest, rufous, with the sheaths longer and black. *Legs*, including trochanters and coxæ uniformly pale yellowish-brown with the tips of tarsi dusky. *Wings* subhyaline and iridescent, with veins and stigma dark brown, the stigma quite large, and the two discoidal cells subequal and, as usual in this genus, joining end to end, but with the upper veins which separate them from the radial cell, slightly elbowed instead of being straight, thus giving the radial cell a quadrangular rather than a triangular appearance. ♂ differs from ♀ only in his somewhat smaller size and unarmed abdomen. Expanse ♀ 0.32 inch, length of body, exclusive of ovipositor 0.22; expanse ♂ 0.28, length 0.18.

Described from 3 ♀ ♀, 1 ♂ bred May 26th–28th, 1870, from cocoons received from Dr. I. P. Trimble, of New Jersey, and 1 ♀ subsequently received from the same gentleman—all obtained from larvæ of *Conotrachelus nenuphar*.

"But of what use are these parasites?" say you! Well, they can not, it is true, be turned to very practical account, because they are not sufficiently under our control; but it is a source of great satisfaction to those who have been looking for many years for some natural aid to help them in the artificial warfare waged against the Curculio,

* As I am informed by Mr. E. T. Cresson, of Philadelphia, who pays especial attention to the classification of the *Ichneumonidæ*, it might more properly be referred to Holmgren's genus *Thersilochus*, which differs from *Porizon* in the greater distance between the antennæ at base, and in the venation of the wing.

to know that besides its several cannibal foes, there are at last two true parasites which attack it. Indeed, with the knowledge of the Curculio enemies figured and described two years ago in the *American Entomologist*, and of the egg-destroying *Thrips* which I mentioned last year in a paper published in the Illinois State Horticultural Transactions for 1869 (p. 90), and these two parasites, the grower of our luscious stone-fruits may with good reason begin to hope for better days, for the prospect brightens. There is no philosophy in the statement of Mr. W. B. Ransom,* that we can never hope for assistance from parasites, because, as he confidently expresses it, "there are none at present but what have always existed!" Such argument will do for the believers in the old-school doctrine, that every thing was created just as we find it; but not for those who rightly comprehend the Darwinian hypothesis of development, and who believe that life is slowly undergoing change and modification to-day just as it ever has since it had an existence on this Earth. For my own part, nothing has ever appeared more absurd than the direct creation of something out of nothing, and I would as soon believe that we all dropped full grown from the clouds—instead of being brought into the world by natural means and gradually developing into manhood and womanhood—or that we have the same habits as our barbarous ancestors had; as to believe that the animal life about us is now as it was in the beginning! Therefore, though these Curculio parasites may have existed in this country long ere the white man first beheld its shores, yet they may only have acquired the habit of preying upon the Curculio within the last comparatively few years. Moreover, much benefit may be derived from their artificial propagation and dissemination, and—utopian as the scheme may appear—I intend next year, *Deo volente,* to breed enough of the first mentioned species to send at least a dozen to every county seat in the State, and have them liberated into some one's peach orchard.

THE APPLE CURCULIO.—*Anthonomus quadrigibbus*, Say.

"Prove all things; hold fast that which is good!"

This injunction of St. Paul applies with just as much force to us to-day, as it did in centuries past to the Thessalonians. In what has been said above about the Plum Curculio, we have had abundant opportunity of testing the soundness of the old proverb, and in ascertaining the history of the Apple Curculio, which I am about to give, it was very necessary to bear the advice in mind. It often takes years to undo the assertions of men who are in the habit of talking glibly of

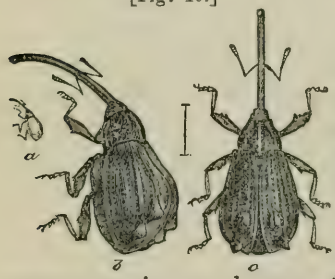
* *Prairie Farmer*, June 4th, 1870.

that which they really know nothing about, and I ought to comment severely on what has been said about this insect; but I refrain from doing so, in this case, lest it be said that my words are prompted from personal considerations.* I shall therefore content myself with a plain narrative of this insect's habits.

First then, let us explain the differences between the perfect states of this insect and the Plum Curculio, that any one may distinguish between them.

The snout of the Plum Curculio hangs down like the trunk of an elephant; it is short, stout, and does not admit of being stretched out horizontally forwards; and as may be seen by referring to the figure (Fig. 1, *c*) is scarcely as long as the head and thorax together, and can be folded back between the legs, where there is a groove to receive it. The Plum Curculio is broadest across the shoulders and narrows behind, and moreover, the black sealing-wax-like, knife-edged elevations on the back, with the pale band behind them, characterize it at once from all our other fruit boring snout-beetles.

[Fig. 10.]



The Apple, or Four-humped Curculio (Fig. 10, *a*, natural size; *b*, side view; *c*, back view,) is a smaller insect with a snout which sticks out more or less horizontally and can not be folded under, and which in the male is about half as long, and in the female is fully as long as the whole body. This insect has narrow shoulders and broadens behind, where it is furnished with four very conspicuous humps, from which it takes its name. It has neither the polished black elevations nor the pale band of the Plum Curculio. In short, it differs generically, and never attacks stone fruit.

The size varies from 1-20th to nearly 1-12th of an inch, but the colors are quite uniform, the body being ferruginous or rusty-brown often with the thorax and anterior third of the wing-covers ash-gray —the thorax having three more or less distinct pale lines.

ITS NATURAL HISTORY.

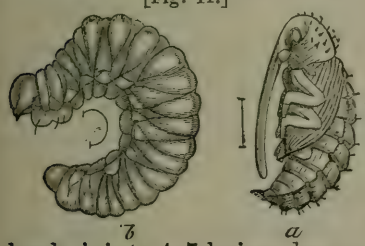
This beetle like the Plum-weevil is a native American insect, and has from time immemorial fed on, and bred in, our wild crabs. It is also commonly met with on the Thorn, and Mr. Wm. Saunders, of London, C.W., tells me that though abundant on the last named tree, it has not yet learned to attack the apple in his locality. It eventually learned to like our cultivated apples and pears, and is also found on quinces. At present it does considerable damage to the crop in some localities, though it yet prefers the wild to the cultivated fruit. Like

* My views on this subject, with comments on what has been said about this insect, may be found in a controversy, in articles published in the *American Entomologist and Botanist*, Vol. II, pp. 225–7 and 268–71; the *Prairie Farmer*, July 16th, 23d and Aug. 27th, 1870; and the *Journal of Agriculture*, Oct. 13th, and Nov. 10th and 17th, 1870.

the Plum-weevil also, it is single-brooded, and winters over in the beetle state, though I was led to believe differently a year ago. With its long thin snout it drills holes into the fruit, much resembling the puncture of a hot needle, the hole being round, with a more or less intense black annulation. and an ash-gray centre. Those holes made for food are about one-tenth of an inch deep and generally scooped out broadly at the bottom in the shape of a gourd. Those which the female makes for her eggs are scooped out still more broadly and the egg at the bottom is often found larger than the puncture at the orifice —thus indicating that it swells from absorption, by a sort of endosmosis, of nutritive fluid from the surrounding fruit, just as the eggs of many saw-flies and of some other snout-beetles are known to do.

The egg is fully 0.04 of an inch long, nearly oval, not quite three times as long as wide, and of a yellowish color, with one end dark and empty when the embryo larva is well formed. The egg-shell is so very fine that the larva seems to gradually develop from it instead of crawling out of it; and by taking a matured egg and gently rolling it between the thumb and finger, the young larva presents itself, and at this early age its two little light brown mandibles show distinctly on the head. As soon as this larva hatches it generally goes right to the heart of the fruit and it feeds there around the core, producing much rust-red excrement, and acquiring a tint of the same color. It feeds for nearly a month, and when full grown presents the appearance of Figure 11, *b*.

[Fig. 11.]



b *a*

It differs so remarkably from that of the Plum Curculio that the two insects can be distinguished at a glance even in this masked form. It is softer, the chitinous covering being thinner and much whiter. It cannot stretch straight and travel fast as can that of the Plum Curculio, but curls round with an arched back, joints 4–7 being larger than the preceding. It is more crinkled, each joint being divided into three principal folds much as in the common White Grub. The space between the folds is frequently bluish-black, and there is a very distinct, continuous, vascular, dorsal line of a bluish color. It has no bristles like *nenuphar* except a few weak ones on the first joint, arising from some ventral tubercles which remind one of feet. The head is yellowish-brown with the jaws somewhat darker, and the breathing pores, except that in the fold of the first joint, are not easily seen.

IT TRANSFORMS IN THE FRUIT.

The fruit of the wild crab containing this larva never falls, and the fruit of our cultivated apples seldom; and in this respect the effect of its work differs remarkably from that of the Plum Curculio,

or even of the Codling Moth. Why such is the case it would be difficult to explain! It is one of those incomprehensible facts which at every turn confront the student of Nature's works. We might with equal reason ask why it is that of the two stone fruits, the plum and the cherry, the larger falls and perishes and the smaller hangs on and lives, when infested with the Plum Curculio; and of the two pomaceous fruits, the apple and the haw, the larger likewise falls and perishes and the smaller hangs on and lives, when infested with similar larvæ? Most persons would naturally infer that the larger instead of the smaller fruits would best resist the injurious gnawings of the worm within; and though we may explain away the paradox by supposing that the longer stem of the smaller fruits prevents the injury from reaching its juncture with the branch, so readily as it does through the shorter stem of the larger fruits; or that the greater weight of the larger fruit causes it to fall so readily; yet this is only assuming, and I doubt whether the vegetable pathologist will ever be able to show the peculiarities of the fruits which cause the different effects.

The larva of the Apple Curculio has no legs and is so humpbacked that it cannot stretch out, and would cut a very sorry figure in attempting to descend the tree. Therefore, as the fruit containing it mostly hangs on the tree, the insect is effectually imprisoned. But Nature's ways are always ways of wisdom and her resources are inexhaustible! Consequently we find that instead of having to go under ground to transform, as does the Plum Curculio, the normal habit of our Apple Curculio is to transform within the fruit. The larva, after becoming full fed, settles down in a neat cavity, and soon throws off its skin and assumes the pupa state, when it appears as at Figure 11, *a*. After remaining in this state from two to three weeks it undergoes another moult and the perfect beetle state is assumed. We thus see that the Apple Curculio is cradled in the fruit in which it was born till it is a perfect beetle, fully fledged, and ready to carry out the different functions and objects of its life. In other words, it never leaves the fruit, after hatching, till it has become a perfect beetle. This fact I have fully tested by breeding a number myself both from infested crabs which I collected, and from cultivated apples, also infested, that were kindly forwarded to me by Mr. J. B. Miller, of Anna, Illinois. I learn also from Mr. George Parmelee of Old Mission, Michigan, that he has satisfied himself of the same trait in the natural history of this insect, and I fully convinced myself that such was the normal habit, by repeatedly removing the full grown larva from the fruit and placing it on the surface of the ground, when, in every instance, it would make no attempt to bury itself, but would always transform on the surface.

THE AMOUNT OF DAMAGE IT DOES.

The observations that I have been able to make on this insect's work in our cultivated orchards are limited, but I think that it attacks with equal relish both summer and winter apples. Whenever a beetle has perfected in the fruit, it cuts quite a large hole for its escape, and these holes are sufficiently characteristic to enable one who has paid attention to the matter to tell with tolerable certainty whether an apple has been infested with Apple-worm, Plum Curculio, or Apple Curculio—even after the depredator has left.

In the southern portion of Illinois and in some parts of Missouri this insect is very abundant and does much damage to the apple crop; it occurs in greater or less numbers in most States of the Union, but in other localities again its work is scarcely ever seen, and I am satisfied that the damage it does has been much overrated. We can only judge of the future by the past, and though we may expect this insect to increase somewhat with the increase of our orchards, it is folly to suppose that it can go on increasing in geometrical ratio; and the pretty mathematical calculations which are intended to alarm the cultivator at the gloomy prospects of the future, are never made by those who understand the complicated net-work in which every animal organism is entangled, or who rightly understand the numerous influences at work to keep each species within due bounds. Such figures look well on paper, but, like air-castles, there is nothing real about them.

Our apples suffer much more, in many localities, from the gougings of the perfect beetle and the burrowings of the larva of the Plum Curculio, than they do from the work of this Apple Curculio; and this was so much the case in my own locality the past summer, that I found a dozen larvæ of the former in apples, where I found one of the latter.

At the late meeting of the Illinois State Horticultural Society, Mr. E. Daggy, of Tuscola, Illinois, had on exhibition some pears that were very much deformed and gnarled. This injury had been caused by the Apple Curculio, which Mr. Daggy recognized from figures and specimens which I had with me. Upon examining the pears I found a little dark circular spot which indicated distinctly where the snout of the beetle had been inserted. This spot was the center of a hard and irregular but generally rounded knot or swelling, which was sunk in a depression of the softer parts of the pear, thus indicating that the growth, by some property of the puncture, was checked and hardened, while the other parts went on growing and swelling. Some of the fruit was so badly disfigured that it could no longer be recognized, and Mr. Daggy informed me that his Vicar of Winkfield, Bergamott and "Sugar" pears were most affected in this way, and that his Duchesse pears were unblemished.

While the fruit is growing these punctures, in almost every instance, cause just such calloused spots and deformities as those des

cribed above, but when the fruit is ripe they have a far more pernicious effect, for they generally cause the fruit to rot. It is now a well established fact that the common Plum Curculio causes the dreaded rot in peaches, plums, etc., to spread at a fearful rate by the punctures and gougings which it makes on the ripening fruit; and that where this predisposing influence is guarded against, such rot is generally confined to comparative narrow limits or does not occur at all. Many varieties of apples are disposed to rot in a similar manner, and to fall from the tree just as they are ripening. This rot in apples, as may be seen from the transactions of our State Horticultural Society, was very prevalent last fall—the Rawles Janet being especially predisposed to it—and there can be no doubt but that the punctures and gnawings of the little Turk, combined with those of the Apple Curculio are likewise the pricipal agents in producing it; for I have over and over again noticed the rot to spread in a circle from these punctures, not only on hanging fruit but just as invariably upon fruit punctured after it was plucked. Whether we believe that the fungus growths, often noticeable on such rotting fruit, are the direct result of the punctures, or that the latter only act indirectly by furnishing a proper nidus for the infectious fungus-spores which are supposed to be ever floating in the atmosphere, is a question which I shall not now stop to consider, though I have my own views which are somewhat heterodox. In either case, the Curculios are just as much to blame, and this should be an additional incentive to a general warfare upon them. Judge A. M. Brown, of Villa Ridge, has noticed that some varieties of apples are much more subject to rot and also more subject to the attacks of Curculios than others,* and it is to be hoped that he will make further observations and give us a reliable list of such varieties, and that other fruit-growers will do the same.

THE SEASON OF THE YEAR DURING WHICH IT WORKS.

The beetles come from their winter quarters and begin to work on the fruit at about the same time as does the Plum Curculio—if anything, a little later. They have generally got fully to work, and larvæ may be found already hatched by the first of June, and they may be found in the fruit, in one stage or another, all along through the months of June and July and the greater part of August.

REMEDIES AND PREVENTIVE MEASURES.

Notwithstanding we have had reports, published in the columns of our agricultural papers, of the relative number of Apple and Plum Curculios captured from peach trees by jarring with the Curculio-catcher, I am fully convinced that such reports were not based on facts, and that we may never expect to subdue this insect by the jarring process. It is not as timid or as much inclined to drop as the Plum Cur-

Prairie Farmer, January 28, 1871.

culio, and though it can occasionally be brought down, it generally remains defiantly on the fruit or on the bough, through the gentlest as well as the severest jarring of the tree. Indeed, its habit of transforming in the fruit, places it in a great measure beyond our control, and I fear that this is one of the few insects with which we can do but little by artificial means. But we have only just commenced to understand this foe, and there is much yet to learn about it. I sincerely hope that the few facts which have been here given, will increase the reader's interest in this insect and enable him to carry on future observations and experiments with a better understanding; so that they will at last result in making us masters of this rather difficult situation. Mr. H. Lewelling, of High Hill, Montgomery county, Missouri, who has had much of his fruit injured by this insect, informs me that Tallman's Sweet is preferred by it to all other varieties, and our observations should, as much as possible, tend in the direction of deciding which varieties are most subject to, and which most exempt from its attacks; and which varieties fall most readily when infested by it. For it is obvious that with our present knowledge, the only real remedy which yet exists, is the destruction of the infested fruit, whether upon or off the tree; and it may turn out that although we cannot jar down the beetles, we can jar down much of the infested fruit, which would, without jarring, remain on the trees.

ANTHONOMUS QUADRIGIBBUS, Say—*Larva* (Fig. 11, *b*)—Average dorsal length when full grown 0.45 inch; soft and white, with a very few sparse soft hairs; arched and wrinkled Lamellicorn-fashion, the space between the wrinkles, and a distinct dorsal vascular line, bluish-black. Head free and almost perpendicular, yellowish-brown with the mandibles darker. A pair of polished ventral tubercles on each of the three thoracic joints, and each bearing a distinct bristle.

Pupa (Fig. 11, *a*)—Average length 0.40 inch. Whitish, the snout of ♀ reaching beyond tip of wing-cases, that of ♂ not much beyond the elbow of middle femora and tibiæ. Thorax with a few short stiff hairs springing from slight conical elevations. Wing-cases showing the striæ and humps of future beetle, the tip of the upper case usually terminating in a thorn. The nine abdominal joints deeply and distinctly separated, the first showing a rounded scuttellar turbercle; the sides angular, conically ridged and armed on each joint with two brown thorns or bristles, which become stouter towards apex; a transverse dorsal row of about eight similar bristles on the posterior sub-margin of each joint, also becoming larger towards apex: Terminal sub-segment ending in *one* stout, slightly curved, thorn.

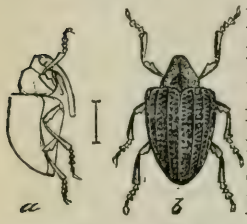
THE QUINCE CURCULIO—*Conotrachelus cratægi*, Walsh.

HOW IT DIFFERS FROM THE OTHERS.

This insect has been called the Quince Curculio by Dr. Trimble, and though it breeds in other fruits, the name is a good one as it will enable us to distinguish it at once from our other fruit snout-beetles. I have had the beetle in my cabinet for several years, but knew nothing of its larval history till a year ago last fall. It breeds very abundantly in our common haws, and I raised a number of them the pres-

ent season from the fruit of the Pear or Black Thorn (*Cratægus tomentosa*) obtained from Mr. Walsh.

[Fig. 12.]



Though belonging to the same genus as our Plum Curculio, and having very much the same form, as may be seen by referring to the figure, (Fig. 12, *a* side view; *b* back view), yet it differs remarkably in its habits from both of the preceding weevils. It is, like them, an indigenous species, and its original fruit was evidently the wild Haw, which in the West it yet seems to prefer to the cultivated fruits. But in the East it has become very injurious to the Quince and, as we might naturally expect, also attacks the Pear, and especially the Lawrence and other late varieties. In September, 1868, I received specimens from W. W. Sweet, of Highstown, N. J., with the statement that they were found on pears, and Dr. Trimble at a late meeting of the New York Farmers' Club (Oct. 22, 1870), gave the following account of its injuries in New Jersey the present year:

"Yesterday five or six hundred were taken from the bottoms of two barrels of quinces, although those quinces had only been gathered four days before. A friend of mine has a quince orchard of 286 trees. These trees this season should average seventy or eighty quinces to a tree, making more than twenty thousand. Upon a most careful search I was unable to find one specimen perfect, or clear of one or more blemishes caused by the punctures of this insect. Frequently four, five, or six grubs will be found in a single quince. Mr. Goldsmith, the owner, keeps this orchard in first-rate order; he has faithfully kept out the borers, so fatal to the quince trees; has fertilized very freely, and the cultivation is perfect. He told me yesterday, that his crop this year is thirty barrels, which will yield him about $125. Had this insect let him alone he should have had at least 100 barrels, worth $800 to $1,000. Many of his later pears, including the Seckel and Lawrence, have suffered greatly, though not to the same extent as his quinces. A few days ago he emptied a barrel of cullings, chiefly Lawrence pears, and in and near the bottom of that barrel were found at least 400 of these grubs. A month ago I visited the orchards attached to one of the best nurseries in Pennsylvania, and I found the sad evidence of the presence of this enemy. Even the Seckel pears, though very abundant, were almost worthless; later varieties still worse. Mr. Fuller tells me that he has seen this season, in Western New York, the same condition of fruit at a well known nursery, even the Duchesse pears almost totally destroyed. This fruit enemy seems yet confined to localities; but is spreading rapidly."

This beetle was first very briefly described by Mr. Walsh in a note in the *Prarie Farmer* for July 18th, 1863, p. 37, from specimens found by him on the hawthorn, but until I bred it this spring, nothing was known of its larval history. It is a somewhat larger insect than the Plum Curculio, has a comparatively longer snout, and is very broad-shouldered; thus tapering just the opposite way to the Apple Curcu-

lio. Its general color is a tolerably uniform ash-gray, mottled more or less with ochre-yellow, dusky and whitish, and it has a dusky somewhat triangular spot at the base of the thorax above, and seven distinct narrow longitudinal elevations on the wing-covers, with two rows of punctures between each.

This beetle differs further from the others, in the fact that it does not appear, even in the latitude of St. Louis, till about the first of June, and I have had its larvæ of the previous year in the ground in May, when the newly hatched larvæ of the Plum Curculio were already working destruction in the fruit. In some of the more northern States it would not appear till the middle of July.

ITS TRANSFORMATIONS AND HABITS.

This snout-beetle does not make a crescent like the Plum Curculio; but, like the Apple Curculio, makes a direct puncture for the reception of its egg, the hole being somewhat larger than that of the latter, and the bottom of the cavity similarly enlarged and gnawed, so as to form a neat bed for the egg. The egg is very similar to that of the Plum Curculio, and hatches in a few days after being deposited. In all probability it also swells and enlarges somewhat before hatching. The larva works for the most part near the surface of the fruit, and does not enter to the heart. It is of the general form of that of the Plum Curculio, and differs principally in being somewhat larger, more opaque-white, and in having a narrow dusky dorsal line and a distinct lateral tubercle on each joint. When full grown, which is in a month or more from the time of hatching, it leaves the fruit through a smooth cylindrical hole and burrows two or three inches into the ground. Here, singularly enough, it remains all through the fall, winter and spring months without changing—no matter whether it left the fruit as early as the first of August or as late as the first of October. This is the peculiar feature of the insect, namely, that it invariably passes the winter in the larva state, and does not even assume the pupa state till the fore part of May, or a few days before issuing as a beetle. In this respect it resembles the nut-weevils which infest our hickory-nuts, hazel-nuts and acorns. In higher latitudes than that of St. Louis, there is evidence that some of the late hatched larvæ do not leave the haws they infest till frost overtakes them, but pass the winter within the fruit as it lies on the frozen ground. The pupa differs only from that of the Plum Curculio in the greater length of the proboscis.

I have already referred to the fact that Dr. Fitch supposed the Plum Curculio to be two-brooded, and those who have read his "Address" on this insect will readily perceive that he based his opinion on finding what he took to be its larvæ in the tender bark of a pear twig late in the fall, and on finding what he similarly mistook for such larvæ in haws in winter. Of course, we know positively now

that the Plum Curculio does not so breed in pear twigs, and it is very evident that what Dr. Fitch took to be Plum Curculio larvæ in such a twig, were the young of some other insect, or perhaps even the eggs of some leaf-hopper (*Tettigonia*), which are generally placed in the position described by him. But, though this first error of Dr. Fitch's has been explained away, the second never has till now, when we may assume, with great reason, that the larvæ which misled the Doctor, and which were found in haws in winter time, were in reality the larvæ of our Quince Curculio. How easily are fallacies exploded, and errors corrected, even years after they are committed, by a few well tested facts!

The two former Curculios which we have been considering have a beetle existence of between nine and ten months, during most of which time, or as long as the weather is sufficiently mild, they feed in the manner described. The present species has a beetle existence of not more than two months, and as though aware of the short term allotted to it for enjoyment, it endeavors to make the best use of its time. Consequently we find it more ravenous than either of the other species, and it is really astonishing how much this insect eats. It excavates immense holes for food, often burying itself in them completely, and I have known apples furnished to these beetles in confinement, to have their substances so completely devoured that nothing but the rind was left. Two years ago last fall there was scarcely a quince that came into the St. Louis market that was not marred by numbers of large gougings, and though I was then inclined to attribute such holes to the gnawings of grasshoppers, I feel pretty well convinced at present that the work might with more justice have been attributed to this Quince Curculio.

The question will naturally arise, since this insect breeds in the Haw, the Quince and the Pear, whether it will also breed in the closely allied Apple? So far as my experiments go, they indicate clearly that it will not; for although the beetle will eat and greatly disfigure apples, when no other nourishment is at hand, yet a number which I confined to a large branch of an apple tree on the 14th of June last, absolutely refused to deposit eggs, and died three weeks afterwards.

REMEDIES.

Very fortunately this insect drops as readily when alarmed as does the Plum Curculio, and the jarring process will be found just as effectual in catching it, with the additional advantage that the jarring need only be carried on for about ten weeks of the year, namely, from about the first of June to the middle of August in this latitude. Moreover, in accordance with its late appearance, we find that according to Dr. Trimble, whenever it attacks pears, it prefers the late ripening varieties. Again, it is, like the Plum Curculio, nocturnal

in its habits, and secretive during the day, so that the Ransom process will undoubtedly prove effectual with it, if used at the right season. All fruit that falls should be destroyed, and as we know that the larva hibernates in the ground, many of them will be injured and destroyed by late stirring of the soil.

CONOTRACHELUS CRATÆGI, Walsh—*Larva*—Average length when full grown 0.32 inch; 4½ times as long as wide, and straight. Opaque whitish, with a narrow dusky dorsal line, generally obsolete on thorax, and a few very short hairs. Distinct lateral tubercles on all the joints. Head rufous with mandibles black, except at base, and distinctly two-toothed at tip.

Pupa—Average length 0.28 inch. Snout reaching a little beyond elbow of middle tibiæ and tarsi, with two stout rufous thorns near the origin of antennæ, two more at base and sometimes others more toward the tip. Head and thorax also armed with such thorns, and also two to each elbow of the femora and tibiæ. Wing cases with rows of short rufous bristles along the elevations between the striæ. Abdomen cylindrical, the basal joint with a central scutellar bristleless tubercle and two others, one each side of it, each bearing a bristle; the other joints conically tubercled, laterally, each tubercle bearing a stout bristle, and each joint bearing dorsally about four other bristles on its posterior sub-margin. Terminal sub-segment squarely cut off and bearing *two* stout inwardly-curved brown thorns.

THE PLUM GOUGER.—*Anthonomus prunicida*, Walsh.

ITS CHARACTER, DISTRIBUTION, AND FOOD.

This name was given by Mr. Walsh to another indigenous weevil which is represented enlarged in the accompanying illustration (Fig. 13). It is easily distinguished from either of the preceding weevils, by its ochre-yellow thorax and legs, and its darker wing-covers, which are dun-colored, or brown with a leaden-gray tint, and have no humps at all. Its snout is not much longer than the thorax, but as in the Apple Curculio, projects forwards, or downwards but cannot be bent under as in the Plum Curculio. This insect was first described in the *Prairie Farmer* for June 13th, 1863, and the description was afterwards republished in the Proceedings of the Boston Society of Natural History for February, 1864.

[Fig. 13.]

Mr. Walsh gave such a good account of it in his report as Acting State Entomologist of Illinois, that it is unnecessary for me to go into detail, and I will therefore only briefly allude to those traits in its history which are well established.

The Plum Gouger seems to be unknown in the Eastern States, or at least is not common there; but it is very generally distributed throughout the Valley of the Mississippi. As a rule it is much less common and does much less injury than the little Turk, though in some few districts it is found equally abundant, and I received specimens on the first of June last, from my esteemed correspondent Mr.

Huron Burt, of Williamsburg, Callaway county, Mo., with the statement that it was doing great damage to the plums in that locality, though the little Turk was scarcely met with. There is a plum known there as "Missouri Nonsuch" which, though said to be Curculio proof, is worked upon very badly by the Gouger.

The Plum Gouger is often found on wild crab trees, and may, like the Plum Curculio, occasionally deposit and breed in pip fruit; but it is partial to smooth-skinned stone-fruit such as prunes, plums, and nectarines, and it does not even seem to relish the rough-skinned peach.

OFTEN MISTAKEN FOR THE PLUM CURCULIO.

It has often been confounded with the Plum Curculio, and was once supposed by my friend L. C. Francis, of Springfield, Ills., to be the male of that species. We all have a right to suppose what we please, and as long as our suppositions are not thrust on the public for ascertained facts, they can do no possible harm. But Mr. J. P. Williamson, of Des Moines county, Iowa, is not satisfied with supposing this or some other straight-snouted weevil, to be the female of the Plum Curculio, but, in a last summer's issue of the *Prairie Farmer*, not only emphatically speaks of it as such, but, finding that these supposed females frequent the trees two weeks earlier than the males, (?) he concludes for some unexplained reason, that the sole object of visiting the fruit is for the deposition of eggs; and straightway hatches the theory that the Plum Curculio can do no harm till the males appear! Consequently, instead of jarring our trees as long as fruit remains on them, we are informed by Mr. Williamson that it is only necessary to jar them about six weeks.

And thus it always is with men who do not sufficiently understand the absolute importance of care and caution in reading Nature's secrets: from supposition to assumption; from assumption to theory; from theory to advice, which—it is unnecessary here to say—is of a most pernicious character.

ITS TIME OF APPEARANCE.

This beetle appears in the spring about the same time as the Plum Curculio, but as no eggs are deposited after the stone of the fruit becomes hard, and as its larva requires a longer period to mature than that of the latter, its time of depositing is shorter, and the old beetles generally die off and disappear before the new ones eat their way out of the fruit, which they do during August, September, and October, according to the latitude.

ITS NATURAL HISTORY.

Though we have no absolute proof of the fact, analogy would lead us to believe, and in my own mind there is no doubt, that this

insect passes the winter in the beetle state, and that it is, like the other species, single-brooded. Both sexes bore cylindrical holes in the fruit for food, and these holes are of the exact diameter of the snout, and consequently somewhat larger than those of the Apple Curculio. These holes are broadened at the bottom, or gouged out in the shape of a gourd; and especially is this the case with those intended by the female for the reception of an egg. The egg, in this case also, enlarges from endosmosis, and it is probable that all weevils that make a puncture for the reception of their eggs, gnaw and enlarge the bottom, not only to give the egg room to swell, but to deaden the surrounding fruit, and prevent its crushing such egg—the same object being attained by the deadened flap made by the crescent of the little Turk. Wherever this insect abounds, plums will be found covered with its holes, the great majority of them, however, made for feeding purposes. The gum exudes from each puncture, and the fruit either drops or becomes knotty and worthless.

The young larva which hatches from the egg, instead of rioting in the flesh of the plum, or remaining around the outside of the kernel, makes an almost straight course for that kernel, through the yet soft shell of which it penetrates. Here it remains until it has become full-fed, when by a wise instinct it cuts a round hole through the now hard stone, and retires inside again to change to the pupa and finally to the beetle state. When once the several parts of the beetle are sufficiently hard and strong, it ventures through the hole which it had already providently prepared for exit with its stronger larval jaws, and then easily bores its way through the flesh and escapes.

It must not be forgotten that, while the kernel of the fruit is yet soft, the larva of the little Turk often penetrates and devours it; but in this case the soft stone is more or less reduced to reddish powder, whereas the larva of the Plum Gouger enters the stone and feeds on the inside while the outside hardens. The normal habit of the former is to feed on the outside; that of the latter on the inside of the stone.

REMEDIES.

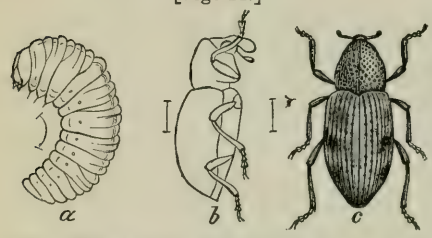
This Plum Gouger is about as hard to deal with as the Apple Curculio. It drops almost as reluctantly and we therefore cannot do much by the jarring process to diminish its numbers. Moreover it takes wing much more readily than the other weevils we have mentioned; and though fruit that is badly punctured for food, often falls prematurely to the ground, yet, according to Mr. Walsh, that infested with the larva generally hangs on the tree until the stone is hard and premature ripening sets in. In all probability the stunted and prematurely ripened fruit containing this insect will jar down much more readily than the healthy fruit, but I have so far had no opportunity of making any practical observations myself, and must conclude by

hoping that our plum-growing members will make the proper experiments and give us the results.

THE STRAWBERRY CROWN-BORER.—*Anaicis frágariæ* N. sp.

This is another indigenous insect, which seems to be confined to our Mississippi Valley, for I have heard no complaints in any of the Atlantic States, of injuries that could be attributed to this weevil. In the *Maine Farmer* for July 25th, 1867, we find a brief reference, made by Mr. G. E. Brackett of Belfast, Me., in answer to a certain "E. B.," of a "worm that eats into the crown of the plant and kills it." The worm referred to was, in all probability, the Crown-borer under consideration, but as no postoffice address of the questioner is given, the paragraph might just as well never have been written, for any light that it throws on the distribution of the insect. However, no such insect has ever been mentioned by our Eastern writers on the Strawberry, and we must necessarily conclude that it does not exist in the Atlantic States.

[Fig. 14.]



This insect has done considerable damage to the strawberry crop in the southern portion of Illinois, especially along the line of the Illinois Central Railroad; and I have seen evidence of its work in St. Louis county, Mo. At the meeting of the Southern Illinois Fruit Growers' Association, held at South Pass, in November, 1867, several complaints were made by parties from Anna and Makanda, of a white worm which worked in the roots of their strawberries and in 1868, the greater portion of the plants of a ten-acre field at Anna, belonging to Mr. Parker Earle, was destroyed by it.

In the fall of 1869 I had some correspondence with Mr. Walsh on this insect, and learned that he had succeeded in breeding it to the perfect state; and had it not been for his untimely death, its history would no doubt have been published a year ago. Through the kindness of Jos. M. Wilson, of Sterling, Whiteside county, and of J. B. Miller, of Anna, Union county, Ills., I received during the past year specimens of the larvæ, from which I succeeded in rearing the perfect beetle. It is therefore by the aid of these gentlemen, and especially from the experience of Mr. Miller, that I am enabled to give the above illustrations (Fig. 14) of the Strawberry Crown-borer, and the following necessarily imperfect account of its mode of working. I give them in the hope that they will prompt further investigation, and serve as a clue to enable others who have opportunity, to in-

crease our knowledge of this pest; for there is much yet to learn of its habits, and consequently of the best means of fighting it.

From the middle of June to the middle of July in Southern Illinois, and later further north, the larva hatches from an egg which, in all probability, is deposited in the crown of the plant, and it immediately commences to bore its way downwards, into the pith. Here it remains till it has acquired its full size, working in the thick bulbous root and often eating through the more woody portions; so that when frost sets in, the plant easily breaks off and is heaved out of the ground. When full grown it presents the appearance of Figure 14, *a*, being a white grub with arched back and tawny-yellow head, and measuring about one-fifth of an inch when stretched out. It undergoes its transformations to the pupa and perfect beetle states within the root, and the latter makes its appearance above ground during the month of August.

The beetle (Fig. 14, *b* side view; *c* back view) is about 1-6th of an inch in length, of a chestnut-brown color, and marked and punctured as in the figure.

From analogy we may infer that the beetle feeds on the leaves of the strawberry, for it is a very general rule with snout-beetles, that the perfect insects feed on the leaves of such plants as they infest in the larva state. But whether it lives on through the winter as a beetle and does not commence depositing eggs again till the following June; or whether it is double-brooded and produces a second lot of larvæ which pass the winter in the roots, are questions which are not yet decided; and until we get a more comprehensive knowledge of this insect's ways and doings, we shall be in a measure powerless before it. From all the facts that can be obtained, the first hypothesis is the correct one, and in that event we can, in an emergency, easily get rid of this pest by plowing up and destroying the plants soon after they have done bearing, or say about the latter part of June in the latitude of St. Louis. By doing this the whole brood of borers will perish with the plants. Most strawberry-growers renew their plants, in some way or another, about every three years, and where this insect abounds, it will be best subdued by destroying the whole bed at the time already suggested and afterwards planting a new one; rather than by annually thinning out the old and leaving the new plants in the same bed. Here we have an effectual means of extirpating the little pest, if, as I believe, the first hypothesis is the correct one; but if the second hypothesis be correct—i. e., if the insect be double-brooded—then it will avail nothing to carry out the above suggestions, and we thus see how important it is to thoroughly understand an insect's habits in order to properly cope with it. Though we may occasionally hit upon some plan of remedying or of preventing an insect's injuries without knowing its habits, yet as a general rule we but grope in the dark until we have learned its natural history!

According to Mr. Miller, all plants infested with this larva are

sure to perish, and he has also noticed that old beds are more apt to be injured by it than new ones.

In one of the roots received from him, I found a parasitic cocoon, so that there is every reason to believe that, as is so very generally the case with insects, this noxious species has at least one natural enemy which will aid us in keeping it in due bounds. Indeed, Mr. Miller so often found this parasitic cocoon, that he at first surmised that the Crown-borer spun it. But no snout-beetle larvæ spin cocoons.

This Crown-borer must not be confounded with another white worm of about the same size which lives in the ground and subsists on the roots by devouring them from the outside. This last may always be distinguished by having six distinct legs near the head, and its habits are quite different. It occurs earlier in the season, and, as I have proved the past summer, is the larva of the little clay-yellow beetle, known as the Grape-vine Colaspis (*Colaspis flavida*, Say). A full account of this last insect, with illustrations, will be given in a later portion of this Report.

The Crown-borer belongs to the genus *Analcis* which is distinguished by its sub-cylindrical oblong-oval body, its short robust snout which fits into a deep grove, its 10-jointed antennæ, and its simple or unarmed thighs. As it is a new species I subjoin a description of it for the scientific reader :—

ANALCIS FRAGARIÆ, N. Sp.—*Imago*, (Fig 14, *b*, *c*)—Color deep chestnut-brown, sub-polished, the elytra somewhat lighter. Head and rostrum dark, finely and densely punctate and with short coarse fulvous hairs, longest at tip of rostrum ; antennæ rather lighter towards base, 10-jointed, the scape much thickened at apex, join 2 longest and robust, 3 moderately long, 4–7 short, 8–10 connate and forming a stout club. Thorax dark, cylindrical, slightly swollen across the middle and uniformly covered with large thimble-like punctures, and with a few short coarse fulvous hairs, unusually arranged in three more or less distinct longitudinal lines ; pectoral groove ending between front legs. Abdomen with small remote punctures and hairs which are denser towards apex. Legs of equal stoutness, and with shallow dilated punctures and uniform very short hairs Elytra more yellowish-brown, dilated at the lower sides anteriorly, and with about 9 deeply-punctured striæ, the striæ themselves sometimes obsolete ; more or less covered with coarse and short pale yellow hairs which form by their greater density, three more or less conspicuous transverse bands, the first of which is at base ; between the second and third band, in the middle of the elytron, is a smooth dark-brown or black spot, with a less distinct spot of the same color below the third, and a still less distinct one above the second band. Length 0.16 inch.

Described from four specimens bred from strawberry-boring larvæ. The black spots on the elytra are quite distinct and conspicuous on two specimens, less so on one, and entirely obsolete on the other.

Larva, (Fig. 14 *a*)—White with back arched Lamellicorn-fashion. Head gamboge-yellow, glabrous, with some faint transverse striations above mouth ; mandibles rufous tipped with black ; labrum emarginate, and with palpi, pale. A faint narrow dorsal vascular line. Legs replaced by fleshy tubercles. Length 0.20 inch when stretched out.

THE PEA-WEEVIL—*Bruchus pisi*, Linn.

Our common garden pea has not many insect enemies, for with the exception of the Striped Flea-beetle (*Haltica striolata*), which

gnaws numerous small holes in the leaves, and the Corn-worm *alias* Boll-worm (*Heliothis armigera*), which eats into the pod, there are very few others besides the Pea-weevil under consideration. This species alone is so numerous, however, as to be a serious drawback to pea culture in this part of the country.

[Fig, 15.]

The term *Bruchus*, meaning a devourer, was given by the celebrated Linnæus to a genus of beetles which at first appear to have very little resemblance to the Snout-beetles. They form, however, at present, a sub-family (*Bruchides*) of the great Snout-beetle family, though they posses nearly as close affinities to the great *Chrysomela* family, and really form a connecting-link between the two. They are characterized by a depressed head and very short snout, by the antennæ being 11-jointed, straight and but slightly thickened towards the end, by the wing-covers being shorter than the abdomen, and by the rather long hind legs and much swollen thighs. Their larvæ are short, arched, and swollen in the middle, with a comparatively small head; and their depredations are confined all over the world, to leguminous or pod-bearing plants—another beautiful illustration of the "Unity of Habits" referred to on page 9.

They are far more abundant in the tropics than in more temperate climes, and in North America we have not many species to contend with. With the exception of the Honey-locust seed-weevil (*Spermophagus robiniæ*, Fabr.), which I have bred from the seeds of that tree, there are only two species, namely: the Pea and the Bean weevils that are really injurious in our State, though *Bruchus discoideus*, Say, often badly infests the seeds of *Ipomea*. A third species however, namely, the Grain Bruchus of Europe, has lately been introduced into this country, and may some day become unduly multiplied in our midst.

The Pea-weevil is very generally dubbed "Pea-bug," but this latter term is not nearly so appropriate as the former, to which it should give way. Though everybody may notknow by sight the perfect beetle, yet every one has most assuredly seen the work of the worm, and though knowledge of the fact may not add to our enjoyment of a mess of green peas, yet the fact nevertheless remains, that those of us in the Mississippi Valley who indulge in this delicious esculent, necessarily devour a young worm with nearly every pea that we eat. Gray's oft quoted lines,

> —"Where ignorance is bliss,
> 'Tis folly to be wise,"

Would seem to apply here with great force; but when we reflect that the diminutive and almost imperceptible worm, nourished so to speak in the very marrow of the pea, really has no flavor and produces no injurious effects on the human system; we can chuckle in

our sleeves and console ourselves with the thought that, notwithstanding the above truism, "wisdom is justified of her children." Neither this nor any other of the true weevils mentioned in this paper, can do harm when taken as food in the larva state, but there is good testimony that the hard-shell beetles are injurious when fed in a ground or unground condition, along with the seeds they infest, either to man or to other animals.

The Pea-weevil which is here well illustrated, Figure 15, *a* showing a back view, and 17, *b* a side view, the small outlines at the sides showing the natural size, is easily distinguished from all other species of the genus with which we are troubled, by its larger size, and by having on the tip of the abdomen projecting from the wing-covers, two dark oval spots which cause the remaining white portion to look something like the letter T. It is about 0.18—0.20 inch long, and its general color is rusty-black, with more or less white on the wing-covers, and a distinct white spot on the hinder part of the thorax near the scutel. There is a notch on each lateral edge of the thorax, and a spine on the under side of the hind thighs near the apex. The four basal joints of the antennæ and the front and middle shanks and feet are more or less tawny. It is supposed to be an indigenous N. A. insect, and was first noticed many years ago around Philadelphia, from whence it has spread over most of the States where the pea is cultivated. This supposition is probably the correct one though we have no means at present of proving it to be so, and certain it is that, as the cultivated pea was introduced into this country, our Pea-weevil must have originally fed on some other indigenous plant of the Pulse family. It is at present found in the more southern parts of Europe and in England, and is one of the few injurious insects which have found their way there from this country; but in accordance with the facts given in my last Report, under the head of "Imported Insects and Native American Insects," which clearly prove that our native plants and insects do not become naturalized in the Old World with anything like the facility with which those of the Old World are every day being naturalized here, this Pea-weevil does not begin to be as destructive there as it is at home.

THE FEMALE DEPOSITS HER EGGS ON THE OUTSIDE OF THE POD.

It is a very general remark that peas are "stung by the bug," and the impression prevails almost universally, not only among gardeners but with many entomologists, that the female weevil punctures and deposits her eggs *in* the pea in which the larva is to be nourished. It is a little singular that so many writers should have fallen into this error, for it is not only the accepted view amongst writers for the agricultural press, but has been adopted by many eminent entomologists, Taschenberg, Harris, and Dr. Boisduval being about the only authors who have rightly comprehended the true manner of egg-depositing. All this comes of course from one man's palming off

the opinions of another as his own, and by his adopting such opinions, whether good or bad, without due credit. Even Noerdlinger in his "Kleinen Feunde der Landwirtschaft," though he cites the excellent and original observations of Taschenberg, feels himself called upon to doubt their correctness, and himself inclines to believe that the female may put her eggs in the pea. In Packard's Guide, the eggs are erroneously said to be laid on the blossoms.

The true natural history of the Pea-weevil may be thus briefly told. The beetles begin to appear as soon as our peas are in bloom, and when the young pods form, the female beetles gather upon them and deposit their eggs on any part whatever of the surface without attempting to insert the eggs within the pod.

The eggs, (Fig. 16,) are deep yellow, 0.035 inch long, three times as long as wide, fusiform, pointed in front, blunt behind, but larger anteriorly than posteriorly. They are fastened to the pod by some viscid fluid which dries white and glistens like silk. As the operation of depositing is only occasionally noticed during cloudy weather, we may safely assume that it takes place for the most part by night. If pea vines are carefully examined in this latitude any time during the month of June, the pods will often be found to have from one to fifteen or twenty such eggs upon them, and the black head of the future larva may frequently be noticed through the delicate shell.

[Fig. 16.]

As already stated, the eggs are deposited on all parts of the pod, and the mother beetle displays no particular sagacity in the number which she consigns to each, for I have often counted twice as many eggs as there were young peas, and the larvæ from some of these eggs would of course have to perish, as only one can be fully developed in each pea. The newly hatched larva is of a deep yellow color with a black head, and it makes a direct cut through the pod into the nearest pea, the hole soon filling up in the pod, and leaving but a mere speck, not so large as a pin-hole, in the pea. The larva feeds and grows apace and generally avoids the germ of the future sprout, perhaps because it is distasteful, so that most of the buggy peas will germinate as readily as those that have been untouched. When full grown this larva presents the appearance of Figure 17, *c*, (after Curtis) and with wonderful precognition of its future wants, eats a circular hole on one side of the pea, and leaves only the thin hull as a covering. It then retires and lines its cell with a thin and smooth layer of paste, pushing aside and entirely excluding all excrement, and in this cell it assumes the pupa state (Fig. 17, *d*, after Curtis,) and eventually becomes a beetle, which, when ready to issue,

[Fig. 17.]

has only to eat its way through the thin piece of the hull which the larva had left covering the hole. It has been proved that the beetle would die if it had not during its larval life prepared this passage way, for Ernest Menault asserts* that the beetle dies when the hole is pasted over with a piece of paper even thinner than the hull itself.

REMEDIES AND PREVENTIVES.

Sometimes, and especially when the summer has been hot and prolonged, many of the beetles will issue from the peas in the fall of the same year that they were born, but as a more general rule they remain in the peas during the winter and do not issue till new vines are growing. Thus many yet remain in the seed peas until they are planted and especially is this apt to be the case with such as are planted early. We see, therefore, how easily this insect may be introduced into districts previously free from it by the careless planting of buggy peas, for it has been demonstrated that the beetle issues as readily from peas planted in the earth as it does from those stored away in the bin. All peas intended for seed should be examined and it can very soon be determined whether or not they are infested. The thin covering over the hole of the peas that contain weevils, and which may be called the eye-spot, is generally somewhat discolored, and by this eye-spot those peas which ought not to be planted can soon be distinguished. Where this covering is off and the pea presents the appearance of Figure 15, *b*, there is little danger, for in that case the weevil has either left, or, if still within the pea, is usually dead. It would of course be tedious to carefully examine a large lot of peas, one by one, in order to separate those that are buggy, and the most expeditious way of separating the sound from the unsound, is to throw them into water, when the sound ones will mostly sink and the unsound swim.

There are, however, other and more certain means of preventing the injuries of this insect, and whenever agriculture shall have progressed to that point where by proper and thorough organization all the farmers of a county or of a district can, by vote, mutually agree to carry out a measure with determination and in unison, then this insect can soon be exterminated; for it is easy to perceive that such a result would be accomplished by combinedly ceasing to cultivate any peas at all for one single year! Until some such united action can be brought about, we shall never become entirely exempt from this insect's depredations, for no matter how sound the peas may be that I plant, my vines are sure to be more or less visited by the beetles as long as I have slovenly neighbors. Yet comparatively, my peas will always be enough better to well pay for the trouble, even under these circumstances.

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*Insectes Nuisibles a l'Agriculture.

As already hinted the Pea-weevil prefers a warm to a cold climate, and its devastations are scarcely known in high latitudes. On this account the impression prevails that it does not occur in certain parts of Canada, and few persons are aware that it is nearly as bad, especially in Ontario, as it is with us. We are in the habit of sending to Canada for our seed peas, because we get them free from bugs; but the reason that their seedsmen have such a reputation is to be traced to their greater care in destroying the weevil and in sorting their seed rather than to any immunity from its ravages which their peas possess The following extract from a letter from Mr. Wm. Saunders, of London, Ontario, who, as secretary of the Ontario Fruit Growers' Association and as a prominent member of the Canadian Entomological Society, is as well posted, perhaps, as any one in the Dominion, will give some idea of its occurrence there:

The Pea-weevil I find prevails in all parts of Canada to a greater or lesser extent, from the Red River settlement to Quebec. In some places it is so numerous as to discourage farmers from attempting to grow peas at all, while other localities are but little troubled. About the neighborhood of Windsor (opposite Detroit) there are no peas grown worth speaking of; but 60 or 70 miles further east, towards London, they are an important crop, and about London, say within 30 or 40 miles, and as far east as Guelph and Hamilton, will include the chief district from which your western supplies are drawn.

During 1869 I grew a field of peas on my own farm. They produced a good crop, and although we have some of them on hand yet I have never observed a buggy one amongst them, although I have examined them several times. But it is rare to find them so free as that and something depends on the season. Last season the weather was very wet and the crop very light, and the dealers tell me now that there are scarcely any peas fit to ship in the country on account of the quantity of bugs they contain. They say that they always have to select for shipping, and while sending them as clean as possible they do not profess to send them entirely free from bugs.

Our farmers here are perhaps a little more particular than yours about their seed. They will sometimes keep it over till the second year or else scald it before planting so as to destroy a large proportion of the bugs. The general opinion seems to be that if peas are sown late, say about the first of June, they will be almost free from bugs in any season, and some adopt this method, but it is not by any means a general thing, for should the weather set in very hot, as it sometimes does about that time, they would become somewhat dwarfed and the crop lessened. I have not heard of any one growing two crops in one season.

Many eminent seedsmen—Mr. Langdon for instance as I have been credibly informed—effectually kill the weevils by enclosing the peas in tight vessels along with camphor. The same object is attained by keeping peas two years, and taking care that the beetles do not escape before they die. Peas will grow well when kept for two years or even longer, but they should always be well dried so as not to mould. A good plan is to tie them up in bags and hang them in an airy place from the time they are gathered till about Christmas, and then in order that they may not become too dry, to put them into

tighter vessels. To a certain extent sound peas may be obtained by planting late, for the period of egg-depositing is limited to about a month. Peas, as Mr. F. A. Nitchy of Jefferson City has demonstrated, may be planted in the central part of the State as late as the first of June, and by the time the plants from such late planted seed begin to bear pods, all the weevils will have died and disappeared. Wherever a second crop of peas can be grown the same year, this second crop will be entirely free from weevils, and though there seems to be some difficulty in producing a second crop in our State, on account of mildew, it is often done in higher latitudes. Choice lots of seed, if found to be infested when received from the seedsman, may be thrown into hot water for a minute or two, and the sprouting of the peas will be quickened, and most of the weevils, but not all, be killed. But whatever plan be adopted to obtain sound seed, it should be every man's aim, in duty to himself and to his neighbors, to plant none but bugless peas!

As natural checks, the Crow Black-bird is said to devour great numbers of the beetles in the spring, and according to Harris the Baltimore Oriole splits open the pods to get at the grubs contained in them.

THE GRAIN BRUCHUS—*Bruchus granarius*, Linn.

[Fig. 18.]

There is a weevil in Europe which is very common, attacking peas there as badly as our own Pea-weevil does in this country. It also infests beans and several other grains and seeds. It has on several occasions been imported with foreign seeds into this country, but very fortunately does not seem so far to have obtained a strong foothold. There is nothing to prevent its doing so, however, except the utmost vigilance on the part of those who import seeds, and it may at any time get scattered over the country by the distribution of infested seed from the Department of Agriculture, unless the authorities are ever watchful to prevent such a catastrophe. To enable a ready recognition of this weevil, I present an enlarged portrait of it at Figure 18. As will be noticed by that figure it bears a tolerably close resemblance to our own Pea-weevil, but it may always be distinguished from the latter species by the following characters as given by Curtis:—

It is in the first place a smaller insect, averaging but 0.14 inch while *pisi* averages nearly 0.20 inch. It is rather darker, there are two small white spots on the disk of the thorax, and the tooth at each side of the thorax is indistinct; the suture of the wing-covers forms a brown stripe, and the apical joint of the abdomen which protrudes

beyond the wing-covers and which is otherwise known as the pygidium, is densely clothed with grayish pubescence, and shows in certain lights four minute dark dots, but no indication of the two large oval spots so characteristic of our Pea-weevil. The four basal joints of the autennæ and the front legs are reddish, and the inner spine of the hind shanks is prolonged.

It would be a sad misfortune to have this insect added to our list of injurious species, and it is no wonder that upon discovering specimens of our own Pea-weevil just disclosed in a parcel of peas which he had taken with him from America, the Swedish traveler Kalm was thrown into such a trepidation lest he should be the instrument of introducing so fatal an evil into his beloved country.

To give some idea of the habits of the Grain Bruchus, I quote the following account from Curtis's Farm Insects:—

"This species, which is everywhere abundant as early as February on the furze when it is in blossom, inhabiting also the flowers of various other plants in the beetle state, as the Rhubarb, Meadow-sweet (*Spiræa ulmaria*), etc., is a most destructive insect in our pea and bean fields, the larvæ feeding in the seeds and sometimes destroying more than half the crop. They are exceedingly abundant in some parts of Kent, where they often swarm at the end of May, and are occasionally found as late as August; indeed I killed one in November, imported with Russian beans, which had been alive since the end of September. It attempted to fly away in October; it then became torpid, but on warming it by a fire in the middle of November, it was as lively and active as in the height of summer, and I dare say would have lived through the winter.

"It is said that the female beetles select the finest peas to deposit their eggs in, and sometimes they infest crops to such an extent that they are eaten up by them, little more than the husk being left. The various kinds of beans are equally subject to their inroads; besides the long-pods I have alluded to, I have had broad Windsor beans sent to me containing these *Bruchi;* and Mr. C. Parsons transmitted me some horse-beans in the beginning of August, 1842, which were entirely destroyed by them. Mr. F. J. Graham showed me some seed beans which were inoculated by these beetles to a great extent, and some of them were alive in the seeds; yet to any one ignorant of the economy of this pest, there would not appear the slightest external indication of their operations. I also received from a gentleman residing in Norfolk a sample of seed beans from Russia, for winter sowing, a large proportion of which was perforated by this *Bruchus.*

"It has already been intimated that as the beetles generally leave the germ uninjured, the vitality of infested seeds is not destroyed. I doubt, however, if they produce strong healthy plants; and from my own experience I have no doubt if peas and beans be sown containing the *Bruchus granarius*, that the beetles will hatch in the ground, and thus the cultivator will entail upon himself a succession of diseased pea and bean crops. Now to avoid this loss, the seed should be examined before sowing, when to an experienced eye the presence of these beetles will be discernible, where to a common observer they would appear sound and good. The maggots, when arrived at their full size, gnaw a circular hole to the husk or skin of the seed, whether pea or bean, and even cut around the inner surface which covers the aperture, so that a slight pressure from within will force this lid off;

these spots are of a different color to the rest of the seed, generally having a less opaque appearance, and often are of a duller tint; on picking off this little lid, a cavity will be found beneath containing either a maggot, pupa, or beetle."

THE AMERICAN BEAN-WEEVIL—*Bruchus fabæ*, N. sp.

This is another *Bruchus* which bids fair to out-do the celebrated Pea-weevil in its injurious work, and since it has but just made its appearance in our State as a bean destroyer, and is yet confined, so far as I am aware, to one single locality, I hope that the following account of it will have the effect to prevent its introduction into neighborhoods where it is now unknown, and thus keep it from spreading over the State. It appears to be a native American insect and doubtless fed originally on some kind of wild bean (*Phaseolus* or *Lathyrus*,) but it was first noticed in our cultivated beans about ten years ago, in Rhode Island, and has since at different times suddenly made its appearance in several other parts of the country. Maj. J. R. Muhleman, of Woodburn, Ills., informs me that while in South Carolina in 1863, some kind of weevil was often so common in the beans used by the army that before using such beans the men had to soak them, and afterwards lay them out to dry, in order to allow the beetles to escape. The weevil was doubtless the species under consideration, but there is no means of ascertaining from which part of the country the beans came.

[Fig. 19.]

Though already pretty well distributed in some of the Eastern States, especially in New York, it appears to be yet confined to certain localities in the Mississippi Valley. It has for instance, been quite troublesome of late years in Madison county, Ills., for I received last spring numerous specimens from Mr. Geo. W. Copley, of Alton, and am informed by Mr. J. F. Wielandy, of Jefferson City, Mo., that his father who is a resident of that county has been much troubled with it; yet it has never been heard of in other parts of the State. The only place in which I have, so far, found it in Missouri, is around Eureka, in St. Louis county, where it was first noticed in 1869, but where it occurred the present year in great numbers in two different fields of a white pole bean. It occurs in some parts of Pennsylvania, and is quite common in New York, and to illustrate the amount of damage it is capable of doing, I make room for the following letter, which was received in November, 1870, from Mr. James Angus, of West Farms, N. Y., and which refers to this insect:

I enclose you a sample of beans to show you how thoroughly and effectually this little vagabond is plying his time immemorial avocations in the bean-patches in this quarter. Five or six years ago I had occasion to call on a neighbor, and in passing through the barn he

pointed out to me a heap of threshed beans, on the floor, of the Early Mohawk variety, which he said had been destroyed by bugs getting into them since they were threshed. (?) A casual inspection showed that they were destroyed sure enough. At least one-half of them were as badly infested as the sample I send you, but as I pointed out to him, the damage which was now an accomplished fact, had been commenced during the growing season, and the "bugs" were now leaving the beans instead of entering them.

Next season I found a few among my own beans, and they have been on the increase ever since; and this year my Yellow Six Week variety are nearly as bad as my neighbors referred to above. They are nearly as bad this year on a pole variety, the "Dutch Case Knife," as they are on the low growing ones. The small black bush variety, however seems to have escaped them. If some check is not put to their ravages soon, the culture of beans will have to be given up here.

In a short article on this weevil, published by Mr. S. S. Rathvon, in the *American Entomologist*, (Vol. II, pages 118-119,) that gentleman gives the following account of its appearance in his neighborhood:

My specimens evolved in the months of June, July, August and September, from three varieties of the domestic bean (*Phaseolus*,) commonly called "Cranberry," the "Agricultural," and the "Wrens-egg" beans, obtained from Mrs. P. C. Gibbons, Enterprise, Lancaster county, Pa. * * * * I have not yet heard of this insect being found in any other locality in Lancaster county than the one above named. The tenant from whom Mrs. Gibbons received these infested beans has been engaged in the bean culture for twenty-five years on the same farm, and never noticed these weevils until within the last two or three years, and only last year did their destructive character become conspicuously apparent; for out of a small sack of seed-beans hung away, containing less than two quarts, she gathered nearly a teacup-full of the weevils at planting time, in the early part of June, and had all been infested as those were which she brought to me, she could have easily doubled the quantity. About five years ago Mrs. Gibbons received some seed-beans of the "Cranberry" variety, from Nantucket, Mass, and prior to that, she also received some from the Agricultural Department of the Patent Office, and with the one or the other of these, the impression is that the weevils must have been received.

If, as I have supposed (and by perusing what is printed below in small type, the reader will see that no other conclusion can be drawn), this weevil is indigenous; it may possibly occur over large tracts of our country, though the fact that, till a few years ago, it had never been collected by any American entomologist, would strongly intimate that, in what may be termed its wild state, it was quite rare and had a limited range. But even if it should occur in this wild state more generally through the country than the facts would lead us to believe, there is nevertheless more danger of its being introduced into a bean field hitherto exempt by the planting of infested cultivated beans, than by its spreading from the wild food. And if once a few buggy beans are planted, they will in a few years contaminate the other beans cultivated in the neighborhood, so that the man who year after

year grows his own seed will suffer as much as the man who originally introduces the weevils from afar.

Except in being smaller, the larva and pupa of this weevil have a close resemblance to those of the Pea-weevil, and its habits are very similar, with the exception that the female deposits a greater number of eggs on a single pod, so that sometimes over a dozen larvæ enter a single bean. I have counted as many as fourteen in one small bean, and the space required for each individual to develop is not much more than sufficient to snugly contain the beetle. The little spot where the Pea-weevil entered can always be detected even in the dry pea, but in the bean these points of entrance become almost entirely obliterated. The cell in which the transformations take place is more perfect and smooth, and the lining is easily distinguished from the meat of the bean by its being more white and opaque. The excrement is yellow or darker than the meat, and even where a bean is so badly infested that the inside is entirely reduced to this excrementitious powder, each larva, before transforming, manages to form for itself a complete cell, which separates it from the rest of its brethren. The eye-spot, as in the pea, is perfectly circular and quite transparent in white-skinned varieties, so that infested beans of this kind are easily distinguished by the bluish-black spots which they exhibit (Fig. 19, *b*). Dark beans when infested are not so easily distinguished.

I have always found the germ either untouched or but partially devoured even in the worst infested beans, so that when but two or three weevils inhabit a bean, it would doubtless grow; but where the meat is entirely destroyed, as it often is, the bean would hardly grow though the germ remained intact, and it would certainly not produce a vigorous plant.

Many of the beetles are perfected in the fall, but many of them not till the following spring, so that there is the same danger of introducing them in seed-beans, as in the case of the Pea-weevil. The remedies and preventives given in the former case will of course apply equally well in this, and I hope that every bean-grower in Missouri who reads this article will make some effort to keep the scourge out of his own neighborhood, by urging upon others, at the Farmers' Club, or at the meetings of any local societies, the necessity of sowing only sound seed, and of thoroughly destroying any that may be received from abroad and found buggy.

Regarding the proper nomenclature of our Bean-weevil, there has been some confusion, and though it has heretofore been considered by several eminent entomologists as the *Bruchus obsoletus* of Say, and I have heretofore, upon insufficient grounds, referred it to that species myself, it nevertheless turns out to be undescribed. In Europe, besides the Grain Bruchus which I just treated of, there are several other species belonging to the same genus which attack

beans; but our insect differs from all of them and especially from the Grain Bruchus, to which it has been erroneously referred by Dr. A. S. Packard, Jr.* If it were the imported Grain Bruchus, our peas and some other grains would probably suffer as much from its attacks as our beans, because that species infests peas and other seeds in Europe; but in reality we have no more reason to believe that our Bean-weevil will attack our peas than that the Pea-weevil will attack our beans.

The general color of our Bean-weevil is tawny-gray, the ground-color being dark and the whole body covered with a grayish pubescence which inclines to yellow or fulvous, or wears a slight moss-green hue, and is shaded as in Figure 19, *a*. It is but half the size of the Pea-weevil and has the four or five basal joints and the terminal joint of the antennæ, and the legs, with the exception of the lower and inner part of the hind thighs, reddish-brown.

BRUCHUS FABÆ N. Sp. (Fig. 19,)—General color tawny-gray with more or less dull yellowish. *Body* black tinged with brown and with dull yellowish pubescence, the pygidium and sides of abdomen almost always brownish. *Head* dull yellowish-gray with the jaws dark brown and palpi black; antennæ not deeply serrate in ♀, more so in ♂; dark brown or black with usually 5, sometimes only 4, sometimes 4 and part of 5 basal joints, and with the terminal joint, more or less distinctly rufous, or testaceous, the color being so slight in some specimens as scarcely to contrast at all with the darker joints. *Thorax* narrowed before, immaculate, but with the pubescence almost always exhibiting a single pale medio-dorsal line, sometimes three dorsal lines, more rarely a transverse line in addition, and still more rarely (two specimens) forming a large dark, almost black patch each side, leaving a median stripe and the extreme borders pale and thus approaching closely to *erythrocerus* Dej.; base with the edges almost angulated; central lobe almost truncate and with a short longitudinal deeply impressed median line; no lateral notch; scutel concolorous and quadrate with the hind edge more or less notched. *Elytra* with the interstitial lines having a slight appearance of alternating transversely with dull yellowish and dusky; so slight however that in most of the specimens it can hardly be traced: the dark shadings form a spot on each shoulder and three transverse bands tolerably distinct in some, almost obsolete in others, the intermediate row being the most persistent and conspicuous: between these dark transverse rows the interstices are alternately more or less pale, especially on the middle of the 3rd interstitial lines. *Legs* covered with grayish pubescence, and with the tibiæ and tarsi, especially of first and second pair, reddish-brown; the hind thighs usually somewhat darker, becoming black below and inside, and with a tolerably long black spine followed by two very minute ones. Length 0.09—0.14 inch. Described from 40 specimens all bred from different kinds of beans. Hundreds of others examined.

This insect has been for several years ticketed in some of the Eastern collections by the name of *B. fabæ*, or else, what is worse, the corruption of it, *fabi*. The former name has been disseminated by my friend F. G. Sanborn of Boston, Massachusetts, who says that he received the weevil thus named, together with beans attacked by it, in the year 1862 from Rhode Island. The name was credited to Fabricius, but I can find no notice in any of the works I possess of any European *Bruchus fabæ*, and several of my Eastern correspondents who have access to large libraries have been unable to find any description or allusion to a species by that name. Dr LeConte has given it the MS name of *varicornis* but as his description will not appear perhaps for years to come and as no comprehensive description has yet been published, I have deemed it advisable to dispel in a measure the confusion that surrounds the nomenclature of the species. There is need of a description of so injurious an insect, and as *fabæ* is not preoccupied I adopt the name because it is entirely appropriate and because it is more easily rendered into terse popular language that *varicornis*. †

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* Injurious insects new and little known, pp. 19–21.

† No one can have a greater regard than I have, for the work of our great Coleopterist, Dr. LeConte, who is justly looked up to as our authority in his specialty; and for no other reason than the one given above would I venture to disregard even one of his manuscript names. Were he now at home, I should have corresponded with him on the subject, and I feel satisfied that he would have sanctioned this course. These remarks are prompted by the fact that certain entomolo-

It resembles most closely of any other species which I have seen, the *B. erythrocerus*, Dej. which, however, is smaller, and differs in having a narrower thorax which has light sides and a dark, broad dorsal stripe divided down the middle by a pale narrow line: *erythrocerus* is further distinguished by the antennæ being entirely testaceous and the hind thighs more swollen.

From *obsoletus* Say, *fabæ* differs materially: *obsoletus* is a smaller species, dark gray, with the antennæ all dark, the pygidium not rufous, the thorax with a perceptibly darker dorsal shade so that the sides appear more cinereous, a white scutel, and each interstitial line of the elytra with a slight appearance of alternating whitish and dusky along its whole length; for though there is nothing in Say's language to indicate whether it is the interstitial lines that alternate transversely, whitish and dusky, or each line that so alternates longitudinally, I find from an examination of a specimen in the Walsh collection, that the latter is the case, and so much so that the insect almost appears speckled. The two species differ both in size and color, though, as Say's description is short and imperfect it is not surprising that *fabæ* should have been referred to it.

From the European bean-feeding *Br. flavimanus* (which is apparently either a clerical error for, or a synonym of *Br. rufimanus*, Schœnh.) as described by Curtis, it differs notably; as it does likewise from their *Br. serratus*, Ill., which also attacks beans.

Dr. LeConte, according to Mr. Rathvon, was inclined to consider this insect the *obsoletus* of Say, from the fact that in specimens which the latter gentleman sent him, the antennæ were not varied as in his MS. *varicornis*, but uniformly black. A few specimens which Mr. Rathvon sent me nearly two years ago, taken from the same lot as were those which he forwarded to Dr. LeConte, were singularly enough, all decapitated but two; and these two showed the varied antennæ. These specimens had all been kept in alcohol, and I am greatly inclined to believe that the uniformly dark appearance of the antennæ that was noticed by LeConte was the effect of the alcohol on those which naturally had the rufous joints but faintly indicated. At all events, though Mr. Rathvon tells me that he found a small proportion of beetles with dark antennæ, after examining, at my suggestion, over two hundred specimens that had thus been kept in alcohol; yet from over one hundred specimens which he had the kindness to send me, I only find (after thoroughly drying them) three with the terminal joint really as dark as the subterminal, and not a single one in which the rufous basal joints cannot be more or less distinctly traced.

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gists have objected to isolated descriptions of insects, on the plea that they cause confusion and an unnecessary synonymy in our nomenclature. There is, in fact, a certain class of persons—and they have been aptly termed closet-entomologists—who manifest a superlative contempt for anything that does not appear in the transactions or publications of some scientific society; and they even claim that the descriptions which have appeared in State Entomological Reports are invalid and should be disregarded. The descriptions of Dr. Fitch, and many of those of the late Mr. Walsh, and my own, would of course come under this head. It is a little significant, however, that the very persons who manifest such a contempt for scientific work, whenever it is combined with the practically useful, are the very ones who indulge in the fatal monomania for grinding out new species from the mere comparison of a few more or less damaged specimens of the perfect insects, obtained nobody knows how, when or where; and without even the slightest knowledge of the larval and pupal history and the general habits of the so-called species. They make species out of the slightest individual variation, and even erect genera upon a slight individual difference in the size or shape of the wing. So baseless a system must necessarily be fraught with great scientific untruthfulness, and is well calculated to disgust the student who endeavors to rightly interpret the significances in Nature. An immense number of the published descriptions in the Class of insects in this country are based upon the simple examination of solitary specimens of the perfect insects, without the fact being mentioned, and are therefore not in any true sense of the term descriptions of species, but mere descriptions of individuals. The few men whose sole ambition seems to be to attach their names to as many of these so-called species as possible, are the ones who are most inclined to sneer at, and treat lightly the honest work of more practical men—forgetting that science does not consist of mere classification and orderly arrangement, but that she wears a nobler mien when applied to penetrating and comprehensive search after Nature's truths.

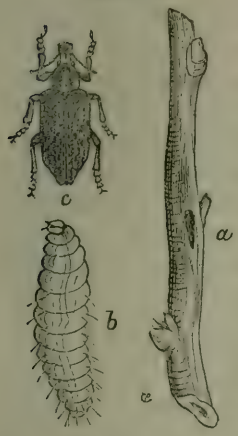
A truth is equally scientific, whether published in a plain, practical work, or in the drier pages of the transactions of some august scientific body; and so far as the science of entomology is concerned, it will certainly be more advanced by the full and comprehensive description of a species, albeit such description be clothed in plain terms and published in a popular work, than by a less complete and more confused description, in the transactions of an Entomological Society; and provided it is published in a work essentially entomological, the monographer will certainly prefer the former to the latter. In the past, science belonged to the few, and was always paraded before the world in as unattractive and technical a form as possible. To-day she is fast becoming the property of the multitude, and should be popularized as much as possible; for it is folly to suppose, as some men do, that in science "popular" and "inaccurate" are synonymous terms, simply because some writers have failed to combine the scientifically accurate with the popular and practical.

The entomologist who occupies himself with the habits of insects, cannot well become a systematist, and would far sooner accurately describe the hitherto unknown habits and transformations of a single common species, than describe a dozen new ones. He may have hundreds of new species in his cabinet; but these he prefers to turn over to the specialist, whose work he fully appreciates and whose aid he must often seek. When, however, in the course of his work, he is obliged to publish an isolated description, the specialist proper should certainly not depreciate his labor, providing it is well performed.

THE NEW YORK WEEVIL—*Ithycerus noveboracensis*, Forster.

The large gray beetle represented at *c*, in the accompanying cut often does considerable damage to fruit trees, and I continually receive it every spring by persons who desire to know more of its habits. It kills the twig by gnawing off the tender bark, in the early part of the season before the buds have put out, and later in the year it destroys the tender shoots which start out from old wood, by entirely devouring them. It eats out the buds and will also frequently gnaw off the leaves at the base of the stem, after they have expanded. It attacks, by preference, the tender growth of the Apple, though it will also make free with that of Peach, Plum, Pear and Cherry, and probably of other fruit as well as forest trees. It is the largest snout-beetle which occurs in our State. and with the rest of the species belonging to the same genus (*Ithycerus*=straight-horn) it is distinguished from most of the other snout-beetles by the antennæ or feelers being straight instead of elbowed or flail-shaped as they are in the common Plum Curculio, for instance. The specific name *noveboracensis* which means "of New York" was given to this beetle just 100 years ago by Forster, doubtless because he received his specimens from New York. But like many other insects which have been honored with the name of some Eastern State, it is far more common in the Mississippi Valley than it is in the the State of New York, it scarcely being known as an injurious insect in the East. It was subsequently described as *Pahyrhynchus Schœnherri* by Mr. Kirby. The general color of the beetle is ash-gray, marked with black as in the cut (Fig. 20, *c*), and with the scutel or small semi-circular space immediately behind the thorax, between the wings, of a yellowish color. Its larval habits were for a long time unknown, but two years ago I ascertained that it breeds in the twigs and tender branches of the Bur oak, and have good reason to believe that it also breeds in those of the Pignut hickory. The female in depositing, first makes a longitudinal excavation with her jaws (Fig. 20, *a*) eating upwards under the bark towards the end of the branch, and afterwards turns round to thrust her egg in the excavation. The larva, (Fig. 20, *b*) hatching from the egg is of the usual pale yellow color with a tawny head. I have watched the whole operation of depositing, and, returning to the punctured twig a few days after the operation was performed, have cut out the young larva; but I do not know how long a time the larva needs to come to its growth, nor whether it undergoes its transformations within the branch, or leaves it for this purpose to enter the ground; though the former hypothesis is the more likely.

[Fig. 20.]



This insect is more active at night than during the day, and is often jarred down upon the sheet or the Curculio-catcher, for it falls about as readily as the Plum Curculio.

The destructive pear blight, otherwise known as fire-blight, has been attributed to a peculiar poisonous fluid which this beetle secretes and with which it poisons the wood.* I have never noticed any such secretion, and feel quite convinced that it has nothing to do with the real pear blight (and there are more than one kind) which is very justly considered by the most eminent horticulturists of the land to be of fungoid rather than insect origin. It is quite probable that the beetle secretes some such fluid which causes a sort of blight, because several bark-boring and wood-boring beetles are known to produce such an effect; but this insect-blight must not be confounded with the far more subtle and destructive Pear Blight, so called.

THE IMBRICATED SNOUT-BEETLE—*Epicœrus imbricatus*, Say.

This is another insect, which is quite frequently met with on our different fruit trees, doing considerable injury to apple and cherry trees and gooseberry bushes, by gnawing the twigs and fruit. Its natural history is, however, a sealed book, and I introduce it at present more to draw the attention of orchardists to this fact than to give any information with regard to it. The beetle is a native of the more Western States and is found much more commonly in the western part of the State, in Iowa, Kansas, and towards the mountains than it is on the eastern side of the great Father of Waters.

[Fig. 21.]

The general color is a dull silvery-white with brown markings as in the figure (Fig. 21), which are sometimes dark and distinct, and at others almost obsolete. Indeed the species is so variable that it has received no less than four distinct names, *i. e.* four distinct species have been fabricated out of one.†

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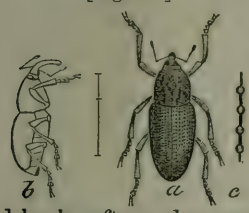
*See a commnnication from H. H. Babcock, of Chicago, in the *Am. Entomologist and Botanist*, Vol. II, p. 176.

†There can be no doubt of this, for the range of variation is so great that specimens agreeing in every respect with *imbricatus*, *fornudolosus*, *vadosus* and *fallax*, are to be met with in very limited localities; and both Dr. LeConte and Mr. Walsh were of opinion that these four so-called species were but varieties.

THE CORN SPHENOPHORUS—*Sphenophorus zeæ*, Walsh.

In the last number of the *Practical Entomologist*, Mr. Walsh gave the first account of a weevil which in certain years does great damage to the corn crop by puncturing the young plant near the ground, and riddling it with holes of about the size that an ordinary pin would make. They may even be found under ground attached firmly to the stalk, and when numerous enough the plant always dies.

[Fig. 22.]



The color of the beetle is brown-black or black, often obscured by yellowish or grayish matter adhering to, and filling up the hollow punctures. Figure 22 gives a good illustration of it, *a* showing a shaded back view, *b* an outline side view, and *c* showing the manner in which the wing-covers are punctured. The original description as given by Mr. Walsh will be found below.

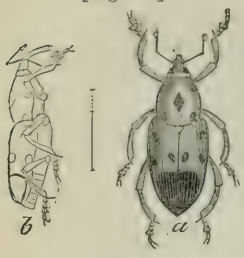
In the spring of 1868, Mr. L. V. Smith, of Geneva, Ontario county, N. Y., sent me numerous specimens; and I have often found it in great numbers on the lake-beach at Chicago, though it does not seem to be common in our own State. But it is well that corn-growers be made familiar with its appearance.

The larval history of this weevil is unknown, but there seems good reason to believe that it breeds in rotting and moist wood, situated in places where it is constantly washed by the water; for the beetles, with others belonging to the same genus are found in such situations and in decayed logs floating in swamps. If this supposition be the correct one—and the fact that it has been injurious only in the immediate neighborhood of rivers and lakes adds great weight to such a supposition—then this weevil will not be likely to multiply unduly where there are not large bodies of water.

"SPENOPHORUS ZEÆ, new species? Color black, often obscured by yellowish matter adhering to the hollow places, which, however, can be partially washed off. Head finely punctured towards the base, with a large dilated puncture between the eyes above. Snout one-third as long as the body, of uniform diameter, as fine as a stout horse-hair, and curved downwards. Before the middle of the thorax a polished diamond-shaped space, prolonged in a short line in front and in a long line behind; and on each side of this an irregularly defined polished space, somewhat in the form of an inverted Y; the rest of thorax occupied by very large punctures, which fade into finer and sparser ones on the polished spaces. Wing-cases with rows of still larger punctures, placed very wide apart in the usual grooves or striæ; the sutural interstice, that between the 2nd and 3rd striæ, and that between the 4th and 5th striæ wider than the rest, elevated, and occupied by very fine punctures; a small elongate-oval polished spot on the shoulder and another near the tip of the wing-case. Beneath, polished, and with punctures as large as those of the thorax.—Length about three-tenths of an inch, exclusive of the snout. Comes very near *Sphenophorus truncatus* Say, but the snout is not "attenuated at tip" and has no "elongated groove at base above;" and moreover, nothing is said in the description of that species of the very large and conspicuous punctures, found in the elytral striæ of our species."

THE COCKLEBUR SPHENOPHORUS—*Sphenophorus pulchellus*, Schœnherr.

[Fig. 23.]



In closing this chapter on snout-beetles I introduce this species (Fig. 23, *a* shaded back view; *b* outline side-view,) not that it is injurious, but because it belongs to the same genus, and is closely allied to the preceding insect; and because its larval habits, which are now given for the first time, may lead us more readily to discover those of its more injurious ally.

The color of this beetle above, is of a deep brick-red inclining to blood-red, often with a tinge of orange, and it is marked with black as in the figure, the whole underside being also black. The larva bores the stalks of the common cocklebur (*Xanthium strumarium*,) and differs from most other snout-beetle larva in having a dark mahogony-brown head, and in the anal joint being slantingly truncated and furnished with fuscous elevations which give rise to short stiff bristles. It transforms in the fall of the year within the stem and issues as a beetle about the end of September.*

Of our other N. A. snout-beetles may be mentioned as especially injurious the Grape Curculio (*Cœliodes inœqualis*, Say), Grape-cane Curculio (*Baridius sesostris*, Lec.) Potato-stalk weevil (*Baridius trinotatus*, Say), the different nut-weevils (genus *Balaninus*), the Grain-weevil (*Sitophilus granarius*, Linn.), the White-pine weevil (*Pissodes strobi*, Peck), and the Cranberry-weevil (*Anthonomus suturalis*, Lec.) The first three have already been treated of in my first Report, the nut-weevils will form the subject of a future article, and the others have either been fully treated of in standard works or are not particularly injurious in Missouri.

*This insect seems to differ from 13-*punctatus*, Say, in absolutely nothing but in having a large black patch at the tip of the elytra instead of two spots. I have bred four specimens from cocklebur, and they are all tolerably constant in the characters accorded to *pulchellus*. But I am strongly of opinion that we have to deal here with but one species, and that with a sufficiently large series, the dividing line could not be drawn. At all events 13-*punctatus* is very variable in the size of its spots, and the greatest variation occurs in these two at the tip of the elytra, while Say describes and figures a variety of his 13-*punctatus* which is singularly intermediate between the two species. In three specimens of 13-*punctatus* in my cabinet, the two posterior spots are so large that they almost meet, while in some specimens they are not larger than the other elytral spots.

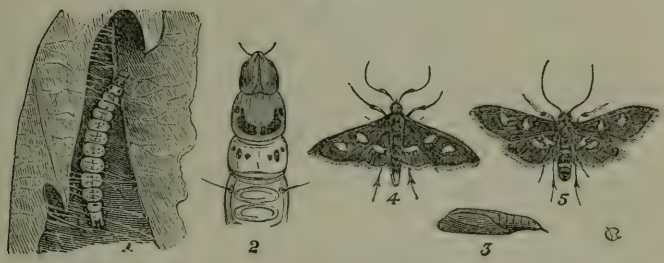
INSECTS INJURIOUS TO THE GRAPE-VINE.

The following articles under this head are a continuation of the series began in my first and continued in my second Report, and I shall continue the series until all the insects of any note, which affect the Grape-vine, shall be treated of.

THE GRAPE LEAF-FOLDER—*Desmia maculalis*, Westw.

(Lepidopteıa, Asopidæ.)

[Fig. 24.]



The subject of this sketch has long been known to depredate on the leaves of the Grape-vine in many widely separated parts of North America. It is not uncommon in Canada West, and is found in the extreme southern parts of Georgia. It appears to be far more injurious, however, in the intermediate country, or between latitude 35° and 40°, than in any other sections, and in Southern Illinois and Central Missouri proves more or less injurious every year. It was first described and named by Westwood,* who erected, for it, the genus *Desmia.*

The genus is characterized by the elbowed or knotted appearance of the ♂ antennæ, in contrast with the smooth, thread-like ♀ antennæ; the maxillary palpi are not visible, while the compressed and feathery labial palpi are recurved against the eyes, and reach almost to their summit; the body extends beyond the hind wings.

The moth of the Grape Leaf-folder is a very pretty little thing, expanding on an average almost an inch, with a length of body of about one-third of an inch. It is conspicuously marked, and the sexes differ sufficiently to have given rise to two names, the female having been named *Botys bicolor.* The color is black with an opalescent reflection, and the under surface differs only from the upper in being less bright; all the wings are bordered with white. The

* Mag. Zool., par M. Guérin, 1831; pl. 2.

† Mr. Glover, in the Agricultural Report for 1854, p. 79, says that the male has a semi-lunar mark of white on the outside of each spot, which in his figure, pl. 6, ibid., is very distinct. In dozens of specimens bred in Illinois and Missouri no such mark appears, though there is an apparent coincident shade, barely distinguished from the black ground-color, on the outside of each spot in both male and female.

front wings of both sexes are each furnished with two white spots;† but while in the male (Fig. 24, 4) there is but one large spot on the hind wings, in the female (Fig. 24, 5) this spot is invariably more or less constricted in the middle, especially above, and is often entirely divided into two distinct spots. The body of the male has but one distinct transverse band, and a longitudinal white dash at its extremity superiorly, while that of the female has two white bands. The antennæ, as already stated, are still more characteristic, those of the male being elbowed and thickened near the middle, while those of the female are simple and thread-like.

There are two broods in this latitude—and probably three farther south—during the year; the first moths appearing in June, the second in August, and the worms produced from these last hibernating in the chrysalis state. The eggs are scattered in small patches over the vines, and the worms are found of all sizes at the same time. These last change to chrysalids in 24 to 30 days from hatching, and give forth the moths in about a week afterwards.

The worm (Fig. 24, 1) folds rather than rolls the leaf, by fastening two portions together by its silken threads; and for this reason, in contradistinction to the many leaf-rollers, may be popularly known as the "Grape Leaf-folder." It is of a glass-green color,* and very active, wriggling, jumping and jerking either way at every touch. The head and thoracic segments are marked as at Figure 24, 2. If let alone, these worms will soon defoliate a vine, and the best method of destroying them is by crushing suddenly within the leaf, with both hands. To prevent their appearance, however, requires far less trouble. The chrysalis is formed within the fold of the leaf, and by going over the vineyard in October, or any time before the leaves fall, and carefully plucking and destroying all those that are folded and crumpled, the supply for the following year will be cut off. This should be done collectively to be positively effectual, for the utmost vigilance will avail but little if one is surrounded with slovenly neighbors.

I believe this insect shows no preference for any particular kind of grape-vine, having found it on well nigh all the cultivated as well as the wild varieties. Its natural enemies consist of spiders, wasps, and a small undescribed species of *Tachina*-fly which I have ascertained to infest it in the larva state, and to which I have given the MS. name of *desmiæ*. There is every reason to believe that it is also attacked by a small clay-yellow beetle, the Grape-vine Colaspis

* I subjoin a description of this worm, as first given by me in the Prairie Farmer Annual for 1868. Average length, 0.80. Largest on abdominal joints, and tapering thence slightly each way. Color glass-green, always darker above than below. A narrow darker dorsal line, with each joint swollen into two transverse wrinkles. Laterally paler or yellowish, and a large and distinct piliferous spot on each joint, with others scarcely visible with a lens. Head fulvous, polished, horizontal, with two small eyespots and two larger dark patches. Joint 1 of the same color, and marked as in Figure 24, 2. Joint 2 has two small spots, with an intermediate larger one, on each side. Legs yellowish. Acquires a carneous or pink tint before changing to chrysalis, which latter is of the normal color, size and form of Figure 24, 3, and has at the tail several very minute curved hooks, joining and forming into a point.

(*Colaspis flavida*, Say,) which is described further on, and which, though a vegetable feeder, may often be found in the fold of the leaf in company with some shrunken, half-dead worm.

THE GRAPE-VINE EPIMENIS.—*Psychomorpha epimenis*, Drury.

(Lepidoptera Zygænidæ.)

Under the head of "Blue Caterpillars of the Vine," an account was given in my last Report (pp. 83–5) of the Pearl Wood Nymph, (*Eudryas unio*, Huebner), and of what I thought there was good reason to believe was its larva, namely, the smaller of the blue caterpillars (Fig. 25, *a* full grown caterpillar; *b* enlarged side view of one of the joints; *c* enlarged hump on the 11th joint). I have since been able to decide definitely as to the character of this larva, having bred numerous specimens to the perfect state. It turns out to be an entirely different insect to what I had conjectured, and produces a beautiful little moth (Fig. 26), which may be known to the grape-grower as the Grape-vine Epimenis.

[Fig. 25.]

[Fig. 26.]

This moth is most strikingly marked and bears no resemblance whatever to the Pearl Wood Nymph. Its color is deep velvety-black with a broad irregularly lunate white patch across the outer third of the front wings, and a somewhat larger, more regular patch of orange-red or brick-red on the hind wings. The underside is similarly marked, but that of the front wings is less velvety with two additional white spots inside near the costa, the outer one generally, and sometimes both of them, connected with the broad white patch. Especially is this the case in the males; the wing appearing to have a large triangular white patch with two quadrate black spots in it connected with the costa. The wings are beautifully tinselled with steel-blue, or purplish scales, which form a narrow band near the outer margin of each and appear more or less distinctly on the basal half of the front wings. On the under side the steel-blue is especially conspicuous on the costa and hind border of the hind wings. In old specimens the scales get much rubbed off and the general color appears duller and more brown. The antennæ of the female are thread-like and with alternate black and white scales. Those of the male are beautifully and broadly toothed on two sides, or bi-pectinate, and he is furthermore distinguished from the female by the more uniform

diameter of his abdomen which is slightly tufted and squarely cut off at the apex.

A full account was given of the larva in the article already referred to, and the proper remedy for its injuries suggested, so that I shall simply add below a technical description of it. Its habit of boring into some substances to prepare for the change to pupa, is inveterate, and it always neatly covers up the orifice so that it is difficult to detect. I have had over a dozen of them enter a single cork but 1¼ inches in diameter and about an inch deep; and such a cork, if given during May of one year to an uninitiated person, with instructions to keep it in a glass vessel, will cause much surprise and interest the following March when the moths will begin to issue from it.

Dr. Melsheimer* wrote to Dr. Harris on the 28th of February, 1840, that he had bred this moth from the larva, and rightly states that recent specimens are not brown, and that the larva is a half looper; but he does not mention its food-plant. Dr. Packard,† who does not mention the sexual differences, quotes Harris as stating on the authority of Abbott, that the larva feeds on the wild Trumpet-creeper (*Bignonio radicans*) in Georgia. But no one has heretofore mentioned its Grape-vine feeding propensities, and it is consequently now added for the first time to our list of Grape-vine depredators, and there are four instead of three bluish caterpillars, all bearing a close general resemblance, which feed upon that plant. They all occur in Missouri, but the present species is far more numerous and destructive than the other three put together. I have now described three of them, and shown wherein they differ from one another, and the fourth, namely, the larva of the Pearl Wood Nymph, is said by Dr. Fitch to so closly resemble that of the Beautiful Wood Nymph that we know not yet whether there are any distinguishing characteristics between them.

PSYCHOMORPHA EPIMENIS, Drury—*Larva.*—General appearance bluish. The ground-color is however pure white, and the apparent bluish cast is entirely owing to the ocular delusion produced by the white with the transverse black bands as in *Alypia octomaculata.* Transversely banded with four black stripes to each joint, the third and fourth being usually rather wider apart than the other two, and diverging at the lower sides where they make room for two more or less conspicuous dark spots placed one below the other; the third on some of the middle joints is frequently broken, with an anterior curve, just above stigmata, and on joints 2 and 3 it is twice as thick as the rest. Cervical shield, hump on joint 11, anal plate, legs and venter, dull pale orange. Joint 1 with about 14 large shiny piliferous black spots, 8 of which form two rows on the cervical shield (those in the anterior row being largest and farthest apart,) and six of which are lateral, namely, three each side, with more or less distinct dusky marks between and in front of them. The spots on the hump are usually placed as at Figure 26, *c*, but vary very much, though the four principal ones on the top are generally placed in a square. The anal plate is marked with 8 such spots, very much as in the cervical shield, but smaller. The tips of the thoracic legs are black and the other legs and venter are also spotted. Head gamboge-yellow, inclining to orange, with 8 principal and other minor black piliferous spots. The ordinary piliferous spots are small, and except two dorsal ones which are in the white space between the second and third band, they are not easily detected. The stigmata are also quite small and round. The abdominal prolegs de-

* Harr. Corr., p. 111.
† Guide, etc., p. 281.

crease in size from the last to the first pair, and the larva curves the thoracic joints and is a half-looper, especially when young. Average length about one inch. Described from numerous specimens.

Chrysalis.—Average length 0.37 inch; reddish-brown; rugose, especially on dorsum of abdominal joints, but distinguished principally by the truncated apex, which has a large horizontally compressed ear-like horny projection at each upper and outer edge.

THE GRAPE-VINE PLUME—*Pterophorus periscelidactylus*, Fitch.

(Lepidoptera, Alucitidæ.)

In my first Report a short account has already been given of this insect, but as it was very numerous last spring, and as I had good opportunities of making further observations, I have concluded, by aid of the accompanying figure, to give a more complete account of it.

[Fig. 27.]

In the earlier published Proceedings of our State Horticultural Society reference is occasionally made to "small grey or green worms which feed on the young leaves before blossoming," * without any definite name being given to them. Husmann, in his "Grapes and Wine," (p. 80) mentions similar worms, and I have little doubt but that the insect referred to is the little Plume we are now considering.

Just about the time that the third bunch of grapes, on a given shoot, is developing, many of the leaves, and especially those at the extremity of the shoot, are found fastened together more or less closely, but generally so as to form a hollow ball. These leaves are fastened by a fine white silk, and upon opening the mass and separating the leaves, one of two caterpillars will generally be found in the retreat. I say one of two, because the retreat made by the smallest of the Blue Caterpillars of the Vine, namely, the larva of the Grape-vine Epimenis (Fig. 26, *a*) which we have just treated of, so closely resembles that of the Grape-vine Plume under consideration, that until the leaves are separated it is almost impossible to tell which larva will be found. Both occur at the same time of year, and both were more destructive than usual the past season in the vicinity of St. Louis. In an ordinary season they do not draw together the tips of the shoots till after the third bunch of grapes is formed, and in devouring the terminal bud and leaves, they do little more than assist the vineyardist in the pruning

* Proceedings for 1860, p. 58, and 1861-2, p. 77.

which he would soon have to give. They act, indeed, as Nature's pruning-knives. But the late and severe frost which killed the first buds last April, so retarded the growth of the vines that the worms were out in force before the third bunch had fully formed, and this bunch was consequently included in the fold made by these worms, and destroyed.

The larva of the Grape-vine Plume invariably hatches soon after the leaves begin to expand; and though it is very generally called the Leaf-folder, it must not be confounded with the true Leaf-folder, which was just now described, and which does its principal damage later in the season. At first the larva of our Plume is smooth and almost destitute of hairs, but after each moult the hairs become more perceptible, and when full grown the larva appears as at Figure 27, *a*, the hairs arising from a transverse row of warts, each joint having four above and six below the breathing-pores * (see Fig. 27, *e*). After feeding for about three weeks, our little worm fastens itself securely by the hind legs to the underside of some leaf or other object, and, casting its hairy skin, transforms to the pupa state. This pupa (Fig. 27, *b*), with the lower part of the three or four terminal joints attached to a little silk previously spun by the worm, hangs at a slant of about 40°. It is of peculiar and characteristic form, being ridged and angular, with numerous projections, and having remnants of the larval warts; it is obliquely truncated at the head, but is chiefly distinguished by two compressed sharp-pointed horns, one of which is enlarged at Figure 27, *c*, projecting from the middle of the back; it measures, on an average, rather more than one-third inch, and varies in color from light green with darker green shadings, to pale straw-color with light brown shadings.

The philosophic student of insect life cannot fail to be struck with the wonderful disguises which these little animals often assume, the better to escape detection from their enemies. The instances of protective mimicry are more numerous among insects than among any other Class of animals, and in the last part of this Report, I shall have occasion to refer to this subject more fully. I had often wondered why the pupa of the Grape-vine Plume was seldom noticed in the open vineyard, and I very well recollect, when three years ago, this worm was abundant in the vineyard of the Rev. Charles Peabody of Glenwood, I. M. R. R., that he one day expressed great astonishment at their total and sudden disappearance. I told him that

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* As Dr. Fitch's description of this larva is the only one I know of, and is rather incomplete, I subjoin the following for the scientific reader:

Mature Larva of Pterophorus periscelidactylus.—Average length 0.50 inch. Color pale greenish-yellow. Joints separated by deep constrictions. Each joint with a transverse row of large cream-colored warts, giving rise to soft white hairs, many of which are slightly clubbed at tip. Four of these warts above, and six below stigmata, the four lower smaller than the six upper ones. The hairs from warts above stigmata diverging in all directions and straight, those from the row immediately below stigmata decurving. Other short and more minute club-tipped hairs spring from the general surface of the body between the warts. Head yellow, with labrum slightly tawny. Legs also yellow, immaculate and very long and slender. Described from numerous living specimens.

they had changed to the pupa state and were more thoroughly hidden among the leaves; but he did not succeed in feeding any of the pupæ, and I did not then suspect that we have here a case of mimicry. From some interesting facts communicated to me by Mr. M. C. Read of Hudson, Ohio, I am atisfied, however, that we have here a clear case of protective disguise. He says: "Of a large number raised in jars by me, there were two well defined colors, one a reddish-brown resembling closely the bark of ripe grape wood, the other a light green, or exactly the color of the leaves and young wood. Without an exception the green ones were attached to the green leaves and green wood, or to the sides of the glass jar of very similar color; while all of the brown ones were attached to stems of the ripened grape-wood." Having noted this fact he put large numbers of larvæ in a jar with sticks and material of various colors, but he obtained only the two varieties of pupæ and each was invariably attached to an article of the same color as itself.

So far as I recollect the facts noticed in my own breeding of this insect, they accord with the observations of Mr. Read, and there is no reason to doubt that in a state of nature the green variety confines itself to the leaves, and the brown variety to the wood of the vine. Upon the theory of Natural Selection, *i. e.*, in this case, the preservation of the best disguised specimens, these facts become significant, and it is easy to understand how the two distinct forms would in time inevitably be produced; but whether these singular disguises be explained on that theory or on any other, they are equally interesting and afford good food for the reflective mind.

The moth (Fig. 27, *d*) escapes from this pupa in about one week, and, like all the species belonging to the genus, it has a very active and impetuous flight, and rests with the wings closed and stretched at right angles from the body, so as to recall the letter T. It is of a tawny yellow color, the front wings marked with white and dark brown as in the figure, the hind wings appearing like burnished copper, and the legs being alternately banded with white and tawny yellow.

All the moths of the family (ALUCITIDÆ) to which it belongs have the wings split up into narrow feather-like lobes, and for this reason they have very appropriately been called Plumes in popular language. In the genus *Pterophorus* the front wings are divided into two, and the hind wings into three lobes. As I have shown in my first Report we have a somewhat larger species (*P. carduidactylus*, Riley) which occurs on the Thistle, and which, though bearing a close resemblance to the Grape-vine Plume in color and markings, yet differs very remarkably in the larva and pupa states.

From analogy we may infer that there are two broods of these worms each year, and that the last brood passes the winter in the moth state. I have, however, never noticed any second appearance of them, and whether this is from the fact that the vines are covered

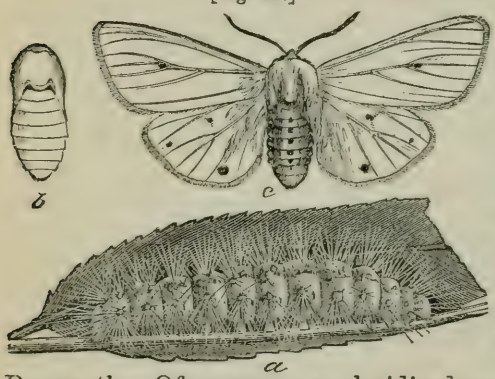
with a denser foliage in the summer than in the spring, or whether there is really but one brood, are points in the history of our little Plume which yet have to be settled by further observation.

On account of its spinning habit, which enables us to detect it, this insect is easily kept in check by hand picking.

THE COMMON YELLOW BEAR—*Spilosoma virginica*, Fabr.

(Lepidoptera, Arctiidæ.)

[Fig. 28.]



This is one of the most common North American insects. The moth (Fig. 28, *c*) which is very generally dubbed "the Miller," frequently flies into our rooms at night; and there are quite a number of our farmers who, somehow or other, have got the idea that this "Miller" is the insect that infests their bee-hives—that it is, in short, the Bee-moth. Of course no such ridiculous idea could for a moment prevail among those who read these Reports.

Though the moth is so common, how few persons ever think of it as the parent of that most troublesome of caterpillars, which Harris has so aptly termed the Yellow Bear (Fig. 28, *a*). These caterpillars are quite frequently found on the Grape-vine, and when about one-fourth grown bear a considerable resemblance to the mature larva of the Grape-vine Plume which we have just described. They seldom appear, however, till that species has disappeared, and may always be distinguished from it by their semi-gregarious habit at this time of their life, and by living exposed on the leaf (generally the under side) instead of forming a retreat within which to hide themselves, as does the Plume.

The Yellow Bear is found of all sizes from June to October; and though quite fond of the vine, is by no means confined to that plant. It is, in fact, a very general feeder, being found on a great variety of herbaceous plants, both wild and cultivated, as butternut, lilac, beans, peas, convolvulus, corn, currant, gooseberry, cotton, sunflower, plantain, smart-weed, verbenas, geraniums, and almost any plant with soft, tender leaves. These caterpillars are indeed so indifferent as to their diet, that I have actually known one to subsist entirely, from the time it cast its last skin till it spun up, on dead bodies of the Camel Cricket (*Mantis carolina*).

When young they are invariably bluish-white, but when full-grown they may be found either of a pale cream-color, yellow, light brown or very dark brown, the different colors often appearing in the same brood of worms, as I have proved by experiment. Yellow is the most common color, and in all the varieties the venter is dark, and there is a characteristic longitudinal black line, more or less interrupted, along each side of the body, and a transverse line of the same color (sometimes faint) between each of the joints: the head and feet are ochre-yellow, and the hairs spring from dark yellow warts, of which there are 10 on each joint, those on joint 1 being scarcely distinguishable, and those on joint 12 coalescing. There are two broods of these worms each year, the broods intermixing, and the last passing the winter in the chrysalis state. The chrysalis (Fig. 28, *b*) is formed in a trivial cocoon, constructed almost entirely of the caterpillar's hairs, which, though held in position by a few very fine silken threads, are fastened together mainly by the interlocking of their minute barbs, and the manner in which the caterpillar interweaves them.

The moth makes its appearance as early as the first of May in the latitude of St. Louis, but may often be found much earlier in stove-warmed rooms. It is easily recognized by its pure white color, by its abdomen being orange above, with three rows of black spots, and by the black dots on its wings. These dots vary in number, there being usually two on each of the front and three on each of the hind wings, though sometimes they are all more or less obsolete, except that on the disk of the front wings.

It is fortunate for us that this caterpillar is attacked by a large number of insect parasites; for, were this not the case, it would soon multiply to such a degree as to be beyond our control. I know of no less than five distinct parasites which attack it—some living singly in the body of the caterpillar, and issuing from the chrysalis without spinning any cocoon of their own; others living singly in the body, but forming a cocoon of their own inside the chrysalis of their victim, and still others infesting the caterpillar in great numbers, and completely filling the chrysalis with their pupæ.*

The best time to destroy these worms is soon after they hatch from their little round yellow eggs, which are deposited in clusters; for, as already intimated, they then feed together.

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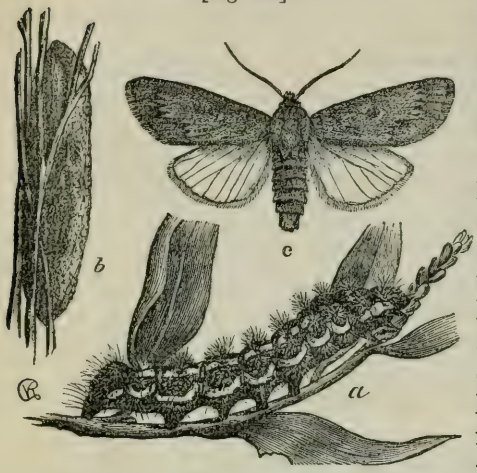
* For the benefit of the scientific reader I enumerate the five parasites which I have ascertained to infest this caterpillar: 1. *Anomalon flavicorne* (Brullé Hym IV, p. 171). 2. *Ichneumon subcyaneus*, Cress. (Proc. Ent. Soc., Phila., III, p. 148), and *Ich. pullatus*, Cress. (Pro. E. S. P., III, p. 146), described as a distinct species, but *pullatus* is evidently the male, and *subcyaneus* the female of the same species, as I have bred from *Spilosoma virginica* three males all answering to the description of the former, and two females both answering to the description of the latter. 3. *Ichneumon signatipes*, Cress. (Trans. Amer. Ent. Soc., I, p. 308). 4. *Ophion bilineatus*, Say. (Int. of N. A., I, p. 379). 5. A small undetermined, and probably undescribed Dipteron belonging to the MUSCADÆ.

THE SMEARED DAGGER—*Acronycta oblinita*, Sm. & Abb.

(Lepidoptera, Acronyctidæ.)

This is another insect which is occasionally found upon the Grapevine, but never in sufficient numbers to do any considerable harm. It is one of our most common insects, and a very general feeder, occurring on a great variety of herbaceous plants, among others asparagus and cotton, and being especially partial to the common smartweed (*Polygonum hydropiper*). It also feeds on some shrubs an trees, occasionaly proving quite injurious, for Mr. F. A. Nitchy, of Jefferson City, sent me specimens last summer with the statement that they were very numerous on his peach trees, and I have known it to denude both apple and willow trees.

[Fig. 29.]



The larva (Fig. 29, *a*) is easily recognized by the distinct wavy bright yellow band at the side, and the transverse row of crimson-red warts and stiff yellowish or rust-red bristles across each joint, in contrast with the black color of the body. When full grown it draws a few leaves or stems together, or retreats into some fence corner, and spins a narrow elongated cocoon (Fig. 29, *b*) generally white, but occasionally inclining to ochre-yellow, some which I have found on Willow being of this last color. The chrysalis is very dark brown, and, with the exception of a smooth shiny band on the posterior border of each abdominal joint, is rough or shagreened. It has the power of violently turning round and round in its cocoon when disturbed, thereby causing a rustling noise. The moth (Fig. 29, *c*) has the front wings of an ash-gray color, caused by innumerable dark atoms scattered over a white ground, and there is a distinct row of black dots along the posterior border, a more or less distinct black zigzag line across the outer fourth, and some dusky spots just above the middle of the wing. The hind wings are pure white.

There are two broods each year, the first brood of worms appearing for the most part during June, and giving out the moths in July, and the second brood occurring in the fall, passing the winter in the chrysalis state, and producing moths the following May.

Handpicking is the only remedy that it has been found necessary to adopt with this caterpillar whenever it becomes troublesome.

There are at least three natural enemies which serve to keep it in check. The largest of these is the Uni-banded Ichneumon-fly (*Ichneumon unifasciatorius*, Say), a large black fly, 0.60 inch long, and characterized by a white annulus about the middle of the antenna, a large white spot about the middle of the thorax, and a white band on the first joint of the abdomen.

This fly oviposits in the larva of the Smeared Dagger, but the latter never succumbs till after it has spun up and become a chrysalis, for I have always obtained the Ichneumon from the chrysalis. The other parasites are smaller and work differently. They each cause the larva of the Smeared Dagger to die when about full grown, and its contracted and hardened skin, which may often be seen during the winter, with the head attached (Fig. 30, *a*), fastened to the twigs of apple and wil-

[Fig. 30]

low trees, forms a snug little house where the parasite undergoes its transformations and through which it gnaws a round hole (Fig. 30, *b*), to escape the latter part of April. One of these flies (*Aleiodes Rileyi*, Cresson,) is described on page 382, of Volume II, of the Transactions of the American Entomological Society, and is of a uniform reddish-yellow color. The other is a black fly of about the same size, but belonging to an entirely different genus, *Polysphincta*. It has two prominent carinæ on the dorsum of the basal joint of the abdomen, and the legs, except the hind tarsi and last half of hind tibiæ are rufous. It is marked *bicarinata* in my MS., but I omit the description as I do not possess the female. The first of these parasites is in its turn preyed upon by a minute *Chalcis* fly of a steel-blue color with honey-yellow legs, which issues in great numbers through a very minute hole, from the dried caterpillar skins.

As I know of no description of *oblinita* in the English language, and as that of Guenèe is rather summary, I subjoin the following:

ACRONYCTA OBLINITA, Sm. and Abb.—*Imago*—Front wings oblong; apex more or less prolonged; posterior margin sometimes rounded, sometimes straight; color ash-gray, caused by numerous dark brown atoms more or less suffused on a white ground, from which the ordinary lines are barely discernible in the better marked individuals; a row of distinct black dots along posterior border; the ordinary spots represented by blurred marks or entirely obsolete; the undulate line across posterior fourth of wing distinct, and relieved inside by a pale coincident shade, with the teeth quite aciculate and with the psi-spot so characteristic of the genus, but rarely traceable; fringe narrow and generally entire. Hind wings pure white, with a faint row of dark spots around posterior border. Under side of both wings white with faint fulvous tint and faint irrorations; each wing showing the brown discal spot and the row of points at posterior border. Head and thorax speckled gray; abdomen whitish-gray; antennæ short, simple in both sexes, gray above and brown below; palpi small. Two specimens with the front wings very dark, showing the ordinary lines and spots conspicuously, and with the antennæ brown above as well as below. Average length, 0.75; expanse, 1.75 inches.

Described from numerous bred specimens.

Larva—Prevailing color black. Each joint with a transverse dorsal crimson-red band across the middle from stigmata to stigmata, and containing six warts, each furnishing 10 or 12 or more stiff yellow or fulvous bristles, and the two dorsal ones being farthest apart. A sub dorsal longitudinal yellow line interrupted by this transverse band and at incisures, in such a manner that the black dorsum appears somewhat diamond-shaped on each joint. A broad, wavy, bright-yellow stigmatal line, containing a yellow bristle-bearing wart in middle of each joint. Lateral space occupied with different sized pale yellow spots, largest towards dorsum. Head chesnut-brown. Venter crimson-

black, with bristle-bearing warts of same color. Stigmata oblong-oval and pale. Thoracic legs black; prolegs with black extremities. Such is the normal appearance of this larva, but it is very variable. In some the yellow seems to predominate over the black, and there is a more or less distinct dorsal line. In some this dorsal line forms a mere speck at the incisures of the middle joints. The transverse crimson band is often entirely obsolete, and the warts distinctly separated, while in others where this band is distinct, the warts frequently coalesce.

Pupa—Almost black, and shagreened with the exception of a smooth and polished rim, at posterior border of joints, which becomes reddish, especially ventrally, on the three joints immediately below wing-sheaths. Terminal joint horizontally compressed, squarely cut off, and furnished with a little brush of short evenly-shorn, stiff rufous bristles.

THE PYRAMIDAL GRAPE-VINE WORM.—*Amphipyra pyramidoides*, Guen.

(Lepidoptera, Amphipyridæ.)

Another worm, never hitherto mentioned as injurious to the Grape-vine, is often found resting upon it in the posture shown in Figure 32, and may be at once distinguished from all others that are known to attack it, by having a pyramidal hump near the end of its body. This worm I have also found upon the Red Bud (*Cercis canadensis*), the Raspberry and the Poplar, but it is only as a vine-feeder that it can be considered injurious. It was more abundant in the summer of 1869 than it has been since. According to the experience of Mr. G. Pauls, of Eureka, it takes the Hartford, Israella and Iona first, and the Concord and North Carolina next, and devours the blossoms as well as the leaves. It is of the form shown in the figure and of a delicate green color, marked with pale yellow or cream-colored lines and spots, as there indicated. It is found on the vines during the month of May with us, and during the forepart of June descends to the surface of the ground, where it spins a loose cocoon of whitish silk, generally constructed between some fallen leaves. Within this cocoon it remains some time in the larva state, but eventually becomes a shiny mahogony-brown chrysalis from which emerges a moth (Fig. 31), with the front wings bark brown and glossy and marked with dark brown and pale grayish-brown as in the cut; and with the hind wings of a lustrous copper color, from which character it may be called in popular language the American Copper Underwing. In Chicago, Illinois, this insect is single-

[Fig. 31.]

[Fig. 32.]

brooded, for a poplar-feeding larva found the latter part of May, and which spun up on the 14th of June, did not produce the moth till the following April; but specimens obtained near St. Louis often produce the moth during July of the same year that they are found as worms. In this last case a second brood is doubtless produced the same year though it is barely possible that the moths winter over and do not deposit till spring; for they are characterized by having very flat bodies, and with their wings folded flatly on their backs they are often found hiding in narrow cracks and crevices where they seem to love to shelter.

There is an insect (*Amphipyra pyramidea*, Linn.) very common throughout the continent of Europe, on Elm, Poplar, Oak, and other trees, and known in England as the Copper Underwing, which our *pyramidoides*, as its name implies, so very closely resembles in all its stages, that it is difficult for one who has become acquainted with both insects in the field, to bring himself to believe that they are really distinct species. No one can behold the two moths and speculate on their great similarity, without feeling that such close resemblance between the insects of two continents is hard to account for on any other theory than that of community of descent; or without questioning whether there really are differences enough to make two species, when he reflects that far greater variations often occur in the particular species of a given continent! The most constant difference seems to occur in the larvæ which, though they agree in almost every other detail, differ in the European species having the pyramidal hump more strongly developed and capped with a red horn-like point which curves backwards, while in our species this point is more or less obsolete and not red.

Remedies.—This worm is easily kept in check by hand-picking, and though its moth is attracted by sweets, it has never been numerous enough in the past to warrant this mode of capturing it. We have no good description of this insect in the English language, so I subjoin one.

Amphipyra pyramidoides, Guen.—*Larva*, (Fig. 32.)—Length when full grown 1.20–1.30 inch. Smallest at joint 1, largest at joint 11 which rises pyramidally above the others. Color pale bluish-green inclining to whitish dorsally, and rather darker at each end than in the middle of body. A continuous narrow cream-colored medio-dorsal line extending from the head to extremity of anal shield; a subdorsal line of the same color or somewhat more yellow, wavy and broken into 4 or 5 unequal spots on each of joints 1–10, more or less distinct, ascending continuously on joint 11 to the summit of pyramid, descending in a curve and vanishing in the anal shield; a broader stigmatal line, bright sulphur-yellow, except where intercepted by stigmata where it is white, distinct on joints 1 and 2, less so on 3 and 4, and running straight to the extremity of anal shield. Looking downwards from the top of the pyramid, six lines seem to radiate from it in as many different directions. Besides these lines, each joint has about ten cream-colored piliferous spots, namely, 4 in dorsal space—the anterior ones nearest together—one in the middle of each joint in subdorsal space, and 2 smaller substigmatal ones. These spots are more or less obsolete on the thoracic and anal joints; they are arranged transversely on the former, and the hairs arising from them are so insignificant that they are scarcely visible. Stigmata white, with a black annulation. Head free, smaller than joint 1, concolorous with body. Venter darker green with cream-

colored points. Legs of the same color, the thoracic with three brown, or black spots outside, the prolegs with purplish clingers. Described from two grape-feeding, two poplar-feeding specimens.

Pupa.—Highly polished mahogony-brown, rather short and thick, impunctate, and with two small short spines and several fine curled bristles at the extremity.

Imago.—Front Wings, with the costal margin more or less arched and the posterior margin more or less scalloped or dentate; general color brown, being variegated with a pale glossy gray, with more or less fulvous, glossy purple-brown and unpolished purple-black; the transverse anterior nearly obsolete or tolerably well defined, in strong zigzag, pale with a dark shade each side; reniform spot entirely obsolete, or well indicated and pale; orbicular small and illy defined, or large and forming a pale ring with the centre sometimes concolorous, sometimes lighter than median space, and with the basal side sometimes, not always, extended into a beak or point; transverse posterior well relieved inside but not outside, except at costa; it starts distinctly about the middle or a little outside the middle of costa, runs outwardly at right angles along costal nerve, either its own width or twice its width, thence obliquely outwards towards the middle of the wing, with a more or less conspicuous inward jog or curve in discoidal cell; thence across the wing in 4 undulations: in some specimens it makes an obtuse angle, so that the inner half runs parallel with the posterior margin, in others it runs almost straight across the wing, so as not to be parallel with the margin at any point; in some it traverses the wing so as to leave a full third, in others so as to leave only a fourth of the wing outside; subterminal line pale and broken, scarcely distinguishable, or well defined, especially at costa, where the apical space is pale and blends with it, or as brown as the rest of wing and relieves it; a series of 8 more or less distinct pale terminal dots, often relieved by an outer black shade, fringes concolorous: sometimes with a pale middle line often broken and appearing like a second series of dots; the posterior median space is the darkest, and the subterminal space the lightest portion of the wing, though the contrast is often very slight. In one dark specimen the sagittate spots and a longitudinal shade in the discoidal cell and another below the sub-median nerve—the two dividing the wing in three equal parts longitudinally—are very conspicuous from their being very dark and without gloss; in two specimens these marks are entirely obsolete; under surface smoky-gray, more or less suffused with fulvous, and with a dark shade below transverse posterior. *Hind wings* bright glossy cupreous, or with but a very faint tint of this color, and more or less distinctly grayish-brown along the costa to the third superior nerve and the upper posterior border; fringe scalloped, grayish-brown, with an inner paler hue; under surface more or less concolorous, with the lunule indicated and with a broad line, half black, half cupreous. *Thorax,* with the scales large and mixed fulvous and brown. *Abdomen,* with the sides dark, intercepted by the fulvous margins of joints; anal tuft more or less rufous. *Legs* with the tibiæ and tarsi alternately fulvous and brown. Expanse 1.65–1.90 inches.

Described from four bred and four captured specimens.

The differences between the European *pyramidea* and this species, as given by Guenée, are: First, In *pyramidea* the transverse posterior curves outward near the costa, so as to produce an inward sinus in the discoidal cell, while in *pyramidoides* it runs nearly straight and obliquely; Secondly, in *pyramidoides* this line is said to border a median space almost always darker than the rest of wing and absorbing the darker longitudinal lines, while the light lines are given as narrower than in *pyramidea,* and the subterminal more continued to costa, where it borders, or cuts, as Guenée has it, a light apical space. While the difference mentioned in the transverse posterior is tolerably constant in the eight specimens of *pyramidoides* in my possession, I have seen two in other collections where this line was almost a fac-simile of the same line in *pyramidea*; and the other characters, as will be seen from the above description are quite variable, sometimes approaching the typical *pyramidea* and sometimes the typical *pyramidoides.* The same variations doubtless occur in the European species, for if we can rely on Mr. Edward Newman's figure (British Moths, p. 457,) the median space is sometimes as much darker than the subterminal in their insect as it is said, by Guenée, to be in ours Upon critically examining two European specimens of *pyramidea* in the collection of my friend, Mr. A. Bolter, of Chicago, I find this shade very distinct on the posterior portion of the median space, but instead of closely bordering and relieving the transverse posterior it fades somewhat before reaching it. The transverse posterior crosses the wing nearer the middle than in our species, leaving, in one of the specimens, more than one-third of the wing outside. But the distinguishing features which struck me as less subject to variation than those mentioned by Guenée, are the somewhat more elongate wings and the broader, more distinct, subterminal line of *pyramidea.* I have little doubt, however, but that from a hundred specimens of each species at least one *pyramidea* and one *pyramidoides* could be found that were undistinguishable in themselves. The undersides of the two species agree entirely.

There is but one other described, N. A. *Amphipyra*, namely, the *A. inornata* of Grote—(*Pro Ent. Soc, Phil.*, III, p. 86,) which upon the very face of it, seems to be but a small variety of *pyramidoides*, as will be seen by comparing his description with that found above. The species was described from a single specimen belonging to Mr. Wm. Saunders, of London, Ont., who agrees with me in believing it to be but a variety of *pyramidoides*.

I have a unique in my cabinet which differs so remarkably in the front wings from *pyramidoides* that I feel constrained to briefly describe it, and yet in all other characters it so closely resembles that species that I should hesitate to do so, had I not bred it from the larva. It looks exactly as though something had been sprinkled uniformily over the front wings and had eaten the dark color away in spots and splashes, but the specimen is in reality perfect, with not a scale ruffled. It may be called the Spattered Copper Underwing:—

AMPHIPYRA CONSPERSA, N. Sp.—*Larva.*—Found full grown July 2nd, 1867 on Hazel. No pyramindal hump, and of a uniform emerald-green, the dorsal palpitations visible and the stigmata pale with a black annulation, but with no other markings either on the head, body or legs.

Imago—Like *pyramidoides* in every particular except that the brown of front wings is almost uniformily spattered over, more or less suffusely with pale grayish spots so that no regular marks appear. The costal marks are however tolerably distinct as in *pyramidoides* and by careful examination and comparison, traces of the more conspicuous marks of that species may be discerned.

Described from one ♀ bred July 31st.

THE GRAPE-ROOT BORER—*Ægeria polistiformis*, Harr.

(Lepidoptera, Ægeridæ.)

The most common root-borers of the Grape-vine in this State are those which I have termed Gigantic Root-borers, namely, the larvæ of two large beetles (*Prionus laticollis* and *P. imbricornis*) which were treated of in my previous Reports. The insect now under consideration is a moth and not a beetle and has for a number of years been known as THE Grape-root Borer. It bears a very close resem-

[Fig. 33.]

blance to the common Peach Borer, both in habit, and in the size and general appearance of the larva, but it is a somewhat larger insect and the moths differ materially.

It has usually been considered a Southern insect and certain it is that it is not as destructive in the vineyards of Missouri as the Gigantic borers. But I captured specimens of the moth and found the larva in St. Louis county last summer, and it has long been known to be destructive throughout Kentucky. It was also reported around Cin-

cinnati in 1867, though there is no evidence that the insects attacking vine roots there were this species and not the Gigantic borers.

The larva can easily be distinguished from the Gigantic root-borers, by having 16 legs as in all normal Lepidopterous larvæ, namely, six true horny legs head near the and ten false or membranous legs, eight of which are in the middle and two at the end of the body. When full grown it measures from an inch to an inch and three-quarters, and it then forms a pod-like cocoon of a gummy sort of silk covered with little bits of wood-bark and dirt, within or adjacent to the injured root. Within this cocoon it becomes a chrysalis which, in due time, by aid of rows of minute teeth with which it is furnished, works its way out of the cocoon to the surface of the ground, and gives forth the moth. As with the Peach Borer, this insect requires a year to develop and is found in its different states of larva, chrysalis and moth, throughout the summer months, and it doubtless also passes the winter as a larva.

The moth looks very much like a wasp and especially like some belonging to the genus *Polistes*—whence its specific name—and the resemblance becomes still more striking when flying, for its flight is accompanied by a buzzing wasp-like noise. The sexes differ considerably though not as much as in the case of the Peach Borer. The colors are dark brown and tawny-orange, and the male is well represented at Figure 33, *a*, and the female at *b*, but as the description which was published seventeen years ago by Harris, and copied by Mr. Walsh in his Report, is brief and defective, I subjoin one which is more complete :—

ÆGERIA POLISTIFORMIS, Harris,—*Imago* ♀—*Head*, including the palpi, orange-tawny. Antennæ simple, blue-black; orange-tawny above at their extreme base and tip and below for their entire length. *Thorax* black; varied with orange-tawny and bright yellow on the lateral and posterior surface above, and below for its entire surface. *Abdomen* generally with the four basal joints black and the rest orange-tawny; sometimes almost entirely orange-tawny; sometimes almost entirely black; always with a narrow yellow ring at the tip of the second joint above and generally with another such ring at the tip of the fourth joint; venter mostly black with the tip of all the joints more or less edged with orange-tawny, and with a short lateral pencil of orange-tawny hairs springing from the tip of the penultimate joint below, and reaching a little beyond anus. Legs orange-tawny above, mostly black below but with a yellow patch at the origin of the middle spurs on the hind tibiæ. All the spurs and tarsi more or less tinged with yellow. Front wings brown-black with a more or less distinct clear space at base, longitudinally traversed by a nervure; hind wings hyaline, with the veins, the terminal edge and the fringe, brown-black. Length 0.66—0.85 inch; expanse 1.15—1.50.

The ♂ differs from the ♀ as follows:—1st. The antennæ are bipectinate four-fifths of the way to the tip, which is strongly clavate and, as in the ♀, bears a few hairs at its apex. The bipectinations are fully one-fourth as long as the head is wide, and, as well as the entire basal half of the antennæ are orange-tawny. 2nd. Both thorax and abdomen are darker, and in addition to the pair of short anal pencils below, there is a pair nearly twice as long above. 3rd. The short hyaline space straddling a black nervure at base is more distinct. Length 0.68 inch; expanse 1.10 inch.

Described from 1 ♂ 1 ♀ bred July 8th—16th, from grape roots, and others captured during August at Kirkwood, Mo. It is remarkable that although Dr. Harris chronicles in his correspondence with Dr. LeBaron, as a notable event, his having captured an *Ægeria* with pectinate antennæ in New England in 1850,* in 1851, when for the first time he described the moth of our Grape-

*Harris correspondence, p. 262.

root borer, he did not say a single word about the ♂ antennæ being bipectinate, if we are to judge from the account he gives in a Report made to the American Pomological Society in 1854 (p 10.) Either his ♂ specimens had lost their antennæ, or the pectinations were rubbed off, the former being the more likely occurrence. Certain it is that the males received by Dr. Harris once had pectinated antennæ, for though Mr. Glover, copying after Harris, likewise fails to mention this sexual character in his account published in the Patent Office Report for 1854 (p. 80), he nevertheless plainly figures the pectinations (Ibid, Pl. 6, lower right hand figure) and the specimens from which he made the figure were received from the very same person who furnished Dr. Harris with his specimens.

Unlike the Peach Borer which makes its abode quite near the surface, this borer lives exclusively under ground, and unlike the Gigantic root-borers which hollow out and bore up along the heart of the roots, it confines itself almost entirely to bark and sap-wood, and the effects of its work are consequently more fatal to the vine. Roots attacked by it, to use one of Mr. Walsh's expressions, look "as if a drunken carpenter had been diligently scooping away the sap-wood with a quarter-inch gouge." It must, however, sometimes hide under the bark of the roots, as Mr. H. J. Kron of Albemarle, North Carolina, in the Monthly Report of the Department of Agriculture for 1867, (p. 329), describes it as being shielded by the bark.

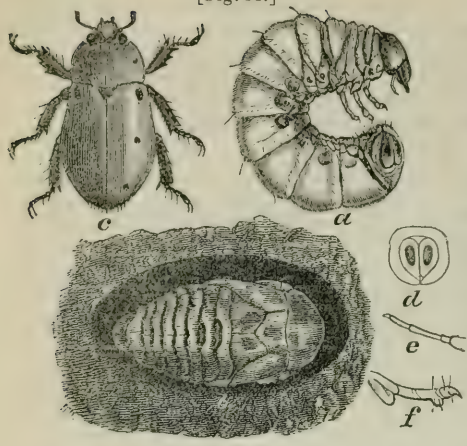
Remedies—It has been ascertained by observation and experiment that the Scuppernong grape-vine—which, according to Gray, is a cultivated variety of the Southern Fox Grape (*vitis vulpina*)—is never attacked by this borer, and consequently that other varieties grafted on to the Scuppernong share its immunity from attack. This is a very easy mode of preventing its ravages in the more Southern States where the Scuppernong flourishes; and if this borer should ever become very numerous with us, it may be deemed advisable to introduce that stock here. At present we have no other preventive than mounding, and the insect is so comparatively scarce that I have not yet had an opportunity of testing whether such mounding would work as well as it does with the Peach Borer. When it is once ascertained that the borers are at work on a vine, they may be destroyed by clearing away the earth and applying hot water to the roots.

THE SPOTTED PELIDNOTA—*Pelidnota punctata*, Linn.

(Coleoptera, Scarabæidæ.)

This is the largest and most conspicuous beetle that attacks the foliage of the Grape-vine, and in the beetle state it seems to subsist entirely on the leaves of this plant, and of the closely allied Virginia Creeper. Though some years it becomes so abundant as to badly riddle the foliage of our vineyards, yet such instan-

[Fig. 34.]



ces are exceptional; and it usu ally occurs in such small numbers, and is so large and clumsy, that it can not be considered a very redoubtable ene ny.

Its larva has, for a number of years been known to feed on the decaying roots of different trees, but was first described by me last September.* It is a large clumsy grub (Fig. 34, *a*) bearing a close resemblance to the common White Grub of our meadows, and it differs from that species principally in being less wrinkled, and in having the chitinous covering (or skin, so-called) more polished and of a pure white color, and in the distinct heart-shaped swelling above the anus (Fig. 34, *d*). Towards the latter part of June I have found this larva in abundance, in company with the pupa (Fig. 34, *b*), in rotten stumps and roots of the Pear. In preparing for the pupa state, the larva forms a rather unsubstantial cocoon of its own excrement, mixed with the surrounding wood. The pupa state lasts but from eight to ten days, and the beetle (Fig. 34, *c*) is found on our vines during the months of July, August and September. It is not yet known how long a time is required for the development of the larva, but from analogy we may infer that the insect lives in that state upwards of three years.

This beetle was named about a century ago by Linnæus who met with a specimen in the magnificent collection of shells and insects belonging to Queen Louise Ulrica of Sweden. It occurs throughout the States and Upper Canada, and is even met with in the West Indies. It flies and feeds by day, and is most abundant during the months of July and August. The wing-covers are of a slightly metallic clay-yellow color, with three distinct black spots on each, and the wings themselves are dark-brown inclining to black; the thorax is usually a little darker than the wing-covers, with one spot each side; the abdomen beneath, and legs, are of a bronzed-green. It is easily kept in check by hand-picking.

PELIDNOTA PUNCTATA, Linn.—*Larva* (Fig. 34, *a*)—Length 2 inches; clumsy, moving on the side. *Head*, bright chestnut-brown, smooth, rounded, with a short, impressed, longitudinal line on the top, and three shallow impressions in front; epistoma trapezoidal and darker; labrum rough, irregularly punctate, and beset on the margin with a few stiff rufous hairs; antennæ (Fig. 34, *c*) as long as epistoma and labrum together, 4-jointed exclusive of bulbus or tubercle in which they are inserted; joints cylindrical, proportioned in length as 2, 6, 4, 1, the terminal joint being often a mere bud; mandibles strong and black, with three denticulations at tip, and a very slight tooth at inner basal portion; maxillæ brown and subcylindrical on outside, angulated on inside, bearing two lobes, each terminating in an inwardly-curved corneous tooth, and each furnished

* See American Entomologist and Botanist, Vol. I, p. 295.

on their inner narrow edge with stiff bristles, the outside one arising close by base of palpus, the inside one extending lower down, and recalling by its form, the terminal joint of the front leg of a scorpion; maxillary palpi 4-jointed, joints cylindrical, short, very gradually longer and longer from 1 to 4, the terminal joint more pointed and narrower than the others; labium quadrangular, labial palpi 2-jointed, the palpigerous piece strongly beset with bristles. *Body*, smooth with but a few wrinkles at thorax; polished translucent white, with faint bluish marblings on all but thoracic joints which are slightly narrower than the rest; a narrow vascular dorsal line, and a very slight yellowish horny plate in a depression on joint 1; a very slight pubescence observable, and a transverse tergal row of sparse but tolerably long hairs on posterior part of each joint; more dense and conspicuous hairs on lower sides of anal joint, which joint is short, cut off squarely, with a heart-shaped swelling [Fig. 34, *d*) sunk into a circular depression, each lobe of the heart with a darker oval corneous elevation; spiracles sub-elliptical, dark chestnut-brown, placed on a prominent swelling, the lateral openings *all* facing the head, the 1st on joint 1, the rest on joints 4, 5, 6, 7, 8, 9, 10 and 11, gradually becoming smaller and smaller from first to last. *Legs* (Fig. 34, *f*) horny, light-brown and covered sparsely with hairs; coxæ long and stout, with a rounded swelling at lower anterior edge; femora cylindrical, sometimes, distinctly, at others indistinctly, separated from tibiæ, sometimes prolonged into a thorn below, with a distinct carina along the inside, at others not; tibiæ cylindrical, incrassated anteriorly, especially below; tarsi cylindrical and terminating in a distinct claw.

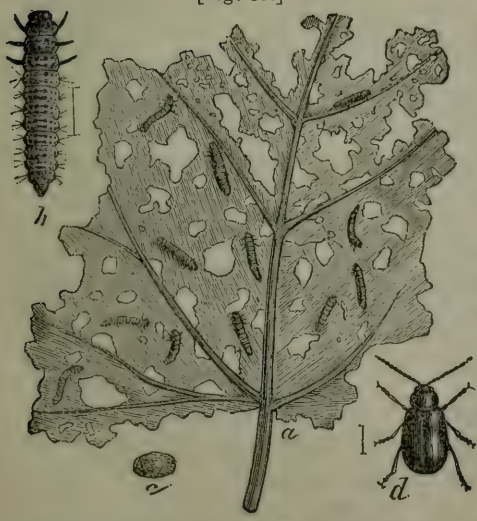
Pupa (Fig. 34, *b*) of the form of *Lachnosterna*.

Described from 12 living specimens.

THE GRAPE VINE FLEA-BEETLE—*Haltica chalybea*, Illiger.

(Coleoptera, Chrysomelidæ.)

[Fig. 35.]



Is there a grape-grower in the State of Missouri who does not know, to his sorrow, what the Grape-vine Flea-beetle is? Hardly one! And yet how few ever connect it with its disgusting little shiny brown larvæ, which generally prove still more injurious than the beetle, by riddling the leaves in the middle of the summer.

The Grape-vine Flea-beetle (Fig. 35, *d*) often goes by the cognomon of "Steel-blue Beetle," and is even dubbed "Thrips" by some vineyardists. The latter term, however, is entirely inapplicable.* The former name is not sufficiently charac-

* The term *Thrips* is confined to an anomalous group of insects—mostly cannibal, but exceptionally vegetable feeding—of which Halliday made a separate Order (*Thysanoptera*), but which are to-day included in the *Homoptera*, or Whole-winged Bugs, by most authors, though they seem to have close affinities to the *Orthoptera*, and to the *Pseudoneuroptera*.

teristic, because the color varies from steel-blue to metallic-green and purple, and because there are many other flea beetles to which it would equally apply.

The Grape-vine Flea-beetle is found in all parts of the United States and in the Canadas, and it habitually feeds on the Alder (*Alnus serrulata*), as well as upon the wild and cultivated Grape-vine. Its depredations seem first to have been noticed in 1831, by Judge Darling, of Connecticut, and in 1834 Mr. David Thomas, of New York, published an account of it in the 26th volume of Silliman's *American Journal of Science*. Its transformations were, however, unknown till some time after Dr. Harris wrote his excellent work on Injurious Insects, and the figure of the larva was first published by myself last fall.

The beetles hibernate in a torpid state under any shelter which is afforded them in the vineyard, such as the loose bark and crevices of stakes, etc., etc., and they are roused to activity quite early in the spring. The greatest damage is done by them at this early season. for they often bore into and scoop out the unopened buds, and thus blight the grape-grower's bright expectations. As the leaves expand, the little jumping rascals feed on the leaves, and soon pair and deposit their small orange eggs in clusters, very much as in the case of the Colorado Potato-beetle. These eggs soon hatch into dark-colored larvæ, which may be found of all sizes during the latter part of May and early part of June. They are generally found on the upper surface of the leaf, which they so riddle and devour as to give it the appearance represented at Figure 35, *a*. When very numerous they devour all but the very largest leaf-ribs, and I have seen the wild vines throughout whole strips of country rendered most unsightly by the utter denudation which these insects had wrought. The larvæ feed for nearly a month, and when full grown present the appearance of Figure 35, *b*, the hair line at the side showing the natural size. They then descend from the vine and bury themselves a short distance in the earth, where, after each forming a little earthen cell (Fig. 35, *c*), they change to pupæ of a deep dull yellow color, and in about three weeks more issue as beetles. These beetles leave the ground from the middle of June to the middle of July, and, so far as I am aware, do not breed again till the following spring—there being but one brood each year. They subsist on the leaves during the fall, but the damage they inflict is trifling compared to that which they cause in spring.

[Fig. 36.]

Like all other Flea-beetles, this species has very stout, swollen hind thighs, which, though hidden in Figure 35, *d*, are well represented in the accompanying cut (Fig. 36). By means of these strong thighs they are enabled to jump about very energetically, and are consequently very difficult to manage during the summer months. In the winter time, however, they can be destroyed in great numbers while hidden

in a torpid state in their retreats, for Dr. E. S. Hull, of Alton, Illinois, tells us* that they were once so numerous in a small vineyard of his that in the spring of 1867 he burnt them out by surrounding them with fire, and letting the fire run through the dry grass in the vineyard. "It was a rough remedy, but as his crop was destroyed, he let the beetles follow suit." Clean culture and general cleanliness in a vineyard will, to a great extent, prevent this insect's increase. Especially should the stakes be clean and free from old bark.

The larvæ can be more easily destroyed by an application of dry lime, used with a common sand-blower or bellows. This has been found to be more effectual than either lye or soap-suds, and is withal the safest, as lye, if used too strong, will injure the leaves.

This insect, like so many others, will one year swarm prodigiously, and then again be scarcely noticed; and such changes in its numbers depend mainly on conditions of the weather, as no parasite is known to attack it. In the spring of 1868, though they were at first out in full force, yet after some subsequent severe and cold weather, they had mostly disappeared. They are apt to be most troublesome where Alder abounds in the woods.

HALTICA CHALYBEA, Illig.—*Full-grown Larva.*—Length, 0.35 inch. Head polished black. Body livid-brown above, paler beneath; subcylindrical, the joints bulging, especially at sides, and each divided superiorly into two transverse folds; on each fold a row of six shiny-black elevated spots, the dorsal ones larger than the others, and often (especially the posterior two) confluent, or divided only by a very narrow dorsal line; each spot giving rise to a single short stiff hair; one such substigmatal black spot placed in middle of joint, and more elongated than the rest, being apparently composed of two confluent ones, as it gives rise to two hairs. Three ventral spots, one anteriorly, which is large, transversely-elongate, central, and without hairs; and two posteriorly (one each side) which are small and piliferous. Six black thoracic legs, and one anal orange proleg.

Pupa.—Length, 0.14 inch. Of the normal Chrysomelid form. Deep dull yellow, and covered more or less above with short black bristles arranged in a transverse row across each joint, and each arising from a slight elevation: two stouter anal bristles or thorns. Eyes brown. Tips of jaws brown.

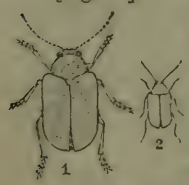
Described from numerous living specimens.

THE GRAPE-VINE COLASPIS—*Colaspis flavida*, Say.

(Coleoptera, Chrysomelidæ.)

There is a little clay-yellow beetle (Fig. 37, magnified, natural size), which does great injury to the Grape-vine by riddling the leaves. It is more or less abundant with us every year, but judging from recorded accounts is still more injurious in the Eastern States, and especially in New York. In the *Country Gentleman* for August 30th, 1866, occurs the following account of it by Dr. Fitch, in answer to a correspondent who wrote that they were destroying grape-vines by the wholesale:

[Fig. 37.]



* Proc. Alton Hort. Soc. for May, 1867.

"The rascals alluded to are a beetle of the Chrysomela family, and are the Brown Colaspis,* *Colaspis brunnea*, Fab. It is an oval, drab-colored beetle, nearly twice as long as broad, and nearly two-tenths of an inch in length, having the outer edge of his wing-covers black, and also the under side of its body and the tip of its antennæ. It is rather a common insect throughout the United States, appearing in the latter part of June, each year, and continuing through the month of July. I have frequently gathered it from the wild grape-vine, the Cinquefoil or Potentilla, and some other plants, but have never known it to invade the cultivated grape until this year.

It has this season been the worst enemy that has attacked the vine in my neighborhood—riddling the leaves with small round holes, interspersed with large irregular ones—and I hear of it in several other parts of the country. * * *

Wherever the Leaf-folder (Fig.24) abounds, this beetle will almost invariably be found in conjunction with it in the fold of the leaf. On finding it so invariably in this fold, I at first supposed that it merely took advantage of the position for shelter, little suspecting that it would feed upon the worm, since the family to which it belongs is essentially herbivorous, and the Leaf folder is so very active; but from having found numbers of the shrunken and half-dead worms, I was led to conjecture that it does actually prey upon them; just as many true bugs (*Hemiptera*) though living naturally on the juices of plants, will still appropriate and relish those of certain caterpillars. Thus may one great pest serve to check another!

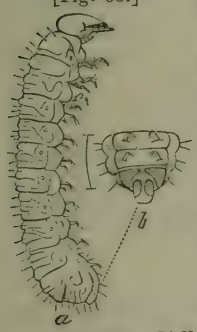
Of the natural history of this beetle nothing has hitherto been known. As the beetle was often found upon and greedily devours the leaves of the Strawberry, and as a white worm was known to injure the roots of that plant, I inferred several years ago (Prairie Farmer Annual 1868, p. 56), that this worm was the larva of the Colaspis. From the facts, however, that the larva of the European *Colaspis barbara* was described as a hexapod, blackish, glabrous grub

* Dr. Fitch referred this insect to *brunnea*, Fabr., and Mr. Walsh (*Practical Entomologist*, II, p. 68) criticised his course, and referred the species to *flavida*, Say. I adopt Say's name simply because it best indicates the general appearance of the insect, and not because I think Mr. Walsh was right in his strictures. I have kindly been allowed to examine Dr. Fitch's specimens; have examined specimens in other large Eastern collections, and those in the Walsh collection, and am convinced that the difficulty between the above two authors arises from the confounding of varieties with species. It is here, as in almost every other genus and Family, the closet systematist divides up and arranges with insufficient knowledge of the variation which species are subject to, and this was especially the case in years gone by, when every little colorational difference was generally supposed to be immutable. The naturalist, therefore, who studies insects for other and more laudable purposes than the mere naming and classifying of them, though fully aware of the importance and necessity of good and clear nomenclature, may well despair of bringing order out of the confusion which often exists, and which the miserably short and incomplete descriptions of older authors have had much to do in causing. The economist can spend his time more profitably, and so long as he always adds the authority to the name he uses, there will be no danger of causing more confusion, and he can coolly disregard the interminable disputes between different authors as to the proper technical name by which an insect should be known. In the present case, I simply give it as my opinion that *brunnea*, Fabr., *suilla*, Fabr., and *flavida*, Say, are all varieties of one species, because specimens according with each are found in the same vineyard, and because Say himself gives a variation in *flavida*, which differs much more from his description than does either *brunnea* tor *suilla*. Mr. Walsh gives the antenna of *flavida* as having the last joint or two, and the tip of the last joint but four, brown-black, but there is variation here, and the dark color on the last joint but four is often obsolete. The exterior edges of the elytra are either concolorous or of all shades of brown to black, and the same may be said of the sutural edges. There is also a somewhat larger form, which must certainly be referred to the same species, which has the punctures so much less profound as to give it a much smoother and more highly polished appearance.

living unprotected upon the leaves of lucern and clover,* and that such was the character of the larvæ of most other insects belonging to the great *Chrysomela* family, I had little confidence that my reference would prove the correct one. Yet it so proved to be, and I have bred the beetle from larvæ infesting strawberry roots that were kindly sent to me by Mr. J. B. Miller, of Anna, Ills. Just as in the European Turnip Flea-beetle (*Phyllotreta nemorum*), the larva mines the leaves above ground, while in our very closely allied Striped Flea-beetle (*Phyllotreta striolata*, Illig.), it feeds upon the roots below ground; so there seems to be the same difference of habit in the genus *Colaspis*. In this last case the difference is not only of habit, but the structure is modified in accordance with the habit, and we have in our Grave-vine Colaspis a Chrysomelid larva bearing a very close resemblance to that of a Lamellicorn.

It is indeed a most singular larva, and differs from all others with which I am acquainted, in having on the underside of the legless joints a pair of curious fleshy projections reminding one of legs, and terminating in about two stiff hairs (Fig. 38, *a*). The office of these appendages it is difficult to conjecture, for they seem to impede rather than aid in locomotion on a flat surface, though, when the habits of the larva are more critically studied, these appendages will doubtless be found to subserve some useful purpose. The color of this larva is yellowish or grayish-white with a gamboge-yellow head. The pupa is formed in the ground and exhibits no unusual characters.

[Fig. 38.]



We are now only treating of this insect as a Grape-vine pest; but it is difficult to say whether the Crown-borer (Fig. 14) or this root-eater is the most injurious to the Strawberry. The work of the two is essentially different, the white Crown-borer confining itself to the crown, and its more dingy ally devouring the fibrous roots and working into the more woody parts from the outside. At this work several of them may frequently be seen with their heads stuck into different parts of one root. They may be found upon the roots all through the fall, winter and spring months, and do not begin to change to pupæ in this latitude till about the month of June, the beetles appearing during that month and continuing to issue from the ground till towards fall. As soon as they issue from the ground they commence to feed upon the tender leaves, and in a measure injure the plants by riddling them with holes. After feeding for a while on strawberry leaves, and depositing their eggs, they spread on to other plants and are generally found most numerous in the vineyard during the latter part of July and during August, where, according to Mr. Miller, they show a partiality for the leaves of the Delaware.

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*Notice sur les Devastations de la Larve du *Colaspis barbara*, par M. Leon Dufour—Annales de la Soc. Ent. de France, 1836, pp. 371—372.

Such, in brief, is the history of this common beetle, as far as I have been able to trace it. It doubtless has natural enemies, and ants are so fond of the helpless pupæ that the Colaspis never occurs on the roots where they abound. The evil effects of its work are more apparent on young and newly set plants than on older ones, and the only way to prevent the ravages of the worm, which we yet know of, is to so protect newly set plants that the beetles will not get access to them. I have had no opportunity to make experiments, but it may turn out that some application to the ground or to the plant, such as ashes, soot, lime, or salt, will ward off the perfect beetle, and I shall be glad to hear reports from those who are troubled with the pest. The same remedies used in killing the Colorado Potato-beetle would also kill this species.

COLASPIS FLAVIDA, Say—*Larva,* (Fig. 38)—Color dingy yellowish; uniformly covered with sparse stiff yellowish hairs. Having the general appearance of a Lamellicorn larva. Slightly arched but capable of stretching out tolerably straight. Narrowest in middle of body, the thoracic and anal joints being slightly swollen. The joints with about three dorsal wrinkles to each. Head honey-yellow, rounded, flattened in front; epistoma and labrum of same color; jaws darker. Legs pale, setous, and terminating in a brown claw. Spiracles scarcely perceptible, the first sub-ventral between joints 1 and 2, the others placed on a lateral series of swellings commencing with joint 4. Joints 4-11 inclusive, each with a pair of soft ventral leg-like appendages, ending in two or more stiff hairs. Anal joint somewhat horny below (Fig. 38, *b*) but with no trace of prolegs. Length 0.25—0.30 inch. Described from two rather poor alcoholic specimens.

THE GRAPE-LEAF GALL-LOUSE—*Phylloxera vitifoliæ*, Fitch.

(Homoptera, Aphidæ.)

Here we have an insect, the life-history of which is as interesting to the entomologist as its devastations are alarming to the grape-grower. I have given it considerable attention the past summer, and though it is a difficult task to present definite and satisfactory information from the multitude of facts obtained, yet I shall endeavor to give a comprehensive account of this little louse, so far as my present knowledge of it will permit. In doing so I am made painfully aware that there is much room left for further observations, and he who will patiently and persistently devote his time for a few years to its study, and will with candor and accuracy give to the world the re-

[Fig. 39.]

sults, will doubtless be rewarded by new and important discoveries, and will render valuable service to the cause of science and of economic entomology.

The first reference to this insect was briefly made by Dr. Fitch, of New York, in the year 1856,** and he subsequently described it in a very insufficient manner, under the name of *Pemphigus vitifoliæ*;* but though the specific name must be retained, the insect was wrongly referred to the genus *Pemphigus*, as we shall presently see. Ten years afterwards this louse was again referred to by myself in the *Prairie Farmer* for August 3, 1866, and during the fall of the same year articles were written upon it by Dr. Shimer,† and by my late associate, Mr. Walsh‡—the former claiming that it was a true Plant-louse (*Aphis* family), and the latter that it was a Bark-louse (*Coccus* family). In this Dr. Shimer was evidently right, and Mr. Walsh wrong. In January, 1867, Dr. Shimer proposed for this insect a new family (DACTYLOSPHÆRIDÆ),§ which, in my opinion, cannot stand.

But not to weary the general reader with purely scientific questions, I shall give the reasons for my opinion on this point, together with some other details, in smaller type at the close.

This louse was subsequently treated of by Mr. Walsh in his report as Acting State Entomologist of Illinois (pp. 21-24), where he still felt inclined to place it with the Bark-lice, though I have good reason to believe that he afterwards changed his mind. During all this time a serious disease of the roots of the Grape-vine began to attract attention in the south of France, and it finally caused such alarm that the Minister of Agriculture and Commerce in France offered a prize of 20,000 francs for the discovery of an efficacious and practical remedy.

A special commission was also appointed to draw up a programme of conditions, examine memoirs submitted to it, settle the experiments to be made, collect evidence from local commissions, and if they saw reason for so doing, to award the prize offered by government. The commission consisted of M. Dumas, M. Milne Edwards and M. Duchartre, of the Paris Academy of Sciences; M. Gervais, M. Planchon, M. Henri Mares and M. Louis Vialla, of Montpellier; the Comte de Vergue, of Gironde; M. Bedel, of Vaucluse, and three members of the Ministry of Agriculture.

The disease is known as *pourridie*, or rotting. It is in the form of little cankerous spots, which cut off the supply of nourishment and cause the roots to rot, and these spots were ascertained by MM. Planchon and Lichtenstein, of Montpellier, to be caused by a louse (*Phylloxera vastatrix*, Planchon,) which bears a close resem-

** N. Y. Rep. I, p. 158.

* Rep. 3, § 117.

† *Prairie Farmer*, Nov. 3 and Dec. 8, 1866.

‡ *Pract. Ent.*, Vol. I, p. 111; Vol. II, p. 19; and Proc. Ent. Soc., Phil., VI, pp. 283–4, notes.

§ Proc. Acad. Nat. Sci., Phil., Jan. 1867.

blance to our gall-insect. This is not all, for a leaf-gall absolutely identical with ours also occurs there, and the identity of the gall-inhabiting with the root-inhabiting insect was demonstrated by "J. O. W.," in the *Gardener's Chronicle*, of England, for January 30, 1869, and M. J. Lichtenstein even contended that their European species was identical with ours, and imported from this country, in which opinion he was supported by A. Combe-Dalmas.*

Of course these views expressed in Europe gave increased interest to our own gall-louse, and I determined to make every effort to decide the question of identity, together with some other questions which presented themselves. To this end I opened correspondence with M. V. Signoret and M. J. Lichtenstein, who were making experiments in France while I was doing the same here. But the blighting effects of the war have not only entailed untold misery and woe to millions in France, but have either paralyzed or effectually balked scientific investigation within her borders, so that at last accounts M. Lichtenstein was in Spain, and M. Signoret shut up in Paris.† I was, however, fortunate enough to receive from the latter gentleman, a few days previous to the investment of Paris, a letter stating that upon examination of specimens of our gall-lice, which I had expressed to him, he was convinced of their identity with the European species. This was indeed satisfactory, and coupled with the fact that I have discovered that our gall-insect likewise attacks the roots of our vines in precisely the same manner as does the European species, and that the winged specimens found in this country by Dr. Shimer agree in having the characteristic dusky band around the middle of the thorax described in the winged female of Europe, it leaves no doubt in my mind that the insects of the two continents are really identical.

As already stated, the war put a stop to investigations in France, and we do not know that any effectual remedy was discovered, or that the premium was disposed of. Carbolic acid, and two other substances, namely, sulphuret of lime dissolved in water, and an empyreumatical oil, known among veterinary surgeons by the name of "oil of cade," dissolved in water, were found to be the best specifics; but neither of them have been tried on a sufficiently extensive scale, and I have little faith in any medicinal remedy.

The two parties who have written most upon the disease, namely, Mr. Signoret and M. Lichtenstein, took entirely opposite grounds as to its cause. The former claimed that it had a botanical rather than an entomological cause, that it was principally due to drouth, bad culture and poor soil, and that the *Phylloxera* was therefore incidental; and acting upon this view, suggested that water, with manure

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* *Insectologie Agricole*, 1869, p. 189.

† Since the above was written, I have heard from M. Signoret through M. Lichtenstein. Nothing daunted by the siege, the former carried on his studies of this little louse, and wrote by balloon, that though he himself was reduced to cats, dogs and horse-flesh, the *Phylloxera*, which he had in boxes, kept well and in good health. No doubt our enthusiastic friend finds much solace in thus pursuing knowledge under difficulties.

and good cultivation, would do away with it; while the latter maintained that the *Phylloxera* was the sole cause of the trouble. There are, doubtless, certain conditions of soil which will prove favorable to the increase of the louse, and it may also be influenced by the seasons and by good or poor cultivation; but that this insect should be found only on such roots as are already diseased is highly improbable, and there can be no reasonable doubt that M. Lichtenstein is right in attributing the disease directly to the *Phylloxera*. The appearance of mites is the almost inevitable consequence of diseased and rotting vegetation, but Plant-lice cannot live on such vegetation, and invariably leave it as soon as they have, by their punctures, reduced the healthy tissues to such a state. Moreover, the history of our louse, which I shall now proceed to give, corroborates M. Lichtenstein's views.

In Missouri this insect has proved very injurious to the Clinton vine for several years past—at least as far back as 1864, when the foliage of the Clinton was reported, in the proceedings of our State Horticultural Society, as "very bad"—and Mr. Geo. Husmann informed me that in 1869, it actually defoliated three-fourths of an acre of Clintons and Taylors on bottom land at Bluffton, though it did not appear to do much injury on the hills. It was quite bad around Kirkwood the present year, and, judging from reports, of correspondents and from my own observations, it was more than usually abundant in most of the Eastern States.

In this latitude the first galls are noticed by about the middle of May, and by the middle of June they begin to be quite common. It occurs most abundantly on the Clinton and Taylor, but is also found on the wild Frost Grape(*V. cordifolia*), and such other cultivated varieties of it as Golden Clinton and Huntington; also on the Delaaware, and early in the year I even found a few large galls on the Concord. According to Dr. Morse it also occurs on the Iona, which is a variety of the Northern Fox Grape (*V. labrusca*). The galls vary somewhat in appearance, according to the vine upon which they occur, those I have noticed on the wild Frost Grape being more hirsute than those on the cultivated Clinton, and these again rougher than on the Taylor.

The few individuals which start the race early in the year station themselves upon the upper side of the leaves, and by constant suction and irritation soon cause the leaf to swell irregularly on the opposite side, while the upper part of the leaf gradually becomes fuzzy and closes, so that the louse at last sinks from view, and is snugly settled in her gall. Here she commences depositing, her bulk increasing during pregnancy. Eventually she grows to be very plump and swollen, acquires a deep yellow or orange tint, and crowds the space within the gall with her small yellow eggs, numbering from fifty to four or five hundred, according to the size of the gall. The young lice are pale yellow, and appear as at Figure 40, *d*, *e*. As soon as

they are hatched they escape from the gall through the orifice on the upper surface of the leaf, which was never entirely closed; and, taking up their abode on the young and tender leaves, in their turn form galls. The mother-louse, after completing her deposit, dies, and the gall which she occupied dries up. There are several generations during the year, and this process goes on as long as the vines put forth fresh leaves. As the galls multiply and the growth of the vine becomes less vigorous, the young lice sometimes so completely cover the upper surface of the newly expanded leaves as not to leave room for them all to form galls. In this event the leaf soon perishes, and the lice perish with it. When two or more lice are stationed closely together they often form but one gall, which accounts for the presence of the several females that are sometimes observed in a single gall. Those leaves which have been badly attacked turn brown or black, and sooner or later fall to the ground, so that the vine may become entirely denuded.

By August the insects generally become so prodigiously multiplied that they often settle on the tendrils, leaf-stalks, and tender branches, where they form excrescences and gall-like growths, differing only from those on the leaves in such manner as one would naturally expect from the difference in the plant tissues. By this time the many natural enemies of the lice begin to play sad havoc with them; and after the vine has finished its growth, the young lice, finding no more succulent and suitable leaves, begin to wander and to seek the roots, so that by the end of September the galls are deserted, and those few remaining on the vines generally become mildewy, and finally turn brown and dry up. Upon the roots the lice attach themselves singly, or in little groups, and cause by their punctures little swellings and knots, which eventually become rotten. Where vines have been badly affected with the gall, it is difficult to find a perfectly healthy fibrous root. Strange enough, these lice not only change their residence as winter approaches, from the leaf above ground to the root below ground, just like the Moor, who, having passed the summer on his roof, gets into his house in the winter; but, Proteus-like, they change their appearance in shedding their skins, and at the present writing (Nov. 6th) have all become tubercled, as represented at Figure 40, *g*.

No doubt the insect passes the winter on the roots in this tubercled state, but whether in the spring these tubercled individuals produce winged males and females, which rise in the air, pair, and by depositing eggs give birth to the apterous females which found the gall-producing colonies; or whether, as spring opens, they lay eggs on the roots, and the young hatching from these eggs crawl up on to the leaves and found those gall-producing colonies, are questions yet to be settled in the life-history of our Grape leaf-louse. The former hypothesis is, however, by far the most probable, for analogy would lead us to infer that winged males and females must be developed at some

time during its annual course, and winged males are so rare in the galls that I have never been able to find them, though I have opened thousands upon thousands of the galls during the summer and fall months. Dr. Shimer, indeed, is the only fortunate individual who has found the winged insect in the galls, and, as he himself tells us, he only succeeded in finding four specimens in the fall of the year, after cutting open ten thousand galls; and he has really given us no proof that his winged specimens were really males, and not females. Let us hope, however, that by pointing out the gaps in the biological history of this insect, attention will be drawn to them, so that they may be the more readily filled.

These discoveries lead us to some most important practical considerations. It now becomes evident that this insect can be transported from one place to another on the roots, either upon transplanted vines or in earth containing fibrous roots. Doubtless it was by some such mode as this that the insect was introduced into France from this country. It may be in this manner likewise that it has in part spread from one portion of our country to another, though as it is found indigenously on the wild Frost Grape, the greater probabilities are that it exists wherever this wild grape is found, and has gradually spread from it on to the cultivated varieties. These probabilities are strengthened by the fact that new grape wood is always rooted in the spring, when the lice, according to my views, are leaving the roots. But the important fact remains, that the insect winters on the roots, and that to exterminate it from a vineyard we have but to root up and destroy, late in the fall, such vines as were affected with the galls. From the poor success that has attended the experiments made abroad to destroy the lice on the roots, and from the fact that it is so difficult to reach them, I have little hope that any other remedy will be found than that of extermination by the means indicated, or by plucking and destroying the gall-infested leaves as fast as they appear in the spring.

Another very important practical lesson may be derived from the facts here mentioned, namely, that no variety of the Frost Grape (*V. cordifolia*) should be cultivated and encouraged where those of the Fox Grape (*V. labrusca*) or of the Summer Grape (*V. æstivalis*) are known to be as good. Some of our best grape-growers, especially in the Mississippi Valley, already discard the Clinton and its nearest relatives as worthless, and, considering its liability to this disease, we heartily commend their conduct.

At the 15th annual meeting of the Illinois State Horticultural Society, at Galesburg, the Clinton was highly recommended by Mr. D. B. Wier, of Lacon, Ills., principally for its vinous and medicinal qualities; but in this recommendation he did not meet with much support except from Dr. Hull the State Horticulturist, who also, in the course of his remarks sustained Mr. Wier in his recommendation of the Clinton, though in our own State Horticultural Report for 1864

(p. 66.) he is reported as being much inclined to discard it, his objection being that it is "troubled by the apple-worm"—by which is doubtless intended, the Grape-berry Moth.

There is some difference of opinion among botanists and experienced grape-growers as to the number of indigenous species of the Grape-vine, and as to the true character of some of the cultivated varieties. Some botanists are inclined to the opinion that we have but two, or even but one, species; and certain it is that the fertile character of the hybrids would lead to such an opinion, if infertility of hybrids is to be taken as a test of specific character. But it is more generally accepted that we have four distinct species (*V. labrusca*, *æstivalis*, *cordifolia* and *vulpina*) and this view is held by most western men,* and is perhaps warranted when we reflect that the very term species is but arbitrary, and that fertility of hybrids is not valued so much as an indication of specific identity among plants and some of the lower animals, as it is among more highly organized beings.

As already stated, our Grape leaf-louse is now principally confined to varieties of the Frost Grape;† but as it has been found in limited numbers on Iona and Concord, which are considered as varieties of the Northern Fox, and on the Delaware, which is considered either as a Summer Grape or as a hybrid between the Summer and the Northern Fox, I fear it may yet spread and become injurious to these species. Morever, now that we know that our insect is identical with that of Europe, there is also great danger that it will attack all hybrids with the European *Vinifera*, some of which, as the "Goethe," now promise well. Thus the reasons for discarding the Clinton and other Frost grapes become multiplied, for their cultivation may endanger the whole grape-growing interest of the country. On entomological grounds, I say emphatically to western men, do not plant any more Clintons, and get rid of those you now have as quickly as possible.

At the recent meeting of our State Horticultural Society at St. Joseph, some little discussion followed a paper which I read on this gall-louse and I was pleased to find that Dr. C. W. Spaulding, well known as a successful and experienced grape-grower, together with many other members, fully concurred in the advice here given. He had examined many of his vines, after his attention had been called to the matter, and found that the lice were found principally on the roots of old vines, and not on those of young ones. At this meeting it was almost unanimously agreed that the Clinton was comparatively worthless and should be done away with, but a few of the more

* See Husmann, "Grapes and Wine"; Flagg, *Hearth and Home*, Sept. 3, 1870; Spaulding, Lecture delivered at the Illinois State Fair, 1870.

† Though Gray considers the Clinton a variety of the *Æstivalis*, it is more generally considered as belonging to *Cordifolia*, which its great liability to the gall-louse would indicate.

conservative members, hesitated about discarding it for fear that such action would bring about the very result which it was intended to avoid, *i e.*, the spread of the insect on to other and more valuable varieties. In other words they feared that by taking away the Clinton, the lice which now prefer this variety and flourish and multiply upon it, would be forced to attack other varieties. They looked upon the Clinton, as a protector to the better kinds, by drawing the lice away from them, arguing, to parady the words of Shakespeare, that

> "'Tis better far, to bear those ills we have
> Than fly to others that we know not of."

Now while I admire the cautious spirit manifested in such an argument and admit that it seems plausible, I cannot believe there is any logic in it. The argument presupposes that the louse, as a species, can suddenly change its habits and tastes when forced to do so; but to my mind, a new habit is not generally acquired in a species by the simultaneous change of all the individuals composing it, but by some aberrant individual first taking on the new habit, and transmitting that habit to its descendants until a new race is in time produced. A single Clinton vine may stand in the midst of a vineyard of Concords for years, and, as we know to be the case, may be badly infested with this louse without its spreading on to the surrounding Concords. The lice may, and perhaps do, year after year spread on to and settle on the comparatively tougher leaves of such Concords, but year after year they perish from incapacity to sustain themselves. Some day, however, one or more aberrant individuals, may, by some slight constitutional difference from the normal type, be enabled to sustain themselves on the Concord leaves, and, by the laws of inheritance, transmit their characteristics to their descendants until, by the survival of those from each generation best fitted to flourish on these leaves, a new Concord-feeding race will be produced. Therefore, as already stated, I believe that there is danger of this louse spreading on to other varieties, and especially on to such as are more closely allied to the *Cordifolia*, or, to use a common but inexact expression, that have *Cordifolia* "blood" in them. But it must not be forgotten that we are here only supposing, from analogy, what *may* occur, because we know not positively that it *will* occur, and it is very obvious that even if there is this danger the chances of such an occurrence will be far greater as long as the Clinton is allowed to grow in the vineyard, than when it is uprooted and banished; and so far as all experience goes, we can safely conclude that to destroy all those vines in a vineyard that are infested with this louse, is to banish it from such a vineyard so that it will in future confine its attacks to the wild frost, as it did in the beginning.

The Apple-maggot (*Trypeta pomonella*, Walsh), as Mr. Walsh has demonstrated,* is an indigenous American insect and breeds in our

*Report as Acting State Entomologist of Illinois, pp. 29-30.

wild haws, occurring abundantly in the West, as well as in the East. Of late years it has acquired an appetite for the cultivated apples in some of the Eastern States, where it already does much damage to the apple crop. Yet, strange to say, it has not yet, and may never attack the cultivated apples in the West, and there is more danger that in process of time the more civilized Apple-maggots of the East will spread to the West, than that our haw-feeding maggots which are now among us, will acquire that habit, as a race of them once did in the East. Now no one will argue that if the Apple-maggots of the East were to be exterminated, the maggots in the wild haws would any the sooner attack our cultivated apples; and in like manner the extermination of the lice on our Clinton vines will not cause those on the Wild Frost to any the sooner attack our Concords.

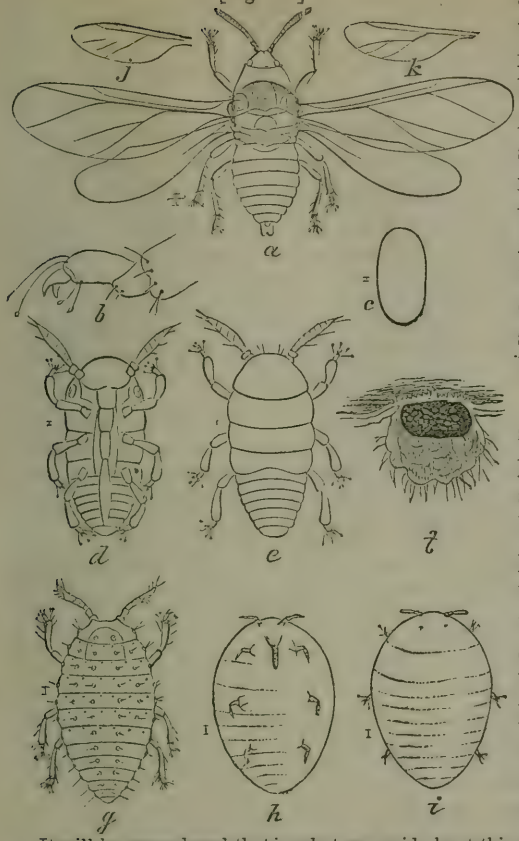
To give another illustration:—Our White pines have for years been greatly injured by the Pine-leaf Scale (*Aspidiotus* [*Mytilaspis*] *pinifoliæ*, Fitch) and I know that this same scale occurs to a slight extent on several other species of the genus, and have good reason to believe that it (or a race of it) is becoming more and more numerous on the Scotch pine around St. Louis. Yet to get rid of this scale I would not hesitate to destroy such White pines as were infested with it, for fear that by such a procedure I should drive the scales on to any other pines; because I believe that the scales on the Scotch pine for instance, multiply among themselves rather than by the annual transportation of individuals from the White pine, and because the experience of the past teaches that the latter is the only pine which has really suffered injury from this scale.

Other similar illustrations might be given, but I close by reiterating the opinion that there is nothing in the past history of the Grape-leaf Gall-louse to warrant the belief that by destroying the Clinton we shall force it on to those more valuable varieties which it has not hitherto attacked, and that whenever, as is admitted to be the case in the central portion of our State, the Clinton can be replaced by other and better varieties, it will be most wise and judicious to discard it. I have no idea that we shall ever exterminate this louse from our vineyards, because we can never obtain concert of action all over the country, and because it will flourish in a measure on other cultivated varieties of the *Cordifolia* group. But let each individual act for himself, and I feel satisfied that so far as he follows the advice here given, just so far will he be benefited.

There are several cannibal and parasitic insects which attack this Gall-louse, but for lack of time to make the proper illustrations, I shall have to leave their consideration to a future Report.

Figure 39, at the head of this article, represents a leaf covered with galls. Figure 40, (*a*) represents the winged female; (*b*) her foot or tarsus—after Signoret; (*c*) an enlarged egg; (*d*) the newly hatched gall-inhabiting type, ventral view; (*e*) same, dorsal view; (*f*)

[Fig. 40.]



a section of a gall; (*g*) the tubercled root-inhabiting form; (*h*) the mother gall-louse at the heighth of her fertility, ventral view; (*i*) same, dorsal view—all from nature; (*j* and *k*) differently veined wings of the Oak *Phylloxera* of Europe. All these figures are greatly enlarged, and the natural size is approximately shown by hair-lines.

The following discussion of this insect's proper place in our classification, and of its characters, may be passed over by the practical reader, as it is intended for those only who take an interest in such questions. I append it with but very slight alteration, as I wrote it for the last number of the second volume of the *American Entomologist*:

It will be remembered that in what was said about this insect on page 248 of our first volume we criticized the founding of the Family *Dactylosphæridæ* by Dr. Shimer. In an essay read before the Illinois State Horticultural Society, at Ottawa, last winter, Dr. Shimer took exception to our remarks, and called upon us to give a reason for the faith that is in us. Not considering a horticultural meeting the proper place to enter into the discussion of purely entomological questions, we declined to waste the precious time of the members, but intimated that we should be glad to answer the Doctor whenever a favorable occasion presented. The opportunity did not offer till now, as the Transactions of the Society, containing the essay in question, have but recently been published, but as we ourselves wrote the strictures, we will briefly give our reasons for so doing. In order to lay the question clearly before those interested, it will be necessary to quote that portion of our former article which so exercised friend Shimer. It runs as follows:

The louse which forms the gall was first described as *Pemphigus vitifoliæ* by Dr. Fitch, of New York, though it does not belong to that genus, Dr. Shimer, of Mt. Carroll, made some interesting observations on the habits of this insect, and made it the type of a new family (*Dactylosphæridæ*) and of a new genus (*Dactylosphæra.*) The distinguishing features of this supposed family are certain appendages attached to the legs which Dr. Shimer calls *digituli*, though the characters of the wings point unmistakably to the genus *Phylloxera* of the true Plant-lice. We shall not now discuss the validity or propriety of this new family, as we intend to give a more complete account of this louse in our future articles on Grape insects; but we will say here that Dr. Shimer is unfortunate in grinding out new genera and new families, for he has proposed a new family and genus (*Lepidosaphes*) for the common Apple-tree Bark-louse (*Aspidiotus*) [*Mytilaspis*] *conchiformis*, Gmél.) based upon similar appendages, which he found on its legs; whereas, if he had been better posted he would have known that these appendages are characteristic of almost all Bark-lice.

And here is Dr. Shimer's appeal:

Here they would like to make the public belive that these appendages, *digituli*, are the characters out of which I have proposed two families in Entomology; whereas, the leading character upon which I propose my family *Dactylosphæridæ*, is two claws on a one-jointed tarsus, and the leading characters in *Lepidosaphidæ* are a tarsus without a claw, and a *scale-making*, not a scale-like insect. The *digituli* from their globe-ended extremities I consider of some importance, but

by no means of primary weight in the first named family, and in the second family I give them no more than secondary importance. What reasons the junior editor, for he alone now becomes responsible, can assign for so gross a misrepresentation I am not able to anticipate. He certainly, however, will be able to give some reason for the faith within him. * * * * * * I have not the slightest personal feeling in the matter, and I hope that my much respected friend, Mr. Riley, State Entomologist of Missouri, will be free to defend the position he has taken against me.

Now, we believe Dr. Shimer is sincere in stating that he has no personal feeling in the matter, else we should not even notice his request. We hope, therefore, that he will believe us when we state that in the few words we are about to pen we are governed by no personal considerations whatever, but by a love of truth for truth's sake. As Dr. Shimer becomes more familiar (and we hope he will so become) with the minute and interesting insects to which he has more especially turned his attention, he will no doubt regret that he ever proposed those two families without longer pondering and considering.

Regarding the Bark-louse, we will dismiss the subject in a few words, as it is foreign to the topic under consideration. Dr. Shimer, it is true, deserves severe handling for the cool and skeptical manner in which he refers to the work of all preceding entomologists, and the laughable way in which he arrogates to himself the power of correct observation;** but at present we will simply accede to his request, as follows:

We confess that in stating that Dr. Shimer had based his new family, LEPIDOSAPHIDÆ, upon the occurrence of *digituli*, we should have qualified our language by inserting "partly" before "upon," since the characters as given by him are, *"Four digituli terminated by pulvilli or arolia, and no claw, and the female living beneath a scale or shell-like habitation of her own constructing."** But we insist that the proposition of a family on such grounds was not only unfortunate, but unwarranted, for the following reasons: First, the so-called *digituli* are not even of generic, much less of family value, as they are nothing but modified hairs, and occur in a more or less perfect form in all young *Coccidæ* and *Aphidæ* which we have examined, and are acknowledged by the best authorities to be common to both these families. Secondly, the insect in question really has a more or less perfect claw, as we have abundantly demonstrated the present year. Thirdly, the assumption† that the scale in all COCCIDÆ should be part and parcel of the insect itself, is a purely gratuitous one, since there are many other species which live separate from their scales, and since the genus *Aspidiotus* was especially erected by Bouché for those species which thus live *under* and seperate from them. Consequently there remains not a single character mentioned by our author but what is well known to belong to the COCCIDÆ, and there is not even the slightest excuse imaginable for seperating it from Costa's genus *Diaspis*, to which it is now correctly referred by Signoret—our highest authority on this family.

Now let us return to our Grape-leaf louse. We have no trouble in proving by Dr. Shimer's own words that we were perfectly justified in saying that the "*digituli*" were the "*distinguishing* features" of his supposed family *Dactylosphæridæ*. The very meaning of the word (globe-fingered) given to the family indicates such to have been the case, and he himself expressly says:‡ "The wing neuration of *Dactylosphæra* is synonymous with that of *Phylloxera*; it is, therefore, upon the other characters that I found this genus." Now what are the other characters? Turning to the family characters given, we find: "Wings four, carried flat on the back in repose. Antennæ few-jointed. Tarsi composed of one joint terminated by two claws, and from two to six *digituli*. Honey tubes none; otherwise resembling *Aphidæ*."§ The only other character given which is not Aphidian is the one-jointed tarsus, which, as we shall presently show, cannot, strictly speaking, be considered a character of our Gall-louse, and which, even if it were, would scarcely warrant the making of a new family. Every other character, including the "*digituli*," is common to dozens of plant-lice, and the neuration of the insect's wing‖ places it beyond any doubt in the genus *Pyllox-*

**Trans. Am. Ent. Soc. I, pp. 371-2.

* Trans. Am. Ent. Soc., I, p. 372.

† Ibid, p. 371.

‡ *Characters for a supposed new family*, p. 5, note; from the Proc. Acad. Nat. Sci., Phil., Jan., 1867.

§ Ibid, p. 1.

‖ The neuration of the wing differs slightly from the typical European *Phylloxera quercus*, in the two discoidal veins of the front wing uniting in a fork instead of being perfectly separated. On this account Mr. Walsh proposed for our insect, and for certain other species found in hickory galls, which have the same neuration, the generic name of *Xerophylla*. But it seems to us that the polymorphism of APHIDÆ has not yet been sufficiently investigated to allow of making even different species, much less different genera, upon a forked or unforked nervure, for there is frequently much greater difference in specimens coming from the same parents; and, as we are informed by M. Lichtenstein, the European *Phylloxera* of the Oak actually presents both kinds of neuration;

era, which has long been ready to receive it, and which, with the genera *Vacuna* and *Chermes*, form the sixth Tribe, *Chermesinæ*, of the APHIDÆ, according to Passerini's latest revision of this family.

We can commend the carefulness with which Dr. Shimer made the interesting observations which he has given us on this insect, but no man should undertake to found new families without first informing himself more thoroughly of what has already been done by others.

It was by no very easy means that we arrived at the conclusion that our Gall-louse is identical with the European species, but now that the fact seems sufficiently proved, Planchon's specific name *vastatrix* will have to give way to Fitch's *vitifoliæ*,* or at the most be retained as a variety.

At first there seemed to be many reasons for considering the two insects distinct. First, the European root-louse was exceedingly destructive, and their gall-louse of only exceptional occurrence; while our gall-louse was very common and destructive, and no root-lice were known to exist here at all. Secondly, the insect found in the galls was smooth, while that on the roots was distinctly ornamented with piliferous tubercles, and the two were sufficiently unlike to cause M. Lichtenstein, who believed in their identity, to propose the term gall-inhabiting (*gallicole*) for the one race, and root-inhabiting (*radiciole*) for the other. Thirdly, our insect was described as having a one-jointed tarsus, whereas M. Signoret described and figured the tarsus of the winged root-inhabiting form as two-jointed. Fourthly, there seemed to be a difference even in the form o our gall-inhabiting louse and theirs, as ours appeared much more obese and globular than theirs, as represented in their figures. All these apparent differences were rather calculated to give rise to doubts as to the identity of the two insects; but by careful observation and persistency we have been enabled to dispel them all.

First, we might naturally expect—and those who believe in the Darwinian hypothesis certainly would—that, presuming our insect to have been imported into Europe, it would undergo some modification in its habits, not only because of change of climate, but because of its having to live on another species of the Grape-vine—all the European species belongs to *Vitis vinifera*. Hence its normal habits there, of feeding on the roots, may have been gradually acquired. We believe a parallel case presents itself in our Apple Root-louse (*Eriosoma pyri*, Fitch) and the Wooly Aphis, or so-called "American Blight" (*Eriosoma lanigera*, Hausm). It is conceded on almost all sides† that the last insect was imported into Europe from this country, and there is now every reason to believe that the two insects are identical, or that at furthest they can only be considered as varieties of one species. Yet while in this country our root-louse is very injurious in the West, and only exceptionally found on the limbs above ground (though more often so found in the Eastern States); all authors that we are acquainted with have spoken of it as occurring solely on the limbs in Europe; though M. Lichtenstein informs us that he has found it on the roots also, and that in those cases it caused just such swellings of the roots as our root-louse does here. We know in St. Louis of an old apple-tree, standing in a yard where the ground is trodden hard, the limbs of which have been for the past three years more or less affected with this insect, though none can be found on the roots. But where the ground is more porous, and not so closely pressed to the roots, it seldom occurs on the branches, but often on the roots, even in the immediate neighborhood. Upon the closest examination we cannot find the slightest difference between the root and branch-inhabiting lice,

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there being red specimens with unforked nerves (Fig 40, *j*) and yellow specimens with forked nerves (Fig. 40, *k*). I have in my possession the very drawing made by Mr. Cresson from Dr. Shimer's specimen of *vitifoliæ*, which Mr. Walsh refers to in his Report, and which led Mr. W. erroneously to place our louse with the Coccids. The drawing is rough, evidently imperfect, and well calculated to mislead, for the discoidal nerve of the front wing is represented more as a fold, the forks are omitted, and the costa of hind wing is represented perfectly straight. The drawing is also accompanied by Mr. Cresson's statement that he could not give any decided opinion as to the neuration, as the wings on the specimen were not spread out.

* M. J. Lichtenstein has objected to Fitch's specific name "*vitifoliæ*" on the score of its being ungrammatical, and has substituted the term "*vitis-folii*" in his published reports. Now Dr. Fitch has given the termination "*foliæ*" to a number of his specific names, and though "*folii*" would of course be more grammatically correct, one would suppose the Doctor had some reason for his conduct. At all events I believe it is perfectly proper to drop the middle *s* in compounding the two words, and certain it is that Fitch's term has been adopted by all subsequent writers in speaking of the insect. Irregularities in entomological nomenclature seem to be allowable, or at least are very frequently and purposely perpetrated for the sake of euphony. "Whatever is, is right," is as true in language as it is in religion, and if we alter *vitifoliæ* we must alter a thousand other entomological names that are not, strictly speaking, grammatically correct. It is quite proper to correct a faulty name, but after showing that it is faulty it seems best, to prevent endless confusion, to adopt the faulty name, and thus make its author shoulder the blame, until he himself corrects it.

† M. Eudes-Deslongchamps and M. Blot are the only authors, according to Amyot and Serville, who believe it is indigenous to Europe.

and no doubt their habitat is governed somewhat by the character of the soil, though in this country their normal habit is to attack the roots, and to appear above ground only occasionly in the fall.

Secondly, we have proved, by transferring on to roots the young grape-lice hatched from galls, and by successfully feeding them on those roots, that our smooth gall-inhabiting type gives birth to the tubercled root-inhabiting type; and we have discovered that our gall insects take to the roots in the fall, on which they cause the same cankerous spots and swellings as does the *vastatrix* of Europe, and on which they evidently hibernate just as *vastatrix* is known to do.

Thirdly, although in the gall-inhabiting type, in both countries, the tarsus seems to be one-jointed, yet in the root inhabiting type it is really two-jointed; for though the basal joint is small, and not visible from above, it is plainly visible from the side or from below (See Fig. 40, *b*). We have here what certain speculative entomologists would consider an excellent illustration of the inferiority of Coccidæ compared with the Aphidæ, namely, a true Aphidian, exhibiting in its larval and agamic stage the one-jointed tarsus of a Coccid, and only showing the two-jointed tarsus of its family in the more perfected tubercled form, and in the winged state. And this Coccid-affinity in the less perfect gall-producing state is sometimes carried still farther, as we have often been unable to discern but a single claw to the tarsi of some of the young gall-inhabiting individuals.

Fourthly, the fact that M. Signoret, who alone has compared actual specimens from both countries, decides them to be identical, would sufficiently indicate that the difference noticeable in the form depends on the observer, and on the stage of growth at which observations are made.

It was the one-jointed tarsus in the gall insect which no doubt in part led Dr. Shimer to propose a new family for it, and it was this character—coupled with the facts that it is oviparous, that does not secrete any sugary or flocculent substance (as do most gall-inhabiting Plant-lice), and that the young forsake the gall and scatter over the leaves as soon as hatched—which led Mr. Walsh to consider it as an anomalous and aberrant Coccid. The genus *Phylloxera* seems also, according to Westwood, to have been doubtingly introduced into this family by Curtis in his Guide. We have already shown that, in the root-inhabiting form, the two joints of the tarsus are plainly to be seen; and Dr. Shimer himself admits* that, in the winged insect which he found in galls, he noticed a constriction on the under side of the tarsus, though he is unwilling to allow that it was a joint, because there was no motion. But even if the 2-jointed character of the more perfect ouse were not demonstrated, all the other characters are so unmistakably Aphidian that there is, we think, no warrant in making a new family. In such degraded insects, where the antennal joints are so variable, we might naturally expect to find variation in the joints of the legs. The more familiar we become with the biological secrets of Nature, the more do we find, not only species but genera, and even families, approaching each other through modifications found in individuals; and these aberrant gall-lice only help to give us a better idea of the close connection between the *Coccidæ* and *Aphidæ*. Our *Phylloxera* brings the two families close together, by its affinities on the one side with *Chermes* of Linnæus, which, though looked upon as a Coccid by Ratzeburg, is generally considered an Aphidian, and on the other with the Coccidan genus *Dactylopius* which contains Linnæus's *Coccus adonidum*. The oviparous nature of these gall-lice will also have less significance when we reflect that there is a sort of gradation in this process, and that many Plant-lice which are considered viviparous or ovoviparous do in reality bring forth their young enveloped in a more or less distinct egg-like film or covering, from which they have to free themselves by a process analogous to that of hatching. This has not only been observed by Curtis, in the case of an *Aphis* found on the turnip,† but by Dr. Wm. Manlius Smith, of Manlius, N. Y.,‡ in the case of *Pemphigus;* but we have, the present year, assured ourselves of the accuracy of Dr. Manlius's observation as to *Pemphigus*, and witnessed the same thing in *Eriosoma*, namely in *E. pyri*, Fitch. In this last case the newly deposited louse (or egg) remains motionless for a considerable time; and the covering, after the young louse has extricated itself from it, may be as distinctly seen attached to the end of its body as the covering or egg-shell of our Grape gall-louse, and was figured by Fitch, who mistook it for the cotton-like matter, which, however, is not secreted till the louse fastens itself and begins to grow.§ Moreover those Aphidians which are viviparous through the spring and summer months, generally lay eggs in the fall; and though agamous and viviparous multiplication can be prolonged by submitting the lice to a continued artificially warm temperature, there is doubtless a limit to this prolongation; and it may be laid down as a rule that, with most Aphidians, the ♂ element and the production of eggs are, at some time or other, indispensable to the continuance of the species.

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*Characters of a Supposed New Family, p. 3.
†Farm Insects, p. 65.
‡Auctore Walsh, P. E. S. P. VI, p. 282, note.
§N. Y. Rep. I, p. 9.

THE COLORADO POTATO BEETLE AGAIN.

THE BEST MEANS OF FIGHTING IT—A WORD TO OUR CANADIAN NEIGHBORS.

To give some idea of the onward march of this destructive insect, and to lay before the reader the experience that has been gained since the publication of my first Report, I transmit the following article from the *American Entomologist* of last September.

Last July, while spending a few days in Ontario, we ascertained that this most destructive insect had just invaded the Dominion at two different points, namely, near Point Edward, at the extreme south of Lake Huron, and opposite Detroit, near Windsor, at the south-western corner of Lake St. Clair. These are precisely the two points at which we should naturally expect to first meet with it on the Canadian border; for all such beetles as fly into either of the lakes from the Michigan side would naturally be drifted to these points. As we know from experience, many insects that are either quite rare, or entirely unknown on the western side of Lake Michigan, are frequently washed up along the Lake shore at Chicago; and these are so often alive and in good condition, and so often in great numbers, that the Lake shore is considered excellent collecting ground by entomologists. In like manner grasshoppers are often washed up on the shores of Salt Lake, in Utah, in such countless numbers that the stench from their decomposing bodies pollutes the atmosphere for miles around. We have not the least doubt, therefore, in view of these facts, that the Colorado Potato Beetle could survive a sufficient length of time to be drifted alive to Point Edward, if driven into Lake Huron anywhere within twenty or thirty miles of that place, or if beaten down anywhere within the same distance while attempting to cross the lake.*

How truly is Mr. Walsh's prophecy being fulfilled, that the northern columns of this great army would spread far more rapidly than the lagging southern columns.†

Now, what will our Canadian brethren do? Will they stand by and listlessly see this pernicious insect spread over their territory like a devouring flame, as it has done over the Western and Central States; or will they make some determined and united effort to prevent such a catastrophe? Of one thing our friends across the border may rest assured—they have not here a sham and braggart Fenian army to deal with, but an army which knows no retreat, and whose

*The following item which was clipped from the St. Joseph (Mich.) *Herald*, after the above was written, attests the accuracy of the inference:—"Whoever has walked on this shore of Lake Michigan has observed large numbers of the Colorado potato beetle, crawling from the water. Many have doubted the source whence they came. It would seem from the following that they fly, and swim from the western shore of Lake Michigan. Capt. John Boyne of the Lizzie Doak, reports finding his deck and sails infested with potato bugs when half way from Chicago to St. Joseph at night. Not a bug was on deck when the schooner left Chicago."

†*Practical Entomologist*, I, p. 14.

embers, though of small and insignificant stature, will fully make up in number what they lack in size.

When we calculate the immense loss, amounting to millions of dollars, which this insect has cost the Western States during the past nine or ten years—when we contrast the healthful and thrifty aspect of the potato fields in Ontario and in those States to which this potato plague has not yet spread, with the sickly, denuded, or Paris-green-besmeared fields at home—but above all when we reflect that, nothing preventing, it will infest the whole of Ontario within, perhaps, the next two, and at farthest within the next three years—we feel that it is high time to make some effort to prevent its onward march through Ontario, if ever such an effort is to be made. The warnings and instructions given by the Agricultural press, and through our own columns, will avail but little, as they reach the few only. It may be, and doubtless is, true that successful culture, as our country becomes more thickly settled, will be confined to the intelligent and well-informed; yet the fact nevertheless remains, that the masses will do nothing to ward off an evil until they are forced to it from necessity. The plodding, non-reading farmer will take no notice of the few bugs he first sees in his potato field, because they do him no material injury; but when the bugs have increased so as to make it a question of "potatoes or no potatoes" with him, then his energies will be aroused. But alas! his best efforts, at this time, often prove unavailing, and he has to spend days to accomplish that which a few minutes would have accomplished before. We therefore fully expect to see this great army of bugs continue its eastward march without hindrance, unless other preventive measures are taken than those already employed. A standing premium offered by the Minister of Agriculture, Mr. Carding, for a given number of beetles, or for the greatest number collected and killed in one season, or for the cleanest and best field of potatoes, of a given number of acres, within the infested districts along the eastern shores of the lakes mentioned and those of the St. Clair river; might, and undoubtedly would, be the best means of stamping it out, and of keeping it out of the Dominion.*

No doubt that, in suggesting any expenditure of money for such purposes, our Canadian brethren will deem us over-enthusiastic about "small things," and over-anxious for their welfare. Well, be that as it may, we don't forget that there is considerable of Uncle Sam's territory beyond Niagara. It is a mere matter of dollars and cents, and we venture to say that, when once this insect shall have spread over Ontario, a million dollars would be freely spent to accomplish that which will then be almost impossible, and which a very few thousands would effectually accomplish now—namely, its extermination from the Dominion.

An excellent chance is now afforded in Ontario—almost surrounded as it is by lakes—to keep this destructive enemy at bay. In the summer of 1869, reports of this insect's ravages, and of its prog-

ress eastward, came thick from Wisconsin and Indiana; but no organized effort was made to check it, and indeed there was very little chance of doing so. It is fast spreading through Ohio; and according to Dr. Trimble of New Jersey, has already reached Pennsylvania. Uncle Sam cannot well prevent its spread around the southern shore of Lake Erie, through Pennsylvania and eastward; but, if it can be effectually resisted between Point Edward and the Detroit river, there will be little difficulty in preventing its crossing at Niagara. A victory would indeed be gained if, by intelligent effort, this grievous pest could be kept out of Upper Canada, while it is devastating the potato fields on all sides in the States; and Minister Carding would add to his well-deserved popularity by making the effort, whether it succeeds or not.

PARIS GREEN A REMEDY.

While on this subject it may be well to say a few words about the use of Paris green. This substance has now become THE remedy for the Colorado Potato Beetle, and it is the best yet discovered. Having thoroughly tested it ourselves, and having seen it extensively used, we can freely say that, when applied judiciously, it is efficient and harmless. If used pure and too abundantly, it will kill the vines as effectually as would the bugs, for it is nothing but arsenite of copper (often called "Scheele's green" by druggists), and contains a varied proportion of arsenious acid, according to its quality—often as much as fifty-nine per cent., according to Brande & Taylor. But when used with six to twelve parts, either of flour, ashes, plaster or slacked lime, it causes no serious injury to the foliage, and just as effectually kills the bugs. The varied success attending its use, as reported through our many agricultural papers, must be attributed to the difference in the quality of the drug.

We hear many fears expressed that this poison may be washed into the soil, absorbed by the rootlets, and thus poison the tubers; but persons who entertain such fears forget that they themselves often apply to the ground, as nourishment for the vines, either animal, vegetable or mineral substances that are nauseous, or even poisonous to us. Animal and vegetable substances, of whatsoever nature, must be essentially changed in character and rendered harmless before they can be converted into healthy tubers, and a mineral poison could only do harm by being taken with the potatoes to the table. That any substance, sprinkled either on the vines or on the ground, would ever accompany to the table a vegetable which develops underground, and which is always well cooked before use, is

* The Rev. C. J. S. Bethune, in the *Canada Farmer* for October 15th, 1870, also recommended the marking off of a tract of country about ten miles in width, all along the border line between the foot of Lake Huron and the head of Lake Erie, with the exception, possibly, of a portion of the eastern shore of Lake St. Clair, and stopping the culture of the potato throughout that whole tract during the prevalence of the pest in the neighboring State of Michigan.

rendered highly improbable. There can be no danger in the use of sound tubers. But the wise and well-informed cultivator will seldom need to have recourse to Paris green, as he will find it more profitable to use the different preventive measures that have from time to time been recommended in these colums.

The poison may do harm, however, by being carelessly used, and it is most safely applied when attached to the end of a stick several feet long, and should not be used where children are likely to play.

NATURAL CHECKS INCREASING.

In many parts of the West this insect is being kept in due check by its cannibal and parasitic enemies, which are still increasing. Thus we learn from many sources that in Iowa and Kansas it is not nearly so injurious as it formerly was, while in some parts of Illinois and Missouri it has also become less troublesome. Last year Mr. T. Glover published the fact that the Great Lebia (*Lebia grandis*, Hentz, Fig. 41) was found devouring its larvæ,* and though hitherto considered rare this Lebia has suddely fallen upon it the present year in many parts of Missouri. During a recent trip along the Missouri Bottom we found this cannibal very abundant in some potato fields belonging to Mr. Wm. Coleman, where it was actively engaged in destroying both the eggs and larvæ of the Potato Beetles. The head, thorax and legs of this cannibal are yellowish-brown, in high contrast with its dark-blue wing-covers.

[Fig. 41.]

This makes fourteen conspicuous enemies of our Colorado Potato Beetle which we have figured, and a dozen more, mostly of small size and inconspicuous markings, might easily be added to the list. Moreover, chickens have learned to relish the eggs, and have even acquired a taste for the young larvæ. So we need not wonder that the army is being decimated in those States first invaded by it.

BOGUS EXPERIMENTS.

It was recently reported to us that a neighbor had succeeded in driving away all his Potato bugs by strewing Elder branches among the vines. We went to examine the field and found our friend enthusiastic over his discovery; and indeed though the vines were nearly devoured, there were but a few full grown larvæ to be found. But, as he could not tell us what had become of the "slugs," we undertook to show him where they had gone, and after digging a few moments with a trowel, unearthed dozens of them, the majority in the pupa, but a few yet in the larva state. Our neighbor had, in fact, been misled by appearances, for want of better knowledge of his enemy. The larvæ as they acquired their growth suddenly became so destructive, that to save his vines he was obliged to try some means of killing them,

* Dept. of Agr. Rep. 1868, p. 81.

and as an experiment he tried the Elder. The larvæ were just ready to disappear of their own accord, and as the great bulk of them did really disappear in two or three days after the application, the apparently logical inference was made that they had been driven away by the smell of the Elder.

How many of the published remedies that flood the country owe their origin to just such defective proof! The sun-scorching remedy, which consists of knocking the bugs off the vines on to the heated ground between the rows, and which has been so often recommended the present year, partakes a good deal of this character; for it can only be of benefit in a very dry season, and at a time of year when the bugs have done most of their damage. A goodly proportion of the larvæ that are thus knocked off will always manage to burrow into the ground and transform, or to get back upon the vines; and

THE TRUE REMEDY

consists in preventing them from becoming numerous so late in the season. Watch for the beetles in early spring, when the vines are just peeping out of the ground. Ensnare as many of them as you can before they get a chance to pair, by making a few small heaps of potatoes in the field planted: to these the beetles will be attracted for food, and you can easily kill them in the morning. Keep an eagle eye for the eggs which are first deposited. Cultivate well, by frequently stirring the soil. Plant early varieties in preference to late ones because the bugs are always more numerous late in the season than they are during the spring and early summer. Give the preference to the Peach Blow, Early Rose and such other varieties as have been found most exempt from attack,* and surround your fields on the outside by rows of such tender-leaved varieties as the Mercer, Shaker, Russet, Pink-eye and Early Goodrich; but, above all, isolate your potato field as much as possible, either by using land surrounded with timber, or by planting in the centre of a cornfield. Carry out these suggestions thoroughly and you will not have much use for Paris green and still less for the scorching remedy.

THE CODLING MOTH AGAIN.—*Carpocapsa pomonella*, Linn.

HAY-BANDS VS. RAGS—ALWAYS TWO-BROODED IN MISSOURI.

After a series of experiments, instituted the past summer, I have proved that, after all, the hay-band *around* the trunk of the tree is a

* After experimenting last summer with eighty-one varieties of potatoes, the Superintendent of the garden of the Iowa Agricultural College reports the varieties of the Peach Blow, the Peerless and Chili No. 2, as most exempt from the ravages of this insect, the last named variety not being worked upon at all.

more effectual trap for the Apple-worm than the rags placed in the *fork* of the tree. There is no superiority in the rags over the hay-band, unless the former are made to encircle the tree as thoroughly as the latter. Where rags are placed simply in the forks, many of the worms pass down the tree from the outside of the branches. If the rag is tied around the trunk, it will impede almost every worm that crawls down the tree from the fruit which hangs on, or that crawls up the trunk from the fruit which alls; and it then has a decided advantage over the hay band, because it can either be passed through a roller or scalded, and used again.

It has been very generally accepted in this country that the Codling Moth is double-brooded, and in all my writings on the subject I have stated it to be so, though no one, so far as I am aware, ever proved such to be the case beyond a doubt. Mr. P. C. Zeller, of Stettin, Prussia, informed me last winter that it is only single-brooded in that part of the world, and Harris gives it as his opinion that it is mostly so in Massachusetts. Now, such may not improbably be the case in northern Prussia, and the more northern of the United States, though I incline to believe otherwise. At all events, this insect is invariably double-brooded in the latitude of St. Louis, and its natural history may be briefly told as follows: The first moths appear, and begin to lay their eggs, soon after the young apples begin to form. The great bulk of the worms which hatch from these eggs leave the fruit from the middle of May to the middle of June. These spin up, and in from two to three weeks produce moths, which pair and in their turn commence, in a few days, to lay eggs again. The worms (second brood) from these eggs leave the fruit, some of them as early as the first of September, others as late as Christmas. In either case they spin their cocoons as soon as they have left the apples, but do not assume the pupa state till towards spring—the moths from the late matured worms appearing almost as early as those from the earlier matured ones. The two broods interloc , so that in July worms of both may be found in the fruit of one and the same tree. I have repeatedly taken worms of the first brood, bred the moths from them, and obtained from these m ths the second brood of worms; and I have done this both on enclosed fruit hanging on the tree in the open air, and on plucked fruit in-doors. In the latter experiments the moths would often cover an apple with eggs, so that when the worms hatched they would enter from all sides, and soon so thoroughly perforate and devour the fruit as to die of starvation. This is a clear case of misdirected instinct in the parent, caused doubtless by confinement.

From the foregoing facts, it becomes obvious that the rags or the hay-band should be kept around the tree, say from the first of May till the fruit is all off; and to be thoroughly effectual, the insects collected in or under them should be destroyed regularly every fortnight during that time.

There is a fact connected with the Codling Moth which, though of interest to entomologists is not generally known, and has never been published in this country. It has always been difficult to distinguish the sexes of this moth, but there is an infallible index recently pointed out by Mr. Zeller in his "Lepidopterologische Beobachtungen im jahre 1870." It consists of a black pencil or tuft of hairs of considerable length on the upper surface of the hind wings. It springs from a point close to the base of the wing and by the side of the median nervure, and lies in a groove running alongside of that nervure to about half the width of the wing, the groove forming a distinct carina on the under surface. The tuft when closely fitted into this groove is not easily noticed, but since my attention has been drawn to it, I have readily detected it on all my cabinet specimens, and it can easily be raised by the point of a needle.

Thus we find that important features are often revealed upon close scrutiny of our commonest insects, and the fact that this feature was so long overlooked in our Codling Moth should teach us to be all the more careful and cautious in our examinations and descriptions. Two similar instances of general oversight of common features in common insects were pointed out to me last fall by that excellent observer, Mr. J. A. Lintner, of the Agricultural Rooms, Albany, N.Y., who ascertained the facts that in the Butterfly genus *Argynnis* the males have invariably a beautiful fringe of hair on the sub-costa of the hind wings, while the females have not; and that in the genus *Grapta* the males have hairy front legs while the females have not.*

In my first Report (p. 65) I mentioned as an exceptional occurrence that this insect had been found quite injurious to plums around London, Ontario; but it has not hitherto been recorded as infesting peaches. Mr. Huron Burt, of Williamsburg, Callaway county, informs me, however, that three-fourths of the peaches in his vicinity were infested with this worm, and that it was more abundant in this stone-fruit than in apples, though its gnawings in the former are not followed by the same serious consequences as they are in the latter. In the peach the worm always lives near the stone, and bores no other holes through the flesh than the one required for egress, and the excrement is packed close to the stone, so that the fruit is generally but little injured for eating, cooking, drying or other purposes. Mr. Burt did not actually breed the moths from these peach-inhabiting worms, but as he is one of my most valued correspondents and an excellent observer and has paid considerable attention to insects, I have little doubt but that he is correct in concluding that they were the larvæ of the Coddling Moth, the more especially as he has far-

* The first mentioned feature, as a secondary sexual character, has long since been pointed out, and according to Mr. H. W. Bates (Trans. Linn. Ent. Soc., Vol. XXIII, p. 502, 1861) is common to all the tropical genera but two (*Lycorea* and *Ituna*) composing the Danoid *Heliconidæ*. Yet Mr. Lintner's observation is certainly original in this country, for, striking and useful as the feature is as a sexual characteristic, it is never given in the beautiful plates of Mr. Edwards's "Butterflies of North America."

nished me, in detail, his reasons for this conclusion; but until the matter is settled beyond all doubt it would be premature to speculate farther on such a new and remarkable habit in such a common and well known insect.

THE CORN-WORM *alias* BOLL-WORM—*Heliothis armigera*, Hübner.

(Lepidoptera, Noctuidæ.)

This is a worm which is every year more or less destructive to our corn in the ear, and which was this year very injurious in many sections.

It has a very wide range, and a Mr. Bond, at the meeting of the London (England) Entomological Society, on March 1st, 1869, exhibited specimens of the moth from the Isle of Wight, from Japan, and from Australia; and, as might be expected from its extended habitat, the insect is a very general feeder. The "Boll-worm" has become a by-word in all the Southern cotton-growing States, and the "Corn-worm" is a like familiar term in those States, as well as in many other parts of the Union; but few persons suspect that these two worms—the one feeding on the corn, the other on the cotton-boll—are identically the same insect, producing exactly the same species of moth. But such is the fact, as I myself first experimentally proved in 1864. It attacks corn in the ear, at first feeding on the "silk," but afterwards devouring the kernels at the terminal end; being securely sheltered the while within the husk. I have seen whole fields of corn nearly ruined in this way, in the State of Kentucky, but nowhere have I known it to be so destructive as in Southern Illinois. Here, as in our own State, there are two broods of the worms during the year, and very early and very late corn fare the worst; moderately late and moderately early varieties usually escaping. I was formerly of the opinion that this worm* could not live on hard corn, and it certainly does generally disappear before the corn fully ripens, but last fall Mr. James Harkness, of St. Louis, brought me, as late as the latter part of October, from a corn field on the Illinois bottom, a number of large and well ripened ears, each containing from one to five worms of different sizes, subsisting and flourishing on the hard kernels. This is, however, an exceptional occurrence, brought about, no doubt, by the long protracted warm weather which we had, and the worms were in all probability a third brood.

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* Am. Ent. I, p. 212.

This glutton is not even satisfied with ravaging these two great staples of the country—cotton and corn—but, as I discovered in 1867, it voraciously attacks the tomato in South Illinois, eating into the green fruit, (Fig. 42), and thereby causing such fruit to rot. In this manner it often causes serious loss to the tomato-grower, and it may justly be considered the worst enemy to the tomato in that section of the country. Mr. Glover also found it feeding in a young pumpkin, and it has been ascertained by Mrs. Mary Treat of Vineland, New Jersey, not only to feed upon the undeveloped tassels of corn and upon green peas, but to bore into the stems of the garden flower known as Gladiolus, and in confinement to eat ripe tomatoes. Last summer it was also found by Miss M. E. Murtfeldt in common string beans, around Kirkwood, and in Europe it is recorded by M. Ch. Goureau* as not only infesting the ears of Indian corn, but as devouring the heads of hemp, and leaves of tobacco, and of lucern. The fact of its attacking a kind of pea, namely, the chick-pea or coffee-pea (*Cicer arietinum*) has also been recorded by M. J. Fallou (See *Insectologie Agricole*, 1869, p. 205) in certain parts of France, the young worms feeding on the leaves but the larger individuals boring through the pods and devouring the peas.

[Fig. 42.]

Thus it seems to be almost as promiscuous in its tastes as the Stalk-borer (*Gortyna nitela*, Guen.), which burrows in the stalks of the Potato, of the Tomato, of the Dahlia, of the Aster and other garden flowers, of the common Cocklebur and of Indian corn, besides boring into green corn-cobs and eating into green tomatoes and ripe strawberries, and in a single instance in Missouri eating into peach twigs, and in Illinois inhabiting the twigs of the Black Currant.†

But for the present we will consider this insect only in the two roles of Boll-worm and Corn-worm, because it is as such that it interests the practical man most deeply.

The egg from which the worm hatches (Fig. 43, *a* side view; *b*, top view magnified) is ribbed in a somewhat similar manner to that of the Cotton-worm, figured in my Second Report (p. 38) but may readily be distinguished by being less flattened, and of a pale straw color instead of green. It is usually deposited singly on the outside

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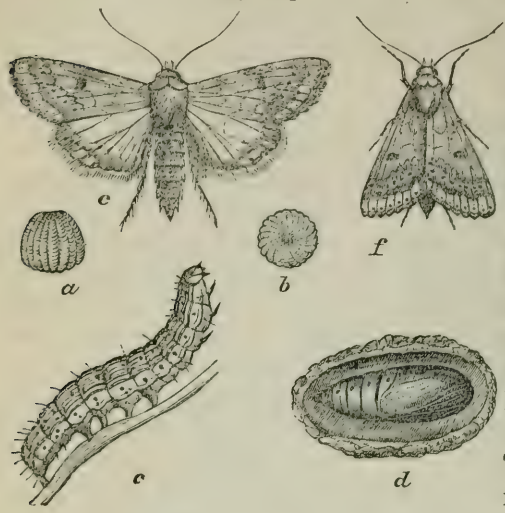
* *Insectes Nuisibles*, 2nd supplement, 1865, p. 132.

† See *Am. Ent.* I. p. 206; II. p. 13.

of the involucel or outer calyx of the flower or young boll, and each female moth is capable of thus consigning to their proper places, upwards of five hundred eggs. Mr. Glover, in his account of the Boll-worm, published in the Monthly Report of the Department of Agriculture for July, 1866, says: "Some eggs of the Boll-worm moth hatched in three or four days after being brought in from the field, the enclosed worms gnawing a hole through the shell of the egg and then escaping. They soon commenced feeding upon the tender fleshy substance of the calyx, near the place where the egg had been deposited. When they had gained strength, some of the worms pierced through the calyx, and others through the petals of the closed flower-bud, or even penetrated into the young and tender boll itself. The pistils and stamens of the open flower, are frequently found to be distorted and injured without any apparent cause. This has been done by the young Boll-worm; when hidden in the unopened bud, it has eaten one side only of the pistils and stamens, so that when the flower is open the parts injured are distorted and maimed, and very frequently the flower falls without forming any boll whatever. In many cases, however, the young worm bores through the bottom of the flower into the immature boll before the old flower falls, thus leaving the boll and involucel or envelope still adhering to the foot-stalk, with the worm safely lodged in the growing boll. The number of buds destroyed by this worm is very great, as they fall off when quite small, and are scarcely observed as they lie brown and withering on the ground beneath the plant. The instinct of the Boll-worm, however, teaches it to forsake a bud or boll about to fall, and either to seek another healthy boll, or to fasten itself to a leaf, on which it remains until at length it acquires size and strength sufficient to enable it to bore into the nearly matured bolls, the interior of which is nearly destroyed by its attacks, as, should it not be completely devoured, rain penetrates through the hole made by the worm, and the cotton soon becomes rotten and will not ripen. * * * * * * * *
One thing is worthy of observation, and that is, whenever a young boll or bud is seen with the involucre spread open, and of a sickly yellow color, it may be safely concluded that it has been attacked by the Boll-worm, and will soon perish and fall to the ground. * * *

[Fig. 43.]



The buds injured by the worm may be readily distinguished by a minute hole where it has entered, and which, when cut open, will be found partially filled with small black grains, something like coarse gun powder, which is nothing but the digested food after having passed through the body of the worm."

This insect is very variable in the larva state, the young worms varying in color from pale green to dark brown. When full grown there is more uniformity in this respect, though the difference is often sufficiently great to cause them to look like distinct insects. Yet the same pattern is observable, no matter what may be the general color; the body being marked as in the above figures with longitudinal light and dark lines, and covered with black spots which give rise to soft hairs. Those worms which Mrs. Treat found in green peas and upon corn tassels had these lines and dots so obscurely represented that they seemed to be of a uniform green or brown color, and the specimens which I saw last summer in string beans were also of a dark glass-green color with the spots inconspicuous, but with the stripe below the breathing pores quite conspicuous and yellow. The head, however, remains quite constant and characteristic. Figure 42 may be taken as a specimen of the light variety, and Figure 43, *c*, as illustrating the dark variety. When full grown, the worm descends into the ground, and there forms an oval cocoon of earth interwoven with silk, wherein it changes to a bright chestnut-brown chrysalis (Fig. 43, *d*), with four thorns at the extremity of its body, the two middle ones being stouter than the others. After remaining in the chrysalis state from three to four weeks, the moth makes it escape. In this last and perfect stage, the insect is also quite variable in depth of shading, but the more common color of the front wings is pale clay-yellow, with a faint greenish tint, and they are marked and varigated with pale olive and rufous, as in Figure 43, (*e* showing the wings expanded, and *f* representing them closed), a dark spot near the middle of each wing being very conspicuous. The hind wings are paler than the front wings, and invariably have along the outer margin a dark brown band, interrupted about the middle by a large pale spot.

Mr. Glover says that there are at least three broods each year in Georgia, the last brood issuing as moths as late as November. With us there are usually but two, though, as already hinted, there may be exceptionally three. Most of the moths issue in the fall, and hibernate as such, but some of them pass the winter in the chrysalis state and do not issue till the following spring. I have known them to issue, in this latitude, after the 1st of November, when no frost had previously occurred.

In 1860—the year of the great drought in Kansas—the corn crop in that State was almost entirely ruined by the Corn-worm. According to the *Prairie Farmer*, of January 31, 1861, one county there which raised 436,000 bushels of corn in 1859, only produced 5,000 bushels of poor wormy stuff in 1860; and this, we are told, was a fair sample

of most of the counties in Kansas. The damage done was not by any means confined to the grain actually eaten by the worm; but "the ends of the ears of corn, when partially devoured and left by this worm, afforded a secure retreat for hundreds of small insects, which, under cover of the husk, finished the work of destruction commenced by the worm eating holes in the grain or loosening them from the cob. A species of greenish-brown mould or fungus grew likewise in such situations, it appearing that the dampness from the exuded sap favored such a growth. Thus decay and destruction rapidly progressed, hidden by the husk from the eye of the unsuspecting farmer." It appears also that many horses in Kansas subsequently died from disease, occasioned by having this half-rotten wormy corn fed out to them.

Remedies.—It is the general experience that this worm does more injury to very early and very late corn than to that which ripens intermediately, for though the broods connect by late individuals of the first and early individuals of the second, there is nevertheless a period about the time the bulk of our corn is ripening, when the worms are quite scarce. I have never yet observed their work on the green tassel, as it has been observed in New Jersey, and do not believe that they do so work with us. Consequently it would avail nothing as a preventive measure, to break off and destroy the tassel, and the only remedy when they infest corn is to kill them by hand. By going over a field when the ears are in silk, the presence of the worms can be detected by the silk being prematurely dry or by its being partially eaten.

In the South various plans have been adopted to head off the Boll-worm, but I believe none have proved very successful. The following experiment with vinegar and molasses, was made by B. A. Sorsby, of Columbus, Ga., as quoted by Mr. Glover:

"We procured eighteen common-sized dinner plates, into each of which we put half a gill of vinegar and molasses, previously prepared in the proportion of four parts of the former to one of the latter. These plates were set on small stakes or poles driven into the ground into the cotton field, one to about each three acres, and reaching a little above the cotton plant, with a six-inch square board tacked on the top to receive the plate. These arrangements were made in the evening, soon after the flies had made their appearance; the next morning we found eighteen to thirty-five moths to each plate. The experiment was continued for five or six days, distributing the plates over the entire field; each day's success increasing until the numbers were reduced to two or three moths to each plate, when it was abandoned as being no longer worthy of the trouble. The crop that year was but very little injured by the Boll-worm. The flies were caught in their eagerness to feed upon the mixture by alighting into it and being unable to escape. They were probably attracted by the odor of the preparation, the vinegar probably being

an important agent in the matter. As the flies feed only at night, the plates should be visited late every evening, the insects taken out, and the vessels replenished as circumstances may require. I have tried the experiment with results equally satisfactory, and shall continue it until a better one is adopted."

Mr. J. M. Heard, of Monroe county, Wisconsin, patented in 1860, a device for trapping the moth, which consists of a tin plate placed on a funnel, which is connected with a bait-pan made of the same material, and which is to be partially filled with molasses mixed with a little anise, fennel or other essential oil. From one summer's test of the trap, I do not think much of it as a decoy for the moth, and it would be altogether too expensive, when the great number required to properly protect a large cotton field is taken into consideration.

THE FALL ARMY-WORM—*Prodenia antumnalis*, Riley.

[Lepidoptera, Noctuidæ.]

In 1868 the true Army-worm appeared in certain portions of the State and I gave a full account of it in my second Report. Last fall another worm very generally mistaken for that insect made its appearance very generally over the State, and caused considerable alarm. Specimens were sent to me from Moniteau, Jefferson, Pulaski and Cole counties, while it was common throughout the greater portion of the county of St. Louis.

The first notice I received of it was from the following item which appeared in the *Journal of Agriculture* of St. Louis:

Army worm.—*Editors Journal Agriculture:*. Since Friday (26th August), the Army-worm has made its appearance in distressingly large numbers almost everywhere in this (Cole) county. They have destroyed for me more than an acre of turnips, a good deal of my late soiling corn, and are still on the march for more. Farther in the country they have eaten up the buckwheat, which is just coming into bloom. Could our esteemed friend Riley give us an article in the next *Journal?—F. A. Nitchy.*

Jefferson City, Mo., August 29th, 1870.

The following published paragraphs, which all refer to this same worm, and which chanced to meet my eye, will give some idea of the extent of country through which it ranged.

Fall Army-worm.—We have received specimens of the Fall Army-worm from several persons. The complaints of its ravages are quite numerous almost all over the State; they are very bad in northeast Missouri. Threatening at Tipton, from which place we have samples, and in St. Louis and Jefferson counties they are quite bad. This pest only returns at intervals, perhaps on account of parasitic

and other enemies gaining the ascendancy over them.—*Rural World, Sept. 2nd,* 1870.

ARMY-WORM IN CALLAWAY COUNTY.—I have found that the Army-worm has been more or less on almost every farm, and have been examining some of the meadows over which they have passed, and have come to the conclusion they are about ruined. From my examination I think that nineteen-twentieths of the grass is entirely killed; at least there is not more than one bulb in twenty that shows any signs of vitality. Why should this insect make its appearance at this season? Mr. Riley, I believe claims that it makes its advent in the spring. But now we have it appearing at the end of summer and beginning of fall, and in numbers as great and as destructive as ever it did in spring. Could it be that the extreme heat of this season, with favorable conditions of moisture, has brought them forth prematurely? I noticed that some plum trees, cherry trees, smoke trees, summer roses and strawberries are blossoming freely from premature development.—*H. B., Journal of Agriculture, Oct. 13th,* 1870.

The Army-worm, on the 28th of August, appeared in force in my neighbor's wheat stubble, moving south towards a piece of land that I had planted in corn, and then sown in rye that was up nicely. When they reached the fence (which they did on the 28th of August), I scattered salt thickly on the rich blue grass on my side of the fence, all along it, while the dew was on. They came no further. As I was obliged to be away from home, I cannot say whether the salt checked them or not—at any rate, it caused the grass to wilt and die.

A very small dark worm about half an inch long, has been doing some damage to the young grain of late.—*J. L. Erwin, Fulton, Callaway County, Mo.*

THE ARMY-WORM—A SLANDER ON THE BIRDS—*Editor Farmer:* Feeling it a duty, as well as a privilege, to contribute all good, or even really bad news for the farmers, through your truly valuable and very much improved and highly esteemed Farmers' journal, enclosed (in a small phial) please find some specimens of Army-worm, many millions of which infest our county. They are everywhere. It is said they are brought by a small, yellow bird, which goes in covies of twenty-five to two hundred—that wherever they alight, the worms first appear. It is said that each petaled portion of the feathers is covered with nits, and their number is legion.

We would be pleased to hear from some of our scientific men on the subject, as we are very much interested. They take a twenty-acre wheat field in two days.

These pestiferous little pests are rapidly arriving at maturity. In traveling, their course seems westward. They last appeared here in 1866, but too late in the season to do any great damage, as a cold rain sent them the way of all the earth. That being in October, nothing of the kind can be expected at this time; and if they are to remain here until October, woe to our wheat fields in this vicinity!

MINERAL POINT, Kansas, Aug. 29th, 1870.

[The above letter came to us too late for insertion last month. Our friends are doing great injustice to our little harmless "Prairie-birds," in supposing that they have anything to do with bringing the Army-worm—EDITOR].—*Kansas Farmer, October,* 1870.

ARMY-WORM.—Late rains are keeping corn too green. Too muddy to plow for wheat. The Hessian-fly and Army-worm are too numerous to allow farmers to seed much this fall. The early sown wheat

and much of the meadows are eaten up by the Army-worm. Dr. C. W. Thornton, of Warrensburg, Kansas, in *Kansas Farmer.*

ARMY-WORM.—We have received from S. S. Tipton, of Mineral Point, a specimen of the above genius, but a little the worst demoralized specimen we ever saw. The bottle was broken, and, as well as we can determine, by the aid of a powerful magnifying glass, the worm is in about sixty thousand pieces. We shall refer to the subject in our next; but in the mean time, we advise our friends to plow and scrape out ditches, in which to spread dry straw. Then muster your force armed with brushes, drive them into the ditches, and set fire to the straw. We have seen them very successfully treated in this way. *Kansas Farmer.*

Thus in all the above accounts this worm was supposed to be a fall brood of the true Army-worm, and in the following letter, we shall see that it was also mistaken for the Corn-worm treated in the last article—a mistake not at all surprising considering the close resemblance between the two worms,

C. V. Riley, Dear Sir.—I herewith send you a box of what I believe to be the Boll-worm although its actions here were similar to the true Army-worm. At my father's and in the neighborhood they complain too of *the Army-worm* eating up the young oats and timothy. With me they commenced about two weeks ago in a field of young oats, or rather oat stubble which had been plowed under and sown to buck-wheat. The oats had got to be about six inches high and were eaten first, next the worm took what little crab grass they could find and they are now scattered, eating grass, corn silks, soft corn, rutabaga leaves and whatever in the grass line comes before them. They have not entered my meadow yet, nor a piece of wheat stubble which is plowed under. G. PAULS.

Eureka, Mo., Sep., 7, 1870.

On the farm of Jno. J. Squires at DeSoto, this worm at first ate off all the grass, then completely stripped the leaves from some corn-fodder, injured his corn, ate into his tomatoes and ruined his turnips —injuring his crops to the amount of nearly $1,000.

In some cases the worm acted strangely, and I have know it to take a whole field of rye in preference to wheat. Judge Wielandy, of Cole county informs me that it was abundant on his potatoes, cutting off the lateral stems. It invaded a large cucumber field and entirely cleaned out the crab grass, and would have injured his cucumbers had he not applied slacked lime. In some parts of Jefferson county it was very abundant and destructive, and Senator J. H. Morse, of Morse's Mills had twenty acres badly injured by it. I have also been informed that in some vineyards it did great damage by gnawing around the stems and causing the bunches to drop off and fall to pieces so that the grapes would scatter on the ground. But I cannot vouch for the correctness of the observation. With me it did more injury to corn than to anything else. It not only greedily devours the leaves and stems, but bores large holes through the ears, burrowing in them in all directions. On late corn it is frequently found in the same ear with the Corn-worm, *alias* Cotton Boll worm. The Boll-worm is,

however, rougher, generally paler, striped differently (see Figs. 42 and 43, *c*,), and always readily distinguished by having a larger gamboge-yellow or reddish head, which invariably lacks the distinct white inverted Y-shaped mark, and the darker shadings of the head of the Fall Army-worm.

Now, until the present year nothing was absolutely known of the natural history of this worm, and though I knew that it was not the true Army-worm, and suspected, from comparing it with the description of certain corn-feeding worms received in 1868 from Mr. E. Daggy, of Tuscola, Illinois, that it would produce a certain moth which I bred from Mr. Daggy's worms—yet I could not feel positive without breeding the Fall Army-worm to the perfect state. This I very luckily did, and I am therefore able to give its complete history.

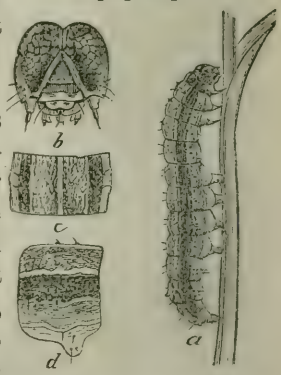
In the fall of 1868 I received a few specimens from Mr. T. R. Allen, of Allenton, with an account of their injuring newly sown wheat on oat stubble, and on page 88 of my first Report it was briefly described by the name of Wheat Cut-worm. The popular term of "Fall Army-worm" is, however, altogether more indicative than that of "Wheat Cut-worm," since the species does not confine its attacks to wheat, and not only very closely resembles the Army-worm in appearance but has many habits in common.

HOW IT DIFFERS FROM THE TRUE ARMY-WORM.

The two insects need never be confounded, however. The true Army-worm never appears in the fall of the year, but always about the time when wheat is getting beyond the milk state; and it generally disappears, in the latitude of St. Louis, by the first of June. It confines its attacks entirely to the grasses and cereals, whereas the species under consideration is a much more general feeder, devouring with equal relish most succulent plants, such as wheat, oats, corn, barley, grasses, purslane, turnips, and, as Mr. J. M. Jordan of St. Louis informs me, even spruces. Moreover, when critically examined, the two worms show many characteristic differences, as will be seen by comparing Figure 44, which represents the true Army-worm, with Figure 45, which represents at *a* the Fall Army-worm natural size, at *b* its head magnified, at *c* a magnified dorsal view of one of the joints, and at *d* a magnified side view of same.

[Fig. 44.]

[Fig. 45.]



Our Fall Army-worm moth is a most variable one—so variable,

indeed, that at least three species might easily be fabricated by any species-grinder who happened to capture at large the three most distinct varieties, without knowing anything of their transformations. I have bred 31 specimens, all from larvæ found on corn, and have others which were captured at large, and though half a dozen sufficiently distinct varieties might easily be picked out from among them, and though scarcely any two are precisely alike, yet they may all be divided into three distinct sets or varieties. The first of these, which is the more common, is represented at Figure 46, *a*, the second at *b*, and the third at *c*. For those who are more curious in such matters I append, at the end of this article, a more elaborate description of this new moth. Not only do I find this great variation in this particular species, but all the species of the genus to which it belongs are variable; and Guenée has truly remarked that they resemble each other so closely, and their modifications are so complicated, that it is next to impossible to properly separate them. By comparing the annexed Figures 46 *a*, *b* and *c*, with that of the true Army-worm moth (Fig. 47) the two insects will be found to differ widely.

[Fig. 46.]

We have in this country a very common moth (*Prodenia commeinæ*, Abb.) which may be popularly called the Spiderwort Owlet moth, some of the varieties of which approach so nearly to some of the more strongly marked varieties of our Fall Army-worm moth that it is necessary to show the very great difference which really exists between them, in order that the cultivator may not be unnecessarily alarmed when he observes the former, by confounding it with the latter, and erroneously inferring that he will be overrun with Fall Army-worms when there is no real danger. The Spiderwort Owlet moth, (Fig. 48, *b* and *c*) is a handsomer and more distinctly marked species, the front wings inclining more to vinous-gray, or purplish-gray, and the ordinary lines being more clearly defined by very deep brown, than in the Fall Army-worm moth. But, however much these characters may vary—and they are quite variable—there are yet two others which will be readily noticed upon comparing the figures of the two species, and by which the Spiderwort moth may always

[Fig. 47.]

[Fig. 48.]

be distinguished from its close ally, namely, by the tip of the wing being more prolonged and acuminate, and by the three-forked nerve in the middle of the wing being much more conspicuous. Its larva never congregates in multitudes as does the Fall Army-worm, and differs so materially from that worm, and is withal so characteristically marked, that it may be recognized at once by the above illustration (Fig. 48, *a*). Contrary to what its name would indicate, it is a very general feeder, as I have found it on all sorts of succulent plants, both wild and cultivated, This insect is more or less numerous every year, but has never been known to multiply so prodigiously as the Fall Army-worm, which we have under consideration. It passes the winter either in the larva, pupa or perfect state, but more generally in the former.

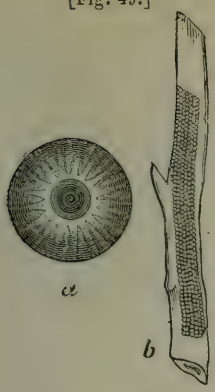
REMEDIES.

Now that I have sufficiently dwelt on the characteristics of the Fall Army-worm to enable any one to distinguish it, even from its nearest relative, let us consider for a moment what can be done to prevent its great injuries to grains and to vegetables. I have proved that there are at least two, and probably as many as three or even four broods during the course of the year; for those worms which appeared in such multitudes in August and the forepart of September, in due time produced moths, and these gave birth to a new generation of worms, which began to make their presence manifest towards the end of October. In 1868, also, I bred the moth as early as July, from worms received from Mr. Daggy. In this prolificacy the Fall Army-worm differs remarkably from the true Army-worm, as well as from most of its close allies, which generally produce but one, and seldom more than two, broods each year.

The moths were so numerons during the latter part of September and the forepart of October, that I not only found them common at Decatur, Vandalia and other parts of Central Illinois, and wherever I traveled in our own State, but I captured a goodly number in the very heart of St. Louis, and even caught some while riding by rail.

The eggs are deposited in small clusters, often in two or three layers one above the other, and the whole cluster is covered sparsely with the yellowish hairs from the ♀ abdomen. Each egg is nearly spherical, of a pale fulvous color, and differs only from that of the Unarmed Rustic (*Agrotis inermis,* Fig. 49, *a*, showing one magnified, and *b*, a batch of natural size,) in being less compressed and less distinctly ribbed. The clusters were found abundantly, not only on the under side of peach and apple leaves, which the worms readily devour, but on the leaves of such trees as sycamore, which, so far as we at present know, they do not feed upon. Under these last circumstances the young worms, upon hatching, would soon descend the tree to feed upon the more succulent herbage below; and the more I learn of the habits of our different Owlet moths,

[Fig. 49.]



the more I become convinced that the long-accepted theory of their eggs being deposited on the ground is a false one, and that most of our cut-worms though fat, lazy and groveling in the ground when we find them, have been born in more elevated and exalted positions.

In the fall of 1868 this worm proved very destructive to the newly sown wheat in many parts of Franklin and St. Louis counties, Mo., and seemed to be confined to such wheat as was sown on oats stubble. I then accounted for this singular state of things by supposing that the scattering oats which were left after harvest had sprouted before the wheat, and had thus attracted the parent moths*; and, acting upon this supposition, I suggested that the attacks of the worm might effectually be prevented by plowing the land early and keeping the ground clear of all vegetation until the wheat was planted. This inference proves to be well warranted by the facts; and in future, when the Fall Army-worm is heard of during the months of August or September, as it was the present year, it will be wise for those who live in the immediate neighborhood, either to sow no fall grain at all or to endeavor, in doing so, to carry out the above suggestions. The last brood of worms, which at this writing (Nov. 7th) are not yet quite full grown, must evidently pass the winter in the ground, either in the larva or the pupa state. In either case a great many of them would be killed by late fall plowing which should be used, when practicable, as a remedial measure in fields where this insect has been numerous. When the worms are overrunning a field of fall grain, most of them could be destroyed by means of a heavy roller, without injury to the grain.

The question has been repeatedly asked: "Will this worm be as numerous next year as it has been this; or will it go on increasing in geometrical ratio, and be still more numerous?" Now, although I greatly dislike to weaken the confidence that some people seem to place in the oracular power of an entomologist to peer into the future, yet I must meekly confess my inability to give any definite answer to such questions.

Byron has truly said that, "the best of prophets of the future is the past;" and we may reasonably draw the inference that this worm will *not* be so abundant next year, because in the past it has only occasionally been so troublesome, and never, so far as the record shows, during two consecutive years. And we may rest tolerably well assured that it will not increase in geometrical ratio, because most vegetable feeding insects are preyed upon by more predaceous

*Report I, p. 88.

species and by parasites,* and because such continued increase of one species is inconsistent with the harmony we find everywhere in Nature. But we may not venture beyond the inference, as the happenings of the future are not for mortals to know. Some persons may also be curious to learn why this worm increases so much more in late summer and fall than in spring, since there are so many broods during the year; or why it is only noticed in certain years? Such questions, likewise, can receive no definite answer,

> "Till old experience do attain
> To something like prophetic strain."

For though, to meet the first, we may assume that the winter decimates their numbers, or that the spring weather is not favorable to their increase; and to meet the last we may conjure up a hundred reasons yet assuming is not knowing, and we must content ourselves with the facts as they occur.

In conclusion, it will afford a grain of comfort to those who have had wheat fields cleaned off by this worm, to know that their wheat is not necessarily ruined; for, as I personally ascertained, wheat that had been thus cut off in the fall of 1868 made a good stand the following spring; and in one instance, where part of a field had been invaded and the rest left untouched, it really appeared that the part which had been eaten off yielded the heaviest. Mr. Huron Burt, of Callaway county, Mo., also informs me that this insect always leaves blue-grass untouched.

PRODENIA AUTUMNALIS, Riley.—*Imago* (Fig. 46, *a*, *b* and *c*.)—*Front wings* narrow with the apex usually well rounded, and with the middle of the hind margin sometimes, but not often, extending beyond apex: general color mouse-gray variegated with smoky-brown, fulvous and pearly or bluish-white; apical patch bluish-white and never extending beyond nerve 5: the subterminal line—which is pale and bends like a bow, approaching nearest the terminal line between nerves 3 and 4—generally blends with this patch so as to appear to start from its lower edge, but is sometimes well separated from it so as to be traced further towards apex: dark space preceding subterminal line, confined between nerves 3 and 5, blending gradually with the rest of the wing, barely showing two darker sagittate spots: transverse anterior and transverse posterior either subobsolete or tolerably well defined, each by a geminate dark line: basal area divided longitudinally by an irregular dark line, the wing below it quite light-colored: orbicular spot large and elongated, a little lighter than surrounding surface, and well defined by a fulvous annulation, the pale oblique shade which generally encloses it in this genus confined to a fulvous shade above, and either a more distinct fulvous line behind or none at all: reniform spot generally dark, but sometimes lighter than space preceding; not well defined, the small pale spot at top being generally distinct, and either partaking of the same form, or resembling the small letter *e* [left wing]; the lower edge occupied by a distinct white dash, which however never extends beyond it and but seldom shows any tendency to furcate with the nerves: four tolerably distinct equidistant pale costal spots from reniform spot to apical patch: terminal line pale, even, parallel with posterior margin: terminal space dark, except near apex and anal angle, divided into subquadrate spots by the pale nerves: fringe either broad or narrow, of same color as wing, with a narrow darker inner line, relieved by two very fine paler ones which are barely distinguishable: under surface smoky, but paler inte-

* Many of the Fall Army-worms had the thoracic joints of the body more or less covered with the eggs of a *Tachina* fly, and I have bred from the worms the same parasite (*Exorista leucaniæ*, Kirk; 2d Rep. Fig. 17) which infests the true Army-worm, and still another allied species (*Tachina archippivora*) which infests the larvæ of the Archippus butterfly, and will be referred to on a future page.

riorly and terminally, and fulvous along costa; the whole with a nacreous lustre and more or less irrorate with brown, and often with a flesh-colored tint near apex; fringes dark. *Hind wings* white with a faint fulvous tint; semi-transparent and slightly irridescent, with extremities of nerves and borders, especially above, brown; fringes dusky, especially at apex, and with a paler inner line; under surface similar. Thorax, abdomen and legs of same general color as front wings, being paler below; the longer lateral and anal abdominal hairs more fulvous. Sexes with difficulty distinguished, the size and shape of the abdomen not even being a safe criterion. Maximum expanse 1.40; minimum expanse 1.05 inches. Described from 18 specimens, bred Sept. 20th—Oct. 10th, from corn-fed larvæ.

VARIETY FULVOSA, (Fig. 46, *b.*)—*Front wings* greatly suffused with fulvous, especially in the lower median space, which often inclines to ochraceous; apical space more or less defined; oblique median band distinct to median nerve, and orbicular spot with an ochre-colored centre. Described from 5 specimens, bred Sept. 25th—Oct. 3rd, from corn-fed larvæ.

VARIETY OBSCURA, (Fig. 46, *c.*)—*Front wings* of a much more uniform and darker color, either grayish-brown with a slight vinous tint, or deep smoky brown inclining to black, or a deep warm brown with but little gray; apical space either entirely obsolete or but very faintly indicated; oblique fulvous band across upper middle of wing also obsolete; the ordinary lines either entirely obsolete [one specimen only] or distinctly marked; the ordinary spots sometimes obsolete, but more generally indicated by fulvous lines. Described from 8 specimens, bred Sept. 21st—Oct. 2d, from corn-fed larvæ.

Larva, (Fig. 45, *a.*)—Ground-color very variable, generally dark and pitchy-black when young, but varying after the last moult from pale brown to pale dirty green, with more or less pink or yellow admixed—all the markings produced by fine, more or less intense, brown, crimson and yellow mottlings. Dorsum brownish with a narrow line down the middle, rendered conspicuous by a darker shade each side of it. A dark, subdorsal band one-third as wide as each joint is long; darkest at its upper edge, where it is bordered and distinctly separated from dorsum by a yellow line which, except on joint 11 where it deflects a little upwards, is quite straight; paler in the middle of each joint. A pale, either buff or flesh-colored, substigmatal band, bordered above and below by a narrow, yellow and wavy line. Venter pale. Head pale yellowish-brown, with sometimes a tinge of green or pink; the triangular piece yellowish, the Y-mark distinct and white, the cheeks with four more or less distinct lateral brown lines and with dark brown mottlings and nettings, which become confluent and form a dark curved mark at the submargin behind the prongs and each side of the stem of the Y. Stigmata large, brown, with a pale annulation, and just within the lower edge of the dark subdorsal band. Legs either light or dark. Cervical shield darker than body, with the narrow dorsal and subdorsal lines extending conspicuously through it: anal plate also dark, narrow and margined by the pale subdorsal lines—both plates furnishing stiff hairs, but without tubercles. Piliferous tubercles on joints 2 and 3, arranged in a transverse row, and quite large, especially on joint 2; on joints 4–10 inclusive the superior eight are arranged as follows: 4 in a trapezoid in dorsal space, the posterior two as far again from each other as the anterior two, and two near stigmata, one above and one behind; on joint 11 the dorsal 4 are in a square, and on joint 12 in a trapezoid, with the posterior and not the anterior ones nearest together: the thoracic joints have each a large subventral tubercle just above the legs. Length 1.10–1.50 inch. Described from numerons specimens.

Pupa.—Formed in the ground, without cocoon; of normal form, bright mahogany-brown, and with a distinct forked point at extremity.

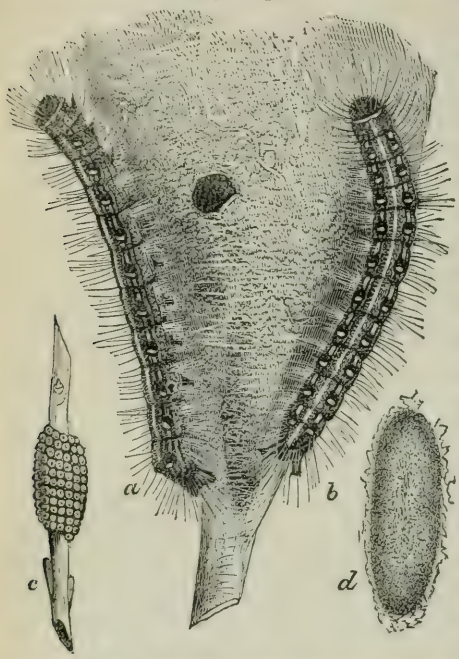
THE APPLE-TREE TENT-CATERPILLAR, OR AMERICAN LACKEY MOTH.—*Clisiocampa Americana*, Harr.

(Lepidoptera, Bombycidæ.)

What orchardist in the older States of the Union is not familiar with the white web-nests of this caterpillar? As they glisten in the rays of the spring sun, before the trees have put on their full summer

dress, these nests, which are then small, speak volumes of the negligence and slovenliness of the owner of the orchard, and tell more truly than almost anything else why it is that he fails and has bad luck with his apple crop. Wherever these nests abound one feels morally certain that the borers, the Codling-moth, and the many other enemies of the good old apple tree, mentioned in the beginning of this Report, have full play to do as they please, unmolested and unnoticed by him whom they are ruining; and when I pass through an orchard with two, three or more "tents" on every tree, I never pity the owner, because there is no insect more easily kept in check.

[Fig. 50.]



The small, bright and glistening web, if unmolested, is soon enlarged until it spreads over whole branches, and the caterpillars which were the architects, in time become moths, and lay their eggs for an increased supply of nests another year.

This insect is so well known throughout the country, and has been so well treated of by Harris and Fitch, that it is only necessary to give here the most prominent and important points in its history, the more especially as the figures alone which are given herewith will enable the novice to recognize it the moment it appears in a young orchard. Though some years quite abundant, it is not as common with us as in some of the Eastern States.

The eggs (Fig. 50, *c*) from which these caterpillars hatch are deposited mostly during the month of June, in oval rings, upon the smaller twigs, and this peculiar mode of deposition renders them conspicuous objects during the winter time, when by a little practice they can easily be distinguished from the buds, knots or swellings of the naked twigs. Each cluster consists of from two to three hundred eggs, and is covered and protected from the weather by a coating of glutinous matter, which dries into a sort of net-work. The little embryonic larvæ are fully formed in the egg by the commencement of winter, and the same temperature which causes the apple-buds to swell and burst, quickens the vital energies of these larvæ and causes them to eat their way out of their eggs. Very often they hatch during a prematurely warm spell and before there is any green leaf for

them to feed upon, but they are so tough and hardy that they can fast for many days with impunity, and the glutinous substance on the outside of their eggs furnishes good sustenance and gives them strength at first. It is even asserted by Mr. H. C. Raymond, of Council Bluffs, Iowa, that the eggs often hatch in the fall and that in these cases the larvæ withstand the severity of the winter with impunity.

The young caterpillars commence spinning the moment they are born, and indeed they never move without extending their thread wherever they go. All the individuals hatched from the same batch of eggs work together in harmony, and each performs its share of building the common tent, under which they shelter when not feeding and during inclement weather. They usually feed twice each day, namely, once in the forenoon and once in the afternoon. After feeding for five or six weeks, during which time they change their skins four times, these caterpillars acquire their full growth, when they appear as at Figure 50 (*a* side view, *b* back view) the colors being black, white, blue and rufous or reddish. They then scatter in all directions in search of some cozy and sheltered nook, such as the crevice of angle of a fence, and having finally decided on the spot, each one spins an oblong-oval yellow cocoon (Fig. 50, *d*) the silk composing which is intermixed with a yellow fluid or paste, which dries into a powder looking something like sulphur. A few individuals almost always remain and spin up in the tent, and these cocoons will be found intermixed with the black excrement long after the old tent is deserted.

Within this cocoon the caterpillar soon assumes the chrysalis state, and from it, at the end of about three weeks, the perfect insect issues as a dull yellowish-brown or reddish-brown moth (Fig. 51), characterized chiefly by the front wings being divided into three nearly equal parts by two transverse whitish, or pale yellowish lines, and by the middle space between these lines being paler than in the rest of the wing in the males, though it is more often of the same color, or even darker in the females. The species is, however, very variable.*

[Fig, 51.]

The moths do not feed, and the sole aim of their lives seems to be the perpetuation of their kind; for as soon as they have paired and each female has carefully consigned her eggs to some twig, they die,

* Dr. Fitch, in the very excellent and detailed account of this insect in his second Report, shows how very variable the moth is, and from a large series of bred and captured specimens, I can fully corroborate the fact. I have specimens which are of an almost uniform pale tawny-yellow, while others are very dark, being what might be termed a bay-brown with the pale markings conspicuous, while others have a pale band across the hind wings so conspicuous as to very closely resemble the European *neustria*. Dr. Fitch in referring to his figures must certainly have made a mistake, for he calls Figure 4 the female and Figure 3 the male, while the reverse is apparent from the figures themselves. My own figure is intended to represent the female, but the middle space of the upper wings seldom if ever appears so light in this sex, as the engraver has erroneously represented.

and when the proper time comes around again the eggs will hatch, and the same cycle of changes takes place each year.

This insect in all probability extends wherever the wild black cherry (*Cerasus serotina*) is found, as it prefers this tree to all others; and this is probably the reason why the young so often hatch out before the apple buds burst, because, as is well known, the cherry leafs out much earlier. Besides the Cherry and Apple, both wild and cultivated, the Apple-tree Tent-caterpillar will feed upon Plum, Thorn, Rose and perhaps on most plants belonging to the Rose family, though the Peach is not congenial to it, and it never attacks the Pear, upon which, according to Dr. Trimble, it will starve. It does well on Willow and Poplar and even on White Oak, according to Fitch, who also found it on Witch Hazel (*Hamamelis*) and Beech.

REMEDIES.

Cut off and burn the egg-clusters during winter, and examine the trees carefully in the spring for the nests from such clusters that may have eluded the winter search. The eggs are best cut off in the manner presently to be described for the Tent-caterpillar of the Forest. Though to kill the caterpillars numerous methods have been resorted to, such as burning, and swabbing with oil, soap-suds, lye, etc., they are all unnecessary, for the nests should not be allowed to get large, and if taken when small are most easily and effectually destroyed by going over the orchard with the fruit-ladder, and by the use of gloved hands. As the caterpillars feed about twice each day, once in the forenoon and once in the afternoon, and as they are almost always in their nests till after 9 A. M., and late in the evening, the early and late hours of the day are the best in which to perform the operation. As a means of facilitating this operation, it would be a good plan, as Dr. Fitch has suggested, to plant a few wild cherry trees in the vicinity of the orchard, and as the moths will mostly be attracted to such trees to deposit their eggs, and as a hundred clusters on a single tree are destroyed more easily than if they were scattered over a hundred trees, these trees will well repay the trouble wherever the Tent-caterpillar is known to be a grievous pest.

The chrysalids of this caterpillar are often found filled with little maggots, which produce minute Chalcididan 4-winged flies of metallic green and black colors,* and belonging to the very same genus as the celebrated Hessian-fly parasite. This parasite, with other cannibal insects, and perhaps more or less favorable seasons, tend to produce a fluctuation in the numbers of these caterpillars, so that they are more numerous some years than others, and they were more numerous in 1868 than they have been since. It has also been noticed that dry summers are injurious to them. According to Dr. LeBaron,

* Described as *Cleonymus clisiocampæ* by Dr. Fitch (Rep., vol. I, p. 200), but subsequently more properly referred to the genus *Semiotellus* (Rep., Vol. III, p. 141.

the Baltimore Oriole occasionally pecks at the nests, but does not make a common article of diet of the caterpillars, and the only birds that devour them greedily are the American Cuckoos (*Coccyzus Americanus* and *erythrophthalmus*).

THE TENT-CATERPILLAR OF THE FOREST—*Clisiocampa sylvatica*, Harr.

(Lepidoptera, Bombycidæ.)

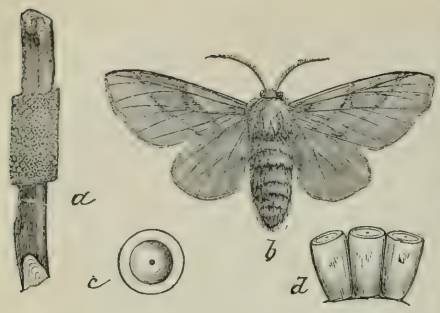
There is another insect which in all its stages so closely resembles the Apple-tree Tent-caterpillar as to be very generally confounded with it. This insect was first described by the great Massachusetts entomologist, Dr. Harris, and very appropriately named the Tent-Caterpillar of the Forest, the better to distinguish it from the other species which is more common in our orchards. He, however, unqualifiedly states that it lives in communities under a common web or tent; but with this exception gives a very clear and truthful account of it.* It has been quite destructive in many parts of Missouri during the past two summers, and as I have had good opportunities of studying its habits I shall endeavor to dispel the confusion and uncertainty about them which have hitherto existed in the minds of most of our farmers.

ITS NATURAL HISTORY.

The egg-mass from which the Tent-caterpillar of the Forest hatches (Fig. 52, *a*, showing it after the young larvæ have escaped) may at once be distinguished from that of the common Tent-caterpillar by its being of a uniform diameter, and docked off squarely at each end. It is usually composed of about 400 eggs, the number in five masses which I counted ranging from 380 to 416. Each of the eggs composing this mass is of a cream-white color, 0.04 inch long and 0.025 inch wide, narrow and rounded at the attached end or base, gradually enlarging towards the top, where it becomes slightly smaller (Fig. 52 *d*), and abruptly terminates with a prominent circular rim on the outside, and a sunken spot in the centre (*c*). These eggs are deposited in circles, the female moth stationing herself, for this purpose, in a transverse position across the twig. With abdomen curved she gradually moves as the deposition goes on, and when one circle is com-

* Inj. Ins. p. 376.

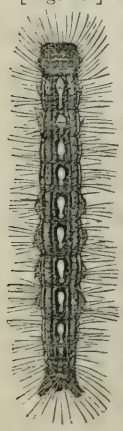
[Fig. 52.]



pleted, she commences another—and not before. With each egg is secreted a brown varnish which firmly fastens it to the twig and to its neighbor, and which, upon becoming dry, forms a carinated net-work of brown over the pale egg-shell. These eggs are so regularly laid and so closely glued to each other, and the sides are often so appressed, that the moth economizes space almost as effectually as does the Honey-bee in the formation of its hexagonal cells. In confinement the moth very seldom succeeds in forming a perfect ring, but in her abortive attempts, deposits them in different sized patches; and as I have found such unfinished patches attached to an oak leaf out-of-doors, we may conclude that either from injury or debility of some kind, the parent's instinct sometimes fails it even when all the conditions are normal and natural.

The eggs are deposited, in the latitude of St. Louis, during the latter part of June. The embryo develops during the hot summer weather, and the yet unborn larva is fully formed by the time winter comes on. The young hatch with the first warm weather in spring—generally from the middle to the last of March—and though the buds of their food-plant may not have opened at the time, and though it may freeze severely afterwards, yet these little creatures are wonderfully hardy, and can fast for three whole weeks, if need be, and withstand any amount of inclement weather. The very moment these little larvæ are born, they commence spinning a web wherever they go. At this time they are black with pale hairs, and are always found either huddled together or traveling in file along the silken paths which they form when in search of food. In about two weeks from the time they commence feeding they go through their first moult, having first grown paler or of a light yellowish brown, with the extremities rather darker than the middle of the body, with the little warts which give rise to the hairs quite distinct, and a conspicuous dark interrupted line each side of the back. After the first moult, they are characterized principally by two pale yellowish subdorsal lines, which border what was before, the dark line above described. After the second moult, which takes place in about a week from the first, the characteristic pale spots on the back appear, the upper pale line becomes yellow, the lower one white, and the space between them bluish: indeed, the characters of the mature larva are from this period apparent. Very soon they undergo a third moult, after which the colors all become more distinct and fresh

[Fig. 53.]



the head and anal plate have a soft bluish velvety appearance, and the hairs seem more dense. After undergoing a fourth moult without material change in appearance, they acquire their full growth in about six weeks from the time of first feeding. At this time they appear as at Figure 53, and for those who are interested in such matters, I quote below Dr. Fitch's description of the full-grown larva, as it is the first accurate and detailed description that was published, and as I have occasion to refer to it further on:

"The caterpillar, as seen after it has forsaken its nest and is wandering about, is an inch and a half long and 0.20 thick. It is cylindrical and of a pale blue color, tinged low down on each side with greenish gray, and is everywhere sprinkled over with black points and dots. Along its back is a row of ten or eleven oval or diamond-shaped white spots which are similarly sprinkled with black points and dots, and are placed one on the fore part of each segment. Behind each of these spots, is a much smaller white spot, occupying the middle of each segment. The intervening space is black, which color also forms a border surrounding each of the spots, and on each side is an elevated black dot from which arises usually four long black hairs. The hind part of each segment is occupied by three crinkled and more or less interrupted pale orange-yellow lines, which are edged with black. And on each side is a continuous and somewhat broader stripe of the same yellow color, similarly edged on each of its sides with black. Lower down upon each side is a paler yellow or cream-colored stripe, the edges of which are more jagged and irregular than those of the one above it, and this stripe also is bordered with black, broadly and unevenly on its upper side and very narrowly on its lower side. The back is clothed with numerous fine fox-colored hairs, and low down on each side are numerous coarser whitish ones. On the under side is a large oval black spot on each segment except the anterior ones. The legs and prolegs are black and clothed with short whitish hairs. The head is of a dark bluish color freckled with numerous black dots and clothed with short blackish and fox-colored hairs. The second segment* or neck is edged anteriorly with cream white, which color is more broad upon the sides. The third and fourth segments have each a large black spot on each side. The instant it is immersed in spirits the blue color of this caterpillar vanishes and it becomes black.

At this stage of its growth the Tent-caterpillar of the Forest may be seen wandering singly over different trees, along roads, on the tops of fences, etc., in search of a suitable place to form its cocoon. It usually contents itself with folding a leaf or drawing several together

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* It is necessary to remark here that in the above description, Dr. Fitch reckons the head as the first segment and the first leg-bearing segment of the body, which he calls the neck, as the second segment. If Lepidopterists could be induced to adopt some uniform rule in describing larvæ, it would prevent much confusion and error.

It is astonishing how loosely these segments are referred to by most authors. Thus Dr. Fitch, after calling the head the first segment in the above description, excludes it in the descriptions of the larvæ of *Dryocampa senatoria and Dryocampa stigma* which immediately follow (Reports 3, 4 and 5, §§ 322 and 323), and speaks of the long anterior horns as proceeding from the *second* segment, whereas, to be consistent, he should have made them proceed from the *third* segment, as Mr. Wm. Saunders has done with *Dryocampa rubicunda* (*Can. Entomologist* II, p. 76). Dr. Packard (Guide etc, p. 271) speaks of the caudal horn of the larvæ of *Sphingidæ* as proceeding from the *last* segment, which it certainly does not, whichever custom be adopted. Westwood (Intr., II,) though his language on page 319 would lead one to suppose that he included the head as the first segment, more often adopts the other rule, as for instance when he refers to the 11th segment in *Mamestra*, etc., (p. 344). Burmeister in his Manual of Entomology evidently excluded the head as a segment, for he refers (p. 35) to the "three first segments of the body following the head," and afterwards (p. 41) speaks in more precise terms of the body consisting of 12 segments.

Strictly speaking, the normal insect larva is composed of 13 segments, and a more or less distinct terminal sub-segment; but in all those larvæ in which the anterior segment is covered by a horny case, so as to form a distinct head, it seems more appropriate to consider this as the head in contradistinction to the twelve articulations of the body. Especially is this the case with Lepidopterous larvæ, which are so plainly marked with a horny head, 12 soft joints and a terminal sub-joint; and this plan has been adopted by most of the leading entomologists, including Boisduval, Guenée, Harris, etc.

In my own descriptions I have always adopted this course, so that when I speak of the first joint I mean that immediately following the head. Of late I have adopted the term *joint* because it is shorter and perhaps more strictly accurate than *segment*. I also discard the term *feet*, as often applied to the horny articulate legs, for they are not feet in any sense of the word, but are the true legs of the insect, and the simple term legs or thoracic legs will at once distinguish them from the abdominal an anal prolegs or false legs.

for this purpose, though it frequently spins up under fence boards and in other sheltered situations. The cocoon is very much like that of the common Tent-caterpillar, being formed of a loose exterior covering of white silk with the hairs of the larva interwoven, and by a more compact oval inner pod that is made stiff by the meshes being filled with a thin yellowish paste from the mouth of the larva, which paste, when dried, gives the cocoon the appearance of being dusted with powdered sulphur exactly as in that of the other species. Three days after the cocoon is completed the caterpillar casts its skin for the last time and becomes a chrysalis of a reddish brown color, slightly dusted with a pale powder, and densely clothed with short pale yellow hairs, which at the blunt and rounded extremity are somewhat larger and darker. In a couple of weeks more, or during the forepart of June, the moths commence to issue, and fly about at night. This moth (Fig. 52, *b* ♀) bears a considerable resemblance to that of the Common Tent-caterpillar (Fig. 51), being of a brownish-yellow or rusty-brown, and having two oblique transverse lines across the front wings. It differs, however, in the color being paler or more yellowish, especially on the thorax; in the space between the oblique line being, even in the males, usually darker instead of lighter than that on either side; but principally in the oblique lines themselves being always dark instead of light, and in a transverse shade, often quite distinct, across the hind wings. As in *Americana*, the male is smaller than the female, with the wings shorter and cut off more squarely. Considerable variation may be found in a given number of moths, but principally in the space between the oblique lines on the front wings being either of the same shade as the rest of the wing, or in its being much darker; but as I have found these variations in different individuals of the same brood, bred either from Oak, Hickory, Apple and Rose, they evidently have nothing to do with the food-plant. The scales on the wings are very loosely attached, and rub off so readily that good specimens of the moth are seldom captured at large. So much for the natural history of our Forest Tent-caterpillar.

THE LARVA SPINS A WEB.

From the very moment it is born till after the fourth or last moult, this caterpillar spins a web and lives more or less in company; but from the fact that this web is always attached close to the branches and trunks of the trees infested, it is often overlooked, and several writers have falsely declared that it does not spin. At each successive moult all the individuals of a batch collect and huddle together upon a common web for two or three days, and during these periods —though more active than most other caterpillars in this so-called sickness—they are quite sluggish. During the last or fourth moult they very frequently come low down on the trunk of the tree, and, as in the case of the gregarious larvæ of the Hand-maid Moth (*Datana*

ministra), which often entirely denude our Black Walnuts, they unwittingly court destruction by collecting in such masses within man's reach.

IT FEEDS BOTH ON ORCHARD AND FOREST TREES.

In the summer of 1867 this insect did great damage in Western New York, where it is falsely called THE "Army-worm." From the fact that Mr. Peter Ferris, of Millville, Orleans county, N. Y., was greatly troubled with it that year in his apple orchard, and that he did not notice any of the same worms on the Oak and Walnut timber of that section, he concluded that his Apple-feeding worms must be different from those feeding on forest trees. In an article signed "F., Orleans county, N. Y.," which appeared in the *Country Gentleman* of July 23d, 1868, the same writer endeavors to prove his Apple-feeding worms distinct by sundry minute characters, as may be seen from the following extract:

Now I am not an entomologist, but still must be allowed to believe that there are several points, if not "distinctive characters," in which our caterpillar differs from the Tent-caterpillar of the Forest, as described by Dr. Fitch. His larva is of a pale blue color, tinged lower down on each side with greenish-gray. In ours the prevailing color on the back is black; there is a sky-blue stripe on each side but no greenish-gray. Both have the white spots on the back much alike, though perhaps ours are more club shaped, looking to the naked eye nearly the shape of ten-pins. Both have these spots surrounded with black; in ours there is quite a broad black stripe on each side of the spots. This black stripe is more or less filled with fine, crinkled, bright orange lines. In some, these orange lines are so plenty as to be seen plainly without the glass; in others the color to the naked eye is a fine velvet-black. In the larva described by Dr. Fitch there is much less of black and of the fine crinkled lines, which are pale orange yellow. There is a somewhat broader stripe of the same yellow color, in place of a narrow orange one in ours. The lower yellow stripe may be much alike in both, but what is sky-blue in one is greenish-gray in the other. In both, the head is of a dark bluish color, but in his it is freckled with numerous black dots; in ours, both to the naked eye and under a glass, it is plain. In his "the second segment or neck is edged anteriorly with cream-white, which color is more broad on the sides. The third and fourth segments have each a large black spot on each side." Both the cream white edge and black spots are entirely wanting in our caterpillars.

The habits of the larvæ also appear to be different. According to Harris and Fitch, the Tent-caterpillar of the Forest lives in large societies, under a tent or cob-web-like nest placed against the side of the tree, and comes out to feed on the leaves. Others, as well as myself, have watched our caterpillars and entirely fail to discover that they lived in communities, or in any one place that they went from and returned to. While small, they remain scattered over the smaller branches and on the leaves, and are first seen to begin to get together when about half grown, on some of the higher limbs in the sun. They only collect in large bunches on the trunk and lower limbs; when nearly full grown, and the weather is hot, they get in the shade; and then they never have any web or particular place

they return to, or show any uniformity in the size of the bunches. But they only manage in this way while the leaves last. As soon as one tree is stripped they go to another, and when one orchard is used up leave for another. They are great travelers; on a smooth track, like a hard road or a fence cap-board, they get along quite fast. They do not try to keep together, but each one goes on his own hook. There is very little said about the Tent-caterpillar of the Forest traveling in this way.

Then our larvæ appear decidedly to prefer the leaves of the Apple-tree, and only feed on the leaves of other trees when the former are not to be had. Though I am not prepared to say that they will not feed on Oak, Walnut or Hickory trees, under any circumstances, I have repeatedly found these trees in full leaf when not only Apple trees, but Ash and Basswood trees near by, were entirely stripped. The eggs are sometimes laid on Hard Maple shade trees, but the caterpillars leave these trees as soon as they get much size, evidently in search of food more suitable to their taste. This may be the case in regard to Oak and Walnut trees.

They also select different places for their cocoons. Dr. Fitch says the Tent-caterpillar of the Forest selects a sheltered spot for its cocoon, such as the corner or angle formed by the meeting of two or three sides. In this the cocoon is suspended. Our larva selects one or more leaves on any tree that is convenient. The edges of the leaves are drawn together, forming a shelter in which there is generally one cocoon; though when the space is large, and they are very numerous, there are often two or three cocoons together. The cocoon is not suspended, but fastened to the leaf. They spin their cocoons in the forepart of July, and the moths appear in the latter part of the month. The Tent-caterpillar of the Forest spins its cocoon about the 20th of June, and the moth appears in the forepart of July.

Now I think enough has been given to show that two distinct insects are under consideration, but, being only a farmer, I may be mistaken. I would like to see Dr. Fitch's views on this question. Undoubtedly he has read Dr. Walsh's article on "The Three so-called Army-worms," in the *Practical Entomologist*, and can tell whether our caterpillar is a distinct insect, or only shows the variations that may be expected in the Tent-caterpillar of the Forest.

Now since Dr. Fitch has not, to my knowledge, complied with Mr. Ferris's courteous wish, the labor has devolved upon me. I have taken upwards of 200 specimens from the same batch of Oak-feeding worms, and upon critically examining them, find that Dr. Fitch's description is accurate, and that the differences or variations mentioned by Mr. Ferris arise in every case, either from a misapprehension of Dr. Fitch's meaning, or from variations which may be found in the same brood. The only real difference between the two writers lies in the statement of Dr. Fitch that the worms live under a large cob-web-like nest, and that of Mr. Ferris that they do no such thing. Both statements should have been qualified, and were made without sufficient observation; for though the normal habit of the worms is to collect outside of their nests, I have seen exceptional instances of their collecting within or underneath it, especially when young.

Now it is just barely possible that in Western New York there may be a race of these worms that has taken to feeding on Apple and

has lost all appetite or become incapacitated for feeding on forest trees; in other words, that there is a phytophagic variety, or a phytophagic species in process of formation. I could mention several similar occurrences among insects,* and to those who believe in the immutability of species these occurrences are incomprehensible enough; but to those who accept the more modern Darwinian views, and believe that species are slowly being formed to-day, just as they have been for long ages and ages in the past, they are most significant, and exactly what we should expect. But that such a race has yet been formed is rendered highly improbable from the following facts: 1st. It is spoken of both by Dr. Fitch and Dr. Harris as occurring on Oak, and by the latter as also occurring on Walnut, Apple and Cherry in the New England States. Mr. George E. Brackett of Belfast, Maine,† in referring to its ravages in the orchard, states that it also ravaged the forests in the summer of 1867, eating the leaves of most kinds of deciduous trees, though Poplar and Ash seemed to be their favorites. 2nd. I have, in our own State, successfully transferred them from Oak to Apple, and from Apple to Oak, and now have a suite of moths bred from larvæ which were fed half the time on the one and half the time on the other. Given an equal quantity of Oak, Apple, Plum, Peach, Cherry, Walnut, Hickory, Rose, they have invariably seemed to prefer and thrive best on the Apple.

IS IT EVER VERY DESTRUCTIVE?

This question is raised by Dr. Fitch, who, on insufficient grounds, discredited the previous assertion of Abbot, that it "is sometimes so plentiful in Virginia as to strip the oak trees bare." The destruction it caused in some of the Eastern States in 1866 and in 1867, is sufficient to decide this question; but there is every reason to believe that in the South and West its injuries are of still vaster extent. From Mr. John H. Evans of Des Arc, Ark., I learn that it last summer completely stripped the over-cup timber in the overflowed bottoms of that country, and for the past two years it has been quite destructive both to forest and orchard trees, in many parts of Missouri. In the Oak timber these worms prefer trees of the Black Oak group, and will seldom touch the White Oak in bodies, though when scattered among the other kinds, they attack it also.

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*For an account of such insects as are known to have phytophagic varieties or phytophagic species I must refer the reader to Mr. Walsh's papers on the subject in the proceedings of the Entomological Society of Philadelphia for 1864 and 1865. But, as the most familiar and striking examples I will mention, first—the polyphagous black-pencilled larva of *Halesidota tassellata*, Sm. and Abb., found feeding on Oak, Hickory, Elm, Plum and other trees, and the monophagous orange-pencilled larva of *H. Harrisii*, Walsh, found exclusively on Sycamore; the moths from the two being absolutely undistinguishable. Second—the yellow-necked larva of *Datana ministra*, Drury, found on Apple and other trees, and the black-necked larva of the same moth found on Black-walnut and Hickory. Third—the large Butternut and Walnut-feeding form of the common Plum Curculio (*Conotrachelus nexuphar*, Herbst.)

†Amer. Journal of Hort., Sept., 1867.

ARTIFICIAL REMEDIES.

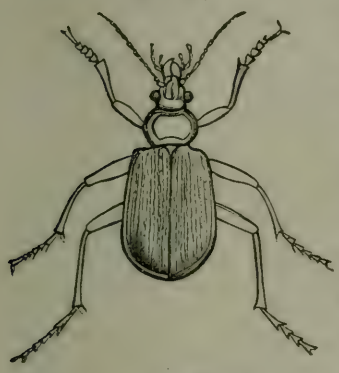
From the time they are born till after the third moult these worms will drop and suspend themselves mid-air, if the branch upon which they are feeding be suddenly jarred. Therefore when they have been allowed to multiply in an orchard this habit will suggest various modes of destroying them. Again, as already stated, they can often be slaughtered *en masse* when collected on the trunks during the last moulting period. They will more generally be found on the leeward side of the tree if the wind has been blowing in the same direction for a few days. The cocoons may also be searched for, and many of the moths caught by attracting them towards the light. But pre-eminently the most effective artificial mode of preventing this insect's injuries is to search for and destroy the egg-masses in the winter time when the trees are leafless. Not only is this course the more efficient because it is more easily pursued, and nips the evil in the bud, but for the reason that, in destroying the eggs only, we in a great measure evade killing, and consequently co-operate with, the natural parasites presently to be mentioned, which infest the worms themselves. A pair of pruning shears attached to the end of a pole, and operated by a cord, will be found very useful in clipping off the eggs; or, as recommended by Mr. Ferris, a more simple instrument may be made by fastening a piece of an old scythe to a pole. If the scythe is kept sharp, the twigs may very handily be clipped with this instrument. Tarred bandages, or any of the many remedies used to prevent the female Canker worm from ascending trees, can only be useful with the Forest Tent-caterpillar when it is intended to temporarily protect an uninfested tree from the straggling worms which may travel from surrounding trees.

NATURAL REMEDIES.

It is always wise to co-operate, whenever we can, with our little friends among the Bugs, and it is consequently very necessary to be acquainted with them. It happens, fortunately, that we have several which aid us in keeping the Tent-caterpillar of the Forest in check, and in the natural forest we must trust entirely to these auxiliaries, as the mechanical means that can profitably be employed in a moderate sized orchard are impracticable in broad extents of timber. Indeed, these cannibals and parasites do their work so effectually that this caterpillar is seldom exceedingly numerous for more than two successive years in one locality, It prevails suddenly in great numbers, and again is scarcely noticed for years, very much as is the case with the true Army-worm. Thus, after attracting such general attention in 1867 in many parts of the East, it has scarcely been noticed since. This is its history everywhere, and we may reasonably hope that in those parts of the West where it has been cutting such a figure

the present summer, it will suddenly be so subdued as not to be noticed for some years to come. Its undue increase but combines the assaults of its enemies, until they multiply so as to gain the ascendency. Then, from insufficiency of food these enemies suddenly decrease in numbers, and their natural prey has a chance to increase again. And so it goes on in the "Struggle for Life," and in the great complicated net-work in which every animal organism is involved: a check here and a check there, and no one of all the myriad forms allowed to keep the ascendency beyond a limited time. The most efficient cannibal insects in checking the increase of this Forest Caterpillar, are the larger Ground-beetles belonging to the genus *Colosoma*. These beetles will pounce upon the worms with astonishing greed, and are especially prone to attack them when helplessly collected together during the moulting periods. The Rummaging Ground-beetle (*Colosoma scrutator*, Fabr.), which every one will recognize from the figure (54), is especially fond of them. The most common parasite which occurs abundantly in the West, as well as in the East, and which I have bred from several other caterpillars, is a maggot producing a Tachina-fly, which differs only from the Red-tailed Tachina-fly (*Exorista leucaniæ*, Kirk.), which infests the Army-worm, in lacking the red tail.* The other parasite which infests it in the East, but which I have not yet met with, is a species of *Pimpla* very closely allied to *P. melanocephala*, Brullé, but differing from that species in the head being red and not black.†

[Fig. 54.]



SUMMARY.

The Tent caterpillar of the Forest differs from the common Orchard Tent-caterpillar principally in its egg-mass being docked off squarely instead of being rounded at each end; in its larva having a row of spots along the back instead of a continuous narrow line, and in its moth having the color between the oblique lines on the front wings as dark or else darker, instead of lighter than the rest of the wing. It feeds on a variety of both forest and orchard trees; makes a web which from its being usually fastened close to the tree is often overlooked; is often very destructive, and is most easily fought in the egg state.

**Exorista leucaniæ*, Kirkpatrick = *E. militaris*, Walsh. I have bred the variety lacking the red at tip of abdomen from larvæ of *Attacus cecropia*, Linn., *Datana ministra*, Drury, *Agrotis inermis*, Riley, and of two undetermined Agrotidians.

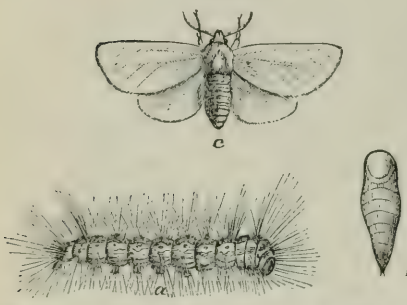
†*Practical Entomologist*, II, p. 114.

THE FALL WEB-WORM—*Hyphantria textor*, Harris.

(Lepidoptera, Arctiidæ.)

With the two preceding caterpillars is often confounded a third which in reality has nothing in common with them, except that it spins a web. The insect I refer to is known by the appropriate name of Fall Web-worm, and whenever we hear accounts of the Tent-caterpillars taking possession of trees and doing great injury in the fall of the year (and we do hear such accounts quite often), we may rest assured that the Fall Web-worm is the culprit and has been mistaken for the Tent-caterpillars, which never appear at that season of the year.

[Fig. 55.]



I do not know how injurious this insect is in the more Southern States, but he who travels in the fall of the year, with an eye to the beauties of the landscape, through any of the Northern and Middle States, especially towards the Atlantic sea-board, will find the beauty fearfully marred by the innumerable webs or nests of this worm. If they are as common as they were last fall, he will very naturally deplore the unsightly appearance of the forests, and feel amazed at the number of these signs of carelessness and slovenliness which occur in the cultivated orchards! The Web-worm is found on a great many kinds of trees, though on some more abundantly than others; but with the exception of the different grape-vines, the evergreens, the sumachs and the Ailanthus, scarcely any tree or shrub seems to come amiss to its voracious appetite. This insect passes the winter in the pupa state under ground and the moth emerges during the month of May or as late as the fore part of June. The female deposits her eggs in a cluster on a leaf, generally near the end of a branch, and these eggs hatch during the months of June, July and August, earlier or later, according to the latitude. Each worm begins spinning the moment it is born, and by their united effort they soon cover the leaf with a web, under which they feed in company, devouring only the pulpy portions of the leaf. As they increase in size they extend their web, but always remain and feed underneath it. When young the worms are pale-yellow with the hairs quite sparse and with two rows of black marks along the body and a black head. When full grown they generally appear pale-yellowish or greenish with a broad dusky stripe along the back and a yellow stripe along the sides, and they are covered with whitish hairs which spring from black and orange-yellow warts. Figure 55, *a*, gives a very good idea of a full grown worm, but the species is very variable both as to depth of coloring and markings.

Both Dr. Harris and Dr. Fitch state that this worm spins its thin cocoon in crevices of bark and similarly sheltered places above ground, but a great many of the specimens which I have reared (and I have bred specimens three different years) buried themselves and formed their cocoons just under the surface of the ground—thus giving evidence that the same insect will sometimes variously spin up above or below the ground. The chrysalis (Fig. 55, *b*) is of a very dark brown color, glabrous and polished and faintly punctured, and is characterized by swelling or bulging about the middle. The moth (Fig. 55, *c*) is white with a very slight fulvous shade: it has immaculate wings, but the front thighs are tawny-yellow and the feet blackish: in some the tawny thighs have a large black spot, while the shanks on the upper surface are rufous; in many all the thighs are tawny-yellow, while in others they have scarcely any color. One bred specimen in my cabinet even has two tolerably distinct spots on each front wing—one at base of fork on the costal nerve, and one just within the second furcation of the median nerve.

During the summer and fall of 1870 this worm was unprecedently numerous, not only in our own State but all over the country, and, as was remarked by others as well as myself, it hatched out much earlier than usual; for the first webs were noticed around St. Louis by the middle of June. It has always been supposed to be single-brooded, and in the New England States it never does perhaps produce more than one brood each year; but though such may be its normal habit, even in the latitude of St. Louis, yet there is good evidence that it sometimes produces two broods in that latitude, and in all probability does so constantly still further south. There appeared to be two broods with us the present year, and Mr. J. R. Muhleman, of Woodburn, Illinois, informed me that on August 5th, he had a second brood of worms, the first brood having appeared in June on Pear and Osage Orange. He did not, however, breed one generation from the other, and until this is done during the same year, we cannot say with absolute certainty that the species is two-brooded, for the disparity in time of appearance can be accounted for in other ways. The climate of the Central portion of our State is intermediate between that of the more Northern and the more Southern States, but the fauno partakes more of the character of the latter; and our summers are so variable in their duration and in their general intensity, that our insects show a great variability in their habits. It is for this reason that I find it very difficult to draw the rigid lines that many of our New England writers have done when treating of a particular insect, and it is for this reason that we frequently find insects, normally single-brooded there, often producing two broods a year here.

With us the Fall Web-worm appears to be most partial to the hickories and to the Black walnut, and least so to the oaks; but I have found scarcely any tree or shrub exempt from its attacks except those already mentioned, and it is even said to feed on the Hop-Plantain, Bean, Sunflower, and many other herbaceous plants.

From the foregoing account it will at once be seen how widely this Fall Web-worm really differs from the Tent-caterpillars. It hibernates in the pupa state, they in the egg state; it appears mostly in the fall, they mostly in the spring; its moth is pure white, theirs reddish brown; its eggs are deposited on a leaf, and hatch before the leaf falls, theirs are deposited around a twig, because they have to pass the winter and would get lost with the leaves if deposited upon them; it feeds solely on the parenchyma of the leaf under its web, they devour the whole leaf outside of their tent; and on account of these differences, we cannot employ the preventive measures against it which we take against them.

REMEDIES.

As, therefore, nothing can be done to materially affect this insect during the winter, we must do all the fighting when the worms first hatch. Their web soon betrays them, and the twig or branch containing it may be pruned off in the same manner described for the Tent-caterpillars. As the worms are always under the tent, the operation in this case can be performed at any time of the day without the risk of missing any wanderers.

HYPHANTRIA TEXTOR—*Larva*—(Fig. 55, *a*) Ground-color greenish-yellow. Dorsum velvety-black, with a narrow median pale line on thoracic joints. Sides speckled with black, except along subdorsal and stigmatal lines, where longitudinal yellow patches are left clear. Venter dusky or smoky-brown. Head shiny black with labrum and antennæ white. Thoracic legs black; prolegs long and narrow, smoky-black with faint orange extremities. Covered with long straight hairs, longest on joints 2, 3, 11 and 12. These hairs are either dirty white with a few black ones interspersed, or of a more uniform reddish-brown. They spring in bundles from around large warts situated as follows on each joint; 4 which are black and dorsal, arranged in a trapezoid, the anterior pair being the smaller; and four which are orange on each side, and arranged in a transverse row in the middle of the joint. Stigmata light yellow. Average length, 1.10 inches.

Varies considerably, in some the black predominating, in others the yellow. Those found on hickories are usually the darkest. When newly hatched it is pale yellow with two longitudinal rows of black marks and a black head.

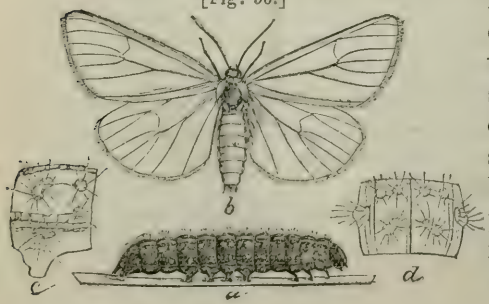
Described from numerous specimens.

THE BLUE-SPANGLED PEACH WORM—*Callimorpha fulvicosta*, Clem.

(Lepidoptera, Arctiidæ.)

In examining apple trees, but more especially peach trees, during winter or early spring, we often come across little black worms, covered with short, stiff, sprangling hairs, and studded with minute blue spots, sheltering under the loose bark. As soon as the leaves put out, these worms issue from their winter retreat and commence feeding. They

[Fig. 56.]



grow apace and by the end of April have usually acquired their full size, when they present the appearance of Figure 56, *a*; *c* showing an enlarged side section of one of the principal joints, and *d* a back view of the same. The color is now velvety black above, and pale bluish, speckled with black below; there is a deep orange line along the back, and a more distinct wavy and broken one along each side: the warts, illustrated in the enlarged sections are steel-blue and granulated, and their irregularities, as they catch and reflect the light, look like minute pale blue diamonds, the whole body, upon casually glancing at it, appearing studded with these blue points. This worm spins a slight cocoon of white silk in any sheltered place it can find, and changes to a chrysalis of a purple-brown color, finely and thinly punctured and terminating in a horizontally flattened plate, which is furnished with numerous yellowish-brown curled bristles. The moth (Fig. 56, *b*) issues from this chrysalis during the fore part of June. It is a very plainly marked species, being either milk-white or cream-colored, with the head, collar, basal and apical joints of the abdomen above, and the whole body, legs, and anterior margins of the wings fulvous or dull orange.* It was described in 1860 by Dr. Brackenridge Clemens under the name of *Hypercompa fulvicosta*† but is now properly referred to the genus *Callimorpha*. It may be known in English as the Cream Callimorpha as it is disguished from all other moths by its unspotted creamy appearance.‡ This worm is found more commonly on

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**Callimorpha vestalis*, Packard (Proc. Ent. Soc. Phil. III, p. 108), must be considered as a synonym of *fulvicosta*, for Dr. Packard has certainly given no characters that should be considered specific. To show on what grounds the new species is founded I will quote in full the original description of *fulvicosta* and afterwards that of the so-called *vestalis:*

C. fulvicosta, Clem.—"White. Palpi yellow orange, tips blackish. Head prothorax, the anterior edge of the fore wings, especially beneath, yellow-orange; sometimes the costa of the fore wings is dark brownish. Breast and legs yellow orange, the middle and fore tibiæ and tarsi blackish. Abdomen tipped with yellowish orange.

"Illinois. From Robt. Kennicott."

C. vestalis, Pack.—"♂ and ♀ pure immaculate milk-white, ♀ white. Tips of the palpi brown. Head and prothorax, basal half of the patagia and costa of both wings above and beneath yellowish. The legs are also yellow beneath. The abdomen is white and unspotted. Antennæ brown. Body ♂ .65, ♀ .65. Exp. wings ♂ 1.70, ♀ 1.70 inch.

"Middle Atlantic States (Coll. Ent. Soc. Phil., through A. R. Grote."

Now, comparing the descriptions, *vestalis* differs in no other respect from *fulvicosta*, than in the legs being yellow beneath instead of having the middle and fore tibiæ blackish as described by Clemens. Three bred specimens in my possession differ in this trifling character, and though Dr. Packard says that his species differs *remarkably* [!!] from the other in being pure white and of smaller size, yet Dr. Clemens gives no measurements and there are specimens in my own cabinet and in Mr. Walsh's of all shades of white to cream color and some of them fully as small as the measurements above quoted. Moreover I have a specimen marked *vestalis*, kindly sent me by my friend Cresson of the Am. Entomological Society, and while in Philadelphia last fall I examined all the specimens marked or said to be *vestalis* without finding any distinguishing characters at all. If a new species is to be made out of such trifling characters in the face of the fact that the species of the genus *Callimorpha* are very prone to vary, and that twenty times as much variation is found in hundreds of other species of Lepidoptera, what is the science of entomology to come to?

†Proc. Acad. Nat. Sci. Phil., 1860, p. 536.

‡The only insect which very closely resembles it is a pale variety of a moth known as the Egle (*Euchætes egle*, Harr.) whose beautiful larva is tolerably common on our milkweeds. This last however may always be distinguished by the feathered antennæ of the male, the different shaped wings and the deep orange and black spotted abdomen.

the Peach than on any other tree, and as it appears very early in the season and commences to feed on the young leaves before they are fully expanded, it does considerable damage when numerous. I have been acquainted with the worm for several years past but its natural history was unknown till last summer when Dr. LeBaron and myself simultaneously bred the moth from peach-leaf feeding larvæ, so that its history is now given for the first time. Figures of the larva were given in the *Prairie Farmer* last summer by Dr. LeBaron who was misled by Dr. Hull into the belief that they were the Tent-caterpillar of the Forest already described. Two years ago I found this Blue-spangled worm tolerably common in the peach orchard of Mr. E. J. Ayres of Villa Ridge, Ills., and he says that he destroyed over a thousand of them last spring. In this State I have frequently met with it but it is by no means common. Hand picking will easily keep it in check.

CALLIMORPHA FULVICOSTA, Clem.—*Larva* (Fig. 56, *a*)—Color velvety-black above, pale bluish-gray speckled with black below. A deep orange medio-dorsal line (usually obsolete towards each end) and a more distinct, wavy, broken, yellow stigmatal line, with a less distinct coincident pale line below it. Covered with large highly polished, roughened, deep steel-blue warts, the irregularities of which as they catch and reflect the light, look like pale blue diamonds. Closely examined these warts are found to be covered with small elevations each of which furnishes a short stiff yellow hair, these hairs radiating in all directions around the warts, which are placed as follows:—Joint 1 with an anterior transverse row of 8 and a posterior dorsal row of 4; joints 2 and 3 each with a transverse row of 8 across the middle; joints 4—11 inclusive, each with 4 circular ones anteriorly, and 2 irregular ones posteriorly on dorsum (Fig. 56 *d*, each of the last evidently formed by the blending of two), and 2 on each side near the middle of joint (Fig. 56 *c*). Joint 12 with 2 that are irregular, on the back, and 1 that is circular, on each side. Anal shield formed of one large irregular wart. In addition to these there is a narrow subventral wart each side, and 2 small ventral ones on the legless joints. Head polished black with a few black hairs. Thoracic legs polished black, but pale at the joints inside: prolegs black outside, flesh-colored within and at extremities. Stigmata not perceptible. Largest in the middle of body. Average length 0.90, greatest diameter 0.15 inch.

Described from 6 peach-feeding specimens. Alcoholic specimens do not reflect the pale blue points.

The larvæ of our different *Callimorphas* seem to bear a very close resemblance to each other. I have bred *C. clymene*, Hubner, from a larva found full grown on oak (tho' whether it fed on oak I did not ascertain) which so resembled that of *fulvicosta* that I fully expected it would produce nothing else. The only difference noticeable was that it was very bright colored, with the medio-dorsal line very clear and distinct. Mr. Wm. Saunders has reared *C. LeContei* from larvæ feeding on Horse Gentian (*Triosteum perfoliatum*), and from his description of the larva* it differs principally from the above in lacking the blue reflections and in having a pale dotted subdorsal line.

THE ASH-GRAY PINION—*Xylina cinerea*, N. sp.

(Lepidoptera, Xylinidæ).

There is a pale green worm with cream-colored spots and a broad cream-colored lateral band, which I have for several years known to

* *Canadian Entomologist* I, p. 20.

[Fig. 57.]

be common on the Apple, Poplar, Hickory and some other trees, the leaves of which it devours, but which last summer attracted unusual attention by its being frequently found boring into apples and peaches, and as I also commonly found it hiding in and feeding upon one of our large oak-apples (the *spongifica*) we may conclude that it is a very general feeder and that it is fond of boring.

This worm (Fig. 57, *a*) is found during the months of May and June and when full grown burrows beneath the surface of the ground where it forms a very thin cocoon of filmy silk with the earth adhering to it on the outside. It changes to a mahogony-brown chrysalis and generally issues as a moth during the September or October following, though in northern Illinois I have known it to remain in the chrysalis state through the winter and not issue as a moth till April.

The moth (Fig 57, *a*) varies considerably in its appearance, but is characterized by the cold ash-gray appearance of the front wings which are variegated with darker gray as in the figure. It is an undescribed species and belongs to a genus (*Xylina*) which is easily recognized by the long narrow almost rectangular wings, the very square thorax which is often furnished behind the collar with a bifid crest, and the rectangular and flattened abdomen. The wings are folded in repose and appear almost parallel and like a flattened roof—giving the insect an elongate appearance.

XYLINA CINEREA, N. Sp.—*Larva* (Fig. 57, *a*.) Length when full grown 1.20—1.30 inches, color shiny silvery-green on the back, darker below. A medio-dorsal cream-colored stripe; a subdorsal one represented by 3 or 4 irregularly shaped spots on each joint. A broad deep cream-colored stigmatal line, with a few green dints in it, extending to anal prolegs. Four slightly elevated cream-colored spots, encircled by a ring of rather darker green than the body, in the dorsal space, and in the subdorsal space there are four or more similar but smaller spots. Venter glaucous-gray. Head as large as joint 1, free, glassy-green with white mottlings at sides and top, and pearly-white lips. Thoracic legs whitish. Prolegs concolorous with venter. When young the body is darker and the markings paler.—Described from two living specimens.

Imago (Fig. 57, *b*)—*Front wings*, with the ground-color pale cinereous shaded and marked either with light brown, having a faint purplish tint, or with darker brown, having a similar reflection, or with a colder grayish-brown with the faintest moss-green reflection: in the first two cases the dark color either blends and suffuses with the ground-color so as to give the wing a nearly uniform and smooth appearance, or else contrasts sufficiently to bring out all the marks distinct; in the latter case (two specimens) the markings are very distinct and the ground color is whiter and more irrorate. In the well marked specimens the usual lines are readily distinguished, the basal half line, transverse anterior and transverse posterior being quite wavy, pale, and bordered each side with a dark shade, the median shade dark and well defined and the subterminal line, though sometimes pale near costa, forming a series of dark angular spots: in the more uniform specimens these lines are barely distinguishable and perhaps the most constant is the sub-terminal which most often takes the form of a series of dark angular spots: the ordinary spots have a pale inner and a more or less distinct dark outer annulation; the orbicular is larger than the reniform and is sufficiently double to take on the form of an 8, the upper part of which is always largest and with the interior

space paler than the general surface, while that of the lower part is either concolorous or darker; the form is, however, quite irregular and differs sometimes in the two wings of the same species: the reniform spot is generally well defined, and is either darker, or has a tinge of reddish-brown, interiorly: at the base of the wing is a more or less distinct pale space occupying the upper half, and bordered below by a brown line which is straight about half its length and then extends upwards and outwards towards transverse anterior. A tolerably distinct terminal line, with the fringes dark. In taking a general view of the varying specimens this pale basal space, the pale upper part of the orbicular and the dark subterminal line, seem to be the most constant characters of the species. *Hind wings* gray-brown inclining to cinnamon-brown, with the posterior border but slightly darker and the fringe paler. Under surface quite uniform, that of front wings being nacreous gray with a faint discal spot and with a narrow costal and broad terminal border of pale fulvous, dusted with purple-gray; the hind wings of this last color with the lunule and line distinct. *Head* nearly entire, though the quadrifid arrangement of the hairs is traceable; palpi hairy throughout. *Thorax* quite square, of same color as primaries and with the collar bordered behind with brown and sometimes the edges of the tegulæ similarly bordered. *Abdomen* of same color as hind wings with lateral tufts, and cut off squarely at apex. Expanse 1.32—1.82 inches.

Described from 3 specimens fed on grape-vine, 2 on peaches and 1 on *Cercis canadensis*. Other captured specimens examined.

This species is the analogue of, and very closely resembles the European *Xylina conformis*, which is known under various synonyms. A specimen sent to Mr. P. C. Zeller of Stettin, Prussia, was, however, pronounced distinct. The well-marked irrorate form still more closely resembles Guenèe's *cinerosa* found in Switzerland, and which he himself thinks may prove to be a variety of *conformis*. The more I study the species of the NOCTUIDÆ as they occur in nature, the more I am struck with their great variability, and there can be no doubt that many of the so-called species will turn out to be but varieties when we better understand them. In this large family none but the more strikingly marked species should ever be described without an accompanying description of their preparatory states and of their principal variations. I am unacquainted with any of Walker's species except *subcostalis* which is very different, and if this should prove to be a synonym of any of them, the fault must be laid to the difficulty under which the naturalist in the Western States labors for want of proper libraries to refer to. It differs essentially from Grote's *Bethunci* and *capax* as described and illustrated in Volume I of the Transactions of the American Entomological Society. I am informed by Mr. A. Lintner of Albany, N. Y., that Dr. A. Speyer of Rhoden, Furtsenthum Walldeck, Prussia, who gives much attention to the Noctuidæ, has it marked *Celæna obl. nga* in his MS., but the insect evidently does not belong to that genus, and as the German pronunciation of *Xylina* much resembles the English pronunciation of *Celæna*, the reference to the latter, is doubtless due to a verbal misunderstanding.

BENEFICIAL INSECTS.

It is not often that there will be much to say in this Department, as most of the beneficial insects are treated of in connection with the injurious species upon which they prey. But the following little fellow is so important to the grape-grower that it should be recognized by every vineyardist in the State, and cherished as the very apple of his eye:

THE GLASSY-WINGED SOLDIER-BUG—*Campyloneura vitripennis*, Say.

A NEW FRIEND TO THE GRAPE-GROWER.

This is the bug; and a pretty little thing it is too! Take a good look at the figure and remember that the hair-line at the side represents the natural size.

[Fig. 58.]

There are perhaps no insects more dreaded by the grape-grower than the different species of leaf-hoppers which sap up the substance of the leaves of the Vine; but as they will be treated of, in all probability, in my next Report, we will pass them over for the present.

No parasitic or cannibal insect has ever been known to prey upon these leaf-hoppers before, but last September, while in the vineyard of Dr. C. W. Spaulding, at Rose Hill, on the Pacific railroad, I discovered that this Glassy-winged Soldier-bug was preying upon them. The leaves were actually covered on the underside with the dead carcasses of the leaf-hoppers, which, in their death-struggle, had firmly attached themselves, and hung thickly, with wings extended and body sucked dry—dead proof of the surprising thoroughness with which their mortal foe had done its work of slaughter. On a single leaf not so large as a man's hand a half hundred of these skeleton leaf-hoppers could be counted, and though this number was above the average, there were few leaves that did not show quite a number. To use Dr. Spaulding's language, "the sight was enough to

gladden the heart of any grape-grower, who had long looked upon the leaf-hopper as a permanent evil against which he could not successfully contend."

Moving about among the leaves our little Soldier-bug* was often seen in its pretty full dress uniform, but far more commonly disguised in its larval or pupal coat; for it is only when full grown and full fledged that it presents the appearance of the first figure. The larva and pupa both have an opaque, mealy, bluish-white appearance, and the latter differs only from the former in the more conspicuous wing stubs, which project so as to give it a somewhat diamond shaped outline (Fig. 59.) It is during these immature, and less conspicuous stages that this insect doubtless does most of its work, for in common with the rest of the true Bugs (*Heteroptera*) it is active and feeds during its whole life, from the time it hatches from the egg till it dies of old age.

[Fig. 59.]

When I first saw the hosts of leaf-hoppers so mercilessly stabbed, I was at considerable loss to understand what animal could be so wary and dexterous as to surprise insects so shy and active, and with such wonderful jumping powers as the leaf-hoppers possess, and I could not rest sure that it was our little Glassy-winged Soldier-bug till I had enclosed specimens in a bottle with living leaf-hoppers, and found the latter dead next day. Like many other animals of prey, it can move actively when necessary, but no doubt prefers to surprise its victims by stealth, assisted perhaps by its colors which resemble those of the leaf-hoppers themselves.

The more common color of this insect is pale greenish-yellow. The antennæ are brown with the basal joint and sometimes part of the second joint blood-red. The head and thorax are pale yellow with a slight tinge of pink, and the eyes, neck, and front part of the thorax, except a pale line on the back, are jet black in high contrast. The scutel is pale yellow or white, and black at base, and the upper wings (hemelytra) are beautifully transparent with a rose-colored cross band and a dusky curved line. The species is a very variable one, however, being dichromous or double-colored, some varieties possessing much more brown than others, and having no rose-color at all. In a variety kindly sent me by Mr. P. R. Uhler, of Baltimore, Maryland, the antennæ are pale, and there is no black on the thorax in front, but a large brown patch behind; there is also a large brown patch each side of the scutel, and the rosy transverse band on the wings is quite brown.

Now this insect is commonly found by collectors in the fall of the year on different kinds of Oak, but no one ever heard before of its

*I have preferred to apply this popular term to this species, because its black, white and red marks, and its war-like propensities suggest something of the sort; and though the term is more strictly and correctly applied to larger cannibal bugs belonging to the genus *Arma*, yet it is not inappropriate here, and will appeal to the popular mind far more readily than the generic name *Campyloneura*, or the English rendition of it, curved-nerve.

attacking the leaf-hoppers of the Grape-vine, and it certainly could not have done so in past years to the extent that it did at Rose Hill last fall, without its work having been noticed. I have been through vineyards by the hundred in the fall of the year, and never before noticed such work. How are we then to account for its sudden appearance in such force in the vineyard of Dr. Spaulding? To my mind it is an excellent illustration of an insect acquiring a new habit. Some individual or individuals wandering from the oaks and from whatever food they there subsisted upon, came upon Dr. Spaulding's vineyard and found the leaf-hoppers of the Vine to their taste. Their food being abundant, they soon multiplied, so as to make their work appreciable, and commenced to spread from one vineyard to another. The facts in the case would support such a theory, for the bugs and their slaughtered victims were found in diminishing numbers in the vineyards in the immediate neighborhood until at the distance of three miles, no sign of either could be found. Consequently, though our little cannibal friend occurs sparingly throughout the country in the native timber, it is found in the cultivated vineyard in a limited district only, so far as we now know. But there is no reason why the field of its operations in the vineyard should not in time become co-extensive with that of the troublesome leaf-hoppers; and with our present mail facilities we can materially help to make it so by artificially introducing a few dozen of the living bugs from one vineyard to another.

This species was first described by Say as *Capsus vitripennis*. The *Phytocoridæ*, as the name indicates, have all been hitherto considered as plant-feeders, and at first the species above considered would appear to be an exception to the unity of habit in the family. But Mr. Uhler informs me that his investigations of the elongated forms of many of the recently established genera have taught him that the affinities of many of them are largely with the *Reduviidæ* through *Anthocoridæ*; for he has often found them in places where small caterpillars were numerous; among the larvæ of *Tingidæ*, and has even caught them in the act of sucking the juices of plant-lice.

INNOXIOUS INSECTS.

THE WHITE-LINED MORNING SPHINX—*Deilephila lineata*, Fabr.

(Lepidoptera, Sphingidæ.)

[Fig. 60.]

The beautiful moth which heads this chapter is quite common in the State of Missouri, and has upon several occasions been sent to me for identification. Almost every one must have been struck with the great resemblance which it bears to a humming bird, as, of a summer's evening, it flits rapidly from plant to plant in the garden, and ever and anon hovers noiselessly over some particular flower, and stretches forth its long tongue to sip the sweet nectar which that flower contains.

Few persons are, however, aware what this beautiful moth looks like, or what it feeds upon, in the caterpillar state; wherefore this brief account of it.

The very great diversity of form and habits to be found amongst the larvæ of our butterflies and moths, has much to do with the interest which attaches to the study of these masked forms. I am moved to admiration and wonder as thoroughly to-day as in early boyhood,

every time I contemplate that within each of these varied and fantastic caterpillars—these creeping and groveling "worms"—is locked up the future butterfly, or moth, which is destined, fairy-like, to ride the air on its gauzy wings, so totally unlike its former self. Verily the metamorphoses of the lower animals must prove a never-failing source of joy and felicity to those who have learned to open the pages of the great Book of Nature!

But beyond the general satisfaction experienced in studying these transient forms, there will be found ample food for the philosophic mind in the larval variations to be met with in the same species. Some vary according to the character of their food-plant, and the study of these variations—of phytophagic varieties and phytophagic species—must ever prove interesting as well as important, by throwing light on the question of the origin of species. Some (*e. g.* the common Yellow Bear, Fig. 28, *a*, p. 68) vary very much without regard to food-plant. Our Sphinx larvæ, more particularly, are subject to these variations, and it is for this reason that larval characters alone, unaccompanied by those of the perfect insect, are of so little value in classification.

The White-lined Morning Sphinx (Fig. 60) presents one of the most striking cases of larval variation, as may be seen by comparing the light form of Figure 61 with the dark form of Figure 62. In the summer of 1863 I took both these forms on the same plant, and have repeatedly met with them since; but the moths bred from them show no differences whatever.

This beautiful moth is called by Harris the White-lined Morning Sphinx, though its generic name means "Evening Friend." It is distinguished principally by its roseate under-wings, and by a broad, pale band running from the apex to the base of the dark-olive front wings.

[Fig. 61.]

The larva feeds upon purslane, turnip, buckwheat, watermelon, and even apple and grape leaves, upon any of which it may be found in the month of July. It descends into the ground and, within a smooth cavity, changes into a light brown chrysalis, from which the moth emerges during the month of September.

The most common form of this larva is that given at Figure 61; its color is yellowish-green, with a prominent subdorsal row of ellip-

tical spots, each spot consisting of two curved black lines, inclosing superiorly a bright crimson space, and inferiorly a pale yellow line—the whole row of spots connected by a pale yellow stripe, edged above with black. In some specimens these eye-like spots are disconnected, and the space between the black crescents is of a uniform cream-yellow. The breathing-holes are either surrounded with black, or with black edged with yellow. The other form is black, and characterized chiefly by a yellow line along the back, and a series of pale yellow spots and darker yellow dots, as represented in the illustra-

[Fig. 62.]

tion (Fig. 62). Even this dark form is subject to great variation, some specimens entirely lacking the line along the back, and having the spots of different shape.

This insect has a wide range, as it occurs in the West Indies, Mexico and Canada, as well as throughout the United States. Feeding, as it does, principally on plants of but little value, and being very commonly attacked by the larva of a Tachina-fly, this insect has never become sufficiently common to be classed as injurious. The Tachina-fly which so commonly infests it, is readily distinguished from the other more common form by the abdomen, which is bright rufous with the exception of a broad dorsal stripe which is dark.

TWO OF OUR COMMON BUTTERFLIES.

THEIR NATURAL HISTORY; WITH SOME GENERAL REMARKS ON TRANSFORMATION AND PROTECTIVE IMITATION AS ILLUSTRATED BY THEM.

In the following pages I propose to give the complete natural history of two of our commonest butterflies, and to close with such philosophical thoughts as the subject warrants. I do so the more willingly as many of the facts are published for the first time; for notwithstanding the butterflies are so common, their complete natural history has hitherto been unknown.

THE ARCHIPPUS BUTTERFLY—*Danais archippus*,* Fabr.

(Lepidoptera, Danaidæ.)

ITS NATURAL HISTORY.

[Fig. 63.]

"What more felicitie can fall to creature
Than to enjoy delight with libertie,
And to be lord of all the workes of Nature,
To raine in th' aire from earth to highest skie,
To feed on flowres and weeds of glorious feature."

The Fate of the Butterfly—Spenser.

This beautiful butterfly, like most of the species of the family to which it belongs, enjoys a wide range, occurring in the more northern of the States and in Upper Canada and extending into South America, where, according to Mr. Bates, it is common throughout the region of the Lower Amazons.† In the Mississippi Valley it is one of our most common species. The family to which it belongs is distinguished by the front legs being spurious or abortive; by the large cell in the centre of each wing being closed, and by the existence of a small nervule originating at the base of the front wing just below the lower or sub-median nerve, and joining that nerve a short distance from its base.‡ This nervule is so covered with scales that it is hardly visible till they are removed. In the genus *Danais* the sexes are readily distinguished by the male having a small horny

* Some late writers use the specific name *erippus* of Cramer, because it seems to have the priority. I have not all the works of the old authors to refer to, but Mr. Sanborn, of Boston, has been kind enough to refer to them for me, and he writes that *erippus* was first applied by Cramer to the ♀ in 1775, and *plexippus* to the ♂ by the same author in 1780. Fabricius published his name of *archippus* in 1793, and the name had already been applied by Cramer to the Disippus butterfly. Accordingly Cramer's *erippus* has the priority; but as this insect has been very generally known by the name which Fabricius gave it, among entomological writers, and as it has become familiar to the popular ear, I prefer to retain it—especially since it is no longer applied to the Disippus butterfly.

†Trans. Linnæan Soc., Vol. XXIII, p. 516.

‡Mr. Bates in a note to the paper already referred to, (p. 497,) gives this as a constant and excellent character discovered by Dr. C. Felder, of Vienna, and describes it as "a small nervule at the base of the fore-wing median nervure which anastomoses with the median a short distance from ts origin." I have no means of referring to Dr. Felder's original article, and cannot say whether e is correctly quoted; but in the two N. A. species of the genus (*D. archippus* and *berenice*) this hervule originates below and anastomoses with sub-median nerve.

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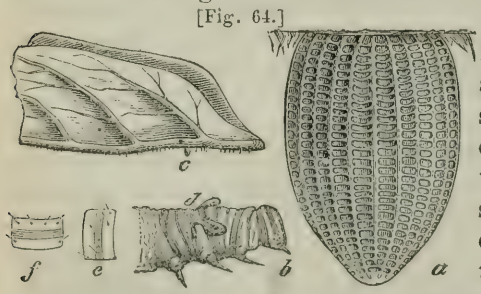
excrescence near the disk of the hind wing, close to, or upon the fourth nerve. This excrescence or tubercle is faintly shown in the above figure, which represents the male, and it is entirely lacking in the female. The color of the Archippus butterfly is of a bright orange-red, marked with black and cream-color as in the figure—the underside being similarly marked but paler, that of the hind wings being bright fulvous. The species feeds upon most of the different kinds of Milk-weed or Silk-weed (*Asclepias*), and also upon Dogbane (*Apocynum*), according to some authors. It shows a wonderful dislike, however, to the Poke Milk-weed (*Asclepias phytolaccoides*), and I was surprised to find that larvæ furnished with this plant would wander about their breeding cages day after day, and would eventually die rather than touch it, though they would eagerly commence devouring the leaves of either *A. tuberosa*, *curassavica*, *cornuti* or *purpurascens* as soon as offered to them.

The butterflies hibernate, though whether any but the impregnated females survive until the Milk-weeds commence to grow is not definitely ascertained. They commence depositing eggs in the latitude of St. Louis during the fore part of May. Some of the earliest developed butterflies from these eggs begin to appear about the middle of June and others continue to appear for several weeks. These lay eggs again, and the butterflies abound a second time in October. Thus there are two broods each year, and though the first brood of larvæ are hatched more uniformly and within a more limited time than the second, the two broods yet connect by late individuals of the first and early individuals of the second, and the caterpillars may be found at almost any time from May to October, but are especially abundant during late summer and early fall.

[Fig. 64.]



The egg (Fig. 64, *a*, magnified; *c*, natural size) is invariably deposited on the under side of a leaf, and is conical and delicately reticulate with longitudinal ribs, and fine transverse striæ. It is yellowish when first deposited but becomes gray as the embryo within develops.

Description of Egg.—Length 0.05; greatest diameter 0.03 inches. Conical, slightly narrower at base than in middle, and generally slightly contracted towards apex. Color pale cream-yellow; opaque, smooth; the shell but slightly polished and rather soft. About 22 longitudinal narrow carinate ribs, usually regular and single, though occasionally one gives forth a branch; interstices crossed by about 30 very fine transverse striæ, often subobsolete. Apex smooth. Slightly and singly attached to the underside of leaf.

Described from numerous specimens.

It is a little singular that this egg has not previously been described. It is very easily found, and I had no difficulty in obtaining great numbers last summer, though I owe the first one ever obtained to the sharp eyes of Miss M. E. Murtfeldt, of Kirkwood, a lady who takes much

interest in Entomology, and is an excellent observer. It were greatly to be wished that more of our ladies would interest themselves in such studies, for we have altogether too few Madam Merians.

In about five days after deposition, the egg hatches, and the young larva as soon as hatched usually turns round and devours its egg-shell; a custom very prevalent with young caterpillars. At this stage it differs considerably from the mature larva; it is perfectly cylindrical, about 0.12 inch long and much of a thickness throughout. The head is jet black and polished; the color of the body is pale greenish-white with the anterior and posterior horns showing as mere black conical points, and with two transverse-oval black warts, nearer together, on the first joint. It is covered with minute black bristles, arising from still more minute warts, six on the back and placed four in a row on the anterior portion and one each side on the posterior portion of each joint, (Fig. 64, *f*); and three on each side, one in the middle of the joint, and two which are substigmatal, posteriorly, (Fig. 64, *e.*) There is a sub-triangular black spot on the anal flap, the legs are alternately black and white and the stigmata are made plainly visible by a pale shade surrounding them. When the young worm is three or four days old, a dusky band appears across the middle of each joint; and by the fifth or sixth day it spins a carpet of silk upon the leaf, and prepares for its first moult. After the first moult the anterior horns are as long as the thoracic legs, the posterior ones being somewhat shorter; the characteristic black stripes show quite distinctly, but the white and yellow stripes more faintly. After this it undergoes but slight change in appearance, except that the colors become brighter and that at each successive moult the horns become relatively longer. There are but three moults.* and the intervals between them are short, as the worms frequently acquire their full growth within three weeks from hatching.

Some persons may be curious to know how the larva acquires longer horns at each moult. The explanation is simple. During each period of growth the skin which is to serve for the next period is forming and perfecting under that which at the the time serves the worm. Upon this inner skin and beneath the outer one, the horns are also developing, and when the outer skin has become useless and the worm, after a short period of rest and fasting, bursts it near the head and works it off, the old horns go with the old skin and the new ones appear as mere stubs. The new skin is now very fresh and moist, and no sooner is the old skin off than these soft stubs begin to swell, and it is then easily seen how wonderfully the long horns

*I do not include the last moult by which the larva is transformed to the chrysalis. Some persons in counting the different moults that larvæ pass through, are content with counting the heads that are shed. Whenever this method is relied on it should be borne in mind that the heads really increase in size between each moult, though not in proportion to the increase of body. Thus, in the present species the first head is considerably larger when shed than it was when the larva hatched, and though appearing uniformly black when hatched, it shows the usual white marks more or less distinctly when shed.

have been folded up and curled over and between the wrinkles of the body so as not to impede the casting of the skin. At Figure 64, *b*, I have given a somewhat enlarged view of a worm just in the act of casting its last skin in order to show (at *d*) how the flexible horns were folded. They unbend of their own accord, though the worm often helps to straighten them out by cunningly turning its head and drawing them over the surface of the leaf.

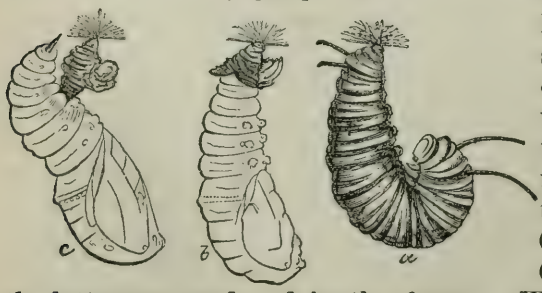
[Fig. 65.]

When full grown the worm presents the appearance of Figure 65, the colors being black, white and yellow.

HOW THE LARVA BECOMES A CHRYSALIS.

The metamorphoses of insects will ever prove a source of wonder and admiration. If a naturalist were to announce to the world the discovery of an animal which, for a short term of its life, existed in the form of a serpent; which then, after performing its own interment and weaving itself a shroud of pure silk, changed to something like an Egyptian mummy; and which after remaining thus buried without food or motion, for a much longer term, should at length struggle through its shroud and start into day a winged bird—every one would be interested in the history of such a marvelous creature! Yet the transformation of insects are scarcely less startling than such an occurrence would be, and it is only by drawing such a picture, that we are made to fully appreciate these changes. The methods of transformation are varied, as the reader who has perused these Reports is well aware. A good illustration is often needed in our schools, and as the present species furnishes an excellent illustration of the process in those butterflies which are suspended in the chrysalis state from the tail, and is withal so common that those who desire to witness the process will have no difficulty in doing so, I will give some account of it; for the person who had never witnessed the true method employed, might gaze a long time at the full grown larva (Fig. 65,) and the chrysalis (Fig. 67) without divining how the latter was produced by the former. We have on the one hand a crawling worm, and on the other a legless body hanging securely by

[Fig. 66.]*



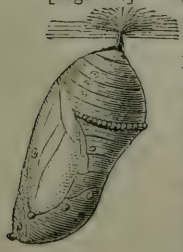
*These figures are drawn from memory and are perhaps a little ideal and inaccurate.

its tail. What has become of the larval appurtenances and how did the chrysalis attach itself? Let us see.

As soon as the larva is full grown it spins a little tuft of silk to the underside of whatever object it may be resting upon, and after entangling the hooks of its hind legs in this silk, it lets go the hold of its other legs and hangs down with the head and anterior joints of the body curved as at Figure 66, *a*. In this position it hangs for about twenty-four hours, during which the fluids of the body naturally gravitate towards the up-turned joints, until the latter become so swollen that at last, by a little effort on the part of the larva, the skin bursts along the back behind the head. Through the rent thus made the anterior portion of the pupa is protruded and by constant stretching and contracting the larval skin is slipped and crowded backwards until there is but a small shriveled mass gathered around the tail (Fig. 56, *b*). Now comes the critical period—the culminating point.

The soft and supple chrysalis, yet showing the elongate larval form with distinct traces of its prolegs, hangs heavily from the shrunken skin. From this skin it is to be extricated and firmly attached to the silk outside. It has neither legs nor arms, and we should suppose that it would inevitably fall while endeavoring to accomplish this object. But the task is performed with the utmost surety, though appearing so perilous to us. The supple and contractile joints of the abdomen are made to subserve the purpose of legs, and by suddenly grasping the shrunken larval skin between the folds of two of these joints as with a pair of pincers, the chrysalis disengages the tip of its body and hangs for a moment suspended as at Figure 66, *c*. Then with a few earnest, vigorous, jerking movements it succeeds in sticking the horny point of its tail into the silk, and firmly fastening it by means of a rasp of minute claws with which that point is furnished. Sometimes severe effort is needed before the point is properly fastened, and the chrysalis frequently has to climb by stretching the two joints above those by which it is suspended, and clinging hold of the shriveled skin further up. The moment the point is fastened the chrysalis commences, by a series of violent jerkings, and whirlings to dislodge the larval skin, after which it rests from its efforts and gradually contracts and hardens until it presents the appearance of Figure 67. The really active work lasts but a few minutes, and the insect rarely fails to go through with it successfully. The chrysalis is a beautiful object and as it hangs pendant from some old fence board or from the underside of an Asclepias leaf, it reminds one of some large ear-drop; but though the jeweller could successfully imitate the form, he might well despair of ever reproducing the clear pale green, and the ivory black and golden marks which so characterize it.

[Fig. 67.]



This chrysalis state lasts but a short time, as is the case with all those which are known to suspend themselves nakedly by the tail.

At the end of about the tenth day the dark colors of the future butterfly begin to show through the delicate and transparent skin, and suddenly this skin bursts open near the head and the new-born butterfly gradually extricates itself, and, stretching forth its legs and clambering on to some surrounding object, allows its moist, thickened and contracted wings to hang listlessly from the body. Under the direct influence of the air, the circulation quickens so that the fluids of the body are driven into every portion of these wings, and they visibly expand under the eye, while the other parts of the body gain in strength and firmness. In less than an hour, and often within half an hour, the wings are ready to perform their intended work and our gay Archippus takes his first lesson in æronautics. Ah! what an enviable fellow is he,

——Lazily flying
Over the flower-decked prairies, West;
Basking in sunshine till day-light is dying,
And resting all night on Asclepias' breast;
Joyously dancing,
Merrily prancing,
Chasing his lady-love high in the air,
Fluttering gaily,
Frolicking daily,
Free from anxiety, sorrow and care!

THE LARVA ENJOYS GREAT IMMUNITY FROM THE ATTACKS OF BIRDS AND OTHER PREDACEOUS ANIMALS.

Many of our insects, from one cause or another, enjoy a wonderful immunity from the attacks of predaceous and parasitic animals and there exists a curious relation between color and edibility. It is a very general rule that those which have such an immunity from the attacks of enemies, are conspicuously colored and feed openly upon the plants they attack; while those which are persecuted are generally of sombre and evasive colors, and often possess some protective resemblance to the objects upon which they occur, or hide themselves in one way or another. For several years past Mr. J. Jenner Weir, of London, England,—a gentleman whom I had the pleasure of meeting some eleven years ago—has made numerous experiments with the direct view of ascertaining what species of insects are eaten by birds and what species are rejected; and the results of these interesting experiments are recorded in the Transactions of the London Entomological Society (1869, pp. 21–26 and 1870 pp. 337–9). They point conclusively to the facts above given, and Mr. A. G. Butler of the British Museum made corroborating experiments, with, lizards, frogs and spiders. Prompted by these experiments made in England, I was led to make similar ones with our gaily colored Archippus larva, and the result fully accords with that obtained by Mr. Weir; for neither turkeys, chickens, toads or snakes would touch it. The reason why predaceous animals refuse these gaily colored larvæ is not always

so easy to explain, but in the present case it is undoubtedly owing to an odor which the larva possesses. This odor is hardly appreciable, when the larvæ are in the open air; but by confining a few of them for a short time in a tight box, it soon becomes apparent, and is pungent and nauseous in the extreme even to our sense of smell, and it is doubtless more intensely so to the keener sense of birds and other animals.

Mr. A. R. Wallace believes that the gay colors of such larvæ are really protective, because if by more sombre colors they were undistinguishable from edible species, they would be seized by birds, and though rejected afterwards, would be so much injured that the probability of their producing butterflies would be very remote, even if they were not killed outright.

The same immunity is enjoyed by our Archippus butterfly in all its stages, and especially in the perfect state, in which the peculiar odor is still stronger, as I have abundantly proved.

The larva does not however enjoy entire immunity from parasites as has been hitherto supposed, for though after extensive experience I have never found any of the numerous Hymenopterous parasites attacking it, it is nevertheless often killed by a Dipterous Tachina-fly. I have never noticed any such parasite in the first brood of larvæ, but last year in the immediate vicinity of St. Louis, not one in fifty of the second brood escaped its fatal work; and this same parasite was by no means confined to one locality, as I received it from Mr. S. S. Rathvon, of Lancaster, Pa., who found the Archippus larvæ and chrysalids badly infested. The eggs of the Tachina-fly must be deposited for the most part while the larvæ are young, for specimens of larvæ taken at the first moult and confined in cages where no flies could get access to them, were frequently parasitised. These victimized larvæ usually succumb a day or two before they are full grown, though occasionally one succeeds in effecting the change to the chrysalis. They grow sickly and, hanging by the hind legs, become flaccid and discolored, while the parasitic maggots pierce the skin and fall to the ground, which they enter to transform. A silky liquid escapes from the breathing pores and from the holes made by these maggots, which, when dry, forms long white semi-elastic threads; and as the discolored larvæ hang by hundreds from the milkweeds, with these glistening filaments, one might at first imagine they had been smitten with some epidemic disease.

The Tachina maggot is not specially distinguishable from the many other larvæ of this kind which are known to infest the bodies of other insects, but the spiracles are encircled by a very distinct dark brown ring.*

* The larva of this Tachina-fly, after it enters the ground, contracts very rapidly to the pupa state, and if retained on a hard surface, one may watch with interest how, as the chitinous covering thickens and hardens, the dark head is vigorously kept at work underneath it, gnawing or abrading the thickening skin in a constant circle, so as to partially sever that portion which serves as a lid to be easily pushed open by the future fly. I have often wondered how this lid in so many

Our Tachina-flies generally very closely resemble each other, and very little attention has been paid to them in this country. The present species seems to be new to science, but I forbear to describe it for the simple reason that it varies so much in itself and so closely resembles many others, that it would be next to impossible to characterize it sufficiently. It may be provisionally known, for purposes of reference, as the Archippus Tachina-fly—*Tachina** *archippivora*. It may be at once distinguished from the two flies described in my second Report (p. 51), and which attack the true Army-worm, not only by the different form and smaller size, but by being of a paler gray, and by lacking the reddish or yellowish tail. The eyes are perfectly smooth. An interesting fact connected with this fly is that it likewise attacked the Fall Army-worm (as already mentioned on page 116, note,) which was so abundant at the same time of year. I have also bred it undescribed cut-worm.

The *Tachinariæ* can only be satisfactorily studied in connection with their habits, and even then they must prove a most difficult Division to work up. The species are very apt to grease in the cabinet and where they do not grease, the colors, especially of the face, lose their brilliancy. I am satisfied that the same species often attacks indifferently many widely distinct larvæ and that there are, in consequence, entomophagic varieties. I have a score of different lots, bred from as many distinct species of Lepidopterous and even Coleopterous larvæ; and the individuals of each lot, often bred from a solitary specimen of some particular species of larva, differ more among themselves than from individuals of some other lot, bred from a distinct species of larva. Indeed, unless there are striking characters, it would be folly for any but the specialist to attempt to describe them. These Tachina-flies, indeed, form such an extensive Division that in order to facilitate study, authors have inclined to erect genera upon characters most trivial and such as would certainly not be looked upon as of more than specific value in other groups. Sixteen specimens bred from *Danais archippus* vary from 0.18—0.30 inch in length and from 0.33—0.60 inch in expanse: some have a rufous spot on the side of the second abdominal joint, while others show no signs of any such spot. From among them two somewhat distinct forms occur in about equal numbers. In the one, which is on an average the largest, the abdomen is rather broader, and when dry shrinks so as to become flat, while the antennæ have the third joint from four to five times as long as the second. In the other the abdomen is rather narrower, remains more cylindrical when dry, and the antennæ have the third joint from five to six times as long as the second. These differences are, I believe, sufficient to cause the specialist to make distinct species or even genera; but as the same two forms occur in those bred from other species of larvæ, and as all the other

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coarctate pupæ was so regularly and smoothly opened by the nascent fly; but am now satisfied from observations made on this particular species, that it is previously prepared by the larva while contracting, in the manner described above. This will be more especially the case where the contracted skin is thick as in *Cuterebra*, *Œstrus*, etc., while in those where the skin is thin and delicate as in *Anthomyia* and many of the smaller *Muscidæ*, the habit probably does not obtain, as the fly can crowd itself out, and the opening is quite irregular, sometimes transverse, at others forming a simple longitudinal slit. I have witnessed the same wonderful forethought in the larva of *Chrysopa*, after spinning its small cocoon. In this case the sharp sickle-like jaws of the larva enable it to cut very finely and smoothly, and the edge of the severed parts show plainly, under the lens, a slight discoloration. The circle inscribed is often, but not always, slightly spiral so that when pushed open the lid hangs as on a hinge. The same habit no doubt prevails in the Lepidopterous genus *Limacodes* and its allies; for I have experimentally proved, by opening several cocoons of *Callochlora viridis*, Reakirt, both while the inmate was yet in the larva or pupa state, that the lid opens with the slightest pressure, and just as regularly as if pushed from within. There is, however, a marked difference in the working in these last two cases and that of our Dipterous larvæ. The former enclose themselves in cocoons, in which they have abundant room to turn round and partially cut their lid, while the Tachina larva performs the work on its own skin while it is hardening and before it has become separated from the transforming body within.

* I forwarded specimens of this fly to Dr. LeBaron, the State Entomologist of Illinois, who is better posted as to the minute generic differences between these flies, than any one else in the West, and he refers it to the genus *Masicera*, Macq., in speaking of which Macquart says: "they are the only *Tachinæ* which have the third joint of the antennæ very long without at the same time having the front very prominent." This and other minor genera of Macquart and Meigen have been discarded by some modern authors, such as Walker and Zetterstedt, and referred to *Tachina*.

details of structure, coloration, etc. are precisely similar, and as these differences themselves graduate, I cannot consider them specific. I have bred the same fly from larvæ of *Prodenia autumnalis* as stated above; also from larvæ of an undescribed Noctuan, closely resembling *Agrotis subgothica*, Haw. These specimens differ only in the rather smaller average size and more slender body, from specimens bred from several other distinct larvæ, and from the pupa of *Cynthia cardui*. It is also an interesting fact that the largest specimens of what appear to be but one species are those bred from the largest larvæ, as for instance that of *Citheronia regalis*.

THE BUTTERFLY OFTEN CONGREGATES IN IMMENSE SWARMS OR BEVIES.

Various butterflies have long been known in Europe, to swarm prodigiously at certain periods; but in this country no other butterfly congregates in such swarms as our Archippus, though the Painted Lady (*Cnythia cardui*), an insect found in all four quarters of the globe, and often seen in swarms in Europe, has been known also to swarm in Canada.

The Archippus butterfly appears in large bevies or flocks almost every year in some part or other of the West. In September, 1868, I received accounts of their sudden appearance in different parts of the city of Madison, Wisconsin, and at Manteno, Ills.; while on the 19th of that month Mr. P. B. Sibley of St. Joseph, Mo., sent me specimens with the statement that he saw millions of them filling the air to the height of three or four hundred feet, for several hours flying from north to south, and quite as numerous as the grasshoppers had been the year before.

In the spring of 1870 I received the following account of such a swarm from L. J. Stroop of Waxahachie, Ellis Co., Texas:

During my ramble this morning (March 31st) I happened upon a flock or bevy of butterflies known as *Danais archippus*, Fabr., containing thirty individuals, four of which I captured for the purpose of identification, only two of which, however, I pinned down. I find them to be of the genuine *archippus*, identical in every respect with specimens bred from the caterpillar by myself last summer, except in that of color, which is somewhat paler in these captured this morning than it was in those bred by me in the summer. They have the appearance of having been on the wing some days.

A little later the same spring similar swarms were noticed in different parts of Kansas, the most remarkable of which was one which occurred at Manhattan about the middle of April, and which, as I learn from Mr. Thos. Wells of that place, came rapidly with a strong wind from the N. W. and filled the atmosphere all around for more than an hour, sometimes so as to eclipse the light. Again, large flocks passed over the same place in a southerly direction, on the evening of the 27th and morning of the 28th September, while at Alton, Illinois, great numbers of them were seen passing in a S. W. direction on the last day of October of the same year.

It would be difficult to give any satisfactory reason for this assembling together of such immense swarms of butterflies. Insects otherwise solitary in their habits sometimes congregate thus for purposes of emigration; but this can hardly be the object of our butter-

fly bevies. They certainly do not travel very long distances or we should hear more numerous accounts of them. There are two significant facts connected with them from which some corollary might be deduced, namely, that only those species which have a very extended range are known to form such flocks, and that they always travel, under these conditions, in a southerly or south-westerly direction. Mr. Bates* gives an interesting account of the uninterrupted processions of butterflies belonging to the genus *Callidryas*, which passed from morning to night in a southerly direction across the Amazons; and as far as he could ascertain these migrating hordes were composed entirely of males.

If our Archippus flocks should turn out to be all males, this fact may lead to some solution of the cause of their congregating; but I incline to believe the flocks are composed of both sexes. Again, if the swarms occurred during the egg-depositing season, we might even then venture to solve the problem. For it is evident that a species which enjoys such immunity from predaceous animals and which is confined in its diet to a single family of plants, must occasionally multiply in particular districts beyond the capability of the plants to sustain them; and as most female butterflies instinctively refuse to deposit eggs on a plant that has already been abundantly supplied by some other individual, the females of our Archippus would naturally roam in vain for fresh plants when once the latter had all been stocked; and would thus congregate together, and, followed by the males, form migrating bevies. Or we might suppose that after the larvæ had eaten up all the milk-weeds in a district, the butterflies they produced, finding no plants upon which to lay their eggs, would be forced to migrate in swarms. But neither of these suppositions can have much weight from the fact that the swarms occur either late in the fall or early in spring; and the most plausible solution under the circumstances is that, as these are the seasons when the milk-weeds are either destroyed or have not yet started to grow, the butterflies, having nothing to confine their attention and keep them isolated, naturally congregate together, and that when in motion, the low temperature of the seasons instinctively prompts them to wend their way southwards. The probabilities are that these swarms are eventually destroyed, for no species can multiply beyond a certain limit, and when there is not check to increase in one direction, there will be in another. Of course this is as yet all theory and hypothesis, but hypotheses in such cases are necessary, for they are threads on which to string and combine the known parts of a case so as ultimately to arrive at the real truth in the matter.

* Naturalist on the River Amazons, I, p. 249.

THE DISIPPUS BUTTERFLY—*Limenitis disippus*, Godt.

(Lepidoptera, Nymphalidæ).

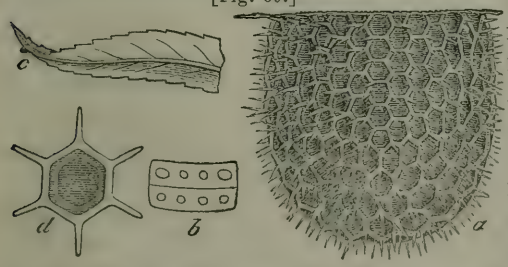
This is another butterfly (Fig. 68) which is well known in the Mississippi Valley. It belongs to a family which agrees with that to which the previous insect belongs, in the front pair of legs being more or less functionally impotent, but differs remarkably from it in the large cell in the centre of each wing never being closed externally by a distinct tubular vein, and in its being generally open towards the outer margin of the wing: also in lacking the small nervule at the base of the front wing, spoken of on page 143.

[Fig. 68.]

The food-plants of the Disippus butterfly are Willow, Poplar and Plum, and though not as numerous as the Archippus, it is yet tolerably common in the Mississippi Valley and occurs sparingly all over the United States and in the West Indies. As will be seen by referring to the figure*, though belonging to an entirely distinct family, it nevertheless bears a great general resemblance to the Archippus butterfly, and this resemblance is rendered more striking by the colors of the two insects being identically the same.

The natural history of this species is fully as interesting as that of the Archippus butterfly—if not more so. The egg which, so far as I am aware, has never before been described and figured, differs remarkably from that of the Archippus butterfly and is well represented at Figure 69, *a* showing it greatly magnified, *c* of the natural size and *d* giving a greatly magnified view of one of the cells with the filamentous processes from each angle of the hexagon. The color is at first pale yellow but soon becomes gray as the embryo within develops. It is usually deposited singly near the tip of the leaf, generally on the underside but often on the upper side; and I have exceptionally found as many as three together, and sometimes one on either side of the leaf, opposed to each other.

[Fig. 69.]

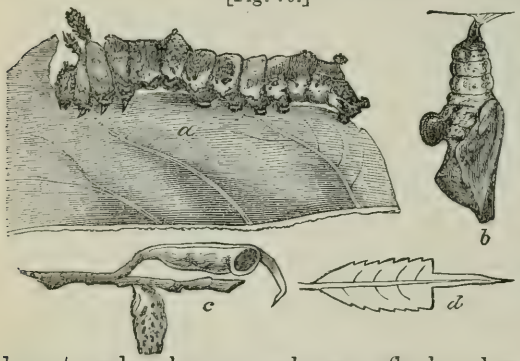


* In Figure 68, which represents the Disippus butterfly, the left wings represent the upper surface, and the right wings, which are detached from the body, represent the lower surface. The difference in the coloration of the two surfaces is but slight in this species, neither does it amount to much in the Archippus butterfly; but in some butterflies and in others belonging to the same genus, it is very considerable.

Description of the Egg.—Length 0.38 inch. Diameter at base about the same. Globular, with the top often slightly depressed. Hexagonally reticulate, the cells more or less regular, sunken so as to give the egg a thimble-like, pitted appearance, and about 10 of them in the longitudinal row and 30 in the circumference. Covered with translucent filamentous spines, one arising from every reticulate angle and giving the egg a pubescent appearance. Each spine about as long as the cell is wide, those on the top being longest.

The young larva differs materially from its more mature self, as will be seen from the description which follows. It grows apace, casting off its old coat and devouring the same three times during its growth, and eventually suspending itself by the hind legs and transforming to the chrysalis, frequently within a month from the time of hatching. The mature larva (Fig. 70, *a*) presents a roughened tubercled appearance and varies much in color, the predominan colors being moss-green, brown and creamy-white; the moss-green parts being studded with beautiful light blue points. The pupa Fig. 70, *b*) is marked with burnt umber brown, ash-gray, flesh-color and silvery white, and is characterized like that of the other species of the genus, by a curious thin almost circular projection which has been likened to a Roman nose, growing out of the middle of its back.

[Fig. 70.]



Description of mature Larva.—Length 1.20, diameter 0.25 inch. General color either whitish or olive-green. Body thickly granulated. Head dull olive, with dense minute prickles; its vertex bifid and terminating in a pair of prickly cylindrical horns, transversely arranged and each about 0.03 inch long. Back speckled and mottled with olive of different shades above the line of the spiracles, except joints 2 and 8 and the upper part of 7 and 9, but with a continuous pure white line below the spiracles, beneath which white line on joints 4–10 is a large olive patch extending on joints 6–9 to the external tip of the prolegs. A pair of black transversely-arranged dorsal dots in the suture behind joint 2, and a more or less obvious lateral one just above and behind the 5th and 7th pair of stigmata surmounting the lateral white line. Joints 3–7 and 9–11 with more or less, shining, elevated, blue dots. On joint 2 a pair of prickly cylindrical black horns, transversely arranged and 0.16 inch long. On joints 3, 10 and 11 a pair of large dorsal tubercles transversely arranged, each crowned by a little bunch of 8–12 robust prickles. On joint 5 a pair of similar tubercles, but still larger, of a yellowish color, and mamma-like. On joints 4, 6, 7 and 9 tubercles similar to those on joints 3, 10 and 11, but smaller. On joint 12 four black prickly dorsal horns, quadrangularly arranged and each about 0.03 inch long. Stigmata and legs blackish.

Described from many specimens. Such are the prominent and more constant traits of this larva, but it is so variable in the general depth of coloring and in the proportion of the lighter and darker shades that it is next to impossible to frame a description which shall alike agree with half a dozen specimens.

The newly hatched larva presents a quite different appearance. It is 0.09 inch long with a yellowish-brown head twice as large as the first joint and distinctly bilobed. The first joint is also larger than the others. Each joint is divided by a transverse impressed line, and upon the dorsum of each fold thus made are 4 pale elevated spots, the anterior outer ones larger than the rest, as shown at Fig. 69, *b*, especially on joints 2, 3, 5 and 11 where they appear conical with a darker annulation at base. There is a subdorsal and a sub-stigmatal row of similar rounded warts, and they all give rise to little pale bristles or spines. The general color is pale yellowish-brown, mottled with dark streaks, especially below the stigmata. The second period scarcely differs from the first

except in the somewhat greater length of the horns. In the third period the horns acquire their mature proportions, and the whole larva becomes more granulated. In the fourth or last the blue points appear and the lateral rows of tubercles lose their conspicuousness to a great extent.

ITS WINTER QUARTERS.

One of the most interesting features in the life-history of our Disippus butterfly is its mode of hibernating. A great many moth larvæ pass the winter in the larva state sheltered in one way or another; but no other American butterfly has hitherto been recorded as hibernating in this state, except the closely related Ursula butterfly,* though no doubt the few other species belonging to the same genus possess a similar habit. Misled, perhaps, by the fact that the butterfly is seen flying about so early in the spring that it could not have had sufficient time to hatch out from the egg and acquire its full larval growth the same season, and with its wings so bright and unworn that it could not have hibernated as a butterfly as some other closely allied species are known to do; Dr. Harris, in his work on Injurious Insects (p. 282) asserts that it hibernates in the pupa state, though he subsequently, in the year 1850, became aware of the facts in the case.†

In reality the larvæ of the autumnal brood, when about one-fourth or one-third grown, build for themselves curious little houses (Fig. 70, *c*), in which they pass the winter. First and foremost—with wise forethought, and being well aware through its natural instincts, that the leaf which it has selected for its house will fall to the ground when the cold weather sets in, unless it takes measures to prevent this—the larva fastens the stem of the leaf with silken cables securely to the twig from which it grows. It then gnaws off the blade of the leaf at its tip end, leaving little else but the mid-rib, as shown in Figure 70, *d*. Finally, it rolls the remaining part of the blade of the leaf into a cylinder, sewing the edges together with silk.‡ The basal portion of the cylinder is of course tapered to a point, as the edges of the leaf are merely drawn together, not overlapped; and invariably the lower side of the leaf forms the outside of the house, so as to have its projecting mid-rib out of the way of the larva, as it reposes snugly in the inside. The whole when finished (Fig. 70, *c*) has somewhat the appearance of the leaf of a miniature pitcher-plant (*Sarracenia*), its length being 0.50–0.65 inch, and its diameter 0.11–0.14 inch.

*There is good reason to believe, however, that some of those butterfly larvæ which habitually protect themselves by a sort of loose cocoon, made by drawing together or rolling up the leaves of their food-plant; likewise pass the winter in the larval state. At least I have known an oak-feeding larva of *Nisoniades juvenalis*, Sm. and Abb., kept by a lady friend of mine, to remain in the larva state nearly all winter before transforming to the chrysalis. But there is not strict analogy between such a case and that of the hibernation of the immature *Disippus*.

† *Harris Correspondence*, p. 245.

‡ In the article in the *Am. Entomologist*—which was the greater part of it written by Mr. Walsh, with my own facts and experience inserted here and there—it is stated that the "gnawed portion of the leaf forming the flap, is bent down and fastened by silken cords, so as to act as a door to the house." After fuller experience, I find that this is very seldom the case, but that the orifice is more often left open.

These curious little cases may be commonly found upon our willows or poplars in the winter time. I have examined hundreds of them, and although they are invariably built upon the same plan, they vary greatly in the degree of perfection which the architect attained; and this is especially the case when they have been built in confinement. The blade on the tip piece is sometimes gnawed off right down to the rib; at others it is left almost as broad as the tube. Sometimes it is bent over the orifice; at others not. They are also much more irregular and ungainly when made from broad leaves such as those of the Silver poplar, than when made from the more narrow leaves of the Willow. These autumnal larvæ have also another peculiar habit not heretofore recorded, and which was first pointed out to me by Mr. J. A. Lintner, of Albany, N. Y. They exhibit a tendency to build from the time they are born, and will always eat the leaves from the side, gnawing large holes and cutting along the sides of the mid-rib, as at Fgure 71, *a*. They commence at the tip and as they work downwards towards the base, they collect the debris into a little bunch, which they fasten with silk to the mid-rib. When the hibernaculum is finished the seam is perfectly smooth and the whole inside is lined with silk. The larva, after completing its work, composes itself for the winter, with the tail towards the orifice. Here it remains till the catkins are in bloom the next spring, when it retreats from its house and commences feeding. Not the least wonderful part of the phenomenon is, that it is only the autumnal brood of larvæ that form pitcher-like houses to live in during the inclement season of the year, the summer brood having no occasion to shelter themselves from the cold. We thus have an instance of a curious architectural instinct being only developed in alternate generations; which is much the same thing as if, with a certain race of men, the great-grandfathers, the fathers and the grandchildren ran wild in the woods, and the grandfathers, the sons and the great-grandchildren lived in houses and led the life of civilized human beings.

[Fig. 71.]

When we duly consider this peculiarity in our Disippus larva, we may well pause and ask—

> What wondrous power enables it so well,
> The coming cold of winter to foretell,
> And to provide for its long torpid rest,
> A house, from means at hand, the very best?

We can but admire the beautiful adaptation of means to an end —no matter how we choose to explain it! There can be little doubt but that many of the phenomena in animal life which we so summarily dispose of by the ready use of that rather blind term "instinct,"

might be explained in a more natural way. The term is justly applied to those actions which are prompted by exterior influences or peculiarity of organization, and which are performed unconsciously; but by its too general application, most people have acquired a deep-set idea that all animals act under its power, and have nothing akin to our reason; whereas there is hardly anything more certain than that true reason of degree exists very generally in the animal kingdom; or that what we know as pure instinct may have been developed by natural law, *i. e.*, first acquired by experience and afterwards fixed as a habit by heredity.

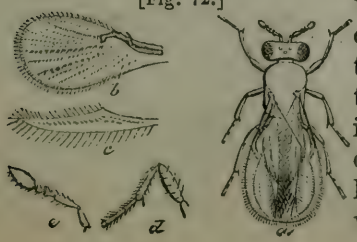
The subtle influences of the late fall which seem to convey through every pulse of nature, intelligence of the approaching winter, and which cause all animals to prepare for their hyperborean sleep, no doubt originally induced the young larva of the ancestral type from which our Disippus and the other species of the genus sprung, to prepare for itself some shelter. The gradually increasing cold and the decrease of nourishment in the leaf, would act as physical prompters, and the pitcher-like house, which at first strikes us as so remarkable, is the simplest structure that could be made with the materials at command. The characteristic smoothness of its food-plant—forbidding as it does the shelter under loose bark which many larvæ seek—would also tend to develop such a trait. That this trait —this instinct—should only be developed under similar conditions to those which gave birth to it, is not so remarkable; and that it does only so develop, seems certain, for I have every reason to believe that while the insect is two-brooded further north, it is sometimes three-brooded with us, and consequently that this peculiar instinct obtains either in the second or third generation, according to circumstances.

ITS PARASITES.

Though not generally known to entomologists, our Disippus butterfly is very subject to the attacks of parasites, at least three distinct species infesting it in the preparatory states. One of these is a *Tachina*-fly, of which I have often noticed the eggs fastened transversely on the back of the neck of the larva, but of which I have not obtained the fly. In all probability it does not destroy the larva till the latter is nearly full grown. The other two I will briefly describe as no mention has heretofore been made of them.

THE DISIPPUS EGG-PARASITE.—The eggs already described were very abundant last fall on a certain clump of willows near Kirkwood, and of about two hundred obtained, fully one-half of them were parasitised. Instead of hatching out into larvæ, as they would have done if they had been unmolested, these last produced little dark colored four-winged flies, from four to six of which

[Fig. 72.]



would gnaw their way through the shell of each egg. This little fly belongs to the great *Chalcis* family, and though scarcely more than 0.02 inch long, it can jump to the distance of several inches. Its wings, especially the hind ones, are beautifully fringed with hairs. It is inconspicuously marked, the body being dark brown with the antennæ and legs pale, and the wings iridescent. The highly magnified outlines at Figure 72 will convey a good idea of its appearance, *a* showing the fly with wings folded on the back, *b* one of the front wings, *c* one of the hind wings, *d* one of the legs, and *e* one of the antennæ.

I shall leave the proper determination of this insect to those who pay more particular attention to the CHALCIDIDÆ. It comes nearest the genus *Trichogramma*, Westw., and may be provisionally called *Trichogramma* (?) *minuta*. It differs from that genus and from all other Chalcididan genera with which I am acquainted, in the antennæ being but 5-jointed (scape, plus 4 joints), the scape stout and as long, or longer, than joints 2, 3 and 4 together; joints 3 and 4 small and together as long as joint 2; 5 very stout, fusiform and as long as 2, 3 and 4 together. The legs have the trochanters stout and long, the tibiæ not quite so long nor so stout as the femora, and with a long tooth; the tarsi are 3-jointed, with the joints of equal length and with the claws and pulvilli sub-obsolete. The abdomen is apparently 6-jointed, the basal joint wide, the 2nd narrower, 2—5 increasing in width till 5 is as wide as 1. The ovipositor of ♀ extends a little beyond the apex, and starts from the anterior edge of the 5th joint.

THE DISIPPUS MICROGASTER.—The third parasite which also very commonly infests the last brood of larvæ, and kills its victim during the second period, is a little black four-winged fly belonging to the genus *Microgaster*. The parasitic maggot eats its way out just before the Disippus larva gets ready to build its winter tenement, and spins a pale yellowish cocoon of silk, either upon the back of its victim or upon the leaf close by; and from this cocoon the fly soon afterwards issues. Figure 73, which represents the Army-worm *Microgaster* enlarged, will convey a good idea of its Disippus relative.

[Fig. 73.]

The genus *Microgaster* is a very extensive one, and the species have not yet been well studied in this country. They are all of small size, and in many instances resemble each other so closely that they can only be satisfactorily studied in connection with their habits and the particular larvæ which they infest. Some appear to confine their attacks to one particular kind of caterpillar, while others infest alike many different species. Thus the one under consideration not only infests the Disippus larva, but I have also bred it from that of the Golden-rod Gall-moth (*Gelechia gallæsolidaginis*, Riley) obtained from Canada; which indicates it to be a widely distributed species.

MICROGASTER LIMENITIDOS, N. Sp.—♂ ♀. Length 0.09 inch. Color pitchy-black. Antennæ black, about as long as body; palpi whitish. *Thorax* minutely punctured. *Abdomen* with the two or three basal joints emarginate and rugose, the terminal joints smooth and polished. *Legs* dusky; front and middle femora yellowish, hind femora black; front and middle tibiæ yellowish, hind tibiæ with terminal half dusky, but the spur pale; front and middle tarsi yellowish tipped with dusky, hind tarsi dusky above, paler below. *Wings* hyaline, iridescent, the nervures and stigma black or dark-brown, the radial nervule, the cubital nervules and the exterior nervule of the [illegible]coidal cell, sub-obsolete.

Described from 6 ♀, 1 ♂, bred from larvæ of *Limenitis disippus*, 3 ♀ bred from larvæ of *Gelechia gallæsolidaginis*. In the latter the nervures of wings are paler and less distinct than in the former. Most of our N. A. species of this genus have been described by Mr. Cresson who has seen this and considers it new. It certainly differs from the other described species.

MIMICRY AS ILLUSTRATED BY THESE TWO BUTTERFLIES, WITH SOME REMARKS ON THE THEORY OF NATURAL SELECTION.

The means by which animals are enabled to escape from their enemies and obtain their food, or in other words to sustain themselves in the great struggle for existence that is continually going on between each species, are as varied as they are wonderful. There is generally a conformity of tint between all animals and their surrounding, and in the higher classes Mr. A. R. Wallace has shown* that in general terms it may be stated that desert animals are desert colored, arctic animals white, and nocturnal animals gray, *i. e.*, of such colors as best to accord with the surroundings. Animals, birds, fishes and reptiles come under this rule to a great extent, and the reader will be amply rewarded by perusing the details given in the valuable and interesting work referred to. But in no Class of animals does this principle of adaptation to environment occur so generally and in such a striking manner as in insects. With them mimicry and other protective resemblances are almost universal, and it may be given as a rule that all insects living above ground, when not naturally protected by odor, luminosity or defensive covering such as hairs, spines, hard shelly wings, etc., or by armor such as stings, beaks, etc., either cover themselves with one substance or another, or similate their surroundings, or mimic either other animals, plants, or even inorganic substances. With insects in their larval states, will this rule especially hold good.

What entomologist has not been deceived by the close resemblance of the beetles belonging to the genus *Chlamys* to the dung of caterpillars; or is not familiar with the quaint and close resemblance of the Walking-sticks and Walking-leaves to the objects from which they take their names? Chapter after chapter might be written on these wonderful imitations which deceive the best trained eyes; and there are many most striking instances among our American insects which have never yet been published and which I hope some day to illustrate. But my present purpose is simply to draw attention to the illustration afforded by the two butterflies which we have been considering.

These striking resemblances were formerly looked upon, for the most part, as curious analogies in nature, intended to carry out the

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*Contributions to the Theory of Natural Selection.

general plan of the Creator; but viewed in the light of modern science, and especially by that of the Darwinian development hypothesis, they have acquired an immense significance. One of the most interesting phases of this mimicry, and one which has only within the last few years been brought to light, is the imitation by an otherwise defenseless butterfly, of one whose great numbers and wide distribution indicate that it enjoys peculiar advantages. This specific imitation of one butterfly by another is precisely of the same nature as the mimicking of a vegetable or inorganic substance, and may consequently be just as properly termed mimicry. Some authors seem to make a distinction between this so-called mimicry and what is known as "protective resemblance," while others again misconceive the true import of the word "mimicry" as used in this connection. Thus, Maj. J. R. Muhleman in an essay on "Mimicry in Insects," read before the Central Illinois Horticultural Society this winter, gave the word so broad an interpretation as to apply it to the possum-playing of some insects, and even to the supposed and far-fetched resemblances such as that of the female Canker-worm to a plant-louse, and of the female Bag-worm to a Dipterous maggot. True mimicry can only occur where it is of benefit to the species, no matter whether the benefit be derived by enabling harmless species to avoid their enemies in one way or another; or by enabling predaceous species to deceive their prey by assimilating the form and colors of the latter.

As already stated, the particular group to which our Archippus butterfly belongs is a large one, and the species comprising it are very numerous. They are especially abundant in South America, and like our own species, they all possess a pungent odor which seems to pervade all the juices of their system. So much is this the case that according to Mr. Wallace,* when an entomologist "squeezes the breast of one of them between his fingers to kill it, a yellow liquid exudes which stains the skin, and the smell of which can only be got rid of by time and repeated washings." The wings of these butterfiies, as may be seen by referring to Figure 63, are rather longer than usual, but their flight is comparatively slow, and they do not dodge and zig-zag about with sudden skips and jerks as the "Skippers," (HESPERIDÆ,) are known to do. They furthermore possess no adaptive coloring to protect them during repose, for they take no pains to hide themselves, and their colors are bright, and those of the underside as conspicuous as those of the upper.

Hence we cannot assume that they are enabled, by their peculiar mode of flying, to escape to a great extent those cannibal animals that would otherwise catch and devour them; and if we propose to account for their prodigious abundance at all, we are driven to have recourse to some other hypothesis. Indeed, so far is it from being the case that it is their mode of flight which enables them to

*Contributions, etc., p. 78.

escape from their cannibal foes, that Mr. H. W. Bates, the English naturalist, who spent eleven years in the Valley of the Amazon River, studying the natural history of the insects of that region, where this particular group of butterflies is very copiously represented, declares that he never saw a single one of them attacked by any cannibal foe whatever, whether bird, or Dragon-fly, or lizard, or *Asilus*-fly.

It is therefore reasonable to assume that their peculiar odor renders them unpalatable to animals of prey. We have seen that the Archippus butterfly enjoys an almost perfect immunity from the attacks of predaceous animals, consequent, in all probability, upon this peculiar odor which attaches to it both in the larval and perfect states. In this case the supposition is even strengthened by the fact that the only parasite known to attack it is a *Tachina*-fly, belonging to a family which is notoriously defiant of strong odors, the larvæ often rioting in filth and the flies many of them known to be especially attracted to such odors.

Now there is another large group of butterflies, known as the *Pieris* family, to which the white cabbage butterflies belong, which were mentioned in my last Report (pp. 104–110.) This group differs widely in structure from the *Danais* group, and is represented by many species in the Valley of the Amazons; but instead of the species being exceedingly abundant in individuals, as in the case of those belonging to the *Danais* family, it is quite the contrary; the proportion between the number of individuals belonging respectively to two of the commonest genera of either group (*Leptalis* and *Ithomia*) being only 1 to 1000. Hence, it is reasonable to infer that this group must be much persecuted by cannibal foes, and such has been found to be the case.*

The colors found in the species of the *Danais* family are red, yellow, orange, white and black; while only the last two colors obtain in the *Pieris* family, the white being sometimes tinged with greenish yellow. So far so good. We see flitting about in the great Valley of the Amazons, vast swarms of long winged butterflies, gorgeously dressed in red, orange, yellow, white and black; and certain short-winged butterflies, in very much smaller numbers, whose proper livery is but the plain black and white that befits a funeral. We see the former enjoy an entire immunity from the attacks of all predaceous animals, and the latter snapped up by every hungry bird, Dragon-fly or *Asilus*-fly that happens to come across them. Will it be believed, now, that there are certain particular species of the homely, much persecuted, short-winged group, that assume the livery worn by certain particular species of their gaily dressed compatriots, and actually even copy their elongated wings? Yet such is the indubitable fact. In the Memoir of Mr. Bates, already referred to, will be found

*These facts were first brought to light about nine years ago, by Mr. Bates, in a most interesting and valuable Memoir, published in the Transactions of the Linnæan Society, (Vol. XXIII, p. 495.)

beautiful colored figures, in the highest style of art, both of the species that mimic and of those that are mimicked; and no one that looks at those figures with an unprejudiced eye can believe for a moment that the resemblance is merely accidental.

Even the practiced eye of the entomologist is sometimes deceived by these close resemblances, and to illustrate, I cannot do better than to quote Mr. Bates's own language:

These imitative resemblances, of which hundreds of instances could be cited, are full of interest, and fill us with the greater astonishment the closer we investigate them; for some show a minute and palpably intentional likeness which is perfectly staggering. I have found that those features of the portrait are most attended to by nature, which produce the most effective deception when the insects are seen in nature. The faithfulness of the resemblance, in many cases, is not so striking when they are seen in the cabinet. Although I had daily practice in insect-collecting for many years, and was always on my guard, I was constantly deceived by them when in the woods. (p. 507).

Mr. Bates accounts for these singular cases of mimicry by supposing that, ages and ages ago, certain individuals of this plainly-dressed and much-persecuted *Pieris* family happened to vary slightly so as to resemble slightly some species or other belonging to the gaily-dressed and unpalatable *Danais* family; that, in consequence of this slight resemblance, they were sometimes mistaken for their more fortunate compatriots by cannibal animals, which would otherwise have preyed upon them forthwith; and consequently that they survived long enough to propagate their species, while almost all the individuals that had not varied in this particular manner perished prematurely by a violent death. Now, we know that, in the language of breeders and stock-raisers, "like produces like," which is what naturalists express by the well-known term of the "Law of Inheritance." Hence the descendents of this primordial race of imitative butterflies would naturally, most of them, vary in the same manner as did their ancestors from the normal type; and some of them would probably vary in a still more marked manner and in the same direction. These last individuals, as they would bear a still closer resemblance to the unpalatable butterflies, would of course stand a still better chance of surviving and propagating their species, in the course of that great Struggle for Existence, which we see going on all around us, not only among the inferior animals, but among the human species itself. By the perpetual repetition of this process, during indefinite ages, that perfect imitation of the imitated butterfly would at length be formed, which at first view appears so utterly inexplicable. And when it had once been formed, the very same process that originally formed it would afterwards keep it up to the standard of perfection. For all individuals, that varied in a backward direction towards the primordial type, would be more liable than the rest to be devoured in early life by cannibals, and would therefore be less likely than the rest to propagate their own image in succeeding generations. The whole pro-

cess, indeed, is so beautifully simple and intelligible, that, but for certain prepossessions and prejudices, it would at once command the assent of every logical mind. In fact, it is strictly analogous to the common operation of "rogueing" a bed of seedlings, which every gardener is familiar with. The only difference is that, when the gardener pulls up what he calls the "rogues" out of a thousand seedling tulips, *i. e.*, those which deviate from the standard of perfection which he is aiming to attain, he acts with the definite object of preventing the further propagation of those so-called "rogues;" whereas, when cannibal animals destroy the "rogues" among the imitative butterflies, they are of course perfectly ignorant of the consequences likely to follow, and act wholly and solely for the gratification of their own carnal appetites. In short, the whole phenomenon is explained on the theory of Natural Selection as expounded by Darwin.

Since the publication of Mr. Bates's paper, a great many additional cases of similar mimicry among butterflies have been observed by Mr. Wallace* in the Malayan region of South America, and by Mr. Trimen in South Africa.† But though most of these wonderful cases of mimicry occur in the tropics, where insect development is so rapid and species are so abundant, we also have a striking instance of similar mimicry in our two N. A. butterflies, *Archippus* and *Disippus*. The resemblance between them must long ago have been noticed, for it is so servile that Prof. Jaeger in his *Life of North American Insects*, has actually favored his readers with a figure of the Disippus and gravely informs them that it is the Archippus butterfly. Indeed it is far more striking than my figures would indicate, and in a state of nature the two insects could hardly be distinguished at a short distance by the sharpest eyes. The fact that these two species offer an illustration of similar mimicry to that observed so frequently in the tropics, was first made clear by Mr. Walsh and myself in the *American Entomologist* for June, 1869; and the facts which have since come to my knowledge all tend to confirm the opinion.

The only other species belonging to the same genus as our Disippus butterfly, which occurs in the Mississippi Valley, is the Ursula butterfly‡ (*Limenitis ursula*, Fabr.), an insect which differs remarkably from our Disippus in being of a sombre blue-black color, with its wings bordered both above and below with blue, and below with a series of dull orange spots inside the blue border. Its larva feeds on Willow, Scrub-oak, Whortleberry, Cherry and Plum, and as already stated, has the same habits as that of Disippus, which it resembles so closely as scarcely to be distinguishable. The pupæ of the two species are also undistinguishable.

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* See the Chapter on Mimicry among Lepidoptera in his Contributions, etc.

† See his paper on "Mimetic Analogies among African Butterflies," in the Transactions of the Linnæan Society for 1868.

‡ There are seven described species of N. A. *Limenitis*, but with the exception of the two above named they are all confined to the more eastern or western portions of the Continent.

If this Ursula butterfly were placed side by side with the Archippus butterfly, everybody would say at once that no two species could possibly be more unlike in the general style of their coloration. Clearly, therefore, it cannot be considered as in any wise mimicking the latter. Now, the Ursula butterfly is found everywhere throughout the Northern States wherever the Disippus butterfly is met with, and yet, while the latter is a common and abundant species, the former is quite rare. This is certainly the case in the Mississippi Valley, and will, according to my own experience, and that of others* very generally hold true all over the country.

To what are we to attribute this fact? It can scarcely be owing to structural differences in the external organization of the two species; for the two belong to one and the same genus. It surely cannot be because the larvæ of the former are more exposed to the attacks of predaceous animals than those of the latter; for they inhabit the same, or very nearly the same trees, and in size, shape and general coloration the two are almost exactly alike. Certainly it can not be because the pupæ of one species are more subject to be devoured by birds, insects, etc., than those of the other species; for it is impossible to tell one pupa from another when placed side by side. The only cause to which we can reasonably attribute the great abundance of the Disippus butterfly and the comparative rarity of the Ursula butterfly is, that the former mimicks the Archippus butterfly, as has been shown above, and is consequently often mistaken by birds, tree-frogs, Dragon-flies, *Asilus*-flies and other beasts of prey for its unsavory prototype and allowed to escape with impunity, while the latter, having no such disguise, is ruthlessly devoured by every insect-eating animal that can get hold of it.

All the facts lead to such a conclusion. The mimicked species enjoys an almost perfect immunity from the attacks of enemies in all its stages, while the mimicker is persecuted by several. The mimicker is often found in company with the mimicked, as I have myself, and as others have witnessed.† But what is still more conclusive is the fact observed by Mr. S. H. Scudder‡ that in the extreme Southern States where the Disippus butterfly occurs, and Archippus is replaced

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* According to Mr. J. A. Lintner, *Ursula* is "rare" and *Disippus* is found abundantly in New York. (*Proc. Ent. Soc. Phil.*, III., pp. 63-4.) According to Mr. J. Kirkpatrick *Ursula* is "rather rare" and *Disippus* "common in the fall" in Ohio. (*Ibid.*, p. 329.) According to Mr. Sam H. Scudder, *Ursula* is "rather rare" and *Disippus* is "common" in New England. (*Proc. Essex Inst.*, III., p. 165.) According to Mr. Billings, who does not seem to have met with any *Ursula* at all, *Disippus* is "very common from July to October" in Canada West. (*Canad. Entom.*, I., p. 45.) There appear to be some exceptions to this rule, however, for Mr. Thos. W Higginson, of Newport, R. I., declares (*Am. Entomologist*, II., p. 177.) that *Ursula* is one of the commonest of the large butterflies there and decidedly more so than *Disippus*. I was also informed while at Troy last fall, that the former outnumbered the latter in the vicinity of New York City in the year 1868, though the previous years it had been quite rare. These exceptions to the rule may be owing to one cause or another, but I shall attempt to explain them when I come to consider the objections to the theory which I espouse.

† Mrs. Mary Treat, of Vineland, N. J., writes that *Archippus* was unusually abundant there last fall, and that she found *Disippus* in company with it.

‡ *Nature*, Vol. III, p. 147.

by the Berenice butterfly—a species of the same genus and of similar appearance but of darker color—the color of the mimetic Disippus deepens nearly or quite to the tint of the Southern *Danais*. Thus it is that facts before unintelligible are explained by Darwinism!

In a discussion on the difficulties of Natural Selection, which took place in late numbers of the London journal *Nature*, some ingenious objections have been urged. As many of them have especial reference to the mimicry we have been noticing, a brief summary of these objections will prove interesting in this connection, the more especially as all objections must in the end only serve to strengthen a theory, if that theory is sound.

Mr. Alfred W. Bennett* undertakes to show upon mathematical considerations, that Natural Selection could not produce these mimetic forms. He assumes that it would take 1000 steps to enable the normal form of a *Leptalis* for instance, to pass into the protective form of an *Ithomia*; that no change less than one-fiftieth of the whole alteration—*i. e.* 20 steps—would be of any use to the insect, and that the alterations in the early stages, being useless to the animal, would not be preserved, and even if they were, could not be attributed to Natural Selection, but to an accumulation of chances. He reiterates what has already been well shown and acknowledged by Darwinians, namely, that Natural Selection cannot produce the first change, and asks with good reason why the same principle that works the first change should not also work the subsequent changes? He does not dispute the secondary power of Natural Selection, but believes in an unconscious organizing intelligence which co-operates with it to produce the mimetic results. He endeavors to strengthen his position by showing that there is a close connection between instinct and mimicry, and ventures the theory that "the power of mimetism, so far as is known at present, runs almost *pari passu* with the development of the nervous system."

The essay is an able and interesting one, and the arguments are skillful and ingenious. It pays due and just respect to Darwinism and forcibly presents the fact, which no one has denied, that some other power than natural selection acts in producing first change The mathematical argument, however, will have little weight with those who fully appreciate the changes in Lepidoptera that take place in nature. No entomologist who has had any experience in rearing Lepidoptera will admit with Mr. Bennett that 1000 steps are necessary to produce mimetic resemblance, and when this foundation stone of his objection is taken away, much of his other reasoning which is built upon it becomes weak. Instances of great and sudden variation among butterflies and more particularly among moths are by

* *Nature*, Vol. III, pp. 30-33.

no means rare. In this Report instances of great variation in species have been given, and hundreds of others might be cited.*

Mr. Bennett furthermore, as Mr. Wallace subsequently pointed out,† fails to take into consideration the fact that each butterfly produces not only one, but numerous offspring, that the right variation has, by the hypothesis which he combats, a greater chance of surviving than the rest, and that at each succeeding generation, the influence of heredity becomes more and more powerful, causing the chance of the right variation to become greater and greater. He also appears to forget that this imitation in butterflies is of comparatively rare occurrence, and that the mimickers generally belong to genera which naturally show a tendency to depart from the normal coloring of their own family and to approach that of the mimicked, so that the first steps are greatly facilitated. I consider therefore that the mathematical objection utterly falls to the ground; but that there is something in the closing ideas which Mr. Bennett throws out, which may yet lead to important discoveries, I can very well conceive. Indeed it must be rash to deny some such influence as he describes when we reflect upon the extraordinary power which the mind of the mother exerts, during pregnancy, on her offspring; and when we further consider that Mr. Wallace himself admits that man's present mental and physical condition could not have been brought about by natural selection alone. It must be obvious to every one, however, that such an admission is no argument against the theory of Natural Selection. All other modifying influences though they may lessen her potency simply assist her in her grand work.

The next objector we find in Mr. Saml. H. Scudder of Boston, Mass.,‡ who, while admitting that there can be no possible doubt of the fact of mimicry, questions its advantage among butterflies, since the greatest destruction occurs in their preparatory states. But as he refers especially to the two butterflies we have been treating of and as from the context it appears that he is also aware of the existence of some of the parasites which I have described, I will quote the greater portion of his letter which was written from Cairo, Egypt, under date of November 9th, 1870; and, will afterwards reply to his objections:

"But of how much actual benefit to the mimetic species is this so-called "protective" resemblance? It seems to occur where it can be of the least possible advantage to the species. The great sources of destruction here, as in all groups of animals, are in early life. How large a proportion of the eggs that are laid by butterflies ever finally produce imagines? Let those answer who have attempted to follow their history in their native haunts. My experience leads me to believe that at the very least, nine-tenths—perhaps ninety-nine hundredths—never reach maturity. Hymenop-

*A most remarkable case came under my notice the past summer. From a single batch of flattened and ribbed eggs, overlapping each other under a piece of Hickory bark, I succeeded in raising eighteen imagines of *Catocala phalangea*, Guen. The upper wings vary greatly in the individuals, and in one specimen the ground-color and markings are so very aberrant, that there is more difference between it and some of the others belonging to the same batch, than there is between the latter and a dozen distinct species.

†*Nature*, III, p. 49.

‡*Ibid*, Vol. III, p. 147.

terous and Dipterous parasites beset them at every step. The eggs, although so small and often so heavily ridged, cannot escape the ovipositors of the tiny Pteromali, while in attempting to breed caterpillars taken in the field, the chance is so greatly against the evolution of a butterfly, that Hymenopterists actually choose this method of supplying their cabinets. 'Of two hundred larvæ of *Pieris brassicæ*,' Mr. Drewsen, of Denmark, writes to me, 'I obtained only twenty pupæ, all the rest were attacked by *Microgaster glomeratus*, and my own attempts with the larvæ of *Pyrameis Atalanta*, both in America and Europe, have been even more unavailing. These caterpillars seem to be peripatetic banqueting halls of Microgasters and Tachinæ.

"Now it is a curious fact that while the globular egg of *Limenitis Misippus*,* with its deeply-pitted shell, defended by long filamentous spines, is constantly attacked by parasites; and the grotesque hump-backed, strangely-colored caterpillar of the same species is likewise infested to an extraordinary degree, I have been unable to discover by very careful search any evidence that the egg or larva of *Danais Archippus* is ever pierced by a parasite; yet the egg is not small and only lightly ribbed, and the caterpillar large, fleshy, smooth-skinned, and gaily banded, living on the widely-separated leaves of Asclepias, with no attempt at concealment. The abundance of the imago of the Danais is then due quite as much to the immunity of the egg and larva from the attacks of parasites, as to any freedom it may itself enjoy from pursuit by insectivorous birds. [1.]

"Although I have hunted butterflies for fifteen years, I confess I have never seen one in a bird's bill, and my faith in that method of lessening their numbers is very slight. Birds, too, must be their greater foes in earlier life; and the chances of living, which are certainly against them before they take wing, seem afterwards rather in their favour, at least, until they have accomplished their mission. [2.]

"If, then, such an extraordinary element as Mimicry is to be summoned to the aid of Natural Selection, and can perform its task in such a masterly manner, why has it been made to waste its energies upon unimportant material? If the object of the resemblance be protection, why does not the unfortunate caterpillar of the Limenitis mimic the more favoured larva of the Danais? [3.]

"I cannot now consult the writings of Messrs. Wallace and Bates, nor do I remember their statements respecting the abundance of the mimetic species compared to that of its normal congeners. In my own country *Limenitis Misippus* is, as a general rule, more common than *L. Ursula*, but the difference in their numbers is not very marked. It is by no means as great as one would expect had Mimicry in the imago state so strong a protective power as has been assumed. [4.] Two closely allied species occupying the same geographical area, do not often occur in the same abundance, whatever be the cause, and the disparity in numbers in these two species of Limenitis is no greate than occurs in many instances where mimicry plays no part. [5.]"

[1.] No one will deny the facts, after what I have already set forth.

[2.] Such an experience from a butterfly hunter surprises me Individually I have on several occasions seen butterflies captured by birds, and have seen Dragon-flies dart after them. Any amount of evidence might be collected on this head, and Mr. Scudder has already been answered by Mr. Arthur G. Butler† of the British Museum, who mentions often having seen birds catch and devour the unprotected species upon the wing, while he has received abundant evidence respecting the immunity of the *Danais* group. "T. G. B." of St Johns College, Cambridge, has also often seen the common English sparrow capture *Vanessa urticæ* and *Pieris rapæ*‡; while Mr. Wallace has shown that great numbers of butterflies are destroyed on the wing by insectivorous birds such as jacamars, trogons and puff-birds, and gives conclusive evidence that while our Disippus congeners, the *Nymphalidæ*, suffer such persecution, the Archippus congeners do not.§ Thus, though there

*The reader must bear in mind that *Misippus* is but a synonym for *Disippus*.

† *Nature* III, p. 165.

‡ *Ibid*, p. 166.

§ Contributions, etc., p. 79.

seems to be no record of any person having actually seen a bird or other animal attack the species of *Limenitis* in this country, there is every reason to believe that they will do so. This fact once being admitted, it must also be admitted that the resemblance of *Disippus* to *Archippus* serves the former as a protection. I freely grant however, that the species of *Limenitis* are kept under by enemies far more in the preparatory states than in the perfect state; but this fact only adds importance to the mimicry of *Disippus* as throwing light upon its greater numbers. The larvæ and pupæ of *Ursula* and *Disippus* so closely resemble each other that it is not likely their enemies would make any discrimination between them; and if in a given district where *Archippus* is abundant, the two former species, by the undue multiplication of their enemies in some particular year, should be so thinned out while in the immature states, that only a dozen imagines of each were perfected in an area of say 100 square miles; it becomes obvious that by deceiving the birds, or by associating with *Archippus*, the twelve specimens of *Disippus* would stand a much better chance of escape than those of *Ursula*, and that consequently more would succeed in perpetuating the species.

[3.] Natural Selection *does not*, therefore, waste its energies upon unimportant material, in giving protection to the perfect insect; and any one, with a little reflection, will perceive that there are the best of reasons why the unfortunate caterpillar of *Limenitis* cannot mimic the more favored larva of *Danais*. *They never come in contact!* The perfect insects are enabled by flight to associate together; but their larvæ—the one being confined to plants of the Willow and Poplar families, the other strictly to those of the Milkweed family—can never so associate. That there is, however, an effort at protection in the preparatory stages of *Limenitis*, no entomologist who has studied them in the field will deny. The egg, as Mr. Scudder has admitted, is in a measure protected by the long filamentous spines, which may protect it from the attacks of some of the very numerous parasites that might otherwise aid in exterminating it. The larva is very variable, and wears a remarkable protective resemblance to its surroundings. I have often noticed that in the mature specimens found on the dark Scrub willow the dark colors predominate; that those found on Golden willow are much brighter and greener, and the palest specimen I ever saw was found upon Silver poplar. Only those who have diligently searched for these larva can fully appreciate the protection which their appearance affords. In one instance I chanced to espy a large full grown specimen of *Disippus* on a Golden willow not more than seven feet high. The specimen on account of its brightness and greenness struck me as remarkable, and I searched for others. In taking a casual glance I could detect none, but after a diligent search I succeeded in finding seven specimens, and then left, fully convinced that I had espied every one upon the tree. The next day, however, my confidence in the sharpness of my eyes was

considerably shaken, for upon returning to the same small tree I succeeded in finding three more, all of them more than half grown.

As to the chrysalis, it bears a very strong resemblance to a bit of bird dung, and for the first few hours of its being, while the parts are yet soft and elongated this resemblance is truly striking.

[4.] I have shown that the disparity in numbers between *Disippus* and *Ursula* is very marked in the Mississippi Valley, and there is every reason to believe that the former is most abundant wherever its protector, the Archippus butterfly, abounds. I have Mr. Scudder's own authority for the statement that the latter is comparatively rare in the northeastern States, and my own experience would indicate such to be the case. Now it is extremely probable that where *Archippus* abounds, birds and other natural enemies are continually reminded of its nauseous qualities both by smell and taste.*

It would very naturally follow therefore, that where *Archippus* is rare, birds would not be so continually warned of its evil properties, and the deceptive resemblance in Disippus would lose much of its protective power in such a case. This explanation of the fact that *Ursula* is in some districts more common than *Disippus* will acquire greater force, if we find that such a state of things occurs only where *Archippus* is rare, and the facts as they at present stand indicate such to be the case.

Mr. Wallace† is inclined to account for the fact that *Ursula* is in some districts as numerous, or more so than *Disippus*, on the supposition that *Ursula* is also a mimicker, resembling the Philenor swallowtail (*Papilio philenor*, Drury‡) especially on the underside, which is exposed when the insects are at rest. We must, however, be very cautious in accepting such resemblances as cases of mimicry, without first ascertaining whether there can be any real cause for mimicry or whether the two butterflies ever associate together. Under the circumstances I incline to believe that the markings on the underside of *Ursula* are of a generic character since they obtain in other N. A., species of *Liminitis*; and that the resemblance to *P. philenor* is merely casual and bears no more relation to mimicry than does the close resemblance of certain plants belonging to different continents. *P. philenor* is itself a rare insect where *Ursula* is common, and must always be so on account of the scarcity of its food-plant; and, if anything, *Ursula* bears a greater general resemblance to *P. troilus*, Linn, and *P. asterias*, Drury, which are both more common species. It also bears a greater resemblance upon the upper surface to the female of *Argynnis Diana*, Cramer.

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*A singular fact bearing on this point has been communicated to me by Mr. Otto Lugger of Chicago, a gentleman who takes much interest in entomology and is a good collector. While employed on the U. S. Lake Survey he once saw a bird dart after an Archippus butterfly, seize it and immediately drop it without devouring the body. The butterfly dropped close by his side and he picked it up and examined it, and had no means at the time of accounting for the singular action of the bird.

† *Nature* III, p. 166.

‡ See my 2nd Rep. Fig. 86.

[5] This in no wise alters the fact, however, of the existence of mimicry in *Disippus*, which Mr. Scudder fully admits. It is, therefore no argument against Natural Selection having produced such mimicry. Because we are able to explain the principle power working to produce the relative abundance of one species, compared with another that is closely allied, it does not follow that we must also give the varied influences which cause the relative abundance or rarity of other species in other groups!

The third objector is Mr. A. Murray, who undertakes to show that these mimetic resemblances have nothing to do with Nnaural Selection.* He takes it upon himself to assert that every inch of ground which Mr. Bates has gone over is "mined and unsound"—that the "bad smell has not been observed in North America where similar mimicry occurs"; and that "birds and insects of prey hunt by sight and not by smell." Any one who will take the trouble to carefully read the paper in which these assertions occur, will, I have little doubt-come to the conclusion that it is the author's ground which is "mined and unsound." The second assertion, as I have already shown, is false; and even if the third is admitted, it does not in the least affect the argument in favor of Natural Selection, because the fact nevertheless remains that some groups do enjoy immunity from the attacks of birds while others do not. The manner in which Mr. Murray would account for this mimicry is by hybridization, and he endeavors to draw a parallel between the phenomenon and hybridization in plants. He carries little weight in his arguments, which were in a measure anticipated by Mr. Bates himself, and have since been refuted by Mr. Butler and Mr. Wallace.† He forgets that hybridization cannot play any part in the mimicry of insects to the vegetable kingdom, or to backgrounds generally. It has never been known to occur between insects of different Orders, families, or even genera, and produce fertile offspring,‡ while mimicry does occur even between insects of distinct Orders; and though he of course supposes the hybridization to have taken place at a very remote date, when the structural characters of the mimickers and mimicked were less specialized, yet had such been the case, these structural characters would not now remain so distinct between them, because it is quite fair to suppose that the hybrids would partake of the characters of each parent. Indeed the assumption of the theory is unsupported by facts. He ignores in a measure the great difference in the affinities of species belonging to the natural Orders of plants, and those belonging to the Orders of insects, and depreciates the importance of the latter by comparing the Orders

Nature III, pp. 154-6.

† *Ibid.*, III, p. 165.

‡Cases of hybridization even between species of the same genus are very rare, and it is doubtful if the hybrids would ever be fertile; and as to hybrids between genera I do not think a case has ever been recorded. In 1865 I succeeded in obtaining thorough coitus between a ♂ *Attacus cynthia*, Hubn., and ♀ *Attacus cecropia*, Linn., but for some reason the eggs resulting from this intercourse did not hatch. Last year I succeeded in producing an equally thorough coitus between a ♂ *Attacus cecropia*, Linn., and a ♀ *Attacus polyphemus*, Linn., but the eggs subsequently deposited by the latter were likewise infertile.

simply to families in other animals—thus showing that he has not a due appreciation of the true affinities of insects.

It must not be forgotten that Natural Selection is not the only power at work producing this mimicry. This we do not claim. There is an inherent tendency in all things to vary—a fact universally admitted. We may not be able to fully comprehend the causes producing this first variation, for they are complicated, and depend on numerous external conditions, and physical and mental influences. But our ignorance in this respect does not affect the theory, because "spontaneous" change is the material out of which Natural Selection has fixed and perfected the mimicry and adaptation; and it is not necessary to know how the "spontaneous" change is produced to learn the origin of the mimicry. Whatever be the causes of variation, and whether or not they continue to act after the first change takes place, Natural Selection is still potent, for the change would be perfectly inoperative in producing specific character without it.

There may be a hundred different influences that have led *Disippus* to mimic *Archippus*. The resemblance being purely colorational, there may have been a tendency from the first in the color of the former to approach that of the latter, and this is rendered very probable from the fact that the red-brown color occurs more or less in all the N. A. species of the genus.*

The very smell which protects *Archippus* may have had, and may still have, attractions for its mimicker, for Mr. Henry Edwards found that a Californian species of the same genus (*Limenitis Bredowii*) was greatly attracted by any offensive odor.† Again, when we reflect that we owe so many of our flowers and fruits to what are called "sports," which are simply instances of great and sudden variation; it is not difficult to imagine that the mimicry of *Disippus* may be due in a measure to some such sudden original variation—an idea that is greatly strengthened by the fact that instances of such great variation are common with butterflies and moths, and that one is known to occur in the very genus *Limenitis*.‡

We may give due weight to the somewhat Lamarckian theory advanced by Mr. Bennett; we may attach the greatest importance to the influence of physical conditions—and we know that similar habitat sometimes produces modification of allied forms in a similar direc-

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* In the seven described N. A. species of *Limenitis*, namely, *L. disippus*, Godt., *Ursula*, Fabr., *Proserpina*, Edw., *Weidemeyerii*, Edw., *Arthemis*, Drury, *Lorquini*, Boisd. and *Bredowii*, Hubn. the red color obtains more or less in all of them, especially on the under side, and this is more particularly the case in the last two. I also possess specimens of *Ursula* in which a very distinct shade of red blends with the blue-black and spreads over the upper surface of the primaries, and is in two individuals quite marked towards the apices. That the blue and black is closely connected with, and shows a tendency to affiliate with the brick-red and black, or *vice versa*, we may also reasonably infer from the wonderful contrast existing between the ♂ and ♀ *Argynnis Diana*, Cram., the former colors obtaining in the ♀ and the latter in the ♂.

† *Butterflies of North America*, by Wm. H. Edwards. It is impossible to make any explicit reference to this beautiful work as it is not paged: this, to my mind, is a deplorable oversight.

‡ *Limenitis Sibylla* figured in "Newman's English Butterflies," and referred to by S. N. Carvalho, Jr., in *Nature*, Vol. III, p. 66.

tion—but all these agencies will not produce specific imitation of one species by another, for they only prepare the way for it. It is therefore quite evident that such imitation can only be brought about to use Mr. Bennett's own words, "by the continuous preservation, through countless generations of those individuals which spontaneously approach most nearly to the ultimate forms;" and Natural Selection is the Preserver.

I have thus endeavored to frankly consider the objections raised against the theory of Natural Selection, as it applies to the mimicry of our two N. A. butterflies. It would be out of place here, and might justly be considered a work of supererogation on my part to undertake to defend it on more general grounds. It has been so well developed by Darwin, Wallace, Bates, and many other writers, both English, French and German, that it only asks a hearing to be understood and appreciated. The rapid increase of organisms is demonstrable, and the consequent struggle for existence, since, all organisms considered, there are as many deaths as births, is manifest. The result of this struggle is the survival of the fittest, by which organic forms are constantly changing to keep in harmony with the changed conditions which it is demonstrable have taken place, and are still taking place, in the inorganic world. And, to use Wallace's language, "as the changes of conditions are permanent changes in the sense of not reverting back to identical previous conditions, the changes of organic forms must be in the same sense permanent, and thus originate species."

That its influence and importance has been overrated by some writers is not at all unlikely, for Mr. Darwin himself now believes that he at first attributed too much to its action; and certain it is that it could have had no influence in producing many purely ornamental features of certain animals, that are of no use to the species thus ornamented. No theory was ever yet propounded, however, which has so well stood the test of scientific investigation in all departments of research, or that has such a power of absorbing new facts; and no theory has in such a short time been so very generally accepted by the leading scientific minds.

A two-fold reason has led me to give it prominence in this Report. First, I believe that when well understood it must prove of the utmost importance to the husbandman, by giving him an intelligent conception of the growth and development of animal and plant life about him, and by adding zest and interest to his efforts to produce superior varieties and breeds. Secondly, my studies of insect life led me several years ago to appreciate the hypothesis, and the more I become acquainted with these tiny beings in the field, the more I become convinced of its truth and importance. It is not to be wondered at that the entomologist who treats the different varieties in any group as independent species, should have implicit faith in the absolute distinctness and immutability of species; but whenever he pays more attention to

the biological part of his science, and studies insects more in the field, his views must necessarily change. Indeed, next to plants, insects offer, perhaps, the best material for the inquiring mind to work upon. Their rapid multiplication, the rapid manner in which one generation is often followed by another, the wonderful manner in which they are often affected by climate and food, especially during the preparatory or adolescent stages—all tend to furnish variation for Natural Selection to work upon, in a profusion unknown in the higher animals. Though the formation of a species in the other Classes of animals may never be in man's power to trace, on account of the great lapse of time required; it seems highly probable that the process may some day be traced in insects, and Mr. Bates gives strong proof of the derivation of one butterfly (*Heliconius thelxiope*) from another (*Heliconius melpomene*) and a clear insight into the manner in which the gradual modifications take place, till at last the two forms cease to interbreed, and are in every sense of the word true species.*

After all, the great objection to the theory of Natural Selection, in the minds of many, is, that it involves belief in the broader doctrine of Development—of Evolution. Very true! But, no matter how much importance be attached to Natural Selection, the fundamental truth of the development of species is now almost universally accepted by scientific men best able to judge of its merits; and those who have not considered the subject may be excused from judging of it. Indeed it can hardly any longer be considered a hypothesis: it is in reality established as a law, and as eminent a naturalist as Carl Vogt has even ventured the assertion that "no one in Europe dares any longer sustain the independent and direct creation of species." Development is a fact in nature, and the revelations of science strengthen faith in the universality of her laws and principles. No one can study well the facts in natural science, or the truths of philology, which point to corresponding results, without feeling more strongly than ever words can express, the general truth of the doctrine. Our own Agassiz is about the only great naturalist who opposes it, though it is rather significant that many of his leading pupils have, within the last few years, boldly proclaimed their faith in Darwinism. If there is one error in Agassiz' life, I take it to be the authority which he has lent to that popular prejudice which has always opposed inquiry into the order of nature, and which has ignorantly accused Darwin of atheism.

A theory which is so opposed to deep-set tradition and to present theological interpretations, must necessarily at first meet with very great objection. Such has been the history of all great scientific truths, for we have Agassiz' own words that "the history of the sciences is present to tell us that there are few of the great truths now recognized which have not been treated

*Naturalist on the River Amazons, Vol. 1, pp. 255-265.

as chimerical and blasphemous before they were demonstrated.' Truth must, however, in the end prevail!

Science and theology have little in common, and will, perhaps, always be at variance, but science and true religion are twin-sisters, and will ever go hand in hand. In the present question, theology affirms supernatural causes beyond man's investigation, and consequently sets an embargo on inquiry; while science affirms natural causes within the limits of investigation: the one appeals to man's senses, the other appeals to man's reason, whose throne should never be abdicated, and whose power to trace effects to antecedent causes is unlimited.

The belief that Darwinism is irreligious and atheistic, is widespread; but this belief is the direct result of prejudging and unfounded prejudice. For no one who understands the theory can entertain such an idea for a moment. The individual is not created by a special miracle, but develops by natural means. Yet no one would claim that the individual was any the less a creation. And so when it is argued that species also develop by natural means—according to natural law; they are none the less therefore creations! It is only a question as to the method which the Almighty employs; for not only does the development hypothesis imply an Infinite cause, but to use Prof. E. L. Youman's language "its conception is as much grander than the common theological idea, as the conception of the Cosmos which science has revealed, transcends the petty ideas of the world which were entertained in the grovelling infancy of the race!" Creation by a process of development is tangible and conceivable, whereas we can have no knowledge and no conception of creation without any process.

Haeckel, one of Darwin's strongest supporters, says: "In recognizing the unity of nature and the efficacy of the Divine Spirit in everything, we may perhaps lose the hypothesis of a personal Creator, but we evidently gain the idea of a Divine Spirit, which pervades the whole universe. God is the highest, the most living, the most active unit through all things which only appear as sensuous representatives for sensuous creatures." Can such men be called atheists or materialists?

The supposition that the creative mind produced all things as we now find them, by a single act of unstinted power, requiring only such time as can be reckoned by ourselves, is the direct outgrowth of our own comparatively feeble minds—is to gauge the power of the Almighty by our own. The supposition that he works through natural law, originally ordained, and by a constant exercise of his prerogative, is a far higher and more comprehensive conception; for it helps to broaden our views and enables us to grasp something more than we have hitherto done. It carries us back æons in the past, and shows us that creation has not only been continuous but still endures, and it

helps us to rise to sublimest contemplation of that unknown Infinity which pervades all.

Von Baer has truly remarked that "the scientific investigation of Nature strives to learn everything in detail, in order to get nearer to the cause of everything," and though we may not always reach the goal we aim at, we should not therefore cease to try. The law of the age is progress, and the point we reach to-day will form our starting point to-morrow. Every step which enables us to more truly interpret the workings of the Divine Mind in nature, necessarily brings us nearer to, and gives us a more intelligent idea, of a Creator. Each new insight into the significances and harmonies around us, helps us to lift the mystic veil and behold with awe and wonder the might and majesty of God—to converse with him as flesh with unknown Infinity: and I look forward to the day when the development of species will not only be universally recognized as a law, among naturalists; but when the liberal-minded theologian will revere the names of men like Darwin, who help to a higher conception of creation—instead of anathematizing them and ignorantly charging to their doctrines those atheistic tendencies which in times past have been vainly thrown up to those of so many other great, clear-thinking, discovering minds!

ERRATA.

Page 7, line 18 from bottom, for "*Hyleæctus,*" read "*Hylecœtus.*"
Page 57, line 18, add "*c*" before the first "*h.*"
Page 58, line 2 from bottom, for "*fornudolosus*" read "*formidolosus.*"

ERRATA OMITTED IN THE FIRST REPORT.

Page 14, line 16 from bottom, for "females" read "males." Page 30, note, for "F" read "T." Page 32, line 14 from bottom, for "III" read "V;" same page, line 7 from bottom, for "XIII" read "VIII." Page 38, line 5, for "*Tredeim*" read "*Tredecim.*" Page 53, line 19 from bottom, for "laid" read "lain." Page 54, line 4 from bottom, for "hatch" read "are deposited." Page 87, line 11 from bottom, for "F" read "T." Page 132, line 16, for "*ampelopsis*" read "*ampelopsidos.*" Page 150, line 6, for "ruddy" read "vigorous;" same page, line 26, for "*thyridopteryx* read "*thyridopterygis.*" Page 154, in the heading, for "*zeas*" read "*zeæ.*" Page 155, line 13 from bottom, for "zeas" read "zeæ." Page 173, line 3 from bottom, for "it" read "the more liquid parts;" same page, under the heading, read ("Lepidoptera, Tineidæ.") Page 174, line 3 from bottom, for "*Solidaga*" read "*Solidago.*" Page 175, line 32, add "front" before "wing." Page 178, lines 2 and 3, for "*gelechia*" read "*gelechiæ.*"

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FOURTH ANNUAL REPORT

ON THE

NOXIOUS, BENEFICIAL

AND OTHER

INSECTS,

OF THE

STATE OF MISSOURI,

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

BY CHARLES V. RILEY,

State Entomologist.

JEFFERSON CITY, MO.:
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PREFACE.

To the Members of the Missouri State Board of Agriculture:

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

The year just closing has been remarkable for the high mean temperature of its spring and summer, and the unprecedented small amount of rain-fall. Yet mother Earth has yielded abundantly of all kinds of Agricultural products, and our fruit crop has generally been unusually fine. The injuries of the notorious Plum Curculio were, comparatively, so insignificant that plums and even apricots ripened where they had failed for many previous years; and though this result may in great part be attributed to the partial failure of such fruit and the consequent scarcity of the "little Turk" in 1870, I think the Sigalphus parasite described last year must receive some share of the credit. But it is unnecessary to anticipate in any manner the burden of the following pages.

During the extreme heat of the season I made a hasty trip to Europe, for the improvement of health and for scientific purposes. During two months' stay there, I was able to gather some facts of importance without which I could not have laid before you the articles on "Grape Disease," and "Silkworms" to which I call your especial attention, and which, I trust, contain some important truths of vast moment to the State.

I have devoted considerable time to lecturing the past year; and hope to be able to fill still more engagements during the year to come.

Respecting the printing of this Report it is necessary to state that I did everything in my power last winter to have the printing and press-work of the third volume done creditably and in a manner which would do justice to the engravings. Mr. Wilcox was obliging, and did all that could, perhaps, be expected of him; but in truth it is utterly impossible for any one to turn out a creditable piece of work from the old rickety presses at the capital; and, with the three years' unsatisfactory experience of the past, I shall strive to get the publishing of this fourth Report done in St. Louis. To enable me to do so, I hope to get your aid and encouragement.

The same rules, in printing, that have been adopted in the other Reports, are followed in this; and the reader will bear in mind that, unless otherwise stated, the latitude of St. Louis is always intended when speaking of the

season of an insect's appearance or disappearance. The older and more familiar generic names are generally employed, and the names in brackets indicate the genera to which the insect is referred in more modern systems.

Figures 35, 45, 46, 47 and 49 have been kindly loaned by Mr. Charles L. Flint, Secretary of the Massachusetts State Board of Agriculture; 51 by Dr. A. S. Packard, Jr., of Salem, Mass., and 52, 53 and 54 purchased of the same: the rest are original.

My office is still at Room 29, Insurance Building, Southeast corner of Fifth and Olive streets, St. Louis; and all letters sent to me should be thus addressed.

I thankfully acknowledge the receipt of free passes over the following railroads: St. Louis and Iron Mountain, Missouri Pacific, Atlantic and Pacific, Hannibal and St. Joseph, North Missouri, Chicago and St. Louis, Illinois Central, and Rockford, Rock Island and St. Louis.

Respectfully yours,

CHARLES V. RILEY,
State Entomologist.

St. Louis, Mo., December 2, 1871.

NOXIOUS INSECTS.

NOTES OF THE YEAR.

Of the more prominent and important of our insect enemies prolonged experience is continually teaching us something new, and of some of those already treated of in former Reports, I shall, hereafter, under the head of "Notes of the Year" bring together such additional facts and discoveries as are worthy of being recorded. These notes are therefore intended to supplement the original articles, and I shall endeavor to avoid anything like repetition of what has already appeared. By thus adding the observations of the year the original reports will be rendered more complete and circumspect.

THE COLORADO POTATO BEETLE.

In its onward march across the continent, this insect attracts, perhaps, more attention than any other. In extending over new territory we find that its enemies increase and that even its habits become more varied; while our means of counteracting its injurious work become more numerous and efficient. For these reasons it demands prominence in the "Notes."

Its Injuries in 1871.—Never before was the insect so numerous with us as last spring and summer. In March the beetle was turned up in great numbers while the ground was being plowed, especially in fields that had been planted the previous year to late potatoes. During the warm days of April they were seen everywhere sailing through the air—their striped elytra or wing-covers raised and held motionless from the thorax, while the more gauzy wings, unfolded and vibrating, reflected pleasantly to the eye as the sun intensified their rosy hues.

Before the potatoe leaves were fairly out of the ground the beetles were, as usual, after them, and the fighting on the part of potato-growers commenced with vigor, for it seemed that twenty bugs came to the funeral of every one slain. It had become very generally known that no powder unless it had Paris green as its base, was efficient enough to be of any practical

use, and consequently the demand for Paris green, suddenly became so great that the price went up from 20c. to 75c. and even $1.00 per lb. Indeed, for a while it was not to be had at all in St. Louis. Several parties in our State, taking advantage of the demand, prepared pound packages, already mixed, and advertised them for sale at 50c. per package. The price was exhorbitant, and by inducing the well known firm of Michell Bros. & Kern, of St. Louis, to prepare packages according to my recommendation, I soon had the satisfaction of seeing the price reduced to a more reasonable standard. During the latter part of May the demand for the green was at its height, and the bugs were in such force throughout the Western country, that the agricultural papers teemed with notices of it, and some writers gave loose rein to their fancy, and allowed so prosaic a subject to prompt to poetic deeds. From among the doggerel, the following taken from the columns of the *Western Rural* will bear repeating and exhibits the right spirit:

POTATO BUGS AND I.

In deadly strife we did engage;
From week to week the warfare wage
With no abatement of our rage—
  Potato bugs and I;
From two to 'leven like Falstaff's foes—
In one brief hour their number grow—
Yet neither any yielding knows
  Potato bugs or I.

Brave fought in ancient times the knight
In coat of mail and vizor bright,
But more tenacious was our fight—
  Potato bugs and I.
Armed to the teeth were foes of old,
But teeth and hands our arms all told,
Yet still we struggled strong and bold—
  Potato bugs and I.

  I fought my fav'rite bulb to save,
Which to the world Sir Walter gave,
Each had our reasons strong and grave—
  Potato bugs and I.
To exterminate was what they meant,
And I toward them had like intent;
Nor one short hour would we relent—
  Potato bugs or I.

Green armor I've procured of late,
Provided by that city great
Where bloodshed seems the normal state;
And now our warfare we'll abate—
  Potato bugs and I;
For all their energy is spent,
Their spears are broken, armor rent,
And now I think we're both content—
  Potato bugs and I.

AGRA.

But if the bugs themselves were unprecedently numerous, so also were their natural enemies. I passed through potato patches where almost every *Doryphora* larva had upon the back of the neck, just behind the head, one or more eggs of its deadly parasite *Lydella doryphoræ*, Riley, (Rep.

I, Fig. 48), which is the only genuine parasite yet known to attack it; and what with the work of such natural enemies and the efforts of man, the pest suddenly became about as scarce as it had been numerous before.

All accounts agree as to the sudden diminution of its numbers in the month of June, and so far as Missouri is concerned, it did not increase to any alarming extent during the rest of the year. The disappearance was, in many sections, so thorough that it is very questionable whether man and natural enemies should alone be credited with the cause. The spring was uncommonly dry and warm, and, so far, was favorable to the increase of the insect; but the summer drought and extreme heat which followed were quite unfavorable to its multiplication. Warm, dry weather in spring is congenial to the growth and well-being of the larvæ as they swarm upon and devour our vines; but at a later stage of their lives when they have to enter the earth to undergo their transformations, a great many of them will undoubtedly die if the earth continues excessively dry and hot. They will, in short, be dried and baked to death. Those who have had large experience in breeding insects, and who understand the importance of coolness, and especially of moisture in the successful development of those which transform underground, feel perfectly warranted in such an inference, even though no systematic and accurate experiments have been made to test its validity. The extreme heat and dryness of the season, furnished a good opportunity to employ the sun-scalding remedy, and it was fully shown that in an intense summer sun, the larvæ and even the beetles will very generally die if knocked from the vines on to the dry and heated ground, especially if the vines have been well hilled; and it is doubtless because the insect cannot thrive when the thermometer ranges near 100° F. that the southern columns of the spreading army extend far more slowly than the northern. Moreover, the past summer was not the first one in which the sudden disappearance of this insect under conditions of heat and drought has been noticed; for a similar state of things occurred in 1868, and Dr. Henry Shimer, of Mt. Carroll, Ill., then attributed such disappearance to the dryness of the season.*

We are justifiable, therefore, in concluding that while dryness and warmth may be very pleasant and agreeable to the Colorado Potato Beetle in the spring or in the fall, they are nevertheless very destructive to it when intensified in the summer months.

Amount of Damage caused by it in Missouri.—Notwithstanding such sudden disappearance of the potato bug, the falling off in the potato product of the State compared with 1870 is fully 20 per cent. In Illinois it is 35 and in Michigan 34 per cent.; while in most of the so-called Middle States it has increased. Much of this decrease may justly be attributed to the same heat and drought that killed off the bugs, but a certain amount of it may be attributed to the early ravages of the latter. In 1870, the Statistician, Mr. J. R. Dodge, informed me that the potato crop of Missouri was 5,525,000 bushels; and after careful estimates of the average market price in St.

* *Am. Naturalist*, Vol. III. pp. 91-99.

Louis, and of the damage done to the crop by this one insect, I showed, in a lecture delivered before the Kansas State Agricultural College, that this one pest had abstracted nearly $500,000 from the pockets of our farmers during that year. No insignificant sum to be sneered at, and well worth saving when the means are at hand!

New Territory invaded.—In the fall of 1870 the northern columns of the great army, in its eastward march, had reached the Canadian border and made their way some little distance into the Dominion. In the spring of 1871 the Detroit river was literally swarming with the beetles and they were crossing Lake Erie on ships, chips, staves, boards or any other floating object which presented itself. They soon infested all the islands to the west of the Lake and by June were common around London, and finally occupied the whole country between the St. Clair and Niagara rivers.

It would be difficult to indicate, with any degree of exactness, the precise eastern limit they have attained in the States; but it can be confidently stated that they have reached in some places the borders of New York and Pennsylvania. Specimens of dried larvæ were sent to Mr. A. S. Fuller of the *Rural New Yorker*, from Martinsburgh, N. Y., but he was not able to decide positively whether they were the genuine Colorado article or the Three-lined Potato beetle (Rep. I. Fig. 42). They were also reported during the summer to have obtained a foot-hold in Massachusetts, as the following item from the *New England Farmer* will show:

"Hon. M. P. Wilder informs us that this long dreaded scourge of the potato field has been found in the town of Worcester, whither it probably stole a ride on the cars of the western railroad, or was introduced by some carpet-bagger. We understood Mr. Wilder that the State Board of Agriculture were contemplating the adoption of some action with a view to 'stamping out' the pest. We are not informed as to the extent of the foothold the insect has secured, but we should certainly advise a most earnest endeavor by hand picking, by poison, by fire, and by every means in their power, to check its further extension in our State."

But I am able to say, with sufficient assurance, that no foundation whatever existed for the rumor, and that the Three-lined species was here the innocent cause of alarm. While visiting Prof. Geo. Thurber of the *American Agriculturist,* I learned that he himself had unintentionally started the rumor by mistaking certain dried 3-*lineata* for the genuine 10-*lineata* larvæ.

I have already given it as my opinion that nothing will stay its onward march. There was a possible chance of keeping it out of Ontario, but that is now lost. It might perhaps be stayed for a time, if, by some edict, no potatoes were allowed to be grown for several years within a belt of one hundred miles east of the district at present infested. But we do not live in the time of edicts, and the chances of its getting across such a belt by one way or another would always be great. So I expect this irresistible army to march on. Indeed it is quite possible that even the broad Atlantic may not stay its course; but that when once the beetles swarm in the streets of New York as they did in those of St. Louis last spring, some female, loaded

with fertile eggs and hidden in the nooks and crannies of some vessel, may be safely borne over to the land of "murphies," where she might easily found a colony which would soon spread consternation into other potato-growing countries to the eastward. In giving, through Walter Raleigh, the precious tuber to Europe, America conferred upon the Old World an everlasting boon. She may yet unwittingly be the means of bequeathing as great a bane, by sending across the ocean the deadliest enemy of that tuber! At all events, it behooves our European neighbors to be on the look-out, and to prevent, if possible, any such catastrophe.

The southern columns of the army lag far behind. In South Missouri it is gradually spreading, but has not yet touched the extreme southern counties. I saw it at Springfield in 1870 and it had then only just reached Green county. It was noticed the past summer by Mr. Wm. R. Howard for the first time in Webster, but had not then reached Taney county. It also made its first appearance in 1871 in Phelps and Reynolds, as I am informed by Dr. Thos. Ferguson of Arlington in the former, and by Dr. M. M. Kenzie of Centreville in the latter county. It also appeared in Wright, Dent and Texas, and will doubtless in time appear in all the extreme south and southwestern counties.

To the east this southern column does not reach much beyond Louisville, Ky., as I learn from Mr. T. J. Key, of that place, that it has only been there two years, and Mr. V. T. Chambers informs me that it was seen at Covington for the first time last year. Broadly speaking, therefore, it may be said to occupy more or less all the territory between latitude 37° and 46°—bounded on the west by the Rocky Mountains and on the east by a line drawn from the extreme eastern limit of Lake Erie to Cairo, Ill.

To the north the pests have extended beyond this limit in Michigan, and I have heard of them even on the northern shore of Lake Superior. An incident related to me by Jno. Hurlburt, Jr., who has been engaged in surveying and prospecting in that part of the country, will illustrate how great a distance they may extend without food, when aided by water. He found them in immense quantities on a potato patch belonging to some Indians on the Menomonee river; yet this potato patch was in a clearing of about twenty acres, with no other clearing near; and to his certain knowledge there could not have been another potato patch within one hundred and fifty miles. To the east and south they extend a little beyond the imaginary line, in Ohio, as Mr. Klippart, Secretary of the State Board, made special inquiries as to their progress, and he informed me that they have been found in every county in the State.

It spreads, but does not travel in the Sense of leaving one District for Another.—Let it not be understood that this insect, in its onward spread, or march, ever entirely quits any district where it has once obtained a foothold. This idea of its itinerant character seems very generally to prevail, and a great many people labor under the impression that soon after its advent, this dreaded foe to the potato will of its own accord take its leave as suddenly as it came—that, like every other dog, it will have its day. This idea

is rather encouraged, though I believe unintentionally, by Dr. LeBaron in his first Illinois Entomological Report, where he gives it as his opinion that the beetle will in time disappear "especially in those localities where it is most abundant, even though we leave the work wholly to Nature." Nothing could, however, be farther from the truth, or less in accordance with past experience. It may, and very generally does, prove more injurious during the first two or three years of its advent than subsequently; because time is required for its natural enemies to multiply sufficiently to keep it in check. But wherever it once obtains a footing, there it may be expected to remain for all time to come—vascillating, it is true, from year to year, in numbers and consequent power to do mischief, according as the conditions for its increase or decrease are favorable; but always present to take its chances in the great struggle for existence, and to get the upper hand if it can.

Mr. Thomas Meehan of the *Gardeners' Monthly*, writes me that while in Colorado the past summer he met with very few beetles, and that these seemed to favor the *Solanum cornutum;* and persons often wonder why the insect does not swarm in the Territory from which it takes its popular name. I have been repeatedly informed by men living on or near the Rocky Mountains, and more especially by Mr. J. Savage, of Lawrence, Kans., that at a certain altitude it scarcely ever touches the Potato, but confines itself to the wild *cornutum;* and it necessarily cannot be as numerous in thinly settled parts of the country as in parts more thickly populated. It received the popular appellation of "Colorado," not because it was numerous there, but because it was first found there by entomologists long before it had advanced to any of the Territories or States to the East. There are hundreds of insects that in like manner take their name from some particular district where first discovered, though they often afterwards prove to be far more common in other districts.

New Food; Cabbage.—It is a notable fact, and a most important one for us, that the Colorado Potato Beetle has in the past been found incapable of flourishing on any other plants but those of the Nightshade Family (*Solanaceæ*), and hitherto it has only been known to thrive upon the nightshade genus proper (*Solanum*) which includes the Egg Plant, the Horse nettle and some other wild species west of the Mississippi, such as *rostratum* and *cornutum*, which are known by various popular and local names. Upon the Nettle (*S. carolinense*), which is common with us but is mostly replaced in Kansas by the *S. rostratum*, it seems to delight even more than upon the Potato, and I have found it quite injurious to other plants of the same genus, such as the *warscewiczi, robustum, discolor* and *sieglinge*, which are often cultivated for their ornamental foliage. The other common plants of the Family such as the Tomato (*Lycopersicum*), Ground-cherry (*Physalis*), Thorn-apple (*Datura*), Henbane (*Hyoscyamus*), Apple of Peru (*Nicandra*), Tobacco (*Nicotiana*), Belladonna, Petunia and Cayenne Pepper, are not overmuch to its liking, though upon a pinch, it will feed on all of them, and especially on the first named. The Cayenne Pepper, if eaten to any extent, is actually poisonous to it, as we learn from Dr. LeBaron.

Under these circumstances it is an interesting fact (as showing how a new habit may be acquired under favorable circumstances), that last summer, this insect was positively found feeding upon the Cabbage, which is botanically so very distinct from the nightshade Family. It would be sad indeed if so all-important an esculent should in the future be doomed to suffer, with the Potato, from the insatiate appetite of such a pest, and I have no idea that cabbage raisers need fear anything of the sort. Yet stranger things have happened! and certain it is that it was found devouring cabbages by Mr. H. H. McAffee, Superintendent of the Wisconsin University Experimental Farm, while Miss Mary E. Murtfeldt, of Kirkwood, in whose testimony I can place the utmost reliance, found that in parts of Northern Illinois it did considerable injury to growing cabbages and was even breeding in great numbers upon them.

Its Hibernation.—Subsequent experience has corroborated the accuracy of the account given in my first Report, of this insect's natural history, and as some authors have since claimed that it winters in the *pupa* state, I must insist that with us it never does, but that the last brood invariably hibernates in the perfect beetle state. Specimens have been found at a depth of eight and even ten feet below the surface, but the great majority do not descend beyond eighteen or twenty inches, and many will not enter the ground at all if they can find other substances above ground that will shelter them sufficiently. The beetles are found abundantly above ground in the month of April in the latitude of St. Louis, but often re-enter it after they have once left, especially during cold, damp weather.

A few Words more about Paris Green.—A good deal of objection has been raised against the too general use of this poison, and perhaps with some reason. Mr. H. H. McAfee, who has had a good opportunity of testing its value, strongly opposes its use on the grounds of its dangerous nature, and shows in the following paragraph, which is from his pen, that the bugs can be subdued by determined hand-picking.

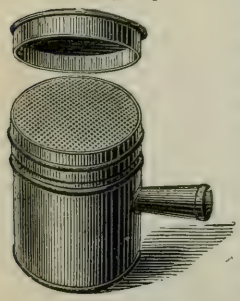
With an astonishing large supply of beetles to start on this spring, we have fought them through to this time at an expense of just $20.15, and we have dug potatoes enough to pay, at market price when dug, for the seed upon the whole plat, also to pay for the picking of the bugs, and a profit of $6.51, and there yet remains to be dug over half the potatoes, which, after paying cost of cultivation and rental, will give a fair profit. There will be a slight bill for picking bugs from this on, for the late potatoes, but we are perfectly sure of a balance of profits, if the potatoes now in the ground never grew another ounce. "Early Rose," yielded at the rate of 232.56 bushels per acre, "King of the Earlies," at the rate of 157.24 bushels per acre. I feel sure that we can count on several million less bugs to winter over, than were on the farm last fall, and I believe that the expense of gathering them another year may be lessened more than three-fourths, by using proper implements for that work.

Some persons have even imagined that potatoes grown on land where it has been used are often watery, rank and of bad flavor, and according to the Monthly Report from the Department of Agriculture for August and

September last, peas planted in soil mixed with the green rotted immediately and would not germinate, while those in unadulterated soil grew finely and flourished, but died immediately when transplanted into the soil mixed with the green. How far these statements are to be relied on, each one must judge for himself, but it is certainly advisable to avoid as much as possible the use of the poison, by carrying out the other methods, both preventive and remedial, advocated in previous Reports; for wholesale remedies always have the disadvantage of destroying some friends with the foes, and in this case the true parasite and those cannibals which by mastication partake bodily of their green-covered prey, certainly fall in the general slaughter. But this remedy has now been so extensively used with good results and without any apparent harm to the tubers, that full and thorough proof against it will be necessary to cause its abandonment. Properly mixed I have used it without the slightest trace of evil effect on the leaves or tubers, and I know hundreds of others who have done likewise; so that with present experience I should not hesitate to recommend its judicious use. What is wanted on this subject, is a long series of thoroughly accurate and reliable experiments. Let our Agricultural colleges make them! Meanwhile Paris green will be extensively used, especially while the vines are young and most need protection; for after the expense of preparing the land and planting has been incurred, it will not pay to get discouraged and abandon the field to the enemy, when such an efficient remedy is at hand. We must take lesson from one of Æsop's instructive fables, and instead of relying on providence to help us out, put our shoulders to the wheel and help ourselves out of the difficulty.

The green may be shaken over the vines in various manners, and some persons have found an old sleazy sack, such as those used for table salt, to do good service, when attached to the end of a stick. It is most safely applied, however, by aid of a perforated tin box attached to the end of a stick three or four feet long. Such a box (Fig. 1) I induced Messrs. Michel Bros. & Kern to manufacture last summer. It can be made of any desirable size. The least possible dusting suffices, and by taking the handle of the dust-box in the left hand, and then tapping the box with another stick held in the right hand, one can walk rapidly along the rows and regulate the amount sifted. The green cannot well be mixed with the flour or plaster except by the aid of a mill, and it is for this reason that those who mix in large quantities have the advantage. It is most effectual when mixed with flour, though plaster has the merit of cheapness. I have generally used and have hitherto recommended from 12 to 15 parts of flour to one of green, but it has been abundantly demonstrated that, if the green be pure, it may be diluted with 25 or 30 times its weight and still be effectual.

[Fig. 1.]



Abundantly as this mixture has been used, I have not been able to learn of a single authenticated case of poisoning resulting in death, except

where it was left exposed in quantity so as to allow animals to get at and eat it. A few cases of slight poisoning of the skin have occurred, and these might have been avoided; and perhaps I cannot better illustrate how small is the risk of its judicious use in the field with the precautions given in my last Report, than by the following circumstance which came under my notice: Two young men of St. Louis—Messrs. August Reitemeyer and J. Fleming—were daily engaged, through the greater part of the month of May, in preparing the mixture for the market. They became unnecessarily careless in their work, and were actually living in an atmosphere heavily charged with the dust, while their clothing was saturated with it through and through. Yet they experienced no ill effects from it till about the first of June, when the weather became so warm that they begun to perspire.

These facts should, however, form no excuse for the careless use of the poison, and it is well to know that it must be especially guarded against during the heat of the day. It should, in fact, always be dusted in the cool of the morning while the dew is on the plants.

At a meeting of the N. Y. Farmer's Club, I made the acquaintance of Dr. Richard Scuppernong, who has had much experience with Paris green, having been engaged in its manufacture with the firm of C. T. Reynolds & Co. of that city. Manufacturers would rather make and sell at 25 cents per pound in winter than to make it at 40 cents per pound in summer, the skin being so much more susceptible to its effects, during the latter season. Men do not ordinarily work at its manufacture continuously more than a week at a time, and every one in the factory is obliged to take an occasional antidote. Those who contemplate using it on their potatoes would do well to procure a supply in the winter time, as they would thus save money. Very much depends on the quantity obtained, and none but that of a deep bright green should be bought, as the paler brands are weaker and adulterated.

Antidote for Paris Green.—The antidote for Paris green poison is hydrated sesquioxide of iron. Nearly every druggist keeps it always on hand. If it cannot be bought it may be prepared thus:—Dissolve copperas in hot water, keep warm, and add nitric acid until the solution becomes yellow; then pour in ammonia water—common hartshorn—or a solution of carbonate of ammonia, until a brown precipitate falls. Keep this precipitate moist and in a tightly corked bottle. A few spoonfuls taken soon after even a bad case of poisoning with Paris green or arsenic is a perfect remedy. Every farmer who uses Paris green for the bugs should keep this medicine always in his house.

Other Applications.—One would naturally suppose that since arsenic forms one of the principal ingredients of Paris green, it would also kill potato bugs, with the advantage of being much cheaper. With a view of ascertaining its value I tried it last spring, but with no satisfactory results. I also tried powdered cobalt which is so generally used to kill flies, and it likewise failed to kill with anything like the certainty which Paris green does. White hellebore has been recommended by those who claim to have

been benefitted by its use; and Mr. Hay, gardener at the Illinois Institution for the Education of the Deaf and Dumb, says that he has found that black pepper and ashes in the proportion of a pound of pepper to the pail-full of ashes, is an infallible remedy. How reliable this last may be, can be ascertained next year, but at present I can safely recommend nothing but the mixture of green.

From a series of experiments made last summer by Messrs. Wm. Saunders and E. B. Reed, of London, Ont., who were directed by the Agricultural Department to institute them, we also learn the great advantage of the green; and as the results of these experiments are interesting and important, I quote herewith those obtained with other chemicals:

Arsenious Acid (Arsenic).—This chemical being much cheaper than *Paris Green*, and more uniform in its composition, we hoped it would have proved a practical and safe remedy. We tried it in the proportions of half ounce, one ounce and two ounces to a pound of flour, and while we are not prepared, from the few trials we have made, to entirely disapprove of its use, the results we have obtained point to the conclusion that where it has been used in sufficiently large proportions to destroy the insect, it has caused more or less injury to the leaves. In cases where *Paris Green* is not obtainable, this might be used as a substitute, in the proportion of one ounce to one pound flour, which should always be colored with some black powder, such as charcoal or black antimony, so as to lessen the risk of accident from its use.

Another Arsenical compound was also tested, known in commerce as *Powdered Cobalt* or Fly Poison; this was used in the same proportions as the last mentioned, and with similar results, but owing to its higher price we do not recommend it for general use.

Sulphate of Copper (Blue Stone).—A strong solution of this salt was tried in the proportion of two ounces to one gallon of water, and showered on the vines with a watering pot, without damage to either the insect or the plant.

Bichromate of Potash.—This is a poisonous substance largely used in dyeing, and one which has attracted some attention in France of late, as a remedy for insects. We used it dissolved in water in the proportion of two ounces to three gallons of water. This killed the insects effectually, but at the same time destroyed the plants. Whether, in a more diluted form, this remedy could be effectively used without injury to the foliage, we are unable at present to say, but shall experiment further with it.

Powdered Hellebore.—This powerful irritant which is so effectual as a remedy for the *Currant Worm* we tried without perceptible effect, both in powder and also mixed with water, in the proportion of one ounce to the gallon of water. Several other poisonous substances were also used with like results.

Carbolate of Lime.—There are several preparations sold under this name, which we found to vary much in composition and character, and equally so in effect. We tried an article known as Dougall's without any good result, but succeeded better with one prepared by Lyman Bros. of Toronto, a black powder manufactured, we understand, from coal tar. This destroyed a large proportion of the larvæ, but we doubt whether it would kill the perfect insect; it is, moreover, used in an undiluted form, which would render its cost greater than that of the *Paris Green* mixture, so we see no advantage in using it, although the fact of its being less poisonous may induce some to try it who are prejudiced against *Paris Green*.

Ashes and Air-slacked Lime, we found, had been extensively used by

many of the farmers on the frontier districts, but, as far as we could see or learn, without any perceptible results.

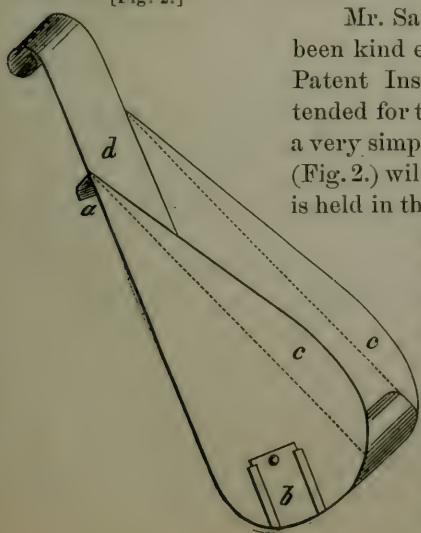
I last year showed how futile it is to use elder leaves as a remedy; but it is so easy for persons who are not thoroughly posted as to the habits of this insect to form wrong conclusions about the efficacy of whatsoever application they may make to the vines, that we this year find the sprinkling of a decoction made from Dog fennel, or from the root of the May apple or Mandrake (*Podophyllum peltatum*) strongly recommended for the same purpose. Mr. John Oliver, of Glencoe,—determined to fully test the latter—went to considerable trouble and expense to procure a sufficient quantity of the May apple decoction; and after thoroughly trying it, he informs me that it had no effect in killing the bugs. Even were these methods successful, they could not be everywhere employed, and must always prove more expensive than the Paris green.

We learn from the *Prairie Farmer* of Chicago, that an intelligent Russian gentleman of that city employs the following method:

He takes finely pulverized, air slacked lime, commences at one end of the field and scatters it over the vines for the distance of about ten rods. In the course of the day, if the lime is applied in the morning, the bugs nearly all betake themselves further down the rows where no lime was scattered. The next day he scatters lime on the vines for a like distance, and thus continues day by day, till the bugs are driven on to a small area, when they are destroyed by Paris green or by other means.

Mechanical Means.—Various contrivances have been devised for knocking the bugs off the vines. Mr. Geo. Squires, of Montgomery, Ill., as I am informed by Dr. LeBaron, built a machine to be drawn by horses, which worked very effectually the past summer. It is a modification of that of Mr. Benson, of Iowa, described in my first Report, being a simple box six inches high, with wheels to which brooms are attached to sweep the vines—the brooms circling towards the box.

[Fig. 2.]



Mr. Samuel Creighton, of Lithopolis, Ohio, has been kind enough to furnish me with an "Improved Patent Insect Destroyer," which is especially intended for the potato bugs. It is a hand machine of a very simple nature, and the accompanying outline, (Fig. 2.) will give a very good idea of it. In using, it is held in the right hand by the handle *a*, and placed at one side of the potato hill, with the upper end more or less inclined, according to the size of the plants. In this position the lower branches of the plants will overhang the forward edge of the plate *d;* and the flanges of the sides, *cc*, which are slightly bent outwards, will embrace the second and third sides of the vines, leaving the fourth exposed. The operator then strikes this exposed side, with a

light, flat and broad broom, thus detaching the bugs which fall to the bottom of the trap. Whenever the trap is filled the bugs are emptied out through a sliding door *b*, and destroyed in whatever manner the operator sees fit. A good size for this trap is 2 1-2 feet in height; 15 inches from flange to flange and 7 inches across the narrow way of the pocket. It should be made of tin or, if of wood, the pocket should be lined with tin; as when kept smooth or moistened with oil or water the bugs cannot easily crawl out, as one goes from hill to hill. This contrivance is but an improvement on the common tin pan, and its principal merit lies in its simplicity and cheapness.

The great difficulty with all mechanical contrivances of this kind, lies in the fact that they can only be used when the vines are of a considerable size, whereas the enemy must be most persistently fought from the moment the ground parts to give way to the sprouting tuber, until the plants are a few inches high. Hence the great advantage of Paris green.

A cheap, rapid and effective method which commends itself to the good sense of every one, is for one person to go along the rows with a short-handled broom and by quick motions knock all the bugs off, while a second person follows immediately after, dragging by a single horse a heavy bundle of brush, or close-toothed harrow made for the purpose. Some of the bugs will escape being killed, and a few of the younger larvæ may not be knocked off; but the operation is so rapidly performed that it will bear repetition as often as neeessary.

Natural Enemies increasing.—To those who have carefully watched the eastward progress of this insect, the manner in which its natural enemies have increased in number and kind is interesting and significant. In previous Reports fourteen cannibal or parasitic insects, specially observed to attack it in one state or another have been figured, and I am now able to add seven more to the list. The toad, and perhaps some other reptiles devour them, and among birds the crow has been observed to do so. Among domesticated birds, the duck was for several years the only species that would touch it, and chickens for a long time would invariably give it the go-by. Last year I stated that chickens had learned to eat the eggs, and had even acquired a taste for the young larvæ; but this year cases are numerous, in various parts of the country, where the beetles, as well as the larvæ and eggs have been devoured by them. I know of one case near St. Louis where, with a few specimens of the common May Beetle, no less than thirty-one perfect specimens of the Colorado Beetles were found in the crop of one chicken; while in another instance, in the same neighborhood, the chickens forsook every other kind of food for these nauseous insects. In these instances the chickens have taken naturally to the new food, but it has been shown (See Dr. Brown, Trans. Ind. Hort. Soc., 1871, p. 81) that they may easily be taught to like it, by first shutting them up and, after denying them all animal food for about ten days, turning them into an infested potato field and keeping them there. Indeed, coops may be taken into such a field, and young chickens raised there to good advantage. To these birds we may also add that blithe and pretty field companion whose

services as an insect devourer have been altogether too much underrated—the common quail. A correspondent of the *Rural New Yorker* from Onargo, Ill., found six Colorado Potato Beetles in the crop of one that was killed on his place. Among quadrupeds, Dr. LeBaron has shown good reason for believing that the skunk likewise preys upon them. As it is also known to destroy great quantities of the common White Grub, and to clean tomato patches of the Tomato Worm, this much abused beast in a measure compensates for its well known disagreeable attributes.

Among spiders we may mention an undetermined species of *Phalangium* (Fig. 3 represents *P. dorsatum*, Say). These animals are popularly

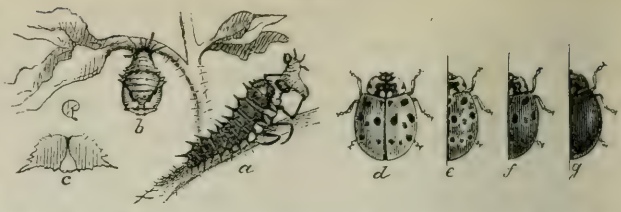
[Fig. 3.]

called "Grand-Daddy-Long-Legs" in this country, but are also known as "Harvest-men" and "Grandfather-Gray-Beards," in some parts. They all have similar habits, being carnivorous and seizing their prey very much as a cat seizes a mouse; but they differ from other spiders in that they bodily devour their victims, instead of sucking out their juices. They are known to devour great numbers of plant-lice, and Mr. Arthur Bryant, of Princeton, Ill., found them devouring the larvæ of our Colorado immigrants.

But the most important of our auxiliaries to be added to this list of natural enemies of the *Doryphora* are to be found in its own Class. They consist of the following species:

THE 15-SPOTTED LADYBIRD.—This may be known as the large 15-spotted

[Fig. 4.]



Ladybird (*Mysia 15-punctata*, Oliv.) It is the largest of the ladybirds that we have, and the only other species of the Family in this country that is larger, is the Northern Squash-beetle (*Epilachna borealis*)—a species which has the wing-covers spotted in a somewhat similar manner, but which I have not yet met with in Missouri. The 15-spotted Ladybird is a very variable insect, and at *d*, *e*, *f* and *g* (Fig. 4), are represented four of the more striking forms. In the more common form the thorax is cream-colored and the wing-covers cream-colored, with a tinge of chocolate. In this form (*d*) the black spots and marks are conspicuous. In the next form (*e*) the thorax remains the same, but the wing-covers are chocolate-brown and the black spots are surrounded with a paler brown annulation. In the third form (*f*) the thorax is a little darker, and the wing-covers so dark that the spots are scarcely perceptible; while in the fourth form the whole insect is of a uniform deep brown-black color.

The larva of this beetle (Fig. 4, *a*) is jet black, with six rows of long spines and six long black legs. It has a paler yellowish stripe along each side, intercepted by two bright orange spots behind the legs, and there is also an orange spot on the back of the flattened first joint (*c*). I found this black fellow devouring the young potato bugs last May at Allenton, and my friends E. B. Reed and Wm. Saunders, of London, Ontario, have found the beetle at the same commendable work in Canada. When about to change, this larva fastens itself to the plant and changes to a cream-yellow pupa, marked with black, as at Figure 4, *b*.

The Icy Ladybird.—This species (*Hippodamia glacialis,* Fabr.) which was doubtless so named from occurring so far north, where it is often found under ice and snow, has likewise been seen in great numbers carrying on the same commendable work. Figure 5 represents it of the natural size, the wing-covers being of a bright orange-red, each marked behind with three black spots, the two upper of which are confluent. The head and thorax are black marked with cream-yellow as in the illustration. The species is closely allied to the Convergent Ladybird (differing principally in being nearly twice as large, and in lacking the spots on the anterior portion of the wing-covers), and will be found to have similar transformations.*

[Fig. 5.]

The Ring-banded Soldier-bug.—The third of these new friends of the

* See 1st Rep. Fig. 52.

[Fig. 6.]

potato grower is a prettily marked insect—a genuine Bug—belonging to the same extensive group (*Scuttellera* family) of the true Bugs (*Heteroptera*) as the Spined Soldier-bug, which is now so well known for its efficiency in thinning out the ranks of our potato pest, and which was illustrated in my first Report (Fig. 54).

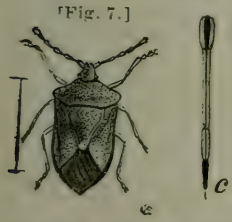
The Ring-banded Soldier-bug (*Perillus circumcinctus*, Stäl.) which is illustrated at Figure 5 (*b* showing an enlarged view of its antenna and *c* of the beak with which it sucks the juices of its prey), is of a rich polished brown color, marked as in the figure, with pale yellow. Underneath, on the venter, there is a large yellow patch containing four black spots quadrangularly arranged, and there is a border of yellow extending around the edge of the whole body. It is a not uncommon species in Missouri, and was found by Mr. Reed, of London, Ontario, preying voraciously upon potato bugs.

These three species are so conspicuously marked that they can be easily recognized. Wherever found let them be kindly dealt with!

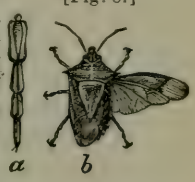
The fourth species to be added may be popularly known as

THE DOTTED-LEGGED PLANT-BUG.—This insect (*Euschistus punctipes*, Say, Fig. 7) is minutely speckled and of an ochre-yellow color, and so closely resembles the Spined Soldier-bug that I reproduce the illustration (Fig. 8) of this last to contrast with it. The most obvious features whereby to distinguish these two insects are those furnished by the figures, namely, the more flattened form of the Soldier-bug (Fig. 8) and especially of its squarish head, compared to the Plant-bug (Fig. 7); and the sharp-pointed thorax of the former compared to the more rounded thorax of the latter. This last character is variable, in both, so that specimens of the former occur with the thorax rounded, and of the latter with it more pointed; but there are two other structural differences which are always constant and can always be relied on to distinguish the two insects. If the Spined Soldier-bug be examined underneath, its beak (Fig. 8, *a*) will be found to be quite stout, especially at the base, and between the hind legs at the base of the venter, a prominent tooth pointing towards the head will be noticed. This last feature is entirely absent in the Plant-bug; while the more slender beak (Fig. 6, *c*) of the latter, the average larger size, the black-dotted legs, and the absence of the opaque brown streak at the transparent and glassy tip of the wing-cases, or hemelytra, combine to distinguish it still further from its more ferocious simile.

[Fig. 7.]



[Fig. 8.]



The Dotted-legged Plant-bug has heretofore been considered a purely vegetable feeder, and its being caught partaking of more carnivorous food must be considered exceptional. It is however an interesting fact, entomologically considered, and shows that the carnivorous is not so widely separated from the herbivorous habit as we are wont to suppose. Many other

facts of a similar nature might be cited, some of which have been already mentioned in these reports; and it has long been known to entomologists that Bugs of this particular *Scutellera* family which normally are plant-feeders, will yet attack other soft-bodied insects when opportunity offers.

According to Dr. LeBaron, there is some evidence, not yet sufficiently conclusive however, that the Tarnished Plant-bug (Rep. II, Fig. 83) also feeds on the Doryphora larvæ.

While touching upon the Spined Soldier-bug, it will be well, perhaps, to state that though, with all true Bugs, its larva and pupa are active, and have the same habits and general form of the mature insect, yet they differ so much in coloration and pattern, that they are scarcely ever properly identified and have often been sent to me as a new Potato bug enemy by those who have found them boldly carrying out their naturally voracious instincts.

[Fig. 9.]

The eggs of this Soldier Bug, as I have good reason to believe, are pretty little bronze-colored, caldron-shaped objects, with a convex lid, around which ciliate fifteen or sixteen white spines (Fig. 9, *c*). They are neatly placed side by side in clusters of a dozen or more, to leaves and other objects, and are so much subject to the attacks of a minute Hymenopterous parasite, that those who undertake to hatch such as are found out of doors will more often get flies than bugs. The newly-hatched bug is ovoid, and shiny black, with some bright crimson about the abdomen. In the full grown larva (Fig. 9, *b*) the black still predominates on the thorax but some four yellowish spots appear, and the abdomen becomes more yellowish, though still tinted with red. In the pupa (Fig. 9 *a*) which is readily distinguished by the little wing pads, the ochreous-yellow extends still more, and finally, with the last moult, the black disappears entirely, in the perfect insect. Throughout the immature stages the shoulders are rounded, and not pointed, and the antennæ or feelers have but four joints instead of five as in the mature bug, while there are but two visible joints to the feet or tarsi instead of three. *

We have been taught to admire the muscular power of the lion, which is enabled to grip and toss an animal larger than itself with its powerful neck and jaws; but feats performed by these young Soldier Bugs, throw the lion's strength completely in the shade, for they may often be seen running nimbly with a *Doryphora* larva, four or five times their own size, held high in air upon their outstretched beak.

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* These facts do not seem to be generally known, but I believe it will be found a very general rule that in the larval and pupal states, all the *Scutelleridæ* have one joint less to the antennæ and tarsi. Westwood mentions the fact with reference to *Pentatoma rufipes* of Europe, but, so far as I am aware, it is not mentioned by Douglas & Scott, Amyot & Serville, or any other authors. With regard to the tarsi, the small third joint may perhaps be detected upon dissection, especially in the pupa, but the antennæ are never more than four-jointed in such species as I have had opportunity to study in the preparatory stages, namely, *Arma spinosa*, Dallas; *Brochymena annulata*, Fabr.; *Stiretrus fimbriatus*, Say, *Euschistus punctipes*, Say. It is the second joint of both the antennæ and the tarsi, in the larva and pupa, which elongates and divides in the perfect insect. [Since the above was written, I have had the pleasure of examining Mr. Uhler's collection of Hemiptera at Baltimore, and I noticed that the same trait occurs in the larva and pupa of *Rhaphigaster* and *Nazara*. Mr. R. had also noticed this physiological peculiarity of the *Scutelleridæ*.

The fifth additional enemy of our Potato bug is the NEBRASKA BEE-KILLER (*Promachus Bastardii*, Loew.) * This active and savage two-winged fly was observed by Mr. A. R. Whitney, of Franklin Grove, Ill., to seize and carry off the mature beetles, as we are informed by Dr. LeBaron. The Missouri Bee-killer (*Asilus Missouriensis*, Riley) would doubtless do likewise, though the fact has not yet been observed; and neither of these flies would be likely to kill Potato bugs enough to atone for their pernicious bee-killing propensities.

The sixth is the Kansas Bombardier beetle (*Brachinus Kansanus*, Lec) —an insect bearing a general resemblance to the Great Lebia (3d Rep., Fig. 41) but being one-third larger and more lengthened, and with the wing-covers of a duller, less polished blue. The beetles of this genus all have the power of discharging from the anus, when disturbed, an acrid fluid of so volatile a nature, that upon coming in contact with the air, it tenuates with an explosive noise and pungent smell, and hides the beetle in a bluish vapor which enables the little artilleryman to effect his escape. The species in question, was found attacking the Colorado Potato bug larvæ, by Mr. Thos. Wells, of Manhattan, Kansas, who furnished me with specimens for identification.

Lastly, we may add a species of Rove-beetle, belonging to the genus *Philonthus*. An undescribed species of this genus was found by Dr. Shimer maliciously killing the *Doryphora* larvæ in one of his breeding cages. There is no evidence yet, however, that it follows the same habit when free in the field. The particular species noticed by Dr. Shimer was in the Walsh cabinet, which was destroyed in the great fire at Chicago, but to give the reader a correct idea of this genus of insects I present a figure of *Philonthus apicalis*, Say (Fig. 10). The larvæ are active and voracious and bear considerable resemblance to the perfect insects. Figure 11 is taken from Westwood and shows that of *Goerius olens*. The pupæ are quiescent and incapable of motion, all the parts being soldered together and encased almost as firmly as in the chrysalis of a butterfly. The head and pro-thorax are suddenly bent forwards, the former touching the breast; and the back is curiously flattened. Figure 12 represents the pupa of an allied insect* found in the ground and from which I bred *Quedius molochinus*, Grav. The rove-beetles are, as a general rule, carrion feeders, preying voraciously on decaying animal and vegetable substances; but some of them are true cannibals, while a few are even parasitic. Indeed they are no doubt more carnivorous than is generally supposed.‡

[Fig. 10.]

[Fig. 11.]

[Fig. 12.]

Thus we have twenty-one enemies of its own Class, that have

* See first Rep., p. 168, and second Rep., p. 122.

† This pupa is yellowish-brown in color. Dorsum perfectly flat with the sides compressed and narrow-edged. First abdominal joint with a lateral spine; second with a larger, blunter, rounded tubercle; each of the others with a stiff bristle: apical joint with two converging thorns. Abdominal joints 2, 3 and 4 with a tubercle each side of dorsum.

‡ It is well known that these larvæ are difficult to rear to the perfect state, and one reason no doubt is that they are often adephagous in habit, and are too generally treated as rypophagous

actually been observed preying on the Colorado Potato-beetle, a round score of which have been figured; but the one true parasite is undoubtedly more efficient than any of the others.

THE CODLING MOTH, AGAIN.

A few additional and important facts in connection with the management of this insect, have come to light during the year just past, and are worthy of record.

Time of Year that the first Moths appear.—To make the statement answer for any latitude, what was said in my first Report may be safely relied on, namely, that the moths begin to appear as soon as the apple trees are in bloom. Egg-laying commences soon after apples form. Of course, the time of blossoming varies slightly with the variety; but the time of issuing of the moths varies still more, so that the statement holds good. As the seasons vary from two to three weeks, or even a month, in relative earliness, and as the appearance of the moths varies accordingly, the futility of giving exact dates becomes apparent.

Time required for its Development.—Having bred some moths nearly every year for ten years, in different localities, I can safely give the following as the average length of time required in the adolescent stages of the first brood; but which, of course, do not hold good in the second brood, which hibernates:—Egg state, 4—10 days; larva or worm state, 25—30 days outside and 3 inside cocoon; pupa state, 12—18 days. Little can be gained by isolated experiments, because the length of time required varies according to the state of the atmosphere, temperature, etc.

Proper Time to commence applying the Bandage around the Tree.—I have heretofore given the first of June as the proper time to commence applying the bandages, but late experience would lead me to advise their application nearly two weeks earlier. For reasons already stated it is difficult to give dates with any degree of accuracy, and the best advice that can be given is to have the bandages on the trees about a week after the first Wilson's Albany strawberries are ripe. It is of no use to put them on earlier with a view to entrap the moths, as I am convinced that these cannot be entrapped in sufficient numbers to make it pay. The bands should be removed and the insects destroyed at least once a fortnight from this time till the apples are all off the tree.

It attacks Peaches.—Last year (3rd Rep. p. 103) I gave reasons for believing that this insect had attacked peaches in some parts of the State, and had, according to Mr. Huron Burt, infested three-fourths of the crop around Williamsburg. I am now able to say positively that the insect mentioned is the genuine Codling Moth, as Mr. Burt has since furnished me with specimens of the worms. Thus, we have a second example in this

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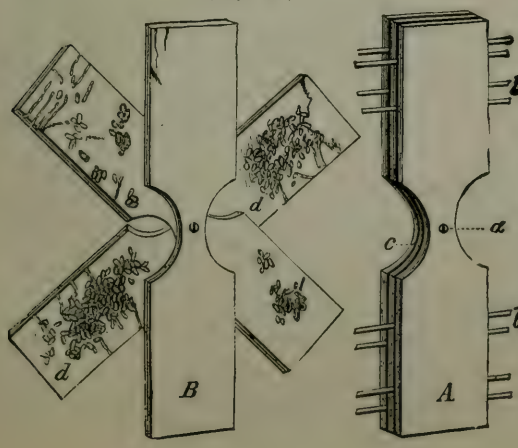
Goerius olens of Europe is noted for its rapacious character, and *Philonthus* may now be included in this category. Westwood (Int. II, p. 164) cites *Velleius dilatatus* as parasitic in the nests of *Vespa crabro*, and other small species of the genera *Dinarda* and *Lomechusa* as residing in the nests of ants. Mr. Fred. Smith (ibid, p. 365, note) found a species of *Megarthrus* parasitic on the larva of *Saperda populnea* while *Aleochora anthomyiæ*, Sprague (Am. Ent. II., p. 370) is parasitic in the larvæ of *Anthomyia brassicæ*.

same species of an insect normally confined to pip-fruit, all at once taking to stone-fruit, and thus acquiring a new habit. Yet, so far as we now know, the stone-fruit-feeding branch is yet confined to plums around London, Ont., and to peaches around Williamsburg, Mo.

THE KIND OF BANDAGE THAT IS BEST FOR THE PURPOSE.—There has been some difference of opinion as to the best form of bandage to be used. To be thoroughly effectual and durable it should be sufficiently firm in texture that it cannot be too easily cut through by the jaws of the worm, or drawn in folds and wrinkles by its silken threads. A stout and narrow piece of cloth or canvas, drawn around and fastened to the tree by a tack, is perhaps the simplest form of bandage and the most quickly fastened. Mr. Jas. Weed of Muscatine, Iowa, (Western Pom. Sep. '70) uses strips of cloth 1 1-2 inches wide. But every one must decide for himself what will be cheapest and most expedient, according to the extent of his orchard and the facility with which he can procure rags, cloth, haybands, or other substances. A good bandage, ready made, is greatly needed in the country, and if some enterprising firm would manufacture canvas strips about six inches wide, lined on one side with four inches of tow, cotton wadding, or some other loose material, and would put it upon the market at a reasonable price per yard, there would be an unlimited demand for it. Such strips would last for years, and could be cut of any desired length, drawn around and tacked, with little labor, to each tree; while, by smearing with tar or molasses, it might also be made to do good service, after the apple worm season, in those orchards infested with the Canker-worm. The advantage of the looser, thicker inside lining (which should however be closely and compactly pressed) would be that it would enable us to fill up all the inequalities of the bark, so as to absolutely prevent the young Canker-worms, as well as the moths, from ascending; and at the same time it would furnish a most enticing substance for the Apple-worm to spin up in.

NEW METHODS OF TRAPPING. THOMAS WIER'S APPLE-WORM TRAP.—Mr. Thos. Wier of Lacon, Ill., has hit upon a very simple device for alluring the worms, which is destined to play an important role in counterworking their injuries. In conjunction with his cousin, Mr. D. B. Wier, he has patented the trap, and though I do not think that the patenting of such simple devices is quite in accordance with a progressive horticultural spirit, or that the patentees will find it a very profitable undertaking, they have a perfect right to think otherwise.

[Fig. 13.]



It was too late in the season when the trap was brought to my notice, to give it a thorough trial, but I was at once very favorably impressed with its usefulness, and what little I have seen of its work has not altered that impression.

The trap (Fig. 13, A closed, B open,) consists simply of two, three or more thin pieces of board, 12 to 20 inches in length, and 2 to 4 inches wide, with a screw (*a*) through their center. The screw must be long enough to be firmly driven into the trunk of the tree, so as to hold the boards in position. The boards are cut out on each side of the screw, as at *c*, to facilitate their separation when fastened together by the silken threads of the worms, and so as to better expose the latter when the trap is opened.

The advantages of this trap, to my mind, may briefly be stated as follows, and I think they so far outbalance the disadvantages that it may be considered the best trap we yet have: It is cheap, accessible to all, easily placed on the tree and removed again; wood forms, perhaps, the most natural covert for the worms; the traps may be collected with little trouble by the barrowfull, submitted to a killing heat, in one way or another, and replaced again; they may be used on the ground as well as on the tree. Its disadvantages are few. One it has in common with all other snares or traps for this insect, namely, that it can never *exterminate* the Codling moth, for the several reasons given in previous Reports. Another is that where one only is used it can be attached to but one side of the tree, and in this single respect, notwithstanding all the theories of my friend Wier, it must always be inferior to any trap that encircles the tree.

The worms will spin their cocoons between the inner shingle and the tree as freely as between the shingles themselves, and I suspect that it will be found less tedious and cheaper to detach the traps and kill the worms by wholesale, than to open them on the tree. Those who prefer the latter method, will be pleased to learn of the means described by Mr. D. B. Wier, who says: "The quickest and best way to do this is to have a large tin pan bent in on one side, so as to fit closely to the trunk of the tree. When you reach the tree drop upon your knees, place the depression in the pan against the trunk of the tree, hold it there by pressing your body against it, and you have both hands free to open the trap. When opening it many of the pupæ or chrysalids will fall into the pan and some of the worms. Kill the rest or scrape them into the pan. The trap must be turned clear around, as many will be found between it and the bark of the tree. A person will open and kill the worms in from 400 to 800 traps in a day."

The inventor informed me that he believes his trap is more apt to come into general use by being patented, than if offered without price to the public. If in his hope to realize a fortune from it, he sends out agents among the fruit-growers of the country, I am not sure but he is correct; especially if such agents are enabled, by proper circulars giving a true and condensed history of the Codling moth, to disseminate important information. But the danger is, that patentees are sure to claim too much for their pet creations. This fact is well exemplified in the present instance, for already

Mr. Wier absurdly claims that all the worms descending a tree will be enticed to the side where the trap happens to be fastened, and the label pasted on such of the traps as have so far been sent out, commences as follows:

THOS. WIER'S

APPLE WORM

AND

CURCULIO TRAP,

Which catches Apple Worms, Curculio, and every species of insect infesting Fruit. [*!!!*]

The love of gain obscures the light of truth; and this wonderful power of a pair of shingles to catch "every species of insect infesting fruit," is altogether too much like Mr. Quackenbosh's patent universal, never-failing Elixir which cures all diseases that possess mankind! It will not deceive the well informed, but the glittering of its panaceal power may lure the unsophisticated.

Other evils will likewise result from the sale of this trap under such spurious claims, and without some explanation of the insect's habits. One of them may be illustrated by the following dialogue, which is not altogether imaginary, but is founded on an actual occurrence: Agent Gaingreedy—his desire to sell rights being stronger than his love of accuracy—meets farmer Glauball, and straightway expatiates upon the merits of the patent trap. He shows how the worms gnaw their way in between the shingles, and how easily they may be destroyed. "Ach," cries the credulous German, "und is it treu das de wurm rader eat de schindel als de apfel." "Oh, yes," says Gaingreedy, "screw one of the traps on to this tree, and in a week I will come back, and you will see." At the expiration of the week, the trap is opened, and upon viewing with wonder the worms that have secreted in it, Glauball rapturously exclaims, "Mein Gott, das ist de best ting I yet see," and purchases the right to use much quicker than he would if he knew that the worms had already been in his apples.

It may be claimed that so long as men can be induced to use the trap, and kill the worms regularly, it matters little whether or not they understand the philosophy of its use; but, barring the principle at stake, the spread of error can never be fraught with any continued good; and as errors on this subject are continually creeping into our best horticultural journals, it becomes patent that it is not the credulous German alone who needs correct rather than bogus information.

I have thus indicated the mischief that may be done by over-estimating the value of this trap, in order that the patentees may strip it of all appearance of sham, and present it to the fruit-grower for what it is—a very useful and important device—and not extol it as a sure Codling moth exterminator.

Jarring.—It is well known to all those who have had any experience with this insect, that the young apples infested with the early brood of larvæ fall much more readily from the tree than the more mature apples infested with the later brood. This fact has been denied by those whose

interests incline them to theorize in a different way, but the bushels of windfalls that cover the ground early in the year, under trees that are badly troubled with the worms, are sufficient attestation of the fact. Working upon this well known fact, Mr. Oliver Chapin, of East Bloomfield, N. Y., has been in the habit of jarring down these windfalls and then collecting them together and destroying them. He has been able by this means to preserve the fruit of a large orchard of a hundred acres, at the rate of about one acre an hour, with two men and a boy. An interesting account of his method was given in the *Country Gentleman* of the 25th of January last; and as he has also proved the insect to be double-brooded in that latitude; and in order to make a suggestion or two, I copy the following passages from the article:

Two men with poles usually knock off the wormy specimens about as fast as one boy gathers them into a basket. Where they are very numerous, more boys may be needed. As the fruit all hangs downward on the stems, the affected points may be easily seen from the ground, *by the exudations from the "blossom,"* and the men with poles know where to strike. The wormy fruit may be thrown into a large stream or pond and the larvæ thus destroyed, but if the apples float ashore, they will crawl out and escape. A kettle of hot water may therefore be better.

Mr. Chapin informs us that he has tried a series of experiments to determine the season when the insects commit their depredations. The earliest winged moths which he has found appeared on the 4th of June. These came from the cocoons in various hiding places and crevices, where they had passed the winter. About the 15th of July he first detected the presence of the worm in the young fruit *by the exudations already alluded to.* They continue appearing for some weeks. Hence the best season for the *first attack is about the middle of July.* By caging the insects, and watching their transformations, he finds that a second brood comes out early in August. He consequently attaches great importance to making the first attack in July a very thorough one. By doing so, but few insects escape for the second attack on the fruit, and the number of late summer specimens is much diminished, so that instead of having most of his apples spoiled by this second brood, as would otherwise be the case, very few are injured. He finds that the moth will not travel far in search of a place to deposit her eggs, if there happens to be plenty of fruit near at hand for this purpose; but in the absence of loaded trees, she will fly to an indefinite distance. * * * He does not, therefore, fear the results of neglect on the part of his neighbors, so long as they raise apples enough to keep their own moths at home, although it would be better for all to make common cause for their destruction.

I have italicised those passages that I more particularly wish to call attention to. The exudations from the blossom end, twice mentioned, are not indications of the presence of the worm, but, on the contrary, are sure indications of its absence in such apples; for they are caused by the exit of the worm. The middle of July is, therefore, by Mr. Chapin's own showing, a little too late to commence operations most successfully, and I have no doubt he will find it more profitable to commence a fortnight earlier, or about the first of July.

In the latitude of St. Louis, operations should commence by the middle or end of May; and those who use the rubber-tipped pole or mallet for the

Curculio, will find it just the thing needed; while those who have hogs to feed will find it pay to boil the fruit and feed it.

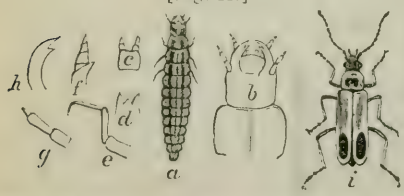
Fires, Lights, Bottles of Liquid as Remedies.—I have elsewhere given it as my decided opinion that neither fires, lights or bottles of sweetened water, vinegar or of any other liquid, can be used with any degree of success in fighting the Codling moth, and I have good reasons for so doing. During one whole summer, three years ago, I had a patent moth catcher, constantly in a garden surrounded by several old apple trees badly infested with this insect, and I never caught a single specimen of *Carpocapsa pomonella*. The trap was made of bright tin, with an inverted cone so placed in a basin that I could attach a light, and fill the basin with sweetened fluid. Again, during the summer of 1870, I was in the habit of working till late at night in an office surrounded by apple orchards known to be badly infested. I worked by the aid of two large kerosene lamps, each having a strong reflector, and the light in the room was so bright as to form a constant subject of conversation among the neighbors. Insects of one kind and another would fly into the room by hundreds, and on certain warm, moist evenings would beat against the windows with such rapidity as to remind one of the pattering of rain. Yet during that whole summer I caught but one or two Codling moths in that room, and there was more reason to believe that they had bred in the house than that they were attracted from without. At the same time I had hung up in an orchard close by, many wide-mouthed bottles, half-filled with various liquids, such as diluted syrup, sugar water, and vinegar more or less diluted. Every two or three days these bottles would contain great numbers of insects, which were critically examined. Many of them would be small moths of one kind and another; some of them larger moths known to be injurious, and many other insects—such as beetles, true bugs, wasps and two-winged flies—that were beneficial. Indeed, there were almost as many beneficial as injurious species, and as I shall presently show, the only two species yet known to prey on *Carpocapsa pomonella*, were among the more numerous victims of these hanging bottles. From my notes I find that but three Codling moths were caught in these bottles during the summer. Indeed, so small is the proportion of Codling moths which I have caught by the above mentioned process, that the chances of their accidentally flying into such situations are about as great as of their being attracted. I might add further experience on this head, but it is unnecessary. Upon showing specimens of the Codling moth to many dozens of eminent and intelligent fruit-growers, who have had to do with apple orchards, and consequently with apple worms, most of their lives, I have seldom found one who did not candidly confess that he had never before identified the insect; and under these circumstances it is not surprising that other similar moths should have been mistaken for the genuine article. The moth is, therefore, occasionally caught in such traps, and in the face of other intelligent testimony the fact cannot be denied, though the experience on this head of non-entomologists is conflicting. But whether we consider that the few so caught are really attracted, or are

captured accidentally, I believe that the methods indicated have no practical value. They are blind ways of shirking the more sure and efficient remedies.

I have been thus explicit as to these would-be remedies because my statement "that the Codling moth was not attracted (to any extent) by light," has been recently quoted by Mr. J. W. Robson as an evidence "that scientific men don't know everything." It would be strange indeed if they did, and I have always labored under the impression, somehow or other, that they were the last to claim any such universal knowledge, and that it was the charlatan alone who was blessed with the knowledge of everything. In the latest work on apple culture that has been given to the public, namely, "The Apple Culturist, with illustrations, by S. E. Todd," we naturally look for all that is new and important about this insect, which cuts such a figure in apple culture. Alas! what do we find? The descriptive part is a perfect plagiarism, almost word for word, from an article in the "American Entomologist," (Vol. I, pp. 112-114,) all palmed off as original; while under the head of remedies, he concludes his advice as follows: "By keeping the bottles containing sweetened water and the pan half filled with thin molasses, with a lighted lamp near it in the orchard every night, in good order, almost every insect will be trapped in a few days," and this excellent (!) advice is accompanied by an illustration of a shallow pan with a kerosene lamp on one edge of it, and "flies" as thick as a swarm of bees around it.

Natural Enemies.—The natural enemies of the Codling moth among birds are principally the Creepers (*Certhiadæ*), especially the Black-capped Tit-mouse. The Downy woodpecker guts great numbers of the cocoons, while the Blue bird and Crow Black-bird also feed upon it, according to Mr. Robson. Among insects two Ichneumons—*Phygadeuon brevis* and *Pachymerus vulnerator*—have been bred from it in Europe, * but no enemies have heretofore been known to attack it in this country. I have, however, discovered two which destroy the worms while they are leaving the fruit, and which in all probability seek them out while in the fruit. The first of these is the larva of the

[Fig. 14.]



Pennsylvania Soldier Beetle (*Chauliognathus Pennsylvanicus*, DeGeer) and I reproduce its likeness (Fig.14, *a*, larva; *b, c, d, e, f, g, h,* head parts; *i*, beetle) from my first Report, where it was shown to prey on the larva of the common Plum Curculio. This larva passes the winter in a nearly full grown state, feeds ravenously during the spring and early summer months; goes into the ground to transform and makes its appearance as a beetle during August, September and October, when it is met quite abundantly on the flowers of such rich pollen-bearing plants as the Goldenrod. While the larva is such a voracious cannibal, the beetle feeds solely on the honey and pollen of these flowers, and it is eminently fitted for this pur-

* Taschenberg's "Entomologie fur Gärtner and Gartenfreunde."

pose by the lower jaws (*maxillæ*) being prolonged into slender extensile pilose setæ, which form a sort of tongue analogous to the tongue of moths and butterflies.

The second of these enemies of the Codling moth is

THE TWO-LINED SOLDIER BEETLE, (*Telephorus bilineatus*, Say).—This is a soft-winged beetle of the same general form of, and closely allied to, the preceding—both species belonging to the Family *Telephoridæ*. The Two-lined Soldier Beetle (Fig. 15 *c*,) has brown-black wing-covers, and a reddish-yellow head and thorax, the latter having two short black longitudinal marks, from which the insect takes its name. The underside is a pale reddish-yellow, with a dusky band on the metathorax; the antennæ, feet, shanks, tips of thighs and a band on the head, between the eyes, being also dusky. This beetle makes its appearance much earlier in the season than the other, being found as early as April. It, also, seems to be principally a vegetable feeder, and is quite common with us crawling over the leaves of a variety of trees, I have repeatedly jarred it down with the Curculio catcher from Plum, Peach and Apricot, and Dr. A. S. Packard, Jr., says that it feeds, in the East, on the newly expanded leaves of the Birch. Mr. C. R. Dodge, of Washington, D. C., informs me that he has found it eating into a Lepidopterous chrysalis, a trait which must be considered exceptional.

[Fig. 15.]

c *b* *a*

The larva was unknown till last year, when Dr. Packard gave a figure and description of it, * without, however, giving any specific account of its habits. I have bred the beetle from larvæ found feeding on Apple worms and afterwards nourished upon them; and as the larva is quite frequently met with under apple trees, among early wind-falls, we may conclude that it has a partiality for the in-dwellers of this fruit; though it doubtless feeds also upon other soft-bodied animals. It is more usually found on the surface of the ground under the fallen fruit, stones, boards or other substances; but I have found it, as well as the larva of the Pennsylvania species, up in the branches, and on the hanging fruit of apple trees.

Both these larvæ are of a rich velvety-brown color, and that of the Two-lined (Fig. 15, *a* natural size; *b* head and first two joints magnified) differs from the Pennsylvania species in having more conspicuous black spots along the body, and an interrupted white line along the middle of the back. For the scientific reader I give below a technical description of it:

The most important fact for the practical man, in connection with what has been said, is, that both these soft-winged beetles—among Nature's appointed checks to the increase of the Apple worm—were quite frequently found by me among the insects in the bottles suspended among apple trees; thus showing that we may do more harm than good with such bottles.

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* First Ann. Rep. on the Inj. and Beneficial Insects of Mass., pp. 26–28.

SUMMARY.

The Apple worm or Codling moth is an imported insect. There are two broods each year, and the second passes the winter within the cocoon in the larva state. Use hogs and sheep in the orchard wherever it is feasible to do so. Place no confidence in lights and bottles, but rely on the bandage system. Have the bandages in place a week after the first Wilson's Albany strawberries ripen, and destroy all the cocoons underneath them every two weeks till the apples are harvested. Be sure and destroy, as soon as the ground thaws out in the spring, all the cocoons found around storehouses. Urge your neighbors to combine with you in this work.

TELEPHORUS BILINEATUS, Say.—*Larva* (Fig. 15, *a*)—*Body*, 12-jointed, joint 1 longest, 4 shortest, the rest of about equal length; flattened; tapering slightly at each end; velvety; of a rich deep brown above, pale below; intersections deep and broadening from sides to middle of dorsum; two deep longitudinal lateral furrows, and two, less deep, ventral ones; a medio-dorsal pale line continuous on the thoracic joints but showing only on the sutures of the rest; joints 2 and 3 each with a large sunken, suboval brown spot, each side of dorsum, these spots with a pale centre; in a line with these on all the abdominal joints but last is a more or less distinct, slightly sunken, pale line, and still another parallel with it further out on the side. Between these pale lines, on every joint but the last, is a slightly elevated, dark, bead-like tubercle which might readily be mistaken for spiracles; but these last which are dark and quite small are placed on the anterior edge of the first eight abdominal joints, in the upper lateral furrow, and between the first two thoracic joints—there being nine pair in all; anal joint with a moderate pooleg. *Legs* rather short, pilose, the tarsus terminating in a prominent and sharp claw. *Head* flattened, divided superiorly a little beyond the middle by a transverse suture, the basal portion of an opaque, velvety, sooty-black; the anterior portion polished, forming three well defined lobes, with the anterior edge irregularly broken; eyes prominent, placed laterally immediately before the occipital suture: antennæ inserted in a deep socket, 2-jointed, the 2nd four times as long as first and bearing a small sub-joint at tip: labrum not visible [Packard describes it as "broad and perfectly square in front, with a medium notch dividing the edge into two slight lobes." As Walsh describes that of *Chauliognathus* as being retractile, it is probably retracted in my specimens which are alcoholic]: mandibles falcate, with a strong tooth a little beyond the middle of the inner edge: beneath, the anterior edge is deeply and semi-circularly cut out: mentum extending between maxillæ for two-thirds their length: maxillæ large, projecting beyond labium, especially on the inside where they seem to be produced into a slight point; maxillary palpi 3-jtd., the second twice as long as the first, the third rudimentary: labium small, formed of a basal quadrate piece and two palpigerous pieces that are soldered together; labial palpi 2-jtd., the second rudimental.

Described from two alcoholic specimens.

Dr. Packard describes the labial palpi as 3-jointed, doubtless considering the palpigerous piece as a basal joint. He makes no mention of the stigmata, and as Walsh describes the closely allied larva of *Chauliognathus* with 11 pair, which is certainly anomalous; and as Chapuis and Candeze give to Telephorid larvæ but 9 pair, I have very critically examined my specimens, and find the stigmata as described above.

THE PERIODICAL CICADA.

It will be well from time to time to note the appearance of this interesting insect, in different parts of the country, so as to see how far its chronological history, as given in my first Report, is correct. The time for the appearance of six of the broods has passed away, and I will reproduce what was said of them in 1868, and append such facts, confirmatory or otherwise, as have come to my knowledge since.

BROOD I.—*Septemdecim*—1852, 1869.

In the year 1869, and at intervals of seventeen years thereafter, they will, in all probability, appear in the valley of the Connecticut river. According to Dr. Asa Fitch (N. Y. Rep. 1, p. 40), they appeared there in 1818 and 1835, and according to Dr. Smith they occurred in Franklin, Bristol, and Hampshire counties, Massachusetts, in 1767, '84, 1801, '18, '35 and '52.

The genuineness of this Brood was fully established, as its appearance in Connecticut in 1869 was recorded by several different journals.

BROOD II.—*Tredecim*—1856, 1869.

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

True to time, this Brood appeared in great numbers in the northwestern part of Georgia, as I am informed by Mr. A. R. McCutchen, of Lafayette, Walker county, in that State. There is a great deal of evidence, however, which goes to show that it is the 17-year Brood XXII which occurs in the northeastern counties, and Mr. Geo. P. Kollock, of Clarksville, Habersham county, writes that the "locusts" were not there in 1869, but that they swarmed in 1868 and 1851. Habersham county must therefore be stricken from the above Brood II, and perhaps Rabun also; while Walker and adjacent northwest counties should be added.

BROOD III.—*Septemdecim*—1853, 1870.

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

From all that I can learn, this Brood is invalid and has no existence. Mr. Rathvon failed to record its appearance in 1870 in the Kreutz Creek Valley, and the Rev. Dr. J. G. Morris of Baltimore, Md., writes positively that it did not appear. He says: "Our Lancaster friend, Rathvon, was a little mistaken in presuming that this would be the year of the appearance of the Cicada in Kreutz Creek Valley, York county, Pa. I have made diligent inquiry of persons familiar with that district, and they report no locusts. Now, it may be that he gives that title to a district different from that which I know by that name (for I was born in that vicinity), but the Kreutz Creek Valley, 7 or 8 miles east of York, and bordering on the Susquehanna, was not visited this year by this singular Cicada."

I likewise failed to hear of the "locusts," either in Vinton county, Ohio, or in Jo. Daviess county, Ill., and as all three of the localities are restricted and widely separated, and as those in Illinois and Pennsylvania are within the range of Brood V, which occurs one year later, the insects recorded to have appeared in the localities named in 1853, were most likely precursors only of the more extensive Brood V.

BROOD IV.—*Tredecim*—1857, 1870.

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

The appearance has been fully confirmed, and as the following communication will show, the Brood extends even into Alabama, Mississippi and Tennessee.

DEAR SIR—The 13-year Brood of the Periodical Cicada mentioned in your first Missouri Report (your Brood IV) appeared, according to prediction, in northwestern Florida this year, extending northward over Alabama and a good portion of eastern Mississippi, and into Tennessee as high as this point. I think I wrote you when they were here. They were not in great numbers at any point. I was at Mobile at the time of their appearrance there, and found them singing quite merrily in the woods below the city. J. PARISH STELLE.

Savannah, Tenn., Sept. 2, 1870.

BROOD V.—*Septemdecim*—1854, 1871.

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

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

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

Throughout the country mentioned in the first paragraph, the woods, orchards, cornfields and even meadows were vocal with the shrill song of these seventeen-year visitors. I was absent during the time of their appearance, but through the kindness of Dr. LeBaron, Mr. Suel Foster, of Muscatine, Iowa, Mr. H. H. McAfee of the Wisconsin University, and several other correspondents, I am enabled to fix more precisely the northern, southern and western boundaries of this Brood. Thus, in Wisconsin we may draw a line from Milwaukee on the east, gradually southward to the middle of the southern line of Waukesha county, then making a sudden dip to the centre of Walworth county, and rising again a little above the southern line of Jefferson county; then falling a little below Dane; then rising from the S. W. corner of Dane to the N. W. corner of Iowa county, and from thence along the Wisconsin river to its mouth. There seems also to be a detached branch commencing about the middle of the northern part of Iowa county and running across the Wisconsin river into Sauk county. In Iowa the boundary line extends from the mouth of the Wisconsin river,

S. W. to Vinton, in Benton county; thence S. E., skirting the Iowa river, to the Mississippi at a point in the northern part of Louisa county—thus embracing about a dozen counties, or 1-12th part of the State. In Illinois the boundary line, in a general way, may be drawn from the N. W. portion of Mercer county, S. E. to the Illinois river at Peoria, W. along the Toledo, Wabash and Western railroad. There seem to be detachments extending further south, especially in the eastern portion of the State, and they occurred as far south as Shelby county. In Indiana the line is not well defined, but includes the extreme N. W. counties, extending as far south as the Kankakee river. In Michigan it does not extend north as far as St. Joseph on the Lake.

As this insect can only appear in districts which were timbered or planted to orchard 17 years ago, it follows that in such an extensive prairie country as that within the limits indicated, the Brood must be very much detached and scattered.

They did not appear in the Pequea Valley in Lancaster county, Pa.: at least I have been unable to get any authentic record of the fact.

From all I can learn no Cicadas appeared at Plymouth, Mass., a fact which corroborates my view expressed in 1868, that the visit recorded by Morton in 1633 was a premature one and that it was due in 1634:

BROOD VI.—*Tredecim*—1858, 1871.

In the year 1871, being the same year as the preceding, and at intervals of thirteen years thereafter, they will, in all probability, appear in the extreme southwestern corner of Mississippi and in the adjoining part of Louisiana. Dr. D. L. Phares, of Newtonia (near Woodville,) Miss., says that in 1858, they extended over most of Wilkinson and part of Amite counties, Mississippi, and East an West Feliciana, La. He has himself witnessed the appearance of this Brood during the years 1832, 1845 and 1858, while it is distinctly remembered by aged people in his neighborhood as having also appeared there in the years 1896 and 1819. Dr. Smith gives their range from the Mississippi river, east to a ridge forty-five miles from the river that divides the State north and south, and north and south to the boundaries of the State; recording them as occurring in 1806, '19, '32, '45 and '58.

This Brood also appeared last summer, and a few precursors were noticed in 1869, but none in 1870. I quote the following account of it from a letter from Dr. Phares: "A few males began to appear about the 20th of April. Not many of any kind came out till the 7th and 8th of May. On those two days from 5 1-2 till 8 p. m., or about dark, they came forth from the earth in vast numbers; and in large numbers from that time for ten days more—the last I noticed, issuing on the 18th of May and being mostly of the smaller and sometimes darker colored individuals. Perhaps three-fourths of those coming up on the 7th and 8th of May were females. They are now (May 22nd) in full song, and I notice, with others, that when my large bell (412 pounds) is rung, they sing with redoubled fury."

Dr. Phares also sent me a large number of specimens, and measurements to show that there is a variation of at least half an inch in the expanse of the wings, and that the small dark form which has been named *Cassinii* is connected with the larger normal form by infinite grades. He is more convinced than ever that the small form cannot be a distinct species, and that there should be no *C. Cassinii* recognized; in which opinion I fully concur.

The experience of the past year furnishes nothing new beyond what I

gave in 1868. As usual, a number of cases of stinging were reported, and my conclusion that such stinging is caused by the beak, is strengthened by the experience of Dr. LeBaron. It was quite apparent that the eggs seldom, if ever, hatched from twigs which fell off the tree and became dried.

The foregoing record clearly proves the genuineness of five out of my first six Broods, the third being the only one, so far, which must be rejected.

THE GRAPE-VINE COLASPIS, AGAIN—*Colaspis flavida*, Say.

[Fig. 16.]

I have had an opportunity of examining a number of additional specimens of the larva of this insect, which has continued its injuries to strawberry roots in some parts of St. Louis county and of South Illinois; and though I have nothing to add to its economy as set forth in my last Report, I find it necessary to revise the description of the larva for the benefit of the entomological student. As stated at the time, my former description was drawn up from two rather poor alcoholic specimens, and after more carefully examining a great number of good, living larvæ, I find that description not sufficiently accurate. Upon more careful study, this larva plainly shows its Family characteristics, and the ventral appendages are rarely as prominent as previously indicated (Rep. 3, Fig. 38), being in reality but largely developed tubercles which the larva has the power of extending or retracting. The following description should therefore replace the other :

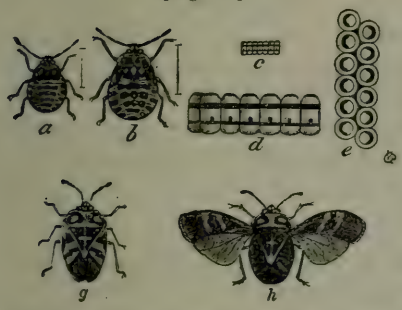
COLASPIS FLAVIDA, Say—*Larva*—Color yellowish. Body slightly arched. Anal joints smaller than the others. First joint horny above and of the same color as head. Dorsum with about three wrinkles to each joint and sparsely clothed with yellowish hairs, each springing from a minute rufous polished point. Stigmata, 9 on each side, rufous, the first between joints 1 and 2, the others placed on a lateral series of swellings, commencing with joint 4. Joints 4—11 inclusive, each with 8 substigmatal concolorous shiny plates (Fig. 16, *a*), the upper row lateral and divided from the second by a longitudinal depression: the second row forming tubercles which are retracted or projected at will. *Head* (Fig. 16, *b*, under side; *c*, upper side), honey-yellow, rounded, slightly flattened in front; epistoma and labrum of same color: mandibles darker, triangular, with the inner edge slightly excavated near the tip; antennæ apparently two-jointed, short and with the terminal joint often bifid; maxillæ well developed, the inner lobe furnished with strong hairs; maxillary palpi prominent, 4-jointed; labium sub-obsolete; labial palpi forming simply two small piliferous tubercles. *Legs* scaly, pale, setous, and terminating in a brown claw. Anal joint not horny below. Length, 0.25—0.30 inch.

Described from numerous specimens.

THE HARLEQUIN CABBAGE-BUG.—*Strachia* [*Murgantia*] *histrionica*, Hahn.

(Heteroptera, Scutelleridæ.)

[Fig. 17.]



Prior to the year 1870 the insect which forms the subject of this sketch was not known to occur in Missouri. It has of late years been gradually traveling towards us from the more southern States, and has already made its presence a little too manifest in some of our southern counties, and in Kansas I have met with it at a latitude higher than St. Louis. It extends to Guatemala, and is found in Mexico; and it varies very much, as most species are found to do when their geographical distribution is studied. As it extends southward we find the dark colors predominating, and becoming more intensified and brilliant, and Stäl has described a species (*Murgantia munda*) from Mexico, which is doubtless but a geographical race, since all the intermediate grades occur between it and the more northern form of *histrionica*. My friend, Mr. P. R. Uhler, has made some interesting experiments on the species, which have clearly proven that when reared in the dark the pale red parts predominate; while if reared in the bright day-light, the dark blue colors predominate. I gave a short account of it in the *American Entomologist* (Vol. II., pp. 79, 80), and cannot do better than repeat that account here with such modifications and additions as are necessary to render it more complete.

Cabbage-growers in the North are apt to think that the plant which they cultivate is about as badly infested by insects as it is possible for any crop to be, without being utterly exterminated. No sooner are the young cabbages above ground in the seed-bed, than they are often attacked by several species of Flea-beetles. By these jumping little pests the seed-leaves are frequently riddled so full of holes that the life of the plant is destroyed; and they do not confine themselves to the seed-leaves, but prey to a considerable extent also upon the young rough leaves. After the plants are set out, the larvæ of these insects are found upon the roots, in the form of tiny elongate six-legged worms. Through the operations of these subterranean foes, the young cabbages, especially in hot dry weather, often wither away and die; and even if they escape this infliction, there is a whole host of cut-worms ready to destroy them with a few snaps of their powerful jaws; and the common White Grub, as we know by experience, will often do the very same thing. Suppose the unfortunate vegetable escapes all these dangers of the earlier period of its existence. At a more advanced stage in its life, the stem is burrowed into by the maggot of the Cabbage-fly (*Anthomyia brassicæ*)—the sap is pumped out of the leaves in streams by myriads of minute

Plant-lice covered with a whitish dust (*Aphis brassicæ*)—and the leaves themselves are riddled full of holes by the tiny larva of the Cabbage Tinea (*Plutella cruciferarum*), or devoured bodily by large fleshy larvæ of the different owlet moths or of the white butterflies that were treated of in my second Report.

Severe as are these inflictions upon the northern cabbage-grower, there is an insect found in the Southern States that appears to be, if possible, still worse. This is the Harlequin Cabbage-bug, so called from the gay theatrical harlequin-like manner in which the black and orange-yellow colors are arranged upon its body. The first account of the operations of this very pretty but unfortunately very mischievous bug appeared in the year 1866, from the able pen of Dr. Gideon Lincecum, of Washington county, Texas, and was printed in the *Practical Entomologist* (Vol. I. p. 110). His remarks are to the following effect:

The year before last they got into my garden, and utterly destroyed my cabbage, radishes, mustard, seed turnips, and every other cruciform plant. Last year I did not set any of that Order of plants in my garden. But the present year, thinking the bugs had probably left the premises, I planted my garden with radishes, mustard, and a variety of cabbages. By the first of April the mustard and radishes were large enough for use, and I discovered that the insect had commenced on them. I began picking them off by hand and tramping them under foot. By that means I have preserved my 434 cabbages, but I have visited every one of them daily now for four months, finding on them from thirty-five to sixty full-grown insects every day, some coupled and some in the act of depositing their eggs. Although many have been hatched in my garden the present season, I have suffered none to come to maturity; and the daily supplies of grown insects that I have been blessed with, are immigrants from some other garden.

The perfect insect lives through the winter, and is ready to deposit its eggs as early as the 15th of March, or sooner, if it finds any cruciform plant large enough. They set their eggs on end in two rows, cemented together, mostly on the underside of the leaf, and generally from eleven to twelve in number. In about six days in April—four days in July—there hatches out from these eggs a brood of larvæ resembling the perfect insect, except in having no wings. This brood immediately begins the work of destruction by piercing and sucking the life-sap from the leaves; and in twelve days they have matured. They are timid, and will run off and hide behind the first leaf-stem, or any part of the plant that will answer the purpose. The leaf that they puncture immediately wilts, like the effects of poison, and soon withers. Half a dozen grown insects will kill a cabbage in a day. They continue through the summer, and sufficient perfect insects survive the winter to insure a full crop of them for the coming season.

This tribe of insects do not seem liable to the attacks of any of the cannibal races, either in the egg state or at any other stage. Our birds pay no attention to them, neither will the domestic fowls touch them. I have, as yet, found no way to get clear of them, but to pick them off by hand.

To give some idea of their numbers in Texas, Mr. Benj. R. Townsend, of Austin, in that State, wrote me, under date of February 28, 1870, that he had, within a few days, gathered 47,000 of the bugs.

In September, 1870, I received from William R. Howard a single specimen of this bug, which was found depositing her eggs near Forsyth, in

Taney county, and this was the first announcement of its appearance in Missouri. From the same source I learn that last July myriads of the insects appeared on the cabbages of the Hon. Jesse Jennings in that county, and that the plants were finally ruined. They have likewise been found on the grounds of Mr. B. F. Lee, in Marshfield, Webster county. Through the kindness of Mr. Howard and of Mr. Townsend I have received a number of specimens and have been enabled to present the following facts in its economy:

The eggs (Fig. 17, *c*), are 0.05 inch long and 0.03 inch wide, and, as stated by Dr. Lincecum, are usually deposited in two rows of about half a dozen each, and they are beautiful objects. When first deposited they are of a light green color, but they soon become white, with black bands. They may be likened to little barrels, for though the sides are straight, the edges are rounded off and the black bands, recalling the hoops, and a black spot near the middle, recalling the bung-hole, add to the resemblance. There are two black bands, the upper thicker than the lower, and the black spot is just above the lower band (Fig. 17, *d*). The upper edge is slightly crenated and drawn a little over a convex lid which is marked with a crescent-shaped black spot on the outside (Fig. 17, *e*). The inner sides by which the eggs are fastened to each other are almost entirely black. In depositing, the ovipositor is moved from row to row in a zig-zag line. To afford a passage to the young larva, one of the heads of the barrel—the one, of course, that is not glued to the surface of the leaf—is detached by the beak of the little embryo as neatly and as smoothly as if a skillful cooper had been at work on it with his hammer and driver. And yet, instead of employing years in acquiring the necessary skill, the mechanic that performs this delicate operation with unerring precision, is actually not as yet born into this sublunary world!

The larva (Fig. 17, *a*) is of a uniform pale greenish color, marked with polished black as in the figure. The pupa (Fig. 17, *b*) differs from it only in some of the pale marks inclining to orange, and in the possession of conspicuous wing-pads; and they both differ from the mature bug, not only in the non-possession of wings, but in their antennæ being but 4 instead of 5-jointed, as they afterwards become.

There are several broods of this bug during the course of the year, and the eggs will sometimes hatch the third or fourth day after deposition; while Mr. Howard informs me that the bugs will go through all their moultings and be ready for reproduction within a fortnight.

The mature bug (Fig. 17, *g* & *h*) is prettily marked with polished orange and blue-black, the relative proportion of the two colors being very variable and the orange inclining either to yellow or red. Besides cruciferous plants, Mr. Howard has found it feeding on a variety of the Pea.

It is said that no criminal among the human race is so vile and depraved, that not one single redeeming feature can be discovered in his character. It is just so with this insect. Unlike the great majority of the extensive group to which it belongs, it has no unsavory bedbuggy smell,

but on the contrary exhales a faint odor which is rather pleasant than otherwise. I have already referred to the beauty of its coloring. As offsets, therefore, to its greediness and its thievery, we have, first the fact of its being agreeable to the nose, and secondly the fact of its being agreeable to the eye. Are there not certain demons in the garb of angels, occasionally to be met with among the human species, in favor of whom no stronger arguments than the above can possibly be urged?

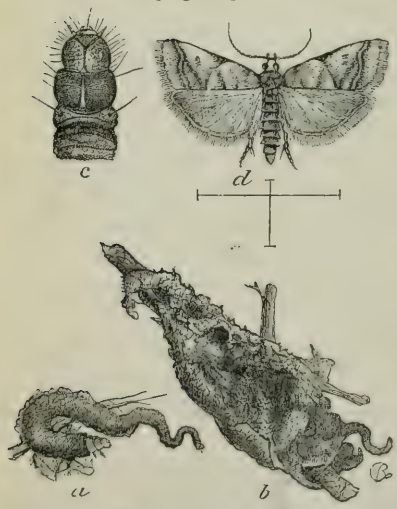
No remedy other than hand picking, is yet known; and I have had no opportunity of trying the effects of the various applications such as salt, ashes, soot, etc.

It is an interesting fact that in Europe, the cabbage grower is pestered with a bug (*Strachia ornata*, *Linn*) which bears a striking general resemblance to our insect in color and ornamentation, and which, as I was assured by M. E. Mulsant, of Lyons, France, has the light parts red in spring and yellow in autumn.

THE RASCAL LEAF-CRUMPLER—*Phycita* * [*Acrobasis*] *nebulo*, Walsh.

(Lepidoptera, Phycidæ.)

[Fig. 18.]



Such is the name given to an insect which is quite common in the Western States, and which also occurs in Ontario, but does not seem to be known in the Eastern or extreme Southern States. It was first described by Mr. Walsh, in the *Prairie Farmer* for May, 1860, p. 308.

It is one of those insects which is hardly noticed while carrying on its most destructive work; for it is most voracious during the leafy months of May and June, and is then more or less hidden by the foliage of the tree which it so effectually helps to denude. But the nakedness of winter, though it does not reveal the surreptitious worm, lays bare and renders conspicuous its little house, and

* For reasons repeatedly given, I retain the technical name first given to this moth by Mr. Walsh. It was certainly properly referred to that genus as characterized by Westwood (Synopsis, p. 113). But genera have become so multiplied of late years, that many of the older and earlier erected are fast vanishing from our classification. None but the specialist can undertake to keep up with the endless new generic characters that are being made, too often, to my mind, on the most trivial grounds; and none but the specialists are particularly interested in these changes. For practical purposes, therefore, unless there are good and sufficient reasons for making a change, it is best to adhere as much as possible to those names by which notorious insects have become generally known. This course is always safe, if the more modern genus to which the insect should be referred is in some way hinted at, for the entomological student. *Phycita nebulo*, Walsh is *Myelois indiginella*, Zeller, as I am informed by the latter author who has had occasion to examine specimens which I forwarded to him. In reality it belongs to the genus *Acrobasis* as characterized by the same author in the *Isis* of 1848, p. 606.

these houses—these larval cases—whether closely attached in clusters to the twigs as at Figure 18, *b*, or hidden in a few seared and silk-sewed leaves as at Figure 19, are unerring tokens of past injury to the tree, and symbols of increased injury in the future, unless removed. The bunches of leaves anchored to the tree by strong silken cables and breasting defiantly every winter's wind, are, indeed, significant insignia upon which is written in characters, if not in words—"result of careless culture and unpardonable neglect."

[Fig. 19.]

This insect sometimes becomes so prodigiously multiplied in young orchards or in the nursery, as to seriously affect the health of the trees; for it does not confine itself to the leaves, but often in early spring commences on the swelling buds, attacks the young fruit, or gnaws the tender bark. Though I have not met with this Leaf-crumpler in Southern Illinois, it nevertheless occurs throughout our own State, and is quite injurious in the southwestern counties. There is but one brood a year, and the larva, about one-third grown, invariably passes the winter protected in its case. At this season of the year it is always of a deep reddish-brown color. As the leaves expand in spring it rouses from its winter lethargy, and after "heaving anchor"—to use a nautical expression—by severing the silken connections of its case, travels in search of food, and, having found it, secures its case again and breaks its long fast. Toward the end of May it acquires its growth, when the earlier brown color frequently takes on a more or less decided deep green hue. It is a smooth worm with the head and thoracic joints as represented at *c*. The case at this time usually presents the appearance of Figure 18, *a*, being crooked and twisted like a little horn, gradually enlarging, cornucopia-fashion, from tip to mouth, and reminding one strongly of a piece of bird dung. It is formed of the worm's excrement and other debris, interwoven with silk, and is completely lined on the inside with a carpet of the last named material. The worm leaves it for feeding purposes mostly during the night. The chrysalis is formed inside this case, and the moths commence to make their appearance during the forepart of June, and later as we go further north.

The moth (Fig. 18, *d* and Fig. 20, *c*) has the front wings of a pale ash-gray color, variegated with cinnamon-brown and dark brown; while the hind wings are of a uniform dusky-gray. The male is distinguished from the female by a little horn-like tuft on the basal joint of the antennæ, which is a characteristic of the genus. The worms hatching from the eggs deposited by these moths are about one-third grown when winter sets in, and they pass this season as already described, and thus the insect continues from year to year the cycle of its life.

I have bred this insect from Apple, Cherry, wild and cultivated; Plum, wild and cultivated; Quince, and Crab-apple, and have noticed the cases on

Peach. Near St. Louis it has been, if anything, more injurious to quince than to apple trees. Yet it does not seem to be able to live on the Pear.

Remedies.—The Rascal Leaf-crumpler is one of those insects which, from their peculiar habits, are easily subdued. The orchardist has but to bear in mind that it is single-brooded, and that it passes the winter in its case, and he will understand that by collecting and destroying these cases in the dead of the year when the tree is bare, he effectually puts a stop to its increase. If this fact were more generally recognized, we should see fewer of these insects in our orchards and nurseries. Whether collected in the winter or pulled off the trees during the spring and summer, these cases should always be thrown into some small vessel, and deposited in the centre of a meadow, or field, away from any fruit trees. Here the worms will wander about a few yards and soon die from exhaustion and want of food; while such parasites, hereafter mentioned, as are well developed or in the pupa state, will mature and eventually fly off. In this manner, as did Spartacus of old, we swell the ranks of our friends while defeating our foes.

When so simple a remedy is at hand it is hardly necessary to seek for others. Applications of air-slacked lime to the tree when the foliage is moist, have been urged as a remedy; but it would seem that the worm is too snug in its retreat to be much affected by any such dustings, and there is scarcely any occasion to resort to any other than the simple and effectual remedy suggested. Because empty cases are found after such applications, men must not run away with the idea that the inmate has been scared away; for there is always a certain proportion of old cases which are empty. These stick to the tree long after the moths have escaped from them, and furnish a snug retreat for some other insects. The female Canker-worm particularly is fond of depositing her eggs within such old cases, as I have frequently found them crowded with such eggs.

Natural Enemies.—In Mr. Walsh's time but one real parasite was known to infest the Leaf-crumpler, and that was a little two-winged fly, which might easily be confounded with the common House-fly. It has not yet been described, and as my friend Dr. LeBaron bred it on several occasions the past year and has undertaken to describe it, I present below his description, as kindly furnished me for use. This *Tachina* larva becomes a pupa within the case of its victim, and Mr. D. B. Wier tells me that it was so abundant at Lacon, that the Leaf-crumpler was not one-tenth as numerous in 1871 as it had been in 1870.

Tachina [Exorista] phycitæ, LeBaron—*Imago.*—Length, 0.20 inch. Antennæ black, third joint twice as long as the second; face silvery, without bristles at the sides; sides of the front silvery at the lower part, pale golden above; the middle black vitta occupying a little more than half of the width of the inter-occular space; frontal bristles continued down the face to opposite the end of the second joint of antennæ; palpi blackish-brown; eyes hairy. Thorax black, with the ordinary cinereous stripes scarcely perceptible. Abdomen black, varied with cinereous at the base of the segments; a large fulvous spot on the side of the abdomen occupying nearly the whole of the side of the second segment, half or more of the third, and sometimes a small spot on the first; bristles on the middle as well as at the hind-margin of the second and third segments. Venation of the wings of the usual type; first posterior cell almost closed, before the end of wing; fourth long vein slightly curved after the angle; fifth long vein prolonged to the margin; hind cross vein moderately sinuous. Tarsal claws and pulvilli unusually long.

Female? A single specimen, a very little larger than the others, was obtained from the same lot of leaf-crumplers, which possibly may be the ♀ of the same species. It differs as follows: Front broader; antennæ dark brown; the cinereous markings of the body more distinct; the tip of abdomen fulvous, but without the fulvous spot at the sides; and with the tarsal claws of ordinary length.

This species appears to belong to the subgenus *Exorista* of Meigen, closely allied to *Tachina* proper, and differing from it chiefly in having the eyes hairy, and in the presence of bristles on the middle, as well as at the hind margin of the second and third abdominal segments, whereas *Tachina* has only the latter.

Mr. Wier has given me specimens, said to be bred from it, of a small Ichneumon-fly which proves to be *Limneria* [*Banchus*] *fugitiva,* Say.* It is a small black species with the legs pale yellow, except the hind tibiæ which are white with black base and tip, and the hind tarsi which are black with the base of the first joint white. In this genus the terminal part of the abdomen is compressed laterally, and arched, and the ♀ ovipositor is so short that it does not extend beyond the tip of abdomen, so that the sexes do not differ very strikingly. This particular species infests other insects,† and I have obtained it from larvæ, at Chicago, Ill., as well as at St. Louis.

PHYCITA [ACROBASIS] NEBULO, Walsh—*Imago.*—I reproduce here the description of the moth in Mr. Walsh's original words: "Expansion of wings 7-10. Length of body 3-10. General color light cinereous, varied with dusky. A row of about seven subsemilunar or linear dark spots on outer margin of fore wing. Then one-fourth of the distance to the body a waving light cinereous band parallel to the exterior margin, marked on each side with dusky black. Nearly at the centre a much abbreviated black band. Beyond the centre on the costal margin a subtriangular dusky black spot, the apex of which connects with the apex of a much larger subobsolete triangular brick red spot which extends to the interior margin, and is bounded on the outside by a wavy light cinereous band, which is again bounded by a wavy dusky black band proceeding from the apex of the costal triangle. Base of wing dusky black, enclosing a small round light cinereous spot. Hind wings and all beneath light cinereous shaded with dusky, the fore wings darker. Tarsi dusky with a narrow light cinereous fascia at the apex of each joint. Hind tibia fasciate with dusky at the apex, sometimes obscurely bifasciate. Intermediate tibia fasciate with dusky at the centre, the fascia generally extending to the base, but becoming lighter. Anterior tibia dusky, with a narrow apical light cinereous fascia. Palpi, both labial and maxillary, dusky."

When compared with other closely allied and resembling species, this little moth may be characterized in the following manner: The ground color of the front wing is decidedly bright and pale; the discal spots are almost always confluent, thus forming an abbreviated transverse bar; the dark markings are well defined and the triangular dark costal spots starting from the inner third of the wing is distinctly relieved, while the "brick-red" (nearer a cinnamon-brown) triangular spot which opposes it is large, so that the space it occupies on the inner margin is nearly as wide (generally within one-third) as that between it and the transverse posterior line. The lower half of the basal space is often of a distinct cinnamon-brown, and an oblique dusky band, which Mr. Walsh has not mentioned, is often quite distinct, running from near the apex to the brown triangle, where it connects with the inner margin. The species recalls, in facies, the European *Myelois suavella.* In a suite of specimens bred from Apple, Quince, Plum and Cherry, there is sufficient variation to prevent a too rigidly drawn description, but the above characters obtain in all of them, and such variation as occurs, runs in the direction of the variety presently to be described.

Larva—Brown or greenish in color. Cylindrical. Tapering gradually from first to last joint. Head and cervical shield darker than the rest of body, slightly shagreened, sparsely covered with long hairs, the shield quite large, convex, and occupying the whole surface between stigmata—there being in front of the latter a sub-cervical dark horny plate. Joints 2 and 3 wrinkled as at Figure 18, *c* the former with two rather conspicuous dark dorsal piliferous spots. The other joints with a few fine hairs, the stigmata plainly visible, and the anal covering but slightly horny. Legs and prolegs of moderate size and of same color as body.

Described from numerous specimens.

Chrysalis—Mahogony-brown, with no striking character. Abdomen, especially above, with very minute punctures.

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* Ent. of N. A. II, p. 701.

† Mr. J. A. Lintner, of Albany, N. Y., has given me specimens bred from *Saturnia maia*, Drury; Mr. H. T. Bassett, of Waterbury, Vt., specimens bred from *Dryocampa senatoria*, Sm., and I have bred it from *Dryocampa stigma*, Sm., from *Euchætes egle*, Harr, and from *Clisiocampa sylvatica*, Harr.

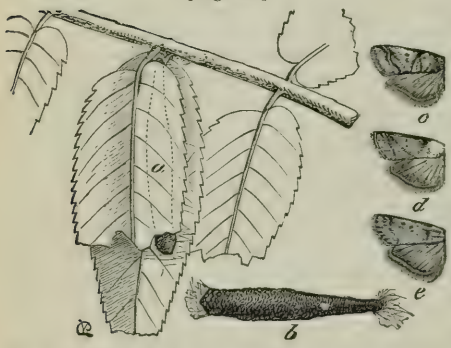
VARIETY NEBULELLA (Fig. 20, *e*).—I have bred a single specimen from wild Crab (*Cratægus*) which differs in some essential features from the normal form, but which nevertheless can only be considered a variety of it, as I observed no larval differences. It differs in the more uniform and subued tone of the front wings, the markings being more suffused and indistinct; but principally in the relative narrowness of the space outside the transverse posterior line the greater consequent width of the middle area, and smallness of the triangular brown spot—the space it occupies on the inner margin being scarcely one-half as wide as that between it and the transverse posterior line. The discal spots are also separated.

Described from one good specimen. An interesting fact connected with this variety is, that precisely the same form occurs in Europe, as I found a single specimen in the cabinet of M. J. Lichtenstein of Montpellier, France, which he had captured in that vicinity, and which he allowed me to bring home for comparison. It seems to be rare, even there, and whether indigenous or imported from this country, is a question yet to be solved.

THE WALNUT CASE-BEARER—*Acrobasis juglandis,* LeBaron.

(Lepidoptera Phycidæ.)

[Fig. 20.]



There are several other worms tolerably common with us which form cases very much like those of the Rascal Leaf-crumpler just described. One of these which is tortuous and crooked, like the preceding, is found attached to the leaf of the Post oak, the worm skeletonizing the leaf for food. Another, which is straight, is found on the Soft maple, the inhabitant drawing a few leaves together and likewise skeletonizing them. The moths which these produce are not yet known; but there is a straight case-bearer found on Hickory and Walnut which produces a moth so much resembling our *nebulo*, that, though the insect cannot be considered a very injurious one, I am led to give a brief account of it for purposes of comparison, and to show how distinct species, with constant larval characteristics, may so graduate into each other in the perfect state as to render knowledge of their larval habits absolutely necessary to distinguish them.

The case of this insect (Fig. 20, *b*) is invariably straight, and the excrementitious grains which cover it on the outside, are very closely and neatly woven together. It is attached by the small posterior end to the main leaf-stalk, and the worm draws down and fastens two of the leaflets to hide it, and then feeds upon them from the point to the base (Fig. 20, *a*). The worm differs in no respect from that of *nebulo*, except in being more commonly dark greenish. There is, in all probability, but one brood a year, and as with *nebulo* the larva passes the winter in a partially grown condition; and as it lives during the summer on a compound leaf, it very wisely abandons this leaf, and anchors its case firmly to the more enduring twig, before winter sets in.

The moth very closely resembles *nebulo*, as may be seen by referring to Figure 20, *d*, which shows its wing characters, the colors being the same. In this cut I have given two subsidiary sketches, the one at *c* showing the typical *nebulo*, the other at *e* representing a crab apple feeding variety of the same; and the general reader will readily perceive (providing the public printer does not give us too muddy an impression) that the intermediate figure (*d*) differs less from the upper (*c*) than from the lower one (*e*). Yet the differences in the habits of the larvæ show that the Walnut Case-bearer is a distinct species.

ACROBASIS JUGLANDIS, LeBaron.—(Fig. 20, *d*)—I have bred this species from Hickory, but as Dr. LeBaron has also bred it abundantly from Walnut, and has signified his intention of describing it in his second annual Report, I adopt his proposed name, and shall content myself with pointing out the manner in which it may generally be distinguished from *nebulo*. Firstly, by the paler basal area of the front wings, which is sometimes almost white, especially near the costa, and by the head and shoulders and sometimes the ♂ antennal horn partaking of this paler color. Secondly, by the darker median space, the dark triangular costal spot not being well relieved posteriorly, but extending so as sometimes to darken the whole space. Thirdly, by the discal spots always being well separated.

Such are its specific characters as taken from 3 hickory-bred and 6 walnut-bred specimens; but of the former there is 1 which when placed alongside of some of the more abnormal specimens of *nebulo*, can scarcely be distinguished from them, and, if chosen without knowledge of its larva, would certainly be placed with them; while of the latter there are two which nearly as closely resemble the variety *nebulella*. In general characters, in the size of the brown triangular spot, and the manner in which the inner margin is divided, *juglandis* is intermediate between *nebulo* and *nebulella*. In one of the hickory-bred specimens, the general color is quite warm, and the basal area carneous rather than white.

NATURAL ENEMIES.—From a lot of parasites bred from this insect by Dr. LeBaron, I find four distinct Ichneumon-flies. Three of them are black with legs variously marked with yellow reddish and black, and they all belong to the genus *Pimpla** which is characterized chiefly by the joints of the abdomen being for the most part broader than long, and the ovipositor of the female, with its sheaths, never extending more than the length of the abdomen beyond its tip. The fourth is a yellow fly belonging to the genus *Perilitus*, and as I am kindly informed by Mr. E. T. Cresson, is a new species. I therefore describe it by the name of

PERILITUS INDAGATOR, N. Sp—Imago—♀, *Head* almost glabrous, transverse, deep honey-yellow, the trophi pale, except the tips of jaws, which are dusky; ocelli touching each other, black; eyes black, very large, occupying nearly the whole side of face, and with a few very short hairs; antennæ with about 24 joints, pale fuscous; reaching, when turned back, to about the middle of abdomen. *Thorax* honey-yellow beneath and very slightly pubescent; very finely punctured and slightly pubescent above; prothorax honey-yellow and prominently convex; mesothorax with lateral and posterior sutures black; metathorax black. *Abdomen* with the pedicel black and slightly punctured; depressed, narrow at base, widening behind, slightly pubescent above; the other joints glabrous, polished, deep honey-yellow, the second joint largest and as long as all the subsequent ones together; ovipositor extending about the length of the abdomen beyond its tip, rufous with the sheaths black. *Legs* pale honey-yellow, the tarsi, especially at tips, slightly dusky, the hind femora and tibiæ a little dusky towards tips, and a narrow rufous ring at base of former. *Wings* hyaline, iridescent; veins brown; stigma honey-yellow, with an opaque brown claud; two cubital cells, the outer small, sub-quadrate; the radial large; one discoidal, long and narrow. Length, exclusive of ovipositor 0.18 inch.

Described from 1 ♀ bred from *Acrobasis juglandis*, LeB.

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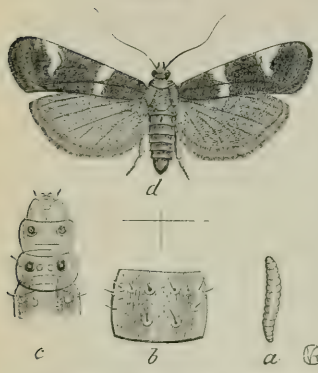
*These are *Pimpla conquisitor*, Say (Ent of N. A. II, p. 689,) *Pimpla indagatrix*, Walsh, Cress. (Trans. Am. Ent. Soc. III, p. 146,) and *Pimpla annulipes*, Br. (Hist. Nat. des Ins. Hym. IV, p. 102.)

THE APPLE-LEAF SKELETONIZER—*Pempelia Hammondi*, N. Sp.

(Lepidoptera, Phycidæ.)

[Fig. 21.]



The leaves of apple trees, and especially of young trees, are preyed upon by such a host of insects that their histories alone would furnish material for a good sized volume. The little worm which forms the subject of this sketch has never been described, and yet it is oftentimes so injurious and its work is so intimately associated with that of one or two other species, with which perhaps it has been confounded, that an account of it becomes doubly necessary. Though having different habits, it is quite closely related to the better known Rascal Leaf-crumpler.

In the fall of the year the foliage of trees in young orchards, and especially in the nursery, often wears a blighted, corroded, rusty look, and upon carefully examining it such appearance will be found to result from the gnawings of this little Skeletonizer. A badly infested orchard or nursery presents such a decidedly seared aspect that it attracts attention at a great distance; and while traveling by rail I have often pointed out the work of this insect and felt as sure of its presence in certain orchards, as though I had closely examined the trees.

The rusty appearance is produced by the worm feeding solely on the green pulpy parts of the upper surface of the leaf, and thus leaving untouched the more fibrous frame-work. In some cases the pulpy portions are eaten off very thoroughly so that nothing remains but the semi-transparent epidermis below, and the net-work of veins; but more usually a certain amount of the parenchyma is left and this it is which acquires a bright rust-red appearance. The worm always covers the leaf with loose tender silken threads, with which it mixes numerous little black, gunpowder-like, excrementitious grains; and it is under this covering that it feeds. It is semi-gregarious, either living alone on the leaf, or in company within a bunch of leaves tied together.

The worm (Fig. 21, *a*) is usually of a brown color marked on the back as at *b*, but it varies from brown to pale yellowish-brown or greenish. The markings are pretty constant, however, and the distinguishing feature consists of four conspicuous black shiny tubercles, with a pale basal annulation near the head, as at *c*.

The chrysalis is of a light brown color with no striking characters. It is generally formed among the leaves, in a very slight cocoon, and often in the folds made by a leaf-roller which is generally found in company with it. In confinement I have known the worms to go below ground where they cemented their cocoons on the outside with grains of sand.

The moth expands about 0.45 inch and has the front wings of a deep glossy purplish-gray, marked with two transverse pale bands, as in the figure (*d*). It may be popularly known as Hammond's "Knot-horn." I first received specimens of this worm in the summer of 1869, from Mr. A. C. Hammond of Warsaw, and W. T. Nelson of Wilmington, Ills. My late associate, Mr. Walsh, had intended to describe the species, and I now carry out his intention by naming it in honor of Mr. Hammond, whose experience with it, as given in the following extracts from one of his letters, will throw further light on its habits:

In August and September, 1868, I noticed that the leaves of my apple trees were being destroyed by some insect. An examination revealed the fact that the mischief was caused by a small greenish larva about half an inch long, with two dark stripes on its back. Their mode of operating appeared to be to locate themselves on or near the end of the twigs in communities of from three or four to a dozen, and form a dwelling place by webbing together a quantity of leaves with a material resembling spider's web. Within this shelter they live, feeding upon the leaves.

In June, 1869, I found the same insect at work in my orchard in great numbers. At this time the apples were about one-fourth grown, and we found that the worms generally inclosed two or three apples within the mass of leaves and that they were feeding upon these as well as upon the leaves, of course causing them to drop. Their ravages were principally confined to a few varieties. The yellow Bellflower, Winesap and Ben Davis appeared to be their favorites. They had caused fully one-half of the fruit to fall from several hundred trees in my orchard.

In Europe a larger species of a closely allied genus (*Acrobasis consociella*), which I have received from Mr. P. C. Zeller of Prussia, works upon the leaves of the oak in very much the same manner as ours does on those of the Apple; and it is one of those insects attended by a companion larva, Our insect seems to be similarly attended by two companion larvæ, namely, the two species next to be treated of. At least it is almost always found in conjunction with them. So far as we now know there is but one annual brood of the Apple-leaf Skeletonizer; but the moths issue very irregularly, and the worms may be found all through the summer, but particularly in the fall, as long as the leaves remain on the tree. I have found but partially grown worms as late as November—unfortunates that seemed doomed to a wintry death. The moths commence to make their appearance in the vicinity of St. Louis by the first of May, but I have had them issue as late as the last of July.

Remedies.—This insect, like a good many others, shows a decided predilection for unthrifty, tender trees, and careful, clean culture is the best preventive. A little hand picking at the proper time will do much to prevent its injuries, and I incline to believe that it may be extirpated by dusting the trees with air-slacked lime. I have bred from it two small Ichneumon-flies, one of which is a *Microgaster;* but during my absence last summer the specimens were destroyed by mice. The larva of some Lacewing fly (*Chrysopa*) also preys upon it, and its round white cocoon may often be found among the skeletonized leaves, and should be saved.

PEMPELIA * HAMMONDI, N. Sp. *Imago* (Fig. 21, *d*).—Average expanse 0.48 inch. Front wings glossy purplish-brown with two silvery gray transverse bands dividing the wing on costa in about three equal parts, the basal band sharply defined outwardly and always extending to inner margin, the posterior band never extending more than half way across the wing, and generally not more than one-third, illy defined. In some specimens the basal transverse band is quite narrow, with the basal space a shade paler than the median: in others the band forms a double line. In some specimens also, a narrow pale transverse line outside the second band, and a pale terminal shade, are visible. Hind wings uniformly paler gray. Under surface glossy gray, with no marks, the front wings a shade darker than the hind. ♂ differs from ♀ in the basal portion of the antennæ being curved, and the curve filled with a tuft of scales.

Described from numerous bred specimens. The species has the general facies of the European *Cryptoblabes bistriga*, which is a larger insect.

Larva.—Length 0.45—0.50 inch. General color olive, or pale green, or brown, with a broad dark stripe along each side of back. Tapers slightly both ways, joints 4-12 inclusive, divided into two transverse folds. Freckled with numerous pale specks and with piliferous spots, the specks often taking the form of two pale broken lines along the upper edge of dark stripe. The piliferous spots are pale with a central black dot, and are best seen in the dark specimens. On joints 4-12 inclusive they are placed 4 in a square on the middle of the back, and four more each side, the two upper lateral ones being on the anterior fold, the stigmata appearing as minute rufous specks between them. Both these spots are often double. The third lateral spot is on the posterior fold and the fourth is subventral and anterior. The hairs proceeding from these spots are long and setaceous. Head horizontal, freckled, pale behind, tinged with green in front and with a few long hairs. Joint 1 also freckled and with a large black piliferous tubercle with a pale basal annulation and in range with middle of dark stripe. Joint 2 with similar black tubercles with a white centre and replacing the uppermost lateral pale spot. There are but two of the small pale dorsal piliferous spots on this joint (between the tubercles) as well as on joint 3. Beneath immaculate, except that the thoracic legs have sometimes a few dusky dots.

In the very dark specimens the head, cervical shield and anal plate remain pale. The cervical shield is then well defined with four small piliferous specks at anterior edgae, and the large shiny tubercle forms the extreme anterior angle.

In many specimens the subdorsal dark stripe is obsolete or sub-obsolete, but even then the four black tubercles on joints 1 and 2 characterize the larva sufficiently.

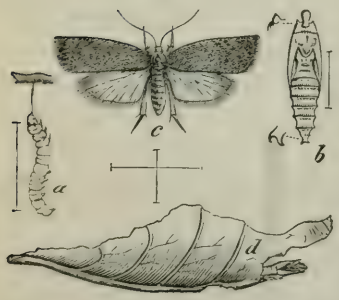
Described from numerous specimens.

Pupa.—0.24 inch long; rather stout and short, with two minute diverging spines and a few stiff bristles at tip.

THE GREEN APPLE LEAF-TYER.—*Tortrix Cinderella*, N. Sp.

(Lepidoptera Tortricidæ.)

[Fig. 22.]



In company with the foregoing Leaf Skeletonizer may almost always be found two or three different species of small green worms which aid materially in withering and denuding the leaves from young apple trees. These worms bear so close a resemblance to each other that it is almost impossible to characterize them. The species under consideration is of a uniform yellowish-green color, with the head and neck horny and a shade more tawny, the head being marked with a crescent-shaped

* Genera and families, so-called, are often instituted on such trivial and even variable characters among the smaller moths, that the proper placing of a species becomes very difficult, and ofttimes impossible. As Mr. Walsh informed me in 1869, specimens of this moth were that year sent to the English microlepidopterist, Mr. H. T. Stainton, who referred it to the genus *Acrobasis* (See Am. Ent. I p. 32). Upon carefully examining my own specimens, I found that the antennal characters of the ♂ placed it in the genus *Pempelia* rather than *Acrobasis*, and I at once suspected that the specimens sent by Mr. Walsh to Mr. Stainton were all ♀. Upon communicating with Mr. Stainton on the subject, and sending him the ♂, my supposition was verified. But, after all, as the late Dr. Clemens tritely remarked, our system of classification is yet "one of convenience and not of nature."

black mark on which are the eyelets, and another dusky spot at base on the sides (Fig. 22, *a*). It webs the leaves together, generally folding a single leaf in two, and living within the fold. Like all true leaf-folders it is very nimble, and wriggles away and drops to the ground when disturbed, while the Skeletonizer makes no especial effort to escape. In feeding, the Leaf-tyer is not confined to the parenchyma.

This worm changes to a chrysalis within a fold of the leaf, lined with silk, and when about to give forth the moth, works its way partially out at one end (Fig. 22, *d*.) The chrysalis (Fig. 22, *b*) is peculiar from having a rounded projection in front of the head. The moth (Fig. 22, *c*) is amost unassuming little body with the front wings of a dark ash-gray without a shade of any other color, the hind wings paler.

In the early part of the year this species may often be found more numerous than the Skeletonizer, but the latter predominates, so far as my experience goes, in the fall. There is much more to observe yet of its habits, and I now merely introduce it and give it a name because of its association with the preceding species. The same remedies which apply to that will answer for this.

TORTRIX CINDERELLA, N. Sp.—*Imago* (Fig. 22, *c*).—Alar expanse exactly 1-2 inch. Front wings deep glossy ash-gray, immaculate. Under a lens they have an irrorate appearance, while in certain lights some of the scales appear to form a series of darker transverse sinuous lines. Also scattered over the wing may be noticed a dozen or more reddish scales, which are not sufficient, however, to destroy the uniform immaculate appearance. Head, mouth-parts, antennæ, legs, and abdomen of same color. Hind wings paler and semi-transparent. Fringes of all wings concolorous. Under surface of wings pale nacreous, inclining to pale fulvous around the margins.

Described from two bred specimens.

Larva (Fig. 22, *a*).—Length 0.50 inch. Form of that of *Acrobasis nebulo*, wrinkled very much in the same manner. Color yellowish-green, the piliferous spots of the same color, but readily distinguished by their polished surface; they are placed in a transverse row on thoracic joints, and on joints 4—12 there are four rhomboidally on dorsum, two laterally on the first fold and one subventral. Stigmata between the two lateral spots, and yellowish. Head and cervical shield gamboge-yellow; only a shade darker than body; labrum and two basal joints of antennæ paler or white, the terminal joint brown; ocelli on a somewhat crescent shaped black spot (the most conspicuous character) a second dusky spot at base of head laterally. Legs immaculate.

Described from many specimens.

Pupa (Fig. 22, *b*).—Length 0.25—0.30 inch. Brown, characterized by a peculiar rounded projection from front of head; by a little pointed prominence at base of each antennæ, and each side of penultimate abdominal joint; and by terminating in a broad suppressed piece which produces two decurved hooks. Posterior rim of abdominal joints rasped dorsally, and a slight rasped dorsal ridge near the anterior edge of larger joints. Legs reaching only to end of wing-sheaths. The head-prominence varies in size and slightly in form.

THE LESSER APPLE LEAF-FOLDER.—*Tortrix malivorana*, LeBaron.

(Lepidoptera, Tortricidæ.)

This is the name given to a small pale green worm, by Dr. LeBaron,* who found it doing much damage to the young apple trees in the nursery of Mr. D. B. Wier, of Lacon, Ill., in the summer of 1870, but which almost disappeared in 1871. In habit and in size, form and color, it is the exact

* First Ann. Rep. on the Ins. of Ill., pp. 20—23.

counterpart of the Leaf-tyer just described.* The chrysalis is also similar, but the moth, instead of being uniformly ash-gray, is of a bright orange, but of exactly the same size and equally uniform in coloration; so that by imagining a bright golden orange instead of deep ash-gray, Figure 22, *c*) would answer for this species.

I have little doubt but this worm is also very generally associated with the Skeletonizer, as I found the latter had been quite abundant in Mr. Wier's nursery last fall; and it very probably helped in some degree to cause the blasted appearance of the nursery which was attributed solely to the Lesser Leaf-folder the year before.

In the *Prairie Farmer* for February 10th, 1872, M. Wier gives the following account of the habits of this Lesser Leaf-folder:

This is one of those ephemeral, and as we might say, local insects, that often do great damage at some point, and may not be troublesome again in that locality for years.

Our nurseries were scourged with it during the summer of 1870 to so great an extent that from the twentieth of June until the first of September, hardly a green leaf could be found on the younger trees.

My attention was first called to it in the fall of '63, by a neighboring nurseryman, who wished me to call and see how the Codling moth (as he termed it) had injured his apple seedlings.

His acre or more of seedlings could have looked no worse if they had been sprinkled over with dry straw, and burned over, yet, as was the case in our nursery, there was scarcely a Tortrix to be seen the succeeding summer, and his seedlings made a very strong growth. I next saw it in my nursery in June '64, when it swept over a large lot of two-year-old apple trees in June, but did no serious damage, as there appeared to be but one brood. It was next seen as stated above about the 12th of June, 1870, involving the entire apple nursery here, and more or less the orchards. At that time the caterpillars were about half grown, but were not numerous enough to do serious damage. They commenced to change to chrysalids about the 20th of June, and in three to four days, the little bright orange moths were flitting around amongst the trees, depositing the eggs for another brood of worms. The eggs soon hatched, and as the second brood of worms was at least one hundred times more numerous than the first, the trees soon began to show signs of damage. I did not determine positively, but I am quite certain that this brood changed to moths in about thirty days, or the 20th of July, and they at once laid their eggs, increasing perhaps fifty fold (enemies had begun to prey upon them). They matured about August 20th, and laid eggs for another brood, about equalling the second. These so far as I could see were all killed by frost, that were not destroyed by their natural enemies, when about two-thirds grown.

The first thing that will be noticed where it is present, is that in looking along nursery rows, leaves will be seen with large reddish-brown spots on them. A close examination will show that these leaves have been folded upwards until their edges met, and are closely fastened together with fine silken threads. Grasp the leaf between the thumb and finger, open it carefully and a small, greenish, very lively caterpillar will be found between the folds, and if you do not grasp the leaf so as to squeeze it, the worm will wriggle out and fall to the ground. It has a pale, amber-brown head, and in many individuals the whole body is of a brownish tint, especially on

* Specific differences may yet be discerned, as Dr. LeBaron has not very minutely characterized his larva.

the anterior portion, and when near mature. We do not usually observe the caterpillar until well grown, for the reason that when first hatched it appears to be in the centre of the opening bud, out of which it eats the heart, and of course stops the growth, leaving generally only three to four leaves to expand. It soon chooses one of these and folds it up as above, and then feeds on its upper cuticle, which makes the conspicuous brown blotches on the exposed side, or under side of the leaf. One leaf is generally more than sufficient to feed the caterpillar. When mature it lines the sides of the leaf with soft white silk, and changes to a dark mahogany-brown chrysalis; about three-tenths of an inch long, slender and lively; its most distinguishing point is a little knob terminating its anterior extremity. In a few days these chrysalides change to bright orange-colored moths, three-tenths of an inch long and spreading their wings about half an inch.

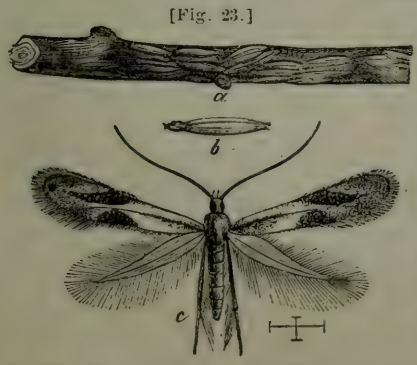
There is no noxious insect, that has come under my observation, that is more difficult to combat successfully than this. There appears to be no way of getting at it with any of the remedies usually employed for destroying such insects. While it is young it is too inconspicuous to be seen, and is always covered by a close web, or hid in the folds of the young leaves, and when it becomes larger it is snugly sealed up between the folds of a leaf, at all times out of reach of liquid or dry applications.

The only remedy that I can suggest is the tedious one of looking over the trees about the time the first brood of larvæ are coming to maturity, carefully picking the injured leaves off, with the worms in them and destroying them. Yet the little things are so delicate, and so easily destroyed by natural causes, that our labor in doing this would be more than half the time thrown away, for the reason that a first brood is no sure sign that there will be a second, and a second that there will be a third; the weather must be continuously dry and hot for them to breed to a noxious degree. Thus, we had here ten times as numerous a first brood the spring of 1871 as we had the spring of 1870; yet the last season they did but little harm, while the year before they swept everything before them. Yet these two seasons were quite similar in this neighborhood, and the difference in their ravages can only be accounted for on the hypothesis that being numerous two years in succession in the same place, their natural enemies bred up also, and destroyed them.

THE APPLE-LEAF BUCCULATRIX—*Bucculatrix pomifoliella, Clem.*

(Lepidoptera Tineidæ.)

[Fig. 23.]



This is a small insect hitherto comparatively little known, and which yet attracted some attention during the past two years. It was sent to the office on several occasions for name, and was found, though by no means abundantly, in several orchards, and more especially in that of Mr. T. R. Allen of Allenton. It cannot be classed as a very injurious insect with us, but to illustrate how unduly multiplied it may at any time become, and the importance of a proper knowledge of its habits, I

will quote the following paragraph which was addressed last spring to the *Rural New Yorker:*

While visiting the grounds of I. M. Babcock & Sons in Brighton, near Rochester, N. Y., we entered a field of eight hundred apple trees in the very zenith of their bearing capacity, loaded down with the finest of winter fruit. But my attention was directed to the branches of the trees, which, to my utter surprise, were thoroughly lined with these insects or minute worms inclosed in their silk-like cocoon, and tightly attached to the small branches which you will readily perceive; also the leaves of the trees are infested with a similar worm incased within the leaf, from one-fourth to one-half an inch in length—what some would call the leaf-rollers. The effect of their ruinous work on the trees is to almost denude them of their leaves, and greatly to diminish the future prospects for fruit. Now, Mr. Editor, through the *Rural New Yorker*, we shall look for some solution of the nature and character of this most formidable enemy that has appeared upon our apple trees. I send you a branch that has the insects on, and the leaf which I believe contains the parent, which is the cause of all the mischief. Will you have this subject investigated by competent hands, and report through the *Rural?*

H. N. Langworthy.

The little worm which is the cause of such mischief feeds externally upon the leaf, and is quite active, letting itself down by a web when disturbed. It measures, when fully grown, nearly one-half inch in length, and is of a dark green color, with the joints swollen so as to look like a series of beads, with a small head held horizontally, and with sparse, short hairs over the body. It has the normal complement of legs, namely, ten false and six true ones. When full grown it spins a dirty white cocoon, which is characterized by being ribbed longitudinally (Fig. 23, *b,* represents one enlarged). Within this cocoon it soon assumes the pupa state, in which state it is of a dark brown color, rough-punctured on the back, and with a smooth, polished anal cap. The pupa works itself partly out of the cocoon and gives forth a little moth (Fig. 23, *c,* enlarged, the hair lines showing the natural size), which is of a dirty-white, or gray color, marked with brown as in the figure. It was first described in the Proceedings of the Academy of Natural Sciences of Philadelphia, for 1860, p. 211.

In this latitude the worm does its principal damage during the month of September, and the greater number of cocoons are formed during the latter part of that month and during October. The moths commence to issue in April, and immediately deposit their eggs on the tender leaves. Fresh cocoons I have found as early as the first of June, and there are at least two, and perhaps more, broods of the worm during the year.

Remedies.—The great peculiarity of this insect is its habit of forming its little ribbed cocoon in company on the bark—a habit which at once gives us the mastery over it; for as the pupa remains in the cocoon all through the winter, we can make war upon it at any time during that season. When the insect is abundant these cocoons will absolutely cover the smaller twigs in the manner shown at Figure 23, *a*; and they will be found even on the larger branches and trunk. Anything applied to the tree with the object of killing these pupæ, must be of an oily nature, so as to readily soak through the

cocoon. I have experimentally proved that an application of kerosene oil is death to them, and though I have had no opportunity of testing it on an extensive scale, I have little hesitancy in advising its use, or that of linseed oil. Alkalies might also be tried. The best time to apply the remedy would doubtless be in March, when tree-growth recommences; but it must not be delayed beyond the end of that month, when the moths commence to issue. The most expedient way of applying the kerosene would be by aid of a force pump and spray machine or atomizer, and it would pay well to first vigorously prune a tree that is badly infested. The kerosene will not injure the tree if applied in a diluted form; and it may be so applied by means of the spray machine.

The only other injurious insect known to form cocoons in company is a little species belonging to the same genus (*B. thuiella*, Pack), which is described by Dr. A. S. Packard, Jr.,* as being common on the leaves of a cedar tree (I presume the Red Cedar is intended), but whose cocoon is smooth instead of ribbed. This species, which I have not met with, is preyed upon by a minute Chalcis-fly, allied to the genus *Eulophus*, and our apple-leaf Bucculatrix is similarly attacked by some such parasite, as many of the cocoons may be found with minute round holes at one end, through which such parasites have issued.

BUCCULATRIX POMIFOLIELLA, Clem.—*Larva.*—Cylindrical and submoniliform; tapers anteriorly and posteriorly; with punctiform points and isolated hairs; first segment with rather abundant dorsal hairs; thoracic feet three; abdominal four and very short, terminal one pair. Head small, ellipsoidal, brown; body dark yellowish-green, tinged with reddish anteriorly; hairs blackish and short.—Clemens.

Pupa.—0.12 inch long. Amber-brown. Head often ending in a little point. Dorsum shagreened, except a hind rim on each joint which is slightly ridged and smooth. Penultimate joint longest and most slender. Apical joint blunt, with an anterior carinated, transverse ridge above and sometimes forming a point at each side. Legs reaching to penultimate joint; wing sheaths (which are paler) to the preceding one.

THE APPLE-TWIG BORER—*Bostrichus* [*Amphicerus*] *bicaudatus*, Say.

(Coleopetra, Ptinidæ).

[Fig. 24.]

a. *b.*

[Fig. 25.]

c *d*

There is a little brown cylindrical beetle, which is so common in Missouri, and is so very apt to attract the notice of nurserymen, that numerous specimens are received at my office every spring and fall. I have passed it by unnoticed in previous reports, in hope of completing its natural history before treating of it; but to satisfy the numerous inquirers, I present the above figures with the accompanying short account of the beetle.

* First Ann. Rep. on the Inj. and Ben. Ins. of Mass. p. 24.

It is a modest looking dark brown insect, varying from 1-5th to 2-5ths of an inch in length, the thorax rounded and rough-punctured, especially in front where it is produced into two little horns, and covered with small rasp-like prominences. The wing-covers are also rough-punctured, and while in the female (Fig 24, *a*) they have but a slight keel-like elevation at the hind end, they are furnished in the male (Fig. 24, *b*) with two little horns, from which characteristic the specific name (two-tailed) is derived. The species is not mentioned by Harris, and does not occur on the Atlantic seaboard, but is found in the whole country between the Alleghany and Rocky Mountains, becoming more and more common as we progress westward, and being most common in the States immediately west of the Mississippi. Its range southward is at least as far as Texas.

The holes made in the twigs, generally have their entrance just above a bud or fork as at Figure 25, *c*. I have never known this insect to bore more than one and a half inches into the twig (Fig. 25, *d*), and the holes are generally made downwards, and in wood of the previous year's growth, though I have seen them exceptionally bored upward and in three-year-old wood. The beetles seem to prefer some varieties, such as Benoni and Red June, to other varieties of the Apple, and though they likewise occur in grape, pear and peach stems, I have never found them in those of the crab apple.

Both the male and female beetles bore these holes, and may always be found in them, head downwards, during the winter and spring months. The holes are made for food and protection, and not for breeding purposes. Indeed, common as this insect is, its preparatory stages are entirely unknown, and that person who will ascertain its larval history, will confer a favor on the community. I have bred a very closely allied species (*Sinoxylon basillare,* Say), which not only inhabits the wood of apple trees, but is found in that of peach and hickory trees and in grape canes. Its larval habits, which I shall presently illustrate, will throw some light on those of our Apple-twig Borer.

Indeed, according to Mr. S. H. Kriedelbaugh, of Clarinda, Iowa,* both sexes of this last have been found in company during the winter, in the sap-wood of "forest trees;" and though we are not informed as to the particular kind of forest trees, yet, since the Oak is the most common in our forests, we may infer that this tree is intended, among the rest. The probabilities are, therefore, that our Twig Borer breeds under the bark of oak trees, and that it is in such situations that we must search for its larva.† That it so breeds in the forest and not in the orchard, is rendered still more probable when we consider that its larval habits have so long evaded de-

* *Western Pomologist*, Nov. '71.

† It may, and doubtless does, breed in other kinds of wood besides oak. I have often found the beetles boring into grape-canes for food and shelter, with no other indications of breeding in them, than we find in apple twigs similarly bored. Dr. Henry Shimer, in a communication to the American Entomological Society, in September, 1868, speaks of finding them in grape-canes, and he also found certain larvæ in such canes, which he conjectured were the larvæ of *bicaudatus*. But, notwithstanding Dr. Packard (Guide p. 472), in speaking of the species, briefly describes its larva which he received from Dr. Shimer, it is evident that the latter gentleman has given no proof of the soundness of his conjecture, and, as he informs me by letter, he cannot now find his notes on the subject. And since, so far as it goes, the description accords with the larva of *Sinoxylon basillare*, Say, which, as I shall presently show, inhabits grape-stems; the probabilities are that Dr. Packard's description was, in reality, from this last named species.

tection. We may furthermore infer that it comes to maturity late in the summer, and, flying into our orchards and vineyards, the beetles bore into twigs during the fall. Here winter overtakes them, and they hibernate in the holes, some of them dying; but most of them surviving till spring, when they continue feeding for a while, and afterwards repair to the forest again to propagate their kind. I have caught both sexes flying as early as the middle of March, during genial, sunny weather.

The bored twigs most always break off by the wind, or else the hole catches the water in spring and causes an unsound place in the tree. If the twig does not break off, it withers and the leaves turn brown. The only way to counteract the injuries committed by this beetle, is to prune the infested twigs, whenever found, and take great care to burn them with their contents. It is in the nursery that most injury is done, as the insect is seldom numerous enough in an orchard of large trees to more than cause what the philosophic orchardist has been wont to term "a good summer pruning."

The genus *Bostrichus* was formerly considered the type of a Family (BOSTRICHIDÆ,) to which older authors referred our insects; but the family is now generally united with the PTINIDÆ, to which *bicaudatus* is consequently referred.

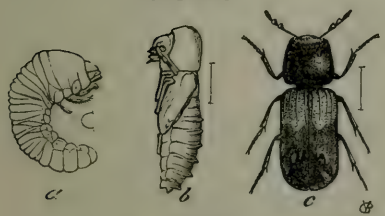
INSECTS INJURIOUS TO THE GRAPE-VINE.

In continuing the articles under this head, considerable space is devoted in this Report to the Grape root-louse, as it is deemed of most importance. As illustrative of the habits of the Apple-twig Borer, I will, however, first introduce—

THE RED-SHOULDERED SINOXYLON—*Sinoxylon basillare*, Say.

(Coleoptera, Ptinidæ.)

[Fig. 26.]



This insect is not so commonly seen in the beetle state as is the preceding, but unfortunately it is much better known in its larva state; and as it belongs to the same Family and is very closely allied to the Apple-twig Borer, its habits in the early stages may serve as an additional clue to those of its close ally, and the accompanying figures of the larva and pupa of the *Sinoxylon*, may be considered illustrative of the general appearance which the yet unknown larva and pupa of the *Bostrichus* will present.*

* It will by no means follow, however, that because the larva of *Sinoxylon basillare* has legs, that of *Bostrichus bicaudatus* has legs also; for many *Bostrichus* larvæ are known to be legless.

This beetle (Fig. 26, *c*) is black, but easily recognized by having a large reddish spot at the base of each wing-cover.* It measures about 1-5th of an inch. The antennæ and palpi are rufous. The thorax is punctured and armed with short spines in front. The wing-covers are rough-punctured, and have the appearance of being cut off obliquely behind, the outer edge of the cut portion being armed with three teeth each side. The larva (Fig. 26, *a*) is a yellowish, wrinkled, arched grub with a very small head. The thoracic joints are swollen and furnished with six small legs.

The pupa (Fig. 26, *b*) is formed in the galleries gnawed by the larva. It is pale-yellowish, and exhibits the characters of the future beetle.

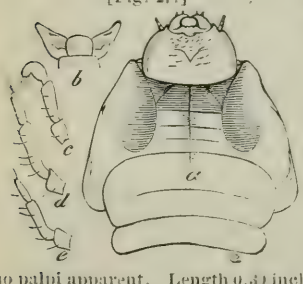
Last spring Dr. C. W. Spaulding, of Kirkwood, brought me certain grape stems which were being badly gouged under the bark and bored more or less in the heart, by a small grub. He met with such injured grape-stems quite frequently, and feared that the insect which caused the trouble might become a serious impediment to grape-growing. The beetles most numerously reared from these canes proved to be the Red-shouldered Sinoxylon.†

Dr. Harris (*Inj. Ins.* p. 92), and Dr. Fitch after him (3d Rep. § 158), speak of this insect as living in the trunk of the Shagbark hickory, boring holes straight towards the heart of the tree, and changing to the pupa state at the inner ends of their burrows.‡ But this is not the height of its offense, for I have found it boring into apple trees, and Mr. J. M. Beecher, of Newport, Franklin county, has forwarded me a number of specimens with the statement that he finds them penetrating to the heart of the trunk and main branches of some of his peach and apple trees, and they have caused the death of two of the former and one of the latter kind.

The only way to get rid of this pest is to burn the infested wood.

SINOXYLON BASILLARE, Say.—*Larva* (Fig. 27, head and thoracic joints enlarged)—Color yellowish. Body smooth, arched and wrinkled transversely. Thoracic joints much enlarged, the prothoracic being slightly horny at the anterior margin above. Six setous legs carried forward close to the body, the first pair (Fig. 27, *c*) bent closely under the head, the second pair (*d*) longer and straight, the third pair (*e*) short. Stigmata 9, and very difficult to detect. *Head* small, horny, rounded, rather darker than body: antennæ conspicuous, 3-jointed; epistoma dark brown, not as wide as labrum; labrum dark brown, rounded, covered and fringed with stiff hairs; mandibles stout, jet black, triangular, edges entire (*b* representing them when open); maxillæ very small with an elongated basal piece, and an inner lobe covered with hair: maxillary palpi with two indistinct joints; labium inconspicuous with no palpi apparent. Length 0.30 inch.

[Fig. 27.]



Described from three alcoholic specimens.

Pupa (Fig. 26, *b*).—Yellowish, elongate, with all the parts of the future beetle distinct, the head at right angles with thorax, the antennæ laid straight under the thorax, the last pair of legs, except the tarsi hidden under the wingsheaths. Length 0.30 inch.

Described from several specimens.

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* Some specimens occur which are entirely black, the reddish spots being obsolete; but they are exceptional.

† I have also reared from similar canes *Callidium amœnum*, Say, and Dr. Shimer in the paper alluded to, on page 52, states that he has likewise bred this species as well as *Lyctus opaculus*, Lec. I have also bred *Elaphidion parallelum*, Lec. abundantly from such canes.

‡ Dr. Geo. H. Horn (P. E. S. P. I, p. 29) also refers to this larva as infesting hickory trunks, but neither of these authors give any description of the larva.

GRAPE DISEASE.

On the Cause of Deterioration in some of our Native Grape-vines, and one of the probable reasons why European Vines have so generally failed with us.

THE GRAPE-LEAF GALL-LOUSE—*Phylloxera vitifoliæ*,* Fitch.

The experience of the past year, enables me to add much of interest and importance to last year's account of the above insect. This experience has already been made public in an article published in the *Rural New Yorker*, and reproduced in the *Rural World* of St. Louis. I am pleased to know that the views there set forth receive the indorsement of such an experienced and practical man as Mr. Geo. Husmann, the well known grape authority in our State, and editor of the vineyard department of the last-named journal.†

It is well known that nearly all the varieties of the European grape-vine (*Vitis vinifera*) have, in the end, proved valueless when introduced and cultivated in the eastern half of the United States. The majority of them grow well at first, and a few exceptional cases might be mentioned where

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* This is the specific name by which I last year gave an account of this grape-vine insect; and I employ it again for that very reason, and for the further reason that it is the name most familiar to the American reader. I have already given my opinion (3rd Rep. p. 95, note) that though the name is objectionable, it ought perhaps to be retained. It is doubtful, however, whether many other entomologists will agree with me; and while I believe in carrying out the "law of priority" to its fullest extent, consistent with reason, there are many cases where it must give way to that of "accord." The present is perhaps just such a case; for aside from the technical objection, Dr. Fitch knew so little of the insect's true characters, when he named it, that he cannot be said to have described it, and did not refer it to its proper genus which was already erected to receive it. His name will, therefore, doubtless give way to that of *Phylloxera vastatrix*, which Planchon first gave to the root-inhabiting form, and which has generally been recognized abroad. The same may be said of Westwood's name *Peritymbia vitisana*, which was also proposed for the same insect in 1868, in a communication to the Ashmolean Society of Oxford, England.

While I would not, therefore, carry out the "law of priority" too relentlessly, I have no sympathy or patience with a certain modern system of attaching to an insect the name of the author who erects the last new genus, instead of that of the describer of the species. This pernicious system—which if not frowned down, will lead to utter confusion and land us in absolute chaos—seems to be getting more and more fashionable among naturalists in this country, and I regret to say, among some entomologists. That man, in my opinion, is no true naturalist, who can pass through the museums of this country and witness the manner in which the names of the older authors are ignored, without feelings of just indignation! He will very naturally look upon it as an attempt on the part of modern ingrates to rob well-earned and long-worn laurels from the older authors, whose spirits still survive, if their bodies are prevented by the grave, from rebuking the insult. Aside from the moral injustice of such a rule, it is hurtful to any science in its practical application; for, as genera multiply, the student will find increasing difficulty in referring to original descriptions; whereas, by the old established rule, the describer's name is an infallible index. In lists or catalogues, such as that of *Coleoptera* by LeConte, and that of *Bombycidæ* by Grote & Robinson, where the synonyms are given, this difficulty does not present itself, though the moral objection remains. As the science of entomology grows, and synonymy multiplies, it will, in my opinion, become more and more necessary to attach the author's name to a species in ordinary works, and any system which will require a continual changing of authorship should not be countenanced. Species—however much they may be changed and modified in the course of ages—have for all the purposes of the naturalist a permanency which under the old rule would render our specific nomenclature like permanent, and secure it against constant change; whereas, genera—though in the proper sense they may have a similar permanency—are, for all practical purposes, more the creations of man than of Nature; and as they have been unstable and changeable in the past, so they will be in the future, and our generic nomenclature will ever have an indefinite, protean, insecure character.

In Europe this system is almost universally ostracised; and—let botanists and ornithologists do as they please—it is to be hoped it will not grow in favor among entomologists in America. It was not followed by any of the older authors, and I am glad to know that some of our leading living entomologists, including Dr. G. H. Horn, Mr. E. T. Cresson, Mr. P. R. Uhler, Mr. J. A. Lintner, Dr. Asa Fitch, and Dr. LeBaron, are opposed to and do not adopt it. In these Reports—however prevalent the contrary fashion may become—I shall always attach to the species the name of its first describer; and shall never change the orthography, even of a name that may be grammatically objectionable, until corrected by the author himself.

† Mr. Husmann says: (*Rur. W.*, Nov. 18, 1871); "We copy the following from the *Rural New Yorker*, and think it one of the most interesting papers we have read for a long time—one that will be of more use to the vintner in his selection of varieties, and throw more light on the deterioration of formerly healthy varieties than anything that has been said or done lately. The grape growers of the country owe Prof. Riley a debt of gratitude for his thorough and scientific investigation of this subject."

some of them, such as Black Hamburg and Chasselas, have even fruited successfully for many years, especially when isolated or trained against walls; while they more generally do well when isolated in cold houses. But the general truth of the first statement holds good. It is also well known that some of our native vines, which for a while were universal favorites on account of their productiveness, vigor and other excellent qualities, have of late years sadly deteriorated. Among such the Catawba was for a long time the popular grape; but its cultivation is now entirely abandoned in many parts of the Mississippi Valley, and even at Hammondsport and other parts of New York, and Nauvoo, Illinois, where it is still largely cultivated, I learn from experienced grape-growers that it is fast on the de cline.

This deterioration—this failure, has been attributed to a variety of causes, for in the absence of anything definite and ascertainable to keep it within bounds, the speculative turn of our minds is sure to have full scope and grasping at every shadow of probability, leave no possible theory unsearched. As in all such cases, also, the mind gets lost in, and is satisfied to vaguely rest with, the theory least provable; and to some occult and mysterious change of climate we are at last satisfied to attribute the change though if the meteorological records were carefully examined, they would probably show no difference in the mean annual condition of our climate during the past half century.

It is very natural to suppose that vines of European origin should be less hardy in this country than our native varieties, that as in the case of the Spanish Chestnut, the English Gooseberry, etc., etc., there is something in our climate which precludes their flourishing as well here as there. I would by no means deny that such is the case, for it is this very comparative tenderness which predisposes them the more to the destructive agent of which I am about to speak. Yet when we consider that in some parts of Europe, where the Vine flourishes, the extremes of heat and cold are as great as here; that we possess a great variety of soil and climate, and that by covering and other modes of protection in winter, we may, where necessary, counteract the rigor of the latter—it would appear that we certainly have attributed too much to climatic influence: and such a view is strengthened by the fact that our native varieties, if free from the insect which forms the subject of his article, usually do well when cultivated in Europe, and further that the *Vitis vinifera* is not a native of Europe, but of western Asia.

The above reflections are of a general character, but apply more particularly to the great State of Missouri, which is admitted to be, in many parts, eminently adapted, both by soil and climate, to the cultivation of the Vine.

One of the reasons why the European vines do well in California, outside of and beyond the more favorable clime in that portion of the continent, is, no doubt, because the insect which here affects them, like many other species common on this side of the Rocky Mountains, has not yet crossed to the other side. If such is the case, our California neighbors should take warning from Europe, and guard, if possible, against an invasion.

The announcement that I have at last ascertained one of the principal causes—if not the sole cause—of this decline, and that, knowing the cause, we may in a measure obviate it, will doubtless cause many a grape-grower to wonder. Some may even pooh-pooh the idea, and deem it impossible that they have so long remained in ignorance of so important a fact, that a "bug-hunter" should discover it at last. Let the facts speak.*

This destructive agent is none other than the little insect we are now treating of.

The general history of the louse, and the habits of the gall-inhabiting type were sketched in my last Report, and need not be repeated.

FURTHER PROOF OF THE IDENTITY OF THE AMERICAN INSECT WITH THE EUROPEAN.

That the two are identical there can no longer be any shadow of a doubt. I have critically examined the living lice in the fields of France, and brought with me, from that country, both winged male and female specimens, preserved in acetic acid. I find that the insect has exactly the same habits here as there, and that winged specimens which I bred last fall from the roots of our vines, accord perfectly with those brought over with me. In the different forms the insects assume, in their work, and in every other minutia—the two agree.

WHY I CONSIDER THE GALL-LOUSE AND ROOT-LOUSE IDENTICAL.

Firstly, wherever this insect has been noticed in England, both the gall-inhabiting and root-inhabiting types have been found. In France the galls occur abundantly on such of our American varieties as are subject to them here, while a few have occasionally been found on their own varieties. Secondly, I have successfully transferred the leaf-lice on to the roots, while M. V. Signoret has succeeded in obtaining leaf-galls from lice hatched on the roots. Thirdly, the winged form obtained by Dr. Shimer from the galls in this country agrees in its characters with those from the roots. Fourthly, the nodosities on the roots are, as already stated, perfectly analogous to the galls on the leaves, and differ only in just such a manner as one would expect from the difference in the plant tissues—a view greatly strengthened by the fact that when the gall-lice are forced, by their excessive numbers, to settle on the tendrils or leaf-stalks, they produce swellings and knots approaching more nearly to those on the roots than to the galls. These

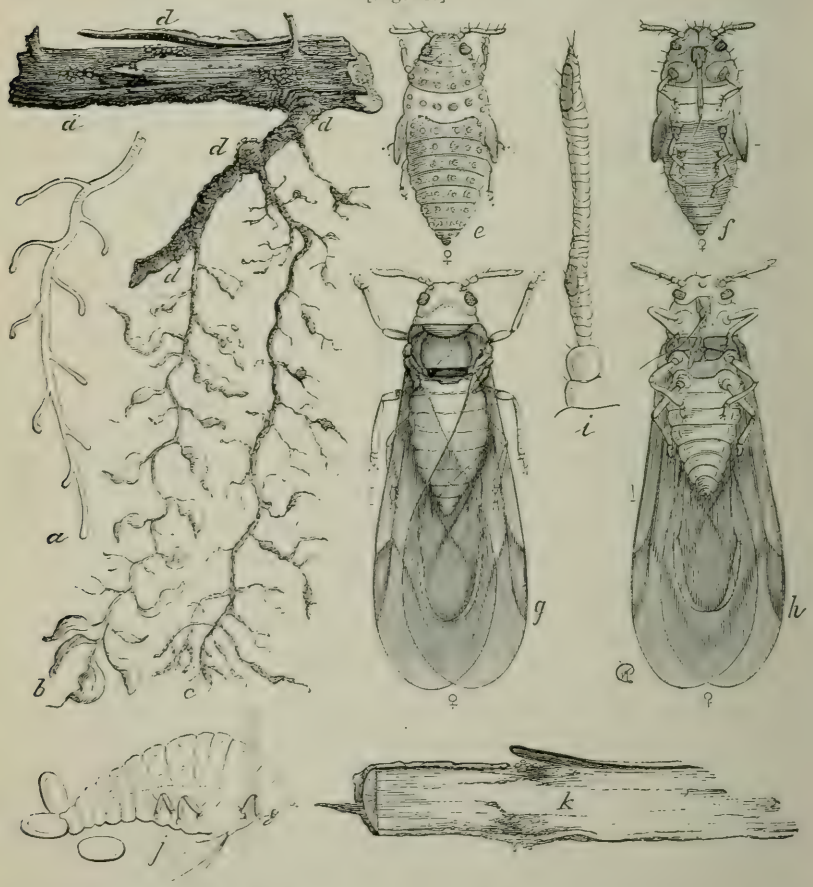
*It is really amusing to witness how the facts here set forth have been received by those who never spent ten minutes investigation of the subject in their lives. In the silkworm disease that has of late years been so prevalent in Europe, M. Pasteur, after the most painstaking and elaborate experiments, at which he sacrificed his health, unraveled its mysteries, gave to the world the true pathology of *pebrine*, and what is more, showed how it might be eradicated. Yet, as I shall show further on, the men most interested were very slow to believe the hard, dry facts which had been snatched from the unknown, and—never having studied the case themselves—were more inclined to consider the disease as something mysterious—something altogether beyond man's understanding, and consequently uncontrollable. The most ignorant are always the most skeptical! I might mention several parties who have expressed their opinion that the *Phylloxera* has no connection with disease or decline in the Vine. To such, I simply say: examine for yourselves, before giving an opinion. Others whom I might mention go to the other extreme and assert that it must be the cause of mildew, oidium, etc., and without any good reason put a similar opinion in my mouth. To these last, I say: Read aright, do not misconstrue, and by no means jump to conclusions!

facts sufficiently attest the identity of the two types, and we have here another case of an insect possessing two distinct habits. It is also like many others of its Family, polymorphic, *i. e.*, it exists in different forms; yet we have to do with but one species.

FURTHER FACTS RESPECTING THE HABITS OF THE ROOT-INHABITING TYPE.

The young hatched from the eggs on the roots are absolutely undistinguishable from those hatched in the galls; and the gravid apterous female differs in no respect whatever from the mother gall-louse. There is, however, a different egg-depositing form, which, as it moults, becomes tubercled, and more elongated or pear-shaped, as shown at Figure 28, *j*. Some of these tubercled individuals remain without wings, while others seem to be

[Fig. 28.]



EXPLANATION OF FIGURE 28.—*a*, shows a healthy root; *b*, one on which the lice are working, representing the knots and swellings caused by their punctures; *c*, a root that has been deserted by them, and where the rootlets have commenced to decay; *d*, *d*, *d*, shows how the lice are found on the larger roots; *e*, female pupa, dorsal view; *f*, same, ventral view; *g*, winged female, dorsal view; *h*, same, ventral view; *i*, magnified antenna of winged insect; *j*, side view of the wingless female, laying eggs on roots; *k*, shows how the punctures of the lice cause the larger roots to rot.

destined from the first to acquire wings. The young, after attaching themselves, become in a measure stationary, and remind one very much of young bark-lice. The fine hair-like setæ, which in their functions and elasticity are analogous to our tongue, become loosened from the more fleshy rostrum or sheath, as shown at Figure 28, *j*, and are often so firmly inserted into the root that the louse, if disturbed from its place, generally hangs by them. Three of the threads of this tongue are sufficiently conspicuous, but there should be, from analogy, four. The females on the roots seem to be less prolific than those in the galls, and their eggs if anything are rather larger. These eggs are always of a bright yellow color, and, on the dark root, are detected with the naked eye as readily as the lice, which become darker or of a dull orange as they grow older.

The insect is found on the roots in all stages during the summer months. In the winter it is found dormant, principally in the larva state, and no eggs are to be seen. With the circulation of the sap in spring, the activity of these young recommences, and in a short time afterwards eggs are deposited again. At this season the punctures of their little beaks produce very decided swellings and an excess of moisture at the wounded parts. The winged forms are by no means uncommon and commence to issue from the ground perhaps as early as July. When I last examined the roots before my departure, or about the middle of May, no pupæ were found; but winged insects were obtained as early as July in France, and after my return I had no difficulty in obtaining all I wished, especially during the latter part of September. The pupæ are easily recognizable with a good lens, by the little dark pad-like wing-sheaths at the sides of the body (Fig. 28, *e*, *f*)—and the sexes may even be distinguished at this stage by the greater constriction of the body near these pads in the female, compared to the male, her abdomen being larger. Before giving forth the winged insect, these pupæ become quite restless and active, and in a state of nature they no doubt issue from the ground.

The winged female (Fig. 28, *g*, *h*), seems to be much more common than the male, and is distinguished by her more lengthened abdomen—the wings, when closed, extending not much more than its length beyond the tip, while in the male they extend more nearly three times its length. The dusky thoracic band is not so distinct and the abdomen is more produced at the apex in the male; and there is also a slight difference in the venation of the wings of the two sexes, which venation is best seen in the fresh specimens, as it becomes in a measure obsolete in drying. In the abdomen of the female two or three large eggs are plainly visible, especially after being soaked in acetic acid. The two-jointed tarsus or foot is also plainly visible in such specimens, and I have found the joint movable, while M. V. Signoret, of Paris, has obtained the skin of the tibia or shank with the basal joint of the tarsus hanging to it. Prof. Westwood also refers to a short basal tarsal joint in the gall insect which he described. These facts, trivial as they may appear, are very important in a scientific view, as they forever settle the differences that have existed as to the proper systematic position which the louse occupies.

SUSCEPTIBILITY OF DIFFERENT VINES TO THE ATTACKS OF THE LOUSE.

I have carefully examined a great many different kinds of vines within a circuit of thirty miles of St. Louis, as well as in Cole, Jefferson and Boone counties, in this State, and the summary which follows indicates the susceptibility of the different varieties to this disease. There may be objection on the part of some persons to the placing of some of the varieties in the following tables; and the opinions both of botanists and vine-growers are so at variance that I shall give in the subsidiary note* my reasons for

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*Classification of the N. A. Grape-vines.—In few genera of plants, is it more necessary to accumulate abundant material in order to arrive at correct classification, than in the genus *Vitis*. The species are with difficulty defined, as they vary in a marked manner in different sections of the country; and the foliage of the same individual vine often varies greatly at different ages and seasons. Preserved leaves are not alone to be trusted, therefore, but every stage of growth must be considered, from the wood to the different leaves, the blossom, bunch, berry and even the seed, which in its shape, and especially in the development of its raphe (or cord) furnishes, according to Dr. Engelmann, some of the most permanent distinguishing traits between the species.

It is interesting to know that not a single real species has been added to those belonging to the old territory of the United States, east of the Mississippi river, since the time of Linnæus and Michaux; though Rafinesque, LeConte, and perhaps others, have attempted to distinguish a great many more.

The number of Grape-vines bearing edible fruit, * now considered species by the best botanists, in the territory of the United States, is limited to 9. They may be tabulated as follows:

I. Vines which are of practical consequence, as having yielded our different cultivated varieties.

1. Vitis Labrusca, Linn. Northern Fox.
2. " æstivalis, Michx. Summer Grape.
3. " riparia, Michx. River Bank Grape.
4. " vulpina, Linn. Southern Fox, or Muscardine.

II. Vines of less consequence, and which have thus far given no cultivated varieties.

5. Vitis cordifolia, Michx. Winter or Frost Grape.
6. " Californica, Benth. Confined to California.
7. " Arizonica Engelm. Similar to the last.
8. " candicans, Engelm. Mustang Grape of Texas.
9. " rupestris, Scheele. Bush Grape or Sand Grape.

Of these 9 species only 4 grow wild in our own State, viz: *æstivalis, cordifolia, riparia*, and *rupestris*.

In stating last year (3rd Rep. p. 90) that our cultivated varieties had been referred to four species, including *cordifolia* and omitting *riparia*, I followed the later editions of Gray's Manual, in which the latter is considered as a variety of the former. The reasons for adopting a different course will be found in the following synopsis which has been kindly prepared for me by the author:

THE TRUE GRAPE-VINES OF THE OLD UNITED STATES.

BY DR. GEORGE ENGELMANN, OF ST. LOUIS.

I. Grape-vines with loose bark (at last separating in shreds), climbing by the aid of branched tendrils, or (in No. 4) scarcely climbing at all.

a. Berries small, 3—6 or rarely 7 lines in diameter; seeds obtuse, with the raphe (or cord) more or less prominent (except in No. 4) over the top. All the species of this group, just like the European grape-vine, exhibit on well grown shoots a regular alternation of two leaves each having a tendril (or its equivalent, an inflorescence), opposite to them, and a third leaf without such a tendril.

1. Vitis cordifolia, *Michaux*—Usually tall, climbing high, trunks not rarely 6—9 inches in diameter. Leaves middle sized, heart-shaped, mostly entire or rarely slightly tri-lobed, with shallow broad teeth, usually smooth and shining on both sides, the young ones sometimes slightly downy below; berries among the smallest; in large bunches, black without a bloom, maturing late in the fall, usually with only one short and broad seed marked by a prominent raphe.

This is a common plant especially of the river-bottoms, and well known under the name of Winter grape, Frost grape or Chicken grape. It is found from New England to Texas, and westward to the western limits of the wooded part of the Mississippi valley. In this valley, at least, the fruit has a

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*There are a few species forming the sections (or according to others, genera) *Cissus* and *Ampelopsis* which are now classed with *Vitis*; but they bear no edible fruit, and are otherwise easily distinguished from the true Grape-vines.

so placing them. I am familiar with the views of many of the leading grape-growers of the country, and have had an opportunity of studying the genus by the excellent herbarium of Dr. Engelmann. It is gratifying to know, therefore, that the position given to such cultivated varieties as obtain in this herbarium, agrees with that given to them by leading grape-growers—the views of the botanist and the practical man coinciding.

When we find it so difficult to properly separate the wild species, we can no longer wonder at the difference of opinion as to the nature of many

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strongly and even fetidly-aromatic taste. No cultivated varieties of the species are known.

2. VITIS RIPARIA, *Michaux*—Mostly a smaller plant than the last, but with larger and more or less cut-lobed glabrous shining (or rarely when young, slightly downy) leaves, the lobes long and pointed; the teeth also more pointed than in *cordifolia;* berries as small, or usually larger than in the last, mostly with a bloom, in smaller bunches, mostly 1 or 2 seeded; seeds with a less prominent raphe.

This species prefers thickets or rocky soil on river banks and extends as far west and south as the last, and much farther north, being the only grape-vine in Lower Canada, where it is found even 60 miles north of Quebec. The northern form, in Canada, northern New York to Michigan and Nebraska, has fewer and larger berries in a bunch and is easily distinguished from *V. cordifolia.* The southwestern form, however, approaches more closely to this last species, with which Prof. Gray in the later editions of his Manual has united it. The fruit ripens earlier than that of *cordifolia*, and is much pleasanter. In St. Louis a variety found on the rocky river banks is brought to market in July. A number of cultivated varieties are referable to this species, among which the *Taylor Bullit*, the *Delaware* and the *Clinton*, are the most prominent.

3. VITIS ÆSTIVALIS, *Michaux*: Smaller than the first, climbing over bushes and smaller trees; leaves large, of firmer texture than the preceding ones, entire, or often more or less deeply and obtusely 3—5 lobed, with short and shallow, broad teeth; when young always very woolly, mostly bright red or rusty; at last smoothish but dull and never shining like the preceding ones; berries usually larger than in both others and, when well grown, in compact bunches, coated with a distinct bloom; seeds usually 2 or 3, with a very prominent raphe.

This is the well known *Summer grape* common throughout the middle and southern States, usually found on uplands and in dry open woods or thickets, maturing its fruit in September. It is the most variable of our grape-vines and hence has seduced superficial observers into the establishment of numerous nominal species. A form with large leaves which retain their rusty down at full maturity has often been mistaken for *Labrusca*, which does not grow in our State. Another form, more bushy than climbing, with deeply lobed rusty-downy leaves and very sweet fruit, is *Vitis Lincecumii* of the sandy soil of Louisiana and Texas. This species assumes a peculiar form approaching *V. cordifolia* through its smaller black berries without bloom and in larger bunches, when it gets into shady woods with rich soil. Another form with ashy-white, downy, scarcely lobed leaves, and fruit like the last mentioned, which grows in our bottoms, often climbing high trees, or growing over bushes on the banks of lakes, I have distinguished by the name of *cinerea*. It is not always easy to distinguish such forms from the other species and perhaps less so to unite them under the single species, *æstivalis*, unless the essential characters above enumerated be closely attended to, and the numberless gradual transitions from one form into the other be watched.

We cultivate many varieties of this valuable species, the most important of which are the *Virginia Seedling*, the *Cynthiana* and the *Herbemont*.

4. VITIS RUPESTRIS, *Scheele*: A small bushy plant, often without any tendrils, rarely somewhat climbing; leaves small (2—3 inches wide) mostly broader than long, heart-shaped, scarcely ever slightly lobed, with broad coarse teeth and usually an abruptly elongated point, glabrous, and of a rather light green color; berries middle-sized, on very small bunches; seeds mostly 3—4, obtuse, with a very delicate raphe.

This very peculiar grape-vine is found only west of the Mississippi, from the Missouri river to Texas and westward probably to New Mexico. In our State where it is called *Sand grape*, and in Arkansas, it grows on the gravelly banks and over-flowed bars of mountain streams; in Texas also, on rocky plains, whence the Latin name; it is there also known under the name of *Sugar grape*. Its luscious fruit ripens with us in August.

It is nowhere yet in cultivation but may in future prove of value.

b. Berries large, 7—9 or even 10 lines in diameter; raphe scarcely visible on the more or less deeply notched top of the seed.—These plants on well grown shoots bear a tendril opposite each leaf with only rare and irregular intermissions.

5. VITIS LABRUSCA, *Linnæus:* Plants usually not large, climbing over bushes or small trees, though occasionally reaching the tops of the highest trees, with large (4—6 inches wide) and thick, entire or sometimes deeply lobed, very slightly dentate leaves, coated when young with a thick rusty,

of our cultivated varieties; for some of them have become so modified that they furnish scarcely any indication of their parentage. If those grape-growers who take interest in such matters will send specimens of such cultivated varieties as they wish to properly classify, to Dr. Engelmann, either directly or through me, they will at least get the opinion of one who is good authority, and such action may be mutually profitable. Specimens should be sent at flowering time, and should include the whole shoot with full-sized and young leaves, blossom, and tendril; and after the fruit is ripe a bunch of the berries and seeds from the same stock should follow.

The proper classification of our different varieties is of more importance, in this connection, than would at first appear. Since the publication of some of the facts set forth in this article, a few enterprising French grape-growers, in the districts desolated by the louse, have conceived the idea of importing from this country such varieties as are most exempt from the attacks of the *Phylloxera*, and M. LeFranc, the Minister of Agriculture, has likewise expressed his intention of so doing. Already a number of varieties, and especially Cunningham, Herbemont, Norton's Virginia, Concord, Hartford Prolific, Clinton and Martha have been shipped to M. J. Leenhardt, of Montpellier, France; and others to Switzerland, by Messrs. Isidor Bush & Co. If America has given this plague to Europe, why should she not in return, furnish her with vines which are capable of resisting it? At least nothing but good can come of the trial, for though our grapes are generally sneered at on the other side of the water, we have made such rapid improvements in viticulture during the last ten years, that they scarcely know anything of our better kinds; and many of those which do well in

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or sometimes whitish, wool or down, which in the wild plant remains on the lower side, but almost disappears in the mature leaf of some cultivated varieties; berries large, in rather small or middle-sized bunches, bearing 2 or 3 or sometimes 4 seeds.

This plant, usually known as the *Fox-grape* or *Northern Fox-grape* is a native of the eastern slope of the continent from New England to South Carolina, where it prefers wet thickets; it extends into the Alleghany mountains, and here and there even down their western declivity, but is a stranger to the Mississippi Valley. The most important varieties of this grape-vine now cultivated in our country (such as the *Catawba, Concord, Isabella, Hartford Prolific*, and dozens of others) are the offspring of this species; they are all easily recognized by the characters above given, and mo readily by the peculiar arrangement of the tendrils as above described.

II. Grape-vines with a firmly adhering bark, which does not scale off; tendrils almost always simple; berries very large (7—10 lines in diameter), very few in a bunch; seeds with transverse wrinkles or shallow grooves on both sides.

6. VITIS VULPINA, *Linnæus:* Bushy, or sometimes climbing high, with small (2 or at most 3 inches wide) rounded, heart-shaped, firm and glossy dark green leaves, smooth or rarely slightly hairy on the under side, with coarse, large or shallow teeth.

This southern species, known under the name of *Southern Fox-grape, Bullace,* or *Bullet-grape* is found along water-courses, not further north than North Carolina and Arkansas, and may possibly straggle into southeastern Missouri. Some of its cultivated varieties, especially the white *Scuppernong,* are highly esteemed in the South but do not perfect fruit in the latitude of St. Louis.

I recognize only three other species of true grape-vines in the territories of the United States. The most remarkable of these is the Mustang grape of Texas, *Vitis candicans,* Engelm. (*V. Mustangensis,* Buckley), with rather large, rounded, almost toothless, rarely deeply-lobed leaves; white woolly on the under side, bearing large berries, which in its native country are now beginning to be made into wine. *Vitis Californica,* Bentham, the only wild grape of California, has rounded downy leaves, and small berries, and is not made use of as far as known. *Vitis Arizonica,* Engelm. similar to the last, but glabrous, with middle-sized berries, reported to be of a luscious taste. Neither of these show a prominent raphe on the seed, so that this character is peculiar only to the first 3 species here enumerated.

Missouri will doubtless succeed in France. Such of our vines as have already been cultivated there are often differently classified by their writers to what they are by American authors, and confusion consequently ensues. Thus, one of my correspondents, M. Laliman, of Bordeaux, who has cultivated a number of them for several years, classes the Clinton and Taylor as *æstivalis*, and the Norton's Virginia and Delaware as *Labrusca*.*

I will now indicate the susceptibility of different varieties to the disease.

Vitis vinifera (European).—All European varieties with roots badly affected. In many instances decomposed and gone, with the vines about dead. No leaf-galls.

V. riparia (River Bank). Clinton.—Leaf-galls extremely abundant. Root-lice only moderately so. Taylor—Where leaf-galls are few, root-lice abundant; where galls are abundant, fewer root-lice. Delaware—A few leaf-galls; lice abundant on roots. Othello (hybrid with *vinifera*)—Both leaf-galls and root-lice, the latter tolerably numerous. Louisiana (some say a seedling of *vinifera*, others again believe it *æstivalis*)—Leaf-galls and root-lice, but neither bad. Alvey—Few leaf-galls; plenty of root-lice. Cornucopia (hybrid with *vinifera*)—No leaf-galls; roots badly affected with lice. Wild vine—Numerous leaf-galls and a few root-lice; much in same condition as Clinton.

V. æstivalis (Summer). Cunningham—No leaf-galls, but a few root-lice. Cynthiana—Occasionally a few galls; lice abundant on roots. The vine has a vigorous growth and the roots are large and strong. Herbemont—A few leaf-galls, and scarcely any root-lice. Norton's Virginia—No leaf-galls, but some root-lice.

V. Labrusca (Northern Fox). Isabella, or seedlings of Isabella—No leaf-galls; a few root-lice: roots strong and vines flourishing. Martha—No leaf-galls; very few root-lice. Hartford—No leaf-galls; very few root-lice. Concord—No leaf-galls; scarcely any root-lice. Almost entirely exempt. Ives—No leaf-galls; lice tolerably abundant on roots. North Carolina—No leaf-galls; very few root-lice. Maxatawney—No leaf-galls; root-lice quite abundant. Creveling—A few leaf-galls; root-lice abundant. Catawba—No leaf-galls; root-lice very numerous, abounding even on the larger roots as on the European vines. Gœthe (hybrid with *vinifera*)—No leaf-galls, but lice on roots very numerous. In the vineyards of Messrs. Isidor Bush & Sons, of Bushburg, Mo., this vine was very vigorous and thrifty in 1869 and 1870, but has done poorly the present year. Dracut Amber—No leaf-galls; few root-lice. Wilder (hybrid with *vinifera*)—No leaf-galls; not many root-lice. Challenge (hybrid with *vinifera*—No leaf-galls; roots affected but moderately. Diana—No leaf-galls, but plenty of root-lice.

V. vulpina (Southern Fox or Muscadine)—As it is not grown in this locality, being considered absolutely worthless here, I know little about it.

From this experience it would appear that no vines of those named, are entirely free from the attacks of the root-louse; but that the European varieties are most susceptible to it—the Northern Fox, next in order, the

* Etude sur les d'vers Phylloxera, et leur médications.

River Bank grape next, and the Summer grape the least affected. It would likewise appear that galls are occasionally found on all of the species except the European, and as they have in a few instances, been found on this species in Europe, it cannot be considered entirely exempt.* Nevertheless, in general terms, the River Bank grape must be considered the species which the gall-louse prefers. Experience on this point will, no doubt, vary in different parts of the country, and more extended experience may modify some of these deductions.

We thus see that no vine, whether native or foreign, is exempt from the attacks of the root-louse. Yet, on the principle that a small dose of poison may prove harmless or even beneficial where an over-dose will kill, we find that a small number of root-lice produce no serious effects upon the vine; and that it is only where they are very numerous, and cause not only the fibrous roots, but even the larger ones to waste away, that their evil effects are perceptible. With most of our native vines when the conditions are normal, the disease seems to remain in the former mild state, and it is only with the foreign kinds, and with a few of the natives, under certain conditions, that it takes on the more acute form.

In France, according to M. Laliman, the American varieties which have resisted the root-louse best are the Clinton, Taylor, Herbemont (known there as Warren), and some others which are considered valueless here, such as Pauline, Elsimboro, Lenoir, Mustang of Texas, and a kind of York-Madeira; while those which succomb are Isabella, Scuppernong, Concord, Norton's Virginia, Maxatawny, Hartford Prolific, Cynthiana, etc. This experience differs a little from ours, but shows that the *Labruscas* suffer most there also.

MEANS OF CONTAGION FROM ONE VINE TO ANOTHER.

The young lice, whether hatched upon the roots or in the galls, are quite active and crawl about for some time; and that they will spread from one vine to another, either under ground upon the roots or on the surface of the ground during the night, is highly probable. Such, however, cannot be the mode of spreading from one vineyard to another; for were it so, the malady could not possibly have assumed such proportions in so short a time, as it has done abroad. One method of transport is upon the roots of seedlings and cuttings, but the insect cannot in this manner find its way to an old vineyard, and there must be still another means. Here we come to that part of the natural history of our louse which must assume the form of hypothesis until further observations shall be made. In this country the malady is general, but in France, where it is still spreading from one place to another, they have a good opportunity to watch its progress; and Planchon finds that it always commences at certain circumscribed points and spreads from these points in more or less regular circles. There is no way of accounting for these nuclei—these starting points in the center of an old vine-

* Since this was written I have been informed by Mr. Glover, of the Department of Agriculture, that the leaves of certain European vines, in green-house, such as *Muscat Hamburg* and *Madam Pince*, were crowded with the galls, even as late as December; and that they had begun to spread on to *Sonora* and the *Duc de Malacoff*.

yard that never showed signs of the disease before, except on the hypothesis of the winged insect having flown there and started the colony.

We have already seen that certain individuals of the root-inhabiting type become winged. Why these individuals become winged while others never do, is, perhaps, not for us to understand. Signoret ventures the Lamarckian suggestion that the need of quitting roots that are already destroyed may be one reason, and the pupæ are certainly found more particularly on badly infested roots. All plant-lice multiply agamically during the summer months while they are abundantly nourished, but towards winter when, by this mode of reproduction, and by the diminishing nutriment in the dying foliage, the lice become, so to speak, exhausted, then lo and behold winged males and females appear! Numerous other facts in insect life, such as the production of drone bees solely from unfertilized eggs, etc., indicate that the winged male may be, in some way or other, connected with defective vitality; and Mr. Thomas Meehan, of the *Gardeners' Monthly*, has so frequently observed such to be the case with plants, that he considers it a law "that with a weakened vitality comes an increased power to bear male flowers."* But this throws no light on the production of winged females, and here, as in thousands of other instances, nature tells us plainly to be satisfied with the facts without the explanation.

Our winged female is a reality! What, then, are her functions? In the breeding jars she invariably flies towards the greatest light, and her large compound eyes, and ample wings indicate that she was made for the light and the air. We have also seen that she is burdened with two or three eggs only, and my opinion is that after meeting her mate, her sole life duty is to fly off and consign her few eggs to some grape-vine or grape-bud, and that the lice hatching from these eggs constitute the first gall-producing mothers.

I am led to this opinion by the fact that about the middle of May, in looking for the galls, I always find but two or three to a vine, and generally but one to a leaf. These vernal galls—as one would expect from the greater vitality of the young from fertilized eggs, and the greater succulency of the leaves at that season—are much larger than the ordinary summer form, and generally have a decidedly rosy tint on one side. Similar galls have also been found in France. Just as many other insects prefer certain species of plants, or even certain varieties of a species, so our winged *Phylloxera* shows her preference for the Clinton and its close allies. She occasionally deposits her eggs on other varieties, as I have found the large vernal galls on Concord, Hartford Prolific, etc., and it follows that she must do so where no *riparia* vines occur. But, except on the varieties of the latter species, the young lice hatching from her eggs do not seem to be capable of forming galls, on the leaves, but make straightway for the roots. Only in this manner can we account for the galls abounding so much more on some varieties than on others.

Some persons may wonder how a minute insect with such delicate wings, braced with so few simple veins, as those possessed by our *Phylloxera*

*Proc. Am. Ass. Adv. Sci., 1869, p. 256.

can manage to fly through the air to any great distance; and those who have not witnessed them in flight are very apt to underrate their power of volitation. There is a conical gall very common on the upper surface of the leaves of our Shell-bark hickories. This gall is made by a louse very closely allied to our Grape-leaf gall-louse and was named *Phylloxera caryæfoliæ* by Dr. Fitch.* This louse occurs abundantly in the winged form, and furnishes an excellent illustration of the power of the insects of this genus to fly. Let any one watch these winged gall-lice, as they issue, during some warm day in June, from the fimbriated mouth of their gall, and he will be struck with astonishment at the facility and power with which they fly off. They are no sooner out of the gall than the wings commence to vibrate so as to become invisible, and the insect suddenly darts away with wonderful force. They must likewise, often be carried great distances by the wind.

Again, it would at first sight seem almost impossible for the female to deposit her loose eggs which have no viscous property, upon a swaying leaf; but this very feat is accomplished by another little louse of the same genus,† which may be found depositing its eggs all through the summer months, on the under side of the leaves of our young Post oaks.

PROBABLE REASON WHY ITS INJURIES ARE GREATER IN EUROPE THAN WITH US.

It is a well recognized fact among careful observers, that in the natural state there is greater harmony between the fauna and flora of a country than in the more artificial state that civilized man induces by cultivation. Through a long series of ages, the species least able to contend in the struggle for life, "go to the wall," until at last, by a process of elimination, the balance is struck and we find the animal and plant world well adapted and adjusted to each other. For this reason the native vines which now flourish in this country are those which have fought the long battle in the past and have best resisted the enemy. They are, in short, best adapted to the circumstances, and by their more vigorous nature resist the hypertrophy of the bark caused by the punctures of the lice, and form new bark under it. The European vines, on the contrary, are not only of a more highly improved and tender character, but have not been accustomed to the disease. They consequently succumb more readily, on the same principle that many diseases that are comparatively harmless among civilized nations, acquire greater virulency and play fearful havoc when introduced among savage, or hitherto uncontaminated peoples.

There may be other reasons, such as the different modes of culture and difference of soil; for in the French districts so badly affected the vines are either grown with a single stake or no stake at all, and their soil is generally much poorer than ours. In America, also, we know that there are several natural enemies of the louse, and these checks have, in all likelihood, never been imported into Europe with their prey. That the louse will in

* Rep. III. § 166.

† This is a species of *Phylloxera* which is yet undescribed, but which M. J. Lichtenstein proposes to call *Ph. Rileyi*. It infests the leaves of our Post oak very much in the same manner as the European *Ph. quercus* infests their oaks—causing a similarly pale speckled appearance of the upper side of the leaves. It differs from all described species in the great length and prominence of the tubercles.

time find enemies, and lose its acute power of doing harm even in Europe, is highly probable; and M. Planchon has already noticed that the infested vines in the later invaded departments of Gard and Herault retained a comparatively greener color than in that of Vaucluse, first invaded. Such has been the history of the Hessian fly and a number of other insects imported into this country. These are the explanations I venture, and whether they be generally accepted or not, the facts remain.

OUTWARD AND MORE VISIBLE EFFECTS OF THE ROOT DISEASE.

As long as the lice are confined to the more fibrous roots which, in a measure, are renewed each year, the vines show no decided outward signs of the malady, which may then be considered in its incipient stage. As they become multiplied and fasten on to the larger roots, their work becomes more visible in a sickly, yellowish appearance of the leaf; and a reduced growth of the vine is the result. As the roots waste away these symptoms become more acute, and at this stage of the disease the lice have generally left, so that when the vine is about dying it is often difficult to find any trace of the cause of death. On the rotten roots little eight-legged mites are frequently met with, and they are also to be found in the galls. They may always be distinguished from the true lice by their white, or dirty-white, color.

PRACTICAL SUGGESTIONS.

Last year, from the knowledge we then had of this insect in this country, I recommended the destruction of the Clinton vine, where other and better varieties succeeded as well. This advice was given in order to get rid of the galls, and wherever it has been followed it has had the desired effect. It was given, however, under the impression that the lice would not attack the roots except where the leaves were covered with galls; whereas, in truth, the roots would appear to be less affected (at least during the growing season) where the leaf-galls are abundant than where they are scarce; while they may be absolutely ruined where no signs of galls exist. Consequently there is no longer any urgent need of, or good reasons for, destroying our Clinton vines. By doing so we may diminish the number of galls, but we can never exterminate the root-lice. Future experiments will no doubt show that good results will attend the grafting of such varieties as are known to be most seriously affected, on to the roots of less susceptible varieties.

The insect should be especially watched, as it is apt to be most troublesome, on poor, gravelly or clayey soils. In deep, rich soils I think there is less danger. In France it has been found to be less troublesome on sandy soils, and in my studies I have always noticed that minute, soft-bodied insects do poorly in sand.* The greater the growth of vine the greater the growth of root, and consequently, vines that are trained on walls and which thus more nearly approach the wild state, or which are rendered vigorous by a rich soil, are least susceptible to the disease.

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* In examining vine roots this fall in some parts of Northern Illinois, where sand formed a prominent portion of the soil, I found very few root-lice, except on *Cordifolia* vines whose leaves had been covered with galls. Even on these the general healthfulness of the roots, indicated that they had not been infested during the summer, and that the lice had all come from the last galls of the season.

REMEDIES.

Destruction of the Gall-lice.—From what we have already seen, we may justly infer that this insect cannot of itself spread from one vineyard to another without going through the gall-producing phase; and a few galls on the leaves are, no doubt, invariably the first signs of its advent, by natural means, into a vineyard not previously attacked. By natural means, I mean without the aid of man's assistance, by which they are introduced from one place to another on the roots. If these galls, therefore, could only be found and destroyed, it would be one way of effectually heading off the evil; and in a new vineyard a little vigilance in searching for these galls might save much subsequent loss and labor. I shall not treat here of the natural enemies of the louse, which are of such a nature that they cannot be practically controlled and increased.

Destruction of the Root-lice.—I hope next spring to institute a series of experiments on the root-lice, with a view to the discovery of a practical remedy. It were to be desired that others having opportunity and occasion would do likewise. Here is an excellent chance for our different agricultural colleges, which have greater means and facilities than any one individual can possibly have. As a guide to such experiments, and to profit as much as possible by the experience of others, I will synopsize the results of trials in France. From these results, which I give below, we may learn that no reliable and cheap remedy, that will destroy all the lice after they have become numerous, has yet been discovered; and the best advice that can at present be given is to guard against the insect's introduction into new vineyards by carefully examining the roots before planting. If knots and lice are found upon them, the latter may be destroyed by the same means used against the Apple root-lice—*i. e.*, by immersing the roots in hot soap-suds or tobacco-water.

Preparations of carbolic acid have, so far, given most satisfaction, and I have great hopes of benefit from the saponaceous compound prepared in this country by James Buchan & Co., of New York. This compound is not yet manufactured in France, where they have to use the pure acid or the crystals.

Carbolic acid added to water at the rate of one-half to one per cent, has been successfully employed, and M. Leenhardt, of Sorgues, has by its use, succeeded in keeping his vineyard alive and bearing, while all those around him are destroyed. He uses a heavy bar, thickened and pointed at the end, wherewith to make two or three holes, a foot or more deep, around the base of each vine. He then fills these holes with the liquid, which gradually permeates the soil in all directions. A good post-hole augur, such as we use in this country, would work more rapidly, with the advantage of compressing the earth less, but it would do more injury to the roots.

Oid of cade.—This empyreumatical oil, which is common and cheap in France, when dissolved in any alkali (the urine of cows being good enough)

and applied in the same manner described above, has also given good results. A mixture composed of lime and sulphur boiled in water at the rate of about five pounds lime and five pounds sulphur to one gallon of water, and applied when hot, has been found good.

Alkalies seem to invigorate the vines, but do not affect the lice. They are also too costly. *Salt.*—Vines on lands strongly impregnated with salt have been found to resist the attacks of the lice. *Acids* generally are neutralized by the lime which most soils contain.

Sulphur has been thoroughly tried without any good results, either upon the leaf-lice or root-lice.

Sulphuretted hydrogen.—They have tried to pump this into the soil, but the pumps always break, and no one would think of going to such trouble here.

Sulphate of iron is of no account. *Sulphate of copper* destroys the roots. Numerous other chemicals have been experimented with, but with very little or no success, and they are besides not applicable on a large scale.

Irrigation and submersion have been pretty thoroughly tested, and it is doubtful, even where they can be employed, whether they have any other effect than that of invigorating the vines, as the lice are, many of them, still found alive after a submergence of months. These methods must be considered conservatives rather than curatives.

RESUME OF THE INSECT'S HISTORY.

We have had in this country, from time immemorial, an insect attacking our native vines, either forming galls on the leaves or gall-like excrescences on the roots.* This insect is polymorphic, as many others of its Family are known to be. It also exists in two types, the one, which may be termed *radicicola*, living on the roots, while the other, which may be termed *gallæcola*, dwells in galls on the leaves. The latter is found more especially on the Clinton and its allies, while the former is found on all varieties, but flourishes best on vines belonging to the *vinifera* species. The gall-inhabiting type was noticed and imperfectly described in 1856, but the root-inhabiting type, being less conspicuous, was unknown in this country till last year.

Such an insect is very readily transported from one country to another on grape roots, seedlings, etc., and just as our Apple root-louse (*Eriosoma lanigera*, Hausm.) was imported into Europe towards the close of the last century, so we find that our Grape-louse was similarly imported, in all probability within the last decade. The mode of transport will become all the more intelligible when I state that M. Signoret showed me, last July, the yet living progeny of some lice which he had placed in a tightly-corked glass tube the year before; and that he had managed to keep a few alive for study all through the siege of Paris up to the time mentioned.

Nothing would be more natural than its introduction at Bordeaux,

* I have been able to trace them with absolute certainty as far back as 1845, for in the herbarium of Dr. Engelmann is a specimen of wild *riparia* gathered in this State in that year, the leaves of which are disfigured by the very same gall.

where M. Laliman has, for a number of years, been assiduous in the cultivation and trial of our different American vines. Or it might have been introduced at the nurseries of the Audebert Bros., near Tarascon,* where all sorts of American plants have been cultivated; and, if I mistake not, M. Planchon, with commendable zeal, has so thoroughly sifted the history of the subject in France that he can trace the first invasion, with tolerable certainty, to a point near this place, Tarascon. It doubtless existed in France a few years before its injuries attracted attention, and the first notice of its work was made in the vineyard of M. de Penarvan, at Ville-neuve-les-Avignon, in 1863. The scourge soon increased and spread, and in 1868 and 1869 acquired such dimensions as to thoroughly alarm the great grape-growing districts of beautiful France. At first all sorts of hypotheses were put forth as to its cause. Some book-worms even thought they had found in this root-louse the *Phtheir* of the ancient Greeks, but the intelligent labors of M. Planchon soon dispelled all such illusions, and proved that the *Phtheir* of the ancients was a true bark-louse (*Dactylopius longispinus*, Targ.) of a totally different nature, and still existing in the Crimea.†

In this manner our root-louse was known and studied in a foreign land before its presence was even suspected in this—its native country.

CONCLUSION—NO NEED OF UNNECESSARY ALARM.

Knowledge of the facts I have here brought forth need not alarm the grape-grower any more than correct knowledge of some indisposition, hitherto incomprehensive and consequently uncured, should alarm the human patient. It was only a few years ago that our eyes were opened to the true character of the entozoa known as *Trichina spiralis*, and there can be little doubt but that previous to our knowledge of this parasite many a death occasioned by it was attributed to other unknown causes. It may not be more easy to cure the disease now than it was formerly, but we are, by understanding its nature, enabled to easily guard against and prevent it. "Full knowledge of the truth," says Helmholz, "always brings with it the cure for the damage which imperfect knowledge may occasion." The *Phylloxera* has always existed on our vines, and those varieties which in the past have best withstood its attacks will be very likely to do so in the future. The presence of a few lice on such varieties need cause no fear, for the idea of ever entirely exterminating such an insect from the country must be perfectly utopian, and all we can do is to watch and more particularly care for those varieties that most easily succumb. In the future, the vineyardist will be enabled, by the revelations here made, to trace to a definite cause many a failure which has hitherto been wrapped in conjecture and mystery.

In thus calling the attention of the grape growing community to this interesting little insect, which is sapping the roots of their vines, my inten-

* M. Laliman in the essay already mentioned (p. 63), shows that this nursery has not existed for nearly fifteen years; but this fact does not preclude the possibility of the louse having been first introduced there. It would only indicate—if the spread of the disease can be traced from that point—that it existed in France, without attracting attention, at an earlier epoch than is generally supposed.

† See an Essay entitled La Phthiriose on Pédiculaire de la Vigne ches les Anciens. Bulletin de la Soc. des Agr. de France, July, 1870.

tion is to do good and not cause unnecessary consternation. Let me hope that others may be induced to study the microscopic plague and thus not only assist to fill the gaps yet occurring in its natural history, but help us to become better masters of it. Only those who have witnessed the fearful havoc it has made abroad—where in three years it caused a loss of 25,000,000 francs in the single department of Vaucluse, France,—can fully appreciate its importance and its power, under favorable circumstances, to do harm.

I must remind those who live outside of Missouri, that my observations in this country have been confined to different parts of this State, and apply more especially to this portion of the Mississippi Valley. The insect occurs, however, very generally over the country east of the Mississippi river, even into Canada; and there are strong indications that it produces similarly injurious effects elsewhere. To give a single example: According to the records, most of the vineyards on Staten Island which were flourishing in 1861, and which were composed principally of Catawba, had failed in 1866, and Mr. G. E. Meissner, of Bushberg, who then owned a vineyard on that island, informs me that he had noticed the nodosities, and that the roots of the dying vines had wasted away.* I cannot conclude without publicly expressing my indebtedness to Messrs. Lichtenstein and Planchon, of Montpellier, France, for the cordial and generous manner in which they gave me every facility for studying the insect there, and witnessing experiments in the field.

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* Since the above was written, I have listened to an essay on Grapes, by Mr. P. Manny, of Freeport, Stephenson county, Illinois. In this essay, which was read before the Illinois State Horticultural Society, the writer states that his Delaware, Iona and Salem vines lose their lower roots. He attributes this loss of roots to the tenacity of the soil (though more likely owing to unseen root-lice) and has remedied it in a measure by grafting on Clinton roots.

BENEFICIAL INSECTS.

SILKWORMS.

"Si Patriæ utilis compensatus est labor."

INTRODUCTORY.

Silk is at once the strongest and most tenacious of fibres, and makes the most beautiful, durable and valuable of tissues. What gold is to metals, or the diamond to precious stones, that silk is to all other textile fibers.

Upwards of 35 years ago speculators succeeded in creating an immense furore throughout this country on the subject of silk-culture. It is not my purpose to repeat the history of the silk excitement, which by the name of the *Morus multicaulis* fever stands out prominently as an integral part of the history of our Republic. Inflated to its utmost the bubble soon burst, and with its collapse came a reaction which has ever since prejudiced Americans against an industry which is justly considered one of the very richest with many nations of the earth. As a people we are too apt to go to extremes, and the history of the White Willow hedge fever in the West, some ten years ago, and of other similar speculations which have for a while excited the people's mind, is present to tell us that the *Morus multicaulis* fever does not stand alone as an evidence of the fact.

Strong as was the reaction and the prejudice against silk-culture, yet during the last few years the subject has received increasing attention, and Commissioner Capron refers hopefully to it in his last report from the Department of Agriculture.* It has been shown that some races of the worm will feed and flourish on Osage orange, and that some parts of this great country are, so far as climate is concerned, eminently adapted to the rearing of this precious insect, whose industry increases that of man. Indeed, so much of an exaggerated nature has been said and written on the subject, since the close of the Rebellion, and more particularly in California, that there is some danger of a repetition of the history of 35 years ago.

It has occurred to me that an accurate account of the Mulberry Silkworm, and of such other introduced or indigenous species as seem to warrant it, may, in great measure, prevent any such unfortunate recurrence, and really prove interesting and valuable to the people of Missouri as not only revealing the habits of some of the most splendid moths which enrich

* 1870, p. 8.

our fauna and constantly attract the attention of the knowledge-seeker; but as giving information which may at any future day become invaluable in an industrial sense.

Though we may not, at present, be able to compete, in their own markets, with the cheaper labor of parts of Europe and Asia, there is no reason why, with proper intelligence, we may not produce our own silk as cheaply as it can be brought here from those countries; and I am convinced that should we ever be cut off by war, from those countries on which we rely for our present silk supply, we can easily fall back on our own resources; and there are few parts of the United States better adapted to the raising of silk than the southern counties of Missouri. Even now, there is no reason why the young people, and those unable to do harder work, in thousands of families, in that section of the State more especially, should not spend a few weeks each year in the pleasant work of producing cocoons. The spinning wheel and the distaff have been superceded and driven from the household by modern machinery; and the time which used to be given to their working in former days, might be profitably devoted now-a-days to silk-raising and reeling. Such a substitution of the finer for the coarser fiber would indeed be typical of our modern civilization and progress compared with the old.

Not very many years have elapsed since grape-culture was considered impracticable in this country, while the practicability of pisciculture is only just now beginning to be realized; and to one who is familiar with the details of sericulture abroad, it becomes very clear that, with the endless variety of our soil and climate, the production of silk might soon be added to our constantly increasing resources—especially if fostered and encouraged at the start by wise government. It is not always wise to prophecy, and yet, to me, the day is not far distant when there will be on our Pacific coast silk-reeling establishments, worked it may be by the most skilled Japanese labor—establishments which will create a ready market for cocoons reared with us, even if we do not erect *filatures* or reeling establishments ourselves; for the completion of the Union Pacific railroad brings us into direct communication with the far West, and an import duty of about 10 per cent. on raw silk, though it would of course be protested against by the manufacturers, would give stimulus to this production and certainly benefit the country.

Nothing in that well known "Boy's own Book" had half the interest for me, in childhood, as the chapter on the Silkworm. The feeding of the worms was the pet summer occupation of my boyhood; while the risks ventured and obstacles surmounted to procure mulberry leaves for the same purpose, are prominent among the reminiscences of after college life. Since then I have lost no opportunity to inform myself of the details of the silk industry, so that I speak from no little experience.

Before proceeding to the more specific consideration of these silkworms, I may as well state that my object is not so much to go into detail, since whole volumes might be, and have been, written on the Mulberry Silkworm alone. My purpose is to lay before the people of Missouri such ex-

perience as is yet unrecorded, and to sift from the mass of unimportant facts, the more salient and valuable ones.

Of the eight species which will be treated of, four, namely, *mori*, *cynthia*, *yama-mai*, and *Pernyi*, are of foreign origin, and the other four, namely, *Cecropia*, *Promethea*, *Luna*, and *Polyphemus*, are native. I shall give an account of the changes these different worms undergo, because these changes have not before received sufficient attention. It will be noticed that, when newly hatched, all of them, even to the mulberry species, are, in form and structure, exactly alike; and that they differentiate more and more as they increase in size, until each acquires its specific characters. This is in accordance with a law which has only lately been fully appreciated, and which prevails throughout nature; namely, that in the early stages, the species of a genus or of a Family closely resemble each other, no matter how dissimilar they afterwards become. To the Darwinian such facts are significant, as implying descent from a common ancestry.

All these silkworms cast their skin four times during the feeding period, and thus have five different stages of growth; the worm resting and fasting from one to three days, then gradually working off the old skin, and afterwards knocking off the head.

The males of all generally issue from the cocoons before the females. This is no doubt due to the fact that the females are generally the largest, have the most vitality, and consequently require a greater time to feed, and to assimilate the food; for it has often been noticed that a small female will develop faster and consequently issue sooner than a large male.

The males generally have much broader antennæ than the females; but in *Promethea* the difference is not great, and in *cynthia* it is often imperceptible.

They all, when in the cocoon, are furnished with an acrid or Bombycic fluid, with which they weaken the resisting force of their cocoons, and facilitate the exit of the moth; though those which make rounded or closed cocoons are much more amply supplied than those which form pointed or open ones.

All the cocoons, whether pointed or rounded, are spun in one continuous thread. In issuing, the moths of all of them rupture, more or less, the threads of the cocoon, thus rendering it valueless for reeling. Many writers assert to the contrary; but I have examined no deserted cocoon which has not shown some broken threads, and have witnessed the threads break during the emergence of the moth. Such as are naturally open are broken less than the others; but if only a half dozen threads are sundered, the cocoon is spoiled for reeling purposes. All the native cocoons are at times found drilled with large holes, and gutted by birds or squirrels; and those which fall to the ground are frequently destroyed by mice, rats and moles.

All the moths are night flyers. All the large heavy worms, when full grown and in a state of nature, hang on the under side of leaves and twigs, being too heavy to sustain themselves in an upright position. They are all of some shade of green—no matter what their color when younger—and in a

measure similate the leaves of their food-tree, so as to render detection difficult.

They all, whether native or foreign, need fresh air for their well-being; confinement in rooms and in large numbers together undoubtedly predisposing to disease. In breeding insects entomologists well know that those species even which best bear confinement, rapidly degenerate in the course of a few generations, and it is a very general law with animal and plant life, that the more it approaches the artificial in contradistinction to the natural, the less vigorous in constitution it becomes.

It is a little singular that the principal trees which may be used for producing the best silk, namely, the Mulberry, Osage orange and Ailanthus, are all three of them remarkably free from the attacks of other insects.

By judicious breeding and selection I believe that the native worms may be improved in their silk-producing qualities, and that the foreign ones may be acclimatized and better adapted to our conditions.

With this brief prelude I will at once introduce—

"The worm that spins the Queen's most costly robe,"

THE MULBERRY SILKWORM—*Bombyx* [*Sericaria*] *mori*, Linn.

(Lepidoptera, Bombycidæ.)

ITS PAST HISTORY.

Silk seems to have been first manufactured and used as an article of clothing in Asia. At least it was first obtained from thence by the ancients, and the Romans called it, from the name of the country whence it was supposed to be brought, Sericum. According to the best records its cultivation commenced in China under the reign of Emperor Houng Ti (Emperor of the Earth), and the Mulberry Silkworm is undoubtedly indigenous to China, where it fed naturally on their wild mulberries.

The wild worm has yet to be discovered, however, and will doubtless be found eventually in some of the provinces of China. A wild variety, of small size, living on Mulberry, is said to occur in Java, but it is difficult to say whether it is there indigenous and has always been wild, or whether it has sprung from escaped specimens of the domesticated races.*

Long before the Christian era, silk was cultivated both in China and India, where a class, whose occupation was to attend to silkworms, appears to have existed from time immemorial, being mentioned in the oldest Sanscrit Books.† Its cultivation can be traced back in China to at least 2700 B. C. From China it was exported to India, Persia, Arabia, and the whole of Asia.

*Maurice Girard. *Les Auxiliaries du ver à soie.* p. 5. 1864.

†Colebrook in *Asiatic Researches*, V. 61—quoted by Kirby & Spence.

The manner in which silk was produced long remained a mystery to the ancients, and Aristotle first rightly conjectured that it was unwound from the pupa of a caterpillar. At Rome, even as late as A. D. 280, a silk attire of purple was considered by the Emperor as a luxury too expensive for an empress—it being worth its weight in gold.

In Europe the mode of producing and manufacturing it was not made known till about the middle of the sixth century, when two monks of the order of St. Basil, arrived at the court of the Emperor Justinian, at Constantinople, from a missionary expedition to China, and brought with them the seeds of the Mulberry, and communicated the mode of rearing the worms. In Greece its culture and manufacture soon spread, and the Venetians in the hight of their prosperity carried supplies to the whole West of Europe. It was introduced in time into Spain, Portugal and Sicily, and in 1540 extended to Piedmont, and throughout Italy. Here the product soon outranked in excellence the very best of Asiatic origin. In France we hear of mulberry trees being planted near Avignon as far back as 1340. Later, namely, in 1494, silk-culture was introduced into Alan; but it did not become thoroughly established till 1603, when encouraged by Henry IV. It has now become one of the most important industries of that country. In 1865 the value of silk goods produced was estimated at $106,500,000, of which $26,-500,000 (raw material) was imported. The home consumption was $35,000,000, and the export $71,500,000. The number of silk looms employed in the empire was about 225,000, and gave bread to half a million of the inhabitants. The United States paid France in 1865, $9,900,000 for her silk goods. During and since the war we have been more economical. About the year 1605, James I, who, while king of Scotland, was forced to beg of the Earl of Mar the loan of a pair of silk stockings to appear in before the English ambassador, endeavored to encourage its culture in England; but the climate is not favorable to the rearing of the worm, and yet the English annually import millions of dollars' worth of raw silk, and only recently a "Silk Supply Association" has there been formed, which now publishes a monthly journal, and the objects of which are thus stated:

1. To stimulate the production of silk, by cottage cultivation and otherwise, in every county where the mulberry tree is capable of giving food to the silkworm. 2. To encourage the introduction and exchange of the best kinds of silkworms in silk-producing districts. 3. To offer practical suggestions and encouragement to the producers of silk for improving the quality and securing a better classification, and for ensuring greater care in the reeling of the silk. 4. To promote the cultivation of silk in the various silk-producing districts in India, where the production of silk has not recently increased, and in other districts of India, where the cultivation of the silkworm has almost ceased, but which are known to possess special advantages, by the growth of the mulberry tree and the habits of the people, for its propagation. 5. To promote the exportation of cocoons from countries not well able to reel them. 6. To communicate with the Foreign, Colonial and Indian Departments of her Majesty's Government, and to obtain the aid of the English representatives in the British colonies and consular agents in all foreign countries to promote and extend the cultivation of silk.

There are but four countries which export raw silk; namely, China, Japan, Italy and France. Estimates gleaned from recent statistics bring the different countries in the following order in regard to their production of this export. At the head is China, which produces every year silk to the value of nearly $100,000,000; then Italy, $42,000,000; France, $26,000,000; India, $24,000,000; Japan, $17,000,000; Turkey and Asia Minor, $12,000,000; Persia, $5,000,000; Spain and Portugal, $3,000,000; Syria and Austria, each, $2,000,000; Greece, $1,000,000. Then follow other countries, averaging from $900,000 to $100,000, while the United States at present produces scarcely any—the product for ten years being, according to the last census, 3,945 pounds; of which California produced 3,587; Pennsylvania, 1; Virginia, 15; North Carolina, 95; Georgia, 14; Mississippi, 31; Louisiana, 1; Tennessee, 153; Kentucky, 45; and Missouri, 3.

An interesting proof of the gradual spread of silk over the globe is furnished by the similarity of name given to it by different nations as follows: China, *se;* Mongolia, *sirkeh;* Corea, *sic;* Arabia, *serik;* Greece, *σηρικόν;* Roman, *sericum;* Mediæval Latin, *seda;* Italy, *seta;* France, *soie, satin;* German, *seide;* Denmark, *silcke;* Sweden, *silke;* Anglo-Saxon, *siolk;* England and America, *silk.*

ITS HISTORY IN AMERICA.

During the reign of James I. of England, or in the beginning of the 17th century, sericulture was first attempted in Virginia. Other efforts were subsequently made, but were very naturally abandoned for the obvious reason that the raising of tobacco, cotton and sugar were found more profitable.

Many years subsequently it began to attract renewed attention, and was gaining strength and importance when the Revolution deranged and crushed it. After the Declaration of Independence, feeble efforts were made to naturalize the worm in the more northern States; and, according to William H. Vernon, of Rhode Island,* $30,000 or $40,000 were annually realized from rearing the worms in Connecticut, at the beginning of the present century.

But from the few data which we have to guide us, we may conclude that silkworm culture, with the exception of the fitful start during the *multicaulis* fever, was very generally abandoned in the States. And indeed the climate of the New England States is by no means well adapted to the raising of the worms; and worse still, there was no market for the cocoons. But the conditions have materially changed within the past decade. Under the stimulus of the duties on the manufactured goods, the growth of silk-manufacture has been unprecedently rapid; for there is no duty on the raw material, and the completion of the Union Pacific railroad has enabled its rapid and direct importation from China and Japan.

The Oneida Community, of Oneida Co., N. Y., have been far more successful as manufacturers than as raisers. They turn their attention to the

* Methodical Treatise on the Cultivation of the Mulberry Tree; on the Raising of Silkworms, etc. From the French of M. De la Brousse. Boston, 1828.

manufacture of sewing silk of different grades, and though the first silk was made in 1866, they realized the very next year the sum of $25,000, and at present their business has so increased that they employ about 150 female operators in their factories.

Half a dozen years ago, within a radius of fifty miles of New York, there were not 50 looms running on broad silks and serges, where now there are nearer 500. In and around Boston there are nearly as many; and Philadelphia boasts of about 30. Last fall I visited Paterson, N. J., and spent some time in the surrounding country for the purpose of inquiring into this new industry. From Mr. Thos. N. Dale, of the Dale Manufacturing Co., I learned that in Paterson alone there are some 30 establishments manufacturing silk, employing about six hundred persons, and making nearly all kinds of goods. Of ribbon factories, the largest in the United States are there, two of them employing from three to four hundred hands, though the leading specialty is silk dress goods, chiefly blacks. A large business is also done in pongee silks, or handkerchiefs, which are sold plain to New York merchants, by whom they are sent to various print works on Staten Island for a finish.

The establishment of the Dale Manufacturing Company, which is the largest, produces braids, cords, dress trimmings, etc., in great variety. This concern, like others, does a heavy business in manufacturing trams and organzines (warp and filling) for silk establishments throughout the country. Another factory employs numerous hands exclusively on ladies' trimmings, gimps and fringes. Several others are making sewing silk, hat bands, etc.

Mr. Dale uses the best European machinery, and has a seri-meter and dynamometer for testing the strength and elasticity of the thread, and scales for weighing it, all from Berthand & Cie of Lyons, France. He employs 350 hands, earning on an average from $5 to $6 a week. He uses nearly a bale (100 lbs.) of raw silk each day, for which he pays from $9 to $12 per pound.

$5,000,000 of capital are invested in the business in Connecticut, the establishment of Cheney Bros., at Hartford, being the largest in that State.

All these facts serve to show that there is at present an unlimited demand for reeled silk right at home, and I believe that reeling establishments will be built wherever sufficient cocoons are raised to warrant them.

The production of the raw material is beginning anew under far more favorable auspices than ever before, and not only in California, Arizona and New Mexico, which for this purpose are favored by heaven; but right here, in this portion of the Mississippi Valley, I believe the day will soon come when silk-raising will be carried on profitably. Any community by coöperation might add to its annual product by this industry, without in the least affecting its other industrial pursuits. Individuals have successfully raised the worms, and Mr. J. F. Wielandy informs me that his uncle, Mr. Pagan, of Highland, Illinois, raised them successfully for four consecutive years. He had some of the silk on exhibition before the Board of Trade of St. Louis; and specimens were sent to Switzerland, and pronounced, by

six different manufacturers, equal to the best grown in Europe. Some attention has been paid to the subject in Utah, and worms have been repeatedly raised, on a small scale, by myself and others in various portions of our own State. All these trials have gone to prove that the worms can be raised with us; and they have not been remunerative simply because they were carried on more for pleasure than profit, and not extensively enough to warrant the purchase or manufacture of suitable reeling machines.

SILK GROWING IN CALIFORNIA.

Through the efforts of Colonel Warren, of the *California Farmer;* the late M. L. Prevost, and others, much attention has been paid to silk-raising on the Pacific Coast since the close of our civil strife. That they have, in that section of the country, a climate most eminently adapted to the growth of the Mulberry and the rearing of the worms, admits of no doubt whatever. The extremes of heat and cold, the thunder storms and rains which often occur in France and Italy during the rearing and breeding season, *i. e.*, in May, June and July, are almost unknown in some of the California Coast Valleys.

M. L. Prevost, who by his enthusiasm earned for himself the title of "Pioneer Silk Culturist of the Pacific Coast,"* selected some 10,000 acres in San Bernardino county as a basis for a silk settlement. In a short time he managed to create a great interest in the subject, especially in Los Angelos, Santa Barbara, and San Bernardino counties. In 1867, he published the "California Silk-growers' Manual," and though he is now no more, and it is unnecessary to criticise the work as it deserves, it is important to point out a few of its inconsistencies in order to prevent others from being deceived and misled by it. It is made up principally of a series of fugitive newspaper articles brought together in an undigested form, and without regard to arrangement or chronological order. He never once mentions the race of worms he raised; asserts without proof that one man can take care of as many worms in California as can eight in France; argues without sufficient ground on a constant demand for California eggs from Europe; and asserts prematurely that California silk by the superiority of the climate is bound to be a superior article, and consequently will command the market in all parts of the world. On page 162 he speaks of the bones [!!] of the scull of the worm. On page 59 he shows that a lot of worms which he attempted to raise in Sacramento in 1866, were, from one cause or another, very badly diseased; while on page 152, in a chapter which was evidently written subsequently, he roundly asserts that he had never been able to observe any disease in California worms. On page 60 he says that a change from Mulberry to Osage leaves started the disease above mentioned, and afterwards (p. 120) clearly shows that it was started before the Osage was fed. On page 105 is given a list of prices of cocoons at Lyons, France, the average of which is $1.96 per lb.; while Ure's Dictionary gives the price of

* According to his own showing, however, (Manual p. 136,) Mr. Henry Hentsch was the first to import the eggs of the worm and the seed of the Mulberry.

cocoons in France in 1851 at about 30c., and M. Combier-Blanchon, of Livron (Drome), France, informed me last summer, that the best of cocoons only bring there about 5 francs the kilogram, which is about 50c. gold per lb. On page 77 he makes the statement that he had raised silk for two successive years at a net result of $104, and (valuing the raw silk at $4.50 per lb.) of $108 per acre. Yet on page 237 there is a calculation to show that the net return from an acre may be $2800; and by taking some of the figures given it might be made still greater.

These few inconsistencies will serve to show how unreliable the work is. M. Provost was an enthusiast, and we may admire his enthusiasm, but when enthusiasm becomes fanaticism and carries one beyond the bounds of reason, it is often productive of more harm than good. Had M. Prevost shown more moderation and reason in his writings; had he been as prone to report failure as he was to magnify success, the silk interests of California would not now be endangered by a reactive depression which is as unnatural as was the over-enthusiasm a few years since. His little work, by false showing, was better calculated to induce another *multicaulis* fever, than to healthily stimulate silk industry. Its exaggerated pictures and immoderate accounts annulled what little of value it did possess, and earned for its author the name of *blagueur,* which has been applied to him in France.

Silkworms were first hatched in California in 1860. In 1868 the interest in silk culture there was at its height, and the legislature of the State, in order to encourage the enterprise, offered liberal bounties. In 1869, the premiums amounted to $115,000; but from this time on the reaction began to take place, and the evil effects of the visionary clamor of enthusiastic advocates began to tell. The season was exceptionably unfavorable, and many of their eggs were spoiled for want of experience how best to keep them.

For a while the diseased state of the Silkworm in Europe created a large demand for foreign eggs, and the trade in the East assumed large proportions. In 1869 two millions of cards, costing on an average three dollars each, were sent to Europe from Japan, and special steamers were chartered to carry home the valuable freight. The demand was such that some eggs raised in California were also sold to France, and large profits were the result. Mr. I. N. Hoag made the following very favorable report of his business in 1868, in a letter to the *Sacramento Union*—a report well calculated to induce others to attempt to do likewise:

In 1868 I fed the leaves from three and one-half acres of land covered with two year old *Morus multicaulis* trees. The trees had been grown from cuttings where they then stood. They had been cut back in the spring or winter close to the ground and the tops used for cuttings, so that they did not furnish much over half the early foliage they would have done had they only been pruned with an eye to that purpose. The result of that operation concisely stated, is as follows: Receipts, 486 ounces and 13½ pennyweights of eggs sold to Hentsch & Berton at $4 per ounce, $1,946.70; eggs retained for self and sold to other parties, $1,897.50; perforated cocoons sold, $75.30; total, $3,919.50. Contra; labor and other expenses, $472.00. Net profits, $3,449.50. The feeding was commenced on the first of June. On

the 25th of July it was fully completed and the eggs all made. On the 7th of August I had my money from Hentsch & Berton, and could have sold the entire product to them.

But it subsequently turned out that Messrs. Hentsch and Berton lost $1,000 by the operation, and that no other such liberal men were to be found who would take such risks.

Mr. Thos. A. Garey, of Los Angelos, gave similarly encouraging results of one of his year's doings in silk-culture, having netted $2,700 from one acre, from eggs and mulberry cuttings. Many other similar cases might be given. Indeed, whenever profits were made they were not legitimately from the cocoons, which seem to have found no sale at all; but from eggs and mulberry cuttings. This was owing to the fact that no reeling establishments had been erected and there was consequently no market for the raw cocoons, while none of the raisers seem to have attempted the reeling of their own silk. But the demand for California eggs never had become an established one, and ceased entirely when the Franco-Prussian war broke out. This war had the effect to depress and almost destroy the spirit of enterprise which had prevailed a few years previous. It even left the Japanese egg trade in a bad condition, so that some lots were shipped to San Francisco at a time when the Californians had a surplus of their own. One lot of 130,000 cartoons left a record that will not encourage further consignments. In the center of the lot the heat hatched the worms, and they had to be reviewed and repacked when they arrived. After some use of the telegraph parties in New York were found who risked the shipment overland to be sent thence to Europe; but the eggs were all ruined, and every cent invested was sunk.

For these various reasons there is great despondency in silk circles in California at present, and the business has very generally been pronounced a failure. The Santa Clara *Agriculturist* says it has given less practical satisfaction and poorer grand results than almost any other industry undertaken on the Pacific coast.

At present there are lots of mulberry trees in nursery, with no demand; and the premium offered has failed of its intended object to promote the interest, because a bounty was also offered for cocoons; and there has been no effort to produce reeled silk, not a single hank having thus far resulted. There has been more speculation than work.

The whole question of the success of silk-culture in that State, and indeed in any part of the country depends, therefore, on the ability to reel the silk and thus furnish a market for the cocoons; and State aid and encouragement should be directed to this end. It always has been a serious question whether or not in producing reeled silk we can compete with the cheap labor of southern Europe and of China and Japan. If by superior intelligence and the advantage of climate the Californians can produce reeled silk —and I sincerely believe they can—so as to furnish it at home at the same rates that it can be imported from abroad, they will succeed, and silk-culture will become one of the prominent industries of the country. If they cannot, it will be a signal failure.

The manufacturing interest, encouraged as it is by import duties, will take care of itself, and silk factories are already springing up on the Pacific coast and proving remunerative, as they are on the Atlantic. Let the productive industry be similarly encouraged, and let all premiums hereafter be offered for reeled silk!

SILK CULTURE IN KANSAS—MONS. E. V. BOISSIERE'S ESTABLISHMENT.

About three years ago, Mons. E. V. Boissière, a French philanthropist, of considerable means, came to this country from Bordeaux for the express purpose of purchasing a large tract of land for general agricultural purposes, but primarily for the cultivation of mulberry trees and the raising of silk. He finally settled in Franklin county, Kansas, about 18 miles southwest of Ottawa, 10 miles west of Princeton station, on the Leavenworth, Lawrence and Galveston railroad, and three miles south of the little town of Williamsburg. Here, in 1869, he purchased 3,500 acres of undulating prairie land, and at once commenced operations by erecting a three-story frame building, 50x30 for his operatives. The land is rich and clayey, with a limestone subsoil and of good elevation. He has already fenced in 360 acres and broken about 150; and contracts are let for the fencing with stone walls of 160 acres intended for pasturage. The place has been christened "Silkville."

He does not contemplate the cultivation of this entire tract; but intends to devote the greater portion of it to the raising of cattle, for which he whishes to have sufficient range on his own land. Only the more valuable portions will be devoted to the silk interest. Already there is a good stable, a few sheds for rearing the worms, and a stone factory 83x28 for working the silk. If the silk business succeeds, the reeling of the cocoons and the manufacture of velvet trimmings will furnish occupation through the winters; but the hope of success now entertained by M. Boissière cannot be realized for at least two years, which will be required to establish the possibility of profitably raising the worms, and to await the growth of the trees. Meanwhile, to avoid any chance of failure, he intends to embark in several industries which have received no attention in that part of the country, and which will give employment to the operatives, and may be carried on entirely from the products of the farm. Of such industries, he mentions more especially broom-making; the preservation of meat in tin cans; the manufacture and refining of sorghum syrup; of castor oil; potato starch; morocco leather, and dark-headed matches, which have nothing poisonous about them and cannot be ignited except on the box containing them.

There are already planted 8000 mulberry trees which have made a wonderful growth, and there are 2,500 fine young trees in nursery to be set out. There is also a young orchard of 900 trees, and 2,000 peach trees; 1,000 Concord vines; and belts of Black locust, Black walnut and Ailanthus, will be planted the coming spring.

The forepart of last November I paid M. Boissière a visit, as I was interested in this novel enterprise just started in a neighboring State. I found him sitting at an immense table with all the operatives, partaking in common of a plain but substantial meal. He is a bachelor of some sixty years of age; a philanthropic, intelligent man—a man of plain habits, and with such broad democratic views that he originally came to this country in sheer disgust of Napoleon III. He is fully imbued with the fact that there should be no conflict between capital and labor, and intends to make the colony self-supporting; but to form eventually a co-operative society, with equitable distribution of profits, mutual guarantees, association of families, integral education and unity of interests—something after the plan proposed by Mr. E. T. Grant, in a work on Co-operation, issued from the office of the New York *Tribune*. So soon as the organization is effected he intends to donate to the association all the capital invested by himself up to that time, reserving only the right of as many votes as the capital will represent.

I found the looms in the factory idle for reasons which need not affect the ultimate success of the enterprise, and the samples of velvet ribbon and silk trimmings which had been made from French and Japanese silks, and which may be seen at Carson Bros., 121 Locust street, St. Louis, sufficiently attested the capabilities of these looms. Other looms have already been ordered from France. I shall await with much interest future developments in this colony, for upon its success very much depends. That it will succeed as a colony I have little doubt, but whether it will do so as a silk settlement, time only will tell. If it becomes a success in this last sense, it will form the nucleus of a new and important industry in the Mississippi Valley; for I cannot help thinking that there are localities innumerable, and plenty of them in our own State, where such colonies could be formed with better commercial facilities, less severe climate, and especially where there would be less annoyance from severe cold winds, which, as M. Boissière informed me, prevail there to a remarkable degree in the spring, and bid fair to form the most serious obstacle to the rearing of the worms. The State of Kansas, if it looks well to its own interests, will not let the undertaking fail for want of encouragement; for when an individual embarks in some new enterprise, the success of which is of so much importance to the State, he deserves encouragement from the Legislature, if it is necessary.

SILK GROWING IN MISSOURI.

I cannot find that the Silkworm has ever been raised in any considerable numbers in this State. I have raised them under a variety of circumstances during each of the last four years, having employed three white and yellow races from Eqin, China, received through the Department of Agriculture; and three rather inferior European varieties. They have also been raised, at my request, by several different persons near St. Louis, by Judge J. F. Wielandy of Jefferson City; Wm. R. Howard of Forsyth, and J. L. Townsend of Columbia. These trials fully warrant the assertion that

the worms can be reared here with perfect success, and that where the rules laid down under the head of "Best Methods of Rearing" are properly carried out, we may be as sure of a good harvest as they are in most of the silk-growing districts of Europe.

The worms naturally commence to hatch with us from the middle to the end of April. They commence spinning usually within thirty days, and remain in the chrysalis state just about two weeks. The feature in our climate which we have most to guard against is the excessive heat that sometimes occurs in May, when the worms are in their last stage. A wet spring with a hot early summer, is most injurious, and these features of 1870 induced a greater mortality than occurred during any of the other four years of my experience. Excessive heat, and too great richness of the food, is very apt to produce jaundice in the worms, and it manifests itself more particularly just before spinning time. Our fall season cannot be surpassed for this industry, as the weather is drier, more uniform in temperature, and the leaves are riper and sweeter than in the spring. For these reasons, future experience will doubtless prove that September and October will be propitious months for rearing the worms; and that consequently it will be best to retard the hatching of eggs by keeping them constantly at a temperature below 40° F.; or we might employ the Bivoltins—raising only enough of the first brood to give us a good supply of eggs for the second.

NATURAL HISTORY OF THE SILKWORM.

The Silkworm is interesting to us, not only from the value of its silk, but from the fact that it is about the only insect that has been under man's complete management for a long series of years, and that has been carried by him from one country to another in widely different parts of the world. It is, so to speak, the only domesticated insect to which we have been able to apply the principle of selection for any length of time; for though the Cochineal insect and the Honey-bee have been in a measure under our control, these principles have never been applied to the former, and it is only within the last few years that we have been enabled, by hive-improvements and deeper knowledge of its habits, to apply them with any degree of satisfaction to the latter. The Silkworm has been subjected to a variety of differing conditions, both of climate and management; and if species are, as many of the more advanced thinkers now contend, not immutable but mutable; we should expect to find great differences in the characteristics of this particular one. These differences we do, in fact, find; for it is notorious that there are about as many breeds of the Silkworm, as there are of the domestic Dog. In the form of the egg, the colors of the larva, and more especially in the size, color, form and quality of the cocoon; and in the varying length of time required for development; the races of *Bombyx mori* show such differences that, if found in any of our wild species, they would be considered as specific by most naturalists. Yet no naturalist pretends to give these differing races specific scientific names, though they are often designated by popular distinguishing terms.

There is one race known as *Annual* which will not produce more than one brood each year, no matter how the eggs are manipulated; another known as *Bivoltin* which produces two broods a year; and a third (*Trevoltin*), which produces three annual generations. Yet by changed conditions each of these races can, in a few years, be rendered inconstant and variable in these particular characteristics. There are races (and they are more especially adapted to warm countries) such as that of Milan, and most of the *Trevoltins*, which habitually moult but three times; and it is evident that even this important difference has been artificially produced, since ordinary worms occasionally moult but three times and the three-moulters or *races à trois mues*, as the French call them, sometimes moult four times.*

The Mulberry silkworm is, when compared to other insects, an anomaly. It had already been so long under the influence of human management ere it was introduced into Europe, that we find the larva, when full grown, possessing the white color so typical of domestication; which is the more remarkable that white is extremely rare in Lepidopterous larvæ, and unknown in any of the external feeders belonging to the Silkworm Family (*Bombycidæ*). That this lack of color is the direct result of domestication, as in so many other animals, may be very justly inferred, because when newly born the worm is almost black, and in the older worms there are constantly appearing individuals with dark or tiger-like marks which have been attributed to reversion by Captain Hutton, who, by separating and breeding from them, found that in the third generation they had become darker and that their moths were likewise darker, and resembled in coloring the wild *Huttoni* of Westwood.† We find furthermore, that it has lost all desire of escape, and the worm will seldom crawl out of the shallowest tray so long as it is supplied with food, while the moth is equally contented to remain in the same trays. So thoroughly has it lost all instinct of self preservation that, as we learn from good authority, when placed upon a tree out of doors, the worm is easily blown down by the agitation of the wind, and not unfrequently commits the blunder of severing the petiole of the leaf upon which it rests, and thus unconsciously brings itself to the ground from which it seldom has the tact or power to rise again. We find also, that the moth has lost almost all traces of color and very nearly all power of flight; its wings scarcely ever expand much beyond the length of the cocoon, from which it issues, while most of the wild silkworms, (take, for instance, the *Polyphemus*, figures 50 and 53,) expand from four to five times the length of their cocoons. The male flutters a little, but the female cannot rise off her feet, and never makes the attempt; yet there is every reason to believe that they both flew in the wild state, and it has been shown that after three generations reared in the open air, the males recover in great part the lost power.

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* See Darwin's Animals and Plants, etc., p. 302.

† Trans. Lond. Ent. Soc. 3rd Series, Vol. 8, pp. 153, 308.

In short, the ordinary Silkworm bears unmistakable evidence of having been modified according to man's wants. He has been interested mainly in producing the largest amount of silk from the smallest amount of leaves, and we consequently find to-day vast differences in the cocoons of the different races, and great bulk of cocoon compared with the insect which makes it.

The Mulberry silkworm is anomalous in one other respect, namely, in having a curved horn on the eleventh joint; for though in those silkworms which are tubercled, there is always a large middle tubercle on the back of this eleventh joint, yet none of them possess this Sphingidous character in the same degree.*

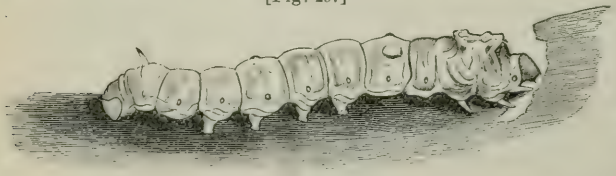
From the foregoing, it will become obvious that what follows of the natural history of the Silkworm is of the most general character.

THE EGG.—The egg is nearly round, a little flattened, and in size rather less than a mustard seed. It is yellow when first deposited, and so remains if unimpregnated,† but when impregnated soon acquires a gray or slate color and becomes indented. It is fastened by a gummy substance which the moth secretes in the act of ovipositing. Each female will lay upwards of 300 eggs. One ounce of good eggs will produce 40,000 worms. The color of the albuminous fluid in the egg corresponds, or is correlated with, that of the cocoon; so that when this fluid is white the worms produce white cocoons, and when yellow they will produce yellow ones.

As the hatching point approaches, the egg becomes more pale in color which is due to the intervening space between the rolled-up worm and the shell which is semi-transparent. Just before the worm hatches there is often heard a slight clicking noise, which, however, is common to many other insect eggs; and when loosened it will sometimes bound a short distance, evidently by the sudden jerk of the worm within, as in the case of some so-called jumping seeds and jumping galls.

THE LARVA.—The newly hatched worm, as already stated, is black or dark gray. It is covered with long stiff hairs, and if closely examined these hairs will be found to spring from pale tubercles of the same number and placed precisely in the same position as those to be found at the same age on all the other silkworms to be hereafter described. It becomes paler at each moult and after feeding for nearly a month, pre-

[Fig. 29.]



* This feature is generally considered so entirely characteristic of the larvæ of a Family of Moths popularly called Hawk-moths (*Sphingidæ*), which, for the most part, undergo their transformations naked ly underground; and so uncharacteristic of those of the large Family of Silk-moths (*Bombycidæ*), that—reasoning from analogy and forgetting his earlier experience with the Silkworm—so good an entomologist as my late friend Walsh, at first took me to task for putting a horn on the figure of this worm, which appeared on the cover of the *American Entomologist*. To me this horn exhibits merely a case of persistence of the middle tubercle on the eleventh joint, while those on the other joints have become obsolete; and we have an approach to the same condition in our *Promethea* (Fig. 43, *d*), which, as it grows, loses all its tubercles except four near the head and this one on the eleventh joint.

† On very rare occasions the embryo in unimpregnated eggs continues to develop and the young worm has even been known to hatch.

sents the appearance of Figure 29, having lost its long hairs, and all its tubercles but that on the eleventh joint. It does not become entirely smooth, however, as there are short hairs along the sides, and very minute ones not noticeable with the unaided eye, all over the body. The preparation for each moult requires from two to three days of fasting and rest, during which the worm attaches itself firmly by the abdominal prolegs and holds up the forepart of the body, and sometimes the tail. In front of the first joint a dark triangular spot is at this time noticeable, indicating the growth of the new head, and when the term of "sickness," as it is often called, is over, the worm casts its old integument, rests a short time to recover strength, and then freshened, supple and hungry, goes to work feeding voraciously to compensate for lost time. It is usually estimated that it consumes its own weight of leaves every day it feeds; but this is not strictly correct. It does, however, consume more during the last few days of its worm-life than during all the rest put together. When about to spin up it shrinks somewhat in size, acquires a clear translucent pinkish appearance, becomes restless, ceases to feed and throws out silken threads.

According to Quatrefages* the color of the silk is correllated with the color of the abdominal prolegs.

THE COCOON.—The cocoon (Fig. 30) consists of an outer lining of loose or floss silk, which is used for carding, and of a strong, tough pod. Its form is usually oval and its color yellowish; but in both these features it varies greatly, being either pure silvery-white, cream, or carneous, green, and even roseate; and very often constricted in the middle. The male cocoon is often more pointed than that of the female.

[Fig. 30.]

[Fig. 31.]

THE CHRYSALIS.—The worm completes its cocoon in about three days and in three days more becomes a chrysalis. In this state it remains from two to three weeks when it issues as a moth.

THE MOTH—Is of a cream-color with more or less distinct brownish markings across the wings as in Figure 31: neither sex flies, but the male is more active than the female. Coitus takes place very soon after issuing, and the female begins depositing in a day or two, whether her eggs be fertilized or not.

ENEMIES AND DISEASES.

It has generally been supposed that no true parasites attack the mulberry silkworm; and certain it is that none such are known in Europe. But in China and Japan great numbers of worms are killed by a disease called "*Uji*," which is undoubtedly produced by the larva of some parasite,

* Quoted by Darwin.

though whether Hymenopterous or Dipterous I have not been able to learn with assurance.

Several diseases of a fungoid or epizoötic nature and several maladies which have not been sufficiently characterized are, however, well known to afflict this worm. One of these diseases called *muscardine*, has been more or less destructive for many years in Europe. It is of precisely the same nature as the fungus (*Empusa muscæ*) which so frequently kills the common House-fly and sheds a halo of sporules, readily seen upon the window-pane, around its victim.

A worm about to die of this disease, becomes languid and the dorsal pulsations become insensible. It suddenly dies and in a few hours becomes stiff, rigid and discolored; and finally, in about a day, a white powder or efflorescence manifests itself, and soon entirely covers the body, developing most rapidly in a warm humid atmosphere. No outward signs indicate the first stages of the disease, and though it attacks worms of all ages, it is by far the most fatal during the fifth or last age or stage.

This disease was proved by Bassi to be due to the development of a fungus (*Botrytis Bassiana*) in the body of the worm. It is certainly infectious; the spores when they come in contact with the worm, germinating and sending forth filaments which penetrate the skin and, upon reaching the internal parts, give off minute floating corpuscles, which eventually spore in the efflorescent manner described. Yet most silkworm raisers, including such good authorities as E. F. Guérin-Méneville and Eug. Robert,* who first implicitly believed in the fungus origin of this disease; now consider that the *Botrytis* is only the ultimate symptom—the termination of it. At the same time they freely admit that the disease may be contracted by the spores of the *botrytis* coming in contact with worms predisposed, by unfavorable conditions, to their influence. Such a view implies the contradictory belief that the disease either may or may not be produced by the fungus; and those who consider that the fungus is the sole cause have certainly the advantage of consistency.

Whichever view be held, it appears very clear that no remedies are known; but that care in procuring good eggs, care in rearing the worms, good leaves, pure, even-temperatured atmosphere, and cleanliness are checks to the disease. The drawers and other objects with which diseased worms have come in contact should also be purified by fumigations of sulphuric acid, which will destroy all fungus spores.

This *muscardine*, or a disease which has not yet been distinguished from it, has also made its appearance in some of the Eastern States among silkworms, both imported and wild; and in the fall of 1870 it was so common around St. Louis, that I found hundreds of caterpillars stiffly fastened to their food plants and covered with the white efflorescence. It was especially noticeable among the "Wooly-bears," or hairy caterpillars of our different Tiger-moths (Arctians); and as the efflorescence is not very apparent at the base of the long dense hairs, such diseased caterpillars look quite life-like.

* See their Guide à l'éleveur de vers à soie.

They die in all sorts of positions, and I have many cabinet specimens of such, cleverly prepared, stuffed and mounted by the hands of dame Nature.

Another disease, known as *pébrine*, has proved extremely fatal in Southern Europe. This is the disease referred to on page 80, which for fifteen years has almost paralyzed silk-culture in France. It is a disease which in its nature and action, except in being hereditary, bears a striking analogy to cholera among men; and its cause and origin have been the subject of almost as much speculation and study. It has been ascribed variously to the vengeance of God, to mildew or other parasitic plants upon the leaves eaten; and more especially to the artificial manner in which the worms have been raised, some authors roundly asserting that it disappears when the worms are reared in the open air, and that it is the result of a conspiracy among opticians who have purposely persuaded silk-raisers that a tempera- of 70° Fahr. (24° Cent.) is too cold for the health of the worms; when in reality they can stand with impunity a temperature of four or five degrees below freezing point.*

Theories and remedies innumerable have been proposed, and as is so often the case, those who gave the least study to the disease, were the most prolific of them.

The worms affected by *pébrine* grow unequally, become languid, lose appetite, and often manifest discolored spots on the skin. They die at all ages, but, as in *muscardine*, the mortality is greatest in the last stage. The real nature of this malady was for a long time unknown. In 1849 M. Guérin-Méneville first noticed floating corpuscles in the bodies of the diseased worms. These corpuscles were supposed by him to be endowed with independent life; but their motion was afterwards shown by Filippi to depend on what is known as the Brownian motion; and they are now known either by the name of *panhistophyton*, first given them by Lebert; or by that of *psorospermiæ*. They fill the silk canal, invade the intestines and spread throughout the tissues of the animal in all its different states; and though it was for a long time a mooted question as to whether they were the true cause or the mere concomitant—the result—of the disease; the praiseworthy and assiduous researches of Pasteur have demonstrated that *pébrine* is entirely dependent upon the presence and multiplication of these corpuscular organisms. He has so epigrammatically analyzed the malady that what was occult and uncurable before has now become clear and comprehensible; and is within man's power to stay or even eradicate.

The disease is both contagious and infectious because the corpuscles which have passed with the excreta or with other secretions of diseased worms are taken into the alimentary canal of healthy ones in devouring the soiled leaves; and because it may be inoculated by wounds inflicted by the claws. It is hereditary on the mother's side because the moth may have

* See results of rearing out of doors for four years, by M. le Dr. Jeannel, of Bordeaux—*Bulletin Mens. de la Soc. Imp. Zool. d'Acclimatation 2me Série, Tome VI. Juillet*, 1869. A Monsieur Sintræ has also reared the worms successfully and free from disease, in the open air, in France; and Jno. S. Gallaher, Jr., of Washington, D. C., wrote to the *Rural New Yorker* in August, 1870, that he had fed the worms successfully in the open air there.

the germ of the disease and yet oviposit. Indeed, the eggs may be affected, and yet look fair and good, the microscopic *psorospermiæ* not being visible; so that the only true test of disease or health is an examination of the parent moth. Healthy moths produce healthy eggs, and here we have the key to the perfect subjugation of the disease.

Both the diseases mentioned are, therefore, in the strict sense of the word silkworm plagues. The one is of a fungus and the other of an epizoötic nature. Each may become epidemic whenever the conditions are favorable for the undue multiplication of the minute organisms which produce them; or when the checks to the increase of such organisms are removed by carelessness or ignorance. The exceptional energy which they exhibit is precisely analogous to the exceptional increase of the Army-worm, and of a number of other insects which have been mentioned in these Reports, and which at times, under favorable conditions get the mastery over their naturally appointed checks. The disease may remain indefinitely latent, until the proper conditions offer, just as seeds may, and do so remain in our forests and prairies until change of circumstance enables them to germinate and grow.

These seeds of disease which are now known to ever pervade our atmosphere play a most important part in the economy of Nature. They are omnipresent guards wisely ordained to keep order and harmony in her Domain—to insure the proper keeping of her laws, whose violation they are ever ready to punish with death—to right the wrong which man's ignorance begets—sacrificing sometimes the just with the unjust; but fulfilling God's will itself in prompting us to better and higher effort; to broader and deeper knowledge.

> "All nature is but art, unknown to thee;
> All chance, direction which thou canst not see;
> All discord, harmony not understood;
> All partial evil, universal good."

Such a view of the nature and origin of these diseases is not only far more plausible and tangible, than to believe that they are caused by some influence beyond our ken or that they originate *de novo* by some "fortuitous concourse of atoms," or by what Huxley has termed *abiogenesis;* but it is the most scientific, being based on the most elaborate experiments, and supported by experience. Pasteur has been able to prophecy with certainty, by examination of the moths, whether the progeny will be diseased or healthy, and through his efforts and the greater care that has resulted from the experience and trial of 15 years' suffering, pébrine is rapidly diminishing in France, and the harvest was better last year than it has been for a long time.

An excellent proof of this epizoötic nature of *pébrine* and of the soundness of Pasteur's deductions is furnished by the experience of Mr. L. Trouvelot in cultivating our Polyphemus worm. As I shall presently show he reared it in large quantities in 1865, and fully hoped and expected to continue his experiments. But some silkworm eggs which he imported from

abroad proved to be infected with the disease; and though upon recognizing it he immediately destroyed the larvæ, and at that time his Polyphemus eggs were not yet hatched—the precaution was of no avail, as the infection was about the house, and the native worms all eventually died of it. Speaking of this fearful disease among them, Mr. Trouvelot writes me: "A few days after the third moultings the worms begun to manifest symptoms of the deadly disease, and two or three days after, of a million, I had but a single one left, and this one even died in the pupa state. The following year, I thought I could begin anew, but I found that the epidemic had spread among the wild ones and all those I found were attacked with it, even to a distance of seven miles from my place. But the disease did not spread further as I had feared, and the third year the wild individuals were as robust as usual, but the disease, or at least the seed of it was infesting my buildings, and as soon as the healthy wild Polyphemus would approach them they became sick and died." Of late the disease has also been introduced by means of Italian eggs, into China and Japan; and while it is on the decrease in Europe, it bids fair to run a fearful course, unless prevented, in these the native countries of the silkworm:

Pébrine, as we have already seen, differs from *muscardine* in being hereditary as well as infectious. It will not suffice, therefore, simply to take the precautionary measure of purification and cleanliness advocated for the latter; we must also take care that our eggs are sound, by microscopic examination of the moths. This may be done after the eggs are laid; and if the corpuscles are found in the mother, her eggs should be discarded.

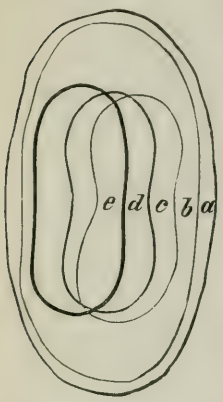
Silkworms are subject to other diseases but none of them have ever acquired the importance of those described. What is called *gattine* by older authors is but a mild phase of *pébrine*. The worms are apt to be purged by unwholesome leaves; they get sickly by too great heat; they become yellow, limp and die of a malady called *grasserie* or jaundice, which is almost sure to appear in large broods, or as the French more appropriately say, *éducations*, and which I have most frequently noticed in those reared in this country. When the worms die from being unable to moult they are called *lasettes;* and such worms are most abundant in the third age. All these different ailments and others, not mentioned, have received names; some local, others more general; but they none of them warrant further notice here, as they are not likely to become very troublesome if the proper attention and care be given to the worms.

BEST VARIETIES, OR RACES.

Since the diseases just mentioned have been so prevalent in Europe, among the French and Italian races, the Japanese annuals have been the most esteemed. The eggs are bought at Yokahoma in September, and shipped during the winter. There are two principal varieties in use; the one producing white, and the other greenish cocoons, and known respectively as the White Japanese and the Green Japanese annuals. These cocoons are by no means large, but the pods are solid and firm, and yield an abundance

of silk. They are of about a size, and both varieties are almost always constricted in the middle (Fig. 32 *c* green; *d* white). Another valuable race is the White Chinese annual (Fig. 32 *e*) which much resembles the White Japanese, but the cocoon is not so generally constricted. Previous to the prevalence of disease, a race known as the White French annual was the most esteemed, and in reality the cocoon (Fig. 32 *a*) is very large, oval, and of a pure white. The Yellow French annuals (Fig. 32 *b*) which are of a deep rich cream, or straw color outside but more yellow inside, were also esteemed, and the cocoon is large and beautiful.

[Fig. 32.]



There are local races or varieties in all the large silk-producing countries, and they generally bear the name of the locality where they are produced. The cocoons may be divided into the yellow, green and white, some races producing cocoons uniform in color; while others produce mixed cocoons. The white silk is the most valuable in commerce, but the races producing the yellow, cream-colored or flesh-colored cocoons are generally considered the most vigorous, and have certainly proved so in my experience in this country. The Annuals are more valuable than the Bivoltins or Trivoltins; though the Bivoltins are often reared, and Mr. Alfred Brewster, of San Gabriel, Cal., says that he found a green Japanese variety of these last more hardy than the Chinese Annuals.

HOW BEST TO REAR.

Volumes have been written on the rearing or *éducation* of the Silk-worm; and most persons who have had no experience with it, fancy that there must necessarily be something unusually difficult in the treatment of the worm whose marvelously lustrous product—the pride of kings and queens, and once weighed in the balance with gold—has always been associated with everything that is choice, delicate and beautiful. Yet if we travel through the different silk-producing countries at feeding or breeding time, we shall find the work very simple. From the reports on silk-culture that have lately been issued by Mr. F. O. Adams, Esq., Secretary to Her Brittanic Majesty's Legation in Japan, we may learn that the culture is carried on there in the most simple and even careless manner, with the most primitive machinery; and that the people are actually in ignorance of some of the very simplest truths, the knowledge of which would enable them to more than double their harvest. It is even worse in China; and in Southern Europe most of the silk is reared by a peasantry which knows absolutely nothing beyond plucking the leaves and feeding them to the worms; and in the best *éducations* they lose one-half the worms hatched.

There are few farm operations more simple, or which require so little training; but proper knowledge is all important to insure success and prevent undue mortality in the brood. It will be well to bear in mind the character of the climate of that part of Japan where silk-culture has at-

tained most importance—an area of about 240 square miles around Yokahoma. As I am informed by a fellow-entomologist, who has resided there for many years, and, in an official capacity, has made minute and daily meteorological observations, the winters are less severe than with us, the snow seldom remaining on the ground more than an hour: the summers are likewise less hot; but the climate during the rearing season is quite similar to that of our southern counties during the same period, though with fewer sudden changes. The mean annual temperature is 63.50 F. and the solar radiation 18.55. The wettest months are April and June, the average rain fall in April being 10.5 in May 5.1 and in June 12.4 inches. The rains stop suddenly in June, when feeding commences. The temperature of the four months of April, May, June and July averages as follows: April, maximum 70°, minimum 52°; May, maxm. 67°, minm. 56°; June, maxm. 74°, minm. 66°; July, maxm. 80°, minm. 72°. Thus their feeding months—parts of June and July—do not compare unfavorably with ours—parts of April and May.

We have already seen the importance of getting healthy eggs, free from hereditary disease, and of good and valuable races. Eggs keep best during the winter at a temperature of 40° F., and should be placed in zinc or tin boxes where no mice or other animals can reach them, and where the atmosphere is not too moist. The temperature may be decreased and may even sink below freezing point, without injury; but should never be allowed to rise above the 40°. Great care should especially be taken to prevent a too early incubation in the spring. Mulberry leaves start to grow quite late, and unless the eggs are kept back by being placed in some room or cellar that is cooler than the atmosphere, our early warm April days will cause them to hatch before there are any leaves for the young worms to feed on. The hatching may be indefinitely delayed providing the eggs are kept at a temperature below 40° F.; for in France it is often deferred by carrying eggs up in the mountains until the second crop of mulberry leaves can be used.

As soon as the mulberry leaves commence to put forth, the eggs may be brought out and they will then very soon hatch by the natural heat of the season; though if the weather be changeable, it is best to regulate the temperature by means of fires, commencing at about 75° F. and increasing it about 2° per day until it reaches 85°, when the worms will begin to hatch. By no means must the eggs be exposed to the sun's rays, which would scorch them in a very short time; and even in the shade, as the temperature is raised and the hatching period approaches, the atmosphere should be kept more and more moist, either by sprinkling the floor or by other means. The worms will thus eat through their egg shells more easily and be more fresh and vigorous.

Any room with a northeastern exposure, and which can be well and thoroughly ventilated will answer for the rearing of the worms. An open fire-place is always desirable, as in cold, damp weather, the room may be rendered comfortable and at the same time purified by the draft which the

fire creates. Buildings erected solely for feeding purposes, should combine these requisites. The feeding may be done on shelves or tables or in trays; but the wood should always be well seasoned, as green wood is injurious to the health of the little spinners, which must from now forth be well supplied with food and guarded from too much moisture or too much light.

Each day's hatching should be kept separate, in order that the worms may be of a uniform size and go through their different sicknesses with regularity and uniformity; and all eggs not hatched after the fourth day from the appearance of the first, should be thrown away as they will be apt to contain inferior, weakly or sickly worms. It is calculated that one ounce of eggs of a good race, will produce 100 lbs. of cocoons; while for every additional ounce the per centage is reduced, if the worms are all raised together, until for 20 ounces, the average does not exceed 25 lbs. of cocoons per oz. Such is the general experience throughout France according to Guérin-Méneville, and it shows the importance of keeping the worms in small broods. Indeed, nine-tenths of all the silk produced in Europe is raised in small quantities, i. e., in separate households.

The young worms may be removed from one place to another by means of a small camel's-hair brush, but should be handled as little as possible. The best mode of managing them is to spread over the hatching eggs a piece of netting or mosquito-bar, upon which are to be placed either plucked leaves evenly scattered or a few leaf-bearing sprigs. The worms will cluster upon the leaves, which, when loaded with them, may be removed from time to time, either by taking the twigs, upon which they do not collect, separately between the fingers, or by lifting altogether with the netting.

This feeding net, which must have larger meshes as the worms increase in size, may be used every time fresh food is furnished, and will save a wonderful deal of time. It entirely obviates the necessity of handling the worms, and enables the person having charge of them to keep them thoroughly clean; for while they pass up through the fillet to their fresh food, their excrement drops through it and is always taken away with the old litter beneath. It really acts as a detective of disease, also, for such worms as are injured, feeble or diseased, usually fail to mount through the meshes, and should be carried off and destroyed with the frass and other debris.

So important is this feeding net or fillet as it may be termed, and so much does it facilitate the caring of the worms, that for many years in Europe it has been made of paper, stamped by machinery with holes proportioned to the size of the worms. The paper has the advantage of cheapness and stiffness, the latter quality enabling its removal, when loaded, without lumping the worms all in the middle. But with a little practice this can be avoided even where other more flexile netting is used; and it is the principle which I wish to lay before the reader—the details of material and method will suggest themselves according to the circumstances.

It is important to get the same batch of worms to go into their sicknesses simultaneously, and as soon as most of those constituting such a batch

begin to lose appetite, become more shiny, and especially when the triangular dark spot appears above the head, feeding should cease, and the shelves or trays be rendered as clean as possible. At each moult there will always be some few which remain sick after the great majority have cast their skins. These should either be set aside and kept separate, or destroyed; as they are usually the most feeble and inclined to disease; otherwise the batch will grow more and more irregular in their moultings, and the diseased worms will contaminate the healthy. Regularity may also be insured by causing those which first shed their skins to wait on their more tardy brethren for one or even two days without feeding; for they can at this time fast without any injury. Indeed, no food should be given till the majority of the batch have moulted.

As the worms increase in size, and become crowded on their shelves or in their trays, they are readily divided by removing the net, when about half the worms have mounted, and replacing it by an additional one.

The food must be renewed as often as the leaves are devoured or as they become in the least way dry, and of course they get dry much quicker when young and tender than when mature.

Many rules are laid down for regularity of feeding, and much stress is put upon it by some writers; but I am convinced that rules are of no avail, as so much depends on circumstances and conditions. In parts of France, for instance, they chop the leaves; but in this country such chopping is worse than waste of time; for Nature has furnished the worm with far better chopping instruments than man can invent; and the chopped food dries much sooner than does the whole leaf. Where the nets are not used, there is an advantage in feeding the worms upon leaf-covered twigs and branches, because these last allow free passage of air, and the leaves upon them keep fresh for a longer time than when plucked. In thus feeding with branches, consists the whole secret of the California system so much lauded and advocated by M. L. Prevost.

The meals most relished are those given early in the morning and late in the evening, and the best time to give them is between 5 and 6 A. M. and 10 and 11 P. M. One or two intervening meals during the day may be given according to circumstances. The leaves given in the morning are best plucked the evening before, as, if plucked and fed with the dew on, they are injurious. During the night the temperature may be lowered a few degrees with impunity, as such lowering is natural and the worms will be more quiet during their night fast. A mean temperature of 75° or 80° F. will usually bring the worms to a spinning point in from 35 to 40 days after hatching, but the rapidity of development depends on a variety of other causes, such as quality of leaf, race of worm, etc. If it can be prevented, the temperature should not be permitted to rise above 80°; and it is for this reason that in our climate a room with a northern or northeastern exposure is preferable to any other.

During the fifth or last age the worms require the greatest care and attention. Frass and litter must be removed often, and all sickly and diseased

worms culled from the rest. Good ventilation must be had, and the temperature be kept as even as possible. At this and at all times during the life of the worms, they must be guarded against the attacks of mice and predaceous insects.

COCOONERY.

When the worms show the signs of spinning, already described, the cocoonery must be prepared by forming arches of the smaller twigs, well dried, of different trees, intermixed with broom-corn, or of any other kind of brush. If tiers of shelves have been used these arches are readily formed by tying together small bunches of twigs exceeding a little in length the distance between the shelves. The feet of these bundles, which should be about a foot apart, are placed upon the lower, and the tips spread out against the upper shelf, insuch a manner that the worms can crawl between them. Where tables are used, arches may be made by intertwining the brush, roof-fashion. The worms will then mount upon this brush and commence forming their cocoons. The thermometer should not be allowed to sink below 80° F. during the spinning, as the silk does not flow so freely in a cool atmosphere. Such worms as do not mount readily, should be separated, and furnished with brush, laid carefully over them. If allowed to remain and spin at the bottom of the arches their cocoons will be soiled by the excreta from the worms above, the last fæces ejected, after the cocoon is commenced, being soft and semi-fluid.

In about a week after the last worms have mounted, or when all sound of spinning has died away, the cocoons may be detached from the brush, care being taken not to taint them with the black fluids of such worms as may have died and become putrid—there being almost always a few such in every cocoonery. The loose silk is then torn from the pods which should be separated according to color, weight, and firmness of texture; those which best resist pressure, indicating that the worm has properly accomplished its work.

CHOKING THE CHRYSALIS.

In most silk-producing countries, the parties who raise the cocoons sell them to the reeling establishments before suffocation is necessary; as these establishments have better facilities for the work than are to be found in private families. The cocoons, which if left over a fortnight would be pierced by the moths, in their egress, are choked either by steam or dry heat. By steam they can be choked in 20 minutes; by dry heat from 2 to 24 hours are required, with a temperature of about 200° F. They are placed in shallow baskets, and these slipped on iron drawers into an oven. A certain humming noise continues as long as there is any life, and its cessation is an indication that the chrysalides are all dead. Where the choking is well done, there is little loss, only about one per cent of the cocoons bursting at the ends. After choking, the cocoons are strewn on long wooden shelves in the shade, with plenty of air, and for the first few days are frequently stirred. After remaining on these shelves for about two months, with occasional stirrings, the chrysalides become quite dry and the cocoons will pre-

serve indefinitely—being subject only to the attacks of *Dermestes* or museum pests which are attracted by the dead chrysalis within, and penetrate and injure the cocoon for reeling purposes.

EGG-LAYING.

There are establishments, especially in Japan, which are entirely devoted to the production of eggs; and most silk-growers prefer to purchase their eggs at the proper season, rather than go to the trouble of caring for the moths and keeping the eggs over winter. When properly managed, so that hygienic rules are carefully carried out, there is an advantage in making the production of eggs a specialty; but their production in too large quantities also has its disadvantage, and it is well for all silk-raisers to provide their own eggs. For this purpose none but those cocoons which are firm, fine and of the right color should be chosen, large size not being so much of an object. Double or treble cocoons, i. e., cocoons which have been spun by two or three worms in company and which, in consequence, are unfit to reel, will often give good moths for breeding purposes. The cocoons, when chosen, may be strung in a chaplet and suspended in the same room where the feeding was done, or they may be pasted on to card-board—the object in both cases being to secure them so that the moths can the more readily make their escape. The male and female cocoons may be approximately separated, by weighing; the whole, say a lot of 50 or 100, being weighed first so as to get at the average, and each being re-weighed separately afterwards; all those below the average to be set aside as males and those above the average as females. The moths come out most abundantly during the early morning hours, and, as they issue, they should be taken by the wings and the sexes kept apart for a short time. The males may then be placed with the females. Coitus, according to the best breeders, should not last more than six or eight hours, and at the end of that time the couples should be separated by holding the female gently by the wings with one hand, and pressing the abdomen of the male with the other. The males may then be thrown away and the females placed for a few minutes on sheets of blotting paper, where they will free themselves of much yellowish or fulvous fluid, which would otherwise soil the cloth upon which the eggs are to be laid. They may then be placed side by side in trays, lined with linen cloth, when they will immediately commence depositing. The trays may be tipped up at one end so that they incline a little, as the moths are then more apt to lay their eggs uniformly. They should also be kept in the dark, in accordance with the nocturnal habit of the moth. Most of the eggs will be deposited in about 24 hours, and the moths may then be thrown away, as eggs deposited after that time are not as well impregnated. No deformed moths should be used. The eggs are best preserved on the cloth where originally deposited, as they are protected by a natural coating of varnish, and, being fastened, the worms when hatching, eat their way out better. For commercial purposes, however, they are usually detached during the winter by immersing the cloth containing them in cool soft water for

a few moments; the moisture being then drained off by means of blotting paper and the eggs scraped off by means of a paper knife. They are then washed in soft water, thoroughly dried and put away for keeping. All eggs which swim on the surface are considered bad, and discarded. The Japanese egg-producers sell their eggs on cards or cartoons made of some kind of coarse silk. The cards are placed in wooden frames, the rims of which are varnished, so that the moths—disliking the varnish—are made to confine their eggs upon the cards, which are consequently covered in a very regular and uniform manner.

REELING.

If the mere rearing of the worm—the production of the cocoons—is simple; the reeling of the silk is by no means so, as the greatest skill is required to accomplish the work properly, and the value of a hank of silk depends as much upon the skill of the reeler as upon the quality of the original thread. In the best cocoons the silk will measure upwards of a thousand feet in length, and though it appears single, it is in reality composed of two threads which are glued together and covered, as they issue from the spinneret of the mouth, with a glossy varnish which enables the worm to fasten the silk where it wills, and which is soluble in warm water.

. It is not my purpose to give a detailed description of a reeling establishment, though I made it a point to visit a number of the best around Lyons, when there last summer. Those who contemplate erecting such an establishment in this country will not rely on written description, but will go to headquarters to get their machinery, which is manufactured by Burdet & Cie., Rue Desirée 17, Lyons, France. There is also a little work by M. Turgon, which gives a description of the establishment of M. Louis Blanchon, of Livron. My object is merely to state the facts and principles which should govern the unwinding and reeling, for the benefit of those who may wish to use single basins and mills worked by hand. In the great reeling districts of France everything is brought to such perfection in the *filatures* or reeling establishments, by the aid of steam, that the hand mills have there almost gone out of use. But most of the silk is unwound by hand power in china; and excellent silk may be made by dextrous management with a good hand mill.

Raw silk is classified into organzine, tram and floss. Organzine is considerably twisted and is the choicest. Tram is made from inferior cocoons and is but slightly twisted. Floss is made of the loose silk carded and spun like cotton or wool.

The thread of silk as it unwinds from the cocoon is valueless for manufacturing purposes, several of them combined going to make the staple of commerce.

The persons employed in unwinding silk are mostly women, one standing or sitting before each basin, of which she has entire charge. The basin is made of copper, and in the large establishments the water in each basin is heated by steam at the control of the operator. The cocoons are plunged into the water when it is near the boiling point and moved about so that the

gum which fastens the threads becomes uniformly and thoroughly softened. They are then beaten with a small birchen broom, having the tips split so that the loose threads readily fasten to them. After beating a short time the operator gets all the cocoons fastened, and, taking the bundle of threads, shakes the cocoons till each hangs but by a single one. She now takes up five or more threads, (*brins*) according to the quality of silk wanted, unites them and introduces the combined staple or strand (*fil*) into a little glass eye on one side of the basin. She then forms a second similar strand and introduces it into a second eye on the other side. The strands are then brought together, twisted several times, separated above the twist, and introduced into two other glass eyes or ringlets through which they are led one to each end of the reel or *tambour* which is kept revolving in a steady rapid manner and to which is also given a certain back-and-forth side motion. The great object in reeling is to get the threads uniform, rounded, well joined, properly freed of moisture, and so crossed on the reel that they will not stick or glaze as it is termed. These objects are attained by the twisting and by the to-and-fro lateral movement of the reel, as also by properly regulating the distance between reel and basin. The uniformity of the thread depends on the skill of the operator, who must supply a new thread as soon as one begins to give out. This is called nourishing the silk and is done by dexteriously casting, with the thumb, the new thread onto the combined strand to which it immediately adheres. In this she must use much judgment, for the silk of a cocoon gradually gets lighter and finer as it approaches the end, and the uniformity of strand does not entirely depend on the uniformity in number of the individual threads forming it. Whenever the silk rises in locks the temperature of the water is known to be too hot; and when it unwinds with difficulty, the temperature, on the contrary, is too low. The operator is supplied with a skimmer with which to remove all chrysalides and refuse silk; also with a basin of cold water in which to cool her fingers which are being constantly dipped in the hot basin. This constitutes the whole operation of unwinding; but before the skeins, as they come from the reel, are ready for the manufacturer, they must undergo still further manipulation. The staple is first passed through a cleanser, consisting of a clasp lined with cloth, which catches any loose silk or other matter that may be adhering to it. It is then further cleansed and purged by being passed through four similar cleansers (*purgeurs*); then twisted about 500 times to the yard; then doubled and again twisted about 400 times to the yard. It is finally run on to reels about 1½ feet in diameter and taken off and twisted in a peculiar knot or hank. Through all these operations the oscillating to-and-fro lateral motion is kept up so as to produce the diagonal crossing of the strands; and it will be readily understood that each staple is in the end composed of ten or more of the simple threads first spun by the worm.

The loose or flock silk, together with all which, from one cause or another, cannot be reeled, is soaked in water for three days, boiled for one-half hour in clear lye, washed in rain water, and when dry, carded and spun: it makes an inferior floss silk.

BEST FOOD.

There are several varieties of the Mulberry, some of which are by no means adapted to the wants of the worm. I have tried in vain to rear it on the leaves of our indigenous Red mulberry (*Morus rubra*); but it either refuses them entirely, or dwindles and soon dies upon them. *Morus multicaulis* has been the most extensively planted in this country, but the wood is so tender and the leaf so thin and delicate, in this variety, that it often gets injured by our severe winters and strong winds. *Morus alba*, with its numerous sub-varieties, and *moretti* furnish the best food. They delight in a light, loamy and deep soil, and grow with great vigor in the West. There is a dwarf variety, called the *rose*, which leafs out earlier than the others and this is an advantageous character in our climate.

The Mulberry propagates easily by cuttings or layers and is also readily grown from seed. When grown in plantations for silkworm purposes the trees are best planted 8 or 10 feet apart and kept dwarfed, so that a good supply of young succulent leaves and shoots will always be in easy reach. The tree needs a warm location and should be at least two years old before robbed of any leaves. Leaves grown in the sun, with but little moisture, are the sweetest and make the best silk, and all which are yellow or blighted should be discarded. Where irrigation has to be employed it should be abandoned three or four weeks before feeding time. Where the leaves only are plucked a few of the terminal ones should always be left. In the silk-growing parts of Europe, though often grown in plantation or orchard, the trees are more frequently grown along roadsides and in all sorts of out-of-the-way corners; and a second crop, not used for the silkworms, is carefully gathered just before the natural fall of the leaf in autumn, and used as fodder for cattle, being very nutritious and highly esteemed for this purpose.

Silkworms have been fed on the leaves of a few other plants, and especially on lettuce, which is very useful, in case of too early hatching, as the worms do very well on it during the first age; but seldom attain the spinning age upon it. Some varieties—more especially the inferior ones—take more kindly to it than others.

The mulberry leaf is exceedingly free from the attacks of noxious insects. A species of woolly Aphis called *Kuwa jirami* sometimes covers the leaves in Japan; but no insect of the sort is known to attack them here.

OSAGE ORANGE AS SILKWORM FOOD.

The Osage orange (*Maclura aurantiaca*) first discovered by Lewis & Clark in 1804 and named by Nuttal in honor of Wm. Maclure, the celebrated geologist, and founder of the Philadelphia Academy of Science, is well known as a hedge plant in the West. At first sight it seems to have little affinity with the Mulberry, but it belongs to the same botanical Family (*Urticaceæ*), and next to the Mulberry furnishes the most palatable silkworm food. This plant was first introduced into France in 1820, by M. Cels, of Paris, who received it through Michaux from M. LeRoi of Balti-

more, Md. In 1833 M. P. Farel published a paper on the value of the leaves as a substitute for mulberry leaves in feeding silkworms*, citing the experience of M. Rudolphi, which was not favorable. In 1834, however, M. Farel published a second paper showing how M. Bonafous produced from osage-fed worms, cocoons which were very regular, firm and apparently perfect in every way—the worms being eight days longer in maturing than when fed with mulberry leaves. In 1835, in the Bulletin of the same Association. M. Delile, Prof. of Botany and vice president of said Association, gave a history of *Maclura* and showed that very good cocoons were produced from it. He says ("cette soie a été parfaite, facile à tirer, sans perte du premier jusqu' au dernier bout, dans tous les cocons") that the silk was perfect, easy to unwind, and without loss from beginning to end in all the cocoons.

Still later, M. Seringe, who wrote an interesting paper on the Osage orange† also made experiments with its leaves as food for silkworms, and found that the latter did well upon them. Yet no one in France to-day pretends to use this plant in lieu of the Mulberry.

In 1866 M. Prevost fed some of his worms on Osage orange,‡ and Mr. Glover of the Department of Agriculture, likewise raised some successfully upon it about that time.

For the last four years Mr. Samuel Cornaby of Spanish Fork City, Utah, has had very good success in feeding worms with these leaves. He writes to me:

Last summer [1871] our worms that were fed on Osage orange all did remarkably well; quite a number of persons in this place fed on Osage the past season, and all with good success. Several of my neighbors remarked to me that the worms preferred the Osage leaves to Mulberry, when the two kinds of leaves were within reach: that has also been my own experience. I have never tried any other variety on Osage, but intend this season to try some French Annuals.

I have fed the same worms on Osage orange four successive seasons, and they continue perfectly healthy and vigorous; in fact, I think they have improved since I commenced feeding on Osage. I do not know the exact number of worms that have been fed here the past season on Osage, but believe the number is not less than 50,000.

In 1870 I attempted to feed some worms of Japanese origin on Osage leaves; but I obtained no cocoons, though some of the worms fed well to within a few days of the spinning point. The worms themselves were not of the hardiest, however, and while the fore part of May was unusually cold, wet and changeable, the last of the month was unprecedently hot: so that similar poor results might have been obtained even with mulberry leaves. At all events, in 1871 I had perfect success in feeding Osage, and obtained great numbers of cocoons. At my request Mr. Cornaby sent me a number of eggs produced by his Osage-fed stock, and these were distributed among several friends, and part of them retained. Some were fed on

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* Des feuilles de Maclura comme succédanées de celles du Murier. *Bulletin de la Soc. d' Agr. de l' Hérault*, 1833.

†Notice sur le Maclure Orangé—*Soc. Royale d'Agr. etc. de Lyon*, Decembre, 1835.

‡Cal. Silk Growers' Manual, p. 60.

Osage; some on Mulberry. From the first the young worms took to the Osage with avidity, and I never raised a brood with less mortality; and the experience of all those to whom eggs were sent was equally felicitous. In two instances they were fed in the city of St. Louis, the atmosphere being anything but pure, and the leaves often laden with lime-dust and smoke. In one case, where there was some difficulty in procuring leaves, the worms were fed alternately on lettuce, Osage and Mulberry, and often made to fast for a whole day; yet they were proof against such hard usage, and eventually spun their cocoons with but trifling loss.

As soon as mine began to mount and form their cocoons, I recognized them as a Syrian race which I had often seen feeding in Covent Garden Market, in London, England; and upon inquiry I learned from Mr. Cornaby that his stock originally came from London, the eggs having been brought over by Mr. A. K. Thurber of Spanish Fork City. The cocoons are ovoid, rather more pointed at one end than the other, and of two distinct shades of yellow, viz., a bright golden inclining to orange, and a pale-greenish or sulphur. Now this race, like most other inferior stock, certainly has the merit of constitutional toughness and vigor; otherwise the worms could not have endured the hardships they were submitted to here last year. The worms also form a very pretty cocoon and are therefore well calculated to give pleasure and edification to the amateur. But the cocoons have little or no commercial value; the silk being inferior, and so loosely spun that the major part of it would beat away and rise in flocks in the basin before the end would be found. I took a number of them with me to France and had them fully tried. It was this same Syrian race that was fed with Osage orange by M. Mathieu Bonafous, in 1834; and though other races have been fed with it, it is doubtful if they thrive as well upon it.

Two advantages which the Osage has over the Mulberry must be mentioned in this connection. 1st. It is hardier, and the young leaves will resist a late frost which will kill those of the Mulberry. 2nd. The leaves do not wilt so soon. It leafs out about the same time, though some plants in a hedge-row are always in advance of others in this respect, and an early leafing variety might undoubtedly be produced in the course of a few years, by propagating from such.

The effect of the osage compared with the mulberry leaves is quite marked. The osage-fed worms generally lose the fresh creamy-white color during the last age, and the skin becomes more or less shiny and slightly greenish. The cocoons from these worms are also less firm than those from Mulberry, the difference being perceptible by trying alternately a handful of each.

For these various reasons I cannot see any present advantage that is to accrue from feeding osage, where mulberry leaves can be obtained, though the former may be very useful on exceptional occasions. As, however, it is within our power to improve the Syrian race which does so well upon it, by choosing from year to year only the best and firmest cocoons for breeding purposes; and as the plant is native and so extensively cultivated, I hope

[Fig. 33.]

CECROPIA MOTH, MALE.

Mr. Cornaby will continue his efforts. If we can contrive to furnish our ladies their silk dresses from our own hedgerows, we shall certainly be outdoing those nations which at present rival us; and such a result is not impossible! Indeed, by constantly choosing the darker and more vigorous worms and moths, there is no reason why a race may not in time be produced, which in the climate of Utah, would feed freely out of doors; and in this manner any amount of silk, though perhaps not of the best quality, could be cheaply grown by simply covering the hedges with some kind of netting, so as to protect the worms from birds and other enemies.

THE CECROPIA SILKWORM—*Attacus** [*Platysamia*] *Cecropia*, Linn.

(Lepidoptera, Bombycidæ.)

In the *American Entomologist* for February, 1870, I published an article on this insect from which is quoted much of what follows. Few insects are as frequently sent to me for identification as this magnificent moth (Fig. 33). It is common and its great size and beauty attract general attention. It is also more easily obtained, for the cabinet, than most of our other large moths, because its cocoon is always fastened to a twig where it remains all winter a conspicuous object; whereas those of Luna and Polyphemus, for instance, fall to the ground with the leaves, and are seldom seen. The ground-color of the wings is a grizzled dusky brown with the hinder margins clay-yellow; near the middle of each of the wings there is an opaque kidney-shaped white spot, shaded more or less on the outside with dull red, and edged with black; a wavy dull red band edged inside with white, crosses each of the wings, and the front wings next to the shoulders are dull red with a curved white and black band, and have near their tips an eye-like black spot with a bluish-white crescent; the upper side of the body and legs are dull red; the forepart of the thorax, and the hinder edges of the rings of the abdomen are white, and the venter is checkered with red and white. There is considerable variation in the ground-color of individuals, some being quite dark and others quite light, but the female differs from the male in nothing but her larger abdomen and much smaller antennæ or feelers.

The genus *Attacus*—meaning elegant—was founded by Linnæus, and our moth received its specific name from the same author. As *Cecropia* was the ancient name of the city of Athens, and as it has puzzled some nat-

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* We have here an excellent illustration of the effect of the custom of attaching to an insect the name of the author of the genus instead of that of the describer of the species. In 1767 Linnæus described this insect as *Attacus Cecropia*. In 1816 it becomes *Samia Cecropia*, Hübn; in 1852, *Hyalophora Cecropia*, Duncan, and in 1865, *Platysamia Cecropia*, Grote.

For reasons, repeatedly stated, I shall refer this and the six other large insects which follow, to the old and well known Linnæan genus *Attacus*, indicating in brackets the more recent genus to which each is at present referred by modern systematists. To my own mind it is very clear that they constitute but three distinct genera instead of six; and I should myself refer *Cecropia*, *cynthia* and *Promethea* to one genus; *Polyphemus*, *yama-mai* and *Pernyi* to a second; and *Luna* to a third. In giving this opinion I intend no disrespect either to Dr. Packard, who erected the genus *Callosamia* for *Promethea* (P. E. S. P. III. p. 379), or to Mr. Grote, who proposed another genus *Platysamia* for *Cecropia* (P. E. S. P. V. p. 228); for our present genera are for the most part the creations of man and not of Nature, and men's opinions will always differ. There must be a limit to genus-making somewhere, as no two species agree in all minute particulars; and in their adolescent and perfect states, as well as in their habits, few insects show a closer generic connection than the three first named. The iniquitous law above mentioned has no doubt been the cause of much of this generic hair-splitting; but I do not believe that it will hold its own in entomology even in this country where it has already obtained a foothold.

uralists to divine why Linnæus applied this name to our moth, I give the following explanation by Dr. Fitch: "The great legislator of this department of human knowledge, as he is expressively styled by Latreille, it has been frequently remarked, was endowed with a genius that few of his disciples have inherited, for selecting names for natural objects, which are most appropriate and happy. The idea which was present in the mind of Linnæus, when he named this splendid moth, we think is sufficiently evident. The Athenians were the most polished and refined people of antiquity. The moths are the most delicate and elegant of insects; they are the Athenians of their race. Cecrops was the founder, the head of the Athenian people. When the names of men were bestowed upon cities, ships or other objects regarded as being of the feminine gender, classical usage changed these names to the feminine form. The moths (Phalæna) being feminine, and the name of Cecrops being more euphonius in this form, probably induced Linnæus to change it in the manner he did. The name thus implies this to be the leader, the head of this most elegant tribe of insects, or in other words, the first of all the insect kind. What name more appropriate can be invented for this sumptuous moth?"

[Fig. 34.]

During the winter time, the large cocoons of this insect (Fig. 34) may be found attached to the twigs of a variety of trees. I have found them upon Apple, Cherry, Currant, Barberry, Hazel, Plum, Hickory, Blackberry, Elderberry, Elder, Elm, Lilac, Red-root, Maple, Willow and Honey-locust. It has also been found on the Pear. This cocoon tapers both ways, and is invariably fastened longitudinally to the twig; it is formed of two distinct layers, the outer one, which is loose, wrinkled, and resembles strong brown paper, covering an inner oval cocoon composed of the same kind of silk, but closely woven like that of the Mulberry silkworm. Inside this cocoon will be found the large brown chrysalis (Fig. 35). The cocoon of the Polyphemus moth, an insect which will be presently treated of, and which has been called by Mr. L. Trouvelot, of Medford, Massachusetts, the "American Silkworm," is rounded, and the silk is very closely and compactly woven; and though that of our Cecropia is not as valuable for utilitarian purposes, yet I incline to believe that it will some day be propagated for the silk which it produces; and though it may not lay claim to the national title of THE American Silkworm, it will nevertheless rank as second best, among those which are indigenous to

[Fig. 35]

this country. The following are some of Mr. Trouvelot's reasons, as communicated to me, for preferring Polyphemus to Cecropia :

1st. The silk fibre spun by the latter is not so strong nor so glossy as that of the former. 2ndly. The cocoon of the latter being double, pointed, and open at one end, makes it unfit to reel, as the water of the bath in filling the cocoon would sink it to the bottom, a very unfavorable circumstance, since it would cause the fibres of the different cocoons to entangle and break every moment. 3rdly. The larva of Cecropia is a very delicate worm to raise, it does not suffer handling, and when once feeding on a given species of plant, it does not readily bear changing to another, or even to a variety of the same plant. 4thly. It has the misfortune to be more generally attacked by birds and parasites, four-fifths of them being thus sacrificed in a state of nature.

I entirely concur in the first two reasons given, but since, as I shall presently show, a method has been devised for unwinding cocoons naturally open, such as those of *cynthia* and *Cecropia*, the second objection loses much of its force. As to the last two objections, though they undoubtedly apply in Massachusetts, where Mr. Trouvelot made his experiments, they will not hold true in the West; for I have always been more successful with in-door broods of Cecropia than of Polyphemus, and with us the latter is fully as much subject to parasites as the former, as might have been inferred from its comparative scarcity. I have also learned from several correspondents in the Atlantic States that whereas it was formerly almost impossible to raise a single specimen of Cecropia to the perfect state, they now have no difficulty in rearing any number.

In the month of May, in the latitude of St. Louis, and earlier or later the farther north or south we go, our Cecropia moth issues from its cocoon, and there can be no more beautiful sight imagined, than one of these gigantic fresh-born moths with all its parts soft and resplendent. The unintiated would marvel how such an immense creature had escaped from the small cocoon which remains at its side, retaining the same form which it always had, and showing no hole through which the moth could escape. The operation—so interesting and instructive—can be witnessed by any one who will take the trouble to collect a few of the cocoons and place them in some receptacle which has sufficiently rough sides to admit of the moth's crawling up, to hang its heavy body and wings while they dry and expand. The caterpillar has the wonderful foresight to spin the upper or anterior end of its cocoon very loosely, and when the moth is about to issue it is still further aided in its efforts by a fluid secreted during the last few days of the chrysallis state, and which is a dissolvent of the gum which so firmly unites the fibres of the cocoon. This fluid is secreted from two glands, which open into the mouth, and as soon as the chrysalis skin is split open on the back, by the restless movements of the moth within, the fluid flows from the mouth and wets the end of the cocoon, dissolving the gum and softening the silk to such an extent, that by repeated contractions and extensions of the body, the moth is at last enabled to separate the fibres, and to thrust out its head and unbend

its front legs; after which it rapidly draws out the rest of its body, the mouth of the cocoon afterwards closing, by the natural elasticity of the silk. At this moment the body of the moth is much swollen and elongated, the wings are small, folded, and pad-like, and the whole insect is soft and moist; but, attaching itself to the first object at hand where it can hang its heavy body and clumsy wings, the latter become expanded in about twenty minutes, and the superabundant fluids of the body sufficiently evaporate in a few hours to enable the insect to take wing.

The eggs of the Cecropia moth are 0.09 inch long, sub-oval, flattened and of a pale cream-color, shaded with light brown; and they are deposited in small patches on the plants which are to form the food of the future larvæ. They are deposited in June, and hatch in from six to ten days after being deposited. Some remarkable exceptions have been known, however, and my friend P. R. Uhler of Baltimore, Md., has had them remain over two years, and yet hatch at the end of that time.

Larval Changes.—The young worms differ so much from the mature ones, and undergo such great changes in appearance in the course of their lives, that it is surprising that no account is to be found of these larval changes in any of our entomological works. When first hatched they are entirely black, with the tubercles placed in the same position, but being larger at the base and with a narrower stem than in the more mature individuals, the upper and smaller end being crowned with a whorl of conspicuous stiff black bristles. After the first moult the body is of a deep orange color, with the tubercles and head black, and with longitudinal rows of black dots running between them. After the second moult, a still greater change takes place; the body acquires a beautiful yellowish-green tint, the tubercles on the back are blue on joints 1, 12 and 13; coral-red on 2 and 3, and yellow with black spines, and a black spot on the inside and outside of the stem, on 4—11; those at the sides are blue, and the head is of the same color as body. After the third moult, the black spots, except a row below the stigmatal row of tubercles, disappear; the tubercles themselves lose all black except the spines, and the head and body become delicate bluish-green rather than yellowish-green as formerly. After the fourth and last moult, the red tubercles near the head frequently become yellow, and when full-grown, the worm measures over four inches, and presents the appearance of Figure 36, the tubercles being respectively of the most delicate yellow and blue.

Two weeks after the worm first began to spin, it changes to a chrysalis, and as already stated, passes the winter in this form, there being but one brood each year.

[Fig. 36.]

The cocoon of this insect is often found to contain a kernel of corn, a grain of wheat, or even an acorn, and the first time I found a corn-kernel in one of them, I was sorely puzzled to comprehend how it came there, and imagined that it must have been accidentally dropped by some

bird, into the meshes of the cocoon while the latter was being formed. But the kernels are found in the cocoons altogether too frequently to admit of any such chance coincidence which must necessarily be of very rare occurrence. There is every reason to believe, therefore, that these foreign materials are placed there, for safe-keeping, by some bird; the loose end of the cocoon admitting of their being forced in, even after it is completed. Dr. LeBaron, thinks that this bird is very likely the Blue Jay which is known to have the habit, in common with other Corvidæ, of pilfering and hiding in holes and crevices any small object that attracts its attention. One of my correspondents from Geneva, Ills., who has found no less than five of these cocoons containing kernels of corn, thinks that the Chickadee (*Parus atricapillus,* L.) uses them as a storehouse, as well as the Blue Jay, and, indeed, inclines to believe that the former is "the sole proprietor." He has seen it, with corn in bill, searching about apple trees for such a storehouse, and has witnessed it deposit a kernel in the crack of a board fence.

The Cecropia worm, as may be inferred from its size, is an immense feeder, and a small number will soon defoliate a young apple tree. It has, on a few occasions, been found numerous enough to do injury in this way; but as a rule, natural enemies keep it so thoroughly in check, that it can hardly be classed as an injurious insect. The same may be said of the other large and native worms which I include with the silkworms, and which on account of their silk-producing qualities may, with propriety, be treated of rather as beneficial insects, though their products have not yet been utilized. Their great size and conspicuity not only renders them a ready prey to their natural enemies, but enables us to easily destroy them by hand-picking whenever they happen to become unduly multiplied on any of our fruit trees.

In the Proceedings of the Boston Society of Natural History (Vol. IX pp. 342—5) Mr. S. I. Smith has described a moth by the name of *Samia Columbia*, and it is also mentioned, and the female figured, by Mr. G. J. Bowles of Quebec, in the *Canadian Entomologist* (Vol. III, p. 201.) It is of rare occurrence, and its larval history remains unknown, and I find nothing in Mr. Smith's paper or in that of Mr. Bowles that ought to warrant us in considering it anything more than a variety of *Cecropia ;* while there is much that would lead me to consider it either an abnormal variety or a hybrid between *Cecropia* and *Promethea.* Hybrids occur more frequently among insects than most entomologists imagine, and we should be careful how we make new species out of abnormal variations of rare occurrence. *Columbia* does not differ more from the normal *Cecropia* than do several of the varieties of *yama-maï* from each other.

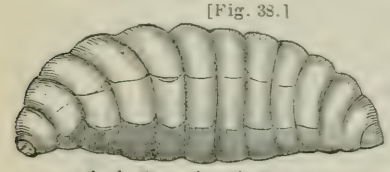
PARASITES OF THE CECROPIA WORM.

THE LONG-TAILED OPHION—(*Ophion macrurum*, Linn.)—This large yellowish-brown Ichneumon-fly (Fig. 37) is often bred from the cocoons in place of the moth which one expects. It is one of the most common parasites of this large insect, and the females appear to be altogether more common

than the males, for I have bred no less than seven of the former and not a single one of the latter sex. The female, according to Mr. Trouvelot, deposits from eight to ten eggs upon the skin of her victim, and the young larvæ soon hatch from them and commence to prey upon the fatty parts of the worm. But as only one of the parasitic larvæ can find food sufficient to mature, the rest all die from hunger, or else are devoured by the strongest one which survives them. At first one would suppose that this deposition of several eggs by the parent Ichneumon, where only a single larva can develop, is a striking instance of misdirected instinct; but we find a similar prodigality throughout Nature, for every individual is so subject to disasters of one kind or another in its struggle for existence that a provision of several ova is often necessary to insure the future development of a single one, just as we often sow several seeds of some particular plant, in order to insure the growth of a single one.

[Fig. 37.]

[Fig. 38.]



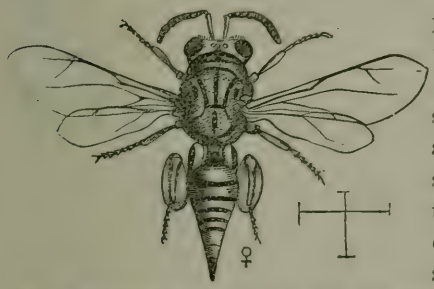
After the Cecropia worm has formed its cocoon, the parasitic larva, which had hitherto fed on the fatty portions of its victim, now attacks the vital parts, and, when nothing but the empty skin of the worm is left, spins its own cocoon, which is oblong-oval, dark brown inclining to bronze, and spun so closely and compactly, that the inner layers when separated have the appearance of gold-beater's skin. If we cut open one of these cocoons soon after it is completed, we shall find inside a large fat legless grub (Fig. 38), which sometimes undergoes its transformations and issues as a fly in the fall, but more generally waits till the following spring.

The Cecropia Tachina-fly—(*Exorista leucaniæ*, Kirk. var. *cecropiæ*, Riley)—The Ichneumon-fly last mentioned usually causes a dwarfed appearance of the worm which it infests, and parasitized cocoons can generally be distinguished from healthy ones by their smaller size. The larvæ of this Tachina-fly, which is also parasitic on the Cecropia worm, seem to produce an exactly opposite effect—namely, an undue and unnatural growth of their victim. In the beginning of September, 1866, I received from Rockford Ills., an enormous Cecropia worm. It measured over four inches, was a full inch in diameter, and weighed nearly two ounces; but like many other large specimens which I have seen since, it was covered with small oval opaque white egg-shells, clusters of four or five occurring on the back of each segment, invariably deposited in a transverse direction. The skin of the worm was black where the young parasites had hatched and penetrated. This large worm soon died and rotted, and in about twelve days a host of maggots gnawed their way through the putrid skin. These maggots averaged

about one-half inch in length, and in form were like those of the common Blow-fly. The head was attenuated and retractile and furnished with two minute curved hooks, and the last segment was squarely cut off, slightly concave and with the usual two spiracles or breathing-holes which this class of larvæ have at their tails. Their color was of a translucent yellow, and they looked very much like little pieces of raw fat beef. They went into the ground and remained in the larva state all winter, contracted to pupæ in the April following, and the flies commenced to issue the last of May. This fly differs only from the Army-worm Tachina-fly (*Exorista militaris,* Walsh, Rep. II, Fig. 17) in lacking the red tail entirely or in having but the faintest trace of it, and I consider it but a variety of that species. I infer that this same Tachina-fly attacks the Cecropia worm in widely different parts of the country; for I have received from Mrs. Mary Treat, of New Jersey, two dipterous pupæ which probably belonged to this species, and which had also in the larva state infested a Cecropia worm.

THE MARY CHALCIS-FLY–(*Chalcis mariæ*, Riley)—In May, 1869, I received from Mr. V. T. Chambers, of Covington, Ky., numerous specimens of the beautiful large Chalcis-fly figured herewith (Fig. 39), which he had taken from the cocoon of the Polyphemus moth, which is quite common, and issues as early as the middle of February in that locality. He says, "I was satisfied that the cocoon did not contain a living Polyphemus and therefore opened it. It contained so little besides these insects and their exuviæ, as to suggest strongly the old idea that the caterpillar had been metamorphosed into them (as in a sense it had). There were 47 of them, of which 23 were females. As all the males and some of the females were dead when I opened the cocoon, I think it likely that the former never do emerge, and perhaps but few of the latter; otherwise Polyphemus would soon be exterminated."

[Fig. 39.]



I can very well imagine that most of these Chalcis-flies would die in their efforts to escape from the tough cocoon of the Polyphemus, but it so happens that these same parasites have been found by Mrs. Mary Treat, of Vineland, N. J., to prey upon the Cecropia worm, from the cocoon of which they can more easily escape. The same fly also attacks the Promethea worm, and Mrs. Treat has had a similar experience with Mr. Chambers, of finding them dead in its cocoon. She has upon two occasions found cocoons with a dead Chalcis-fly fast in the hole which it had eaten to make its escape; and upon cutting open such cocoons they were found literally packed with dead Chalcis-flies. It would seem that they all make their escape through the hole made by some one of their number, and that if this particular one fails in the undertaking, they all perish rather than make holes for themselves.

I subjoin the original description of this fly which is of a yellow color, marked, as in the figure, with black:

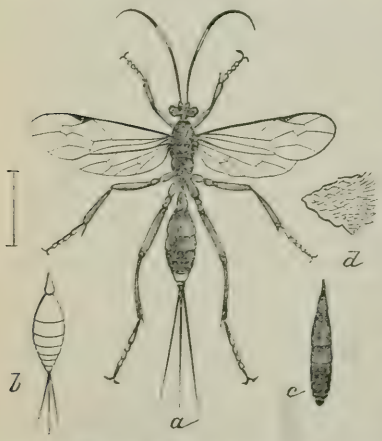
CHALSIS MARIÆ, Riley—♀, yellow, beautifully marked with black. *Head*, yellow with an arcuate black mark behind base of the antennæ, connected with a fine short longitudinal black line leading to lower ocellus, and from thence to posterior margin of occiput which is margined with black; prothorax with a medium black dot. *Antennæ* (scape plus 9 joints) 10-jointed; scape fulvous with superior edge black, flagellum dark brown or black. *Thorax* with large shallow close-set punctures; mesothorax somewhat striated transversely, trilinear with black, the three lines connected by a transverse line which separates the prothorax from mesothorax, the middle line straight, the outer ones deeply impressed, approaching behind and connected on the posterior margin by a short transverse line, and then suddenly diverging on lateral suture of scutellum; a longitudinal black dot on each side over tegulæ; scutellum edged anteriorly with black and with a central longitudinal black line; basal margin of metothorax, with a spot on each extreme side and a large subtriangular mark on disk, black; pleuræ with two black lines on each side. *Wings* hyaline. *Abdomen* yellow with sometimes a faint tinge of green, black at base and tip, and each segment banded with black superiorly; petiole yellow, black at tip above. *Legs* yellow, the tarsi inclining to fulvous; a broad line on posterior coxæ above, and interior edge of femora and tibæ, and tip of femora, black; the femora about as large as abdomen with over 12 minute black spines on inferior edge. Average length 0.20 inch.

♂ differs in the less pointed abdomen, and somewhat longer petiole, in the scape of antennæ not being black superiorly and being much more robust; in the flagellum being of the same color as scape, and in the coxæ having a black line both above and beneath. Average length 0.15. Described from 10 ♂s 4 ♀s bred from *Attacus Polyphemus* and 2 ♂s 1 ♀s bred from *A. Promothea*. Variable in size some ♂♂ being much larger than some ♀♀.

Say's *amœna*, bred from a *Thecla*, in which no sexual difference is mentioned, somewhat resembles the ♀ of this species, but differs from it principally in having the thorax quadrilinear with black, the petiole black, the pleura black, with four yellow spots, and in the thighs having six or eight *prominent* spines, the superior one divided into three or four.

THE CECROPIA CRYPTUS—(*Cryptus extramatis*, Cresson).—Another Ichneumon-fly often infests the Cecropia worm, the larvæ filling its cocoon so full of their own thin parchment-like cocoons, that a transverse section (Fig. 40) bears considerable resemblance to a honeycomb. The flies issue in June, the female presenting the appearance of Figure 41, *a*, the hair-line showing natural size. The wings have a smoky appearance, caused, as may be seen when viewed under a microscope, by innumerable little hooks regularly arranged over their surface as at *d*. The antennæ have a pale annulus, the head and thorax are black, the abdomen reddish-brown except near the end where it is black tipped with white; and the legs are reddish ringed with black. The male has a more slender abdomen which lacks the ovipositor and the white spot at its tip. This sex has not yet been described; for what Mr. Cresson took to be the male turns out to be the male of another species (*C. nuncius*, Say), which infests the Promothea worm, and the female of which has a much shorter ovipositor (*b*). *Cryptus samiæ*, Pack., which, for reasons given below, may turn out to

[Fig. 41.]



[Fig. 40.]

be but a variety of *extrematis;* and *Cryptus Smithii*, Pack., (Proc. Bost. Soc. Nat. Hist., IX, pp. 345–6) infest the form that has been described as *Samia Columbia.*

As the ♂ of *extrematis* has not yet been described, and as upon comparing numerous specimens, in conjunction with Mr. Cresson, it appears that his ♂ *extrematis* is really ♂ *nuncius*, Say, I shall append Mr. Cresson's original description of the ♀, with a few amplifications, and then describe the ♂ by comparison. It is proper to add that Say's description of *nuncius* is so incomplete that the ♂ is not clearly made out, and from ought there is in the text he may have described from a single ♀ specimen; and the ♂♂ of the two species could only be separated by breeding, and by comparison of numerous specimens.

CRYPTUS EXTREMATIS, Cress., ♀—"Black, shining, somewhat robust; head short and broad; antennæ as long as the body, slender, black, the 7th to 12th [more often 11th] joints white [or dirty yellow], the 3rd and 4th joints long, the 3rd rather the longest, 5th a little shorter than the 4th, and the 6th about half as long as the 3rd. [Palpi black or only white at joints]. Thorax finely punctured, the dorsal lines rather deep; scutellum subconvex, polished; metathorax finely scabrous, opaque, its base smoother and shining, the elevated lines tolerably well defined, forming a large more or less distinct, subrhomboidal central area, lateral tubercles not well defined. Wings faintly tinged with fuscous; nervures and stigma blackish, pale at base; areolet large, subquadrate. Legs pale rufous, [the front coxæ black] the posterior femora and tibæ at tips, and the base and apex of their tarsi blackish [basal joint always black], rest of their tarsi white. Abdomen rather stout, sub-ovate, polished, rufous or yellowish-rufous; basal segment strongly arcuated, broad at tip; the 4th and following joints black, the 6th or 7th [mostly 7th] or both, more or less white above; ovipositor about as long as the body [abdomen], rufous, valves black. Length 4—5½ lines; expanse of wings 6—9½ lines."

♂—Differs from ♀ by his more slender abdomen, by his front coxæ being rufous sometimes tinged, especially above, with black; his posterior coxæ black or blackish, especially above; his four anterior trochanters paler; his palpi white, the terminal joint a little dusky; his antennæ with the two basal joints black, the rest brown on the upper surface interrupted by a paler yellowish line from joints 9—15 or 16, uniformly pale testaceous on the lower surface; the basal abdominal joint rufous, more or less tinged with black; the apex of abdomen, or from 5th to last joint, entirely black with no white spot.

I have bred 7 ♂s, 29 ♀s all from one cocoon of *Cecropia*, and have received 10 ♀s, 2 ♂s, also bred from the cocoon of that species, from Mr. Otto Lugger now of St. Louis. Other specimens bred from *Cecropia* are in the collection of the Entomological Society at Philadelphia and they all agree closely.

C. extrematis ♀ may be distinguished from *nuncius* ♀ by the palpi being always mostly black, by the posterior tarsi being always broadly black both at base and apex, by the greater length of the abdomen and especially by the greater length of the ovipositor *which is as long as the abdomen*, or nearly so. *Extrematis* ♂ differs from *nuncius* ♂ by the four anterior coxæ being rufous, the front ones inclining to black, by the basal abdominal joint being rufous, by the apex of abdomen being black with no white spot, and by the posterior tarsi being broadly black at base and apex.

C. nuncius, ♀ may be distinguished from *extrematis* ♀ by the palpi being more or less white, by the posterior tarsi being generally entirely whitish, except terminal joint; by the broader and shorter abdomen, and more especially by the ovipositor being much shorter, *never exceeding one-half the length of abdomen. Nuncius* ♂ is distinguished from *extrematis* ♂ by the four anterior coxæ being white, the posterior tarsi generally entirely whitish except terminal joint, by the basal abdominal joint being generally black, and by having generally—not always—a white spot on joints 6 or 7, or both.

I have bred 6 ♀s from the cocoon of *Promethea*, and Mr. Cresson has examined numerous specimens of both sexes likewise bred from *Promethea;* and they all agree, though the species is more inclined to vary than *extrematis*, and especially in the size and conspicuousness of the white apical spot. Were it not that Say's *nuncius* was also bred from the same species I should feel inclined to believe it distinct from the species here characterized as such; but rather than describe a new species I prefer to believe that Say inadvertently overlooked the white apical spot on abdomen of ♀ or that it may have been more or less obsolete; and that he either had no ♂, or overlooked sexual differences.

If authors were more careful in describing species, and especially if they would tell us how many specimens they describe from, these difficulties in separating them would rarely arise.

The only other species, which I know of, at all likely to be confounded with *extrematis*, is one subsequently described as *Cryptus samiæ* by Dr. Packard (Proc. Bost. Soc. Nat. Hist. Vol. IX p. 345; 1865.) and bred from *Samia Columbia*, Smith, in whose cocoon it forms a collection of its own cocoons just as *extrematis* does in those of the genuine *Cecropia*. Indeed if we substitute the words "trochanters" for "coxæ" and "coxæ" for "trochanters," in Dr. Packard's description, it agrees in every minute particular with *extrematis*, except in lacking the apical white spot in the ♀. From the similarity of habit, and from the exact similitude in every other respect, I strongly suspect, therefore, that Dr. Packard has inadvertently misapplied the terms "coxæ" and "trochanters;" that the white apical spot, which is variable in size, may sometimes become as obsolete in the ♀ as in the ♂, and that *samiæ* should at the most be considered a variety of *extrematis*.

THE AILANTHUS SILKWORM—*Attacus* [*Samia*] *cynthia*, ~~Hübn.~~ Drury

(Lepidoptera, Bombycidæ.)

Of the different worms which have been introduced from Asia, either into Europe or America, the Ailanthus worm is the only species which has, so far, proved hardy; or which has become fully acclimated. Indeed it seems to possess the same vigor of constitution so characteristic of the tree upon which it feeds, and which enables that tree to flourish on all kinds of soil and in widely different latitudes. This merit at once gives it a claim to our attention.

DIFFERENCE BETWEEN THE CASTOR BEAN AND AILANTHUS SILKWORMS.

There are two insects which very closely resemble each other. One was brought from India, and feeds on the Castor Bean (*Ricinus communis*). It is domesticated in Hindostan and was introduced into France by M. Milne Edwards in 1854, and was tested at Paris, and at many other points in France, Italy, Spain and Algeria. The silk is soft and glossy, and the worm goes through its changes with great rapidity, producing four or five generations annually. The rearing of this insect was soon abandoned in Europe, because in the first place it had no advantage over the Ailanthus worm, and in the second, there was no prospect of obtaining, in that country, any great quantity of a raw material which depended on the Castor Oil plant for its production; for there, as with us, the plant is only annual, and kills down each winter. It has been ascertained, however, that the worm will feed and flourish on Lettuce, Chickory, Willow and Teasel (*Dipsacus.*).

This insect was first figured in 1804 by the English botanist Roxbury,* who confounded it with the genuine *cynthia* under consideration. It likewise feeds upon the Ailanthus, and the resemblance to *cynthia* in all stages, is so great, that it might well be considered as but a Castor Bean feeding variety; the more especially as both insects are known to vary greatly, and that in its domesticated state in Bengal, *ricini* acquires an orange color, and looks quite different to what it does in the feral state.† The hybrids of the two are also quite vigorous and fertile *inter se.* But in 1857 M. Guérin-Méneville pointed out what he considered sufficient specific differences, and the *Ricinus*-feeding form is now known to entomologists as *Samia ricini*, G-M. These differences may be briefly set forth as follows: While the egg of *cynthia* is covered with dark particles, that of *ricini* is immaculate. The full grown larva of *cynthia* is of an emerald green, with black specks, and dark freckles; while that of *ricini* is of a pale azure and lacks the spots. The cocoon of the former is larger, more compact and of a paler gray than that of the latter, and while the former produces but two or at the most three broods, the latter produces five or six, annually. The moths when closely examined will be found to differ in some essential points: *Cynthia* has separated white tufts on the abdomen, while *ricini* has them

*Trans. Linn. Soc. of London VI, p. 42, pl. III.

†See also some interesting observations by Dr. A. Wallace, in a paper "on some variations observed in *Bombyx cynthia* in 1866"—(Trans. London Ent. Soc. Feb. 4th, 1867.) where he gives reasons for believing that both *ricini* and *Guerinii* are enfeebled varieties of *cynthia.*

[Fig. 42.]

AILANTHUS SILKWORM.

united in parallel bands, but these characters cannot be relied on as they connect by variations: in *cynthia* the rosy band across the wings is broader than in *ricini*: the crescent-shaped lunule on the front wings of *cynthia* is yellow beneath, the yellow being bordered with white above; in *ricini* the white surrounds the yellow, and the lunule is generally smaller.

A third species by the name of *Guerinii* has been described, but with scarcely any evidence that it is anything more than a variety of either of the former.

RETROSPECTIVE HISTORY OF THE AILANTHUS SILKWORM.

The Ailanthus silkworm was first mentioned in the writings of missionaries about the middle of the last century. In 1760 or 1765, according to Dr. Morris, a fair figure of the moth was published by D'Aubenton the younger, who called it the *Croissant.** In 1773 Drury gave the moth the name which it now bears, but its larva, and general habits were not known till the middle of the present century.

The first eggs of the Ailanthus silkworm obtained in Europe were sent by the Abbé Fantoni, a Piedmontese missionary, from the province of Shang Tung, a little south of Pekin, in the north of China, to some friends at Turin. From these eggs two successive generations of worms were produced in 1857, and in 1858 Mons. Guérin-Méneville received from Turin, both eggs and fertile females, and experimented with them in the acclimatization gardens in Paris.

From the very outset this worm promised well. It adapted itself readily to the climate and its food-plant was everywhere abundant. Soon after its introduction into France it attracted the attention of scientific men in England and other parts of Europe; and the Emperor himself, charmed by the tune of the words chanted to him by M. Guérin-Méneville, and the evident prospect of the success of the new enterprise, lent his aid to the carrying out of experiments on a large scale, and in the summer of 1859 thousands of the caterpillars were reared on M. Aquillon's property at Toulon, and also on that of Count Lamotte Barace, near Chinon, (Indre et Loire).

In 1859 Mr. F. Moore of the East India Museum, reared a few in England, and exhibited them before the London Entomological Society. Subsequently they were fully tested in England by Lady Dorothy Nevill of Dangstein, Dr. Alexander Wallace of London and others. Mr. Wallace, in 1865 published an interesting memoir on the subject, entitled "Ailanthiculture, or the Prospect of a new English Industry," in which he showed that the worm did very well in that moist climate. Indeed it was supposed to do better in England than in France, and the following paragraph which I quote from the memoir will very well reflect the opinions and hopes entertained at the time.

In 1862, at Lady D. Nevill's town house, I first beheld these beautiful larvæ feeding on the leaves of the *Ailanthus glandulosa*. In 1863 I became possessed, through the kindness of her ladyship, of some eggs and procured others from France, and I obtained that summer, as also in 1865, two gen-

*Planches d' Histoire nat., enluminées, X, pl. 42. Ins.

erations. In confirmation of the statement that the cocoons in England were remarkable for their size, M. de Roo van Westmas, writing from the Netherlands, a moister and more temperate clime than France, in August, 1864, says "The acclimatization of *B. Cynthia* has perfectly succeeded, and presents a remarkable fact, viz., that the race is, without doubt, ameliorated. The moths are larger and more vigorous than those of the preceding year. The females laid last year from 100 to 150 eggs, but now give from 300 to 350, and what is still more remarkable is, that the eggs are larger and heavier, for whereas before a gramme contained 540—560, now I find only 440—460 in that weight; this fact appeared to me of such importance that I counted the eggs in five grammes taken from a weight of thirty grammes. I found the number 2261 which gives an average of 452 eggs to a gramme." A gramme being equal to 15½ grains (nearly), this gives twenty-nine or thirty eggs to the grain. My own experience tallies exactly with that of Mr. de Roo; specimens bred in 1865, the progeny in part of French eggs purchased in 1863, exhibited as the result of two years' acclimatization in England a marked improvement in size, color, etc., in all their stages, as contrasted with their French progenitors, and the cocoons were finer in 1865 than in 1864. Lady Dorothy Nevill also reports that the English eggs and cocoons are finer than the French. If this be proved by further observation it becomes an important argument in favor of English Ailanthiculture, for a larger cocoon implies a greater weight of silk.

WHEN INTRODUCED INTO AMERICA.

In 1861 the Ailanthus worm was introduced into this country, the credit of which is due to Dr. Thomas Stewardson of Philadelphia, Pa. Two able and interesting papers on the subject were published by Dr. J. G. Morris of Baltimore, Md., in the Agricultural Reports for 1861 and 1862, great hopes being entertained as to the success of the new enterprise.

Since that time the insect has been raised by a great many different persons in the United States, and has been fully experimented with. In the summer of 1865 I gave it a very thorough trial at Chicago, and raised large quantities both indoors and on trees in the open air; and the following paragraphs from an article which was published in the *Prairie Farmer* of April 28th, 1866, will serve to illustrate its real value:

I raised two broods last summer without difficulty, the last worm of the second brood having spun on the 23d September. Not one died, either of those raised in doors or out on the trees exposed to the weather, except by accident or from the attacks of birds.

So, therefore, as regards hardiness and adaptibility to our climate there is little question of its merit, there being few places on our continent subject to more sudden changes and extremes of temperature than Chicago; but in an economical point of view, the sanguine expectation of its advocates have not been realized, and notwithstanding the furore which it at first occasioned in France and the much that has been said in its favor by our Commissioner of Agriculture,* it never will take the place of the Mulberry Silkworm, and M. E. F. Guérin-Menéville is at this day making researches for, and experimenting with other worms, and has lately laid before the Academy of Sciences, Paris, a species of Bombyx (*Antheræa*) which was obtained on the frontier of Cashmere and feeds on an Oak, (*Quercus incana*).

The Ailanthus worm has two rather serious disadvantages. The cocoon

* Isaac Newton was incumbent at that time.

is prolongated and its threads are attached by strong and very tenacious gluten; for which reasons it has never been successfully unwound, and even carding is not an easy operation. In endeavoring to dissolve this gluten by different compositions, I obtained great quantities of a soapy substance or varnish, which might perhaps be turned to some use. When, by patience, I succeeded in dissolving the gluten from a few cocoons, sufficiently to unwind them, the thread often broke by the weight of its own cocoon. The silk when wound off compares unfavorably with that of some Mulberry worms I reared several years ago: the threads have not the gloss, are not as thick by one-third, and not over one-half as strong. Mr. Townend Glover, Entomologist to the Department of Agriculture, while in Paris last summer, made many inquiries about new silk-reeling machines for the purpose of unwinding the cocoons, but could learn nothing about them.

THOROUGHLY ACCLIMATED IN AMERICA.

Since 1866 this worm has become thoroughly acclimated, and is now found in a wild state around the cities of Baltimore, Washington. Philadelphia, New York, Brooklyn and Chicago. Indeed, it had multiplied to such an extent in 1870 around Brooklyn, that the Ailanthus trees were in many parts of the city entirely stripped of their foliage by it. The bare petioles bore unmistakable evidence of the hardihood of the worm, and of its power to multiply so as to become a nuisance. Singularly enough, a certain Mr. J. Q. A. Warren, who travels between this country and Europe, and deals in natural history specimens, was at this very time attempting to get government aid for the introduction and encouragement of this insect.

Arriving from Europe, in apparent ignorance of what had already been done in this country, and possessed of a sort of a seri-mania, he extolled it in a most enthusiastic manner in lectures delivered before the scientific academies of our principal cities.

It has also become so abundant in Australia, where it was introduced some years since, that unless kept down by birds, it will soon become a perfect pest. One interesting fact connected with its naturalization as an American citizen, is that, as I am informed by Mr. J. S. Ridings of Philadelphia, the moths reared in a wild state in that city have very generally become darker than they originally were; thus showing how, in a very few years, change of conditions and especially of climate may affect coloration. During the past year, for some reason, it has not been as abundant as it was in 1870.

VALUE OF THE COCOON.

The silk is valuable in the same sense as that of some of our native worms, and if ever the supply from the Mulberry silkworm should fail, would undoubtedly be turned to good account. It bleaches well, and has long been used in China, where it is known to be so durable that a dress made from it frequently descends as an heirloom for generations. It has for many years been in the market in France, and I saw specimens of manufactured stuffs from it, both in London and Paris, and they had taken on sundry dark colors very well, and looked remarkably fine. I understand

also from Mr. P. R. Uhler of Baltimore, that specimens have been woven successfully in Paterson, N. J. This class of goods is known by the name of *Ailantine* and might be put to a great many uses, as there is always a demand for coarse silks. But it has so far been woven principally from carded silk, and no cheap, efficient and simple method of reeling the cocoons has been made public. The value of any silkworm depends on our ability to unwind its cocoon. The cocoon of the Ailanthus worm, like that of our *Cecropia*, is open at one end, and though the thread is continuous, and if disengaged of the glutinous matter which binds it, may be continuously reeled off; yet such reeling is rendered extremely difficult from the fact that the moment the cocoons are placed in the basin they fill with water, sink to the bottom, and cause the threads to continually break.

Several devices for unwinding the cocoons have been patented in Europe, but as already stated, none seem to have come into general use. The method invented by M. Forgemol, and described in a report made in 1864 to the Imperial Society of Acclimatization, in France, will indicate in what direction experiments may be made, and I copy the description of that method from Dr. Wallace's essay. M. Forgemol says:

By way of experiment, seeking to follow in your steps, I myself, a short time ago, exhibited before you a particular method of reeling open cocoons. This method has since been studied anew, and I have thought it right to bring before you the following alterations. Let me remind you that the cocoons conveniently prepared were placed within linen or some other fabric permeable to water; were then passed through many waters in succession containing soap and potash, in order to separate the different layers of silk which compose the cocoon; were placed, not too dry nor yet too moist, in a vessel of a cup-shape (either one or in compartments), and were then reeled when nearly dry—differing from the method of reeling closed cocoons, which is done on the surface of water more or less boiling.

Such was our first method. The following are the modifications resulting from our experience:—It seemed easier, and likely to save time, to have a plate divided in several cups, which might be removed at will, and to place therein the cocoons for reeling. This plate, of any form, should fit the basin of the ordinary winding machine, such as they use in the South of France. Each cup is pierced with little holes in its centre, for the admission (if desirable) of steam from the hot water in the basin, in order to supply the necessary amount of moisture which the cocoons may have lost. No change is made in preparing the cocoons and reeling them when nearly dry, but they are placed in the moveable cups pierced with holes fitting into the plate as described. These plates, with moveable cups, are well suited to reel cocoons naturally open, so long as they contain the chrysalis (plein), but seem no longer to answer when the cocoons are empty (vides), that is, when the moth has escaped.

In fact, the force used to draw apart and collect the single threads (*brins*), no longer finds a counterpoise in the empty cocoons, which do not remain in the cups, but are drawn out. Hence it becomes necessary to give the empty cocoon a certain weight, a certain resistance, sufficient to retain them "in situ," but not so great as to rupture the threads. After considerable experience, I conceived an apparatus intended to retain the empty cocoons, and yet to allow the reeling to proceed easily and rapidly. This apparatus is composed of several skewers (*broches*), carrying needles of varying height, and it is placed on a basin for the purpose, if necessary, of

keeping the cocoons in a state of slight moisture, by means of steam from water beneath, more or less boiling in the basin. These empty cocoons are reeled, as we have already stated, when nearly dry, but yet they require a certain amount of moisture, which is indispensable for the perfect torsion of the several threads (*brins*), which go to form the one strand (*fil*). The needles have, 1st, an olive-shaped head, which is capped by the empty cocoon, suitably prepared beforehand and divested of its outer envelope; 2ndly, a middle portion sliding through a ring, secured by an upright (*guide, parti sur les broches*) attached to the skewer; and 3rdly, a base, with a blunt point, which revolves in a little cup worked in the thickness of the skewer.

The needles are very moveable on their pivot, and the cocoons being moveable also on the olive-shaped heads, turn on them in every direction, following the position and the direction of the threads as they unwind. The head is olive-shaped to avoid making a hole in the base of the cocoon during the movement and rotation by the resulting friction, which must ensue were the head pointed. The needles are of different lengths to allow more cocoons than one to be reeled off at once, those of the first skewer being the smallest, those of the second bigger, and so on according to the number of the strands and the required thickness of the thread. The skewers, armed with needles of different height, after being capped with empty cocoons suitably prepared, are placed on the basin so that two or more may be used at once. So arranged, the skewers slide into a groove made into the frame of the machine. They are kept apart by a little bar of division fixed at either extremity. When the cocoons are reeled the skewers, whose needles are now free, are pushed forwards and removed, they are immediately replaced by others prepared beforehand, and placed ready at the end of the groove. There is no interruption in reeling; the mechanism of the skewers and needles is both simple and easy. These, as also the plate with moveable cups, are easily and without cost adapted to the well-known machine, which seems a great advantage since the old implement for reeling closed cocons is now made available, almost without change, by the simple method which I have described."

ITS NATURAL HISTORY.

The female deposits, on an average, two hundred and fifty eggs (Fig. 42, *5*). These are about 0.07 inch long, oval in form, and of a cream color. They are spotted in places with dark green or black particles which can be rubbed off and which under the microscope are found to consist principally of gum, mixed with minute hairs. They become depressed four days after being deposited and acquire a greener hue just before hatching. The shell is very hard and tough and the clicking noise mentioned in speaking of the eggs of *mori* (p. 86) may often be heard. The moth fastens them by means of a gum with tolerable firmness to whatever object she may be upon. They are however easily detached, and if subsequently placed on moist cloth or paper will again adhere. They hatch at a temperature of 65° Fahr.

LARVAL CHANGES—The young worm is yellow, with a dorsal, subdorsal, and stigmatal row of black spots—each row with two to a joint—the anterior one in the stigmatal row being the smallest and the posterior one the largest. Between each of these rows, in the middle of each joint, is a black tubercle, crowned with white bristles, and there is an additional row (6 in all) which is substigmatal. The head is polished black, and there is a black patch on joint 1, on the caudal plate, and on the outside of the anal prolegs. The thoracic legs are black, and the prolegs yellow with a black mark outwardly near extremity. After the first moult the head is brown and the tips only of the tubercles remain black, the rest of the stem being light yellow. After the 2nd moult the color is paler, being of a cream-yellow: the head is entirely yellow, except the feelers which are brown, and all the tubercles, except the stigmatal row, are cream-colored, with bristles ending in a knob of the same color: the stigmatal row is black, with cream-colored bristles: legs of a bright yellow: stigma-

ta black. At this stage a mealy powder begins to manifest itself on the surface of the body. After the 3rd moult it is of a still paler cream-color, and only the stem of the stigmatal tubercles remains black, the knob and bristles being cream-colored: the head, legs, and anus are now sulphur-yellow; the stigmata are larger, and there are two black spots at base of prolegs and three at base of thoracic legs, the central one elevated and forming, as it were, a spine. (These spots are often visible after the second moult.) The white powder-like or wax-like secretion, now covers the body giving it a most delicate look. After the last moult the tubercles become blue—the lower row having black at base—and as the worm approaches its full growth, the white powder for the most part gets rubbed off and vanishes. When full grown it appears as in the upper part of Figure 42 and is of a light mealy bluish-green, freckled—aside from the black or, as they now often appear, blue-black spots already mentioned— with numerous roundish spots of a darker green, more decided laterally and ventrally: the head and thoracic legs are shiny yellowish-green, and the prolegs and anal joint pale orange-yellow.

Within a month after hatching the worm spins up, forming its cocoon (Fig. 2, *3*) within the leaf which is drawn partly around it, and fastening the leaf stalklet to the main stalk with strong silk. In five days it becomes a chrysalis (Fig. 2, *4*) and, if of the first brood, produces the moth within three weeks afterwards. The second brood of worms generally have the instinct to fasten their cocoons to the more permanent twigs, to which they hang securely during the winter; but they often attach them to the leaf stalk, with which they are carried to the ground in the fall; and the streets of the cities in which they have become wild are often strewn with such cocoons which get trodden on and ruined.

The moth (Fig. 42, *2*, ♀) is of a rusty yellow color inclining to green and marked with pale lilac and white with transparent crescent spots as in the illustration. The males are smaller than the females, having smaller bodies and narrower wings, the hind ones, especially, being much less rounded. The male antennæ are scarcely any broader than those of the female.

The above descriptions are general in their character. The insect is not only variable in intensity of markings and coloration; but likewise, to an unusual degree, in the time required for development. Some of the first ones I bred were very irregular in this respect, part of the second brood issuing as moths in the fall, and part remaining over winter in the cocoon till the middle of the following June. I have also had the chrysalis remain not only through one winter, but throughout the summer and succeeding second winter, and not give forth the moth till the second summer; though the cocoons were submitted to precisely the same conditions under which others, hatched from the same batch of eggs, issued in the fall of the year in which they were hatched. This is the common experience of most persons who have raised the worms in large quantities.

A high temperature generally hastens their development, as it does in other insects; and while my summer broods averaged but 25 days from the time of hatching to spinning, those of the fall brood which issued the same year, averaged 30.

Some specimens which I happened to have feeding in 1869 in cages containing plum twigs as well as ailanthus, seemed to eat the leaves of the former with as much relish as of the latter; and no doubt other food-plants might be found for this insect, if it were desirable. In Europe they have also been fed with success on *Rhus coriaria* and Pimpernel; while Dr. Wallace has fed them with Plum and Laburnum producing moths weakened and

defective in size; and gives a very interesting account of some dwarfs produced from celery fed worms.

BEST METHOD OF RAISING THE WORMS.

As this worm takes so kindly to our climate, there will be no difficulty in rearing it in any quantity in the open air, if only care be taken to protect it from the attacks of birds and predaceous insects such as ants, ground-beetles etc. It does not seem to be palatable to birds, as Dr. Wallace found that none of them touched it in England, except the tom-tit, robin and rook. Consequently, by a little vigilance in keeping away enemies, it may be reared with but slight loss, upon trees without covering. Yet it would be expedient and satisfactory in making an Ailanthery to keep the trees in plantation so trimmed and pruned that an awning of some kind of light material could be stretched over them during the feeding season, and removed and put away during the rest of the year. A few cocoons, well chosen for size and quality, might be left on the trees for breeding purposes, and the moths as they issue would soon pair naturally and the females deposit their eggs upon the branches of the trees. The males show a wonderful power in finding the females, as the following incident will demonstrate. In 1865, knowing that the moths I reared in Chicago were the first that had been introduced there, and that there were no others within hundreds of miles, it occurred to me that an excellent opportunity was offered to test the attractive power of the female; this power being generally very strong in the *Bombycidæ*, and often made use of by entomologists to semble the males of rare species. Accordingly I took a virgin female bred indoors before any out of doors had issued, and after placing her upon a tree where she inclined to remain, went the same evening a full mile away, with the wind, and let loose a male with wings slightly notched so as to be recognizable again. I hardly expected the experiment to result favorably; but sure enough, the next morning the identical male which I had marked was with the female. Two broods can easily be produced each year, and the time of hatching of the eggs, of the issuing of the moths, and that required for the development of the worm, depends so much on the temperature, that the broods can be produced at the seasons most convenient and favorable. When this control is desired, the eggs and the cocoons must be properly managed. The cocoons intended for breeding purposes may be suspended in chaplets so that the moths may issue more readily and have good opportunity to hang their damp wings as they expand. They may then be coupled and placed in wicker boxes or any other well ventilated vessels, from which the eggs, when laid, can be easily removed. The eggs when about to hatch may be fastened to the trees in various ways, so that the young worms, from the first moment of their lives, will find the leaves convenient. They may be pasted on to thin wood, paper or linen, and pinned in small quantities to the leaf-stalk; or portioned into lots of fifties or hundreds and suspended in small muslin bags pinned near a leaf.

The young worms are gregarious and generally remain on the under-

side of the leaves; and as they do not consume much at this period, and are more liable to the attacks of their enemies, it may be found profitable to rear them during the first stage indoors upon cut branches or young trees in pots.

A GOOD WORD FOR THE AILANTHUS.

This tree (*A. glandulosus*), taken from Japan to Europe in 1851, and for a long time supposed to be a sumac and known as the Japan Varnish tree, was first rightly described by the French botanist Desfontaines. It is now grown as a shade tree all over this country and is one of the most valuable, and at the same time worst abused trees we have. A peculiar odor, reminding one of the urine of a male cat, and quite nauseous to many persons, attaches to the staminate flowers, and in a slight degree to the leaves and the rest of the tree. This odor is even faintly communicated to the silkworm which feeds upon it; and is the cause of the prejudice which many have against the tree; it is never disagreeable in the open air, except during the flowering season, and may be entirely avoided by growing only the female or pistillate tree, or by clipping off the blossoms of the staminate tree. The advantages of the Ailanthus so far outbalance this one obnoxious feature that I consider it one of the most valuable shade trees we have. Growing freely in chalky, sandy, or clayey—in the poorest or the richest soil; defiant of city smoke or prolonged drought; wonderfully free from insect injuries; easily propagated by root or seed; a rapid grower, with a graceful semi-tropical appearance—it is quite undeserving of the abuse that has been heaped upon it. Away out on the plains on the Kansas Pacific railroad, where tree-planting is yet an experiment, Mr. R. S. Elliot has had excellent success with it, and I was never more favorably impressed with it than in passing through the thronged streets of New York and Brooklyn last summer. There it was, on every side, presenting its fresh rich foliage to the eye, and giving elegance to the streets where all other trees either failed or looked unhealthy. During the excessive drought of the past year, it held its own in our own city of St. Louis better than all other trees; and when it finally shed its leaves, they formed a welcome and nourishing morsel to the hungry cattle who at that time found little else to browse upon. The female tree may always be secured by root propagation and is not only free from the nauseous odor, but grows more symmetrically than the male, and when laden with its large seed-bunches, tinted with shades of yellow, orange and crimson, it is really beautiful. The Ailanthus is said to impoverish the ground and is supposed to furnish the best food for the worms when grown on a chalky, or limestone soil.

[Fig. 45.]

PROMETHEA MOTH, MALE.

[Fig. 46.]

PROMETHEA MOTH, FEMALE.

THE PROMETHEA SILKWORM—*Attacus* [*Callosamia*] *Promethea*, Drury.

(Lepidoptera, Bombycidæ.)

[Fig. 43]

This is one of our native worms possessing many charac ers which closely ally it to the Cynthia worm. Its cocoon is, like that of the two preceding species, elongate and open at one end. It is also double, but the outer coat is not loose and rough, but smooth and solid like a piece of tough manilla paper; and there is very little space, and consequently very little floss silk between it and the inner coat. The silk is finer, weaker, less in quantity, and much more closely compacted and agglutinated than in the others, and, when coupled with the fact that it is suspended by a rope or cord, as long as, and often longer than, the cocoon itself; these qualities render it less valuable than that of either the Cecropia or Cynthia worms. Indeed, under present conditions, the cocoon of Promethea is valueless, as it cannot be reeled, and I doubt whether it could even be carded.

The Promethea moth lays her eggs on the twigs of the tree which is to supply the worms with food, in clusters of five or six together. They are of the size and form of those of *cynthia*, of a pale cream color, variously shaded with a brown gummy substance, which is often mixed with the hairs of the mother's abdomen. They hatch in the latitude of St. Louis from the middle to the last of June.

Larval Changes.—The young, in the first stage, is very much like that of *cynthia*, being yellow, with six rows of tubercles; but instead of having two spots to each joint between these tubercles, it has two transverse dorsal black stripes on each joint, the posterior reaching a little further down than the anterior. The tubercles are blunt, thickened at tip, and are white, except on the thoracic and anal joints, where they are tipped with black: they are furnished with long bristles, which are also pale, except on the joints just mentioned. The head is yellow, with two transverse dark bands, the upper one broad and excavated laterally. In the second stage there is no essential change, except that the black tips are confined to the 4 uppermost tubercles on the first, and those on the anal joints; the black stripes are also more conspicuous. In the third stage (Fig. 43, *a*) the body is paler; the transverse stripes are more conspicuous, the bristles on the tubercles are shorter, having more the appearance of spines, and the two uppermost tubercles on joint 2 are often tipped with black. In the fourth stage there is considerable variation, but generally the body is still paler and covered with a whitish pruinescence or powder which recalls the powdery appearance of *cynthia* at the same age; the transverse stripes are broader (Fig. 43, *c*, represents an enlarged side view of one of the joints) and show a tendency to approach between the tubercles; the dorsal rows of tubercles are sulphur-yellow, except on joints 1 and 12, where they are black, and the central yellow tubercle on joint 11 becomes more prominent; the subdorsal row is entirely black, and the stigmatal row is black on the thoracic joints and yellow on the rest; three black ventral tubercles each side of thoracic joints are now often quite conspicuous; the spines correspond in color to the tubercular stalk; the head (Fig. 43 *b*) is yellow, with the lips and triangular piece white, and is prettily marked with black, as follows: two

black spots on frons, one behind antennæ, a stripe around labrum, and one at lower base of cheek: the anal legs are also marked above with a rectangular black stripe. In the fifth stage, *i. e.*, after the fourth moult, the appearance is totally changed: the body is of a most delicate bluish-white, with a faint pruinescence; all the spiny tubercles become smooth, and with the exception of the four dorsal ones on joints 2 and 3 and the large one on joint 11, they are mere rounded,* polished, black or blue-black elevations; the four on joints 2 and 3 are at first yellow, with a black basal annulation, but they soon become red; that on joint 11, which is of the same size, remains yellow with its black base; the rectangular black mark on anals becomes sub-triangular; and the marks on front of head generally disappear. The legs and anal shield are yellowish, the abdominal prolegs having each a black spot outside, while there is often a minute black spot on each side of venter, to correspond with them, on joints 4 and 5. The stigmata are narrow and brown.

As this worm acquires its full growth, the pruinescence, mentioned above disappears, and it acquires a more greenish cast, except around the base of the tubercles where there is a more decided blue annulation. At this time it presents the appearance of Figure 43, *d*. It is quite irregular in developing, but usually acquires its full growth within a month from hatching. In making its cocoon it instinctively fastens to the twig, by woolding around it a strong band or cord of silk, the leaf which it intends to use for the purpose, and connects the leaf with this anchor-band by continuing the silken girdle around the leaf-stalk. In the winter time the leaf-stalk shrinks and rots, so that the cocoon swings either the whole length of its fastening, or but part of its length, as at Figure 44. As may readily be inferred, the length of this fastening depends on the length of the leaf-stalk, and if no leaf-stalk is at hand the worm may form a cocoon without a cord. This insect is single-brooded, and the cocoons hang through the winter and give forth the moths during the end of May and beginning of June. I have known the latter to issue, however, during the same year, but such an occurrence must be considered exceptional.

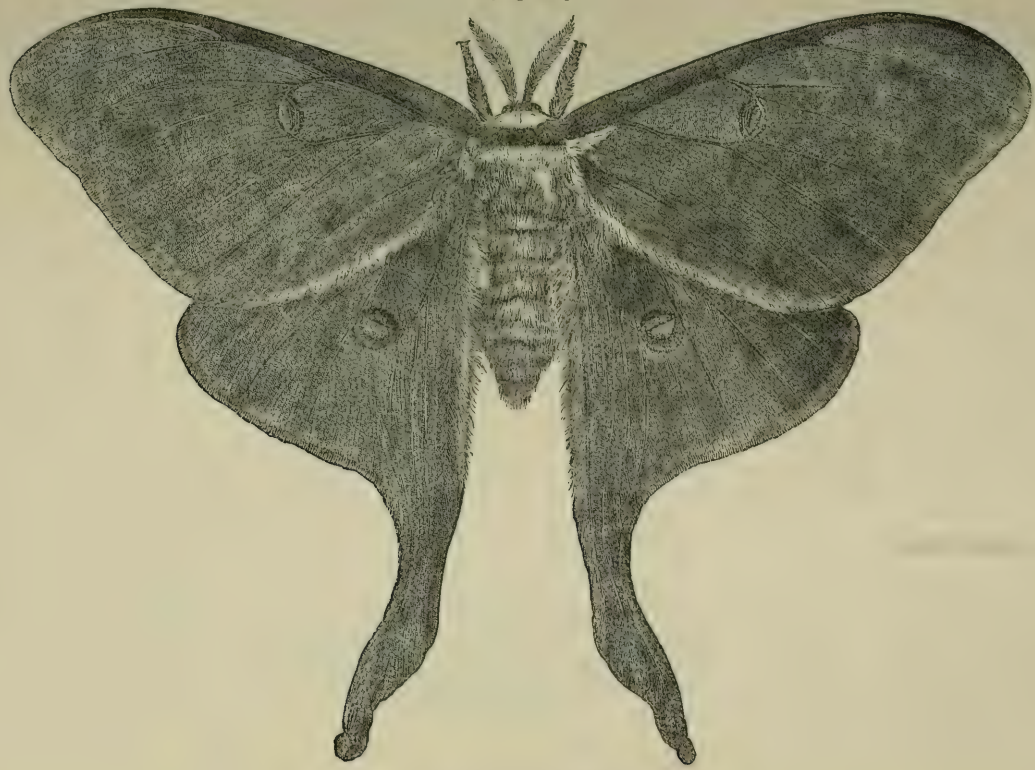
[Fig. 44]

The sexes differ strikingly in appearance. As with *cynthia* the wings of the male are more narrow and more falcate than those of the female, but though the same design is manifest in both sexes, the general color of the male (Fig. 45) is a deep rich smoky or amber-brown; while that of the female (Fig. 46) is of a lighter rust or reddish-brown. Both have a pale wavy line across the middle and a clay-colored border along the hind edges of the wings. Both also have an eye-like black spot with a pale bluish crescent inside, near the tip of front wings; but the female has a pale angular spot, shaded outside with black, near the middle of each wing, which is only occasionally faintly indicated on the underside in the male. The antennæ of the male are about twice as broad as those of the female.†

* Sometimes conical on the back of joints 3 and 12.

† Occasionally specimens are found combining the pattern of the female with the dark colors of the male, and these should be considered either as hermaphrodites or anomalies, But they have been described as a new species under the name of *angulifera* by Mr. Francis Walker of the British Museum. I have seen the specimens under this name in said Museum and in the collection of the Entomological Society of Philadelphia and should not think of considering them anything else than

[Fig. 47.]



LUNA MOTH, FEMALE.

The cocoons are found upon the Ash, Sassafras, Wild cherry, Tulip tree (*Liriodendron*,) Sweet gum (*Liquidambar*), Spice bush (*Lindera*), Maple Plum, Poplar, Azalea, Cephalanthus, Snowdrop tree (*Halesia*), Barberry, Birch, Bayberry (*Myrica*) and Lilac. Of course it does not follow that the worm feeds upon all trees and shrubs upon which its cocoon is found: on the contrary, there is good evidence that it often prefers to wander onto some tree, other than that on which it fed, when about to spin up; and Dr. Fitch (Rep. III, § 80) has shown that in New York it spins up by preference* on Lilac. But I have fed it successfully on the five trees first mentioned while my correspondents in Pennsylvania and Maryland have fed it on Tulip tree, Sweet gum and Spice bush; and there is reason to believe that it will feed upon the others. In fact Mr. Chas. S. Minot of Boston, Mass., informs me that at a pinch it will feed on Arbor-vitæ. It is most commonly found on Sassafras and Cherry with us, while singularly enough, Dr. Fitch has shown that in his locality, it prefers the Ash, and does not touch Sassafras even when adjoining Ash. These facts go to show how a species may get to prefer different trees in different sections of a country, and indicate how incipient races at first, and in time varieties and species may be formed.

NATURAL ENEMIES.

The cocoons are often gutted by birds, hard pushed for food in the winter; while the worm is attacked by several parasites. The cocoon is often found to contain numerous other small silken cocoons, very much as represented in Figure 40, but formed of a somewhat darker material; and from these I have bred *Cryptus nuncius*, Say which differs principally from *extrematis*, Cresson, in having the ovipositor shorter than the abdomen as in Figure 41, *b*; instead of nearly twice as long as at *a**. *Chalcis mariæ* also preys upon it, and Mrs. Chas. S. Minot has bred an *Ichneumon*, an *Ophion* and a *Tachina*-fly from it.

THE LUNA SILKWORM—*Attacus* [*Actias*] *Luna*, Linn.

(Lepidoptera, Bombycidæ.)

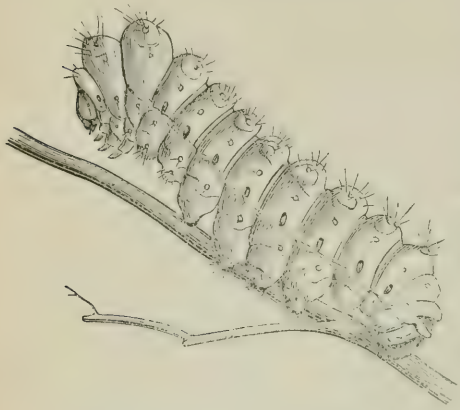
Whichever of the preceding moths may carry off the palm of beauty in the eyes of different persons, no one will hesitate for a moment to accord to *Luna*, our "queen of the night," entire supremacy in grace, elegance and chasteness. No other N. A. insect can win this distinction from her. All the large moths figured in this article on silkworms draw forth expressions of admiration from those who see them in my cabinet; but the delicate green, relieved by the eye-spots and by the broad purple-brown or lilaceous anterior border; the soft downy hair of the body, and above all the graceful

varieties of *Promethea*. From the fact that this exceptional form has been reared from cocoons spun up around the base of trees, I infer that it is often produced from enfeebled worms which have fallen to the ground.

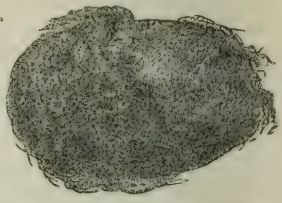
*For further details see page 111.

prolongation of the hind wings (See Fig. 47) of *Luna*, are the first to attract the eye. The green varies in tint, having either a cold, bluish, almost pearly look, or being strongly suffused with yellow. The body is sometimes pure white but more generally yellowish or cream-colored, and though the hind borders of the wings are usually yellowish, they are sometimes stained with the same deep color as the anterior or costal border.

[Fig. 48.]



[Fig. 49.]



The cocoon of this insect (Fig. 49) is formed within a leaf, or leaves drawn together, and in the fall of the year drops to the ground where it remains all through the winter. It is whitish or brownish*, closely spun, tough, oval and closed at each end; but it is so thin and contains so little silk, that it cannot be unwound and possesses no value compared with some of the others.

The eggs are deposited in small batches on the twigs: they are slightly larger than those of *cynthia*, and more or less deeply colored with a brown adhesive fluid.

The worm feeds with us principally on Walnut and Hickory; but is also found on Sweet gum, Beech, Birch, and even Willow and Plum.

Larval Changes.—In the first stage the worm is of a pale green color, with two brown transverse bands across the head something as in Figure 43, *b*, and a brown longitudinal mark along each side of the body, especially distinct on the four anterior joints and sometimes meeting on the back of the 4th. It is covered with setaceous tubercles, placed in precisely the same position, and of the same size, as those of *Cecropia*, *Promethea* and the others at the same age, the stiff hairs being mostly tinged with brown. In the second stage the brown marks on the head mostly remain, but often are less distinct; the lateral brown stripes vanish and the four dorsal tubercles on joint 1, the two uppermost tubercles on joints 2 and 3 and the middle one on joint 11 are generally orange-red. In the third stage there is very little change; the upper band on the head usually disappears entirely, the tubercles become uniform in color again, and some of the bristles become more conspicuously black and more spinous. In the fourth stage, the tubercles are reduced in relative size, especially the subdorsal row. In the fifth stage these tubercles become relatively still smaller, and some few other changes take place. The full grown larva (Fig. 48) almost equals the parent moth in delicacy of color, being of a remarkably clear pale green inclining to yellowish above and bluish below. The sides slope, roof-fashion, from the spiracles to the back, which is comparatively narrow, and where the sutures are very deep, causing each joint to form a sort of tubercle having a crescent shaped indenture, and reminding one of those on the back of some of our wood-borers such as the Round-headed Apple-tree Borer. There is a longitudinal substigmatal yellow line each side, and a transverse yellow line on the posterior edge of the 4th to the 10th joints inclusive. The tubercles are vermillion-red, the lower ones darkest, the upper ones verging on to orange; and on joints 2—5 there is an additional ventral tubercle each side. The spiracles are deep reddish-brown: the head is bluish-green shaded above with light brown, and at sides with darker brown†: the upper lip is produced into two appendicles more prominent than in any of the species yet described and serving no doubt to steady the leaf which the worm is gnawing. The cervical shield is horny, with a tinge of blue. The thoracic legs are brown with yellow at base, and the prolegs light brown with a black outer line just above the coronet of hooks. The caudal plate is narrow, bluish, with brown edges and bordered

* Doubtless according to food-plant. Specimens fed on Hickory have given me the darker cocoons.
† Exceptional specimens occur with the head and thoracic legs almost black.

[Fig. 51.]

POLYPHEMUS MOTH, FEMALE.

[Fig. 50.]

POLYPHEMUS MOTH, MALE.

above with yellow, and there are plates on the anal legs of nearly the same size, form and color. The whole body is sparsely covered with short yellowish bristles, aside from the few longer ones which emanate from each tubercle.

The moths issue during the month of April up to about the middle of May. The worm acquires its full growth in about a month from the time of hatching, and goes through the eariler moults quite rapidly. In a state of confinement the moths from these first worms have always issued in July near St. Louis, and it is quite probable that the insect is frequently 2-brooded with us though considered single-brooded further north.

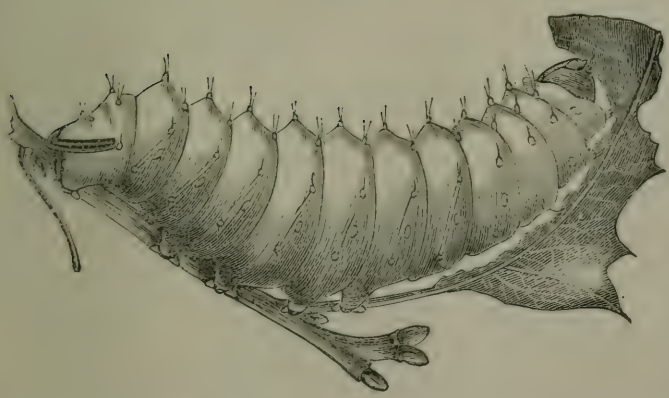
I have never known this insect to be parasitized, but Mr. V. T. Chambers, of Covington, Ky., has know a *Tachina*-fly to deposit eggs upon the worm, without, however, preventing its maturing to the moth.

There is a moth occurring in China (*A. Selene,* Leach) which must, I believe, be considered identical with our *Luna,* or at the most should be considered only as a variety. Dr. Fitch has minutely described such differences as are supposed to separate the two as species.*

THE POLYPHEMUS SILKWORM—*Attacus* [*Telea*] *Polyphemus*, Linn.

(Lepid ptera, Bombycidæ.)

[Fig. 52.]



This is the insect which, as I have already remarked, has been styled, with much justice, "the American Silkworm" by Mr. L. Trouvelot, of Medford, Mass. That gentleman made a series of very interesting experiments in rearing the worm in large quantities in the open air, and in 1865 he had not less than a million feeding upon bushes covered with a net. An interesting account of these experiments, but more especially of the natural history of the species may be found in the first three numbers of that excellent periodical the *American Naturalist.*

The eggs of Polyphemus are deposited singly, or in twos or threes, on the under side of a leaf or upon a twig; and as a further instance of the fallibility of instinct, Mr. Trouvelot has known them to be deposited in the open air upon plants which could not nourish the young worms. They are of about the same size of those of Cecropia, less oval—the lateral cir-

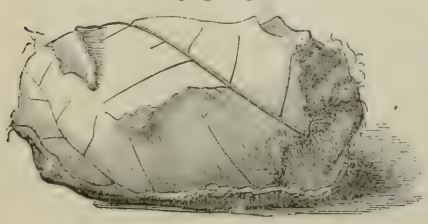
*3rd N. Y. Rep., § 180. Note.

cumference being nearly cylindrical—and more flattened. They are whitish, inclining to flesh color on the top and bottom, and encircled on the sides by a characteristic broad band of amber-brown, which is the natural coloring of the egg-shell and distinct from the brown fluid which is secreted with and fastens them to whatever object they are consigned. This brown band has a narrow pale spot at the two smaller ends. The moths issue with us the latter part of April, or in May, and the female commences depositing very soon afterwards. The eggs hatch in about ten days after deposition.

The worm feeds on Oak, Walnut, Hickory, Bass-wood (*Tilia*), Elm, Maple, Hazel, Apple, Rose, Quince, Thorn, Plum, Choke cherry, Sycamore, Poplar, Birch, Honey locust, Blueberry and Willow; on the first nine of which I have found it myself. It has the general form of that of Luna, though the sides are not so sloping nor the incisions so deep. When full-grown (Fig. 52) it is a most delicate and beautiful object, being of a clear apple-green color, with oblique yellow lateral lines, and tubercles tinselled with orange, gold and silver. The head, spiracles, legs and ends of prolegs are of a buff-yellow, the front edge of the first joint sulphur-yellow, and the edges of the anal shield purple.

Larval Changes.—In the first stage the larva is yellow, becoming greener in appearance as it increases in size. The tubercles are situated as in the other species and are yellow, capped with a whorl of rufous bristles. The two dorsal rows are large, conspicuous, and except on joint 11 uniform in size. In the subdorsal row they are large on the thoracic and 12th joints, but almost obsolete on the rest. In the stigmatal row they are small and of equal size. Each joint has two transverse black lines between the subdorsal and the stigmatal rows of tubercles: the head is reddish-brown, and there is a transverse line of the same color on the first joint. In the second stage it is of a beautiful green; the tubercles are of the same relative size, those on the back having a length of ¼ the diameter of the body; they are thick and slightly bell-shaped, green at base, yellow in the middle, and orange-red at tip, with the bristles or spines mostly black. Only one of the black lines remains to each joint and that is very faint, contains the spiracles, and is shaded with paler green behind. The head and cervical shield are of a deeper red-brown and the anal plate is edged with pearly whitish-green. In the third stage there is little change: the tips of the tubercles deepen into coral-red; the subdorsal row becomes almost as conspicuous as the stigmatal, and there is no longer any black lines between them, though the spiracles are now quite black and well relieved by pale green behind. In the fourth stage the tubercles are relatively smaller, the head is of a still deeper purple-brown, with the front edge of first joint, and the lateral oblique line, which is now more distinct, of a delicate sulphur-yellow; the spiracles are deep brown, and the edge of the anal plate is silvery-white below, graduating into lilaceous and then into deep purple above. As it approaches the fourth moult, the tubercles acquire a metalic, or silvery cast, and the other colors deepen. In the fifth stage the seven oblique lines, connecting the subdorsal with the stigmatal tubercles on joints 5—11 are bright sulphur-yellow, the tubercles appear tinselled and reflect golden, silver and purple hues: the dorsal rows give forth but two or three straw-colored bristles, and the subdorsal rows but one of the same color, all pointing upward and forward; while the stigmatal row produces one light and one dark one which point exactly in the opposite direction. Numerous other stiff hairs spring directly from the skin, especially below; the subventral thoracic tubercles are conspicuous; and there is a faint longitudal ventral band. The front edge of the first joint is bright sulphur-yellow, with a soft retractile band of slate color between it and the head.

[Fig. 53.]



The cocoon (Fig. 53) is formed of strong silk which when unwound has a glossy fibre. It is oval and closed at both ends, dense and generally fastened to a leaf or leaves, with which it falls to the ground, though sometimes it is fastened to twigs and therefore remains exposed during the winter, to

its enemies. This cocoon is said by Fitch to so closely resemble that of Luna, that the two cannot be distinguished from each other, and Harris speaks of their great similarity: but with us they are very easily distinguished. That of Polyphemus is not only more dense, but its fibres are intermixed and cemented with a gummy substance which when dry gives the cocoon a hard chalky appearance. This hardness renders the exit of the moth unusually tedious and difficult, and the process has been so well described by Mr. Trouvelot, that though I have watched it myself, I repeat his words:

"But the moth must have some means of exit from the cocoon. In fact it is provided with two glands opening into the mouth, which secrete during the last few days of the pupa state, a fluid which is a dissolvent for the gum so firmly uniting the fibres of the cocoon, This liquid is composed in great part of bombycic acid. When the insect has accomplished the work of transformation which is going on under the pupa skin, it manifests a great activity, and soon the chrysalis covering (Fig. 54) bursts open longitudinally upon the thorax; the head and legs are soon disengaged, and the acid fluid flows from the mouth wetting the inside of the cocoon. The process of exclusion from the cocoon lasts for as much as half an hour. The insect seems to be instinctively aware that some time is required to dissolve the gum, as it does not at first make any attempt to open the fibres, but seems to wait with patience this event. When the liquid has fully penetrated the cocoon, the pupa contracts its body; and pressing the hinder end, which is furnished with little hooks, against the inside of the cocoon, forcibly extends its body; at the same time the head pushes hard upon the fibres and a little swelling is observed on the outside. These contractions and extensions of the body are repeated many times, and more fluid is added to soften the gum, until under the efforts the cocoon swells, and finally the fibres separate, and out comes the head of the moth. In an instant the legs are thrust out, and then the whole body appears; not a fibre has been broken, they have only been separated.*

[Fig. 54.]

"To observe these phenomena, I had cut open with a razor, a small portion of a cocoon in which was a living chrysalis nearly ready to transform. The opening made was covered with a piece of mica, of the same shape as the aperture, and fixed to the cocoon with mastic so as to make it solid and airtight; through the transparent mica I could see the movements of the chrysalis perfectly well."

Mr. Trouvelot also gives some very interesting facts to show the wonderful vitality of the chrysalis. He once thrust a pin through a cocoon which he wished to preserve, and, as might be supposed, the pin also pierced through the body of the chysalis inside. This was done in October, and nine months afterwards, in June of the following year, he was surprised to find a great commotion in the cabinet where the specimen was pinned, and

* As I have already intimated (p. 74) this statement is not sufficiently guarded.

the moth with head and legs projecting, endeavoring in vain to escape from its prison. To prove also that no air is needed from outside for the proper development of the moth, he carefully covered cocoons so as to make them air-tight and kept them so covered all winter without in the least affecting the exit of the moth.

The moth (Fig. 50 ♂; Fig. 51 ♀) is of a dull ochre-yellow, shaded more or less distinctly with innumerable black particles and with a broad gray band along the front, or costal edge, and passing over the thorax. There is a darker, reddish-brown shade across the middle of the wings, and near this shade on each wing is a transparent eye-like spot, divided by a slender opaque line, and margined by a yellow and a black ring, the last much broader on the hind than on the front wings, being there widened on the inside into a large black spot with the part adjoining the eye-spot bluish-white. Near the hind margin of each wing is a dusky band, (bluish on the front ones) edged with pink-white behind; and near the base of the front wings is a zig-zag crimson line, edged inside with white. There is great variation in the colors of this insect, dependent in some measure no doubt on the food of the larva; and it is a wonder that some of them have not been described as distinct species by those who consider *Callosamia angulifera* or *Samia Columbia* good species. Specimens occur which have the general tint either very dark or very pale; either brown, smoky-yellow, cream-color, rust-red or greenish; while the large black spot on the hind wings is sometimes replaced by rust-red.

The male is easily distinguished from the female by his smaller abdomen, and very broad antennæ which are, in fact, broader than represented in my figure, as I have known them to spread nearly half an inch. They have actually been mistaken for a third pair of wings by inexperienced persons, and my friend, M. Provancher, gives the following amusing account of such a mistake in the *Naturaliste Canadien*, which he edits: *

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 neighbors 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

* Vol. I. p. 22.

add a foresail; and I should not be at all surprised if some other one took it into his head, to hoist a jib ahead of his other sails, so as to be still more complete. But in the meantime 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 is a rule, without exception, that no insect has more than four true wings. The wings may be split up as in the Plumes, of which the Grapevine Plume (Rep. 3, Fig. 27) is an example; or they may be furnished with a membranous lobe as in the European genus *Lobophora;* but they never are increased in number beyond four.

The principal difficulty in the way of reeling the cocoon of Polyphemus is the hard matter which binds it; but it is not an insurmountable one, and the cocoon could no doubt be improved by a proper process of continued selection. The silk, as already stated, is strong and lustrous.

As with some of the other species already mentioned, two broods of this insect are frequently produced each year in this latitude, though it normally appears to be single-brooded in the more northern States. In the South it is always double-brooded, the first moths issuing about the middle of February in Louisiana. If it is ever grown for silk the South will be the most favorable part of the country, for it often abounds in New Orleans in such numbers, on Sycamore, Elm, and live Oak—especially the latter—as to be easily gathered by bushels.

The parasites of Polyphemus are, the Mary Chalcis-fly (Fig. 39), the Long-tailed Ophion (Fig. 37) and a Tachina-fly which I shall not now describe for reasons given in my 3rd Report (p. 150). It differs from that which I have bred from Cecropia, principally in its gray color being less bluish, and in having smooth eyes; and may be provisionally designated as *Tachina anonyma.**

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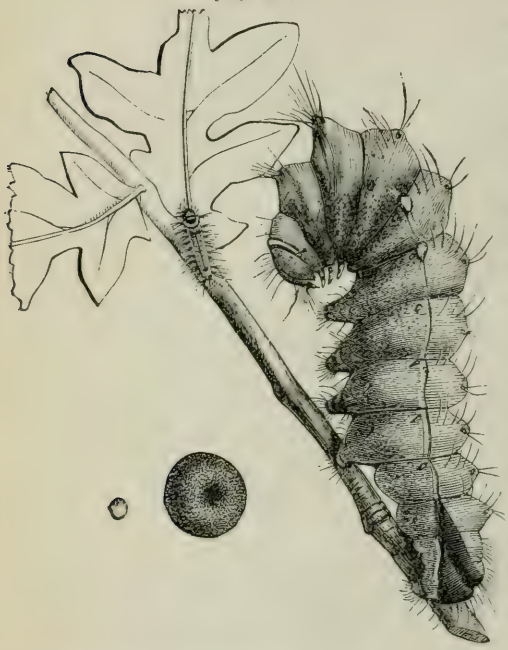
* It belongs, apparently, to Macquart's genus *Mascicera.* I have bred precisely the same species from *Citheronia regalis*, and others that differ only in being smaller, from *Prodenia autumnalis*, an undescribed Noctuan, *Cynthia cardui*, *Heliothis armigera*, *Datana ministra*, and *Danais archippus;* while I have others from *Sphinx carolina* which differ only in having the apical joint of abdomen rufous. The face appears quite golden on the top and the second and sometimes the third abdominal joints incline to rufous at sides.

THE YAMA-MAÏ SILKWORM—*Attacus* [*Antheræa*] *yama-maï*, Guér.-Mén.

(Lepidoptera, Bombycidæ.)

[Fig. 56.]



This worm is a native of the northern parts of Japan, living, as its name (meaning "worm of the mountains") implies, in the mountainous districts. It feeds on a species of Oak known botanically as *Quercus serrata*, and called Kunogi by the natives. Its silk is produced in large quantities in its native country and already forms an article of export. It was first introduced into Europe in 1861 and soon afterwards named and described by Guérin-Méneville.* It has been found more difficult to acclimatize than the Ailanthus worm, and but indifferent success has attended its culture. Yet there are striking exceptions and in Austria it has been successfully reared in considerable quantities for several years. It is withal so valuable an insect that further trial is fully justified. In America it has been experimented with only since 1868, and I have for two years attempted to raise it in small quantities in Missouri. In 1869, the weather was quite unfavorable, and from two dozen eggs I failed to obtain any moths though most of the worms passed through the third moult. The eggs hatched prematurely and I had to feed the young worms on crushed buds. The disease they died of was similar to one which attacks them in their native country, and which has also been noticed in Europe. I am very much inclined to attribute it to excessive heat. The worms become speckled and blotched, the beautiful clear green changes to dull yellow, diarrhœa ensues, the body hangs by the prolegs, a flaccid shapeless mass of putrid fluid which soon bursts through its tender and rotten covering, and finally leaves nothing but a dry shrunken skin. In 1870 I had a little better luck with a second two dozen, though nearly one-half hatched before food could be obtained for them, and consequently died, and only one went through all its transformations and pro-

* For details of the history of this worm, and its culture in Europe, the reader may refer more especially to the following works: Different papers by Guérin-Méneville in the *Revue et Magazin de Zoologie*, and *Revue de Sericiculture* for the years 1861–3. *Le ver à Soie du Chêne* (*Bombyx Yama-mai*) *son histoire, sa description, ses mœurs*, by M. Camille Personnat. *Rapport sur une éducation en Anjou du ver du Chêne* (1863) by F. Blain. Also two essays by Alexander Wallace, M. D., one published in the Transactions of the London Entomological Society (Vol. V, Part V, 1867) and one in separate form in 1869.

[Fig. 55.]

YAMA-MAÏ MOTH, MALE.

duced a beautiful male moth. This specimen was hatched on the 13th of April, commenced spinning June 3rd and produced the moth September 8th —thus requiring the unusually long period of nearly five months for its changes.

Mr. W. V. Andrews, of New York, who has taken great interest in the introduction of foreign silkworms, gives me the encouraging information that last summer, nearly 800 cocoons were obtained from about 1600 eggs, in the vicinity of New York. The moths issued at such irregular intervals, however, and were so scattered among different experimenters, that no fertile eggs were produced.

[Fig. 57.]

Yama-mai undoubtedly belongs to the same natural genus as *Polyphemus,* which it closely resembles in habit and appearance. Its culture may be carried on in the same manner as that of *cynthia,* and it will suffice here to point out such of its peculiarities as will guide in its management.

The egg is rather larger (Fig. 56 shows it of natural size and magnified) than that of *Polyphemus,* less flattened and of a pale straw-color with a pinkish tint. It appears brown from being more or less thickly coated with a brown tenacious gum, which may be washed off by any alkaline fluid. The eggs should be kept over winter in a temperature never higher than 40° F. When hatching they should be moistened or kept in a moist atmosphere. As in the case of our American Tent-caterpillar, the young larva is fully developed within a month after the deposition of the egg, and passes the winter in a curled-up, quiescent state within the egg-shell.

The worm thrives best in an atmosphere that is cool, moist and shady,

and the heat, if it can be controlled, should not exceed 80° F. It is a lazy slothful creature, and often rests for hours in the position given in Figure 56. As we learn from Mr. F. O. Adams, who has lately made an interesting report on the culture of this species,* the color of the more mature worms so thoroughly corresponds with that of the leaf on which they naturally feed that they can with difficulty be detected while clinging, motionless, to the branches and leaf-stems. They are of a beautiful clear green with generally two silvery spots each side on the fifth and sixth joints, and a pale yellow line running along the sides. This line, with the position which the worm sometimes assumes, strengthens the resemblance to the leaf, and I reproduce a rough outline (Fig. 57) from Mr. Adams' Report which will well convey this resemblance to the reader's mind—the worm being outlined at *a*.

The life of the worm lasts from 50 to 80 days, and it feeds on all kinds of Oak, but prefers those of the white oak group. Dr. Alexander Wallace, of Colchester, England, to whom I am indebted for specimens of the moth, and who has extensively experimented with it, found that the worm would feed also on Beech, Apple, Quince, White thorn, Neapolitan medlar (*Photinia glabra*) and Chesnut.

Larval Changes.—The larva in the first stage is yellow with tubercles corresponding exactly in number and position with those of *Polyphemus*, and the others described at the same age. It has a narrow, but distinct, dorsal, subdorsal and stigmatal black line. The four upper rows of tubercles, (except the two dorsal ones on joint 3, and the central one on jt. 11, which are large and dark) are yellow and give rise to stout black outwardly-curving bristles; the stigmatal row is black with a white basal annulation, and gives rise to white bristles. The bristles are longest on thoracic joints, and are all white on the first. Head shiny gum-copal yellow; cervical shield paler, more orange and without polish; a black spot on anal shield and on each anal proleg. Thoracic legs black with yellow extremities; prolegs with brown extremities. Approaching the first moult, the yellow color becomes more greenish. In the second stage the color of body is greener, the head is chesnut-brown, the longitudinal lines are almost obliterated, the medio-dorsal one being of a faint and delicate blue: there is a broad lateral band of the same faint blue, with a light yellowish line below it. The tubercles are longer, especially on joints 2, 3 and 4, the dorsal rows of a delicate yellow, the lower one of a delicate blue with yellowish base. The bristles from all are black with a few scattering pale ones. The anal shield is edged with blue. In the third stage there is not much change; the tubercles are relatively still more prominent, the lateral ones tipped only with blue, the green of the body is more intense, and is speckled with straw-color; and the lateral yellow line is suppressed on the thoracic joints. In the fourth stage the change is slight, but from one to three silvery spots appear on the lateral yellow line, usually on joints 5, 6 and 7. In the fifth or last stage, and when full grown, it presents a most beautiful and delicate appearance, but varies considerably, and the following description is taken from those I fed, and more especially from that which produced the male moth. It is of the same form as *Luna* and *Polyphemus*, the joints being deeply insected, narrowing from stigmata upwards, and flattened on dorsum by a crescent-shaped depression. Head opaque green with slight bluish tint, the five ocelli distinct and brown; a few pale hairs especially around, and decurved over, the trophi; antennæ with bulbus yellow, the other two joints brown, the last terminating in a long seta; epistoma with sutures and margins pale lilaceous; labrum very large, with pale margins. Cervical shield paler than body, only slightly polished, ridged behind, and edged in front with yellow. Body clear yellowish-green; tergum of joints (5—10 especially) paler, and almost nacreous at insections; studded with minute (0.02 inch long) short, clavate, sulphur-yellow projections or scales; the tubercles are blue and emit black hairs, and there are besides about half-a-dozen long yellow dorsal, anteriorly-curving setæ on joints 4—11; joint 1 is small and retractile, 2 and 3 large and rendered square by the prominence of the dorsal tubercles; 5—9 subequal; 9—last diminishing; a lateral pale yellow line, faintly edged above with lilaceous, extends from middle of joint 4 to tip of anal legs; a silvery spot in this band on joint 5, and sometimes on joints 4 and 6. Stigmata immediately below the yellow line, slightly oblique, sub-elliptical, fulvous, with (except on joint 1) a brown fringe; a broad triangular brown patch on anal prolegs, and a broad margin on the caudal plate, extending and diminishing to anterior part of joint 11, also purple-brown.

*3rd Rep. on Silk-culture in Japan, p. 8.

[Fig. 58.]

The cocoon (Fig. 58) is large, heavy and handsome, and requires a full week for its completion. It is formed within a single leaf or within several drawn together and attached to a twig. It is oval and usually of a bright golden-yellow color on the outside though nearly white inside. Those raised out-of-doors are more green, while those raised in-doors are more yellow, and white specimens have already been produced. The silk is strong and valuable; it bleaches well and may then be dyed; fewer threads are required to make a strand than in that of *mori*, and it unwinds with perfect facility, by the ordinary process. It shows its affinity to that of our *Polyphemus* by the gum which surrounds it containing a chalky or calcareous substance which may be noticed upon tearing or rubbing the cocoon.

The Moth (Fig. 55, male) is magnificent in point of size and color. The front wings are broadly falcate and more so in the male than in the female. The collar and broad costal margin are always of an ash-gray. The eye-spots are surrounded with more or less pink and yellow, white and black, the black always being on the outside. The broad lines across the wings are either wavy and slate-colored, with an inner wavy coincident shade, or more straight with a whitish outer shade, relieved by a darker more reddish posterior shade. The posterior margins are either paler than the general surface, or ornamented with a dark wavy line. The median shade across front wings is either very distinct and scolloped, or obsolete; and there is either one or two such shades on the hind wings. The species varies, in fact, very much in the detail of ornamentation, and in general color, being either yellow, brown, grayish or olivaceous, and some specimens much resembling certain forms of our Polyphemus.

According to the testimony of those who have had most experience with this species in Europe, coition invariably takes place at night, and lasts but a comparatively brief time. As the moths issue very irregularly and the males are apt to appear many days before the females, and as it has been further ascertained that unless they emerge within a day or so of each other, the sexes show little affinity; it is best to retard the male cocoons. This can be done by first separating them, by weighing as described on page 97, and keeping the male cocoons in a cooler place than those of the female

From the foregoing it is evident that while *yama-mai* is the most valuable silk producer next to *mori*, it is nevertheless very difficult to rear. It

cannot well endure a heat beyond 80° F., and will doubtless thrive best in the more northern States, for it will bear a moderate amount of cold, even below freezing point, for brief periods, with impunity. It is invariably single-brooded, and runs a longer course of life than any of the other species treated of. The hatching of the eggs must be retarded till the first oak leaves (the buds of the Post oak are among the earliest to swell, but some species of the black oak group, especially the Laurel-leaved oak, leaf out first) put forth, and moisture, which is prejudicial to the Mulberry silk-worm, is grateful to this one at all times. I have already said that the embryo larva is fully formed soon after the egg is deposited. Now all our eggs, so far, have been obtained indirectly from Japan *via* Europe, and in the transit they must necessarily be subjected to too much dampness and confinement, too great changes from heat to cold, and the reverse; and the vitality of the young worm thus impaired. Mr. Andrews * believes that to this fact must be attributed much of our failure in this country, and I fully concur with him. In this country which, compared with Europe, is so rich in oaks, and in the large silk-producing insects so closely allied to *yama-mai*, and which is so varied in climate, we certainly ought to meet with better success than our European friends; and until we procure eggs more directly, or obtain them from insects reared in this country, so as to preserve them in uniform and favorable conditions, it cannot be said that we have taken the proper steps towards acclimatizing it. Let us hope that friend Glover will induce Minister Capron to send direct from Japan a good supply of eggs, next winter, to experiment with!

Before concluding my notice of this insect I will transfer from the third Report of Mr. F. O. Adams, already alluded to, the following excellent account of rearing it in Japan, which will be found valuable and interesting in this connection:

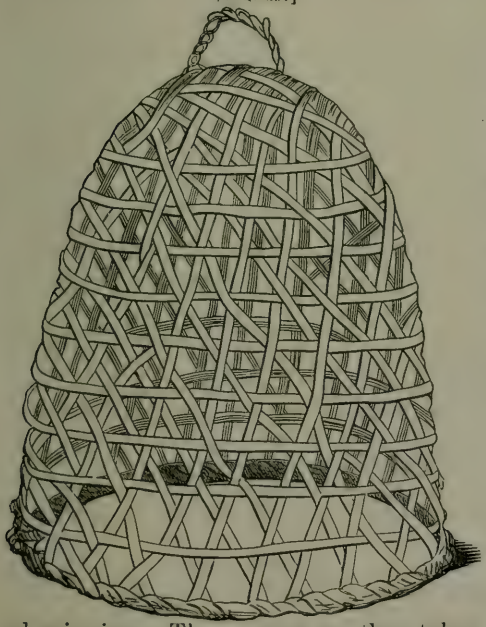
The eggs of the Yama-mai are deposited by the female on the bars of cages made of plaited bamboo strips, of the bell-like form delineated in the sketch (Fig. 59). This is probably towards the end of July, and the cages are hung up one under the other, in rows of ten, under the eaves of the roof where ventilation can be secured without exposure to sun, rain, or smoke.

In the 10th month (November-December) it is generally the custom to take the eggs off the cages with the fingers, and place them in hempen trays of oblong form, with wooden rims about three inches high. Care must be observed that the eggs are not crowded one upon another. The trays are placed upon the verandah. A cold atmosphere is essential at this stage. Sometimes the eggs are not detached from the cages, and the latter are placed in a shed outside the houses, where good ventilation can be secured. The walls of the shed are formed of a coarse matting composed of reeds, and the roofs should be constructed of such material that no rain can penetrate inside and injure the eggs. About the end of the 2nd Japanese month (say the beginning of April) the eggs are collected in small hempen bags, which are placed in boxes pierced with holes, in order to admit of proper ventilation. These boxes are either suspended out-of-doors amongst the trees where no sun can reach them, or kept in a cold cellar, where they are put into deep holes dug in the ground. This operation is only necessary when the hatching has to be retarded, because the buds of the Kunogi have

* *Scientific American*, March 18th, 1871.

not come out. The eggs, in short, have to wait for the buds, which are expected about the 88th day after the Japanese new year, (say at the end of April or in the first ten days of May), though they may be much later. As soon, however, as the buds have come out, all the eggs, whether from outside or from the cellar, are brought into the house, and fixed with paste made of barley, or still better, of buck-wheat, on the middle of slips of paper five inches long and a quarter of an inch broad. About ten eggs are placed upon each paper, and all the slips are then taken to the plantation and tied to the branches of the Kunogi in a single knot, which the nature of Japanese paper readily admits of, the two ends standing out at right angles to the branch. The paper thus surrounds a small section of the tree, the eggs lying on the external surface. The slips are placed in such manner that the eggs may have a northern aspect, and not be exposed to the rays of the sun. One slip is sufficient for a small plant, two or three may be attached to a large one. In four or five days the hatching will commence, and it continues for five or six days more; the young caterpillars, on leaving the shells, immediately crawl from the papers upon Kunogi, and seek the leaves. We saw a number of these papers still remaining on the trees as they had been tied before the hatching, with the empty shells sticking to the surfaces, and we untied some and brought them away with us as specimens.

[Fig. 59.]



The length of time between hatching and spinning, during the whole of which the larvæ remain in the open air, passing through four periods of rest, is reckoned at about 60 days, more or less, according to the temperature. We were told that the first rest commenced on the seventh day, and continued for two days, that the succeeding three periods of activity and torpor were severally longer than the first, and that the spinning commenced about ten or eleven days after the fourth rest.

Three days after the commencement of spinning, said our informants, the hinder part of the cocoon is seen to be stained a white color. This comes from the secretion of the Yama-mai which it emits after having finished spinning. The cocoons are then taken off the Kunogi, together with the leaves to which they are attached, and a small portion of the branches. They are then brought into the house, and placed upon shelves. About ten days subsequently the leaves are stripped off, and the cocoons, held by the lower and broader ends, are shaken. Those which do not rattle are considered to contain dead chrysalides, and after having been dried through the action of a charcoal brazier, are reeled. Those which rattle on being shaken are considered to be in good condition, and such of them as are to be reserved for seed are placed in trays, and the moths emerge in about twenty-five days from the time of spinning. The remainder are, of course, subjected to heat, in order to kill the chrysalides, and are reserved for reeling.

The moths emerge between 4 in the afternoon and night, and the great majority of the first moths are males. The proportion was stated to us to be 300 males to 10 females.* The males are then secured in the bell-shaped cages already mentioned, and as the females emerge, they are distributed among the males. It would be best, we heard, to place but one couple in a cage; in practice, however, several couples were put into the same, otherwise there would not be sufficient cages. One of the men said he had as as many as 500. The bottoms of the cages are then closed with paper. The coupling commences in the evening, and lasts ten or twelve hours,† after which the males are thrown away and die. It happens now and then that other males, coming from a distance, fly to the bars of the cages and couple with the females inside; these however are looked upon not as legitimate husbands, but as interlopers, and their presence or absence does not enter into the calculations of the rearers of this district. The females then lay their eggs, as already stated, on the bars of the cages. This operation lasts four or five days, the average number of eggs to each female being estimated at from 150 to 200. The females then die. The best eggs are those laid on the first two or three days, and it is considered preferable that the males which emerge on one evening should couple with the females which emerge on the following evening.

The same process which has already been described is then adopted with the new eggs.

The men to whom we spoke did not seem to trouble themselves much about the Uji. They all allowed that this parasite preys upon the chrysalis of the Yama-mai, and they considered that it was more prevalent after a rainy season. They even talked of *ten* Uji found in one chrysalis. To our questions as to how they knew whether it existed, and at what stage of the Yama-mai's life it was observable, we received the invariable answer, that they could only detect it after the worm had become a chrysalis, which did not rattle in the cocoon when the latter was shaken; that such chrysalides never turned into moths, and generally contained Uji.

With regard to other diseases, they stated that after the 4th rest dark spots sometimes come out upon the worms, which subsequently die before spinning: that they are also subject to attacks of diarrhœa, which prove fatal; that another disease shows itself by a watery fluid exuding from the pores, the worms turning a brown color and then dying. No particular names appeared to be given to these maladies. Our informants also said that if a considerable amount of rain falls whilst the egg-papers are attached to the Kunogi in the open air, the eggs are apt to be spoiled.

We were shown a species of creeping plant called *Tonzuru*, with leaves resembling those of the Convolvulus and a dark stem, which sometimes clings to the Kunogi. If the Yama-mai eats of these leaves, it is poisoned and dies at once.

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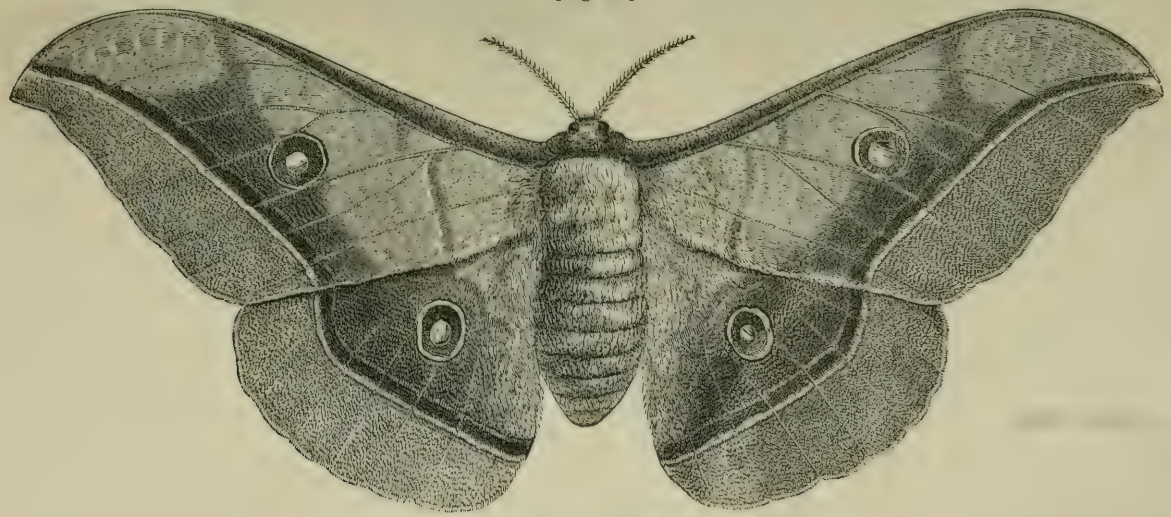
* It is not clear what our author here means; but probably that in a given lot of cocoons 300 males will appear by the time 10 females have issued. If he means that the sexes are proportioned as 300 ♂ to 10 ♀, then the statement is erroneous, as in a given lot the females predominate at last, so as nearly to equal the males in number.

† This is also most probably an error; for there is abundant evidence to show that coitus lasts seldom as long as an hour.

[Fig. 60.]



PERNYI MOTH, FEMALE.

THE PERNYI SILKWORM—*Attacus* [*Antheræa*] *Pernyi*, Guér-Mén.

(Lepidoptera, Bombycidæ)

[Fig. 61.]

This is also an oak-feeding species which has been introduced from Northern China, and it so closely resembles *yama-mai* that a few remarks by way of comparison with the latter, will serve my purpose.

It was named after M. Perny, a missionary who, in 1850, sent it to France from Mandchouria, China. It has been cultivated in Europe with better success than has attended the culture of *yama-mai*, and in this country the success with it has also been greater. It develops more rapidly than the *yama-mai* and differs essentially from that species in being double-brooded, and in passing the winter in the chrysalis state, like *cynthia* and our native species. This trait gives it agreat advantage over *yama-mai*, as not only can more silk be produced, but we can more easily obtain sound eggs. It is also less affected by confinement indoors. Its cocoon is not so valuable, though ranking third best of the eight species treated of.

The egg (Fig. 61, enlarged and natural size) is of about the same size, form and color. The worm in the first stage is of a chocolate-brown with the tubercles reddish and emitting reddish bristles. In the second stage it is yellowish-green; in the third and fourth it becomes greener, while silvery spots begin to show at the base of the anterior tubercles. In the last stage it is of a dark green with a faint reddish lateral line over the stigmata; the head and legs are light brown with black spots and the triangular anal mark is chocolate-brown. In form and general appearance it resembles *yama-mai*.

The cocoon (Fig. 61) is suspended by a cord which does not, however, materially effect its reeling properties, as it is attached only to the loose outer silk. The silk is yellowish-gray, stout, brilliant and valuable. It is almost twice as thick as that of *yama-mai* and stuffs made of it are said to have the appearance and nature of mixed silk, cotton and wool.

Some eggs which I received from Dr. Wallace, of England, in 1869, were so injured on the way hither that but few of them hatched, and none of the worms completed more than one moult. I have not, therefore, been able to present a figure of the worm, but through the courtesy of Dr. Wallace, who sent me specimens, I present good figures of the cocoon and moth. The moth (Fig. 60, female) bears a striking resemblance to *yama-mai*, and varies nearly as much in color. The tips of the front wings are generally a little more curved; there is less black about the eye-spots, the hind wings are less produced behind, so that their transverse band is more in a line with that of the front wings, and the ground color is usually darker and more uniform.

In China the species is reared in the open air in a wild state, and also in-doors on cut branches kept fresh by insertion in vessels containing water. In this country Mr. Andrews obtained cocoons from the first brood of worms by the 4th of July: the moths began to issue about three weeks later; copulation immediately ensued, and by the middle of August, or about ten days from the time of laying, the second brood of worms began to hatch. He also found that the worms would feed on Beech and Sweet gum.

The Tusseh Silkworm (*Attacus Mylitta=Antheræa Paphia*), an insect found in India, and which is quite common in the wild state, especially in Bahar, Assam and Bengal, feeding on the *Rhamnus jujuba*, is very closely allied to *Pernyi*, and should, perhaps, only be considered a geographical race. It bears the same relation to *Pernyi* as does the India castor-bean-feeding *ricini* to the Chinese ailanthus-feeding *cynthia;* and differs principally in the cocoon which is more solid, and hangs by a more solid, harder cord. It has never been introduced into America, though its silk is much used in its native country, and, if not put into hot-water, the goods made from it have a wonderful durability.

SUMMARY.

There can be no good reason given why silk-culture may not become one of the industries of this country, or of our State—especially if fostered at the start. I would, however, advise no one to enter into it on a large scale, as a business. The raising of silk is seldom lucrative, even in the most favorable countries; for in this as in most other industries, the principal profits accrue to the middle men, reelers and manufacturers; but on a small scale, and prosecuted in connection with other branches of Agriculture and Horticulture, it will give most desirable returns for the time employed. The erection of a few reeling establishments is absolutely necessary to establish this industry.

For in-door culture, no worm surpasses the Mulberry species (*mori*). For out-door culture none at present surpass the Ailanthus species (*cynthia*), though if *yama-mai* and *Pernyi* can once be acclimated, their cocoons are more valuable. Of the native worms *Polyphemus* is the most valuable and important, its silk being easily reeled and of excellent quality: *Cecropia* comes next in order, its silk being reeled with difficulty, while that of *Promethea* and *Luna* is of less value, has never yet been, and probably cannot be, reeled.

INNOXIOUS INSECTS.

THE HORNED PASSALUS—*Passalus cornutus*, Fabr.

(Coleoptera, Lucanidæ.)

[Fig. 62.]

Many an one will doubtless recognize in the insect illustrated at Figure 62, *c*, the "bug" with which he, or she, as a child, was wont to play at "oxen"—the curved horn on the head forming such an inviting projection on which to hitch, by means of a thread, small chips and other diminutive objects, to be dragged by the rather awkward beast of of burden. Every pioneer in this Western country, as he rolled over huge decayed logs, in the work of clearing his land to make it ready for the plow, must have become familiar with this highly polished coal-black beetle. Every woodsman who has split or grubbed an old stump, will be likely to recognize in this horned "bug" an old acquaintance. Every entomologist who has dug into or pulled to pieces old rotting stumps, in search for other treasures, must time and again have seen this lazy, clumsy *Passalus* tumbling down with the loose and crumbling dust and excreta of its own making, and expressing its disapproval of such summary disturbance in the plainest manner, by emitting a peculiar half-hissing, half-creaking noise. And though met with at almost every step in his forest rambles,

"Where wild birds sing beneath the leafy bowers,"

the inquisitive student has no doubt found himself repeatedly examining specimens, not only to admire the elegance and beauty of form, but to ascertain the means by which the peculiar noise is produced. A sufficiently careful examination will end in the knowledge that it is caused by the rubbing of the rather horny terminal joints of the abdomen, known as the *pygidium*, against the inside of the hard wing-covers.

This insect cannot be considered injurious in any sense of the word,

and might with propriety be introduced in the section of "Beneficial Insects." It is never found in sound or green wood, but invariably in that which is decaying; and it very materially assists and hastens the reduction of stumps which might otherwise remain treble the length of time to occupy valuable ground, and serve as an eye-sore to the careful farmer in wooded countries. Unseen and unheard it carries on incessantly the good work of converting useless timber into mould which enriches the soil; and this has been its office in all the past ages of its existence. A decaying, moist condition of the wood is necessary to its development, and it will be found most common on low moist ground, and in Oak, Hickory and Sweet gum logs or stumps.

Common as is this beetle, its larva and pupa are rarely seen, and seem to be unknown even to most entomologists, while no good figures of them have been published.

The larva (Fig. 62, *a*) is of a very exceptional character being the only one in this country which possesses but four well developed legs, for though many butterflies in the imago state have the front pair functionally impotent, no other insect than our *Passalus* exhibits a similar feature in the larva state. Indeed the only other larvæ in the whole Class of Insects which are similarly characterized, are those belonging to the same genus in other parts of the world. The third pair of legs really exists, however, in a rudimentary state, as shown at Figure 62, *d*. This larva is of a bluish-white color with the anterior joints broader and flatter than the rest. It transforms in the fall of the year, within the wood it inhabits, to a whitish pupa (Fig. 62, *b*) in which the front pair of legs is thrown forward under the head, and the horns of the future beetle show plainly on its top. The pupa lasts but about a fortnight, when, throwing off the pupal garb, it becomes a perfect beetle. At first the parts are all beautifully white and delicate; then the head, thorax and limbs gradually become amber-brown, and lastly the wing-covers assume this color. The whole body then deepens very gradually so that many days elapse before the coal-black color is acquired; and in the month of August the beetle is as often found brown as black. As larvæ only half grown are found in company with those that are full grown, they require at least two years to mature.

PASSALUS CORNUTUS Fabr.—*Larva*—Color bluish-white, with a dark medio-dorsal line; polished, with scarcely any hairs; 13 joints exclusive of head; slightly arched; the thoracic joints broader and flatter than the rest [though in alcoholic specimens they often appear the reverse]; joint 1 with a prominent neck-wrinkle underneath, and with a slight horny depression each side above, the prominences immediately outside of the depression being often marked with dark brown; abdominal joints, 4—11 inclusive, each with a broad, slightly elevated fold, occupying the hind ⅔ of the joint in the middle of the back, gradually increasing until at the sides it occupies the whole width of joint; 13th or anal joint, bulbous, as long or longer than any of the others; anus transverse, surrounded by triangular folds. *Head*, except the parts mentioned below as dark brown, light rust-brown; rather small; flattened above; smooth, with a few stiff lateral yellowish hairs springing from ocelli-like dots; antennæ 3-jointed, the basal joint broad, short; 2nd only half as wide and about the same length; 3rd brown, as long as 1 & 2 together and fusiform; epistoma large, transverse, divided in two by a brown transverse line; labrum smaller, transverse-oval, and sparsely furnished with stiff, yellow hairs; mandibles moderately large, with two sharp-pointed teeth at extremity and a larger single tooth inside; brown with the teeth black; maxillæ composed of a basal transverse piece, a stout cardinal piece; two inner lobes, well separated, pointed and curved inwardly in the same direction as the madibulary teeth and with their inner border fringed with stiff hairs; maxillary palpi 3-jointed, the

basal broadest, 2nd rather longest, 3rd brown, fusiform, constricted a little near the tip, and directed inwards; labium narrow, elongated, divided into 3 transverse pieces, the basal as long as the other two combined, the 3rd or palpigerous piece short and trapezoidal with a square, horny, brown plate extending between the palpi; labial palpi 2-jointed, joints of about equal length, the 2nd fusiform and directed inwards. *Legs*, well developed only on joints 1 and 2, being long, with a stout thigh, a slightly curved shank, and a fine-pointed horny claw; rudimentary on joint 3, consisting of a simple horny process, projecting obliquely outwards under the second pair of legs, and armed on the inside with 5 small blunt teeth (Fig. 62, *e*). *Stigmata* 9 in number, the first in a line with the others, on posterior portion of joint 1, the others on anterior portion of joints 4—11 inclusive. Average length 1.60 inches.

Described from one living, and two alcoholic specimens.

Madame Merian, in her work on the insects of Surinam, Pl. 50, has figured what purports to be the larva of *Passalus interruptus* with six legs, but as she has incorrectly figured, on the same plate, what is apparently a Lamellicorn larva for that of *Buprestis gigantea*, the probability is that her *Passalus* larva is equally spurious. Chapuis & Candéze (Catalogue des Larves des Coléopteres, 1853) describe and figure that of *P. distinctus* which, as in ours, has but 4 well developed legs. In their description they allow but 2 joints to the antennæ, and consider the joint which I have described as basal but a part of the head; in *cornutus* it is certainly well divided by sutures from the head. They likewise consider the anal joints 9 and 10 as but one, but, though bearing no stigmata, they are as thoroughly and distinctly segmented as are any other two joints of the body. I have not at hand the description of *cornutus* by Burmeister, to which they refer, but if he mentions more than nine pair of stigmata, as they indicate, he errs. Mr. Walsh (Proc. Ent. Soc. Phil., III, p. 559, note) speaks of the rudimentary legs being "decussated on the sternum." If the larva has the power of moving them, they may possibly be found in such a position but I have never seen them thus crossed.

Pupa—(Fig. 62, *b*) White, with all the parts of the beetle distinctly traceable, the head bent almost at right angles from the thorax, the jaws, enclosing the labrum, projecting prominently nearly in the same direction, and the front legs brought obliquely forward under them. The third pair of legs fully developed.

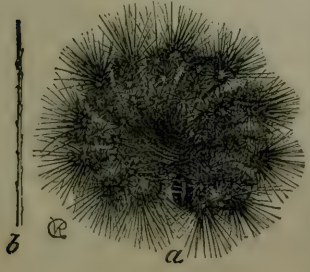
THE GREAT LEOPARD MOTH—*Ecpantheria scribonia,* Stoll.

(Lepidoptera, Arctiadæ.)

There is a large Family of moths, known as Arctians or Tiger-moths, which is rendered conspicuous by the beauty of design and boldness of contrast in color which its members generally present. There are two whose caterpillars are often seen, either rolled up cozily under some plant or crawling rapidly across a path, but which are not by any means generally known in their more beautiful and perfect states. They were both more than usually common the past year, and both have very similar habits. They neither of them can be considered injurious; but a brief account of their transformations, in this department of my Report, will doubtless please and gratify many an inquisitive reader, who has wondered what these "hedge-hog" caterpillars produce.

The species above-named is the largest, and perhaps the most beautiful of the Family in North America.

[Fig. 63.]



Its larva (Fig. 63) may be called the Large Black Bear, as the hairy worms of our different Arctians are popularly called bears, and the Family name was derived from the Greek word for "bear." It is often observed in the fall of the year, though few persons have ever seen the moth which it produces. This larva is black, and so thickly covered with jet black spines as almost to hide a series of roughened warts on each joint, from which the spines spring. When

disturbed, it curls itself up, and then the sutures of the joints are seen to be reddish brown, in strong contrast with the black of the rest of the body. If carefully observed, the spines will be seen to be barbed, as represented at *b*.

This worm feeds, mostly during the night, upon the wild Sun-flower (*Helianthus decapetalus*), the different species of Plantain (*Plantago*), and upon Willows. My friend J. A. Lintner, of Albany, N. Y., thinks it likewise feeds on Black Locust, as he has often found it beneath that tree and has fed it on the leaves. It comes to its growth in the fall, and curls up and passes the winter in any shelter that it can find, being especially fond of getting under the bark of old trees. In the spring, it feeds for a few days on almost any green thing that presents itself, and then forms a loose cocoon, casts its prickly skin, and becomes a chrysalis. The chrysalis is black, and covered with a beautiful pruinescence, which rubs off almost as readily as that covering a Duane's Early plum. It has a flattened blunt projection at the extremity, armed with a few barbs and bristles.

In a few exceptional instances I have known both this and the following species to go through all the transformations and produce the moth in the fall. The chrysalis state lasts but about a fortnight when the moth escapes.

[Fig. 64.]

The accompanying illustration (Fig. 64) represents the female moth at *a*, and the male at *b*. The upper portion of the abdomen is steel-blue, or blue-black, marked longitudinally along the middle and sides with yellow or orange. With this exception, the whole insect is white marked and patterned with dark brown, as in the figures. The male differs from the female principally in his smaller size and more acuminate wings, and by the narrower abdomen, which is also generally duller in color, with the pale markings less distinct. The markings on the wings, vary in a striking manner in different individuals, the oval or elliptical rings sometimes filling up, especially in the male, so as to look like black blots. This insect is considered rare in New England, but is much more common in the Mississippi Valley. It occurrs still more abundantly in the Southern swamps, where the larva is dubbed "Fever Worm" by the negroes, under the absurd impression that it is the cause of fever and ague.

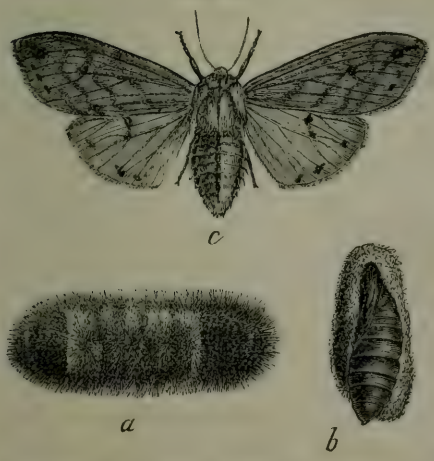
As an illustration of the wonderful power of resisting extreme cold, which this caterpillar possesses, I will quote the following experience communicated to me by Mr. Lintner. He says: "I had placed one for hybernation in a small keg among leaves, which I inserted in the ground. During my absence from home, either the thawing of the snow or the wind had overturned the keg, and driven away the leaves. On my return I found the larva remaining, but stiffly frozen, with its head encased in ice and fastened to the ground. As an experiment I detached a piece of the ground with the larva, and placed it in a warm room. On the thawing of the larva and the release of its head, it was restored to activity."

ECPANTHERIA SCRIBONIA, Stoll.—*Larva*—(I know of but one good description of this larva, and that by Mr. Wm. Saunders, in Proc. Ent. Soc., Phil., II, p. 29; but as that is not as full as it might be, I give the following): Average length 2½ inches. Head black, polished, brownish at sides and below; epistoma, antennæ and palpi more or less distinctly glassy white, the joints of antennæ marked with light brown, cervical shield brown-black. Body above black, inclining to brown laterally; bright reddish-brown at sutures, showing in strong contrast, especially between joints 3—10 when the larva is curled up, but scarcely visible when straightened and contracted. Verrucose warts arranged as follows: On joint 1, two each side of cervical shield; on jts. 2 and 3, a transverse row of 8; on jts. 4—11 inclusive 12, the 4 on dorsum trapezoidal, the two anterior ones approaching nearest; on jt. 12 a transverse row of 6. Venter dull purplish-brown, the legs of the same color, the legless joints with 4 small verrucose warts. Hairs barbed, stiff, spine-like and jet black.

THE ISABELLA TIGER MOTH—*Arctia Isabella,* Smith.

(Lepidoptera, Arctiadæ.)

[Fig. 65.]



The larva of this insect (Fig. 65, *a*) is very common with us and is familiarly known by the name of the Hedge-hog Caterpillar. It is thickly covered with stiff black hairs on each end and with reddish hairs on the middle of the body. These hairs are pretty evenly and closely shorn so as to give the animal a velvety look; and as they have a certain elasticity, and the caterpillar curls up at the slightest touch, it generally manages to slip away when taken into the hand. It feeds on Plantain, Clover, Dandelion, grasses, and a variety of other plants, and after passing the winter in some sheltered spot, rolled up like a hedge-hog, it comes out in the spring to feed upon the first herbaceous vegetation, and finally spins its cocoon (Fig. 65, *b* represents one cut open, giving a view of the chrysalis) and goes through its transformations. The cocoon is composed principally of the caterpillar's hairs (which are likewise barbed) interwoven with coarse silk. The chrysalis is brown with tufts of very short golden bristles, indicating the positions of the larval warts, and with a tuft

of barbs at the extremity. The moth is of a dull orange color, with the front wings variegated with dusky, and spotted with black, and the hind wings somewhat lighter and also with black spots.

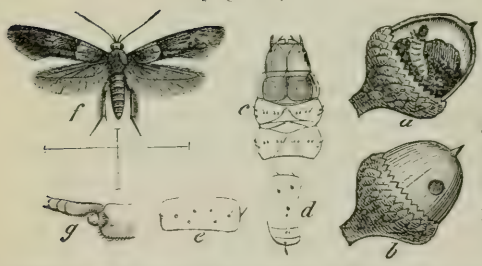
Mr. Huron Burt, of Williamsburg, informs me that this caterpillar is also called "Fever-worm" in his neighborhood. As the miasma of the Southern swamps induces ague, and as the large black species is found abundantly in such situations, the two circumstances have doubtless been associated through ignorance; and some Ethiopean, right from Dixie, has perhaps perpetuated the name in Missouri, by applying it to our more northern Hedge-hog Caterpillar.

Neither of these insects are, so far as known, attacked by any parasite, though a peculiar fungus-disease, probably identical with *Muscardine* in the Silkworm, (see p. 88) often causes the larvæ to die. Worms attacked with this disease fasten themselves firmly to some stem, and, stretched out naturally, death would scarcely be suspected were it not for a certain rigidity, and a mildew-like powder covering the skin.

THE ACORN MOTH—*Holcocera glandulella*, Riley.

(Lepidoptera, Tineidæ.)

[Fig. 65.]



The mast which is so valuable to the swine breeder in the oak-land sections of the State, is often very seriously affected and greatly diminished in quantity by the workings of the larva or "grub" of a species of long-snouted nut-weevil (*Balaninus rectus*, Say.) The female, with her long bill, pierces a hole in the young acorn, and deposits therein an egg which gives birth to a legless, arched grub with a brown head. This grub devours during the summer, the contents of the acorn, and in the autumn drops, with the rifled fruit, to the ground, where it soon gnaws its way out through a circular hole and buries itself for the winter. It becomes a pupa in the spring, and eventually issues as a beetle.

After the original depredator has vacated its tenement, a little guest-moth comes along and drops an egg into the already ruined acorn. The worm hatching from this egg grows fat upon the crumbs left by the former occupant, rioting amid the refuse (Fig. 66, *a*) and securing itself against intruders by closing with a strong covering of silk, the hole which its predecessor had made in egress (Fig. 66, *b*). In the winter time, or in spring, or early summer, the farmer who notices three-fourths of the acorns under his trees infested, as they have been for the past two years, by this worm; is very apt to consider it the true culprit, whereas it is rarely, if ever, found in acorns that have not first been ruined by the weevil above mentioned or injured by some other insect, or in some other way.

This after-comer is of a yellowish or grayish-white color, often with dark marks on the back, a light brown head, and a horny piece of the same color on the first and last joints, and small hair-emitting dusky points over the body (see Fig. 66, *c*, *d*, *e*). It is, withal, easily distinguished from the weevil larva by its full complement of six true and ten false legs. It changes to the chrysalis within its borrowed domicile, and the chrysalis gives forth the moth by first pushing partly through the silken door.

The moth (Fig. 66, *f*, ♀) is ash-gray in color, and characterized chiefly by two distinct spots near the middle of the front wings and a transverse pale stripe, well relieved behind, across their basal third. The male differs from the female by the basal joint of his attennæ being much flattened and articulating with the stalk by means of a nodule (Fig. 66, *g*). The moths issue all along from the end of April till September. They vary much in size and conspicuity of design. The following description of the species was first published in the *Canadian Entomologist* (Vol. IV, pp. 18—19).

HOLCOCERA GLANDULELLA, Riley, (Fig. 66, *f*, ♀)—*Imago.*—Alar expanse 0-50—0.80 inch. Front wings silvery-gray, more or less distinctly suffused and marked with fuscous: two distinct dark discal spots; a pale transverse stripe across the basal third of wing, slightly elbowed outwardly at its middle; this stripe is well relieved behind by a dark shade, and this shade generally extends from the elbow to the costa above discal spots, forming a more or less distinct triangular shade in the anterior middle portion of wing: three tolerably distinct dusky spots surround the discal dots on the outside; and a series of minute vein-specks mark the posterior margin; fringes concolorous. Hind wings of a more glossy, warmer, brownish-gray, the reflection inclining to golden in certain lights; fringes concolorous but not glossy. Under surface uniformly of same tint as hind wings. Head, thorax and legs concolorous with front wings; abdomen with hind wings, the joints often ringed with a paler shade: Apical joint tipped with yellowish or pale pulvous hairs, the ovipositor of ♀, which may be exserted one-half the length of abdomen, of same color. The basal antennal joint of ♀, the nodule on ♂ attennæ, base of palpi, and sometimes tarsi, also tinged with fulvous.

Described from 8 ♀s, 20 ♂s, all bred from acorns. The intensity of the dark shadings is quite variable, and in some specimens the basal space shows decidedly paler than the rest of wing.

Larva—Length 0.35—0.50 inch. Largest in middle of body. Translucent grayish-white, or yellowish, with blue-black vesicular dorsal marks. A conspicuous light brown head and cervical shield, and dusky anal plate. Head with the mouth parts darker, and the sutures and margins likewise darker and well defined. Piliferous spots small but quite noticeable from being brown, the hairs springing from them pale and soft. The dorsal ones on joints 2 and 3 are geminate and in a transverse row (*i. e.* there are 4 pair, Fig. 66, *c*), while at the sides of these joints there are three triangularly arranged, the front one sometimes double. Joints 4—12 with four, which are dorsal, nearly in a square, the hind pair farthest apart (Fig. 66, *e*), two which are lateral in a transverse line with stigmata (Fig. 66, *d*), the lower sometimes double, and one which is subventral in middle of joint. Stigmata small and bright rufous. Legs same color as body, the thoracic tipped with brown, the prolegs with a ring of minute brown hooks.

Described from numerous specimens.

Pupa—Light brown, smooth, with no characteristic marks.

ERRATA.

Page 112, in the heading, for "Hübn." read "Drury."
Several foreign words are not properly accented for lack of proper types.

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Fifth Annual Report on the Noxious, Beneficial, and other Insects of the State of Missouri, *made to the State Board of Agriculture, pursuant to an Appropriation for this purpose from the Legislature of the State.* By Charles V. Riley, State Entomologist. Jefferson City, 1873. 8vo, pp. 160, and index, pp. viii. ; figs.

We lay special stress on the fact that the present is the fifth of a series of reports concerning applied entomology, due to the annual vote of funds granted for the purpose by the enlightened members of the Missouri State Board of Agriculture. We congratulate these gentlemen on their good luck in being able to retain the meritorious services of Mr. Riley, than whom a more efficient and more devoted scientist could not be easily met with. Not many Commonwealths are as yet far-seeing enough to spend in five years 10,000 dols. for the sole purpose of furthering the practical acquaintance with the habits of insects injurious to human economy in all its various bearings. Missouri has done it. This honourable mention is praise enough. The present report contains an easy and yet solid introduction to the study of entomology, its relations to agriculture, and its advancement, combined with brief instructions for collecting, preserving, and studying insects. This chapter is followed by notes of the year on noxious insects, which form the *pièce de résistance* of the treatise, comprising natural history facts, means of prevention, &c., of such well known pests as the Codling Moth, the Colorado Potato Beetle, the Grape Vine Phylloxera, the Bark Louse of the Apple, and a host of other creatures less known to fame, but not less destructive, and many of which may possibly at some time or other, under favourable conditions, literally eat themselves into public notice, when we doubt not that the paragraphs here devoted to particulars of their private life will find eager readers. Succeeding pages are devoted to papers on insects injurious to the Grape Vine, namely, to four distinct minute gall midges, causing galls on different parts of the Vine; to the description of various insect eggs found in or on canes and twigs of sundry plants, to the life-histories of several moths, &c. Then follow two papers on innoxious, but interesting, insects, such as the curious neuropterous Hellgrammite fly, and the Goat Weed Butterfly; and last, but not least, we are gratified by Mr. Riley's most interesting discovery of the very close quasi-clerical relations which exist between a newly described small moth and the well-known genus Yucca, the female of the former acting as "marriage priest" to the latter by carrying its pollen into the stigmatic tube. It appears from Dr. Engelmann's observations, quoted by Mr. Riley, that the plants of the genus Yucca must rely on some insect or other for fertilisation. The sagittate anthers open a little earlier than does the perianth, and expel the pollen grains, which, being glutinous, remain attached in different sized lumps to the inside of the flower. The stigmatic tube contains nectar, and is connected with the ovarian cells, and the pollen must be introduced into the tube, but cannot be so introduced without artificial aid. (*Report*, p. 153.) Mr. Riley fully enters into the curious circumstances which oblige the moth to fertilise the Yucca while providing a proper supply of food for her larvæ, which live on its seeds. Space forbids us here to enter into details, but we cordially recommend this part of the report to such gardeners on both sides of the Atlantic as have the care of Yucca plants. In Europe especially we should be glad to learn which moth replaces the American species in its beneficial functions to the plant. In conclusion, we wish the author of this *Report* all possible success in his useful career. He bids fair to be a worthy member of the same stock which has given to the world a Curtis and a Westwood.
Alb. M.

FIFTH ANNUAL REPORT

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OF THE

STATE OF MISSOURI,

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

BY CHARLES V. RILEY,
State Entomologist.

JEFFERSON CITY:
REGAN & CARTER, STATE PRINTERS.
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PREFACE.

To the Members of the Missouri State Board of Agriculture:

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

The year has been one of abundance, and no one insect has attracted unusual attention or caused very serious alarm. Some, which were unknown and unobserved before, have figured rather prominently, but the great enemies of our staple products have been comparatively harmless, as the sequel will show.

I have given more time than in previous years to lecturing, having responded to the calls of many of our own Agricultural and Horticultural societies, of the Kirksville Normal School, and—outside the State—of Cornell University, N. Y., and of the Kansas State Agricultural College at Manhattan.

It has been a source of true gratification to find my work more and more appreciated, as evidenced in the increasing demand for these Reports, and the more enlightened warfare against noxious insects, which is so noticeable in many sections; and I can not, here, help expressing the wish that our Legislature may be induced to provide for the printing of an extra thousand separate and paper-bound copies of this part of your Report, to meet the increasing demand. Your Secretary is often petitioned for the Entomological Report, which he must needs send with the whole bound Report of the Board, and thus incur unnecessary expense; or else not send at all.

All the figures are made by myself from the natural objects, and mostly engraved by Emil Lampe, and Wm. Mackwitz, of St. Louis.

As in former reports, the older and more familiar generic names are generally employed, and the names in brackets indicate the genera to which the insects are referred in more modern systems.

The name of the author of the species, and not of the genus, is given as authority; and in order to indicate whether or not the insect was originally described under the generic name which it bears, I have adopted, for the first time, the following plan: When the specific name is coupled with the generic name under which it was first published, the describer's name is attached without a comma—thus indicating the authorship of the dual name: e. g. *Phycita nebulo* Walsh. But when a different generic name is employed than that under which the insect was first described, the authorship is inclosed in parenthesis, thus—*Acrobasis nebulo* (Walsh); except where the whole name is already in parenthesis, when a comma will be used for the same purpose: e. g. (*Acrobasis nebulo*, Walsh).

My office is still at Room 29, Insurance Building, south-east corner of Fifth and Olive streets, St. Louis; where all communications should be sent.

My thanks are due to many friends, but more especially to Mr. Otto Lugger and Miss Mary E. Murtfeldt, who have aided me in experiments, and assisted in other ways during my absence from home.

I also thankfully acknowledge the receipt of free passes over the following railroads: St. Louis and Iron Mountain, Missouri Pacific, Atlantic and Pacific, Hannibal and St. Joseph, North Missouri, Chicago and St. Louis, and Illinois Central.

Respectfully yours,

CHARLES V. RILEY,

State Entomologist.

St. Louis, Mo., *December* 2, 1872.

ENTOMOLOGY.

ITS RELATIONS TO AGRICULTURE AND ITS ADVANCEMENT.

With brief Instructions for Collecting, Preserving and Studying Insects.

[The following is an amplification of an article published by me in Campbell's New Atlas of Missouri. I incorporate it with this my Fifth Report at the suggestion of members of the Board and others, who think that something of the kind will form a desirable prelude to the Report proper. Judging from the letters of inquiry which reach me day by day, especially with reference to the collecting, preserving and studying of insects, interest in the subject of Entomology is fast increasing in Missouri and the other Western States, and the demand for elementary knowledge increases *pari passu* with the interest manifested. Already in our sister State of Illinois, teachers in the public schools are required to be qualified to instruct in the natural sciences, and natural knowledge is receiving more nearly its due in the schools of our own and of other States, and in the agricultural colleges. It is my desire that Entomology receive its share of attention, and, so soon as leisure permits, I hope to prepare a manual for the special use of these schools, and of which the following prodrome is a mere outline.]

DEFINITION OF ENTOMOLOGY.

It would seem almost superfluous to define the meaning of this word; but from the many letters that come to me addressed "State Etymologist," it is evident that there are those who yet imagine that my office is somehow or other connected with philological science. For the benefit of such, then, Entomology is derived from the Greek, (εντομον, insect; λογος, discourse,) and constitutes that branch of Natural Science which treats of Insects.

WHAT, THEN, IS AN INSECT?

The term "Insect" is derived from the Latin *insectum*, which signifies "cut into," and expresses one of the chief characteristics of this class of animals; but we can only obtain an intelligent idea of what constitutes an insect by comparison with other animals.

THE ANIMAL KINGDOM.

Animals are variously classified by zoölogists, but the best known and most comprehensive system of classification is that called the Cuvierian, which separates them into four great Branches or Subkingdoms. These are again divided into Classes, Orders, Families, Genera, Species and Varieties, each division being frequently subdivided into minor groups. The four Subkingdoms are:

1—VERTEBRATA or Backbone Animals, comprising the four respective classes of *Mammalia* (mammals), *Aves* (birds), *Reptilia* (reptiles), and *Pisces* (fishes). Normally these all have four limbs, and an internal skeleton to which the muscles are attached.

2—ARTICULATA or Jointed or Segmented Animals, comprising the five classes of *Insecta* (insects), *Arachnida* (spiders, mites, etc.), *Crustacea* (crabs, lobsters, etc.), *Myriapoda* (thousand-legged worms), and *Annelida** (true worms, as leech, earthworm, etc.).

These animals are readily distinguished by their jointed or segmented nature. It is plainly seen in a caterpillar as it crawls along; each joint moves one after the other, with its own peculiar motion; each has its separate set of organs, so that a caterpillar may be said to have a head and 12 distinct bodies attached, for which reason it has 4,000 muscles to move its body, while man has only 529. The jointed character is seen even in the Earthworm and in the Leech, but not in the slug, which is a Molluscous—not an Articulate animal. Articulates are further characterized by having no internal skeleton; they wear their skeleton on the outside, and every one must have noticed the close resemblance which the exterior of the limbs of a grasshopper or of a lobster bears to the bones of our own limbs or to those of other Vertebrates. Sidney Smith wished that, in hot weather, he could put off his flesh and sit in his bones. He ought to have been an Articulate! It is true that some Articulates, and almost all insects in their young and larval days, have this outer skeleton quite soft and delicate; but the same may be said of the internal skeleton of Vertebrates. We may crush and crunch with ease the bones of a newly hatched chick; but he who would undertake to do likewise by those of an old rooster, would, I fancy, have a rather tough job of it!

3—MOLLUSCA or Soft-bodied Animals. These are without distinct joints, and have neither internal nor external skeleton, the surface being soft, flexible and retractile, and often covered with calcareous deposits which assume a variety of different forms.

*Rolleston (*Forms of Animal Life*—a work propounding a more modern system of classification, which, though less simple than the Cuvierian, every zoölogist should study), makes of the *Articulata* two subkingdoms: 1st, ARTHROPODA (ἄρθρον, joint; ποδός, foot), including the tracheate *Insecta, Myriapoda* and *Arachnida* and the branchiate *Crustacea;* 2nd, VERMES, including five Classes—thus separating the articulates without legs from those which have legs.

4—RADIATA or Star Animals. These have the body arranged on the plan of an asterisk (*), radiating from a common center. They are often called Zoöphytes, and comprise the very lowest animals—some of which, as the sponges, corals, etc., were for a long time considered plants, and do, indeed, connect the Animal and the Vegetal Kingdoms.

With the exception of a few Molluscous snails and slugs, the animals of the last two Branches live almost entirely in water, and we see that an Insect belongs to the second great Branch, and that it shares the jointed or articulate structure in common with the other animals of that Branch. Wherein, then, does it differ from them? Briefly, in having only 13 joints to the body,* including the head as a joint, and in the adult stage 6 true, jointed legs, and usually (not always) wings. The five classes of Articulates differ from each other in the number of legs they possess in the adult form, as follows: *Insecta*, 6 legs; *Arachnida*, 8; *Crustacea*, 10–14; *Myriapoda*, more than 14; *Annelida*, none.

I say TRUE legs and in the ADULT form, because there are some mites (Class *Arachnida*) which, when young, have six legs only, while many insects have additional legs in their preparatory or adolescent stages, which are not jointed, but membranous, and are lost in the perfect stage: these are called false, sham, or prolegs.

Insects are further characterized by having the body divided into three distinct parts: the *head*, which bears the sense organs; the *thorax*, which bears the organs of locomotion; and the *abdomen*, which bears the reproductive organs. They also undergo a series of molts, and exist in four distinct stages: 1st, the *egg* stage; 2nd, the *larva* (meaning masked—the future and ultimate form being usually masked or hidden, so far as external appearance goes) or active stage; 3rd, the *pupa* (sometimes called chrysalis or nymph) or usually quiescent stage; 4th, the *imago* or perfect stage, in which alone the wings appear. To be brief, then, I would give the following definition of an Insect: *A 13-jointed, 6-legged animal, with an external skeleton; undergoing transformations or metamorphoses, and breathing through spiracles (breathing holes) which lead to tracheæ (air tubes): the body in the adult divided into three distinct parts (head, thorax and abdomen); with or without wings.*†

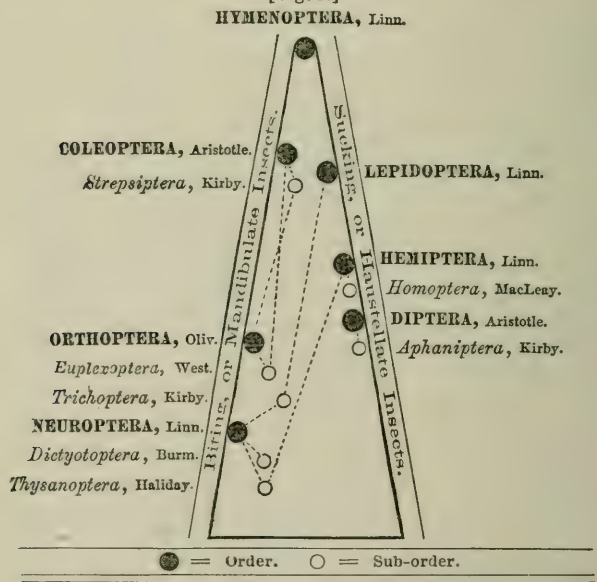
*An additional subjoint is often apparent, and sometimes very fully developed, as, for instance, in the larva of *Passalus cornutus* (4th Rep., Fig. 62, *a*).

†I fancy the exclamation from some curious reader—"Well, why, if the possession of 13 joints and 6 articulate legs be so true a test of an insect, do some authors include the spiders and thousand-legged worms in the same Class and call them insects? Does not Packard in his 'Guide to the Study of Insects' give us in his first figure a 21-jointed larva as typical of the Class, and does he not give us three Orders in the Class, elevating the *Arachnida* and *Myriapoda* to the same rank as *Insecta*; and has not this arrangement the sanction of such eminent men as Agassiz and Dana?" It is true, there is some dispute as to how many *typical* joints the head of insects is composed of, Packard himself arriving at different conclusions in the first and third editions of his work; while the figure referred to might convey the impression above expressed. But all the discussion on the first head is more or less hypothetical, and the larva represented by the figure referred to is only *apparently* 21-jointed, being that of

CLASSIFICATION.

This subject may be disposed of in few words, though we can not speak intelligently of insects, without some idea—however general—of their relations. In treating a subject about which so much has been written, the study should be what *not* to say, rather than *what* to say. All insects, as just defined, are referable to one or the other of seven well-defined Orders, founded on the structure of the mouth in the imago, the number and nature of the wings and the transformations. Some of these Orders are, however, connected by aberrant and osculant families, or groups, which have, by certain authors, been ranked as independent Orders; but which it will be more convenient —if not more natural—to consider Suborders. In my lectures I have found it very convenient to make use of the following pyramid, (Fig. 1), which gives at a glance the distinguishing characters and the relative rank of these seven Orders and of the osculant groups:

[Fig. 1.]



Pyramid showing the nature of the mouth, and relative rank of the Orders, and the affinities of the Sub-orders of Insects.

Scenopinus, and, as explained by Packard himself, (*Guide*, p. 401), remarkable for the double-segmented appearance of all the abdominal joints, except the last one, so that the body appears to have 21 instead of 13 joints. As to the different classifications, authors have differed in the past and will differ in the future, as to what constitutes a natural system; and to attempt to harmonize or even consider the various plans would be to discuss words and not things. Remembering that classifications are but means to an end—appliances to facilitate our thought and study; and that, to use Spencer's words, "we can not by any logical dichotomies, accurately express relations which in nature graduate into each other insensibly," the difference of opinion becomes intelligible; and for my part I adopt that system which appears most natural, and which best promotes the object in view. It is essentially that of Westwood, given in his "Introduction," which has justly been called the entomologist's bible. Those who include the *Arachnida* and *Myriapoda* in the same Class with Insects, must particularize the latter

[Fig. 2.]

BEMBEX FASCIATA.

1—HYMENOPTERA (υμην, a membrane; πτερα, wings), Clear or Membrane-winged Flies. Bees, Wasps, Ants, Saw-flies, etc. Characterized by having four membranous wings with comparatively few veins (Fig. 2), the hind pair smallest. The transformations are complete: i. e., the larva bears no resemblance to the perfect insect.

Some of the insects of this Order are highly specialized, and their mouth parts are fitted both for biting and sucking, and in this respect they connect the mandibulate and haustellate insects. The common Honey-bee has this complex structure of the mouth, and if the editors of our agricultural papers would bear the fact in mind, we should have less of the never-ending discussion as to whether bees are capable of injuring fruit at first hand. The lower lip (*labium*) is modified into a long tongue, sheathed by the lower jaws (*maxillæ*), and they can sip, or, more properly speaking, lap up nectar; while the upper jaws (*mandibulæ*), though not generally used for purposes of manducation, are fitted for biting and cutting. The Hymenoptera are terrestrial, there existing only a very few degraded, swimming forms.

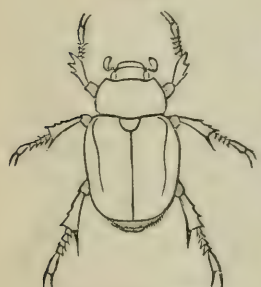
This Order is very naturally divided into two sections — the *Aculeata* and *Terebrantia*. The aculeate Hymenoptera, or Stingers, comprise all the families in which the abdomen in the female is armed with a sting connected with a poison reservoir, and may be considered the typical form of the Order, including all the social and fossorial species. The insects of this section must be considered essentially beneficial to man, notwithstanding the occasional sting of a bee or wasp, the boring of a carpenter-bee, or the importunities of the omnipresent ant. Not only do they furnish us with honey and wax, but they play so important a part in the destruction of insects injurious to vegetation that they may be looked upon as God-appointed guards over the vegetal kingdom — carrying the pollen from plant to plant, and insuring the fertilization of diœcious species, and the cross-fertilization of others; and being ever ready to clear them of herbivorous

as hexapods or hexapod insects, and relegate the long-accepted natural Orders to the rank of Suborders. This departure from stricter definitions is defended principally on embryological data, which though of great value as pointing to the derivation of insects—their homologies and relations to the past—do not always subserve the best interests of classification. It would be absurd, for instance, to class man with the reptiles or fishes, because, embryologically, up to a certain stage he can not be distinguished from members of those Classes; and we should, for the most part, confine ourselves to mature forms and external characters in classification. Finally, insects proper, (as defined in the italics,) spiders and millipeds have so many characters that are not common to all, that it is very inconvenient to consider them as belonging to one Class. This inconvenience—not to say incorrectness—is apparent in the writings of many of those who adopt the plan; for their general descriptions of the organs and parts of an INSECT, and especially of the three great divisions into head, thorax and abdomen, apply solely to hexapod articulates, and can not apply to the *Arachnida*, which have but two, or to the *Myriapoda*, which have no great divisions of the body. It is no wonder, therefore, that in separating the *Arachnida* from *Insecta*, Lamarck has been so generally followed. Perhaps, as has been suggested by Dr. Packard in the third edition of the excellent work referred to, these three divisions might best be considered Subclasses.

worms which gnaw and destroy. The whole section is well characterized by the uniformly maggot-like, legless nature of the larva. The transformations are complete, but the chitinous larval covering is often so very thin and delicate that the budding of the members, or gradual growth of the pupa underneath, is quite plainly visible, and the skin often peels off in delicate flakes, so that the transition from larva to pupa is not so marked and sudden as in those insects which have thicker skins.

The terebrantine Hymenoptera, or Piercers, are again divisible into two subsections: 1st, the ENTOMOPHAGA, which are likewise, with the exception of a few gall-markers, beneficial to man; 2d, the PHYTOPHAGA, comprising the Horn-tails (*Uroceridæ*), and the Saw-flies (*Tenthredinidæ*), all of which are vegetable feeders in the larva state, those of the first family boring into the trees, and those of the second either feeding externally on leaves, or inclosed in galls. They are at once distinguished from the other Hymenoptera by the larvæ having true legs, which, however, in the case of the Horn-tails, are very small and exarticulate. The larvæ of many Saw-flies have, besides, prolegs, which are, however, always distinguishable from those of Lepidopterous larvæ by being more numerous and by having no hooks.

[Fig. 3.]



COTALPA LANIGERA.

2—COLEOPTERA (*Κολεος*, a sheath; *πτερα*, wings), Beetles or Shield-winged Insects. Characterized by having four wings, the front pair (called *elytra*) horny or leathery, and usually united down the back with a straight suture when at rest, the hind ones membranous and folded up under the elytra when at rest (Fig. 3). Transformations complete.

This is an Order of great importance, and in the vast number and diversity of the species comprised in it outranks any of the others. The ease with which the insects of this Order are obtained and preserved makes it one of the most attractive to the amateur, and beetles are, perhaps, of all insects, the best known and understood in the popular mind. For the same reason they have, in the perfect state, received most attention from entomologists; but their transformations and preparatory forms yet offer a wide and inviting field for the student. The simplest and best-known classification of the beetles is the tarsal system, founded on the number of joints to the tarsi, by which we get four great sections: 1, PENTAMERA, in which all the tarsi are 5-jointed; 2, HETEROMERA, with the four anterior 5-jointed and the two posterior 4-jointed; 3, PSEUDO-TETRAMERA, with apparently only 4 joints to all the tarsi, though, in reality, there is a fifth penultimate joint, diminutive and concealed; 4, PSEUDO-TRIMERA, with apparently only 3 joints to all the tarsi. This system, like most others, is not perfect, as

there are numerous species not possessing five joints to the tarsi belonging to the first section; and for practical purposes beetles may be very well arranged according to habit. We thus get, 1st, the ADEPHAGA, or carnivorous species, including all those which prey on other living insects, and to which, following Mr. Walsh, I have, for obvious reasons, applied the suggestive term "Cannibal"; 2d, the NECROPHAGA, comprising those which feed on carrion, dung, fungi and decaying vegetation; 3d, the PHYTOPHAGA, embracing all those feeding on living vegetation. This arrangement is by no means perfect, for there are beetles which are carnivorous in the larva and herbivorous in the imago state; while some of the *Necrophaga* are actually parasitic. Yet, it is not more artificial than others which have been proposed. The carnivorous species, broadly speaking, are *Pentamerous*, the only striking exception being the *Coccinellidæ* (Lady-birds), which are *Pseudo-trimerous.* The carrion-feeders are also *Pentamerous;* but vegetable-feeders are found in all the tarsal divisions, though the *Pseudo-tetramera* are the more essentially herbivorous, and consequently the most injurious.

[Fig. 4.]

DEIOPEA BELLA.

3—LEPIDOPTERA (λεπις, a scale; πτερα, wings), Butterflies and Moths, or Scaly-winged Insects. Characterized by having four branching-veined, membranous wings, each more or less densely covered on both sides with minute imbricated scales which are attached by a stalk, but which easily rub off, and appear to the unaided eye like minute particles of glistening dust or powder. Transformations complete. (Fig. 4.)

Next to the *Coleoptera*, the *Lepidoptera* are, perhaps, most familiar to the popular mind. Every one admires the beauty of these frail creatures, dressed in every conceivable pattern, and adorned with every conceivable color, so as to rival the delicate hues of the rainbow, and eclipse the most fantastic and elaborate designs of man. When magnified, the scales, to which this beauty of pattern and coloring is entirely due, present all manner of shapes, according to the particular species or the particular part of the individual from which they are taken. According to Lewenhœck, there are 400,000 of these scales on the wing of the common silk-worm.

The transformations of these insects are complete, and the changes are usually so sudden and striking, as to have excited the wonder and admiration of observers from earliest times.

The more common form of the larva is exampled in the ordinary caterpillar—a cylindrical worm with a head, twelve joints and a subjoint; six thoracic or true legs, four abdominal and two anal prolegs. But there is a great variety of these larvæ, some having no legs whatever, some having only the jointed legs, and others having either

four, six, eight or ten, but never more than ten, prolegs. With few exceptions they are all vegetable feeders, and, with still fewer exceptions, terrestrial. The perfect insects make free use of their ample wings, but walk little; and their legs are weak, and not modified in the various ways so noticeable in other orders, while the front pair in some butterflies are impotent.

As an Order this must be considered the most injurious of the seven.

A convenient system of classification for the *Lepidoptera* is based on the structure of the antennæ. By it we get two great sections: 1st, Butterflies (RHOPALOCERA); 2nd, Moths (HETEROCERA), which latter may again be divided into Crepuscular and Nocturnal Moths. Butterflies are at once distinguished from moths by their antennæ being straight, stiff and *knobbed*, and by being day-flyers or diurnal; while moths have the antennæ tapering to a point, and are, for the most part, night-flyers or nocturnal. The crepuscular moths, composed mostly of the Sphinges or hawk-moths, hover over flowers at eve, and not only connect the two sections in habit, but in having antennæ which first thicken toward the end, and then suddenly terminate in a point or hook.

[Fig. 5.]

EUSCHISTES PUNCTIPES.

4—HEMIPTERA (ἥμισυ, half; πτερα, wings), Bugs. The insects of this Order are naturally separated into two great sections: 1st, Half-winged Bugs, or *Heteroptera* (ἕτεροῖς, different; πτερα, wings) having the basal half of the front wings (called *hemelytra*) coriaceous or leathery, while the apical part is membranous. The wings cross flatly over the back when at rest. (Fig. 5.) 2d, Whole-winged Bugs or *Homoptera* (ὁμός, equal; πτερα, wings), having all four wings of a uniform membranous nature and folding straight down the back when at rest. (Fig. 6.) The latter, if separated, may be looked upon as a Suborder.

[Fig. 6.]

CERESA BUBALUS.

Transformations incomplete: *i. e.*, the larva has more or less the image of the perfect insect, and differs little from it except in lacking wings.

The genuine or Half-winged Bugs are usually flattened in form when mature, though more rounded in the adolescent stages. They may be divided into Land Bugs (AUROCORISA) and Water Bugs (HYDROCORISA). The species of the first division very generally possess the power of emitting, when disturbed or alarmed, a nauseous, bed-buggy odor, which comes from a fluid secreted from two pores, situated on the under-side of the metathorax. Such well-known insects as the Bed-bug and Chinch-bug belong here. The habits of the species are varied, and while some are beneficial, others are quite injurious to man.

The Whole-winged Bugs, on the contrary, are all plant-feeders, and with the exception of a few, such as the Cochineal and Lac insects, are injurious. The secretion of a white or bluish, waxy or farinose substance, from the surface of the body, is as characteristic of this section as the nauseous odor is of the first. It forms three natural divisions, arranged according to the number of joints to the tarsi—namely, TRIMERA, with three joints; DIMERA, with two joints, and MONOMERA, with one joint to the tarsi.

[Fig. 7.]

ASILUS MISSOURIENSIS.

5—DIPTERA (δις, twice; πτερα, wings) or Two-winged Flies. The only Order having but two wings, the hind pair replaced by a pair of small, slender filaments clubbed at tip, and called halteres, poisers, or balancers. (Fig. 7.)

No Order surpasses this in the number of species or in the immense swarms of individuals belonging to the same species which are frequently met with. The wings, which are variously veined, though appearing naked to the unaided eye, are often thickly covered with very minute hairs or hooks. As an Order, the *Diptera* are decidedly injurious to man, whether we consider the annoyances to ourselves or our animals, of the Mosquito, Buffalo-gnat, Gad-fly, Breeze-fly, Zimb or Stomoxys, or the injury to our crops of the Hessian-fly, Wheat-midge, Cabbage-maggot, Onion-maggot, etc., etc. There are, in fact, but two families, *Syrphidæ* and *Tachinidæ*, which can be looked upon as beneficial to the cultivator, though many act the part of scavengers. No insects, not even the Lepidoptera, furnish such a variety of curious larval characters, and none, perhaps, offer a wider or more interesting field of investigation to the biologist. It is difficult to give any very satisfactory arrangement of these Two-winged flies, though they easily fall into two rather artificial sections. These are: 1st, NEMOCERA, or those with long antennæ, having more than six joints, and palpi, having four or five joints. The pupa is naked, as in the *Lepidoptera*, with the limbs exposed. This kind of pupa is called *obtected*. 2d, BRACHOCERA, or those with short antennæ, not having more than three distinct joints, and palpi with one or two joints. The pupa is mostly *coarctate*, *i. e.*, is formed within, and more or less completely connected with, the hardened and shrunken skin of the larva.

The most anomalous of the Diptera are the Forest-flies and Sheep-ticks (*Hippoboscidæ*). They have a horny and flattened body, and resemble lice in their parasitic habits, living beneath the hairs of bats and birds. Their mode of development has always attracted the attention of entomologists. The larvæ are hatched in the abdomen of the female, which is capable of distention. There it remains, and, after assuming the pupa state, is deposited in the form of a short, white,

egg-like object, without trace of articulation, and nearly as large as the abdomen of the parent fly. Closely allied to these are the Bat-ticks (*Nycteribidæ*), which possess neither wings nor balancers, and remind one strongly of spiders.

In this Order we may also place certain wingless lice (such as *Braula cœca*, Nitzsch — figured by Packard), which infests the Honey-bee in Europe, but which has not yet been detected in this country.

[Fig. 8.]

ŒDIPODA DIFFERENTIALE.

6 — ORTHOPTERA (ορθος, straight; πτερα, wings) or Straight-winged Insects. Characterized by having the front wings (called *tegmina*,) straight and usually narrow, pergameneous or parchment-like, thickly veined and overlapping at tips when closed: the hind wings large and folding longitudinally like a fan. (Fig. 8.) Transformations incomplete.

The insects of this Order have a lengthened body and very robust jaws, with a correspondingly large head. The legs are strong, and fashioned either for grasping, running, climbing, jumping or burrowing. As in the other Orders where the transformations are incomplete, the young differ little from the parent, except in the want of wings; and in many instances even this difference does not exist, as there are numerous species which never acquire wings. There are no aquatic *Orthoptera*. Some are omnivorous, others carnivorous, but most of them herbivorous. They form four distinct sections: 1st. CURSORIA, cockroaches; 2d. RAPTATORIA, Mantes; 3d. AMBULATORIA, Walking-sticks; 4th. SALTATORIA, Crickets, Grasshoppers and Locusts.

[Fig. 9.]

LIBELLULA TRIMACULATA.

7—NEUROPTERA (νευρον, nerve; πτερα, wings) or Nerve-winged insects. Characterized by having the wings reticulate with numerous veins so as to look like net-work. (Fig. 9.) The Order forms two natural divisions, the first including all those which undergo a complete, and the second, called *Pseudo-neuroptera*,(=*Dictyoptera*, Burmeister), those which undergo an incomplete metamorphosis. The latter, when separated, may be considered a suborder. The insects of this Order are, as a whole, more lowly organized, and more generally aquatic than either of the others. A natural arrange-

ment of them is difficult, on account of their degradational character. They present forms which are synthenic and closely approach the other Orders, and the evolutionist naturally looks upon them as furnishing an idea of what the archetypal forms of our present insects may have been. They are, as a rule, large and sluggish, with the body parts soft and little specialized, and the muscles weak. Their remains are found in the Devonian and Carboniferous deposits.

They are mostly carnivorous, and with the exception of the White ants and certain Book-lice, they none of them affect man injuriously, while some are quite beneficial.

The osculant and aberrant groups, already spoken of, and the proper position of which has so perplexed systematists, are:

1—Strepsiptera (στρεψῖς, a turning or twisting; πτερα, wings) or Bee parasite, comprising the single family *Stylopidæ*, now classed with the *Coleoptera*. They are minute insects, with the front wings transformed into short, twisted appendages and the hind wings large and folded longitudinally like a fan. They are most remarkable animals, undergoing what is termed hypermetamorphoses* and having a curious life-history. The young are very minute, active, six-legged objects, with two fine hairs or setæ at the tip of the abdomen. They crawl on to the legs of different species of bees and wasps, are carried into the nests of the latter, and there live on the bee larvæ, changing appearance at each molt and assuming a more degradational form. On account of their very small size, and the few which generally attack a single bee-larva, they do not kill their host, or prevent him from completing his transformations; and while the infested bee is flying about, the parasitic and degraded *Stylops* larva stations itself under one of the abdominal joints on the back, whence the active winged male issues, and where the female—who never acquires wings—is destined to remain, receive the male, and give birth to young within her own body.

2—Aphaniptera, (αφανης, inconspicuous; πτερα, wings) or Fleas, comprising the single family *Pulicidæ*, now placed with the *Diptera*. Everybody is supposed to be familiar with the appearance of the flea—its bloodthirsty propensities and amazing muscular power; and while every one may not have the leisure and means to experience the exhilarating influence of the chase after larger animals, there is no one—be he never so humble—who may not indulge in the hunt after this smaller game! In place of wings the flea has four small scaly plates. The minute eggs—about a dozen to each female—are laid in obscure places, such as the cracks of a floor, the

* i. e., before reaching the third or *pupa* stage, the larva assumes other distinct forms, so that instead of existing only in the normal four stages, characteristic of most insects, those which go through hypermetamorphoses, exist in five or six stages, according to the number of distinct larval forms.

hair of rugs, etc., and the larva is worm-like and feeds on whatever animal matter—as grease and blood—it can find.

3—Euplexoptera, (ευ, well; πλέχω, folded) or Earwigs, consisting of the single family *Forficulidæ*, which may be placed with the *Orthoptera*. They are rare insects with us, but very common in Europe, where there prevails a superstition that they get into the ear and cause all sorts of trouble. The front wings are small and leathery; the hind ones have the form of a quadrant and look like a fan when opened; and the characteristic feature is a pair of forceps-like appendages at the end of the body, best developed in the males. They are nocturnal in habit, hiding during the day in any available recesses. The female lays her eggs in the ground, and, singularly enough, broods over them and over her young—the latter crowding under her like chicks under a hen.

4—Trichoptera, (τριχος, of hair; πτερα, wings) or Caddice-flies, containing the single family *Phryganeidæ*, and placed with the *Neuroptera*, though bearing great affinities with the *Lepidoptera*. Every good disciple of Walton and lover of the "gentle art" knows the value of the Caddice-fly or Water-moth, as bait. These flies very much resemble certain small moths, the scales on the wings of the latter being replaced in the former with simple hairs. The larvæ live in the water and inhabit silken cases, which are usually cylindrical and covered with various substances, according to the species, or the material most conveniently obtained by the individual.

5—Thysanoptera (θυσανος, a fringe; πτερα, wings) or Thrips of entomologists, containing the single family *Thripidæ*, which may be placed with the *Pseudo-neuroptera*, though bearing strong relations to the *Hemiptera*. They are small insects, feeding on plants, or other plant-feeding species of their own Class, and are characterized by having narrow wings crossed on the back when at rest and beautifully fringed.

Prof. Westwood of Oxford, England, has lately proposed an additional Order (*Achreioptera*) to contain a single species (*Platypsyllus castorinus*) parasitic on the Canadian beaver, but Mon. Ritsema, who also described the same insect about the same time, hesitated to found even a new Family for it; while our own Coleopterist, Dr. J. L. LeConte, gives good reasons for placing it with the Coleoptera.

As already stated, if separated from the other Orders, these abnormal tribes should, at the most, be considered as Suborders; and in reality they differ no more from the Orders to which they are here referred than, for instance, the Bark-lice (*Coccidæ*) do from the more typical *Homoptera* from which no one thinks of separating them.

IMPORTANCE OF ENTOMOLOGY AS A STUDY.

Time was when the entomologist was looked upon as a mere trifling enthusiast. The derisive term "bug-hunter" was applied to him, as though his sole occupation in life was to run after and catch "bugs." So long as he contented himself with such trivial doings, the epithet was, perhaps, not undeserved; but that day has long since passed away! A whole galaxy of illustrious names—Schwammerdam, Ray, Rösel, Réaumur, De Geer, Latreille, Lamarck, Lyonnet, Linnæus, Fabricius, Kirby, Spence, Harris, Say, and others, of days gone by, and hundreds of others of the present day—stand forth to redeem the science of entomology from such obloquy; and I hazard nothing in the statement that not even her sister science, botany, may boast of a literature more extensive or more worthy, whether judged by its intrinsic merit as pabulum for the philosopher, as a storehouse of facts for the practical man, or as a conscientious and accurate presentation of the pure and unalloyed truths of nature. I am aware that, among those who have never opened the pages of her vast treasure-book, there is yet a prevailing belief that insects are little, contemptible things, unworthy any special attention on our part; but if it does not detract from our idea of the majesty of a Creator to have produced myriads upon myriads of these tiny beings, so perfect in their many parts that Solomon in all his glory was not arrayed like the very meanest of them, it should not, surely, derogate from man's dignity to study them in all their infinitesimal perfection. Nothing is great or small but by comparison. The earth is a mere mustard seed compared to the sun, and the sun, viewed in comparison with the host of starry suns scattered through infinite space, sinks into complete insignificance. Now, what should we say of a school-boy who objected to study geography because the earth was too small a body to be worthy his attention?

In common with all the other sciences, Entomology, viewed solely as an educator, enriches the human mind by adding to its store of knowledge; and has few, if any, equals as a means of developing the observing faculties of the young. The life-habits of insects—their wonderful metamorphoses, their instructive industries—furnish ample food for reflection, and for our natural love of the curious and marvelous; and it is surprising that the fact has not been more fully recognized in our educational systems. Botany has long since had her place in our schools, and her importance as a means of mental training is not ignored. Yet lessons in animal life—the histories of living, sentient, active creatures—can certainly be made as instructive and entertaining as lessons in vegetative plant-life, and should receive as much or more attention.

ECONOMIC IMPORTANCE OF ENTOMOLOGY.

Man receives some direct benefits from insects, which fact may be well brought home by taking for example the case of a young lady dressing for an evening party: — Her card of invitation is written with ink, the principal ingredient in which—if it is good ink—is the gallic acid made from the so-called "gall-nut" produced by a little gall-fly (*Cynips gallæ-tinctoriæ* Oliv.) on the leaves of a species of Oak (*Quercus infectoria*) very common throughout the Levant. The sealing-wax which fastens the envelope inclosing the invitation is made mainly of shellac, the product of a species of bark-louse (*Coccus lacca* Kerr) found on various trees, such as the Jujube and Indian fig, in India. Her toilet table is, of course, illumined with wax tapers, and for these she is indebted to the common Honey-bee, (*Apis mellifica*), a naturalized American citizen. If she is a *fashionable* young lady, the very rouge on her cheeks is prepared from lac-lake, made either from the bark-louse above mentioned or from the Cochineal. The silk that enters into various portions of her dress comes from the Silk-worm, artificially propagated in many parts of Europe and Asia, and now beginning to attract renewed attention in some parts of our own country. Her dress is probably dyed with cochineal, an extract from the dead bodies of another species of bark-louse (*Coccus cacti* Hern.) artificially propagated on cacti in Mexico. Finally, if the young lady contracts some inflammatory cold, the chances are that her physician will apply to her person a blister prepared from cantharides, the dried and powdered bodies of a Spanish blister-beetle, of which we annually import large quantities at great expense, because our pharmaceutists are ignorant of the fact that we have some half-dozen indigenous species belonging to the same family, the vesicatory properties of some of which are every bit as good, and which are so common during certain years that they are among the most serious enemies of that valuable esculent, the Potato. Indirectly, insects are also of essential service to us; some acting as guards over the vegetable world by destroying the herbivorous species of their own Class, some as scavengers in clearing away decaying animal and vegetal matter; while others perform a most important part in the pollenation of plants.

But the direct or indirect benefits we derive from insects are trivial compared with the damage they do us, as destroyers of our crops. It is, therefore, in

THE RELATION OF INSECTS TO AGRICULTURE,

That they more particularly interest us. In his essay on "What I Know of Farming," the lamented Horace Greeley says:—

"If I were to estimate the average loss per annum to the farmers of this country from insects at $100,000,000, I should doubtless be far

below the mark. The loss of fruit alone by the devastations of insects, within a radius of fifty miles of this city, must amount in value to millions. In my neighborhood the peach once flourished, but flourishes no more, and cherries have been all but annihilated. Apples were till lately our most profitable and perhaps our most important product; but the worms have taken half our average crop, and sadly damage what they do not utterly destroy. Plums we have ceased to grow or expect; our pears are generally stung and often blighted; even the currant has at last its fruit-destroying worm. We must fight our paltry adversaries more efficiently, or allow them to drive us wholly from the field."

The above estimate, great as it seems, is, I believe, far below the mark; and, indeed, it is only when we begin to make careful computation of the average annual loss to this country by insect depredations, and express the sum in round numbers, that we can form any intelligent conception of its magnitude. The State of Missouri, alone, loses annually from fifteen to twenty million dollars, at the very least, and the loss to the Southern cotton-growing States, the present year, within a single fortnight, by a single insect, (the Cotton-worm, *Anomis xylina*), was lately estimated at twenty millions. There is not the least doubt but that the damage inflicted by insects on the farmers of the United States exceeds tenfold the united damages of all other animals put together. It is rarely, if ever, that entire crops are destroyed by birds, rats or squirrels; yet we all know that a single minute insect—the Chinch-bug—often so injures a crop of wheat that it is not worth the cutting.

PROGRESS OF ECONOMIC ENTOMOLOGY.

It is upward of a century since the Swedish authorities became greatly alarmed at the fearful destruction of timber in their dock-yards, caused by a minute boring beetle (*Lymexilon navale*). They did the very best thing they could have done, under the circumstances —they applied to their celebrated entomologist, Linnæus. After a tedious investigation, Linnæus found that the perfect beetle which laid the eggs from which proceeded all the mischief, appeared in the month of May, and in no other month. So he said to the authorities— "Gentlemen, all you have to do is to immerse your timber under water during the month of May, and you will be no more troubled with *Lymexilon navale*." The Government did so—for the remedy was simple and inexpensive; and the result was as Linnæus had predicted. From that time forth, the importance of a knowledge of insect economy as a means of preventing the depredations of the pests which affect our products, began to be realized; and the growth of Economic Entomology began. In Prussia and many parts of Germany —where the appreciation of true science has done so much to elevate the nation—the rudiments of Entomology are taught in the common schools; and in the great agricultural colleges there are often special Professors of this department, distinct from the Professors of the other departments of natural history. Their best text-books devote

a great deal of space to Entomology, as witness that of Troschel and Ruthe, and especially that of Leunis, of which there are several editions for the use of the different classes. They possess, also, many excellent works entirely devoted to the science applied.

Ratzeburg, who held the position of entomologist to the King of Sweden up to the time of his recent death, was appointed by the government; and his world-renowned works on "Forest Trees, their Diseases, and Insect Enemies," have done much to build up the industries of that country, and to preserve the natural forests.

In France, again, before the late fearful war so prostrated her, and when there was an enlightened despotism centralized at Paris, a wise surveillance of her agricultural interests was maintained—especially with reference to insect depredations. They had a National Agrico-entomological Society which held annual exhibitions at Paris, and they also had a monthly journal especially devoted to what the editors were pleased to term agricultural insectology; and only a few months before the war broke out, the Government, to stimulate research, offered a prize of 20,000 francs for a remedy for the Grape-root disease which has lately caused such consternation in the southern part of that country, and which likewise greatly interests the people of the United States, as the readers of these Reports are aware. I am glad to see that under the present Government the offer has been renewed, and that the interest in Economic Entomology is not abating; for there is being held at Paris—as I write—under the auspices of the Central Society of Agriculture, an exhibition of useful insects and their products, and of noxious insects and their injuries. Questions in entomology as well as in general zoölogy are also made part of every examination in their colleges.

In England, where agriculture is not so much relied on, and where insects are not so troublesome to the agriculturist, the authorities have been more indifferent, though the economic writings of J. O. Westwood, and the excellent work on "Farm Insects," by John Curtis, have done much good; and from the fact that an entomologist has lately been officially connected with the South Kensington Museum of London, we may infer that increased attention is there being given to the subject. That the pure science is appreciated there, we may infer from the fact that the first-named author—so celebrated as an entomologist—holds the Hope professorship of Entomology and Zoölogy at Oxford University.

But it is to our own country that we must look for the greatest progress. As is the exigency, so will be the effort. America has been justly termed the land of insects. The vast extent of our country and the great number of species contained within its limits; the fashion which our farmers have of scattering their energies over large tracts, instead of concentrating them on smaller and better-managed farms; the great number of noxious insects imported from foreign lands; the

rich feast which our varied and extensive flora affords—all tend to make it a sort of insect pandemonium. While in Europe the whole people become alarmed if a fifth of a given crop is destroyed by insects, the cultivator here often thinks himself fortunate if he loses not more than half. And yet the sums so far paid out by our State and National Governments appear paltry indeed in view of the loss sustained. It is as if a gigantic army of foreign soldiers was actually among us—burning, ravaging and destroying—and the authorities, after taking the matter into their grave consideration, were to vote $1,000 a year to General Sherman, and smaller sums to two or three other officers, and for the maintenance of the Military School at West Point, and the forts, arsenals, dock-yards and navy-yards of the country. For a long time, New York was the only State that employed a salaried entomologist, and during the last sixteen years the able and celebrated incumbent has issued numerous Reports. The salary he received sixteen years ago was $1,000 per annum, which, though it went three times as far at that time as it does at present, was yet scarcely sufficient to defray his annual expenses in books. Notwithstanding the great change sixteen years have produced in valuations, this salary has not been increased; and should we wonder, as old age fastens its enervating hand upon him, to find him losing interest and becoming indifferent? Yet notwithstanding the office in New York State had lately become nearly obsolete and useless on account of the insufficient salary, and was finally abolished last winter, the effect of Dr. Fitch's earlier work is still felt, and Senator A. B. Dickinson, a few years ago, gave it as his deliberate opinion that the New York Entomological Reports had saved annually to the State over $50,000. Massachusetts once voted a sum of money to Harris for a Report on the Injurious Insects of Massachusetts, (and, to his honor be it said, Mr. Thomas Allen, the enterprising and intelligent President of our Iron Mountain Railroad, had much to do in getting the vote through), and Dr. Harris expressly states that he was obliged to procure a great number of books at an expense far exceeding the compensation allowed him. Yet this Report has become a standard work to-day, has run through four editions, and is not only an honor and credit to the State, but, besides the incalculable good which it must have done, has doubtless brought in a revenue far exceeding the original cost to the State. There is also at present, and has been for some time, an entomologist, Mr. Townsend Glover, attached to the Department of Agriculture at Washington; but, as he himself has often informed me, besides his regular duties, he is not only called upon to receive, arrange and take care of specimens of birds, specimens of fruits, specimens of grain, specimens of flax, specimens of hemp, specimens of cotton, and specimens of silk, but must also act as general curator to the Museum. This is a good deal like hiring a single cradler to harvest 10,000 acres of wheat, and then expecting

him, in addition, to cut and fetch in wood, peel and wash the potatoes, and be always on hand ready to wait on the good woman of the house. Can we wonder, under such circumstances, that the Entomological Reports from the Department do not contain a world of original and practical information? When Mr. Glover should have been studying the Insects, he was called off to attend the Birds. If he intended to discover some facts about the Army-worm, he was hurried away to unpack a bushel of apples. And instead of learning how to master the Curculio, his time was occupied in classifying and arranging specimens of flax, hemp, cotton, etc.! As if Entomology required neither time, study nor attention! Those who have the pleasure of Mr. Glover's acquaintance know full well that there are few harder working men than he; but his position is by no means enviable. Entomology is enough for one man to shoulder, without having all the other ologies piled on his back.

In the East, Dr. A. S. Packard holds the office of State Entomologist in Massachusetts; and Dr. I. P. Trimble has somehow or other been supposed to hold a similar office in New Jersey, though with no State authority. Prof. S. I. Smith, of New Haven, has lately been appointed Entomologist to the State Board of Agriculture of Connecticut, and the celebrated Neuropterist, Dr. H. A. Hagen, is Professor of Entomology at Harvard. In the middle States, Michigan and Iowa have entomologists attached to their agricultural colleges; but in each instance the position is a sort of adjunct to something else. Illinois, always wise, and leading in the higher walks of Agriculture, was the first to establish the office of State Entomologist in the so-called West. In the winter of 1866–7, the Legislature enacted a law creating the office, and on the 11th of June, 1867, the Governor very judiciously appointed to it Mr. Benj. D. Walsh, of Rock Island, a gentleman who had been the principal editor of the *Practical Entomologist*, a journal published in 1865 and 1866 in Philadelphia, and solely devoted, as its name implies, to practical entomology.

Following the example of her sister State, Missouri—through the efforts of a few of her more progressive and intelligent citizens, and especially of Norman J. Colman, editor of the *Rural World*—created the office of State Entomologist, and endowed it by a special appropriation to the State Board of Agriculture, under whose direction the incumbent acts. In April, 1868, the writer was called to fill the position. In the fall of the same year Mr. Walsh and myself commenced the publication of the *American Entomologist* (a monthly journal devoted to economic entomology) at St. Louis, in order to supply needed information pending the publication of our annual reports. But a sad and cruel accident deprived Illinois of one of her most useful citizens, and myself of a lamented and valued colleague. His mantle fell upon Dr. Wm. Le Baron, of Geneva—a gentleman of ripe knowledge, and whose work is highly appreciated. The value

placed on the entomological work that is being done in the Mississippi Valley may be partly inferred from the constant references to it at the meetings of our horticultural societies, farmers' clubs, and in the agricultural papers; but only those who have had opportunity can properly judge of the sympathy and encouragement constantly tendered by private parties who have been pecuniarily benefited by the reports made to the States mentioned.

The producers of Michigan, Indiana, Iowa, Wisconsin and Kansas are all taking steps to get the office of State Entomologist created, and bills to that effect are already pending in the Legislatures of some of these States.

Thus the good work proceeds! These States will, doubtless, in the end, succeed in following the example of Illinois and Missouri; for, in our broad and fertile valley, the voice of the tiller of the soil is now heeded in our legislative halls. Our agricultural interests demand protection from the numerous enemies which threaten them, and the indifference with which the farmers' requests have been listened to in the past is incompatible with that intelligence which should elevate his calling, and which is absolutely necessary to enable him to carry it on profitably. Nor is the day far distant when our agricultural colleges will awaken to the necessity of paying more attention to the subject. Nothing will so surely give to these colleges the distinctive character which their name implies, or prevent them from degenerating into ordinary institutions of learning, as increased attention to the applied sciences, of which Economic Entomology is by no means the least important. Already, courses of lectures on the subject have been given in Maine before the State College at Orono; in Kansas, before the college at Manhattan, and at Cornell University in New York; while Michigan Agricultural College has a chair of "Zoölogy and Economic Entomology," filled by Prof. A. C. Cook, already favorably known as a careful and conscientious investigator. I may also state that even in South America, applied entomology is appreciated, as Mr. B. P. Mann is now carrying on important labors as Entomologist to the Government of Brazil.

A virgin soil, enriched by the leafy mold of ages, and a harmonizing flora and fauna—the result of the long-continued struggle of each species for existence—gave to the early tiller of the soil in this country a rich reward with little labor; but at present he is beset with obstacles on every hand, and none but the well-informed are successful; for success in Agriculture and Horticulture, to-day, implies knowledge—scientific knowledge!

HOW TO COUNTERWORK NOXIOUS INSECTS.

Since, then, we sustain such immense loss from insect injuries, the question presents itself, how can we avert wholly, or in part, this great evil, and in what way are we to be benefited by the services

of one who makes it his especial duty to investigate the subject? There are two grand methods of counterworking a particular noxious insect: 1st, Prevention — i. e., guarding against the advent of the evil by proper foreknowledge, and prophylactic steps; 2d, Cure — i. e., the destruction of the pests, in one way or another, when once they are upon us. The last method consists of two distinct plans of action — that of killing directly by hand-picking, machinery, or the application of destructive substances to the plants or animals affected; and that of causing them to be killed by encouraging their natural enemies.

PREVENTION. — The first method — prevention — is by far the most satisfactory.

> The feathery snow-flake, on its ærial course,
> Is made, with ease, to vanish by a breath;
> To avalanche augmented, 'tis the source
> Of dire calamity — inevitable death.

It is an undeniable fact that many of the most troublesome weeds of American agriculture, as also some of its very worst insect enemies, have been imported among us from Europe; and the list of such species, given in my second report, might be greatly extended. The single case of the Rape Butterfly (*Pieris rapæ*) will serve to show how rapidly these foreigners multiply, and how injurious they become when unattended by the natural enemies which keep them in check in their native homes. Introduced at Quebec, Canada, in 1856, it has now spread over Canada West and most of the New England States, as far south as Baltimore, and nearing the eastern limit of New York. It sweeps the cabbage crop at all points it reaches, and caused, in 1871, a loss of $500,000 in the vicinity of New York City alone, if we are to believe the New York *Tribune*.

Now, there can not be the least doubt but that with the proper precautionary steps many of these immigrants from a foreign land need never have been introduced, or might have been stamped out, on first arrival, and kept from spreading over our fair country.

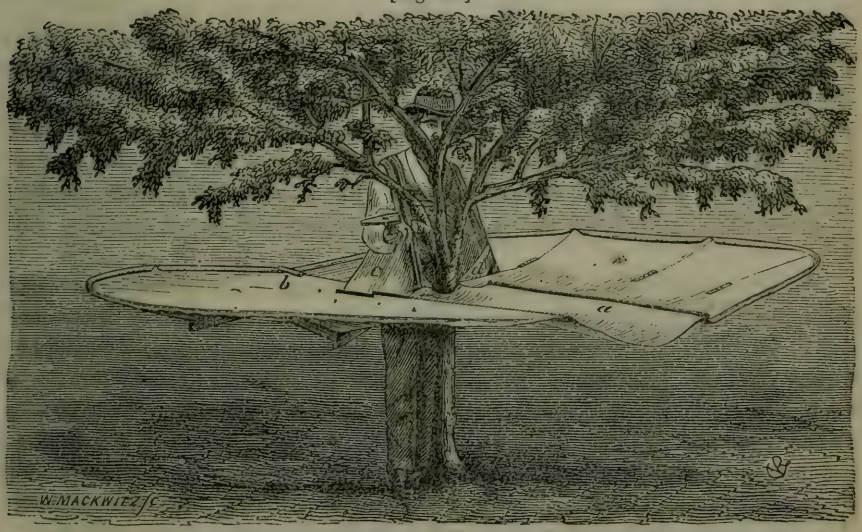
But insects not only spread from one country to another: they spread from State to State, from county to county, and from orchard to orchard; and in very many instances, this spread from place to place is very easily prevented, but unfortunately, just as easily, and more often, aided by man. Quite a number of our most noxious species would scarcely spread fifty miles in a century, were it not for the aid which man in his carelessness gives them. Some are active but a single day in the year; some move slowly under ground; some never quit the trees on which they are born; while still others are apterous in the female sex, and have otherwise very feeble ambulatory power.

In checking the spread of noxious insects does not consist the only way to prevent their injuries. We can also take advantage of their weak points, or nip the evil in the bud. Thus, when we know

that the parent Hessian-fly (*Cecidomyia destructor*) makes its first appearance in this latitude the fore part of September, and usually leaves by the end of the same month, we may avoid its injuries by deferring the planting of our grain till October. And if the parent Army-worm (*Leucania unipuncta*) deposits her eggs at the base of grass stalks in the fall of the year, we may avoid the ravages of her progeny by burning the stubble in the winter. A great many species which, like the Army-worm, are difficult to control in their other stages, are thus readily killed in the egg stage.

CURE.—The second method, namely, the cure of the evil when once it is upon us, is sometimes sufficiently easy; at others, almost, or quite, impossible. As already stated, we have here two distinct lines of action. That of killing the pests requires our ingenuity in the construction of mechanical devices, or our time and patience in the test and repeated trial of some external application that will kill the enemy, while it leaves the plant, or the animal, uninjured.

[Fig. 10.]



Here we learn the value of such contrivances as Dr. Hull's Curculio-catcher, (Fig. 10*), and the many modifications of it that have

* This is a modification of Dr. Hull's wheeling machine, (3d Rep. Fig. 2), which modification he used with good effect last summer, and which I described in the *Scientific American*, August 3, 1872, in the following terms:

"Dr. Hull was wont to claim that he could use his machine without injury to the trees, but the present modification of it is an evidence that experience has taught him differently. In all rolling machines, whether upon one or two wheels, when the bumping was not done by the machine itself, it had to be done by a long pole, tipped with rubber and used by a second person. But where I have used such a pole and separately jarred the larger boughs, the trees have been much injured in the course of a single year's work, and in some instances killed outright.

"The advantages of the present modification over the others may be thus briefly stated: It costs less, and enables the operator to get close to the tree, to which he can give a sudden jar with a hatchet or hammer. This is best done by striking a screw or spike previously inserted into the trunk, and purposely made with a shoulder so as to prevent driving; or by striking the end of a limb previously sawn squarely off. Such a hard, sudden jar, with an iron instrument, is far more effectual in bringing down the beetles than the more subdued bumping of a rubber mallet, as it is the sharpness and suddenness rather than the force of the blow which disturbs and alarms the little shy and cunning customers we have to deal with.

"The working of the machine is very well indicated in the illustration (Fig. 10). There is a bag, *d*, in the center, into which the operator can brush all fallen fruit, and a bottle of cheap alcohol may be kept in the vest pocket, into which the beetles should be thrown; or they may be simply crushed between the thumb and finger."

been used; here we see the importance of such applications as lime for slug-worms (genus *Selandria*) and other larvæ having soft, slimy skins; of white hellebore for the currant-worms (genus *Nematus*), and of some preparation having Paris Green as its base, for the Colorado Potato Beetle. As a rule, however, these methods of cure are far less satisfactory in their results than the modes of prevention, and should never be relied on when the latter can be resorted to.

That of causing them to be killed by encouraging their natural enemies, is one of the most effectual methods of counterworking noxious insects. Among such natural enemies, birds, toads, snakes and other reptiles hold a prominent place; and we have here to treat of the complicated bird question, or what may be termed ornithological entomology, which is yet in its infancy, and calls loudly for more attention. But the more important enemies of noxious insects are found in their own Class, and consist of the predaceous or cannibal and the parasitic species, wisely ordained to keep the others within due bounds.

To avail ourselves, in the fullest manner, of the aid of these friends, it is necessary, first, that by observation we discover what particular species prey on a particular vegetable-feeder; second, that by observation and experiment we determine the cheapest and most convenient method of spreading or propagating the species that so prey upon it; and if, as often happens, there are several such species, to determine which of them can be propagated most readily and cheaply.

In some cases we can do much to encourage the growth and distribution of our insect friends. Take, as an example, the imported Cabbage Butterfly already alluded to. In searching for insects in the winter time, in England and other parts of Europe, I recollect very well, when a lad, how common the naked and suspended chrysalides were along the ledges of palings, and in other sheltered situations; and how a large per centage of them were always parasitized, and generally distinguishable, in consequence, by their discolored look. Now, these could be collected by hundreds in winter time, shipped to this country, and the parasites allowed to escape in some cabbage-field infested with *Pieris rapæ*. The little Chalcid parasite of the Oyster-shell Bark-louse is easily introduced into "scurvy" orchards not yet favored with it, as I shall show in this Report. The parasites of the Plum Curculio (3d Rep. pp. 24–9), and those of the Codling moth, to be described further on, are easily bred and dispatched to parts where they are yet unknown. So of the enemy of the grape-leaf hoppers (3d Rep. p. 137), and of many others.

But practically, the propagation of a large proportion of parasitic and cannibal insects is beyond man's power; and all we can do is to protect and encourage them, as opportunity offers. To do so, it is very important that we know how to distinguish between our friends and

our foes, so as to avoid the blunders of one of Dr. Fitch's neighbors who complained that his currant bushes were suffering from plant-lice ten times worse than those of his neighbors, notwithstanding he took "the greatest pains every morning to kill off the old ones they breed from." Upon inquiry the Doctor ascertained that his worthy neighbor had busied himself in killing, not the aphides or plant-lice, but the ladybirds (*Coccinellidæ*) or plant-louse devourers that eat and drink plant-lice, have plant-lice for breakfast, dinner and supper, and are no more capable of breeding plant-lice than a lion is of breeding lambs.

It will be observed that in both these methods of fighting noxious insects — whether of prevention or cure — an accurate knowledge of the nature and of the habits of each particular species is absolutely necessary. It is the all-essential, the basis and groundwork on which every intelligent experiment must rest. *It therefore becomes the duty of the economic entomologist primarily to study and give to the world accurate accounts, with descriptions, of such insects, whether friends or foes, as more particularly concern the husbandman!*

DUTIES OF STATE ENTOMOLOGIST.

Many persons, not familiar with the facts here set forth, have no doubt wondered what can possibly be the duties of a State Entomologist; while in the minds of not a few the idea prevails that he is to catch and kill, or by some means rid the State of, all vermin. As if by the power of an Aaron's wand or the magic hest of a mighty Mulciber, he could perform the Augean task of clearing the land of insect plagues! It may not be amiss, therefore, to briefly define his duties.

Broadly speaking, insects are ten times as numerous in individuals and species as all other animals combined, and it is estimated that, on an average, there are five insects to one plant in any given area. From calculations which I have elsewhere made, (*Am. Ent.* II, p. 258,) it would require the entire working life of eighty-three persons, at a cost of one hundred and twenty-six million dollars, to describe and figure, in all four stages, the insects of the world. Insufficient as the estimate doubtless is, it will serve to convey some idea of the magnitude of the subject of entomology.

Where the field is so wide, the labors must be divided, and the comparatively few insects which particularly interest the producer are more than sufficient to occupy one man's time. The farmer, as a rule, has neither the means nor the opportunity to pursue the requisite studies; hence the wisdom of having a State officer for the purpose.

Such an officer should make an annual report, which should reflect the experience and observations of the year. Such a report, if well

made, is, necessarily, the result of much labor in the field, and close study in the closet, and should combine the practically useful with the scientifically accurate. It should be copiously illustrated, and the illustrations must generally be prepared from life by the author; for, strange as it may seem, there are few artists — however talented they may otherwise be—who can draft an insect with anatomical precision. Such a report, aside from its educational value, is of great material value to the State; but its usefulness will depend on the methods established by law for its distribution, as well as on the time of year of such distribution. In our own State it is bound in with the Agricultural Report, which is often a bulky volume, requiring a large amount of postage when sent through the mail; and I regret that there is not some provision of the law to have a small edition of the Entomological Report bound separately, to meet the demand that is constantly being made of me for the same.

The State Entomologist must, further, answer by letter or through the columns of different journals a host of queries that are continually pouring in upon him from correspondents. He should endeavor to protect the farmer from the impostors and quack nostrum venders who are ever ready to palm off their vile compounds upon the unsophisticated, as panaceas for all vegetable and animal ills. He must lecture; he must read a paper here and an essay there, whenever good can thus be accomplished. He must travel hither and thither over the State, to investigate the insects that are peculiar to different sections; he must carry on all sorts of experiments; but above all, he should employ every moment of time, not otherwise occupied, in ascertaining the habits and transformations of species.

These are the more ostensible duties of such an officer; but he has, in addition, to form a cabinet; and the collecting, the classification and arrangement, the proper determination of the species or description of such as are new—not to mention the manipulation necessary to prepare the specimens for such a cabinet—involve an amount of scientific detail and application, and of correspondence with scientific men throughout the civilized world, which few but those who have some insight into the life of a naturalist can appreciate.

Now, according to the means expended will be the results attained. There is a limit to one man's capabilities, and where the means are restricted, it often happens that only the independent enthusiast, who looks for other than mercenary reward, can afford to fill such a position if he wishes to do any good at all. His expenses for engraving, electrotyping and other illustrating material; for books, stationery, expressage and postage; for assistance, experiments and experimental material; for cabinets, chemicals and paraphernalia for collecting and preserving; for traveling, etc., must all come from a salary which in no instance has yet exceeded $3,000 per annum. The means are not at all commensurate with the vital interests at stake,

and I hope to live to see the day when there will be a corps of well-supported economic entomologists scattered through the country, instead of the few who are now in the field under crippled conditions. It is not well for our legislators to be penny wise and pound foolish in matters of this kind; and the office should be so endowed as to warrant at least the proper assistance. In my own capacity I have often felt cramped and restricted in my efforts; and experiments have frequently been valueless where, if they could have been carried out more thoroughly, they might have resulted in great good. An incomplete experiment is negative, and simply tantalizing, where a full and thorough one would be positive and definite, and might prove of the utmost importance.

HOW TO COLLECT, PRESERVE AND STUDY INSECTS.

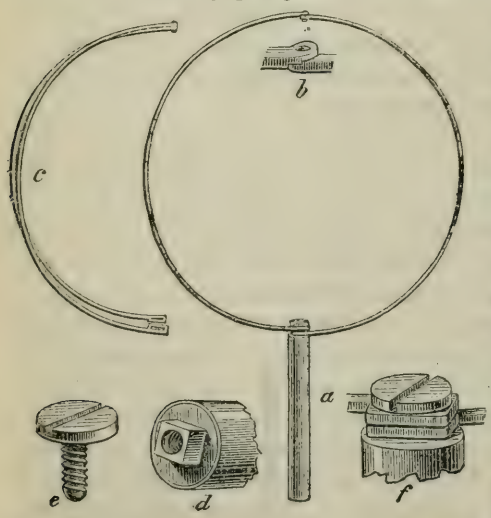
Few departments of natural history offer greater inducements or facilities to the student than Entomology. He need not pass his threshold for material, for it may be found on every hand and at all seasons. The directions for collecting, preserving and studying insects might be extended indefinitely in detail, as volumes have already been written on the subject; but the more general and important instructions are soon given.

Collecting.—Beginners are very apt to supply themselves with all sorts of appliances advertised by natural history furnishing-stores. Many of these appliances, when it comes to real, practical field-work, are soon abandoned as useless incumbrances; and the greater the experience, the simpler will be the paraphernalia. My own equipment, on a collecting trip, consists chiefly of a cotton umbrella, a strong and narrow steel trowel or digger, a haversack slung across the shoulders, a cigar-box lined with sheet cork, and a small knapsack attached to a waist-belt which girts a coat, not of many colors, but of many pockets so made that in stooping nothing falls out of them. The umbrella is one of the indispensables. It shields, when necessary, from old Sol's scorching rays and from the pelting, drenching storm; brings within reach, by its hooked handle, many a larva-freighted bough which would otherwise remain undisturbed; and forms an excellent receptacle for all insects that may be dislodged from bush or branch. Opened and held inverted under a bough with the left hand, while the right manipulates a beating-stick cut for the occasion, it will be the recipient of many a choice specimen that would never have been espied amid its protective surroundings. Some collectors use an umbrella painted or lined on the inside with white, to facilitate the detection of any object that drops into it; but as there are fully as many, if not more, pale and white insects as there are dark or black ones, the common dark umbrella is good enough for all ordinary purposes; and if any improvement on the ordinary cotton umbrella is

desired, it should be in the way of a joint or knuckle about the middle of the handle, which will facilitate its packing and using. The trowel is valuable for prying off the loosened bark from old trees, whether felled or standing, and for digging into the ground or into decaying stumps and logs. The haversack is for the carriage of different kinds of boxes (those made of tin being best) intended for larvæ and other forms which it is necessary to bring home alive for breeding purposes; and if made with a partition so that the filled and empty boxes may be separated, all the better: it may also be used for nets and other apparatus to be mentioned, and for such provender as is necessary on the trip. The knapsack may be made on the plan of a cartridge-box, of stout canvas or leather, and should be of moderate size and slung on to the belt so as to be slipped to any part of the waist and not hinder free bodily motion. It may be used to carry bottles, phials and many other small appliances, and should be accordingly partitioned and furnished with loops or pockets on the inside. The cigar-box is for the reception of pinned specimens, and may be slipped on to the belt, or buttoned to the pants, by means of leather.

The greatest requisites in collecting are a pair of sharp eyes and ready hands, with coolness and self-possession; but a few traps will materially aid. One of the most important is the hand-net, which may be made so as to subserve the two purposes of a sweeping and an air-net. The frame of the net which I use is illustrated herewith (Fig. 11), and will be found strong and serviceable and conveniently portable. It is constructed as follows: Take two pieces of stout brass wire, each about 20 inches long; bend them half-circularly and join at one end by a folding hinge having a check on one side (*b*). The other ends are bent and beaten into two square sockets (*f*) which fit to a nut sunk and soldered into one end of a brass tube (*d*). When so fitted, they are secured by a large-headed screw (*e*) threaded to fit into the nut-socket, and with a groove wide enough to receive the back of a common pocket knife-blade. The wire hoop is easily detached and folded, as at *c*, for convenient carriage; and the handle may be made of any desired length by cutting a stick and fitting it into the hollow tube *a*, which should be about six inches long. It is well to have two separate hoops—one of lighter wire fur-

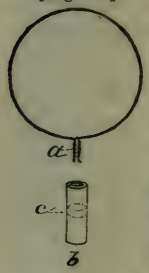
[Fig. 11.]



nished with silk gauze or some other light material for catching flying insects; and one which is stouter and furnished with a net of stronger material for sweeping non-flying specimens.

Another still more simple, but less convenient, frame is thus described by my friend F. G. Sanborn, of Boston, Mass.:

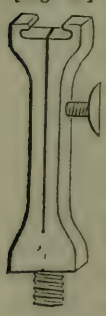
[Fig. 12.]



"Make a loop of strong iron or brass wire, of about 3-16ths of an inch in thickness, so that the diameter of the loop or circle will not exceed twelve inches, leaving an inch to an inch and a half of wire at each end bent at nearly right angles. Bind the two extremities of the wire together with smaller wire (Fig. 12, *a*), and tin them by applying a drop of muriate of zinc, then holding it in the fire or over a gas flame until nearly red hot, when a few grains of block tin or soft solder placed upon them will flow evenly over the whole surface and join them firmly together. Take a Maynard rifle cartridge tube, or other brass tube of similar dimensions; if the former, file off the closed end or perforate it for the admission of the wire, and having tinned it in the same manner on the inside, push a tight-fitting cork half way through (Fig. 12, *c*) and pour into it melted tin or soft solder, and insert the wires; if carefully done, you will have a firmly constructed and very durable foundation for a collecting net. The cork being extracted, will leave a convenient socket for inserting a stick or walking cane to serve as a handle."

My friend, J. A. Lintner, of Albany, N. Y., makes very good use, in his ordinary promenades, of a telescopic fish-rod, with a head (Fig. 13.) screwed on to one end, in which to fasten an elastic brass coil on which the net is drawn, but which when not in use sets snugly inside his silk hat.

[Fig. 13.]



The bag should taper to the bottom, and in either case, should be fully twice the diameter of the hoop, so that by giving the net a twist, the mouth may be closed and the contents thus secured. The sweeping-net may be protected around the hoop with a covering of leather, and in use should be kept in a steady and continued back-and-forth motion, over and touching the plants, until the contents are to be examined; when, by placing the head at the opening and quietly surveying the restless inmates, the desiderata may be secured and the rest turned out. A sudden dash of the air-net will usually lay any flying object at the bottom. A net for aquatic insects may be made on the same principle, but should be stout, with the meshes open enough to allow free passage of water, and the bag not quite as deep as the diameter of the hoop. A forceps net, which consists of two gauze or bobbinet covered frames, having riveted handles, so as to close like a pair of scissors, is employed for small insects; but I find little use for it. A coarse sieve, together with a white towel, or sheet,

will be found of great service for special occasions, particularly in the spring, when the search for minute insects found under old leaves, or for pupæ around the butts of trees, is contemplated. With the sheet spread on the ground, and a few handfuls of leaves and leafy mold sifted over it, many a minute specimen will be separated from the coarser particles, and drop to the sheet, where the eye may readily detect it. Conversely, the earth taken from around trees may be sifted so as to leave in the sieve such larger objects as pupæ, etc. Another favorite plan, with some collectors, of obtaining specimens, especially night flying moths, is by "sugaring." This consists of applying to the trunks of trees, or to strips of cloth attached to the trees, some sweet, attractive and stupefying preparation. Diluted molasses, or dissolved brown sugar, mixed with rum or beer, is most frequently employed. I have found sugaring of little use till after the blossoming season, and — notwithstanding assertions to the contrary — it is almost impossible to so stupefy or intoxicate an insect that it will remain till the next morning. I generally sugar at eve, and visit the tree several times between sundown and midnight, armed with wide-mouthed killing bottles, and accompanied by a second person who carries a dark-lantern. Isolated trees, on the edges of woods, give the best results. Everybody knows how some poor moths will persist in flitting round a light, until they singe their wings; and, as many insects are strongly attracted to bright artificial light, it may be employed with good results, especially during warm and damp evenings. The collector should never go unprovided with a small box or tube full of different sized pins (a corked cartridge tube makes a good box), a pair or two of forceps, a pair of scissors, a little mucilage, and the killing apparatus to be described.

Killing.—After capturing an insect, intended for the cabinet, the next thing is to kill and dispose of it till one gets home. All those, as the various Beetles, Bugs, some Nerve-winged and some Straight-winged insects, which have either hard or naked coverings, and do not spoil when wetted, may be thrown into alcohol kept in stout, wide mouthed and well-corked bottles. The alcohol at once kills and preserves.

The cyanide bottle is very useful for killing the more delicate Scaly-winged and Two-winged insects. It is a wide-mouthed bottle, with a few grains of cyanide of potassium kept in place at the bottom by a layer of cotton-wadding, pressed down upon it and capped with something smooth, such as perforated card-board. The cyanide is a deadly poison, and soon kills anything thrown into the bottle. Different sized bottles may be used, and one made of a chemist's test-tube (Fig. 14) is convenient in the field. Carbonate of ammonia may be used as a substitute for cyanide, but it affects the colors more, especially of delicate green insects. In countries

[Fig. 14.]

where the Laurel grows, its bruised leaves may be used in place of the cyanide; they kill less quickly, but have the advantage of safety. The leaves of the Laurel-Cherry, (*Prunus lauro-cerasus*), a plant commonly grown in England for screens and hedges, are also used for this purpose. A small and stout bottle of chloroform, or ether, with a brush securely inserted into the cork, (Fig. 15.), will be found very serviceable. A slight moistening through the air-net will stupefy most insects caught in it, and facilitate their removal to the cyanide bottle; while a touch or two with the wet brush under the head and thorax, will kill the more delicate specimens outright, without in the least injuring them. Another way of using chloroform is by means of a small, hollow tube passed through the cork (Fig. 16), what is called jeweler's hollow wire answering the purpose. The liquid evaporates more readily in such a bottle, and I altogether prefer the first mentioned. Some large insects, and especially female moths, whose size prevents the use of the ordinary cyanide bottles, are difficult to kill. With these, fluttering may be prevented by the use of chloroform, or by a squeeze of the thorax under the wings with the thumb and finger; and they may be killed by puncturing the thorax, or piercing the body longitudinally, with a needle dipped in liquid cyanide, or oxalic acid. A long bottle with a needle thrust into the cork may be kept for this purpose; but the needle must be of ivory or bone, as those of metal are corroded and eaten by the liquids. Hot water kills rapidly, and leaves the specimens in good flexible condition for mounting; the heads of large insects may be held for a few moments in the water, while smaller specimens should first be thrown into a corked bottle, and the bottle submitted to the heat.

[Fig. 15.]

[Fig. 16.]

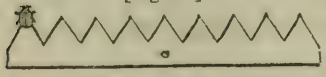
For killing small and delicate moths which have been bred, I find nothing more handy than chloroform. They may be caught in turned wooden boxes, which are kept by every druggist; and a touch of the chloroform on the outside of the box immediately stupefies them. It has a tendency to stiffen them, however, and they are best set immediately after death.

Some collectors, with indifferent olfactory sense, moisten the cork of their boxes with kreosote. Its killing power lasts for several days. A few whiffs from a cigar, when nothing else is at hand, will also kill many of the more tender insects.

ENTOMOTAXY.—Unlike the ornithologist, the entomologist has no one word to express the preparing, setting and preserving of his specimens; but that used herewith will very well answer the purpose. In preparing insects for the cabinet, entomological pins, expressly made, should be used. Those manufactured by W. Klæger, of Berlin, are far superior to those of American make, and may be obtained through the agency of several of our Eastern natural history societies. They range, in number, from 00, or extremely fine, to 7, which is coarse and stout. Nos. 2, 3, 4, 5 and 6 are the most useful, and the others may, in reality, be dispensed with. French pins, ranging from 1 to 10, and over, the lower numbers finest, are next best, and may be had of John Akhurst, 19 Prospect street, Brooklyn, New York. All insects should be pinned through the middle of the thorax, where—as is more generally the case—this portion (*mesothorax*) is largely developed. Beetles (*Coleoptera*) and Bugs (*Hemiptera*) should, however, be pinned, the former through the right elytron or wing-cover, (Fig. 17, *a*), the latter through the scutel or triangular piece behind the thorax (Fig. 17, *b*), the pin issuing between the middle and hind legs. The specimens look very pretty with all the legs neatly spread out; but for practical purposes, it is usually as well to let them dry in the naturally folded positions: it is a saving of time, a saving of space, and the limbs are not so apt to break. There should always be about half an inch of the pin above the insect, to facilitate handling, and uniformity in this regard will have much to do with the neat appearance of a collection. Most insects which are too small to be pierced by a No. 2 pin may be fastened to card-board, by means of gum tragacanth. A drop of corrosive sublimate, added to the water with which the gum is diluted, will indefinitely prevent its souring, but should not be used where the gum is to come in contact with the pin, as it inclines the latter too much to verdigris. In such cases a little spirits of camphor mixed with the tragacanth is best. I have tried gum arabic with white sugar, as used by my late friend Walsh, French varnish, shellac dissolved in alcohol, and other gums; but much prefer the tragacanth. The card-board or Bristol-board may be cut into points or tags, of shape to suit the fancy. I use, myself, rows of wedge-shaped points (Fig. 18) of three different sizes, according to the insects to be fastened; and to facilitate the cutting of these rows, and to obtain uniformity, I have had three different sized stamps made, which prick the paper and indicate

[Fig. 17.]

[Fig. 18.]



each angle or corner. Delicate flies and moths which it will not do to fasten with mucilage, may first be mounted on very fine pins, (Nos. 19 and 20, made by Eddleston & Williams, Crown Court, Cheapside, London, are very fine and excellent,) or on silver wires, and these inserted into one end of little strips of cork or pith, through the other end of which a No. 3 or 4 Klæger pin passes to secure the specimen in the cabinet. Pith for this use should be dense, and that of Wormwood (*Artemisia*) or Mullein (*Verbascum*) will be found best. By this means the proper height is preserved, and the inconvenience and vexation of handling such very fine pins obviated. Some, who have plenty of time and patience to spare, throw their beetles into warm water, and, while all the parts are limp, fasten them by the legs on to card-board coated with tragacanth, which, in drying, secures the beetle without discoloring the paper. The paper is afterward cut up into squares and pinned.

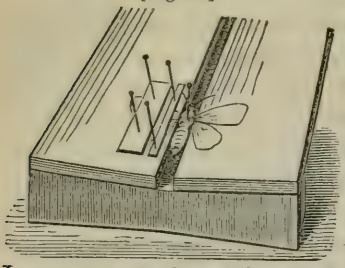
Many Coleopterists prefer to use separate slips of card-board, cut into isosceles triangles, crosswise on to the narrow tips of which the specimens are gummed with a cement of inspissated ox-gall, gum arabic and water, as recommended by Dr. LeConte; but, though more of the underside of the beetle is in this manner left exposed, I find my own method much the most convenient.

Many English entomologists use short pins, very much like those of ordinary make, and my late friend Walsh never gave up the custom, and most vehemently opposed the use of what he ridiculed as "long German skewers." But the only advantage that can possibly be claimed for the short pins is that they are less apt to bend, are consequently more easily stuck into the bottoms of boxes, and require less room; while, compared with the long pins, they have numerous disadvantages. Long pins admit of the very important advantage of attaching notes and labels to the specimen; render it more secure from injury when handled, and from museum pests in the cabinet; and on them several rows of carded duplicates may be fastened, one under the other, so as to economize room.

I have seen few old collections in better condition than that of M. E. Mulsant, of Lyons, France; and he uses iron wire, cut slantingly of the requisite length—a common custom in France. These wires bend so easily and have such dull points that they require much more careful manipulation than the pins, and the claim made for them that they do not verdigris, would, perhaps, not hold good near the sea. Silver wire, or silver-plated wire, is used for the same purpose.

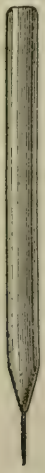
For the proper setting of insects with broad and flattened wings, such as butterflies and moths, a spreading board or stretcher is necessary. One that is simple and answers every purpose is shown at figure 19. It may be made of two pieces of thin white-wood or pine board, fastened together by braces, especially at the ends, and left wide enough apart to admit the bodies of the insects to be spread: strips

[Fig. 19.]



of cork or pith, in which to fasten the pins, may then be tacked or glued below so as to cover the intervening space. The braces must be deep enough to prevent the pins from touching anything the stretcher may be laid on; and by attaching a ring or loop to one of them, the stretcher may be hung against a wall, out of the way. For ordinary-sized specimens I use boards 2 feet long, 3 inches wide and $\frac{1}{3}$ inch thick, with three braces (one in the middle and one at each end) $1\frac{1}{2}$ inches deep at the ends, but narrowing from each end to 1 1-6 inches at the middle. This slight rising from the middle is to counteract the tendency of the wings, however well dried, to drop a little after the insect is placed in the cabinet. The wings are held in position by means of strips of paper (Fig. 19) until dry. For stretching the wings, and for many other purposes, a handled needle will be found useful. Split off, with the grain, a piece of pine wood three or four inches long; hold it in the right hand; take a medium-sized needle in the left hand; hold it upright with the point touching a walnut table, or other hard-grained wood, and bring a steady pressure to bear on the pine. The head of the needle will sink to any required distance into the pine, which may then be whittled off, and you have just the thing you want (Fig. 20). To obtain uniformity in the position of the wings, a good rule is to have the inner margins of the front wings as nearly as possible on a straight line (Fig. 19). When the specimens are thoroughly stiff and dry, they should be taken from the stretcher and kept for several weeks in the drying box before being permanently placed in the cabinet. The drying box is simply a box of any required dimensions, containing a series of shelves on which to pin the specimens, and without a solid back or front. The back is covered on the inside with fine gauze, and on the outside with coarser wire, and the door in front consists of a close-fitting frame of the same material—the object being to allow free passage of air, but at the same time to keep out dust and prevent the gnawings of mice and other animals. The shelves should be not less than two inches deep, and if made in the form of a quadrangular frame, braced with two cross-pieces on which to tack sheet cork, they will serve for the double purpose of drying spread specimens, and for the spreading of others; as there are many insects with long legs, which are more conveniently spread on such a board, by means of triangular pieces of stiff cardboard braces or "saddles," than on the stretcher already described.

[Fig. 20.]



Two of these braces are fixed on the setting board, by means of stout pins, at sufficient distances apart to receive the body between them. The wings are then spread upon them and kept in place, until dry, by means of additional braces.

CABINET AND BOXES.—The boxes or cases, which are used to keep insects in permanently, may be made of any dimensions to suit the fancy—12x16 inches, inside, being a convenient size, and allowing economic use of cork. They must, however, be perfectly tight, and should not be more than 2½ inches deep on the inside. The bottoms should be lined with something which will hold the pins, and the whole inside covered with white paper, which, if delicately cross-ruled, will facilitate the regular pinning of specimens. While the size and style of the box and cabinet may be left to individual taste, some choice must be had of material. *Red cedar should never be used.* I have learned, to my sorrow, the baneful effects of this wood, notwithstanding it is recommended—evidently by those who are guiltless of having used it—as having the advantage over other wood, of keeping off museum pests. It seems impossible to get this wood so seasoned but that a certain amount of resin will continually exude from it; and insects in boxes of this material are very apt to soften and become greasy. Paper boxes are also bad, as they attract moisture and cause the specimens to mold. The French used to make very neat boxes of this material, and Dr. Fitch, of New York, imported a number for his insects. He has been paid for his trouble by having almost all of his specimens ruined by mold. I use, myself, well seasoned pine and white-wood; and in such boxes as have glass covers, and are intended to form part of a neat cabinet for parlor ornament, the fronts may be of walnut or cherry.

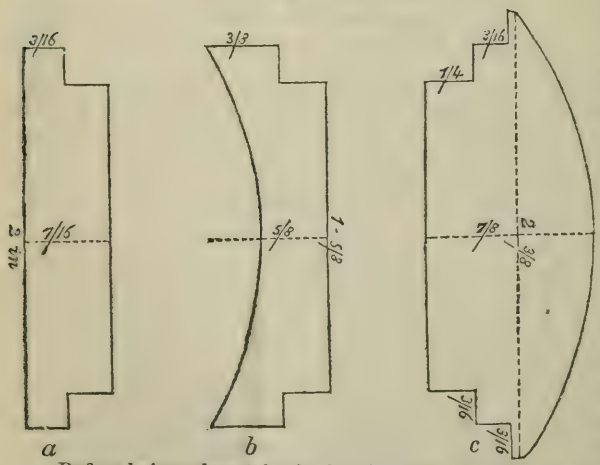
My best cabinet consists of 60 boxes of the above dimensions, in three tiers of twenty each. The boxes are made of well-seasoned pine, the lower part having a depth of 1½ inches, with a rabbet extending ⅝ inch above it. The glass cover, with a frame 1 inch deep, fits over this. The sides and back, exclusive of rabbet, are made of ¼ inch stuff, but the front, which is made of cherry, is twice as thick, the better to hold a ring, sunk flush in the middle. The bottoms are made of two thin pieces, cross-grained, to prevent warping or cracking, and the whole varnished with shellac and alcohol. The cabinet is made of black walnut, with the exception of the back, which is pine, and is simply a case with folding doors in front, and a series of skeleton shelves ¾ inch thick. Boxes, such as these, when the lid is secured by hooks, will also be found convenient to hang upon a wall.

A very convenient and secure box, 12x8x2½ inches inside, and made to look like a book, is manufactured (price $3.00) by Mr. J. S. Ridings, of Philadelphia. The back is made in one piece, 12x3⅜ inches, ½ inch thick in the middle and rounding off on the outside to ¼ inch at the ends. The front and ends are 3 inches wide and ¼ inch thick, the front piece having a length of 12 and the ends, which overlap it, of 8¼ inches. The sides are 12⅞x8½ inches, with a thickness of ⅓ inch. When glued and bradded together, and sand-papered, this box is carefully sawed in two down the middle. Thin strips 2 inches wide and

$\frac{3}{8}$ thick are then cut in around one of the halves, so that the edges project and form a rabbet, which is beveled off and fits tightly against the inside of the other half when closed. The inside is lined with cork and paper, the back covered with stout linen or leather, which forms a hinge, and the whole either painted or papered to suit the fancy. It is neat, may be stood edgwise on a book-shelf, is easily handled, and is, withal, valuable to the working student, because new boxes may be added, in their proper places, as the collection increases; and the insects always kept in proper systematic order. Such boxes are also readily packed and moved from one place to another, and for this reason will commend themselves to the itinerant entomologist. Those who are ingenious, and have the proper tools, can make them at a less cost, but hardly with the same finish as does Mr. Ridings.

For beauty and security, and the perfect display of the larger *Lepidoptera*, I have seen nothing superior to a box used by Mr. Lintner, of Albany, N. Y. It is a frame made in the form of a folio volume, with glass set in for sides, and bound in an ordinary book cover. The insects are pinned onto pieces of cork, fastened to the inside of one of the glass plates; and the boxes may be stood on ends, in library shape, like ordinary books. For the benefit of those who wish to make small collections of showy insects, I give Mr. Lintner's method, of which he has been kind enough to furnish me the following description:

[Fig. 21.]



Figures *a*, *b* and *c* represent, in section, the framework of the volume — *a* showing the ends, *b* the front, and *c* the back. The material can be prepared in long strips of some soft wood, by a cabinet-maker, (if the collector has the necessary skill and leisure for framing it,) at a cost of sixty cents a frame, if a number sufficient for a dozen boxes be ordered. Or, if it be preferred to order them made, the cost should not exceed eighty cents each.

Before being placed in the hands of the binder, the mitering should be carefully examined, and any defect in fitting remedied, so that the glass, when placed in position, may have accurate bearings on all the sides. The interior of the frame is covered with tin-foil, made as smooth as possible before application, to be applied with thoroughly-boiled flour paste, (in which a small proportion of arsenic may be mixed), and rubbed smoothly down till the removal of the blisters, which are apt to appear. The tin-foil can be purchased, by weight, at druggists', and the sheets marked off and cut

by a rule in strips of proper width, allowing for a trifle of overlapping on the sides. Its cost per volume is merely nominal.

First quality single-thick glass for sides must be selected, wholly free from rust, veins, air-bubbles or any blemish. Such glass can be purchased at fifteen cents a pane. The lower glass, after thorough cleaning, especially of its inner surface, with an alkaline wash, and a final polishing with slightly wetted white printing paper, is to be firmly secured in its place by a proper number of tin points; the upper glass is but temporarily fastened. The binder must be directed to cover the exposed sides of the frame with "combed" paper, bringing it over the border of the permanent lower glass, and beneath the removable upper glass.

The covers of the volume are of heavy binder's-board (No. 18), neatly lined within with glazed white paper. On one of the insides of the lids may be attached, by its corners, a sheet with the numbers and names of the species contained in the volume, or these may be placed on the pin bearing the insect. If bound in best quality of imitation morocco, with cloth covers, lettered and gilded on the back, the cost (for a dozen volumes) need not exceed $1.00 each. If in turkey-morocco, it will be $1.50.

The lettering and ornamentation of the back will vary with the taste of the individual. The family designations may be permanently lettered, or they may be pasted on the back, on a slip of paper or gum-label, as are the generic names, thus permitting the change of the contents of a volume at any time, if desired.

The bits of cork to which the insects are to be pinned are cut in quarter-inch squares from sheet-cork of one-fourth of an inch in thickness. If the trouble be taken to trim off the corners, giving them an octagonal form, their appearance will be materially improved, and much less care will be required in adjusting them on the glass.

The cement usually recommended for attaching the cork to the glass is composed of equal parts of white wax and resin. My experience with this has not been favorable, for after the lapse of a few years, I have invariably been subjected to the serious annoyance of being compelled to renew the entire contents of the volume, clean the glass and replace the corks with new cement. From some cause, inexplicable to me, a gradual separation takes place of the cork with its cement from the glass, first appearing at the angles of the cork, and its progress indicated by an increasing number of iridescent rings which form within, until the centre is reached, when, if not previously detached, the insect falls with the cork, usually to its injury and that of others beneath it.

A number of years ago, I happened to employ, in attaching a single piece of cork in one of my cases, a cement originally made for other purposes, consisting of six parts of resin, one of wax and one of Venetian red. Several years thereafter, my attention was drawn to this piece, by finding it as firmly united as when at first applied, and at the present time (after the lapse of twelve years) it is without the slightest indication of separation. Acting upon this hint, I have, of late, used this cement in the restoration of a number of my cases, and with the most satisfactory results. It is important that the cement, when used, should be heated (by a spirit lamp or gas flame) to as high a degree as it will bear without burning. An amount sufficient to cover the bottom of the small, flat metal vessel containing it to the depth of an eighth of an inch will suffice, and prevent the cork from taking up more than its requisite quantity. It should be occasionally stirred to prevent the precipitation of its heavier portions. The cork may be conveniently dipped by the aid of a needle inserted in a handle, when, as quickly as possible, it should be transferred to the glass, for the degree of adhesion seems to depend upon the degree of fluidity of the cement. From some experiments made by me, after the corks had been attached as above, in heating the entire glass to such a degree as thoroughly to melt the cement until it spreads outward from beneath the weight of the cork, and then permitted to cool—the glass meanwhile held horizontally, that the corks might not be displaced—the results appear to indicate that the above cement, applied in this manner on glass properly cleaned, will prove a *permanent* one. It is scarcely necessary to state that this method is not available where the glass has been bound as above.

Preparatory to corking the glass for the specimens assigned to it, the spaces required for them are to be ascertained by arranging them in order on a cork surface, or otherwise. On a sheet of paper of the size of the glass, perpendicular lines, of the number of the rows and at their proper distances, are to be drawn, and cross lines equal in number to the insects contained in the rows. The distances of these lines will be uniform, unless smaller specimens are to occupy some portion of the case, when they may be graduated to the required proportion. With the sheet ruled in this manner and placed beneath the glass, the points where the corks are to be applied are indicated by the intersections of the lines. The sheet, marked with the family of the insects for which it was used, and with the numbers designating its divisions, may be laid aside for future use in the preparation of other cases for which it may be suitable. In a series of unbound cases in my collection, in which the glasses measure 11x14½ inches, I have used for my Lepidoptera and lain aside the following scales, the citation of which will also serve to show the capacity of the cases: 3x8, Catocalas; 2x7 and 3x9, Sphingidæ; 4x11 to 4x14, Bombycidæ; 5x13 to 6x16, Noctuidæ; 8x16 and 8x20, Lycænidæ and Tortricidæ.

The unbound cases above referred to are inexpensive frames, made by myself, of quarter-inch white wood or pine, the corners mitred, glued and nailed with ¾ inch brads, lined within with white paper, (better with tin-foil), and covered without with stout manilla paper. The glasses are cut of the size of the frame, and when placed in position thereon, are appressed closely to it by laying upon them, near each corner, a heavy weight, and strips of an enameled green paper, cut to the width of one inch, are pasted over their edges, extending a little beyond the thickness of the frame, and brought downward over the outside of the frame. On its back, two gum labels, indicating the insects inclosed, are placed at uniform heights (seven and twelve inches), when, if all has been neatly done, they present a tasteful appearance upon a shelf. When there is reason to believe that the case will need to be opened for the change or addition of specimens, it will be found convenient to employ, for the fastening of the left-hand side of the upper glass, paper lined with a thin muslin, to serve as a hinge when the other sides have been cut.

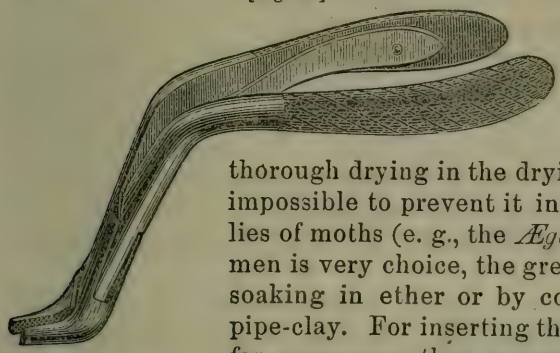
Should it become desirable to bind these cases, outside frames may be constructed after the plans above given, with the omission of the inside quarter-inch, (the equivalent of these frames), in which these may be placed and held in position by two or three screws inserted in their sides.

A similar case, used by Mr. Titian Peale of Washington, is described by Dr. Brackenridge Clemens (Smithsonian Rep., 1858, p. 196).

To hold the pins, various substances may be used, but nothing surpasses cork. It may be obtained in sheets, 12x3½x¼ inches, made expressly. It is for sale by several parties in the East, and is advertised by the Naturalists' Agency, Salem, Mass., and by Mr. Akhurst. The pith of Elder, Broom corn or Indian corn may be used by those who have time to properly cut it into uniform and square pieces; but it should first be boiled to extract the saccharine matter it contains, and afterward very thoroughly dried; otherwise it will corrode the pins. Boiler felt, properly split, has the advantage of cheapness, and is valuable. Where none of these materials can be obtained, two sheets of stiff paper, stretched on each side of a frame ¼ of an inch deep, and supported on a ledge of the same depth, may be fastened into the bottom of the box; and even bog peat, or a couple of thicknesses of blanket, will serve a good purpose. All these linings may be dispensed with in an emergency, and the pins stuck into the soft wood, especially if cut across the grain: i. e., horizontally from the tree.

A collection well mounted and cared for will last indefinitely. It must be kept from the light, which fades the specimens, and by all means from dampness. The preserved insects, if not constantly cared for and watched, will soon be injured or devoured by mites, *Psoci*, *Dermestes*, and other museum pests, against which there is nothing so effectual as vigilance. A little camphor kept in the boxes will assist in preserving the collection from these enemies; but it should not be used too freely, as I incline to think it has something to do in causing the specimens to grease. The best preventive of greasing is thorough drying in the drying box; but it is almost impossible to prevent it in the males of some families of moths (e. g., the *Ægeridæ*). When the specimen is very choice, the grease may be extracted by soaking in ether or by covering with pulverized pipe-clay. For inserting the more delicate pins, and for numerous other necessary operations, different forceps, and especially those shown in figures 22, 23 and 24, will be found invaluable.

[Fig. 22.]



[Fig. 23.]

If the paper in the bottoms of the boxes becomes yellow with age, or soiled in any way, it may be cleansed and whitened by a painting of very finely ground white zinc dissolved in isinglass or milk, and put on with a broad brush. A little corrosive sublimate worked in with the paint will serve to protect the insects.

[Fig. 24.]

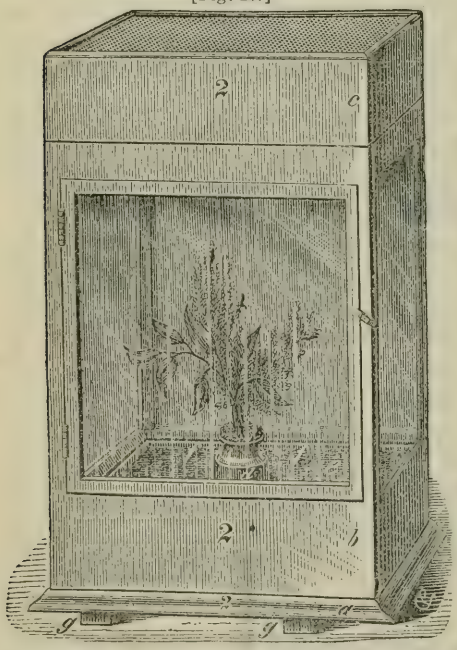
Relaxing.—Specimens which have become stiff before being spread, or which need resetting, may be relaxed by placing them in a tight tin vessel, half filled with moist sand; and a little carbolic acid in the moistening will prevent molding.

Breeding.—Far too little attention has been given by entomologists in this country to the breeding or rearing of insects, notwithstanding it offers a greater field for usefulness, and for original observation, than any other special branch of the science.

Insects are by no means difficult to rear, and there is a genuine pleasure in watching their transformations, and in the anticipation and expectancy with which one looks forward to the ultimate form of some new or unfamiliar larva. If it is gratifying to be able to properly determine and classify a species, it is still more so to be acquainted with it in all its forms, and to understand its curious habits and ways of life.

In the hands of the careful breeder, an insect may be secured against its numerous natural enemies, and against vicissitudes of climate; and will consequently be more apt to mature than in a state of nature. Yet the great secret of successful breeding lies in otherwise supplying, as far as possible, the natural conditions. The breeding of aquatic insects requires properly arranged aquaria, and is always attended with the difficulty of furnishing a proper supply of food. The transformations of many others, both aquatic and terrestrial, can only be studied by close and careful out-door observation. But the great majority of insect larvæ may be reared to the perfect state indoors, where their manœuverings may be constantly and conveniently watched. For the feeding of small species, glass jars and wide-mouthed bottles will be found useful. The mouths should be covered with gauze or old linen, fastened either by thread or rubber; and a few inches of moist earth at the bottom will furnish a retreat for those which enter it to transform, and keep the atmosphere in a moist and fit condition.

[Fig. 25.]



For larger insects I use a breeding cage or vivarium of my own devising, and which answers the purpose admirably. It is represented in figure 25, and comprises three distinct parts: 1st, the bottom board (*a*), consisting of a square piece of inch-thick walnut with a rectangular zinc pan (*ff*), 4 inches deep, fastened to it, above, and with two cross pieces (*gg*) below, to prevent cracking or warping, facilitate lifting, and allow the air to pass underneath the cage. 2d, a box (*b*), with three glass sides and a glass door in front, to fit over the zinc pan. 3d, a cap (*c*), which fits closely on to the box, and has a top of fine wire gauze. To the center of the zinc pan is soldered a zinc tube (*d*) just large enough to contain an ordinary quinine bottle. The zinc pan is filled with clean sifted earth or sand (*e*), and the quinine bottle is for the reception of the food-plant. The cage admits of abundant light and air, and also of the easy removal of excrement and frass which falls to the ground; while the insects in transforming enter the ground or attach themselves to the sides or the cap, according to their habits. The most convenient dimensions I find to be 12 inches square and 18 inches

high: the cap and the door fit closely by means of rabbets, and the former has a depth of about 4 inches to admit of the largest cocoon being spun in it without touching the box on which it rests. The zinc pan might be made 6 or 8 inches deep, and the lower half filled with sand, so as to keep the whole moist for a greater length of time.

A dozen such cages will furnish room for the annual breeding of a great number of species, as several having different habits and appearance, and which there is no danger of confounding, may be simultaneously fed in the same cage. I number each of the three parts of each cage to prevent misplacement and to facilitate reference, and aside from the notes made in the note-book, it will aid the memory, and expedite matters, to keep a short open record of the species contained in each cage, by means of slips of paper pasted on to the glass door. As fast as the different specimens complete their transformations and are taken from the cage, the notes may be altered or erased, or the slips wetted and removed entirely. To prevent possible confounding of the different species which enter the ground, it is well, from time to time, to sift the earth, separate the pupæ and place them in what I call "imago cages," used for this purpose alone and not for feeding. Here they may be arranged, with references to their exact whereabouts.

A continued supply of *fresh* food must be given to those insects which are feeding, and a bit of moist sponge thrust into the mouth of the bottle will prevent drowning, and furnish moisture to such as need it. By means of a broad paste-brush and spoon the frass may be daily removed from the earth, which should, by sprinkling, be kept in a fit and moist condition—neither too wet nor too dry. In the winter, when insect life is dormant, the earth may be covered with a layer of clean moss, and the cages put away in the cellar, where they will need only occasional inspection, but where the moss must nevertheless be kept damp. Cages made after the same plan, but with the sides of wire gauze instead of glass, may be used for insects which do not well bear confinement indoors, the cages to be placed on a platform on the north side of a house, where they will receive only the early morning and late evening sun.

Such are a few directions, of a most general nature, for those wishing to commence to collect and study insects. Experience will teach a hundred others here unmentioned, and the best closing advice which I can give to the novice is to get acquainted, if possible, with some one who already has that experience. You will find him pleasant and instructive company—whether in the field or the closet.

NOTES. — The collector should never be without his note-book, for more profitless work can scarcely be imagined than the collecting of natural history specimens without some aim — some object. Every observation, carefully made, should be recorded, and the date of capture, locality, food-plant, and such minor notes should be attached to

the specimen. More extended notes should be made in a permanent memorandum-book, under numbers corresponding to those attached to the specimens mounted or being reared.

How to transmit Insects. — Insects about whose habits information is desired, should, whenever possible, be sent alive. Larvæ should be packed in some light tin box, along with a supply of their appropriate food-plant. The tighter the box, the fresher will the food, as well as the specimens, keep. Insects do not suffocate so quickly as human beings, and it is worse than useless, in the majority of cases, to punch air-holes in such boxes. Dead specimens may be sent in a variety of ways. Small ones may be dropped into a quill, and inclosed in a letter, or in a small phial, fitted into a piece of bored wood. Those which do not spoil by wetting may be sent in alcohol, or in saw-dust moistened with alcohol. Mounted specimens should always be pinned securely in a cork-lined box, and this packed in a somewhat larger one, with cotton-wadding, or some other yielding substance, in the intervening space, to obviate jarring, and insure safe carriage. When more than one specimen is sent, they should always be numbered. Packages, not exceeding twelve ounces, tied with string, so that they may be examined, and marked "samples," may be sent by mail, at the rate of one cent for two ounces, under the present postal rules.

Text-Books. — The only text-book worthy of the name in this country, is Packard's "Guide to the Study of Insects," already referred to — a work which every entomologist should possess. For the novice, Harris's "Insects Injurious to Vegetation," will prove more pleasant and instructive, and he should read Kirby and Spence's "Introduction." Westwood's "Introduction," although published thirty years ago, is indispensable. The reports of the different States should be consulted, and especially those of New York. These are a few of the more important works, but the number might be greatly multiplied. There is no better text-book, however, than that which lies open before us on every hand — the great text-book prepared for our reading by the Creator. There it is, ready to unfold the great truths it contains, to all who earnestly seek them. I would not decry or depreciate text-books, although — in this country more especially — there are so many inferior and so few good ones; but the student who confines himself too much to them, is apt to get his originality dwarfed, and to become the mere mouth-piece for others' thoughts. By original study and investigation, one escapes from the thraldom of mere words, and we should remember that, as Huxley appropriately remarks, "the study of things and not of words is the source of true knowledge;" and that "there is a world of facts outside and beyond the world of words." In libraries and museums, the entomologist may find the dry bones of knowledge; but only in Nature's own

museum can he clothe those dry bones with beauty and life. Let him, then, go forth into field and wood, where alone he can receive that rapturous inspiration, and experience that unutterable admiration and awe, caused by the mysterious animating force around and about him, and which sends zeal and strength thrilling through every fibre of the earnest naturalist — where,

> Meeting him at every gaze,
> New truths give pleasure and amaze!

NOXIOUS INSECTS.

NOTES OF THE YEAR.

Of the more prominent and important of our insect enemies prolonged experience is continually teaching us something new, and of some of those already treated of in former Reports, I shall, each year, under the head of "Notes of the Year," bring together such additional facts and discoveries as are worthy of being recorded. These notes are therefore intended to supplement the original articles, and I shall endeavor to avoid anything like repetition of what has already appeared. By thus adding the observations of the year, the original reports will be rendered more complete and circumspect.

THE CODLING MOTH.

The first moth was bred this year, from larvæ which had wintered out-doors, on May 7th, and the first one captured, at large, May 14th. The experience of the year is of importance, more especially as giving a confirmed estimate of the value of

WIER'S APPLE-WORM TRAP.

Fully resolved to test this trap thoroughly, in comparison with other methods of allurement, I commenced (having, of course, purchased the right to use!) as early as the first of May to prepare a number of trees as follows: 1st. With Wier's trap screwed on in different positions—some trees having single traps, either on the north, south, east or west sides, and placed at different heights from the ground, and some having as many as three traps; 2d. Strips of old sacks, four inches wide, and lined on one side with pieces of lath tacked on transversely, and at such distance from each other that, when brought around the tree, they formed an almost complete wooden

ring; 3d. Bandages of various kinds of rag; 4th. Hay ropes; 5th. Paper bandages, made of the cheapest kind of straw paper, folded several times, and in widths varying from three to six inches. In order to insure the utmost accuracy, these several traps were regularly examined every twelve days throughout the season, and a careful account kept of the worms or chrysalides found under each; and where it was a question as to the comparative merits of the different traps, they were placed on trees of the same variety. The results of these experiments—not to waste space with the detailed array of figures—may be thus summed up:

No apple-worms were found until the 14th of June, and, though many other insects had previously taken advantage of the shelter, *not a single Plum Curculio was found.* While, therefore, there is no harm in having the bandages on as early as recommended last year, in ordinary seasons, little, if anything, will be lost by waiting till the first of June. Where three of the Wier traps were on the same tree, I obtained more worms than where there was but one; and where there was but one, there was no difference in favor of position, as regards direction or altitude—taking the season through. The lathed canvas encircling the tree secured, on an average, five times as many worms as any single Wier trap. The rag, paper and hay bandages allured almost as many, and either kind more than the single Wier trap.

I hope, therefore, that the patentees have already realized the anticipated fortune from their invention; for while I should be sorry to injure their chances in the least, truth compels me to state that, after a year's trial, I am not quite as favorably impressed with the usefulness of this shingle-trap as I was before trial, and am more thoroughly confirmed in the opinion expressed last year that, "notwithstanding all the theories of my friend Wier, it must always be inferior to any trap that encircles the tree." I do not wish to detract from its merits one jot, and where old shingles are abundant and other material scarce, the former will still prove valuable for the reasons given a year ago; and Mr. Wier would deserve our thanks for showing us how to use them, did he not persist in claiming too much for them, and in making us pay for their use.

Time, expense and efficiency considered, and so far as one year's comparison will warrant conclusions, I place the different materials enumerated in the following order of merit:

1.—Paper bandages. Common straw wrapping paper, 18x30, can be bought for sixty cents per bundle. Each bundle contains 240 sheets, and each sheet folded lengthwise thrice upon itself, will give us eight layers, between two and three inches wide, and be of sufficient length to encircle most ordinary trees. It is easily drawn around the tree and fastened with a tack, and so cheap that when the time comes to destroy the worms, the bandages containing them may be

detached, piled in a heap and burned, and new ones attached in their places. If eight bandages are used to each tree during the season, the cost will be just two cents per tree; and the owner could well afford to treble the number of sheets, and keep three on each tree, either together or in different places.

2.—Rags. These have very much the same effect as paper, but are more costly and difficult to get of the requisite length. Where they can be had cheaply, they may be detached from the tree and scalded with their contents.

3.—The Wier-trap, used as recommended last year, is, perhaps, the next most useful; but both cost and time required to destroy the worms, are greater than in the first two methods.

4.—The lath belt is the very best of all traps, so far as efficiency goes; but it is placed 4th on the list, because of the greater cost and trouble of making. On the same kinds of tree, (Early Harvest), and in the same orchard, I have taken, with this belt, between June 15th and July 1st, as many as 68, and 99 larvæ and pupæ, against 14 and 20 in the single Wier-trap.

5.—Hay-bands, on account of their greater inconvenience, I place last.

The experiments were mostly made in a large and rather neglected orchard, belonging to Mrs. Spencer Smith.

All these methods are good, and the orchardist will be guided in his choice by individual circumstances.

JARRING.

Regarding this plan, I reproduce the following item, which I sent to the *Country Gentleman* last summer:

"Being much pleased with Mr. Chapin's method of freeing his orchard of apple-worms, as described in your issue for January 25th, I inserted a description of his process in my fourth Report, with a few comments as to the time when the jarring should be commenced. Mr. Chapin commences when the little brown masses of excrements are first observed on the outside of the apples, generally near the blossom end. As these masses of excrement — these "exudations," as Mr. Chapin terms them—are usually sure signs that the worm has already left the fruit, it struck me that jarring should commence somewhat earlier, and I suggested the first rather than the middle of July. But I find this spring that this excrement is only an indication of the worm's exit, with some varieties, while with others the worm may be often found after these exudations are visible. In justice to Mr. Chapin, I take the first opportunity to make the correction. Our blossoming season, in this latitude, was nearly two weeks later than usual, and I caught the first worms, under bandages, on the 13th of June."

To prevent bruising of the branches, it will be well, as suggested by Mr. J. Fitz, of Albemarle county, Virginia, (*Country Gentleman*, August 2), to use a light pole, with a short fork, padded with some soft material at one end. This can be jarred by means of a mallet.

As confirmatory of the fact that the Apple-worm

ATTACKS PEACHES,

I last fall received specimens of this fruit, infested with it, from Geo. T. Anthony, of the *Kansas Farmer*.

ALREADY FOUND IN CALIFORNIA.

There were several reports, during the last year, that this insect has been noticed in California; though how truthful they are, I have no means of ascertaining.

NATURAL ENEMIES—DISCOVERY OF TWO PARASITES.

In addition to the two cannibal larvæ which I have described as feeding on the Apple-worm, I can now add two genuine parasites to the list of its enemies. If we except a species of hair-snake, belonging probably to the genus *Mermis*, and which Mr. P. H. Foster, of Babylon, New York, has found on two occasions infesting it,* no true parasite of the Apple-worm has ever been discovered in this country. I have the past year discovered two. Both of them are Ichneumon-flies, and the first may be called

[Fig. 26.]

THE RING-LEGGED PIMPLA (*Pimpla annulipes* Br.)—This is a black fly, varying considerably in size, the female sometimes measuring but $\frac{1}{4}$, at others fully $\frac{1}{2}$ inch, exclusive of ovipositor; the male somewhat smaller. The genus *Pimpla* was briefly characterized in my last Report, (p. 43), where it was shown that this same species attacks the Walnut Case-bearer (*Acrobasis juglandis* LeB.) I annex a lateral outline of a female *Pimpla* (Fig. 26). The male has a more slender abdomen, which is unarmed.

PIMPLA ANNULIPES is black; the abdomen rough-punctured above, with the borders of the joints polished and inclined to brown. The tegulæ are white, and the legs are reddish, with the exception of the middle and hind tibiæ, which are dusky—especially the hind pair—and have a broad white annulus, sometimes indistinct on the middle pair. The posterior tarsi are dusky, especially at tip. The palpi are pale-yellow. Cresson says it may be distinguished from the other species of the genus, by the scutellum being black, the tegulæ white, and the anterior coxæ yellowish-red.

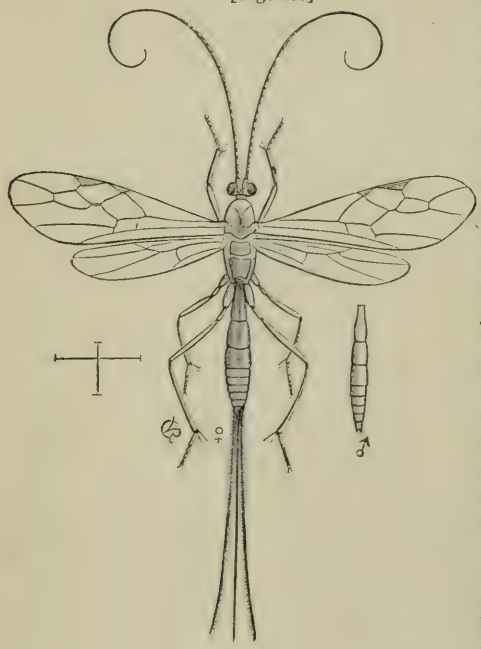
This fly eats its way through the chrysalis and cocoon of the Codling-moth, without having previously made any cocoon of its own. It

Gardeners' Monthly, May, 1872.

was quite abundant last summer, as from one lot of 162 *Carpocapsa* cocoons I obtained 21 parasites—all of them females but one. It is a widely distributed, and common species. The second parasite may be called the

DELICATE LONG-STING (*Macrocentrus delicatus* Cress.).—It has recently been described by Mr. E. T. Cresson, (Transactions Am. Ent. Soc., IV, p. 178), and is a somewhat variable species, occurring throughout the Eastern, Middle and Western States, and in Mexico I subjoin a description, drawn up from my bred specimens:

[Fig. 27.]



♂—Length 0.25; expanse 0.45 inch. Slender. Color pale, polished, honey-yellow; uniformly and sparsely pubescent; tinged with brown superiorly, the basal joint of abdomen and a medio-dorsal line on the other joints being quite brown. *Head*, with the eyes, (except at disc), and a spot between ocelli, brown-black; palpi long and almost white; antennæ ¼ longer than the whole body, about 48-joints, exclusive of bulbus, curled at tip, the ends of basal joints and the whole of apical joints dusky. *Thorax*, with the sutures well defined, and two small triangular black spots behind front tegulæ, the metathorax strongly trilobed; legs very long, pale honey-yellow, with tips of tibiæ and tarsi faintly dusky; wings yellowish, hyaline and iridescent, with the veins luteous, and the stigma pale honey-yellow.

♀—Rather larger, and with the abdomen somewhat paler, otherwise similarly marked. Ovipositor yellow, 1-5 longer than body, the sheaths quite pilose, and inclining to fuscous.

Described from 2 ♀'s, 1 ♂.

It is a graceful fly, with very long antennæ and legs, and the female with a long ovipositor (Fig. 27). The color is pale honey-yellow, inclining to brown above. The unfortunate Apple-worm is probably pierced while yet in the fruit, as it always succumbs soon after forming its cocoon, and before changing to chrysalis; while in the case of *Pimpla*, it is probably attacked either while leaving the fruit or after having spun its cocoon. The larva of the Delicate Long-sting forms, for itself, within the cocoon of its victim, a sufficiently tough, thin, oblong-oval, shiny, brown cocoon, from which the perfect fly issues by cutting open a lid at one end.

As both of these parasites transform within the *Carpocapsa* cocoon, it is next to impossible, and quite impracticable, to separate friend from foe in removing and destroying the contents of the band-

ages. But where it is desired to disseminate the parasites, they may be bred by inclosing large numbers of *Carpocapsa* cocoons in some tight vessel. The apple crop was abundant, and the Codling-moth comparatively harmless in most parts of the country the past year, though whether or not this abundance was in any way connected with the work of these parasites, it is useless to speculate.

The *Pimplas* were, most of them, bred from cocoons taken from the lathed bandages, and the spaces between the pieces of lath may have more easily permitted the access of the Ichneumon-fly than was the case with some of the other bandages.

Besides these parasites, and enemies previously alluded to, I found that ants, cockroaches, and the larvæ of certain predaceous beetles,* played by no means an unimportant part in destroying the apple worms.†

FALSE DOCTRINES.

An apparently plausible method of eradication has been proposed by Dr. J. S. Parker, of Ithaca, N. Y. In an article in the *Maine Far-*

* The larva of some species of *Trogosita*, and closely resembling that from which I have bred *Trogosita nana* Melsh., was frequently found at this work.

† While this is going through the printer's hands, I notice that Dr. LeBaron has made similar and corroborative observations regarding a *Trogosita* larva (*Prairie Farmer*, April 12, 1873). He also publishes the following communication from Mr. G. W. Shaw, of Decatur county, Iowa:

In the spring of 1870, I planted among my currants the Early Goodrich potatoes. Currants were six by six feet apart. When the potatoes were fairly up, the Colorado potato beetle commenced upon them. I tried hand-picking, and for the first time became acquainted with the soldier-bug, seeing him spear the young potato beetles. The next spring, 1871, the currant bushes were alive with the currant worm. It seemed almost useless to try and pick them off. I commenced, however, and the second day was rewarded by seeing the soldier-bug spearing them, and in a few days not a currant worm was to be seen. This season the codling moth, or apple worm as it is called, was very bad in my orchard; nearly every apple had a worm in it. I noticed very many of the soldier-bugs on the trees. They would pass up and down the branches, and when they came to an apple would go down to the blossom end and stick their bill into the calyx of the apple, and remain as long as five minutes, as I then thought, sucking the juice out of the apple. In June, 1872, I saw a soldier-bug sucking an Early Harvest apple, and watched him for some minutes. When he was through, he folded his bill under his body and moved to another apple, and what was my surprise to see the skin of an apple worm on the blossom end of the apple that he had just left. It seemed very strange to me that I had spent ten or twelve years in the orchards and had never known before what the soldier-bug was after. Frequently after that I saw the beetle take the worms out. At other times, after cutting the apple open, the worm would be found dead. The part of the orchard near the currant plantation was much less affected by the codling moth than that farther off.

This is certainly a very interesting observation, but will need corroboration before being accepted. Mr. Shaw is evidently not much of an entomologist, else he would not use the term beetle in referring to a Heteropteron; and though this is nothing to be ashamed of, it renders us less ready to receive his conclusions as valid when we reflect on the following facts: 1. The beak of the Spined Soldier-bug (4th Rep., Fig. 9) is, at the most, not more than 1-5 inch long (I speak from memory) and I have never seen it inserted above the terminal joint. 2. It would, therefore, be of little service, except when the fruit is very small. 3. Until the apple-worm is nearly grown and the fruit has acquired some size, there is seldom any outward sign of the work of the worm, which enters by a very minute hole, and, for the most part, bores in the heart, around the core. 4. It could not be pulled out of such fruit by a haustellate bug, which can only penetrate and pierce, and not cut. 5. There are many other Half-wing bugs which few but the entomologist could distinguish from the Spined species in question, and which are vegetarian in habit, but occasionally suck the juices of soft-bodied larvæ. 6. There is another and smaller worm, namely, the larva of what Mr. Walsh called the Plum Moth (*Semasia pruniivora* Walsh), which is quite common on haws and apples. It does not penetrate deeply into the apple, but remains around the calyx, and generally spins up there; and it so closely resembles the young apple-worm that the two might easily be confounded.

While, therefore, I do not doubt but that *Arma spinosa* would stab an apple worm if it got a chance, it will require better proof than we yet have to make me believe that it pulls this worm out of its hidden abode.

mer for June 1st, 1872, in which nine-tenths of all the apples set in 1871 are said to have been either totally lost or greatly damaged, he suggests that the insect might be well-nigh exterminated, if, by united effort, we could forego one year's crop, by knocking off all the young fruit. He fails to attach sufficient importance to the fact that the insect breeds in wild crabs, pears, peaches, and even plums.

THE COLORADO POTATO BEETLE.

One of the characteristic features of the past year was the comparative harmlessness of this insect. What with the increase of its enemies, and the thinning out in its ranks which took place the previous year, it did comparatively little damage with us, though somewhat conspicuous early in the season in Phelps, Perry and other counties. The decrease in its numbers seems, also, to have been very general over our own country, as the newspapers were unusually free from reports of its injuries. In Ontario, it has increased and spread, though not to the extent anticipated.

NEW FOOD PLANTS.

Mr. J. D. Putnam, of Davenport, Iowa, who was out collecting in Colorado during the summer, reports having found the larvæ on Stickseed (*Echinospermum strictum*), common Pigweed (*Amaranthus retroflexus*), and a wild Sunflower (*Helianthus peteolaris*). These plants belong to three distinct families, and Mr. Putnam believes that the larvæ were feeding on them.

ITS PROGRESS EASTWARD.

In 1871, this insect had reached the western borders of Pennsylvania and New York. Last year it extended into Cattaraugus county, N. Y.,* and obtained a foot-hold as far east as Lancaster county, Pa. In July, my valued correspondent, Mr. S. S. Rathvon, informed me that it had reached that county, and in the Lancaster *Weekly Express* for July 6th, he gave a long account of it, urging vigilance in its destruction upon those who were being visited by it. From later accounts, there were no insects to be seen after the middle of Sep-

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* *Rural New Yorker* for Aug. 3rd and Aug. 17th, 1872.

tember, and it is barely possible that, by being forewarned and forearmed, the farmers succeeded in eradicating the evil; especially if, as I believe, the arrival of the pest at a point so far east was premature and artificial. Had its appearance in Lancaster county been the result of its gradual spread, we should first have heard of it in the intervening western counties of the State, and it would have been beyond human power to stay its irresistible march. But all the evidence points to its transportation with some cargo, on the railroad.

The southern columns have extended somewhat east of Louisville in Kentucky, for they were abundant around Harrodsburgh, in Mercer county, as I learn from Jas. B. Clark, editor of the *People* of that place.

These are the only trustworthy records of its eastward progress which have come to my knowledge; for though other reports have been made, there is no more proof that some other insect was not mistaken for it than there is in the statement in the monthly report of the Department of Agriculture for July, that it was found in one county in each of the States of Virginia, North Carolina, Alabama and Tennessee—a statement evidently loose.

With regard to the safety of the

USE OF PARIS GREEN,

Prof. W. K. Kedzie, of the Michigan Agricultural College, has made some interesting experiments. In a paper read before the natural history society of the college, he showed how the green was insoluble in pure water, and that where water was charged with carbonic acid or ammonia, the very small portion that is dissolved is quickly converted into an insoluble precipitate with the oxide of iron which exists in our western soils. He shows just as conclusively that there would be great danger in using pure arsenic—even were it as effectual as the green—for the reason that it is soluble to such an extent that it could not be neutralized by the oxide of iron in the soil.

Prompted by the report from the Department of Agriculture, to the effect that peas planted in soil mixed with the green rotted immediately, I made the following experiment with peas and the mixture of one part green, twenty flour: I planted five rows of peas, using no green on the first, a little on the second, and increasing the amount on the others, so that on the fifth the peas had, in addition to that mixed with the soil, a covering of about one-eighth of an inch. The peas all grew and bloomed without noticeable difference, and were finally eaten by a cow.

NEW ENEMIES.

So little troublesome was this *Doryphora* in my own neighborhood, that, with other more pressing duties, I paid little attention

[Fig. 28.]

to it, and made few personal observations. But from facts communicated by Mrs. H. C. Freeman, of South Pass, Illinois, it is safe to add to its natural enemies the Rust-red Social Wasp (*Polistes rubiginosus* St. Farg.), which carries the larva to its nest.

Figure 28, *a* shows this wasp, and *b* the manner in which her spring nest is built.

In July, Prof. C. E. Bessey, of Iowa Agricultural College, wrote me word that he found the Rose-breasted Grosbeck, (*Guiraca ludoviciana*), devouring the potato beetles, and soon afterward, the same bird was sent to me by E. H. King, of Steamboat Rock, Iowa, with a similar statement. Other persons, especially in Iowa, observed the same trait in this bird, which, though formerly quite rare, seems to have suddenly multiplied and acquired this habit. Mr. Joel Barber, of Lancaster, Wisconsin, informed me that this bird, though seldom seen there before, was quite common in that vicinity about the first of June, breeding there, and clearing potatoes of the nasty "bugs," which it seemed to prefer to all other food.

The Rose-breasted Grosbeck is a beautiful and conspicuous bird, the male having a heavy bill, with black head, black back varied with brown, and black wings, the latter with three white bands. Some of the outer tail-feathers and parts of the abdomen are white, and the breast is rose-red.

THE APPLE-TWIG BORER—*Amphicerus bicaudatus* (Say).

This insect (Rep. 4, p. 51) has at last been found on the Atlantic sea-board, as I have received it from Mrs. Mary Treat, of Vineland, N. J., who found it boring into pear twigs. It has also been found in pear trees, received from Patapsco, Md., * but without any evidence that it came from that place. Regarding its larval habit, Dr. Henry Shimer has just informed me (March 24th) that he recently found a brief note of the breeding of this insect from grape-canes, the note being attached to the insect bred. This substantiates the statement in Packard's *Guide*, giving at least one known food-plant for the larva, and proving the great similarity between it and that of the Red-shouldered Sinoxylon, (*Sinoxylon basillare*, Say). The perfect beetles, received in the spring of 1872, have been kept alive for over five months, feeding on grape-vine, in a small phial.†

* *Country Gentleman*, June 13th, 1872.
† *Rural New Yorker*, Oct. 12th, 1872.

EGG OF THE HORNED PASSALUS — *Passalus cornutus* Fabr.

In my last year's account of this fine beetle occurs the sentence, "As larvæ only half-grown are found in company with those that are full-grown, they require at least two years to mature." This conclusion, though a very natural one, is entirely opposed to the facts. I have been surprised at the rapid development of the species which I have been able to breed from the egg. The eggs, which are deposited under the loose bark of decaying logs, are ovoid, with an average length of 0.12 inch, and diameter of 0.10 inch. The shell is smooth, flexile, but tough, and of various shades of olive-green, yellow, or brown. The newly hatched larva differs only from its full-grown self in having the legs relatively a little longer, the rudimentary pair mere fleshy tubercles, and in having four superior equi-distant, longitudinal rows of stiff rufous hairs as long as the diameter of the body, and each row one to a joint, except on the thoracic joints, where the lateral row is composed of several. The sides of the head and the ventral surface of the penultimate and terminal joints are also armed with such hairs. These hairs are very conspicuous, but in the mature larva they are either wanting entirely — being indicated only by the minute tubercle from which they sprang — or else are greatly reduced.

The eggs hatch all along through the month of July, and the larvæ acquire their growth and become pupæ in the amazingly short period of six weeks. It is for this reason that we find them of different sizes at one and the same time. The rudimentary legs are capable of a sudden and rapid side motion, which I have occasionally witnessed.

My stricture on Mr. Walsh's use of the term "decussated on the sternum," in describing the position of these rudimentary legs, was induced by a too restricted definition of the word, and is hardly warranted, according to Worcester.

EGG OF THE COMMON MAY BEETLE — *Lachnosterna quercina* (Knoch).

The eggs of this beetle, (Rep. 1, Fig. 88), which, so far as I am aware, have not been described, are white, translucent, spherical, with an average diameter of 0.09 inch. They are deposited between the roots of grass, and are inclosed in a ball of earth, evidently formed by the ovipositor of the female before deposition, as the cavity is sufficiently large for the egg to roll about in.

EGG OF THE BROAD-NECKED PRIONUS—*Prionus laticollis* Drury.

The eggs of this species (Rep. 2, Fig. 61) are elongate-oval, 0.15 inch long, and three times as long as wide. They are bright yellow, opaque, faintly granulated, (or rather impressed with abbreviated striæ), and fastened by a glutinous substance to stumps and old trees, about half an inch below the surface of the ground. The process of oviposition has been well described, (*Rural New Yorker*, July 20th, 1871), and I have obtained upward of 140 eggs from a single female in one night. The eggs of the other species of the genus are doubtless similar.

EGGS OF AMERICAN TENT-CATERPILLAR—*Clisiocampa Americana* Harr.

The figure of the egg-belt of this moth, which I have already given, (3d Rep. Fig. 50, *c*), is incorrect, in that it indicates the eggs to be bare, whereas, as described in the text, they are thickly covered with a glue-like varnish, which almost conceals them. That figure was not made from nature, and I was misled, at the time, by an incorrect figure given by Emmons in his "Insects of New York." The annexed figure (29) will give a far more correct view of the unhatched mass. There is some variation in the amount of glutinous matter covering the eggs, which are, at times, quite visible, at others not; and this difference may be connected with the difference of climate.

[Fig. 29.]

COUNTERWORKING THE TOBACCO WORM.

Mr. E. M. White, of West Fork, Reynolds county, sends me the following account of his method of counterworking the Tobacco or Potato worms, (1st Rep. p. 95):

"In every tenth hill on the outside rows of my field, I sow the seed of Jamestown Weed, (*Datura stramonium*), instead of setting tobacco plants. As the Daturas grow up, I pull out all but two to each hill, and when these are in bloom, I go around every evening, and, after destroying all but two flowers, pour into these a few drops

of common fly poison, mixed with sweetened water and whisky. [the fly stone of druggists is intended, it being an ore containing cobalt and arsenic]. The moths sip the poison, and die from it, and I find them scattered over the farm for a space of several hundred yards."

Mr. White's testimony corroborates that of many others who have killed these large Sphinx moths in the same manner.

THE GRAPE PHYLLOXERA.*

I have little in the natural history of this insect to add to the account given in last year's Report; nor have I found any occasion to alter the views then and there given. A few remarks, however, embodying the observations and discoveries of the year, on such an important insect, will naturally be expected. The reader can get some idea of the interest attaching to this insect when I state that in a bibliographical review† lately published by my friends Planchon and Lichtenstein, notices and summaries are given of 484 articles or treatises published during the four years of 1868–71.

MORTALITY OF VINES LAST SPRING.

There was very general complaint last spring of vine mortality, and this not from one but from many sections of our vine-growing country. This unusual mortality has been attributed to a variety of causes; and, after citing the views of a few grape-growers and horticulturists whose eminence and reputation entitle them to respect, and whose experience adds weight to their opinions, I shall endeavor to show how the Phylloxera, though generally left entirely out of the calculation, had much to do with the singular death of vines in the spring of 1872. In quoting these opinions, and to save time and aid precision, I shall italicize and number such passages as I wish more particularly to call attention to afterward.

First, we have the editorial opinion of the *Rural World*, as given in the following quotations from the number of that journal for June 1st, 1872:

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*This word, though it really means "withered-leaf," has already become so well known and popular that it is as significant to the vine-grower as are the words "root-louse" and "gall-louse;" and has the advantage of tersely expressing and comprehending both these compound terms. It is also being used to designate the disease caused by *Phylloxera vastatrix* Planchon, (the scientific name *vastatrix* is universally being employed, and Fitch's *vitifoliæ* will have to give way,) just as the generic term Oidium is popularly used to designate the mildew caused by *Oidium Tuckeri*. The term *Phylloxera* will, therefore, in future not only apply to the insect, but to its effect on the Vine.

† *Le Phylloxera; Faits acquis et Revue Bibliographique, par* J. E. Planchon *et* J. Lichtenstein. Montpellier, 1872.

MORTALITY AMONG VINES.—We have had our attention called to the great mortality among grapevines in some places, especially in St. Louis and Franklin counties.

There are two distinct stages of disease, or degrees of injury, visible among the vines. (1) First, *whole streaks or stretches in the vineyard are killed dead, and now dried out. The form of the portion is often quite irregular;* but we have, in every case, seen that there are certain analogies existing between the forms and two special facts that are subsequently stated. Second, there are very large and irregular pieces of vineyards in which the shoots are pushing very slowly, and in many cases are not more than three to six inches long, while the other portions of the vineyard have shoots over fifteen inches in length.

Among those who have lost heavily are our old, intelligent friends and neighbors, F. Braches, C. Paffrath and A. Stricker, while there are scores of others whose vines are in the second stage named.

Insects in general are claimed by some; others specify the root-louse as the cause. (2) *There is no special or direct evidence of the root-louse being at work at all. Neither the naked eye nor the magnifying glass can detect their existence on roots of the vines.* In the position of the vines they are liable to be affected by the drouth; the energies of the vines have been too severely taxed in the attempt to perfect the crop of fruit. As one or both of these influences were at work, the effect has been a reduction of vital energy, or the entire death of the vines.

In every instance of which we are advised, heavy cropping has been very clearly indicated. Some of the vineyards were exhibited last fall with a distinct reference to their abundant crop and liberal display of new growth; but, as the case now stands, we invite the attention of grape-growers, and solicit the full facts and opinions bearing on the subject.

That well-known and experienced grape-grower, Hon. F. Muench, sums up his views as follows, in the same journal for August 3d, 1872:

GRAPE MORTALITY.—During the first months of the summer, the vintner has to attend to his cherished vines with so much solicitude and care that he can hardly afford to engage in anything else. July will bring some relaxation, and thus I will once more take up the pen, instead of the knife and hoe, and make some remarks on the state of our vinicultural efforts.

I find the appearances of "mortality among the vines" correctly stated in No. 22, present volume of this paper; the evil, however, extends far beyond the counties of St. Louis and Franklin, in our State; it may, indeed, be traced through all of the Western States, more or less. The effect is before our eyes, but about the cause the vine sages differ. Let me briefly say what observation and experience have suggested to me.

What in the vine is called the inner bark, or liber, is, I think, in all plants with stems enduring through the winter—such as forest and fruit trees, vines, bushes, etc.—denominated *cambium*. It consists of a green, marrow-like matter, between the outer bark and the woody part of the stem or branch; is chiefly formed in the latter part of the season, and designed as the material from which, in the following spring, the first leaves sprout and also the blossoms come forth. The more completely formed and the more richly stored up the cambium is, the more vigorous will be the first growth of the whole plant, or of its several branches in the next season, and also the greater the productiveness. Different reasons may operate singly or in combination to prevent the proper formation of the cambium, such as—

1. A very poor soil.
2. A superabundance of branches and limbs.
3. A decrepid or otherwise sickly state of the plant.
4. Injury to the roots or leaves.
5. Very early frosts, or a fall time too wet and cold.
6. Overbearing.
7. Such a dry autumn that the scorched ground affords no nutriment to the tender capillary rootlets.

From all that I can see, and as a general thing, the two last mentioned causes combined have effected the mischief.

Last year most of our vintners had allowed their vines to bear about one-third more than is proper to allow. Such greediness is generally punished by the inferior quality of the fruit, by incomplete maturity, and also by a stunted growth of the vines in the following season—that is, by the want of the necessary new bearing wood. It was not so last year; already early in the season, sufficient new bearing wood, apparently sound and vigorous, had been formed, and the warm weather, uninterruptedly continued through September and the first half of October, not only matured our grapes, but developed in them such an amount of grape sugar as I have never witnessed

before. But therewith the whole natural power of the vines was fully exhausted; nothing, or too little, could be done for the shoots, the arid and impenetrable soil refusing to contribute any portion of alimentary substance.

What are the young shoots in the primary part of the season? A watery substance which afterward must be consolidated and furnished with the necessary ingredients; and just that was not done. I have examined such last year's shoots early in the spring, and found that their cambium amounted to nearly nothing. No wonder that such vines made either a scanty and sickly growth, or none at all.

(3) *The remarkable circumstance, that on the same piece of ground some of the vines are just as we could wish, and others either sickly or dead, may thus be accounted for: The one vine may have suffered by too heavy cropping, the other not; the one may have been naturally more vigorous, the other more feeble; here the subsoil may be more porous, there it may have been fully dried out and hardened, like a threshing floor; surely, neither the root-louse nor the winter frost had anything to do with this unexampled mortality.* The best thing that could be done, anyhow, was to cut back the vines to a few buds, near the ground, as soon as this morbid condition could be ascertained.

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From an interesting article in the *Cleveland Herald*, by F. R. Ellicott, in which the author gives an account of the exceptional death of many other deciduous and evergreen plants, and his belief that it was owing mainly to want of moisture, I abstract those passages which particularly refer to the Grape-vine:

It is this same want of moisture food to the roots that has caused more or less of Walter, Diana, Iona, as well as other late growing varieties of grapes—(4) *and especially of those having a large per centage of foreign blood in them*, such as Diana, Hamburg, Weehawken, Rebecca, Croton, etc.—to die out since the incoming of spring; for many of them now dead were, on the first of March, apparently perfect; as cuttings we now have, made at that time, show, and are growing, while the vines from which they were cut are dead. * * * * * * * *

Many vineyards of Catawba and Delaware are more than half destroyed, and even many vines of Concords. *Young vines, and those of strong growth and on sandy soils, have come out best.*

Dr. S. J. Parker, of Ithaca, N. Y., after showing (*Country Gentleman*, June 29, 1872) that nearly two-thirds of all kinds of grape-vines were partially or entirely killed, (5), *and that the Isabellas and Catawbas suffered most*, concludes with the following paragraphs:

Yet this much should be said. In vineyards trimmed early in the fall, and whose canes lay on the ground, the loss is hardly perceptible in a few instances. And it is not easy to explain why a vineyard like Mr. Baker's has his fine Rogers in beautiful estate, and his Isabellas, etc., also largely escaped, while others, with similar care and earlier attention, have suffered.

This is no trifling evil, and its causes and consequences need to be commented on. Let us first have the extent of this unusual damage and its peculiarities, and then, and not until then, *theory*, and the lessons to be learned by it. *That the remarkable dryness is connected with it I am certain; yet this can not be all.*

These extracts are from among many that might be given, but as they come from well-known writers, and include all the rational theories propounded, it is needless to quote further.

We see from the above that two principal causes are given to account for the result stated: 1st, Drouth; 2d, Overbearing. A third, namely, winter-killing, has been often urged; but meteorological data show that there was nothing unusually severe in the winter of 1871–2, at least in our section of the country, and the experience of Mr. E. A. Riehl, as given at the August (1872) meeting of the Alton (Ills.) Horticultural Society, proves pretty conclusively that winter-killing

should not be taken into account. In the fall, before cold weather set in, he cut 150,000 grape cuttings, which he put in a frost-proof cellar and preserved carefully; after putting them in sand they calloused and rooted well, but many had not enough vitality to push the eye, so that he did not make more than one-third of them live, though there was no chance of winter-killing, as the cellar was kept at an even temperature of about 55 deg. F.

That the excessive drouth had much to do with our grape-vine mortality, as it had with the mortality of evergreens and other plants, is quite evident. But that it was not the direct cause there would be serious reasons for believing, even were there no evidence of the fact in the above-quoted experience of others. The Grape-vine rather delights in dryness, and has been known to do well and yield abundantly under conditions of drouthiness which have killed evergreens and other trees. Moreover, this influence alone will not fully explain the irregular manner in which vines, under precisely similar conditions of soil and elevation, were affected; nor the greater mortality of some varieties than of others under such similar conditions.

Nor can the result be attributed to overbearing alone, for though cases of overbearing may have occurred, there is abundant evidence of vines dying where the yield, the year preceding, had not been larger than it is wont to be. Remembering also that in the spring of 1871 there was a late frost on the 17th of April, which cut off almost universally the first fruit in the more central portions of our own State, and that the crop consisted of the latent or secondary bunches, it is difficult to conceive how our grape-vines, speaking generally, can be said to have overborne, except where—already sick and injured from other causes—they were making that final effort at fruitfulness which so often precedes death; and where, consequently, such undue fruitfulness was the effect rather than the cause of disease. Mr. Horace Holton's vineyard at Webster Groves was so severely injured by the late frost of 1871 that it bore no fruit whatever that year; yet his vines suffered with the rest in 1872.

If then the undue mortality of grape-vines can not be solely attributed to either of these causes, what other influence would most nearly account for the facts in the case? I unhesitatingly answer *Phylloxera!* There is much that would go to prove this in the writings which I have quoted, as indicated by the italicized passages. We find that (1) the death has been noticed in streaks and stretches in the vineyard; that (3) in the same piece of ground some vines were sound and healthy, while others were either sickly or dead, and that (4) those varieties which most succumbed were those having a large per centage of foreign blood in them, or (5) else *Labruscas*, or, in short, just the very varieties which I have shown to be most injured by this insect. The fact (2) that there was no special or direct evidence of the root-louse "*being at work*," or that neither the naked eye

nor the magnifying glass could detect its existence on the roots, is precisely the state of things to expect whenever the lice have been injuriously or fatally abundant the previous year; and I can not too strongly or earnestly enforce the fact upon our grape-growers that by the time a vine dies, or is brought to death's door, by these root-lice, we can only discover the evidence of their work, as the lice themselves are no longer to be found.

But there is better proof than this circumstantial evidence, of the sorry part played by Phylloxera in the unwonted death of grape-vines last spring. That the lice were injuriously abundant on many kinds of vines, and in many parts of the State, in the fall of 1871, I know from personal experience, and have sufficiently shown; and in the spring following the more or less complete destruction of the roots, we might naturally have expected to find either lack of vitality or death of such vines. I also made a careful study of the mortality in the spring, digging up many dying or dead vines in the vicinity of St. Louis, and in every instance I found that the finer roots had wasted away, and that the larger ones were hypertrophized just as they are when injured by the root-lice; while upon those not yet dead there was no difficulty in finding the more living evidence of disease in the shape of the lice themselves, and the knots which they caused. In a vineyard belonging to Charles Paffrath, of Melrose, referred to in the extracts, I found a forcible illustration of the influence of Phylloxera. This vineyard is on a gentle slope, and is composed mostly of Catawbas, with which the owner has been quite successful, owing, as I believe, to the great pains which he takes to keep the roots healthy and vigorous, by first mellowing his soil to a great depth, and then planting with the utmost care. In this vineyard were both young and old vines, and the former had not suffered at all, while the latter showed greatest mortality, not in the higher or drier portion, but along certain middle rows, and mostly in the center. I examined the roots of many of these dead vines, as well as of some in the immediate vicinity of them, and was able to show the rotten and exhausted roots of the former, and the lice at work on the latter; and thus convince the owner, as well as Mr. Wm. Coleman, who was present at the time, that the lice, though unseen and unheeded, had not been unoccupied. No man could have been more skeptical as to the working of these lice than Mr. J. J. Kelly, of Webster; yet in a half day spent in his vineyard I was able to convince him that they had played an important part in the death of his Catawba vines. And so of others.

To summarize from the known facts in the case, I am of the decided opinion that, while the unprecedented drouth may be justly looked upon as the indirect cause of the trouble, the more immediate and direct cause must be attributed to Phylloxera. The meteorological conditions served to promote the undue increase of the lice at the same time that they rendered the vines less capable of resisting

depletion of sap. The conditions of a soldier in an army—where many are camped and barracked together, and where it is difficult to obtain hot water wherein to wash one's under-clothes—are favorable to the increase of certain body parasites, and other more invisible organisms, which produce disease. Yet, while in such a case the conditions have assisted, it is very palpable that the organisms are the direct cause of disease; and that if they can be warded off or removed, the disease may be prevented, though the conditions remain. Precisely in the same sense, I do not believe there would have been the mortality among our vines had the lice been kept off or removed from the roots.

It is a noteworthy fact that, notwithstanding the loss of vines, the general grape crop was large in 1872, and prices were so low as scarcely to be remunerative. It is very evident that the time is fast approaching, if it has not already come, when the simple growing of the Concord because it is hardy and bears neglect, will not pay; and in the future, only those viticulturists—basing their operations on more knowledge, more science—who can grow the finer qualitied varieties, will find the business remunerative. One of the first requisites of success with these latter is, to my mind, a full understanding and management of the Phylloxera; and I am not without hope that those who do obtain this knowledge, and who put it into practice, will yet be masters of the situation, and succeed with the Wilder, the Goethe, the Catawba, the Walter, the Iona and other varieties of acknowledged excellence, but which are at present precarious.

I am aware that it is difficult to bring home to the average vintner any just sense of the importance of a microscopic atom, which is naturally hidden from his eyes, and which it requires some effort and training to see, and still greater effort to understand. There are few so simple as to deny the injury caused by the Chinch-bug, the Colorado Potato-beetle, and such other insects as, from their conspicuous size, render their presence and their ravages too patent; but where the enemy is so much more insidious, there will always be those who will deny its existence, or who, when made to see it by the aid of others, will prefer to look upon it as the effect rather than the cause of disease, and to attribute the disease itself to other causes. It is so much easier to deductively jump to hypothetical conclusions than to patiently and laboriously work out the truth by induction, and the proneness to attribute insect injuries to meteorological influences, and especially to drouth, is exemplified in the past history of many insect pests, and in that of the Hickory Bark-borer, given further on.

RANGE OF THE INSECT IN NORTH AMERICA.

I have found the galls abundant on wild vines of the species *Riparia* as far west as Manhattan, Kansas, and that it extends as far south as Florida, we learn from a communication from L. H. Tallman,

of Duval county, to the *New York Tribune* of September 4th, 1872, in which he speaks of the galls being abundant on what is known there as the Madeira or St. Augustine Grape, and upon the wild vines.

ITS SPREAD IN EUROPE.

In France, the Phylloxera has continued its ravages, and is spreading in Provence and Vaucluse, but not to the same extent in l'Herault. So threatening, indeed, has it become that the French Academy of Science has a standing Phylloxera committee, and M. d'Armand, at one of its sittings, demanded that the premium of 20,000 francs, offered by the government for a remedy, be increased to 500,000, or, if necessary, to 1,000,000 francs. The plague is also spreading in Portugal and Switzerland, and in some parts of Germany; while in England it is doing serious damage to hot-house grapes.

MORE FACTS ABOUT THE GALLS; THEIR TRANSIENT NATURE.

In the year 1870, and previously, the Clinton vine was always the most seriously affected by the leaf-galls; but an interesting change has since been manifested in the taste of the gall-making form (*gallæcola*) of our Phylloxera. In 1871, it became less numerous in this part of the country, and very generally abandoned the leaves of the Clinton and fell upon those of the Taylor; and what is still more singular, this same change was noticed in France in one case where these vines were cultivated in proximity. I have made many observations which prove this change to have been quite general, and shall cite a few instances in the foot-note* in corroboration. In 1872, I had such difficulty to find galls on either the Clinton, the Taylor or any other variety, in the early part of the season, that certain intended experiments and observations upon the Gall-louse were effectually frustrated. In some vineyards, later in the season, I found galls on Delaware, and a few, more or less perfectly formed, on Concord, and more especially on Herbemont. There seems to have been a persistent attempt on the part of the young lice to form their dwellings on the leaves of this last variety; but in almost every instance the attempt was fruitless, and the louse died soon after the gall commenced forming. On these vines, where the galls were suddenly arrested in

*Mr. T. W. Guy, of Sulphur Springs, had Clintons covered with galls in 1870, which, in 1871, were entirely free from them. Mr. Chas. Peabody, of Glenwood, also had Clintons covered in 1870, while in 1871 there were no galls in his vineyard, except sparsely on the Delaware vines. Dr. H. Clagett, of Gray's Summit, had Clintons covered in 1870, fewer in 1871, and in 1872 could find none in his vineyard. Mr. J. Squires, of DeSoto, and Mr. N. DeWyl, of Jefferson City, report a similar experience. Mr. O. S. Westcott, of Chicago, Ills., informs me that a striking instance came under his observation of an abundance of galls on Clintons in Kendall county, in 1870, succeeded by an entire lack of them in 1871. Dr. LeBaron reports a similar experience. M. Laliman writes that at Bordeaux the Gall-louse, which had been abundant on Clinton in 1870, left that variety and went on to the Taylor in 1871.

various stages and degrees of completion, the method of formation was easy to observe. The first effect of the puncture is a slight depression of the upper surface, bordered by a circular fringe of down (Fig. 30, *c*); the under or convex portion being covered with fulvous down (Fig. 30, *d*). As the depression increases, the circular fringe closes up and forms the mouth of the gall, as already described (3d Rep., p. 87). I saw Herbemont vines whose leaves were covered with these abortive galls, and saw them, not only in Missouri, but in Kansas. On some of the wild vines in the last-named State, I have also collected galls which were so lengthened that they appeared quite abnormal, and almost pedunculated (Fig. 30, *a*, *b*).

[Fig. 30]

This inconstancy in the habits of the gall-lice furnishes another interesting instance of the changeableness of Nature, and of the difficulty the naturalist encounters in making generalizations. It is impossible, at the present time, to give the rationale of this change of habit, though future discoveries may explain the facts and render them significant.

SUSCEPTIBILITY OF VARIETIES.

The relative immunity of most of our American varieties, compared with the European, is exemplified in Europe as well as in this country. Several interesting instances are cited in *La Province* of Bordeaux (Nov. 26, 1872) of our vines being cultivated, for a number of years, in the midst of affected French varieties without injury; while M. Laliman has been more explicit, and, mentioning varieties, has shown that as with us the *Labruscas*, as a species, suffer most, (*Ann. de la Soc. d'Agr. du Dép. de la Gironde*, Vol. XXVI, p. 19).* M. J. Leenhardt-Pomier, of Montpellier, reports that the vines which he received from this country are doing well, and gives, in substance, the following details, under date of November 6, 1872: "Cunningham showed most vigor, the leaves being as green as in summer. Next, the Herbemont gave most satisfaction. Third, the Clinton. The Concord and Goethe ranked next. The Rentz, and especially N. Carolina, made but a feeble growth, while the Cynthiana and Ives' Seedling did not succeed at all."

From examination of some California vines, in Mr. G. Gill's vineyard at Kirkwood, I discovered that they were badly attacked by the

*M. Laliman has published (*Journ. de Viticulture Pratique*, April 25, 1872) a colored plate of what is known there as the York Madeira, or Bland Madeira, a vine which he considers is the very best as resisting the Phylloxera. The plate is beautiful, but it is difficult to establish from it what variety is meant. It is evidently a *Riparia*, having a smooth leaf, and black berry, and, according to Mr. Bush, it resembles the Aughwick in leaf and the Israella in bunch. Husmann finds that it resembles the Franklin. According to Downing, the Bland Madeira has a red berry, and the York and the Bland can not be synonymous. The plate represents a variety evidently not cultivated in our State.

Another variety, which is unnamed, and which is No. 1 of his plate, published in his work entitled "*Etude sur les divers Phylloxera*," successfully resists the *Phylloxera*. The leaf might belong to Norton's or Cynthiana; but it is impossible to give accurate judgment from a single leaf-figure.

root-lice. It is thus rendered quite certain that, if it once finds its way to the Pacific slope, our Phylloxera may prove a most serious scourge, and it behooves the Californians to endeavor to prevent its introduction. Let them take warning of France!

AMERICAN GRAPE-VINES IN FRANCE.

The fact that some of our American varieties resist the louse has caused an increasing demand for them abroad. The principal varieties sent by Messrs. Bush & Son are the Cunningham, Herbemont, Taylor and Clinton, which have been found to resist with M. Laliman, as well as here; and the Norton's Cynthiana and Concord, which succeed well with us, but have suffered with M. Laliman.

As some of my foreign correspondents have thought it would be cheapest to order long cuttings, with several eyes, it will be well to state, for their benefit, that few of our American vines root as easily as the European varieties, and it is almost impossible to propagate some of them, except by layering. With the exception of Clinton and Taylor, those which propagate easiest by cuttings are, as a rule, the most sensitive to the Phylloxera, while those which are with difficulty so propagated are among the best resistants. This is very much what we should naturally expect: the tougher the wood the tougher the root, causing, in the one instance, difficult rooting, and in the other better resistance to the suction of the louse. The accompanying list, showing the comparative difficulty with which some of the better-known varieties root from cuttings, and which is based on the experience of Messrs. Bush & Son, will prove of value in this connection:

1. HERMANN (*Æstivalis*)—Most difficult of all to propagate; refusing to root even with bottom heat.

2. NORTON'S and CYNTHIANA (*Æst.*)—In a very favorable season, on well-prepared, virgin soil, and with the best care, only a small per centage will root.

3. HERBEMONT, CUNNINGHAM, DEVEREUX (*Æst.*)—From cuttings made *early* in fall, *soon* after the leaves drop, and under very favorable circumstances and conditions of soil, a better per centage than from the former will root; yet they often entirely fail.

4. RULANDER, LOUISIANA, ALVEY (*Æst.*), and DELAWARE (*Rip.*)—Are less uncertain than the former, and with skillful treatment, first causing callus, with best of care afterward, good results have been obtained at times. Without such treatment and care, these also will not root well from cuttings.

5. EUMELAN (*Æst.?*), CREVELING, MAXATAWNEY (*Lab.*)—Root more freely, and with proper care may safely be propagated from cuttings.

6. HARTFORD PROLIFIC, TELEGRAPH, IVES, CONCORD, CATAWBA, IONA, DIANA (*Lab.*)—Root easily from cuttings. Being mostly long-jointed, they make better roots and plants from short cuttings (2 to 3 eyes long) than from long canes.

7. ROGERS' HYBRIDS, as GOETHE, MASSASOIT, WILDER, LINDLEY, AGAWAM, MERRIMAC, SALEM, ETC.—All varieties produced by crosses between *Labrusca* and *Vinifera* grow from cuttings as easily, at least, as the varieties of either of these two species. ARNOLD'S HYBRIDS, crosses between Clinton and foreign (*Vinifera*) varieties, grow from cuttings even more freely than any others, except—

8. CLINTON and TAYLOR (*Rip.*), which grow from cuttings, like willows, almost without care.

So far as I can learn, the varieties of *Vulpina* root with difficulty from cuttings.

As an evidence that our grapes are beginning to be appreciated in Europe, I may be pardoned for quoting the following from one of M. Laliman's letters: "The wines which I obtain from certain American varieties age very rapidly, and I may tell you that the Jacquez, [I do not know this variety, unless it be a synonym of the Ohio], the Lenoir, the Clinton and the Long, [known to us as the Cunningham], mixed together, give me a wine much superior to those I get from our French varieties. The Delaware, also, mixed with the Taylor, makes a very agreeable wine."

In an article written by him last April,* he further says: "Certain vines of the *Cordifolio* [*Riparia*] species make a very good wine; and certain hybrids, as well as some varieties of *Æstivalis*, produce wines so like our own that we shall find it to our advantage to cultivate them, not only from an alcoholic stand-point, but for an abundance, color and taste, which will astonish those who are acquainted with the *Labrusca* only. * * * The Americans have made such rapid strides in horticulture of late that, we repeat, they have entirely changed the character of their vineyards. Certain grape-growers have succeeded, by hybridization, in so improving their wild vines that their grapes to-day equal our best products of the kind."

This speaks well for American vines, which our fastidious transatlantic friends deemed, not long since, unfit for cultivated tastes. But whether these vines be there appreciated for their fruit or not, they will prove valuable as graft-stocks. Mr. DeWyl has the Goethe, Salem and Rogers No. 12 grafted (under ground) on to Taylor roots, and, although a few galls are found upon the leaves, the grafts are doing well. By growing such Hungarian vines as Tokay, Foment and Scegety on Concord roots, and protecting them in winter, he has also succeeded in making them thrive and bear. Indeed, the benefits of grafting the more susceptible varieties on to the roots of those which best resist the Phylloxera, must be patent to all; and in thus grafting we have one of the few practical methods, so far known, of thwarting the enemy.

It is to be regretted that more caution is not taken by those who write upon the subject of the Phylloxera. In the monthly report from the Department of Agriculture for February, 1872, it is stated that varieties of *Labrusca* are freest from attacks of the louse; whereas *Labrusca*, as a species, suffers most. Such careless statements mislead, and may account for the fact that the varieties imported by the French minister have been mostly of this species. Some few of the *Labruscas* effectually resist the louse here, and there is every

* *Réponse à la Soc. Linnéenne.*

reason to suppose they would do so there; but, until further experience shall give more decided results, we must be guided by that of M. Laliman, across the ocean, and our own here, as given last year (Rep. 4, p. 64).

With regard to the best method of grafting the grape-vine, it may be well to state that such grafting requires the greatest care, and that experienced authors agree that it is best done under ground, and soon after the frost is out in spring. Details will be found in the standard works on grape-culture; and I would refer to articles in the last volumes of the *Western Planter* and of the *Rural World*, and more particularly to the number of the last-named for February 1, 1873.

NEW THEORIES.

Quite naturally, there have been numerous persons abroad ready to assert that the Phylloxera was the effect rather than the cause of disease. Such opinions, from some quarters, would not cause surprise; but when intelligent naturalists like Messrs. Signoret and Guérin-Méneville persist in such belief, it is difficult to give any other explanation than that they are too much absorbed in closet studies to make the proper field observations; or are biased in favor of theories hastily announced before any field studies were made. In the face of the gradual spread of the disease from infested to uninfested regions, and of the exemption which vineyards enjoy where the insect has not yet appeared — in face of the demonstrable and hurtful results which follow its puncture, and the isolated spots or centers of attack from which it often originates — men still have the hardihood to compare the disease with scrofula in man, to attribute it to "meteorological perturbations," and other equally illusive explanations. They invoke some remote, mysterious cause, and prefer the vague to the definite. Most of them would, of course, scout the idea of these mysterious causes producing the lice, for they would scarcely go so far, even if abiogenetically inclined; but I can not help likening their views to those of the average Cockney, who so implicitly believes that the east wind and certain atmospheric conditions peculiar to London, beget and engender the myriad lice which blight his plants at certain seasons. For my part, I want no better explanation than the greater tenderness and susceptibility of the European vines compared with those on which the lice have bred from time immemorial in this country.

In spite of the abundant rains that have, from all accounts, soaked the vineyards in the infested districts of France without decreasing the disease — in spite of the fact that other plants have not suffered for want of rain — the sophism is still reiterated that the disease is owing to meteorological abnormities, and especially to drouth. The poor wine-grower is told to wait for more rain, and that if he pursues

that treatment which will cause the vine to regain its normal vigor, he will see no more of Phylloxera — a most undoubted truism! I am the last to deny that meteorological conditions accelerate or retard the multiplication of plant-lice, as they do of so many other insects; but I see no reason for presupposing a diseased condition of the plant first attacked by them, when, as every entomologist knows, they can flourish only on living vegetation, which they forsake when its life has been sapped. Conditions may be favorable to the increase of the plant-lice on our hops, of Cotton-worms, of the Army-worm, and of a thousand well-known insect pests; yet no one doubts that if by increased effort we, in some way or other, prevent or destroy these insects, we effectually overcome the (to us) unfavorable conditions, and our plants thrive.

Whenever abundant enough to attract attention, these plant-lice have already brought the infested plants into a state of disease, and it is this fact which blinds so many persons, and makes them so ready to believe that it was the diseased condition which attracted, or, as some more ignorantly put it, "produced," the lice. *Aphidæ*, I repeat, (Rep. 3, p. 87), must always be the cause rather than the effect of disease.

I shall simply add in this connection, as strengthening the position of those who consider Phylloxera the true cause of the mischief, that I never yet found root-lice so abundant as on some California vines belonging to Mr. G. Gill, and which were unusually well cared for and manured.

Other persons, again, have, as might have been expected, insisted that the European insect is not an importation from America, and argued that it may either be a distinct species, either indigenous to both continents, or else may even have been imported from Europe to America. To waive unnecessary detail, I may state that such views are based on fallacious grounds, and that, setting aside theory, and weighing the undeniable facts, the evidence gives overwhelming force to the opposite view — that the insect is a native American, and was originally unknown in Europe;* and indeed the views expressed in my last report were adopted by M. Plumeau and others, at the recent organization of the French Society for the Advancement of Science, when the Phylloxera occupied much attention.

* M. L. Laliman, of Bordeaux, is, perhaps, the most voluminous and influential writer who has espoused the last-mentioned doctrines, in opposition to Lichtenstein, Planchon, myself and others (*Annales de la Soc. d'Agr. du Dep. de la Gironde; Jour. de Viticulture Pratique; La Gironde; La Provence, etc.*). Assuming that the insect has always existed in both hemispheres, he quotes M. E. Nourrigat, the President of the *Comice* of Lunel, as proving that it played havoc in Germany from 1730 to 1776. There is no proof whatever that the disease which attacked vines in Germany during that epoch, and which likewise affected the Mulberry and other fruit trees, bears any relation to the Phylloxera disease in question. The article of M. Nourrigat, referred to, first appeared in the *Journal de Lunel*, of March 28th, 1871, and describes a disease which, first noticed in Austria, along the Danube, desolated Moravia, Hungary and Germany, and finally penetrated into Alsace; but from the symptoms given, it has plainly no connection whatever with Phylloxera. M. Laliman, to support his views, ventures a theory so visionary and untenable as to presuppose the existence, from time immemorial, of the Phylloxera on trees and plants, whose disappearance and eradication have caused it, as he believes, to attack the Vine. I presume he was led to such theories by the fact that a certain root-

MEANS OF CONTAGION FROM ONE VINE TO ANOTHER.

The modes of spreading indicated last year have been fully proved correct. There can be no doubt about the young lice traveling under-ground along the roots of the vines, or in any cracks or minute passages in the soil; while I had no difficulty last August in finding them crawling over the surface of the ground. Moreover, M. Faucon and M. Gaston Bazille discovered not only the larvæ, but the winged individuals, passing abundantly over the surface of the earth last September, in France, and we thus have evidence that the winged insects make good use of their legs. They have likewise been caught in spiders' webs, and seen in other situations to which they must have

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louse was found on wheat in several parts of France the past year, and that other root-lice, supposed to be Phylloxera, were found by himself and others on the roots of several fruit trees. So there is a well-known root-louse, producing knots on Apple, and others, either little known or undescribed, on Purslane, Turnip, Persimmon, and many other plants in this country; but they are distinct species, and the entomologist will want other proof than is yet forthcoming ere he can believe that *Phylloxera vastatrix* attacks anything else but the Vine. But M. Laliman goes still further, and weakens all faith in his deductions, by promulgating the abstract ideas that the soil is impregnated with plant-lice, and that the increase of Phylloxera is in some way due to the destruction of birds. In support of the view that the European insect is a distinct species, and was not introduced on American vines, he makes three statements: 1st. He publishes the annexed letter from Mr. Berkman, of Georgia, of whom he obtained his American varieties, to prove that Phylloxera is unknown there:

"In our region, the Phylloxera is unknown. Riley observed it in 1864 in Missouri; at that time it was injurious to the Clinton; but in fact the plague which ravages our vines is known only to entomologists through scientific investigations; vintners do not dream of its presence, and the damage it does is not worth speaking of."

2d. That American vines are not affected exactly alike here and in France, so far as his and my experience go. 3d. That he has distributed American varieties through divers countries where the malady is unknown, without introducing it.

None of these statements prove his position. 1st. If the insect is unknown in Mr. Berkman's section, (the State of Georgia is pretty large, but no postoffice address is given), it only indicates that it was not sent over on his vines, but does not prove that it was not sent from other sections, either to France direct, or via England; while Mr. B.'s mere dixit that Phylloxera is unknown in his region, without attending proof, will have little weight when we reflect that three years ago no one dreamt of the existence of the root-louse in any part of this country. We have, moreover, seen that it *does* occur as far south as Florida. 2d. The sort of argument that proves the insects of the two continents distinct, because the vines in the two hemispheres are not affected alike, would equally prove that the *Oidium* which so troubles grape-vines in Europe is not the same as ours; for there is good evidence that some of our vines are sorely troubled with it here; whereas, he himself shows that his American varieties are not affected by it there. Yet I know of no mycologist who has studied the subject who doubts the identity of the *Oidium Tuckeri* Berk. of Europe and America. I have seen what was evidently the same, prevalent in the vineyards of Michigan; but not to rest on my own authority, I may say that Mr. Husmann believes the two identical, and I shall append to this note the testimony of Mr. William Saunders, of Washington.

In considering the relative susceptibility of the same varieties in the two countries, defective, imperfect experience and climatic and terrene influences are important factors which have been overlooked by M. Laliman. 3d. The statement that he has sent American varieties to different countries where the malady is unknown without introducing it, would have more force if he had stipulated the varieties sent, and whether, when sent, he observed that their roots were lousy or not.

Finally, the same author refers to my writings in a controversial spirit, and makes the same pardonable mistake as have other writers, (see Dr. Le Baron, *Prairie Farmer*, September 21, 1872; A. H. Trimoulet, *Mem. sur la Maladie Nouv. de la Vigne, Bordeaux*, 1873, and others), of considering the earlier conclusions, drawn from imperfect knowledge of the insect in America, without taking into account the subsequent and more mature convictions of greater experience. He wonders how I could recommend the destruction of the Clinton one year, and reverse the recommendation the year following; when a closer reading of my last year's article would very plainly give him the reason. As to his criticisms of the classification adopted, I attach more importance to recognized American botanical authority than to the opinions of one who even confounds the terms species and genus. M. Laliman also publishes the contents of a letter of inquiry addressed to me, under date of December 14, 1871

flown; and there is no longer any doubt—as there had never existed any in the minds of entomologists—about their flying capacity. On a calm, clear day, the latter part of last June, it was my fortune to witness a closely allied species (*Phylloxera caryæfoliæ*) of the same size and proportions, swarming on the wing to such an extent that to look against the sun revealed them as a myriad silver specula. They settled on my clothing by dozens, and any substance in the vicinity

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but either because my answer did not reach him in time, or because it explained away his antecedent objections, and would necessitate their expunging, my answer to said letter does not appear.

It is an unprofitable business to have to meet theories and objections which have in themselves little force; but, lest silence should be construed into acquiescence in M. Laliman's views, I have deemed these few remarks proper, though somewhat irrelevant and of import to but few. While thus reprehending M. Laliman, I heartily concur in his advice to import from America vines which have best resisted the *Phylloxera*, and in the caution urged upon those who would import all the *Labruscas*.

PROOF OF THE OCCURRENCE IN AMERICA OF OIDIUM TUCKERI, OF EUROPE.

Communicated by Mr. Wm. Saunders, of the Department of Agriculture.

It is now twenty years since I became convinced of the presence of *Oidium Tuckeri* in this country. Previous to that time I had been giving what attention I could to the study of mildew—its origin, causes, etc. I early became convinced that there were two very distinct forms appearing on the grape-vine, and moreover, that one of these forms was most prevalent in dry weather, and the other in damp weather. It had been ascertained that the foreign grape, even when grown under glass in this climate, was very liable to attacks of mildew; and in all book directions, at that time, as to its culture, sulphur applications were constantly recommended. From its close resemblance to the pea *Erysiphe* of Europe, that I had often seen in England, attacking peas in dry summers, (and only during periods of great drouth,) I concluded this mildew, appearing like a white down, or floury mass, on the *upper* surface of the leaves of grapes in the glass grapery, and occasionally spreading itself over the young green shoots and berries, was an *Erysiphe;* I named this in my first published notices (see *Phil. Florist*, 1852, and *Horticulturist*, 1855,) as an *Erysiphe*. I reached this conclusion from other points—notably, the English gooseberry, Persian Lilacs, English hawthorns, oaks, etc. These, when grown in this warm and arid climate, become covered with this same, or a very closely allied form of *Erysiphe*. Before promulgating this opinion, I had, as has always been and still is my practice, to first verify to my own satisfaction the truth of my statements. Acting upon the theory that this form of mildew was produced on the foreign grape in graperies, as well as oftentimes in the open air, by dryness, I commenced and have since recommended a mode of treatment, which is now generally followed, and which entirely obviates any necessity for sulphur applications, because it prevents the occurrence of the conditions necessary for the growth of this fungus. The treatment is, briefly, to ventilate graperies only from the top of the house, never opening any side sashes that will allow a current of dry air to come from the exterior and circulate out at top, carrying with it the moisture of the house; also to maintain a moist atmosphere by keeping the floor of the house constantly damp, and sprinkling water freely on very bright days, so that as the temperature increases the atmospheric moisture will also be proportionately increased. When this practice is fairly carried out, no mildew of an *Erysiphe* kind will make its appearance. I did not then, so far as I now can recollect, connect this mildew with the *Oidium* of Europe, until later, when it was discovered that the so-called *Oidium Tuckeri* was simply a form of *Erysiphe*, or rather a transformation occurring during its growth. (I think that this *Oidium* or *Erysiphe* has not yet fruited in England.) This led me to further investigations, and proved to me that our *Erysiphe* was really and truly the *Oidium Tuckeri* of England, and moreover, that the plant perfected itself fully in this climate. This was my conviction fifteen years ago; recent microscopical investigations prove beyond doubt the correctness of my suppositions.

But we very rarely observe this *Erysiphe* on our native grapes in ordinary vineyard culture, although it is frequently to be found on vines growing in warm, very sunny, sheltered, dry positions, such as may always be found in city yards. It is not by any means confined to these, however. Last summer we had plenty of it on the leaves of many varieties growing on our trellis here. As already remarked, this mildew shows a powdery appearance on the *upper* surface of leaves, and frequently forms a somewhat leathery coating on shoots and berries. Its effects are to corrode and prevent the further swelling of the parts attacked. Grapes, for instance, that are touched by it, will show an indurated spot, hard and brown, the portions of the berry not attacked will swell out freely, and all that this hurt portion can do is to crack open, which it usually does, and the seeds may frequently be seen to protrude from this crack.

But the mildew most injurious to our native grapes is altogether different. This is a *Peronospora*, and shows itself on the *under* surface of the leaves, usually looking like a small patch of whitish-brown downy matter. It adheres closely to the leaf, and is a perfect parasite; it destroys the part where it adheres, the sun burns a hole, and it is called blister, leaf-blight, etc. But if you say that it is mildew—oh, no! I never had any mildew. I have lots of amusing incidents of this kind in my mind. Some whose vines were all but denuded of foliage would still insist that they never had a case of mildew, until I convinced them of the facts, and pointed out the mildew to their wondering eyes. Being confined to the under surface of the leaves, it escapes observation. This mildew is encouraged by dampness on the foliage, by continued damp, rainy weather, or even constant heavy dews, followed by still, balmy days; anything in fact that will prevent moisture from quickly leaving the foliage.

About 1857, I tried a board covering over a trellis of Catawbas that yearly failed to mature their fruit, owing to the destruction of the foliage during summer by this mildew, and the effect was all that could be desired. In the Agricultural Report for 1861 you will find this affair figured. This covering prevents the radiation of heat from the plants, consequently they are not rendered so cold as to condense upon them the moisture of the air and form dew. A series of observations made many years ago with registering thermometers explained to me the *modus operandi* of the whole. During still, clear nights in July, I found that the thermometer, having clear two feet from the trellis, would fall from five to ten degrees lower than the thermometer directly under the cover.

that was the least sticky was covered with them. With such a sight before one's eyes, and with full knowledge of the prolificacy of these lice, it required no effort to understand the fearful rapidity at which the Phylloxera disease has spread in France, or the epidemic nature it has assumed. Imagine such swarms, mostly composed of egg-bearing females, slowly drifting, or more rapidly blown, from vineyard to vineyard: imagine them settling upon the vines and depositing their eggs, which give birth to fecund females, whose progeny in five generations, and probably in a single season, may be numbered by billions—and you have a plague (should there be no conditions to prevent that increase) which, though almost invisible and easily unnoticed, may become as blasting as the plagues of Egypt!

THE MALE LOUSE.

M. Signoret, because he has not seen the male himself, has seen fit, both in print and by letter to me, to deny that it has yet been seen by any one. It may please my friend to be thus incredulous, but I have certainly noticed the differences specified on page 59 of my last Report, both in specimens obtained from France and those obtained in this country. Both Lichtenstein and Planchon likewise believe that they have seen the male, and pointed out the differences before I was familiar with them myself. We know positively that his presence is not absolutely necessary, and that the females greatly preponderate. A knowledge of his appearance, therefore, is of little practical moment; but as it is of considerable scientific interest, I regret that I did not know of M. Signoret's skepticism in time to have dispelled it the past year. Being absent from home during the months of September and October, I saved no winged specimens in 1872; and on looking at those saved in 1871, I found that the acetic acid in which they were preserved had so destroyed them that little but a white soft mass of matter was left. From a few preserved in glycerine I found one specimen of what I have taken for the male; and, though discolored, it has been forwarded to M. Signoret at his request—with what results I have not yet learned. *Nous verrons!*

REMEDIES.

The new insecticides that have been tried, and the various measures that have been essayed to destroy the Phylloxera, are innumerable, and the French horticultural and agricultural journals teem with them. Practically, however, the great mass of them are useless. Next to carbolic acid, soot has been found most efficacious, and a mixture of these two articles may be profitably employed to save a few choice vines which are known to be suffering from Phylloxera, and where they may be applied thoroughly. In this country, where the disease is not likely to become threatening on our tougher rooted, native varieties, these applications will never be made extensively;

but a remedy—even if laborious and expensive—will be of great use to us in saving the finer varieties; and, judging by the experience in Europe, I greatly incline to believe that these finer varieties, and even the European vines, will succeed on our bluffs, if planted in trenches first prepared with a mixture of sand and soot, or the carbolic powder presently to be mentioned.

The value of submersion or irrigation, where it can be effected, has been demonstrated by M. Louis Faucon,* of Graveson, (Bouches du Rhone), France, who has been indefatigable in his experiments, and who considers that he has totally annihilated the insect in his own vineyard. From his experience we may draw the following conclusions: 1. A vineyard should never be submerged more than two days consecutively during summer. 2. The best season to submerge is in autumn (September and October) when the lice are yet active and the vines have ceased growing. 3. Brief and repeated inundations have little effect on the lice: a submergence of 25 to 30 days is required to rout them all. 4. He finds that a submergence for such a period in the fall or winter does not injure the vineyard, and kills all the lice. 5. He makes an embankment around his vineyard, and lets the water evaporate, but does not let it run off and carry away any nutritive properties of the soil.

On our best hilly vine land submersion is impossible; but on some of our bottom lands, the Catawba, which is always in such demand for the manufacture of sparkling wine, may be made to flourish by this means.

The fact, now ascertained beyond peradventure, that the insects, both winged and wingless, crawl over the surface of the ground in the months of August and September, has led to the idea of sprinkling the surface with quick-lime, ashes, sulphur, salt or other substance destructive to insect life, during those months. This is a practical step toward the ultimate management of the insect, and adds still more importance to submergence and inundation.

M. Lichtenstein has been experimenting in the way of alluring the lice on to the tender rootlets of newly-set cuttings and layers, and finds that a great many lice may thus be destroyed. He advises, whenever a center of attack has been discovered, to layer the yet healthy vines surrounding the already dead and dying ones. These

*M. Faucon (*Messager Agricole du Midi*, February, 1872) appeals to me for information as to the conditions of planting, nature of soil and climate, which obtain with us, and the kind of vines, whether wild or cultivated, upon which my observations were made. Most of the questions which he puts to me have already been answered; and I may add briefly, that our Missouri soil, comprising most of the vine lands, is either a sandy loam, or a heavier yellow clay, both with a limestone subsoil, and often with a layer of pure sand intervening. The heavier clays are stronger, and give a heavier must, but vines are generally healthier on the sandy loams. These soils are not subject to periodic inundations, and to the best of my recollection they are not unlike those around Montpellier. Our vines are usually cultivated on trellis, eight feet apart in the row, and six feet between rows. The climate is much like that of the South of France, though more extreme and changeable. We sometimes have milder winters, but ordinarily the frost penetrates deeper. We are more subject to drouth than to excessive rain, but we have no greater drouths than have occurred in South France of late years.

form a sort of invitation barrier to the lice, which are continually spreading from the dying vines, and great numbers settle on to the layer rootlets, and may easily be detached from the main stocks and destroyed. This can never be more than a partial barrier; but every practicable and intelligent means of combating such an enemy helps. By splitting the ends of the layers or cuttings, they produce a great number of minute fibres, which are especially attractive to the lice.

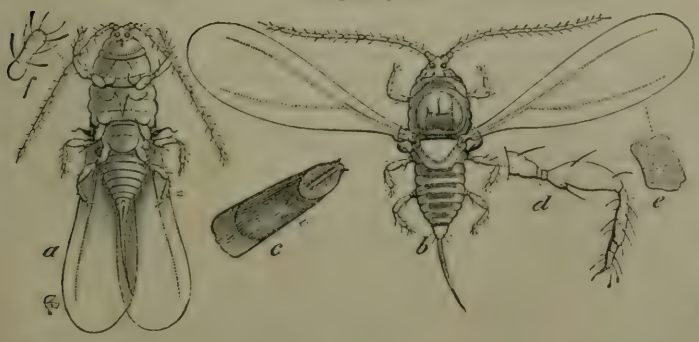
My own experiments have been solely with carbolic acid, and the results can only be fully ascertained the forthcoming season. It is perfectly impracticable to use the liquid solution on our hills and bluffs, upon which water can be carried only at great cost and effort; and, at my suggestion, G. Mallinckrodt & Co., of St. Louis, have prepared a cheap powder, which, in quantities in barrels or casks, they sell for 5 cents per pound. I found this quite convenient, and have treated a number of vines with it, in varied quantities, at Kirkwood and Bushburg.

The following letter, received March 7th, 1873, from Mr. F. A. Brewer, of Chillicothe, bears on this subject and is suggestive:

"Having been interested in your writings on Phylloxera, and not understanding the bad condition of my Catawbas, I examined them in the spring of 1872, and found the excrescences on the roots and deadened portions, as you describe. This left no doubt in my mind that the lice had been at work. So I opened the ground, exposing a goodly portion of the roots, and thickly sprinkled leached ashes and a little sulphur over the parts exposed, and replaced the dirt. I cut away all dead wood, and the sprouts from the trunk look well, and I think will produce me a fair crop this year. Will report to you this fall again."

THE OYSTER-SHELL BARK-LOUSE OF THE APPLE—*Mytilaspis pomicorticis* N. Sp.

[Fig. 31.]



Since the publication of the article on this insect in my first Report, several interesting and important facts in its economy have been revealed, and I am now able to give a much clearer insight into the life-his-

tory of the little animal which causes what is often called "scurvy" on apple-trees.

ITS OCCURRENCE IN MISSOURI.

From numerous facts stated, and from experiments made, in 1868, I had every reason to suppose that this insect could not thrive at any point south of St. Louis, and that it had, up to that time, not yet been introduced into the State. But, alas! both these cherished notions have been dispelled like "the baseless fabric" of a vision, and I am very forcibly reminded of the uncertainty of analogic reasoning, and how necessarily imperfect and partial human knowledge must always be! The conclusions drawn from the facts at hand in 1868 were: 1st, that this Oyster-shell Bark-louse did not yet occur in the northern part of the State, though quite capable of existing there; 2nd, that by care and caution on the part of orchardists in the more northern counties, its introduction could very easily be prevented; 3rd, that it could not thrive in the southern half of the State. The first conclusion, from all I have been able to learn since, was fully warranted; for, except in the latitudinally opposite localities presently to be specified, I have not met with or heard of it. So truly indeed is this the case that specimens for study were necessarily obtained from these localities, or from the more northern parts of Illinois, and the observations here recorded were, consequently, made under difficulties. The soundness of the second conclusion we have been abundantly able to test, for the worst fears that the pest might be introduced have been realized. Just as might have been expected, also, it has gained a footing in the extreme northeast corner of the State—the point of greatest proximity to the infested sections of Illinois and Iowa.

In the spring of 1870, Mr. B. P. Hanan, of Luray, Clark county, sent me some Sweet June apple-twigs that were completely covered with the scales of this Bark-louse, and the eggs underneath the scales were plump and healthy. The twigs were taken from the orchard of Dr. Wm. H. Martin, of Kahoka in that county, and I quote part of Mr. Hanan's letter which accompanied them:

"This tree is rather badly infested, and I find by examination that they (the insects) are spreading slightly on to the nearest trees around it. Will they spread from one orchard to another, one or two miles distant? I saved my orchard from the native White Bark-louse by sending you specimens of them and of their foes, and by learning from you what to do to destroy the lice. I took your advice, encouraged the ladybirds, and they cleared my trees of the lice. If your advice in this case shall accomplish as much for my friend Dr. Martin, the object of this communication will have been accomplished."

At my suggestion, the tree was cut down, and other measures taken to eradicate the evil on trees adjoining; and, from correspondence, I was finally led to believe that it had actually been eradicated.

But toward the close of 1872, just before giving this report to the printers, I concluded to write again to Mr. Hanan, and learn the latest experiences. The following is his reply:

DEAR SIR—In reply to your inquiries of the 27th, in regard to the Oyster-shell Bark-lice on Dr. Wm. H. Martin's apple trees, in Kahoka, in this county, I will state that I have just returned from a visit to his and his neighbors' orchards.

I long ago satisfied myself that the Dr. had them all exterminated from his trees, from what he had told me at various times. And as I could neither find nor hear of them being on the trees in any other place in our county or State, I gave the matter but little thought of late. But imagine my surprise and sorrow when, to-day, I found them more abundant on Dr. Martin's trees than when I first wrote to you about them, in February, 1870. In your reply to that letter, you requested Dr. Martin and his neighbors to use every possible effort to destroy them and prevent their further spread, as they were the only ones known to be in our State; and you referred us to your article on the insect, published in your report of 1868. Dr. Martin, in the early spring of 1870, cut down the Sweet June apple tree, which seemed at that time to be the only tree much infested, and carried it into an open space, forty or fifty yards from his orchard, and burned it up, after leaving it lay there for several days. He cut it down about four feet from the ground, at the first branches, then scraped the trunk or stump well, and destroyed the eggs scraped off, after which he made a sort of thick wash or paste, as follows: 1 quart soft soap, 1 quart fresh slaked lime, and ½ pound tobacco, boiled together in 1 gallon of water. With this wash he painted every every part of the stump, then grafted it with healthy scions. This treatment was effectual on that tree, and it now has a nice young top again, six to eight feet high, and no lice on it.

The trees near this tree just described had but few lice on them when the Dr. cut down the Sweet June; therefore, he scraped off all the scales or eggs that he could find, before the time for them to hatch, and washed or painted their trunks and branches (there were only two others) with the same compound used on the stump. But he discovered last spring that they were not all killed, as he had thought, but were multiplying very fast, and extending to other trees on his lots. (He lives in town, and has only a few dozen trees on his lots, consisting of apple, pear, cherry, plum, apricot, etc. He informs me that there are none on the trees in his young orchard on his farm, adjoining town, nor any of his neighbors' trees, that he can learn of). He says that the lice, after hatching out last spring, spread to his pear, plum and apricot trees — all being close by — and killed one young apricot tree, and injured a dwarf pear tree very much, by sucking the sap out of the leaves from the under side, where they were so abundant as to completely cover the under surface of every leaf, causing them to dry up as if parched by fire.

To-day I examined many of the trees on his neighbors' grounds, but found none, except on one apple tree in Mr. Matthew Woodruff's orchard, about thirty-five or forty rods north-east of Dr. Martin's infested trees. They are quite abundant on this tree of Mr. Woodruff's. Of course I refer to eggs at this season of the year. I examined the eggs with a microscope of 45 diameters in power. The eggs were all, with two exceptions, out of thousands, perhaps, clear, white, and perfectly sound.

Dr. Martin was of opinion, before I showed him the sound eggs to-day, that he had destroyed their vitality by medicating the trees last summer. He did it thus: By boring a hole into the trunk at the surface of the ground, then filling the hole with a compound of equal parts of sulphur and bromide of potash, and then corking up the hole tightly. He thinks it enters into the sap, and the circulation carries it to the leaves, and kills the insects. I have no faith in it. I think the safe way is to cut the trees down, or at least, cut off all the branches and burn them. I never knew any benefit by trying to force obnoxious or poisonous substances into the circulation of sap in trees, to kill or drive away borers, caterpillars, or other insects, and I have known or heard of such trials all my life.

The trees are all covered at this time with a heavy ice, caused by the recent sleet, which makes it difficult to examine them. I hope there are no others but those mentioned; but a gentleman to-day told me he believed he had them on one of his apple trees, about two miles south-west of Kahoka. I hope he is mistaken, but still I fear they may be there. [Afterward ascertained to be the native white species, *Harrisii* Walsh — C. V. R.]

Dr. Martin requested me to urge you to come up as soon as possible, and give them your personal inspection, and suggest some remedy by which he can, if possible, save his trees.

Please do not fail to come up before the eggs hatch next spring. Write to me and let me know just when you will be here, so that I and the Dr. may be sure to be at home.

Yours for the public good,
B. P. HANAN.

CLARK CITY, Mo., Dec. 4th, 1873.

I shall certainly do all in my power next summer to try and check the spread of this scourge; and should this Report fall into the hands of others in the neighborhood of Kahoka, whose trees are affected, I hope such persons will be kind enough to inform me of the fact, and to give me as full particulars as possible.

Upon subsequent examination, Mr. Hanan could not find any scales on Dr. Martin's plum and apricot trees; but some of the pear twigs which he sent me were sparsely covered with scales. These scales were invariably in a transverse position to the axis of the twig, and usually between the natural transverse rugosities, so as to be easily overlooked; and they were, furthermore, smaller and evidently less thrifty than on the Apple, as was shown by the unhealthy condition of their eggs, which were few in number and mostly dead and discolored, though no evidence of violence from mites or other enemies could be detected.

The third conclusion — namely, that the insect could not thrive in the southern half of the State — was, unfortunately, an erroneous one; for though apparently incapable of living in St. Louis county, this louse has in reality a much more southern range, being found in at least one county in the extreme southern part of the State, and even in Mississippi and Georgia.

In Colman's *Rural World* for October 15th, 1866, (p. 312), may be found the following paragraph:

FROM HARTVILLE, MO.

N. J. COLMAN, ESQ.: The lice are utterly destroying the best apple orchards in this county. They seem to start on the trunks of the trees, spreading rapidly over the branches, and then on the apples—killing large trees in two years. Orchards on land descending to the north are more subject to them than when planted on other land. Some men in this neighborhood have tried every remedy they could hear of, without effect, so far. What is an effectual remedy against them?

R. B. PALMER.

It was in supposing that this communication referred to the native white species known as Harris's Bark-louse (Rep. 1, p. 7) that I erred; for it was in reality the Oyster-shell species to which reference was had. Such false inferences would be impossible if correspondents were more explicit! From facts given by Mr. Wm. Palmer, of Hartville, to whom I am indebted for many kindnesses, it appears that these scales were first discovered, as much as twenty-five years ago, in the southern part of Wright county, on some trees obtained from New York. They spread in a circuit of four or five miles, and destroyed several orchards, but have been dying out of late years, as several newly planted orchards, within the circuit, are uninfested and thrifty. They first were noticed in his own orchard in the year 1860, and have more or less infested eight hundred fine trees, though they have, for the past two years, been perceptibly on the decrease, and were scarcely to be found on the new growth of 1872. Why this bark-louse flourishes in Wright, and dies out in St. Louis county, is not easy of explanation. It may be owing to the occurrence of enemies in the one which do not occur in the other; but it is more likely owing to the fact that in Wright county the infested orchards are situated on the Ozark Mountains, where the climate is exceptional, and more resembles that of the northern half of the State—that, in short, the isentomic conditions, which otherwise limit the southern range of the species to a higher parallel, there occur as an exception.

ITS RANGE SOUTH.

Facts still more interesting and unlooked-for, regarding this insect's distribution, are, however, to be given. It not only thrives on the 37th parallel, when the conditions are favorable; but actually flourishes below the 33d, as I have received it from Carthage, Leake county, right in the center of Mississippi, where it has done much damage, *and is double-brooded!* In July, 1870, Mr. J. W. Merchant, of Carthage, wrote to me that he was satisfied the insect was found there, and that he had, the winter previous, cut down and burned about 200 apple trees that were infested with it. Upon expressing

doubts as to the possibility of the species thriving there, Mr. Merchant soon gave me proof that he had not been misled, and among other communications which he was kind enough to make, I give the following for the facts it contains:

Dear Sir: I have taken the trouble to ascertain something with regard to the depredations of the Oyster-shell Bark-lice in this part of the country. I first went to Mr. Wm. Hendrix, who has had them longer than any one else I know of. He informed me that they had been very bad in his orchard; but that they had, now, nearly disappeared. He thought he had one tree, however, which was still liberally supplied with them; so we went to that tree; but, lo and behold, they had disappeared from it also. I found a few, however, on another tree near by. Mr. Hendrix informed me that he had discovered the lice in his orchard at least ten years ago. He first found them about the center of his orchard, from which they spread very rapidly, until they covered all his trees—many of which they killed. Finally, they began to disappear, and last spring he could only find them on one tree, which he trimmed closely by cutting off the infested branches; and he then scraped off all the "shells" that he could find. This is the tree we first went to, which resulted as stated above. Mr. Hendrix has grafted pretty extensively for his neighbors, taking the scions from his own orchard; and by this means, I suppose, the lice have been spread, but to what extent I can not tell. I next went to J. D. Eads, as I had heard that his orchard had been ruined by the Bark-lice. He informed me that they had been in his orchard and remained there in "force" until his apple trees all perished, when they became scarce; but he has a few on his pear trees yet. He thinks they will not hurt pear trees. I next saw Mr. Howard. He said he could show me any amount of Bark-lice; but we looked over one orchard and found none—that, too, where there had been "plenty" of them. We then went to another place, and you can judge, by the limbs I now send, whether or not we found Bark-lice. I saw "shells" on several trees here. Finally, I went to Dr. J. L. Plunckett; he carried me over his orchard, and I saw more "shells" in his orchard than anywhere else. The lice are on a great many of his trees. I found even the apples on one tree covered with "shells." Mr. Hendrix informed me that he had seen the Bark-lice in the woods on Black-gum Elm, and perhaps other trees. He has never found any effectual remedy for Bark-lice except sulphuric acid, and that is only effectual when applied without dilution. Eads expects to keep them from his young apple trees by frequent applications of soap-suds. Howard thinks an application of potash is beneficial, and that carbolic acid "does the work for them." Mr. Hendrix says there came a late frost one spring, and the Bark-lice have not been bad in his orchard since.

J. W. MERCHANT.

CARTHAGE, MISS., *September* 8th, 1870.

Later advices from Mr. Merchant inform me that it has done great damage to the orchards in Attala county.

It also occurs in Georgia, and I have received the identical species from Mr. J. Rufus Rogers, of Waynesborough, Burke county, with the following history:

"In 1860 I got from a neighbor two sprouts (winter variety). They did well for a year or two, when I noticed the insects on them. In 1869 I cut and burned them, and set 75 young trees on the same land. In 1871 I noticed that the insect had again made its appearance on my young trees, commencing on trees nearest the old stumps. They spread very rapidly, and increased very fast, and my orchard, once the finest in this part of the country, is now well-nigh ruined. The trees stop growing, and the fruit rots. I know of no other trees in this vicinity infested with the lice."

Judging from the specimens sent, the lice are not in the most thrifty condition, for few eggs were found that had not been injured by mites; and there were evidences that some little Chalcid, and perhaps the one described further on, had been at work upon them.

Is this occurrence so far south, of what we have had good reason to consider a comparatively northern insect, to be looked upon also as exceptional, or will the insect be found, upon investigation, more generally spread through the Southern States? These are questions to which satisfactory reply is, at present, impossible. From all I can learn, there is nothing exceptional in the country, either around Carthage or Waynesborough; and we may conclude that the bark-lice will thrive in any parts of Georgia and Mississippi, or of the other Southern States. It is an interesting fact, however, as I learn from elaborate meteorological data furnished by Mr. Merchant, and covering a period of 25 years, that the mean temperature of the months of May - October, inclusive, is, at Natchez, Mississippi, lower than that of the same months at St. Louis while, as every one knows, the other months have there a much higher mean temperature than here. It is possible, therefore, that the great height which the thermometer reaches in the latitude of St. Louis, is prejudicial to the Oyster-shell Bark-louse, and precludes its flourishing in this latitude, while it lives and thrives to the north and south of us. At least, I can now give no other explanation for the peculiar geographical distribution of the species.

ITS SPREAD WESTWARD.

It has already obtained a foothold in several orchards around Lawrence, Kansas, having spread from trees originally brought from Ohio.

BOTH SINGLE AND DOUBLE-BROODED.

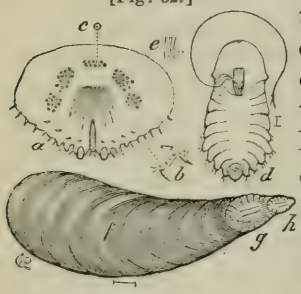
Not the least interesting feature of the southern range of our Bark-louse is its double-broodedness there. In Wright county, Mo., though the young hatch only a month earlier than in North Illinois—or about the first of May—it is nevertheless double-brooded, according to Mr. Palmer; and in Mississippi I know there are two generations each year, as I have received the second brood hatching about the first of September. Dr. Harris, years ago, asserted that there were at

least two broods of this Apple-tree Bark-louse each year, and, though he was evidently in error, so far as his own particular State (Massachusetts) was concerned, and has been severely berated for the statement by subsequent writers, yet it finally appears that his language is not so very wide of the mark!

TRUE NATURE OF THE SCALE, WITH ADDITIONAL PHYSIOLOGICAL FACTS.

Not to repeat the views formerly entertained by Mr. Walsh, Mr. Shimer and myself, as to the nature of the scale, it is only necessary to state that my own opinion, that it is a secretion analogous to that which is so generally characteristic of the *Homoptera*, has now become a conviction, and is fully supported by the study of this and allied species. If we look at the common "Mealy Bug," (*Coccus adonidum* Linn.), and take notice how the mealy matter is secreted from the general pores of the body, but more especially from the sides and around the anus, and then imagine this secretion to be more attenuated and more glutinous, and to harden and thicken at the periphery, so as to confine the louse, and cause it to add more and more behind, as it requires more room, we shall get a very good conception of the manner in which our Bark-louse scale is formed.

[Fig. 32.]



The newly hatched louse (Rep. 1, Fig. 2, *2*) is oblong-oval, 0.01 inch long, rather more than half as wide, and one-fourth as thick. It has antennæ in which may ordinarily be traced 7 joints;* legs having a short, one-jointed tarsus, a more or less distinct, but soft claw, and, among other hairs, four at tip, which are knobbed, the upper pair somewhat longer than the lower. The end of the body is bilobed, and furnished with two long hairs or setæ. Except a deep yellow spot near each end, the color is yellowish-white.

As soon as fixed, there exudes, from the surface of its body, a white waxy powder, which at first is seen in the form of threads, (Rep. 1, Fig. 3, *3*), but soon becomes homogeneous. In the formation of this scale I have seen, in this species, quite coarse filaments extending on to the twigs, and in other species I have seen a waxy precipitation, covering the twig for some distance from the insect. This secretion is easily rubbed off or dissolved in alcohol or ether, but if undisturbed, forms a thin fibre on the thickening skin-covering. In a few days the first molt takes place, not as in the ordinary manner with insects, by a series of contractions and extensions which work the old skin to the end of the body from which it is finally freed, but

* The 8-jointed figure in my first Report is evidently a mistake, caused by the use of too feeble resolving power, as I have not been able to detect 8 joints in specimens examined more carefully since.

by a sort of loosening and shrinking of the body underneath—all the members, except the proboscis, being shed and abandoned with the skin. Strengthened by the secretions from the body, this skin forms the larval or first scale, (Fig. 32, *h*), and the cast-off antennæ are more or less easily discerned, as are also the intersections of the body. The legs and anal setæ are more thoroughly obliterated, though, by proper manipulation, traces of the former may be found.

For the sake of precision, let us now first trace the growth of the female, and afterward that of the male. As the now memberless and underlying body increases so as to crowd against the inner wall of its carapace, the latter is lifted up at its hind end, and the second or medial scale is soon secreted, as already illustrated (Rep. 1, Fig. 3, *4*). Presently, the skin is shed a second time, and mingles with the second secretion, which thus takes on the form of the body, and shows the insections almost as plainly as in the first scale (Fig. 32, *g*). In a short time this second scale becomes too small, and as the inclosed body needs more and more room, this scale, in its turn, is lifted up behind, and the third portion, or shield proper, (anal sack of Mr. Walsh), rapidly forms, by a series of increments, and soon acquires its final shape, which varies considerably, according as the lice are crowded or not, but has more often that of an elongate oyster-shell, and, upon close examination, is seen to consist of about a dozen more or less distinct eccentric layers or strata (Fig. 32, *f*). It is not known whether the female sheds her skin more than twice, but there is no evidence that she does. As pregnancy advances, she loses the jug-shape of her earlier days, (Rep. 1, Fig. 3, *5*), and becomes more rounded and swollen (Fig. 32, *d*). If carefully examined, the proboscis, which is easily overlooked on account of its fineness, will be found to consist of a long, thread-like organ, originating from a tubercle on the anterior, inferior surface, (Fig. 32, *d*). I have often succeeded in extricating it entire, and the end may be seen to be tripartite, though in reality the whole is composed of four pieces.* It is undoubtedly tractile, and, when once inserted, extends, perhaps as much from pure growth as from effort on the part of the animal, for it certainly has no such length in the active larva as it possesses in the adult female. It seems to be the seat of a good deal of nervous force, and quite strong, as it is capable of a serpentine and jerking motion, and when the scale is raised, frequently retains the louse, and prevents her falling to the ground. It is, perhaps, not thrust straight into the bark, but runs just under the more delicate epidermis, in a line with the body of the louse; for such is the case with the White Pine-leaf scale

*In former years this sucker was overlooked by myself, as well as by others, though we knew from analogy that it must exist. After the eye is once trained in special search for it, this sucker may be seen even with a good lens, and appears corneous and darker than the body. If not broken off, it is longer than the body, and though usually but three ends can be seen, I have been fortunate enough to separate and discern four pieces close to the base, the two upper corresponding to the upper jaws, (*mandibulæ*), and the two lower to the lower jaws (*maxillæ*).

presently to be treated of, as Dr. LeBaron has already recorded, (Ills. Rep. 1, p. 30), and as I have myself observed.

We shall also notice that the abdominal joints are each furnished at the sides with two or three spines or stiff hairs, and, upon still more careful examination, we shall find the principal pores through which the substance of the scale is secreted. These have very naturally been overlooked, in the past, by myself and other authors, for they are only visible with great care in the preparation of the specimen, and under the highest microscopic power. I feel quite convinced, from my studies of this and allied species, that a secretion, so subtle and attenuated as to be invisible, emanates from the general surface; but as is the case so generally with the insects of this and allied families, the bulk of the matter which forms the scale, and particularly the anal portion or shield, is secreted by visible pores upon the posterior portion of the body, and which may be noticed at the intersections of the abdominal joints, but more conspicuously in sets just under and around the anus. These anal sets of pores, or secretors as they may be called, are found to vary in position and number according to the species, and have been made use of by Targioni and Signoret to separate supposed species which are otherwise not easily distinguishable. The number of pores in the different sets is not, however, constant, as will be seen from the description at the close; and should not, therefore, be too much relied on when unaccompanied by other differences. After careful examination of several specimens of our apple-tree species, I find the median set to consist most commonly of 10, the upper laterals of 20 each, and the lower laterals of 14 each (Fig. 32, *a*).

We thus see that the larval and medial scales differ materially from the anal shield, in that the two former are composed in part of the shed skins, while the latter is a pure secretion. From the extreme fineness of the threads from which it is formed, they are invisible to the naked eye, and so easily ruptured that the louse always appears separate from its shield when the latter is lifted. Yet, with a good lens, the anal threads may sometimes be seen, especially in the pine-leaf scale to be treated of; and, strictly speaking, the louse is truly separated from its shell only when the latter is completed and oviposition begins.

We will now trace the growth of the male scale. Up to the formation of the larval scale, there is no perceptible difference between the sexes, but henceforth they are readily distinguished. In the male there is but one other scale formed, and this corresponds not to the second scale of the female, but to the anal shield. It is about twice the length of the larval scale, and though there is a distinct conchoidal fracture toward the end, which would indicate a short period of rest during its formation, no insections or traces of shed skin can be found. Under this shield the louse gradually becomes a pupa, the

members budding out, and the delicate larval skin being gradually loosened and detached; when, very soon after, the third molt takes place, and the winged insect retreats from the hind end of his little tenement and seeks his dissimilar mate, who is by nature forever debarred from enjoying the same aërial liberty.

The male covering differs essentially, therefore, from that of the female, not only in being of much smaller size, but in lacking the medial scale. The anal shield seldom exceeds twice the length of the larval scale, while in the female it sometimes extends six or seven times the length of the larval and medial scales together. It is, perhaps, a little more truncated behind and straighter than in the female, of finer texture, and of lighter and brighter color; otherwise, it has the same form (Fig. 31, *c*). I have found it quite abundantly both on the upper and under sides of the leaves, especially along the midrib; and though it is also found associated with the scales of the other sex, alike on the more succulent and the harder twigs, especially when thickly covered, yet the leaves seem to be its natural dwelling-place. The female, on the contrary—in that part of the country, at least, where there is but one annual brood—seldom settles on these deciduous organs; were she to do so, there would be no security for her eggs, which would drop with the leaf to the ground and perish. How wonderful must be that power which guides the new-born atoms, and allows the short-lived male to wander on to the succulent leaf, while it wisely prompts the female to remain on the more permanent twig! Nor is the wonder diminished in the least, whether we believe the power to be direct from the Supreme and Infinite, or—after finding that it is fallible, and that the female sometimes commits the *faux pas* of settling on the deciduous leaf and fruit, while the male often settles on the twigs—indirect through inheritance and congenital habit! The respective actions being by no means constant, the instinct prompting them can not claim infallibility, and may be accounted for on the principles of heredity, as there is a constant weeding out of all such females who chance to depart from those actions required to perpetuate their kind.

THE MALE LOUSE.

Though, from analogy, all authors have felt that the male of this bark-louse must have an existence, yet he has never heretofore been discovered or described. During the latter part of June and fore part of July I succeeded in rearing quite a number from scales from Mr. Palmer's orchard, and the ventral and dorsal figures which I have made (Fig. 31, *a b*) will convey a correct idea of this interesting little being. The wings appear whitish, and under a high magnifying power are seen to be covered with infinitesimally small hooks or bristles (*e*). The general color of the body is pale purplish-brown—not unlike the color of the shield which protected him—and, like the

other gentry of his family, he has no proboscis, (having lost it when shedding the larval skin), but near the place where it naturally would be are a couple of ocular tubercles, which give him the appearance of having four eyes—two above and two below. As Signoret has proved, and as may easily be seen by crushing the head, these tubercles are directly connected, by a pigmental substance, with the eyes, and they doubtless convey the power of sight; for the superior eyes can be of little service to the possessor as he crawls over the arched coverings of the other sex. The penis is about as long as the abdomen, and is protected and covered by two valves; and the hind wings are replaced by two fusiform balancers, which terminate in a long, delicate hook, and which hold and give strength to the front wings, which are spatulate in form and traversed with but two veins.

Frail and delicate as these little beings appear, they are yet possessed of wonderful nerve-force and wing-power; for the few days of life allotted to them are days of great activity, and in the breeding jar they keep up an almost constant wing-vibration, and are never at rest, except when the temperature is unusually low.

In his excellent account of the closely-allied Pine-leaf scale, Dr. LeBaron (Ills. Rep. 1, p. 88) gives expression to the following sentiment:

"Fixed immovably to the surface on which she reposes, and hidden from view beneath the shadow of her vaulted carapace, but dimly conscious, we may presume, of some unfilled requirement of her being, the helpless female *Coccus* awaits the addresses of her unknown and invisible paramour. Nor does she wait in vain. Of all the countless myriads of these lowly creatures which congregate upon the bark of the apple-tree, or whiten with their spotless phylacteries the foliage of the pine, not one, so far as we know, fails to be called to enact the offices of maternity. Nature, in the universality of her providence, takes them in her charge and ministers to their necessities, and no unloved or unfruitful virgin is permitted to languish in the halls of the *Coccidæ*."

However beautiful and even rational this view may be in the abstract, I have serious doubts of its correctness in point of fact, especially with regard to the Oyster-shell species. Nothing in the past history of this insect has been more noteworthy than the failure on the part of entomologists to discover the male. It is barely possible that this failure may be attributable to negligence and oversight, or that other circumstances may have contributed to it, such as the probable facts that the males hatch out earlier than the females, and that they are naturally less numerous — each being able to serve several females, as Reaumur found to be the case with another species. But with such careful observers as Walsh and Shimer, and with Dr. Le Baron himself, surrounded by infested trees at his home, in Geneva, it would hardly seem probable. When, also, I recall my own observations in past years, in Northern Illinois, and my attempts to solve the

riddle of his existence — when I recall the fact that he has likewise remained undiscovered by eastern observers, and that the males of closely allied European species are unknown — the impression becomes irrisistible that these insects are metagenetic, and that, just as in the closely allied plant-lice, (*Aphidæ*), they may and do go on multiplying agamically for a series of generations, and that the male only occasionally appears. To strengthen the impression, M. Signoret informs me that M. Balbiani absolutely denies that the presence of the male is necessary in the *Lecanides*, a subfamily of larger bark-lice. It would also seem that in accordance with what appears to be a very general law both among plants and animals,* the male is in some way connected with weakened vitality; for with the very batch of leaves and twigs from which I bred the ♂, came the statement that the insects seemed to be dying out, and were less injurious; and, certain it is, that wherever I have found the male scales on the twigs, it was always on such as were so thickly covered with the other scales, that these were two or three thick and many of them aborted. Moreover, it is well-known that this bark-louse has, during the past few years, become less and less troublesome in portions of the North-western States, which suffered so much from its injuries ten and fifteen years ago. It seems to have lost vitality, and in carefully examining some trees in the vicinity of Dubuque, Iowa, I had no difficulty, last August, in discovering a certain percentage of male scales. However, the question as to whether our Oyster-shell Bark-louse can multiply agamically, or not, is easily settled by a few simple experiments, which will doubtless be made by those who have the proper opportunities. Even believing, as I do, in agamic multiplication in this case, we may, nevertheless, naturally conclude, from analogy, that there is a limit to it, and that without occasional fecundation, eggs would eventually either become addled, or the female die without giving birth to them; and on this hypothesis we can account for the abortive scales which are often found without any trace of the contents having been destroyed by other agencies.

MODE OF SPREADING.

Having already (Rep. 1, p. 15) referred to this subject, I allude to it again only because a good deal of wonder has been expressed at the wide extent of this insect's range, considering that it is active but three or four days in the course of the year. Dr. LeBaron records some interesting observations, which show that the active larvæ are seldom blown by the wind more than three rods from the outermost branches of a tree, and he thinks that the theories so far propounded

* See Rep. 4, p. 65; also an article "On the Relation between Organic Vigor and Sex," by Dr. Henry Hartshorne, read before the Am. Ass. for Adv. of Science, at Dubuque, and partly copied in the *American Naturalist* for December, 1872; also *Gardeners' Monthly*, November, 1872, and *Old and New*, February, 1872.

are inadequate to account for the wide dissemination of the species. It is very clear to me, however, that by aid of winds and their natural powers of locomotion, the lice can soon overrun a large orchard from a given point; and their wide distribution is easily accounted for *by the transport of the female scales on scions and nursery stock*, to say nothing of the aid they get from birds, flying insects and even running water; for Dr. Shimer has shown that this last may, under favorable circumstances, serve as a means of transportation. Moreover, severe storms, passing over infested districts at the right season, may help to carry them still greater distances.*

FOOD PLANTS.

Besides the Currant, Plum, Pear, Crab and Persian Lilac,† there is evidence, as we see from Mr. Hanan's letter, that it will also live on the Cherry and Apricot, while the same, or a closely allied species, occurs on the Elm and Sweet Gum in Mississippi, according to Mr. Merchant; on the Mountain Ash, according to Dr. Shimer (Trans. Ills. State Hort. Soc., 1868, p. 228) and others; on the Dogwood (Am. Ent. II, p. 334), and on the Ash-leaved Spirea, according to Judge J. G. Knapp, in a paper read before the Madison (Wisc.) Horticultural Society, at its meeting in 1870. In Europe, what has been taken for the same species, is also found on the Dogwood, as well as on the Elm, White Thorn, Medlar and Currant.‡

The rule among the bark-lice seems to be that each species is restricted to plants of a given family, and future investigations may show that those existing on trees, which do not belong to the family *Rosaceæ*, have structural differences, and are distinct, notwithstanding their superficial resemblance. Such differences may be expected, as will be shown in the closing bibliological remarks. However this may turn out, it is very certain that the species in question, though partial above all things to the Apple, yet shows a preference for some of its many varieties, or at least thrives better on some than on others. Dr. LeBaron mentions the Red Romanite, Red Astrachan, Rambo, Early Harvest, Summer Rose, as being most largely infested, and the

* After a thunder storm in the middle of March, I saw the ground in places in St. Louis sufficiently covered with pollen to appear as though sprinkled with sulphur; and this pollen, upon examination, proved by its trilobed and oily character, to belong to some pine, and probably to the Long-leaved pine, which was at that time in bloom in the Southern States, and from which it must have been carried a distance of at least four hundred miles. This pollen grain is, though aided in floating by the lobes, heavier than the young bark-louse; and numerous other instances of the carrying power of severe storms are on record.

† The negative evidence is very strong that the species found on the Persian Lilac is distinct, for some of these shrubs, belonging to Mr. F. Starr, of Alton, Ills., are crowded with the scales, in the immediate vicinity of apple trees that have none. Yet from specimens of these scale-covered lilacs, received from Mr. Starr, and from others examined in other quarters, I can find no superficial differences which would enable me to distinguish the bark-lice thereon from the apple-tree species.

‡ Boisduval's *Entomologie Horticole*, 318; Taschenberg's *Entomologie fuer Gærtner and Gartenfreunde*, 430.

Northern Spy, Maiden's Blush, Benona, Soulard, Willow Twig, Lowell, and Limber Twig as most free—his observations being made principally in the orchard of J. W. Robson, of Galena, Ills., where the trees alternated and were similarly situated with respect to outside agencies.

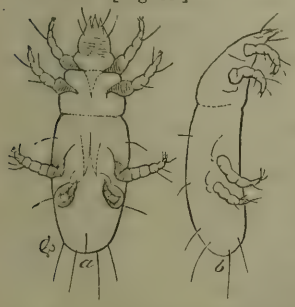
I once witnessed a very beautiful and striking illustration of this truth in an orchard belonging to Mr. A. M. Herrington, of Geneva, Ill. Though, as already stated, the scales are found upon the wild Crab, they are always so found in sparse numbers, which indicates that the wild apple is not so congenial to the species as many of the cultivated kinds. Mr. Herrington has an orchard of about a hundred Ohio apple trees, grafted on to crab stock, together with a few of the ungrafted crabs. Scales are found on the grafted parts of almost all the trees, but scarcely one can be found on the crab stock; and in a few instances the grafts are covered right down to the junction with the stock, but do not go beyond.

ENEMIES AND PARASITES.

Besides mites* and lady-birds, the latter of which make ragged holes through the scales, it has long been known that a little Hymenopterous parasite preyed upon this bark-louse, and in 1854 Dr. Fitch was familiar with its larva, and figured a scale that had been perforated by the mature fly.† It was not till the year 1870, however, that this fly was really known and described by Dr. LeBaron, who has given such excellent accounts of it,‡ that I prefer to quote his experience

*These mites may generally be distinguished from the young bark-louse by having eight legs instead of six, though some of them have but six legs in the larva state, and this criterion will not always hold. Moreover, in the 8-legged species the front pair are easily mistaken for antennæ. We must therefore look for other distinguishing traits, and we find them in the relative position of the legs, the third pair in the mites always being widely separated from the two front pair, while in the bark-lice they are all equidistant. The mites are also more transparent and polished than the lice. There are doubtless several mites which destroy the lice, and while one of the 8-legged forms has been described as *Acarus? malus* by Dr. Shimer, he has proposed the name of *A. Walshii* (Trans. Ills. Hort. Soc. 1869, p. 281) for the 6-legged form, but without description; and indeed descriptions, unless accompanied with habits, development and variation, amount, in these cases, to very little.

[Fig. 33.]



I present, herewith, (Fig. 33), a side and ventral view of the species which so effectually destroyed the contents of the Georgian scales, in order that the reader may get a correct notion of the appearance of these mites. It may be a form of the *Acarus? malus* of Shimer, but differs from his description in being almost four times, instead of twice, as long as broad, as well as in other details. The head and the limbs are yellowish, and more horny than the rest of the body, which is white. Four prominent hairs are seen from behind; and when the animal is crawling, a dorsal view discerns but six legs, the posterior pair being smallest and apparently of little use, as they are generally curled up, as in the figure (*a*). The ends of the legs are flexile, and are spread out in the act of walking. It apparently belongs to the genus *Dermaleichus*.

†N. Y. Rep. I., p. 35.

‡*Am. Ent.* II, pp. 360–2: 1st Ills. Ent. Rep. pp. 34-9.

in his own words; especially as I have had no opportunity of making personal observations upon it. It belongs to the extensive family

[Fig. 34.]

Chalcididæ, which comprises insects of small size, characterized chiefly by their jumping power and parasitic habit. The species in question was described (*Amer. Ent.* II, p. 360) under the name of *Aphelinus mytilaspidis* from the female sex only, the male being yet undiscovered. Her habits are thus recorded by Dr. LeBaron:

In the course of a series of observations upon the Apple-tree Bark-louse, during the past season, it has been my good fortune to trace the history of this interesting little insect, which, if it has ever been seen before, has not been identified, and whose very existence has been only a matter of inference from the visible marks of its beneficent operations.

In the early part of the season, while examining the lice upon an apple tree, I noticed two or three little yellow Chalcides running along the infested twigs, which I conjectured might be the parasites of the Bark-louse, but had no proof that this was the case. But about the first of August, upon raising one of the scales, I happened to uncover one of these insects in the last stage of its transformation. Its wings were not yet unfolded, but it ran so rapidly that I had some difficulty in keeping it within the field of the lens. As soon as it paused long enough to be examined, it was easily recognized as a Chalcis by its general aspect, and especially by the peculiar vibratile motion of its short geniculate antennæ.

Having once become familiar with its appearance, I have had no difficulty in capturing, in the latter part of August and September, all the specimens I desired on the infested trees. I have repeatedly watched the female Chalcis in the act of inserting her ovipositor through the scale of the Bark-louse, for the purpose of depositing her egg in the cell beneath. She always places herself transversely with respect to the scale. Sometimes she mounts upon it, and then her tiny body is seen to be considerably less in length than the width of the scale. Usually she backs up upon it only so far as to bring the tip of her abdomen about opposite the middle of the scale. Then bringing her ovipositor down perpendicular to her body, she forces it through the scale by a series of boring or short plunging motions. Having accomplished this, she remains stationary for many minutes, while by some invisible intestine motion the egg is carried down the ovipositor and deposited beneath the scales. So absorbed is she in this delicate operation, upon the successful accomplishment of which not only her own hopes, but those of the horticulturist, so largely depend, that nothing can deter her from it. In one instance, having drawn down a branch of an apple tree, I discovered a *Chalcis* in the act of depositing. While holding the branch in one hand, and viewing the insect through a lens held in the other, the branch slipped through my fingers and flew back with violence to its place. Drawing it down again, the twig I had hold of broke, and it flew back a second time. I supposed that that observation had, of course, been brought to an abrupt termination. But, upon drawing down the limb the third

time, there stood my little *Chalcis* as immovable as a statue at her post. She may be touched with the finger while thus engaged, or even crushed, as I have often inadvertently done in my attempts to capture her, but nothing short of this actual violence can move her from her position. With such wonderful perseverance and devotion do these living atoms of creation perform their allotted part in the complicated economy of nature.

The egg thus deposited hatches into the little footless larva previously mentioned. This larva is so admirably described by Dr. Fitch, in a single sentence, that I can not do better than copy his description: "Under these scales I have repeatedly met with a small maggot, three-hundredths of an inch long, or frequently much smaller, of a broad oval form, rounded at one end and tapering to an acute point at the other, soft, of a honey-yellow color, slightly translucent and shining, with an opaque brownish cloud in the middle, produced by alimentary matter in the viscera, and divided into segments by faintly impressed transverse lines." (Fig. 34, *c*.)

The only motion of which this small grub is capable is a slight extension and contraction of its body, particularly at the two extremities, by which its form is correspondingly modified.

There is usually but one larva under each scale, and I have never seen more than two. In the earlier part of the season it is seen adhering to the body of the Bark-louse, but later it is found in the midst of the eggs or their remains.

The Chalcis-fly itself is a beautiful object under the microscope. Its length is a little less than half a line, or about one-twenty-fifth of an inch, though I have captured a few specimens considerably smaller, being but little more than one-third of a line. I at first supposed that these smaller individuals were males, but all the specimens that I have examined have proved to be females. Their color is a uniform pale lemon yellow. The only variation from this color is in the minute mandibles, which are reddish brown. There are three coral red occelli on the summit of the head, and the ovipositor, which lies in a groove on the underside of the abdomen, exhibits a slight reddish tint. The wings are thickly beset, over nearly their whole surface, with bristly points, and their margin is ornamented with a long fringe.

But a better idea of the appearance of this little insect will be obtained from the magnified figures which accompany this article (Fig. 34 *a* showing perfect fly, *b* the greatly magnified antenna, and *c* the larva) than from any verbal description.

By observations, made as late as the first week in November, the opinion is confirmed that the Chalcis of the Bark-louse has two broods in a year. By the middle of September we find many of this year's scales pierced with the round holes through which the first brood of Chalcides has escaped; and late in the fall we find, under about an equal number of scales, the fully-grown larvæ of the second brood, sometimes with the eggs of the Bark-louse upon which they have subsisted all consumed, and sometimes with a few remaining; and in this state they undoubtedly pass the winter. This second brood must appear in the winged form early enough next summer to deposit the eggs from which the first brood of next year will proceed.

Dr. LeBaron found that in 1870, in different orchards in DuPage county, Illinois, only one in fifteen of the scales examined contained healthy eggs—so effectually has this little *Aphelinus*, assisted by other enemies, such as mites and lady-birds, done its work

This little parasite, which works for the most part unseen but none the less effectually, and which so materially aids man in protecting his apple-trees, is, fortunately, easily introduced into sections of the country not yet favored with it, and may, no doubt, be colonized wherever its natural prey flourishes. The second brood sleeps away the winter in the larva state, sheltered by the scale intended to protect the bark-louse eggs; and twigs thus freighted with our little sheltered friends may easily be carried from one part of the country to another, or even to a foreign land. The torpid condition of the larva will insure its safe transportation in winter, and its presence may not only be surmised by the smooth holes in the deserted scales which are found in orchards where this *Aphelinus* abounds, but may be positively ascertained by careful lifting of a few parasitized scales. To colonize the parasite, all that is necessary is to tie such parasitized twigs on to trees which it is required to protect, and the microscopic flies will issue at the proper season and carry on their good work, unconscious of the carrying process which man had submitted them to during their larval dormancy. Dr. LeBaron has already made some efforts to introduce this parasite around Galena, Ills., where, as he ascertained, it did not previously occur; and I shall take steps the coming season to introduce it into Clark and Wright counties in our own State.

REMEDIES.

I have little to add to the advice given in 1868. The importance of critical examination, before planting, of all young trees and scions, or of applying some simple remedy when the young lice are hatching, can not be too strongly urged; and, as a rule which will hold very generally true, it may be stated that the young begin to hatch just about the time the blossom falls and the fruit begins to set. Let those who prefer to work toward eradicating the pest in winter time (as many no doubt will, on account of the leafless state of the trees and the greater leisure which most fruit-growers have at that season) vigorously prune and scrape the infested trees; and afterward apply some of the oily applications previously recommended. As a remedy not previously named, I would mention linseed oil, which has been used with marked and beneficial results in Grundy county, Ills. Many persons have been deterred from using greasy or oily substances on their trees from a fear of evil consequences resulting to the trees; but there is nothing more certain than that, judiciously applied in early spring after the sap begins to flow, these applications do not injure trees; while they are effectual, more especially when applied at such season or during thawing weather, in killing the eggs under the scales—the oily particles being absorbed through and under the scales, and destroying the eggs as soon as touched. The following experiment, performed by Dr. LeBaron, and which I quote from his second Report, will give confidence to the hesitant:

"On the 30th of March, the buds not having yet expanded, I selected six thrifty five-year-old apple-trees, of three different varieties, and applied to two of them simple lard, greasing over every part of the trees, trunk, branches and twigs. To two others kerosene oil was applied in the same manner. To the other two linseed oil was applied; but in this case, to vary the experiment, the terminal twigs were omitted. None of these trees were eventually damaged by the applications. Upon those to which the lard and linseed oil were applied, no effect was perceived. They leafed out as early and looked as well as other trees standing beside them. The kerosene, as might have been anticipated, acted more severely. It killed or seriously damaged all the first buds, and the trees were several weeks later in leafing out than the others; but at an examination of them on the 5th of July, no difference could be seen in the quantity or healthiness of the foliage from that on the other trees. One effect of the kerosene is deserving of notice. The check thus given to one of these trees had an effect similar to girdling or root-pruning, namely, that of throwing it into premature bearing—this tree producing an apple though still standing in the nursery row.

Mr. Palmer has used hot lye, applied with a brush, soon after the lice hatch, to the trunk and limbs as far as he could reach, with good results. The injury to the foliage is only temporary.

BIBLIOGRAPHICAL AND DESCRIPTIVE.

Generic Name.—This insect, ever since the publication of Dr. Asa Fitch's first N. Y. Report, has been known, in American entomology, by the technical name of *Aspidiotus conchiformis* (Gmélin). The genus *Aspidiotus* was erected, in 1833, for those species living *under* a scale, by Bouché, a German entomologist; and our insect has been referred to it; but this author paid little regard to the work of those who preceded him, and the genus *Diaspis*, which covers the characters of *conchiformis*, had already been erected by Costa in 1827. Costa's name, therefore, has priority, though his observations were superficial and unreliable. In 1868 (Trans. Am. Ent. Soc., Vol. I, pp. 361–374) Dr. Henry Shimer, of Mt. Carroll, Illinois, proposed still a new genus, (*Lepidosaphes*), and even a new family, founded on certain characters of this insect. Dr. Shimer appears to have been unacquainted with the work that had been and was being done in the same field by other authors. His generic name might have been adopted, had not another genus already been erected for it, and employed by Targioni and Signoret. As for the other characters mentioned by Dr. Shimer, and supposed to be of family value—viz: (1) the scale constructed by, and separated from, the insect; (2) no tarsal claw; and (3) the possession of *digituli*—they are easily disposed of. (1) The separation of the scale had already suggested to Bouché his genus *Aspidiotus*; (2) the tarsal claw I have plainly seen, and though blunt and soft in the larva, it is quite conspicuous and more perfect in the male;* (3) the digituli, or knobbed hairs, are common

*See Fig. 31, *d*.

attributes of the *Coccidæ*, and precisely similarly knobbed hairs are found at the antennal extremities of some species—e. g. *Lecanium aceris* (Schrank), *auctore* Signoret.

Mons. V. Signoret, of Paris, has lately been engaged on an elaborate monographic revision† of the insects of this family. This distinguished author has, perhaps, devoted more time to the *Coccidæ* than any one living; and in his admirably illustrated essay, with copies of which he has favored me, the *Coccidæ* are divided into four distinct subfamilies, distinguished by the more obvious characters, as follows:

1.—Diaspides:—*Species covered with a scale composed of successive moltings, and of a secretion forming a shield or sack more or less independent of the body of the animal.*

Nine genera are included in this subfamily, but the scales may all be reduced to two principal types, viz: Those with rounded shields, like an oyster-shell, with the larval scale in the center; and those with more lengthened shields, in the form of a large comma, or of a muscle-shell, and having the larval scale at one end.

Among the latter is the genus *Mytilaspis*, to which our apple-tree species, under consideration, belongs, and which is characterized by the male and female shields having much the same form.

2.—Brachyscelides:—*Species living in gall-like or tube-like excrescences.* These insects are, so far as known, confined to Australia.

3.—Lecanides:—*Species either naked or inclosed, or simply covered with waxy, calcareous or filamentous secretions; and in which the female, after fecundation, generally acquires an entirely different form to that which she previously possessed, and becomes fixed. Before pregnancy, they have the power to move, if necessary.*

A number of genera are included in this subfamily, some of which, approaching in some characters to the *Diaspides*, have been separated by Targioni, under the name of *Lecanio-diaspides*.

4.—Coccides:—*Species retaining to the end the body-form, with all its joints distinct. They never become necessarily fixed, and are either naked or more or less covered with waxy or spumous matter, arranged generally in filaments.*

Specific Name.—In considering the specific name of this insect, we meet with the same difficulty which constantly presents itself to the conscientious student of animal life, especially in its lower forms; and there can be no stronger argument in favor of the mutability of species than this difficulty experienced in properly defining them. All nature is a whole, and our classificatory divisions, though very essential to enable us to study and understand her, have hardly a more real existence than the divisions by which we measure time. With partial knowledge, only, of her facts, it is easy to separate and draw distinctions in the cabinet; but deeper knowledge of these facts often begets doubt and difficulty, as to these distinctions, and shows the unnaturalness of strict and fast definitions.

With our bark-lice, as already stated, it has been customary to consider the forms found on different plants as distinct species. No

† *Essai sur les Cochenilles*, in *Annales de la Soc. Ent. de France*, commencing in 1868.

other course could well have been taken, considering our imperfect knowledge of them in the past; but it is evidently a very artificial one. We now know that some of the larger species thrive on plants of widely different families, and a correct knowledge of the present relations of these bark-lice will first be had, when, by prolonged experience and deeper search, we understand all the more minute structural differences; the variation resulting from phytophagism or cause whatsoever, and the male as well as female characters.

It has generally been supposed that our Oyster-shell Bark-louse is the same species originally mentioned by Reaumur, in 1738, (Mem. Tom., IV, p. 60), and found in Europe on the Elm. Doubts have existed as to the identity of the two, because of the difference of food-plant; but his account and description of the insect itself agree otherwise with ours. In 1762 Geoffroy described a species supposed to be the same, by the name of *arborum-linearis*, and twenty-six years afterward Gmélin gave the name *conchiformis* to what has also been considered the same insect. Geoffroy's name has been very generally ignored, because of its non-conformity to existing rules of scientific nomenclature, and of the inappropriateness of the term, if intended for our apple-tree species. In 1851 Bouché (Stett. Ent. Zeitung XII, No. 1) gave to a similar species, occurring on the Apple in Europe, the name of *pomorum*, which has either been considered synonymous with the others, or entirely ignored by most subsequent authors. Signoret, in the second part of the essay already referred to, considered all these names synonymous; but he subsequently changed his mind, and in the sixth part of his essay he has employed each of the three names for what he considers distinct species, and has characterized them as follows:

M. linearis (Geoff.) is found on the Linden, and is supposed to differ from *conchiformis* by the shield being long, more or less straight, of a yellowish-brown color, and generally covered with a soot-like substance; by the female being nearly as broad before as behind, and by the secretors on the anal plate being nearly continuous, the middle set with 6 or 7, the upper laterals with 10 or 12, and the lower laterals with 9 or 10. The ♂ is unknown.

M. conchiformis (Gmélin) is the species found on Elm, and which differs in no respect from the apple species, except in the number of anal secretors possessed by the female, the median set composed of 6 or 7, the upper laterals of 8 or 9, and the lower laterals of 5 or 6. Signoret says that the male scale is of a pale yellow, and with straight and parallel sides, while the male is described, from a mutilated specimen, as pale gray, with the antennæ appearing short.

M. pomorum (Bouché) is the species found on Apple, and it differs from the preceding, principally in the median set of secretors in the female being composed of 17, the upper laterals of 17, and the lower laterals of 14. The eggs are described by Signoret as being of a *deep red*, and the antennæ of the active larva as 6-jointed. The scale has the same form, but is described as brownish-black, with a portion of the "apical border white and more oblong." Bouché, in characteristic German, describes it as ham-muscle-shaped (schinkenmuschelförmig), slightly bent, and with the pointed end, and edge of broad end, yellowish. He also describes the eggs as *red brown*, and mentions the food-plants as "Apple, Pear, Plum, Dogwood, etc."

It will be seen that in thus distinguishing these three species, M. Signoret attaches a great deal of importance to the number of anal secretors. Judged by this criterion, our own insect, under consideration, can not be referred to either species, and is consequently undescribed. The name being appropriate, it would have pleased me to refer it to Bouché's *pomorum*, and in the secretors it comes nearer to that than to the other species; but aside from the difference in the secretors, the difference in the color of the eggs is an insuperable objection, as I find this character the most constant. Noticing that in his generic diagnosis M. Signoret says that the eggs of *Mytilaspis* are always either white, yellowish or grayish, and knowing that those of our species, though normally pure white, become discolored and ferruginous when addled or otherwise injured, and are always yellowish just before hatching, it struck me that this author might have made a mistake in describing those of *pomorum* as "deep red." And, in fact, after examination of specimens of our insect received from me in 1870, he was inclined to think the two identical, and that he *had* made a mistake. But there is Bouché's original description, in which the eggs are distinctly described as red brown, and which effectually separates the two forms; and as *conchiformis* is properly relegated by Signoret to the species on the Elm, and may be considered distinct, not only on account of the differences indicated above, but of the negative evidence that our apple-tree species does not affect the Elm, there seems no other course left but to give our insect a new name. I have little doubt that the species occurring on the Apple in England, and treated of by "Ruricola" (Jno. Curtis) in the *Gardeners' Chronicle*, 1843, p. 736, under the common name of "Apple-tree Mussel-scale or Dry scale," and the scientific name of *Aspidiotus conchiformis*, is the same as our *pomicorticis;* for though the mother louse is described as "fleshy-green" and "yellow-green," the eggs are said to be white, and the size, form and habit otherwise coincide. The same may be said of the European apple tree species mentioned by Boisduval and by Taschenberg, who describe the eggs as white.

Now, these four bark-lice certainly bear sufficient resemblances to be mistaken for one species; and whether they really constitute but one species, merely varieties of one species, or four genuine species, according to the usual acceptation of the term, can only be definitely ascertained when the males of all are known, and when, by experiment, it is found that the one can not live upon the food-plants of the other. A slight difference in the number of anal secretors can not be looked upon as of sufficient specific importance when all other characters agree; for the number, as we have already seen, is not constant. Yet, there is no doubt a limit to the variation from the ordinary number, and the differences noted above probably have their value, and at all events are made by the highest authority. It will certainly facilitate our study to have these four insects separated, and

I shall, in future, always refer to our apple-tree species by the scientific name of *Mytilaspis pomicorticis.* On general principles, I dislike to change long-established names, but by doing so in this instance we not only brush away the cobwebs of uncertainty which have gathered around the nomenclature of the insect, but we also obtain more appropriate terms. All former descriptions were in so far imperfect and provisional that they lacked the male characters, and in thus connecting the name *pomicorticis* with this more complete description, I hope that our insect's title is secured. I have not thought best to change the popular name by which it is known, for though the term "Mussel-shell" would be more appropriate, the scale not unfrequently assumes an oyster-shell form.

MYTILASPIS POMICORTICIS, N. Sp.—*Eggs*—From 30 to 100 under each scale; length scarcely 0.01 inch, irregularly ovoid, nearly thrice as long as wide, snow-white, except just prior to hatching, when they become yellowish. *Larva*—Length of body 0.01 inch, ovoid, thrice as long as wide, pale yellow, with a darker yellow spot near each end; a few short hairs seen around border; two fine anal setæ about half as long as body springing from two lobes between which two spinous hairs are always seen; antennæ quite variable, the joints irregular and not easily resolved, sometimes appearing only 6-jointed, but more generally 7-jointed, with a few hairs, two or three at tip the longest and most persistent; legs with a one-jointed tarsus, a feeble claw, and, among other hairs, four more or less distinctly knobbed ones near tip, the two uppermost longest.

♂—Length of body, 0.022 inch; color, translucent carneous-gray; a dorsal transverse band on each abdominal joint, and portions of the mesothorax and metathorax darker, or purple-gray; the members somewhat lighter. *Head*, sub-triangular; rostrum rudimentary; ocular tubercles, one each side of it, plainly visible, the eyes on the upper surface prominent, dark, and with few facets; antennæ as long as body, 10-jointed, jts. 1 and 2 bulbous and sometimes indistinctly separated; 3—9 about four times as long as wide, slightly constricted; 10 half as long and fusiform; all but basal two with a whorl of about eight hairs, slightly clavate and as long as width of joint. *Thorax* very large, oval; prothoracic portion narrowing in front, composed of two transverse folds, the anterior one having a transverse row of four dusky dots; the mesothoracic portion large and elevated, showing three lateral swellings; a well defined medio-dorsal plate, rounded in front, shallowly notched behind, with a medio-longitudinal suture, and a transverse one dividing it in two, the anterior half pale, the posterior darker; the metathoracic portion showing a sub-triangular scutel, and separated from mesothorax by the transverse band (*apodema* of Targioni). *Wings* about as long as body, arising from base of mesothorax, spatulate, closing flat on back in repose, and appearing whitish, finely and uniformly covered with short, stiff hairs; supported by a bifurcate vein, the bifurcation arising from basal fourth, and each fork running near and almost parallel with the wing-margins; balancers dark, with the hook quite long. *Legs* with the middle pair longest, and—from large size of coxæ—further from front than from hind pair; the coxæ and femora large and swollen, the latter with a more or less distinct lobe near the base below; the tarsi one-jointed, with a constriction occasionally indicated, and terminating in a single flexible claw, surrounded by four clubbed hairs; the tibiæ and tarsi are quite bristly, but on the femora there are usually but two bristles, one about the middle above, and one on the basal lobe below; the coxæ also have one above. *Abdomen*, seen from above, nearly as long as thorax; appearing shorter from below; 8 joints only discerned; the last joint abruptly narrowed into a large tubercle bearing four bristles on the under side, and sending forth the genital armor in the form of an awl-shaped style as long as the abdomen.

♂ Scale—Larval part golden-yellow; the anal shield yellowish-brown, sometimes quite pale, inclining to white, flattened, straight, rather more than twice the length of larval scale, increasing in width from tip to end, where it is slightly truncate; attached by a white film; average length, 0.035 inch.

♀—Average length, 0.05 inch; color, pale yellow; jug-shaped and flattened when young, more globular when mature, and twice as long as wide; the cephalo-thoracic portion rounded and entire, but narrower than the abdominal, at the juncture with which it forms a more or less conspicuous lateral projection; on its inferior side is a tubercle, having two longitudinal ridges, and giving rise to a corneous, filiform proboscis, longer than the body, and composed of four separate parts; posterior abdominal joints deeply lobed laterally, with two or three blunt, fleshy hairs to each lobe; anal plate gamboge-yellow, corneous, with an irregular border, presenting two larger, slightly tri-lobed, median projections, and one or more smaller ones each side, furnished with spinous hairs, two especially between the tri-lobed projections aforenamed; five more or less complete sets of secretors visible from below, arranged around anus in form of an arc, the median set with normally 10, the upper laterals 20, and the lower laterals 14; besides these, some six or more blunt tubes, and a series of shorter pointed ones, may be noticed along the border, and doubtless serve as secretors. (See Fig. 32 *b*.)

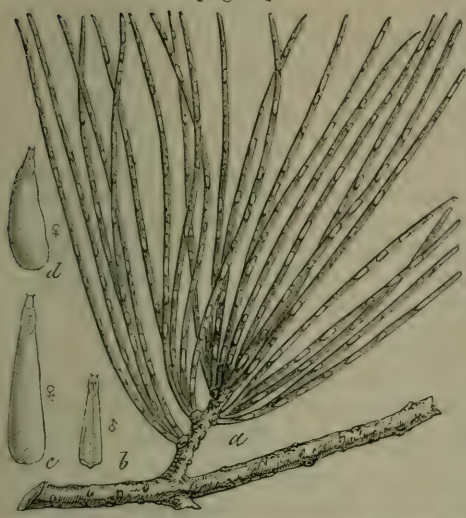
♀ Scale—Larval scale golden-yellow; median scale somewhat darker; anal shield varying from pale brown to deep purplish-gray, and generally of a color with the bark it is upon. The whole scale is often incanous, but the hoary film easily rubs off; it averages 0.12 inch in length, but is quite variable in form and size, being either straight or curved, narrow and strongly arched, or broad and flatter, but always rounded at the end; the white inferior laminæ at sides sometimes show distinctly from above, and give the appearance of a pale border.

The lice, whether ♂ or ♀, vary in appearance according to position and state of maturity. In making the foregoing descriptions and figures, I have taken what appeared the most natural positions, after examination of many specimens. The ♂ abdomen shrinks very much in drying, and the more detailed ♀ characters are variable. While the normal number of secretors in the middle set is never more than 10, I have sometimes found but 8 or 9; that of the upper laterals never surpasses 20, but may be as low as 15; while that of the lower laterals is more uniformly 14, though I have sometimes found 16, and at others 12. Opposite sets do not always contain the same number.

THE PINE-LEAF SCALE-INSECT—*Mytilaspis pinifoliæ* (Fitch.)

(Subord. HOMOPTERA, Fam. COCCIDÆ.)

[Fig. 35.]



There are several undescribed bark-lice—some of them quite interesting—which attack our forest and shade trees, and especially our evergreens; but for want of time to make proper descriptions and figures, they must be passed over for the present. An exception is made of the Pine-leaf Scale, because, first, it is the most common and injurious of them all; and, secondly, by coupling its history with that of the Oyster-shell species of the Apple, much unnecessary repetition is avoided; for notwithstanding the last named normally inhabits the bark, while that under consideration is confined to the leaves, the two insects belong to the same genus, and have precisely similar modes of development.

Many persons, who justly esteem the White Pine one of the most valuable of our ornamental, shade, and timber trees, and who, in adorning their homes, have duly planted of it, have doubtless been sorely vexed at seeing their favorites gradually overspread with what is by some called the "white malady." This malady is an affection of the leaves, and though not many are aware of its true nature, they readily perceive that the unfortunate trees wear an unnaturally yellow, or brown, and sickly aspect, and in some cases, after languishing a few years, die outright.

The leaves of such trees present the appearance of figure 35, *a*, being covered with innumerable elongate white bodies, and looking very much as though finely and profusely sprinkled with molten wax or paraffine. Careful examination will show these bodies to be the scales of the insect in question, and though when few in number they are mostly found in the groove of the leaf, which partially screens them, yet when abundant they cover the more salient sides, and give the tree a whitened look. I have never found this insect in injurious abundance, except on young trees; and according to Dr. Fitch, it is never met with upon the trees growing wild in our forests. It has proved quite troublesome to the young trees around St. Louis, and especially along the line of the Missouri Pacific Railroad. It was

described * by Dr. Fitch,† who had but an imperfect knowledge of it, and mistook the scale for the relic of the body of the dead female, and the true relic of said body for the remains of viscera; the three parts of the scale seemed to him to represent the head, thorax, and abdomen, while the male scales were supposed to be but half grown. In 1870 the male louse was simultaneously discovered by Dr. LeBaron and myself, and the first comprehensive account of the species appeared in the former's first report (pp. 83–96).

ITS NATURAL HISTORY

Is briefly told. The eggs, which may always be found under the new and healthy female scales during the winter, to the number of from fifteen to thirty, instead of from thirty to a hundred, as in the Oyster-shell species, are scarcely 0.01 inch in length, perfectly oval, and of a blood-red or brown-red color. The young larvæ usually commence hatching and leaving the scales about the first of May, though I have known them to do so as early as the 25th of April. They are of the same blood-red color as the egg, but have, otherwise, essentially the same form and structure as *pomicorticis*, though the head appears rather more squarely cut off between the antennæ, and is sometimes even a little sunken. The joints of the antennæ are irregular and not easily distinguished, but I have discerned seven, the terminal one ending in a long hair, and having two lateral hairs, the middle joint also having quite constantly two lateral hairs. The claw of the tarsi is imperfect and clumsy, and the two upper knobbed hairs or *digituli* are much longer than the lower ones.

The earliest hatched are, for the most part, males. They travel but little, and remain on the old leaves. Indeed, they often become attached under the tented protection of the mother scale. Soon after fastening, the skin becomes yellowish, and, with the exception of the antennæ, all trace of members is lost to the unassisted eye; a ridge forms down the middle of the back, and a dusky spot each side of it may always be noticed anteriorly. After the retreat of the insect, this scale is delicate, semi-transparent and amber-colored. The anal shield is pure white, straight, widening slightly behind, where it is either cut off squarely or ends in a slight lobe or an obtuse angle; the posterior border is somtimes ridged, and a distinct longitudinal ridge always runs along the middle. The average length of the male scale is 0.035, and it is fully formed in about ten days from hatching (Fig. 35, *b*).

* Signoret informs me, after examining specimens sent to him, that it is probably the *pini* of Hartig, described in 1839 in the *Jahresberichte ueber die Fortschritte der Forstwissenschaft* for that year. Not having access to the work, I am unable to decide the point; but I know that a very similar, if not identical, species occurs on the cultivated pines in England, as I have seen it on some trees in Mr. W. C. Hewitson's beautiful grounds, at Weighbridge.

† N. Y. Reps. Vol. I, p. 256.

The male louse (Fig. 36) may be seen by the well-trained eye, crawling over the needles and branches, and he may be found before the anal shield of any of the females begins to form. He has the same size and structure as his apple tree kinsman, and differs principally in being of a uniform orange-red.

(Fig. 36.]

The female scale averages 0.10 in length, and is completed in about three weeks; the median part is a little darker than the larval, and the anal shield has an even, white surface. It differs materially in form, according to the kind of pine it inhabits, being broader and more curved on the broader-leaved species, (Fig. 35, *d*), but usually narrow, and with a very slight curve on one side, on the White Pine (Fig. 35, *c*). The female herself presents very much the same appearance as figure 32, *d*, except in being red. The form is more lengthened, and there are not the strong bristles on the lobes of the abdominal joints. The margin of the anal plate is, also, less deeply notched, and the tubular secretors near it form a more regular row. The minute circular secretors are compact, the median set composed of 7–10, the upper laterals of 12–20, and the lower laterals of 14–18—the upper and lower laterals sometimes blending.

The newly-hatched female lice are instinctively prompted to migrate to the terminal and more permanent foliage, so as not to be borne to the ground themselves, or permit their eggs to be so carried to destruction, on the more basal leaves; while, as we have seen, the shorter-lived males, which are soon destined to become active again, fix themselves indifferently on the older foliage. The same end is attained on the part of the female as in the case of the Oyster-shell species, though a converse action is required in its attainment.

TWO-BROODED.

The Pine-leaf Scale-insect produces at least two broods each year, even in the more northern regions, where the Oyster-shell Bark-louse is single-brooded. Furthermore, the hatching is much more irregular than in the last-named species, so that it is difficult, if not impossible, to establish any definite period which shall separate the two broods. Neither am I sure that there are not more than two annual broods in the latitude of St. Louis; at all events, during the fore part of July the insect may be found in every stage of development, from the newly fixed larva to the full-formed and egg-covering female scale;

while as late as the first of October, females may be found which have not yet deposited; and even in the winter time many dried bodies are discovered, more or less completely filled with eggs, and indicating that they were overtaken by frost and killed before having accomplished the great end of their life.

CONFINED TO THE PINES PROPER.

From observations extending over several years, I conclude that this scale flourishes on trees belonging to the genus *Pinus* only, as I have never found it on the allied spruces or firs, or on any trees belonging to the other genera of the Pine family. The Red Pine (*P. resinosa*), the Bhotan Pine (*P. excelsa*), and the Yellow Pine (*P. mitis*), are affected almost as badly as the White Pine; while the Cembra Pine (*P. cembra*) I have found, in two instances, still more susceptible to it. It occurs only sparsely on the Pyrenaian Pine (*P. pyrenaica*) and the Corsican Pine (*P. laricio*); while on the Scotch Pine (*P. sylvestris*), the Austrian Pine (*P. austriaca*), and the *P. pumilio*, it likewise occurs sparsely, and the scales are broader.

NATURAL ENEMIES.

There is no evidence that mites attack this species as they do the preceding, but the smooth holes made by a little Chalcid which has not yet been bred, but which is either the *Aphelinus mytilaspidis* LeB., or a closely allied species, may frequently be noticed in the scales. The larvæ of certain small ladybirds belonging to the genus *Scymnus*, with their dense and even clothing of white cottony tufts,* feed alike on the Bark-lice and upon a woolly Aphid (*Chermes pinicorticis*, Fitch) which ofttimes covers the bark, and is frequently found in conjunction with the leaf-scale.

Certain unbred Lace-wing flies (*Chrysopa*) are also quite common, and their white, spherical, silken cocoons (see Rep. 1, Fig. 20, *c*), which are fastened to the twigs, should never be destroyed.

The Twice-stabbed Ladybird (*Chilocorus bivulnerus* Muls., Rep. 1, Fig. 4) may frequently be found crawling over the scale-infested trees, and is most efficient in checking the increase of the Coccids. Both the beetle and its gray and prickly larvæ feast upon the lice, and require great numbers of such minute animals to appease their appetites. I have often colonized a dozen or more larvæ on to a badly affected young tree, and the rapidity with which they clear such a tree is both interesting and satisfactory. I have previously shown how these prickly larvæ gather together and attach themselves in clusters when about to assume the pupa state, and how the pupa remains pro-

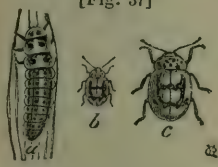
* I have bred *Scymnus consobrinus* Lec., and *S. cervicalis* Muls., from larvæ thus found, and Dr. Shimer has found *S. terminatus* Say, under similar conditions (Trans. Am. Ent. Soc. II, p. 385). A somewhat larger but similar larva found upon infested trees produces, as I have some reason to believe, the *Hyperaspis normata*, Say.

tected by the larval skin, which merely splits on the back and is loosened from the inclosed body, instead of being entirely worked off behind, as is the normal fashion with insects. On apple-trees, they usually crowd together on the rougher portions of the trunk, where the general similarity in color to the surroundings renders them sufficiently inconspicuous; but on the pines, they more frequently congregate around the ends of the twigs, which then appear as if covered with prickly burs, reminding one strongly, as Dr. Fitch well observes, of the ripened spikes of the Hounds-tongue (*Cynoglossum officinale*), and presenting a decided *nole-me-tangere* aspect.

The manner in which this memberless pupa shrinks and separates from the armed and membered larval skin furnishes a good illustration of that in which the larval scale of the Bark-louse itself is formed; and, were the skin ruptured below and behind instead of above and before, and strengthened by a secretion from the retreating body, the analogy would be perfect. As I have found the full-grown larva as early as the first of April, there is every reason to believe that the Twice-stabbed Ladybird hibernates both as larva and beetle.

Still another insect of this family, namely, the Painted Ladybird (*Coccinella picta* Randall), I have discovered preying on our Pine-leaf scale, as well as on the afore-named *Chermes*. The beetle (Fig. 37 *c*, enlarged; *b*, natural size) is of a pale clay-yellow or straw color, marked with black as in the figure; and its dusky-brown and pale-yellow larva (Fig. 37, *a*) has never before been connected with it or described. Hence I subjoin the following description:

[Fig. 37]



COCCINELLA PICTA Randall.—*Larva*—Form normal, rather stout, 0.36 inch long when full grown; 12 joints, exclusive of head. Color dark sooty-brown, with a mediodorsal pale yellow stripe, narrowing at each extremity, broadening posteriorly on thoracic joints, and brightest on joint 3; a similarly pale lateral stripe. The ordinary tubercles—4 dorsal rows on abdominal joints, the two each side coalescing on the thoracic joints—polished black, with short bristle-stubs. Described from 3 specimens. *Pupa*—naked and suspended. No description taken.

It is not so numerous as the Twice-stabbed Ladybird, which is, perhaps, to be accounted for by the fact that its helpless pupa is not protected by any such mimic *chevaux-de-frise*.

REMEDIES.

Few trees suffer more from the loss of their leaves during summer than do the pines. Mr. Thos. Meehan, though not supported by many other botanists, considers that, physiologically, they are not true leaves, but half leaf, half branchlet; and, however much truth there may be in such a view, it is certain that they can not be replaced by new ones, as true leaves often can. But I have experimentally

proved that, if done in the spring, just at the time or a little after the new year's growth commences, all the old leaves of *strobus* may be stripped with impunity. It stands to reason that with small trees which are affected with the Leaf-scale, and which admit of being thus stripped, this is one of the most efficient means of exterminating the lice. As an experiment, I thus stripped two young trees belonging to Mr. Wm. T. Essex, of Kirkwood, and prevented the lice from extending to the newer growth. In this manner the trees recuperated, though so near unto death at the time that Mr. E. was quite willing to risk the operation. By the second year they presented a healthy and clean appearance. This remedy, where it can be employed, has the advantage of being thorough, and of enabling us to save the natural enemies, just enumerated, from the destruction which awaits the lice.

The White Pine holds its leaves a little over two years on older trees—somewhat longer on younger ones; but as on badly infested trees the old leaves are already well-nigh exhausted, their loss is not so much felt. Moreover, the lowermost branches are always most thickly covered with the lice, and it will often happen that the top of the tree will not need stripping. I have already stated that large trees on which this remedy would be impracticable do not suffer from the scale to the same extent as do smaller ones; so that where the remedy is most needed it can be applied. Care must be had to collect and burn all the detached leaves, and the operation should only be performed after the new growth of leaves has commenced, but *before* any of the female lice have settled thereon.

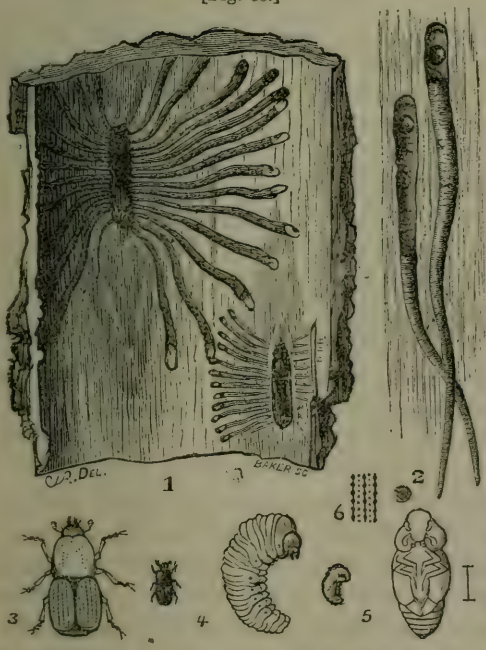
Powdered or liquid applications, intended to kill the young lice, are of little use, because, as we have seen, the latter do not all hatch out within a few days, as with the Oyster-shell species; but so irregularly as to necessitate continued applications throughout the greater part of the growing season, if intended to reach them all while young and unprotected by scales. For this reason, applications, to be of any value, must be of such a nature as to allow of being dusted or syringed over the trees; and must also have some caustic or penetrating properties, so as to destroy life under the scales, and reach these last in the protective groove in which they more generally dwell. I have tried carbolic soap with not very satisfactory results, except where it was used strong enough to kill all the leaves; and one tree thus treated, when the new growth was starting, recovered, and was freed of lice, but was evidently injured more than those which had been stripped, as I was for some time in doubt whether it would live or not. Dr. LeBaron has made applications of common fish brine, diluted at the rate of one pint to two gallons of water, or made twice as strong; also strong soap-suds, and unleached ashes dusted onto the trees when moist; but while none of them materially injured the trees, they none of them entirely exterminated the lice. Oily solutions, as with the Oyster-shell species, would doubtless prove most effectual here,

and those who have trees badly troubled with this "white malady," and can afford to risk destruction of them, should experiment in this direction. My friend, M. L. Dunlap, of Champaign, Ills., who had certain trees in front of his house which were once badly attacked, assured me that he had saved and cleared them by repeated syringing with cold water; but I am much inclined to think that natural agencies played a more important part than the cold water in producing the result.

THE HICKORY BARK-BORER—*Scolytus Caryæ* Riley.

(Ord. COLEOPTERA, Fam. SCOLYTIDÆ.)

[Fig. 38.]



Last summer I received the following descriptive letter:

DEAR SIR: I inclose you today, in a newspaper, a section of bark of shell-bark hickory. Tree stood in a cornfield on this "Chouteau Claim;" was deadened, and large portions of the bark came off, revealing the whole body of the tree covered with marks engraved in the hard wood—fac-similes of the marks on inclosed bark—and making the tree look as if flowers were photographed all over it, but flowers all of one kind. I found in some of the channels in the bark a black bug, which, I suppose, did this regular work. There was invariably, as far as I could observe, a hole through the bark, at the base of each of the longitudinal channels leading to the cross-channel. We removed large sections of bark already quite loose, and the entire inside was covered like the piece I send. I propose to have the tree cut down, and to preserve sections of it.

Yours, truly,

N. W. BLISS.

KINGSTON FURNACE, WASHINGTON CO., *July* 2, 1872.

The insect referred to by Mr. Bliss is the Hickory Bark-borer, first described from the female only, under the name of *Scolytus caryæ*,

in the *Prairie Farmer* of February 2d, 1867. I first became acquainted with the injurious nature of this beetle, through Mr. Arthur Bryant, of Princeton, Illinois, and the case of Mr. Bliss is the first on record of its doing damage in Missouri. The following passages from a letter received in 1867, from Mr. Bryant, convey an idea of the loss the insect has occasioned him, and contain some facts regarding its mode of working:

I send you, by express, some pieces of wood and bark containing a worm which has for some years been destroying the hickory-trees on my farm. The trees grow on a strip of rich soil, striking the prairie on the east side of the forest, bordering the Bureau River. When I settled here, thirty-three years since, this tract was covered with bushes, with a few scattered trees, and was annually ravaged by fire. Since then a tall, dense growth of thrifty young timber, mostly bitternut hickory, (*Carya amara*), has grown up. The insect commenced its ravages about ten years since, and has killed many hundreds of fine young trees. It has sadly thinned my beautiful grove, and bids fair to destroy all the hickory trees in it. It is found in other localities in this vicinity.

I first detected the insect in its winged form in September, 1855. Noticing some small holes, newly bored, in the smooth bark of a hickory-tree, I found, on examination, in each hole a small black beetle, which subsequent investigation satisfied me was the parent of the mischief. The mode of operation appears to be as follows: Boring through the bark, the insect forms a vertical chamber next to the wood, from half an inch to an inch in length, on each side of which it deposits its eggs, varying in number from twenty to forty or fifty in all. The larvæ, when hatched, feed on the inner bark, each one following a separate track, which is marked distinctly on the wood. Some trees contain them in such numbers that the bark is almost entirely separated from the wood. In many cases the upper part of the tree is killed a year or two before the lower part is attacked.

The insect has continued its ravages, and doubtless will do so until Mr. Bryant's entire grove is destroyed.

Through the kindness of Mr. Bryant I have, since 1867, been able to fully study the habits of the species.

There is, in Europe, a very closely allied beetle (*Scolytus destructor*) known to attack the Elm. It was for a long time a contested question as to whether this insect ever attacked healthy trees, and there were not wanting men of repute who considered it the effect rather than the cause of disease.* But Mr. Spence long ago discovered that though the female is probably seldom guilty of depositing her eggs in healthy, vigorous trees, both she and the male bore into such trees for food, thereby causing an unhealthy state of the tree, by which it is rendered an agreeable nidus for the insect. The habits of our Hickory *Scolytus* are similar to those of the Elm; but while, according to the best authority, the vertical channels formed by the

* See Westwood, in *Gardeners' Magazine*, (Eng.), Vol. XIV, p. 363.

female of *S. destructor* are generally about two inches long, those of *S. caryæ* are seldom more than one inch.

The natural history of the Hickory Bark-borer may be thus summed up:

It seems not to be very particular about the kind of hickory it attacks, as, besides the Bitter-nut and Shell-bark, (*alba*), there is good evidence that it affects the Pecan,* (*olivæformis*); and Dr. A. H. Barber, of Lancaster, Wisconsin, has favored me with specimens, and an account of its injuries to the Pig-nut Hickory (*porcina*). The beetles issue the latter part of June and fore part of July. Both sexes bore into the tree—the male for food, and the female mostly for the purpose of laying her eggs. In thus entering the tree, they bore slantingly and upward, and do not confine themselves to the trunk, but penetrate the small branches and even the twigs. The entrance to the twig is usually made at the axil of a bud or leaf, and the channel often causes the leaf to wither and drop, or the twig to die or break off.

The female, in depositing, confines herself to the trunk or larger limbs, placing her eggs each side of a vertical chamber, as described by Mr. Bryant. Here she frequently dies, and her remains may be found long after her progeny have commenced working. The larvæ bore their cylindrical channels, at first, transversely and diverging, (Fig. 38, *1*), but afterward lengthwise along the bark (*2*)—always crowding the widening burrows with their powdery excrement, which is of the same color as the bark. The full-grown larva (Fig. 38, *4*, natural size and enlarged) is soft, yollowish and without trace of legs. The head is slightly darker, with brown jaws, and the stigmata so pale that they are with difficulty discerned. It remains torpid in the winter, and transforms to the pupa state about the end of the following May. The pupa (Fig. 38, *5*) is smooth and unarmed, and shows no sexual differences. The perfect beetle issues through a hole made direct from the sap-wood, and a badly infested tree looks as though it had been peppered with No. 8 shot. The sexes differ widely from each other, the male having spines on the truncated portion of the abdomen, not possessed by the female. The eggs are deposited during the months of August and September, and the transformations are effected within one year, as no larvæ will be found remaining in the tree the latter part of July.

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† See *Prairie Farmer*, August 10th, 1872, where Mr. Smiley Shepherd, of Hennepin, Ills., writes: "I have inclosed for your inspection a few specimens of a small beetle, found boring into the present year's growth of the Pecan-hickory. I also send you a package of the spray, that you may see the evidence of depredations in former seasons. This is the fourth year since they were noticed on my trees. The injury done is greater each year than the preceding. The trees can not survive such treatment more than one or two years more. They have been planted about thirty years, and were about fruiting."

These beetles are referred, by Dr. LeBaron, to *Scolytus muticus*, Say, and *S. 4-spinosus*, Say; but, as I have since learned, they were ♀ ♂ of *caryæ*.

I have always found associated with this bark-borer another larger borer, (*Saperda discoidea* Fabr.), an insect in which the two sexes differ so remarkably, both in size and coloration, that the male was subsequently described as *fuscipes* by Say, and whose larva, before maturing, penetrates the solid wood.

NATURAL ENEMIES.

I have bred two interesting parasites from this *Scolytus*. They both belong to the same subfamily (*Braconides*) of the Ichneumon-flies as the two parasites of the Plum Curculio, (3d Rep., pp. 24–28), and according to the eminent Hymenopterist, Mr. E. T. Cresson, to whom I am under obligations for so many favors, they are both undescribed. Their larvæ, after killing the bark-borers, form little pale cocoons in which to undergo their transformations. The first may be called the Three-banded Spathius. The genus was characterized by Esenbeck, who believed that the insects composing it deposited their eggs in the larvæ of leaf-eating beetles.

SPATHIUS TRIFASCIATUS, N. Sp.—♀. Average length, 0.18 inch. Color, light-brown. *Head* pubescent, palpi long and pale; eyes black; ocelli black, contiguous; antennæ smooth, pale, and reaching to second abdominal joint. *Thorax* with sutures dark-brown; legs more or less dusky, the tarsi (except at tip) an annulus at base of tibiæ, and the trochanters, pale; wings fuliginous, with a white fascia at base, at tip and across outer middle of front wing, including the inner half of stigma, the outer half of which is dark-brown; middle fascia most clearly defined. *Abdomen* slightly pubescent at sides and tip; first joint pale, petiolate, and with short and longitudinal aciculations above; second joint pale above, the others more or less brown; ovipositor pale, dusky at tip, and as long as abdomen.

One bred specimen.

♂—Differs in being much darker colored, the head, thorax and femora being brown and the metathorax and base of first abdominal joint black.

One bred specimen.

The second is a fly of about the same size, and belongs to the genus *Bracon*. Mr. Cresson has described it in MS., and I append his description:

BRACON SCOLYTIVORUS, Cress.—♀—Black, shining, metathorax and base of abdomen pubescent; face, anterior orbits, lower half of cheeks, clypeus, mandibles, except tips, palpi, tegulæ, legs, including coxæ, and abdomen, honey-yellow, the latter darker; posterior coxæ sometimes dusky; antennæ at base beneath, dull testaceous; wings fuliginous, apical half paler, iridescent; abdomen shining, first segment whitish laterally, the base and disc sometimes dusky; base of second segment with a large subtriangular flattened space inclosed by a deep groove, the posterior side of which is generally blackish; ovipositor longer than abdomen; sheaths black; length, .15—.17 inch.

♂—More pubescent; posterior coxæ blackish, also the femora above, especially the posterior pair; posterior tibiæ dusky; abdomen black, polished; apex of first, basal half of second and sides of apical segments more or less honey-yellow; sides of basal segment whitish; wings paler; abdomen narrower and rather more convex; length, .16 inch.

Three ♂, three ♀ specimens.

REMEDIES.

As to any remedy, though practical men, especially those owning fine hickory groves, will naturally look for one, they can, in this respect, not be satisfied; for if, after so many years' experience, Mr. Bryant can not think of any practical cure, it would be folly in others to speculate. The habits of the insect defy our efforts in this regard; and though in Europe coal tar brushed on the trees has been found effectual in keeping the Elm *Scolytus* away, the idea is of little value, since the tops of the trees are first attacked, and, in a large grove, the roughness of the lower bark often renders a close inspection necessary to detect the first holes made.

The only hope I entertain is from the little parasites above referred to; for when nature comes to man's aid, in the shape of parasitic insects, the vegetable feeders often have to succumb. If, therefore, upon careful examination, the white cocoons of this parasite are found abundantly in the bark of the infested tree, I should advise Mr. Bliss to let other trees in the neighborhood remain. But if no such parasites are found, the only way to prevent the spread of the *Scolytus* is to cut down *and burn or scorch* all infested trees.

SCOLYTUS CARYÆ Riley—*Larva*—showing no characters of specific value.

Pupa—perfectly glabrous, the pygidium truncate.

Imago—length, 0.15–0.20 inch. Color, either entirely black, or black with brown elytra.

♂—Head above flat, concave toward tip and coarsely aciculate, coronated with long incurved dull-yellowish hairs around the margin; labium also quite hairy; antennæ pale rufous. Thorax very little longer than wide, and very little narrowing in front; sub-obsoletely punctate above, but more distinctly so at sides. Elytra with about 10 striæ, confused at sides but regular above, and composed of small, deep, approximate punctures, bearing (not always) a few short hairs; interstitial spaces with a single row of minute and sub-obsolete punctures; tip more rugosely punctured and pubescent; venter opaque, densely punctate at tip, less so at base; the first joint emarginate and produced in the middle into a blunt spine; the second as long as the others together, strongly excavated, with the hind margin carinate and slightly spined at sides, and with a longitudinal carina dividing it into two concavities; third with the hind margin also carinate, and bearing three more or less prominent conic-acute spines; fourth also carinate with a smaller spine in the middle; fifth, pubescent.

♀—Differs in having the head rather shorter, more rounded, less aciculate and less hairy; the thorax perhaps a little more narrow in front; the elytra with the interstitial spaces rather more distinctly punctured, and the venter unarmed.

Described from 50 bred specimens of each sex.

The ♂ closely resembles *S. 4-spinosus*, Say, (Am. Ent. I, p. 182,) but differs from the description of that species in not having the tips of the elytra denticulate, in having the venter punctate, and in the projection on the first and longitudinal carina on the second ventral joints. It is just barely possible that the ♂ of *caryæ* ♀ is the insect intended by Say in his description of *4-spinosus*, in which event *caryæ* sinks. But if such prove to be the case, he either described from an aberrant individual, or neglected to mention important characters, as none of the differences mentioned are obsolete in the many specimens of *caryæ* which I have examined. The question can only be settled by comparison with his types, if such exist. I leave it with the specialist, and shall

abide by his decision. Under the circumstances, without typical specimens, we should have most right to conclude that the two are distinct, and should be slow to charge faults of omission, where such prominent and constant characters are concerned. *S. 4-spinosus* Say may prove to be ♂ of *muticus* Say. This uncertainty as to the species intended by some of the old and honored authors, who did not understand, as we do, the variation to which species are subject, is constantly confronting the entomologist, and should teach him the importance of mentioning the number of specimens from which a description is drawn up.

The ♀ might be referred to *muticus* Say, as described in the same work, but is easily distinguished by LeConte's subsidiary diagnosis. (Trans. Am. Ent. Soc. II, p. 167.)

THE ROSE CHAFER—*Macrodactylus subspinosus* (Fabr.).

(Ord. Coleoptera, Fam. Melolonthidæ.)

[Fig. 39.]

In the summer of 1872, this beetle was unprecedentedly abundant in some parts of Missouri, and more especially to the west of us, in Kansas. I reproduce, therefore, in the main, an article written for the Transactions of the Kansas State Board of Agriculture.

Dear Sir—Having been appointed by our State Horticultural Society (at the meeting held at Humboldt this week) to conduct correspondence with you relative to an insect that troubles us greatly, which we are unable to name correctly, I send you samples and description of the work done by it.

The extent of country over which it does damage enough to make it noticeable is, as far as I can learn, confined to only two or three counties—Allen, Woodson, Linn and Bourbon. It has only been some three years since it appeared to be so troublesome as to call the attention of persons of common observation. Last year (1871), my first year in Kansas, I noticed it in the grape bloom, but not in destructive numbers. It reappeared May 25th this year, and began eating the grape bloom, and, where very numerous, even the foliage. I have seen vines entirely stripped of leaves, except the net-work. They do not trouble the fruit after it is as large as shot (No. 1). Whole trees, and I am told, whole orchards of peaches are eaten up—only the fruit. Several beetles stay on one peach until it is gone before going to another.

I have seen small three-year-old cherry trees stripped of leaves and the fruit eaten entirely up too. They are about gone now; three weeks will suffice them, I guess. We know of no remedy except hand-picking, but some who have only a few grapes to watch catch them in a basin of water into which they easily drop when disturbed, and so save their crop. The beetle devours the bloom of the blackberry and sometimes the young fruit. I can't find a correct description of it in your reports published by the State of Missouri. *Colaspis flavida* comes the nearest. But the description of the "Grape Fidia," in Bush's catalogue, comes nearer, according to my observa-

tion. One man reported at the meeting of having seen it fourteen years ago in Linn county, first on wild persimmon blossoms and then on his grapes. But he caught them, and has been troubled but little. Please return a description, etc., etc., for our benefit and instruction.

Yours respectfully,

H. E. VAN DEMAN.

GENEVA, ALLEN COUNTY, KANSAS.

This insect is named in the heading, and illustrated at figure 39. It is one of those species whose larva develops under ground, and can not be very well dealt with in this stage of its life. We must contend with it in the beetle form, and there is no other effectual means than by hand-picking, or by shaking into vessels and on to sheets. This work can be greatly facilitated by taking advantage of the insect's tastes and preferences. There is conclusive testimony that it shows a great predilection for the Clinton, and its close allies, of all other varieties of the Grape-vine, and that it will gather upon that variety and leave others unmolested, where it has a chance. Those who are troubled with this beetle will no doubt take the hint. No better account of its natural history has ever been written than that by Harris in his work on "Injurious Insects," and I quote some of the more important paragraphs:

"The natural history of the Rose Chafer, one of the greatest scourges with which our gardens and nurseries have been afflicted, was for a long time involved in mystery, but is at last fully cleared up. The prevalence of this insect on the rose, and its annual appearance coinciding with the blossoming of that flower, have gained for it the popular name by which it is here known. For some time after it was first noticed, rose-bugs appeared to be confined to their favorite, the blossoms of the rose; but within forty years they have prodigiously increased in number, have attacked at random various kinds of plants in swarms, and have become notorious for their extensive and deplorable ravages. The grape vine in particular, the cherry, plum and apple trees have annually suffered by their depredations; many other fruit trees and shrubs, garden vegetables and corn, and even the trees of the forest and grass of the fields, have been laid under contribution by these indiscriminate feeders, by whom leaves, flowers and fruits are alike consumed. The unexpected arrival of these insects in swarms at the first coming, and their sudden disappearance at the close of their career, are remarkable facts in their history. They come forth from the ground during the second week in June, or about the time of the blossoming of the damask rose, and remain from thirty to forty days. At the end of this period, the males become exhausted, fall to the ground and perish, while the females enter the earth, lay their eggs, return to the surface, and, after lingering a few days, die also.

"The eggs laid by each female are about thirty in number, and are deposited from one to four inches beneath the surface of the soil; they are nearly globular, whitish, and are about one-thirtieth of an inch in diameter, and are hatched twenty days after they are laid. The young larvæ begin to feed on such tender roots as are within their reach. Like other grubs of the Scarabæians, they lie upon the side, with the body curved so that the head and tail are nearly in contact; they move with difficulty on a level surface, and are continually falling over on one side or the other. They attain their full size in autumn, being then nearly three-quarters of an inch long and about an eighth of an inch in diameter. They are of a yellowish-white color, with a tinge of blue toward the hinder extremity, which is thick and obtuse or rounded; a few short hairs are scattered on the surface of the body; there are six short legs, namely, a pair to each of the first three rings behind the head; and the latter is covered with a horny shell of a pale rust color. In October, they descend below the reach of frost, and pass the winter in a torpid state. In the spring, they approach toward the surface, and each one forms for itself a little cell of an oval shape, by turning around a great many times, so as to compress the earth and render the inside of the cavity hard and smooth. Within this cell the grub is transformed to a pupa during the month of May, by casting off its skin, which is pushed downward in folds from the head to the tail. The pupa has somewhat the form of the perfect beetle, but it is of a yellowish-white color, and its short, stump-like wings, its antennæ and its legs are folded upon the breast, and its whole body is inclosed in a thin film that wraps each part separately. During the month of June, this thin, filmy skin is rent, the included beetle withdraws from its body and its limbs, bursts open its earthen cell, and digs its way to the surface of the ground. Thus the various changes from the egg to the full development of the perfected beetle are completed within the space of one year.

"Such being the metamorphoses and habits of these insects, it is evident that we can not attack them in the egg, the grub or the pupa state; the enemy in these stages is beyond our reach, and is subject to the control only of the natural but unknown means appointed by the Author of Nature to keep the insect tribes in check. When they have issued from their subterranean retreats, and have congregated upon our vines, trees and other vegetable productions, in the complete enjoyment of their propensities, we must unite our efforts to seize and crush the invaders. They must indeed be crushed, scalded or burned to deprive them of life; for they are not affected by any of the applications usually found destructive to other insects. Experience has proved the utility of gathering them by hand, or of shaking them or brushing them from the plants into tin vessels containing a little water. They should be collected daily during the period of their visitation, and should be committed to the flames or killed by scalding water."

THE FALSE CHINCH-BUG — *Nysius destructor*, N. Sp.

(Subord. HETEROPTERA, Fam. LYGÆIDÆ).

A NEW ENEMY TO THE GRAPE-VINE, POTATO, CABBAGE, AND MANY CRUCIFEROUS PLANTS.

By calling this a *new* enemy, I do not wish to be understood to intimate that it never existed before. It has, in all probability, been in existence as long as its more injurious, genuine name-sake; but I call it new because it has heretofore been unknown as an injurious insect, and because, further, it has not even been described by entomologists, though I have had it in my cabinet for some years.*

[Fig. 40.]

The first time I heard of the injuries of this insect was in the fore part of last May, when I learned that young Delaware vines, belonging to Dr. James D. Davis, of Clarksville, Missouri, were being much injured by them, and that they were so numerous that the ground was literally covered with them. From many specimens received, they all at that season proved to be in the immature stages. Subsequently I received the following letters, which refer to the same species:

DEAR SIR — Dr. Bell, living four miles from this city, sends in the inclosed insects, which he says are destroying his potatoes. He wishes to know what they are, and if you can suggest any way of driving them off or protecting his crops against them. Will you be so kind as to write me? I send specimen of leaf showing injuries.

Yours, truly, W. B. STONE.

KANSAS CITY, MISSOURI, June 15, 1872.

DEAR SIR — Many of our market gardeners are complaining of the ravages of a certain insect of the order Hemiptera, of which I send specimens in box by mail with this note. The pest in localities occurs in great numbers, injuring the foliage of turnips, beets, radishes and cabbages. Can you tell me the name, and refer me to some account of this bug?

Thanks for your prompt reply to my inquiry concerning the White Grub Sprout.

Hoping soon to hear from you, I remain most sincerely yours,

F. H. SNOW.

STATE UNIVERSITY, LAWRENCE, KANSAS, June 24, 1872.

* Last summer I announced my intention to describe it in the *Western Planter* for June 29th, 1872; but Mr. Wm. R. Howard, of Forsyth, not having noticed the announcement, subsequently published in *Phillips' Southern Planter*, under the name of *Nysius raphanus*, a description which, considering the close resemblances the bug bears to other described species of *Nysius*, and the variation it is subject to, was somewhat insufficient, but which was afterward copied into the *Country Gentleman* (Sept. 15th, 1872), and the *Canadian Entomologist* (Nov. 1872). Upon communicating the facts to Mr. Howard, and for other good reasons, he expressed the desire to sink his own name in favor of that here employed.

Later in the season the mature bugs were forwarded to me from Taney county, Missouri, under the supposition that they were Chinch-bugs, and other accounts reached me from Kansas, of the ravages of a bug, generally called the Chinch-bug, but which was evidently the species in question. Several insects have, at different times, been mistaken for the Chinch-bug, and under the head of "Bogus Chinch-bugs," I have indicated some of them in my second Missouri Report, (p. 31). They are thus confounded with that arch-destroyer, more on account of the nauseous, bed-buggy odor which they have in common, than because of their close relationship or resemblance. The bug under consideration, however, not only has the same odor, but in size and general appearance bears a good deal of resemblance to its more notorious associate, and for that reason may be known by the vernacular name of False Chinch-bug. From the figure (Fig. 40) of the genuine Chinch-Bug, that insect will be seen to have a decidedly black head and thorax, with two conspicuous black spots on the front wings (*hemelytra*); while *Nysius destructor* (Fig. 41, *c*) is of a more uniform, paler, tarnished brown color. In habit the two insects differ materially; for while the former is the grain-grower's particular dread and terror, and confines its injuries almost entirely to cereals and grasses, the latter has not yet been found on cereals, and shows a predilection for plants of the Mustard family, though it attacks alike the Potato and even the Grape-vine.

[Fig. 41.]

In common with all other true Bugs, this insect feeds by suction; and the way in which it injures a plant is by depriving the same of its juices, and causing it to wilt. The potato leaves sent me by Mr. Stone presented the appearance of figure 41, *a*, showing little, rusty, circular specks where the beak had been inserted, and little, irregular holes, which looked more as if made by some Flea-beetle, one of which, the Cucumber Flea-beetle (*Haltica cucumeris* Harr.), is known to thus injure Potato leaves.

I can not now give you its complete natural history, as to do so will require further study of its habits, which I hope to be able to make before the close of the year. From analogy we may infer that there are two or three broods in the course of the year, and that, as in the case of the Chinch-Bug, it passes the winter in the perfect state, and is difficult to combat when once infesting the field or garden. Clean culture, and especially the burning of weeds and rubbish in the winter time, will doubtless prove to be the best guarantees against its injuries. The young bugs are without wings, and are of a paler color, with more or less distinct longitudinal dark lines on the head and thorax. The pupa (Fig. 41, *b*) has the front part of the body marked

with more distinct red and brown lines, with the abdomen paler, and with longitudinal pinkish mottlings. It is a variable species in all stages, and I submit below a full description for those interested:

NYSIUS DESTRUCTOR, N. Sp. (Fig. 41, *c*). General color grayish-brown; of shape of *N. thymi* Wolff. *Head* either minutely or more coarsely punctate, and more or less distinctly pubescent; the surface usually brown, with a distinct black, longitudinal line each side, broadening on the crown, but generally leaving the orbit of the eyes pale; these lines sometimes more diffuse and occupying the whole surface, except a median brown spot at base of crown, and a narrow, paler spot on the clypeus; ocelli piceous; eyes opaque, either black or slate-color; face sometimes uniformly pubescent and appearing dark grayish-brown; but more generally black each side of rostrum, with a distinct yellowish-brown spot on the cheeks below the eyes; rostrum piceous, paler at base and reaching to hind coxæ; antennæ either pale yellowish-brown or darker brown, the torulus and first joint darkest. *Thorax*, pronotum narrowing anteriorly, the sides slightly sinuate, irregularly and more coarsely punctate than the head, more or less pubescent, dingy yellow or brown, with a transverse black band near the anterior edge, obscuring the incision and leaving the edge pale, especially in the middle, where there is often a conspicuous pale spot; also five more or less distinct longitudinal dark lines, the central one most persistent and leading on the posterior margin to a pale, shiny, impunctate spot; the callus at hind angles, and sometimes an intermediate spot between it and the median one, and the entire posterior margin, also pale and impunctate; scutellum dark, coarsely punctate, sometimes with a smooth median longitudinal ridge ending in a pale spot, and with the lateral margins pale; prosternum dark, more or less pubescent, the anterior and posterior margins, and a band outside of coxæ, more or less broadly pale; mesosternum and metasternum also dark, with the pale spots outside of coxæ. *Legs* pale yellow, inclining more or less to brown; coxæ dark at base, pale at tip; trochanters pale; front and middle femora spotted more or less confluently on the outside with brown; hind femora, ♂ dark brown, except at tips and base; ♀ spotted only; tibiæ ringed with brown at base; tarsi marked more or less with brown, especially at tip. *Hemelytra* either colorless, transparent and prismatic, or distinctly tinged with dingy yellow; shallowly punctate and very finely pubescent, the veins of corium and clavus dingy yellow, with brown streaks, the more constant of these streaks being two on posterior margin of corium, and one at the tip of clavus. *Abdomen*, ♂ tergum piceous, with the sutures and the sides of some of the joints rarely paler; venter piceous, minutely and regularly covered with gray pubescence; ♀ sutures and spots on tergum more often pale; venter dingy yellow, except at base; ♀ paler than ♂, and generally larger. Average length 0.13 inch.

Larva—Dingy yellow, with more or less distinct longitudinal dark lines, especially on head.

Pupa (Fig. 19, *b*). Same color, with more distinct red and brown longitudinal lines, and two little tooth-like, pale yellow processes at inner base of hemelytra pads, indicating the wings; the abdomen paler than the rest of the body.

Described from numerous specimens. I have some, especially males, in which the black so predominates that the paler parts of the head and thorax are scarcely traceable, while in others again the pale parts predominate almost to the exclusion of the black. Indeed, so variable is the species that it is difficult to see wherein some of the specimens differ from the European *thymi*, or from *N. angustatus* Uhler, and it is barely possible that future comparison will show specific identity between some or all of the three. But as long as authors fail to give the variation a species is liable to, or the number of specimens a description is drawn up from, it will remain impossible to decide such questions satisfactorily, and I name *destructor* at the suggestion of our Hemipterist, Mr. P. R. Uhler, of Baltimore, who has examined specimens which I sent him.

[The above account of this new and injurious bug was sent, with other matter, on the first of July last, to Mr. Alfred Gray, Secretary of the Kansas State Board of Agriculture, for publication in the Transactions of said Board, where it appears. Since that time I have met with it everywhere in my travels in our own State and in Kansas. Besides the plants above enumerated, it proved in some instances troublesome to strawberry plants, to young apple grafts just as they were sprouting, and especially to turnips and beets. On all the more tender plants enumerated the bugs cluster just as does the genuine Chinch-bug, and cause the leaves to wilt by their suction. Late in the fall I found them very abundant, in all stages, collecting under purslane, and they doubtless make use of this spreading and close-fitting weed for winter quarters. At some of the fall meetings of the Meramec Horticultural Society, complaints were made of a new habit which the Chinch-bug had of injuring potato vines, and of crowding on the tubers and injuring them after they were dug. The False Chinch-bug was undoubtedly the insect observed.]

INSECTS INJURIOUS TO THE GRAPE-VINE.

THE GRAPE-VINE APPLE-GALL—*Vitis pomum* Walsh & Riley.

(Ord. DIPTERA, Fam. CECIDOMYIDÆ.)

[Fig. 42.]

Besides the leaf-gall caused by the Grape Phylloxera, the Grape-vine is subject to various other gall-growths or excrescences, the nature of which often puzzles the vine-grower. I shall give an account of four of the most conspicuous which are found in Missouri. They are all caused by Gall-gnats (*Cecidomyidæ*), the larvæ of which are distinguished by being very generally of an orange color; but more especially by having on the upper surface, near the head, a horny process known as a breast-bone.* This process is variable in shape, but more often clove-

*This process is said, by all authors with whom I am acquainted, including Baron Osten Sacken, to be ventral, for which reason, I suppose, it has been called the "breast-bone." I believe myself that it is dorsal. As, however, it sometimes has a good deal the form of the breast-bone, or "wish-bone," of a fowl, the term may be retained, though conveying a wrong idea. These larvæ are also said to differ from all other insect larvæ in having fourteen joints. I have examined a great number of Cecidomyidous larvæ without being able to make out any such abnormal number, while in many species it is difficult to detect more than twelve and a subjoint. Usually, I have been able to clearly make out thirteen joints and a subjoint, which is the normal number in insects.

shaped, Y-shaped, or oar-shaped. It always has a stem, which is mostly hidden, and terminates in two projections or prongs (sometimes three in those which are oar-shaped), which are armed with sharp points. It is retractile, and the prongs may be exerted at will, and are doubtless intended to assist in abrading the tissue of plants, so as to cause an abnormal flow of sap, which serves as food for the larva. That they have little, if anything, to do in causing the gall-growth, we may infer from analogy, and from the fact that many Cecidomyidous galls are formed before the larva hatches, and depend on something deposited with the egg. The perfect flies are mostly of a dull black color, like that represented at figure 43, (*a* female; *b* antennæ of male,) and many species so closely resemble each other that it is next to impossible to distinguish them when dry. Those which produce the galls here mentioned are difficult to rear, and, with one exception, are not yet known.

[Fig. 43.]

The Grape-vine Apple-gall has been a fruitful source of speculation, and has given rise to some curious botanical theories, as the following extract will attest:

AN APPLE GROWING ON A GRAPE-VINE.

A Vegetable Phenomenon.—In the garden of Capt. David E. Moore, Lexington, Va., there is growing on a grape-vine, a fully developed apple. On one side of the apple is an appearance of what might have been a grape-bloom. This interesting *lusus naturæ* is, as far as we know, without precedent, and of course has attracted marked attention, and caused no little speculation in the circle learned in such matters about Lexington. The prevailing opinion, we learn, is that an apple-bloom falling accidentally upon a grape-bloom, became incorporated with it and produced the result; but, if so, is it not singular that such an accident had never occurred before? And, if so, again, does it not teach that the grape and apple may be grafted on each other? We hope the pomologists of Lexington will note very carefully all the phenomena of this freak of nature, and that they will have the apple photographed, with a portion of the vine, before its removal, for engraving and publication in Horticultural journals.

—[*Richmond Whig.*

When growing on vines in the vicinity of hickory trees, it has ridiculously been considered a hybrid fruit between these two very widely separated plants.

The form of the gall is variable—sometimes being quite flattened or depressed, but more often spherical, or flattened at base and more pointed at tip. When young it is downy on the outside, and succulent, with a pleasant, acidulous flavor. When mature, it usually has eight or nine longitudinal lobes, as in a musk-melon, and is smoother (Fig. 42, *a*). A transverse section (*b*) shows it to consist

of a fleshy outside covering, like the hull of a walnut, and of a much harder, woody interior, with numerous longitudinal two-tiered cells or cavities, the upper tier twice as long and more regularly separated by harder fibre than the lower. The yellow larvæ are found in these cavities, and they have a brown, clove-shaped breast-bone. This gall, which bears so great a semblance to a fruit, doubtless carries the semblance still further by falling to the ground. And as the seed is released upon the death of the fruit which surrounded it, and consigned to the bosom of the great Mother Earth for development, so the larvæ escape from the decomposing and softening gall to consign themselves likewise to the same great Nursery, which seems to be absolutely necessary for their well-being and growth, as I have kept the galls for over a year out of Earth and away from her fecund influences without getting the perfect gnats.

This gall was first described in the *American Entomologist*, (Vol. 1, p. 106.)

THE GRAPE-VINE FILBERT-GALL—*Vitis coryloides* W. & R.

(Ord. DIPTERA, Fam. CECIDOMYIDÆ.)

[Fig. 44.]

This gall, (Fig. 44, *b*,) as its name implies, bears some resemblance to a large bunch of filberts or hazel-nuts. It is found more frequently than the preceding, and especially on the wild River Bank grape, (*Riparia*), in the month of July. It is an assemblage of separate galls, more or less coalescent, varying in number from 10 to 40 or more, and of different shapes, being either round, irregularly oval, fusiform or pyriform, but generally narrowing at tip. When young, these galls are densely pubescent or woolly on the outside, but less so when mature. The interior is fleshy, juicy, sub-acid; and a transverse section shows a single longitudinal cell in each (Fig. 44, *c*.) The gall is evidently a defor-

mation of a bud, as it springs from a single point where a bud would be, and often has quite a stem to it. A stunted, deformed leaf is also sometimes found upon it, as given in the figure.

The larva is orange-yellow, partly transparent, partly opaque, and has the breast-bone clove-shaped as in the preceding (Fig. 44, *a*), and doubtless leaves the gall and enters the ground to transform. First described in *Am. Entomologist* (I, p. 107.)

THE GRAPE-VINE TOMATO-GALL—*Vitis tomatos.*

MADE BY *Lasioptera vitis* O. S.

(Ord. DIPTERA, Fam. CECIDOMYIDÆ.)

The following clipping will show that this gall, which is quite common in the summer months on the River Bank grape and its cultivated varieties, has not remained unnoticed by the curious, and that it has, like the others, its fruit resemblances:

[Fig. 45.]

FREAK IN A VINEYARD.—In gathering grapes to-day we found one of the clusters, in shape, a *perfect tomato.* It is of quite large size, and on the outside is divided into eight segments or lobes, having a seed to correspond with each segment or lobe. It was found on a cluster of one of Rogers' Hybrids, and a peculiarity is, that the grape is *blue*, while this is *red.* In flesh and seeds and all else it is a perfect grape. President Wilder's Trophy tomato stands about three rods from the vine.

I call upon President Wilder to explain with what sort of propagating qualities he has invested his Trophy tomato, to know, if we continue the cultivation of that fruit, whether our apples, plums, cherries, etc., will or will not turn into Trophy tomatoes. I have saved the eight seeds for a further solution of the problem.

If President Wilder declines an explanation for *fear of the consequences*, I call upon all the horticulturists of America to commence at once an investigation, and I will furnish them with the *hide*, which I have carefully preserved as conclusive testimony against him.

R. L. DORR.

DANSVILLE, Livingston county, N. Y., *Oct.* 6, 1872.

[*Rural New Yorker.*

It is the most variable gall with which I am acquainted, as it may be found of all sorts of fantastic shapes, from the single, round, cranberry-like swelling on a tendril to the large collection of irregular bulbous swellings on the stem or leaf-stalk; sometimes looking not unlike a bunch of currants or a bunch of grapes, but more often like a collection of diminutive tomatoes, such as the Cluster Tomato, grown by Mr. J. C. Ingham, of St. Joseph, Michigan.* It was first briefly described, together with the fly which produces it, by Baron Osten Sacken (Diptera of N. A., part I, pp. 201–2). The substance of the gall is soft, juicy and translucent; the flavor pleasantly acid, and the color yellowish-green, with rosy cheeks, or else entirely red. Each swelling has several cells, (Fig. 45, *a*), in each of which is nursed an orange-yellow larva, which, upon the dissolution of the gall, enters the ground to transform, and emerges as a pale reddish gnat, with black head and antennæ and gray wings.

This gall-maker is subject to the attacks of at least two different enemies—one a species of *Thrips*, which invades the cell and destroys its inmate, and one a true Hymenopterous parasite, belonging apparently to the family *Proctotrupidæ*, and which, after killing the gall-maker, spins a cocoon within the cell.

THE GRAPE-LEAF TRUMPET-GALL—*Vitis viticola* O. S.

(Ord. DIPTERA, Fam. CECIDOMYIDÆ).

This is another, more regular, gall, made by a gall-gnat which has not yet been described. It is elongate, conical, and grows more or less numerously from the surface of the leaf, looking something like a small trumpet. I have found it on both wild *Cordifolia* and *Riparia*, and it doubtless occurs on their cultivated varieties. It is also found on *Labrusca* and *Vulpina* (see A. E. II, p. 28). The usual color is a bright crimson, but it sometimes inclines to green, especially when young, or on the under side of the leaf; for though it is more often

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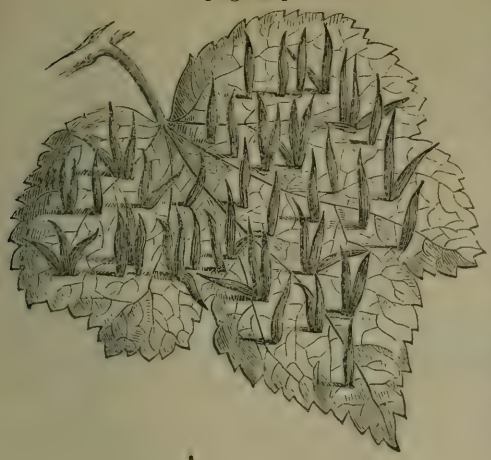
*Figured in *Prairie Farmer*, September 21, 1867.

[Fig. 46.]

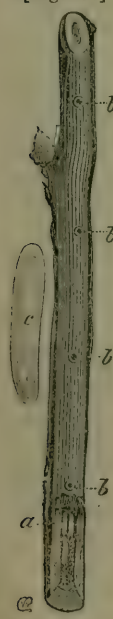


found on the upper side, I have met with it antiposed. Upon cutting into these galls we shall find them to be hollow, and each to contain a pale orange larva, which probably resembles those already mentioned in transforming under ground. The gall was first briefly described by Baron Osten Sacken (Diptera of N. A., part 1, p. 202). Similar but distinct galls grow on the leaves of Hickory and Hackberry, but are always green.

EGGS IN AND ON CANES AND TWIGS.

Of the innumerable forms of insect-eggs which are met with on plants, the few herewith described are continually sent to me from correspondents who desire information as to their nature. Some of them were described by me in the *American Agriculturist* for last August, from which I shall draw largely in describing them again. The first (in all probability those of the Jumping Tree Cricket, *Orocharis saltator* Uhler) are represented at figure 47, and are so abundant this winter that they were received from six different quarters just as this report is going to press.

[Fig. 47.]



The punctures are one-third to half an inch apart, and appear as if made by a rather large-sized pin. The illustration is from a piece of grape cane. On Damson twigs sent by J. A. Franklin, of Bluffton, the parent insect has very generally gnawed off a portion of the tender bark before making a puncture—a proceeding not always followed when harder wood is used. Each of these punctures leads to from one to twelve slender, elongated eggs, (*c*), rather more than the tenth of an inch long, more or less opaque and whitish, but generally of the color and transparency of amber, except at the extreme head end, which lies toward the orifice, and which is always opaque and very finely granulated. The puncture is direct to the pith, in which the eggs are inserted lengthwise; and the number varies, according to the amount of pith in the twigs selected. About the first of May these eggs hatch out into little, dingy crickets; and though I have not

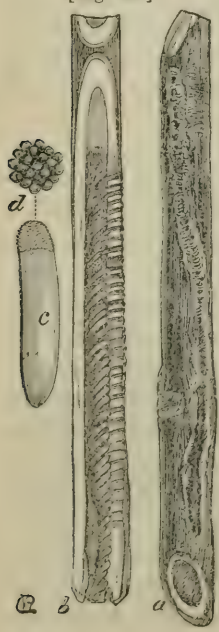
[Fig. 48.]

yet succeeded in bringing them through all their molts, and no one has bred the perfect insect, I have little doubt, from the larval characteristics, that they will prove to be the Jumping Tree Cricket mentioned.

This insect (Fig. 48, *a*, ♀; *b*, ♂) is of a pale yellowish-brown color, the female differing from the male in possessing a long ovipositor, and in her wings being more rounded and less ribbed and veined, so that she can not sing as he does.

The twigs or canes of various cultivated plants, and notably those of the Grape-vine, Apple, Peach, Raspberry, Blackberry, White willow and Soft maple, are often more or less split or disfigured by a series of closely set but irregular punctures, as illustrated at figure 49, *a*. Upon cutting into such twigs we find that, unlike the eggs we have already mentioned, these all lie diagonally across the pith, close together, in a single, irregular, longitudinal row, as at *b*—the irregularity sometimes making the row look as if double. More carefully examined with a lens, each egg appears pale yellowish, sub-elliptical, a little curved, more pointed at lower end (*c*), and capped at the head or more rounded end, with regulary arranged, white, opaque granulations, which, under a low-power microscope, appear as shown at *d*.

[Fig. 49.]



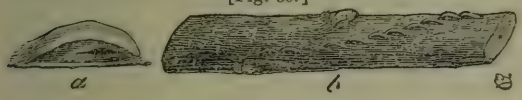
These are the eggs of the Snowy Tree-cricket (*Œcanthus niveus* Harr.), an insect briefly noticed in my first Report (p. 138). The young also hatch about the first of May. After eating through its egg-cap, the new-born cricket is still enveloped in an exceedingly fine membrane, from which it soon extricates itself, and which it leaves at the orifice of the puncture. These young crickets are whitish and very active, and generally conceal themselves in the thick June foliage of our woods or our orchards. At this time of their life they subsist principally on plant lice, eggs of insects, and other delicate animal food, and, if they can get nothing better, will exhibit their cannibalistic propensities by devouring the weaker individuals of their own kind. It is astonishing how rapidly, at this age, they will clear an Aphis-covered twig. Subsequently, as they grow larger, they are often content with a vegetable diet, and thus they perfectly combine in one species herbivorous and carnivorous habits. After the first molt, they begin to vary a good deal

in color, the females generally being quite dark. The mature insects were illustrated in my first Report (Figs. 77, 78).

I had, last summer, an extensive brood of these little crickets in one of my breeding cages, and succeeded in rearing them to the winged state, which they assume during the fore part of July. The male produces a very shrill noise by the friction of his front wings, but the female is silent.

This Snowy Cricket shares with his more robust Jumping companion in the nefarious midnight-work of gnawing, girdling or severing different parts of the grape thyrse, causing the berries either to shrivel or fall, and producing what is often known as "shanking." It is while the grapes are yet green that they are mostly severed, and the ground beneath vines is often scattered with this green fruit, where the cause of the trouble is little suspected. Such *useless* waste and destruction is doubly provoking, and as the virtues of their youth do not atone for the bad habits of their after-life, these jumping crickets must be classed with the bad bugs. The infested twigs often die beyond the punctures of both these species; and the best remedy is to cut and burn the twigs in winter.

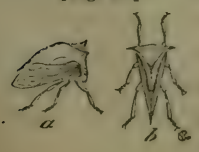
[Fig. 50.]



In his twelfth annual Report, (Trans. N. Y. State Agr. Soc., 1867, p. 889), Dr. Fitch elaborately describes these eggs, which he, for some unaccountable reason, and without question, refers to the insect next to be treated of—viz., the Buffalo Tree-hopper. He certainly never bred this last insect from such eggs, and how he could for a moment imagine that any but a much larger insect, possessed of a much longer ovipositor, could insert so many long eggs into the very pith of twigs, is difficult to conceive. The fact that he mistook the real slits made by this Tree-hopper, or an allied species, for the crescent cuts of the Plum Curculio (see 3rd Report, p. 38), and was thoroughly imbued with that error, may afford some explanation. My good friend has not, I regret to say, been in the habit of correcting his own errors; but nevertheless I draw his attention to this one—not as a fault-finder, but for the sake of truth. We are all liable to mistakes!

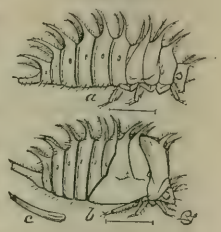
The egg-punctures of this Buffalo Tree-hopper (*Ceresa bubalus*, Fabr.) are represented above (Fig. 50). The punctures consist of a row, more or less straight, of little raised slits in the bark (*b*), in each of which, upon careful examination, may be found an oval, dark-colored egg (*a*, enlarged). These eggs hatch about the middle of May, and the young are at first brownish, with a formidable row of ten pairs of compound spines, and looking totally unlike the mature insect. After the first and second molts, they are still furnished with these sprangling spines on the back, but are of a paler color, with some transverse lilac-colored lines (Fig.

[Fig. 51.]



52, *a*). With the third molt, they assume the pupa state (Fig. 52, *b*), in which the wing-pads become conspicuous, the spines are reduced in size, and the prothorax is produced into a point behind. With the fourth and last molt, which takes place toward the end of July, the mature characteristics are suddenly acquired. This Tree-hopper is a yellowish-green, hunchbacked object, with two little horns on the prothorax, which render its name not inappropriate (Fig. 51, *a*, side view; *b*, back view). It subsists, during its whole life, on the sap of apple, pear and other trees; but never does serious injury. The female is furnished with a sheathed ovipositor (Fig. 52, *c*) well adapted for making the incisions described. In common with all the other insects of its Family, (Order *Homoptera*, Fam. *Membracididæ*), it has remarkable jumping power.

[Fig. 52.]



[Fig. 53.]

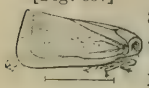
A fourth kind of egg-puncture, very similar to those just described, but with the eggs inserted more regularly, and more closely together, (Fig. 53, *a*, natural size; *b*, enlarged), is also frequently found on apple twigs. It is doubtless produced by some closely allied tree-hopper, but the species is not yet known.

A fifth kind of puncture is found not unfrequently in the tender growth of sassafras. It consists of a continuous raised slit (Fig. 54, *c*) of the epidermis, into which are regularly crowded a series of elongate-oval, dirty yellow eggs, each 0.04 inch long, and the end of one pressed on to the top of the next, as represented enlarged in the figure (*a*, eggs extracted, *b*, within twig.) About the middle of May, these eggs produce little hoppers, which leave a thin and delicate pellicle attached to each egg-shell, at the point of egress, as is so generally, if not universally, the custom with *Homoptera* and *Orthoptera*. As soon as they begin to pump the sap of the tree on which they hatch, these insects copiously secrete a farinose or cottony substance, which completely covers them. They grow slowly, shed their skins but three times, so far as I have been able to observe, and by the first of September, or earlier, produce the Frosted Lightning-hopper (*Pœciloptera pruinosa*, Say).

[Fig. 54.]

This insect belongs to the same suborder as the preceding, but to the family *Fulgoridæ*, the insects of which are remarkable for their marvelously quick jumping power, and for the large size of the soft wings — some species looking much like moths. The species under consideration is quite common on a variety of trees, and varies from lead-color to pale green, and is dusted over with a fine white powder. Up to the time

[Fig. 55.]



it acquires wings, the cottony secretion is always copious enough to cover all but the head.

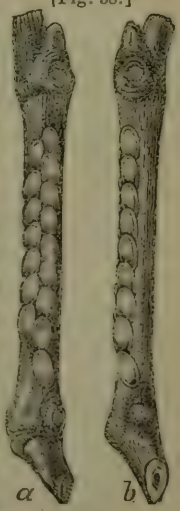
[Fig. 56.]

A sixth kind of puncture is illustrated herewith, (Fig. 56), and is found in a variety of soft, fibrous plants, such as the more cylindrical parts of Indian corn, the stems of roses, and particularly those of the Raspberry. There are usually ten or twelve rounded punctures, at a distance of from half an inch to an inch, or more, from each other—the fibre of the plant being torn in shreds longitudinally. Upon cutting into these punctures, the wood is found to be discolored and dead, as far as they extend, and in the center of the pith, placed longitudinally, is an elongate, dull yellow, opaque, soft, more or less flattened egg, 0.22 inch long, and 0.04 wide, the anterior end tapering to a tolerably fine point, the posterior end more blunt. I have not yet succeeded in hatching the insect from these eggs, and it is impossible to say positively to what species they belong. But I strongly incline to believe that they produce our largest meadow-grasshopper, (*Orchelimum glaberimum*, Burm.), because I have had just such eggs deposited in cork by the female of this species, kept for that purpose in confinement, and have found it quite common where these punctures were abundant. It is a glassy green species, with some brown each side of the thorax, the female having a strong, smooth, cimeter-like ovipositor, and the male a transparent violin at the base of his front wings, which is principally instrumental in causing that incessant and continued singing or ringing so characteristic of our autumns.

[Fig. 57]

The hard, more or less flattened, slate-colored eggs, deposited in a double row, and overlapping each other as in the accompanying figures, repeatedly excite the curiosity of the inquisitive. Harris describes these eggs as belonging to the common Broad-winged Katydid (*Platyphyllum* [*Cyrtophyllus*] *concavum* Harr). He received them from Miss Morris, and whether it is on her authority or on his own that they have been given such a parentage, is not stated; but certain it is that the statement is a gross error, and has misled entomologists generally. Several years ago I hatched the insects from the eggs, illustrated at figure 57, and proved them to belong to the Oblong-winged Katydid (*Phylloptera oblongifolia*, DeGeer). As I found others which were somewhat flatter and broader, (Fig. 58), and as Harris's statement was unqualified, and he moreover expressly states that "in form, size and color, and in their arrangement on the twig,"

[Fig. 58.]



those of *oblongifolia* strikingly resemble those of *concavum*, I was led to suppose that the broader ones belonged to the latter. After hatching nothing but *oblongifolia* year after year from such eggs, and noticing structural differences in the ovipositors of the two insects, which seem to have escaped previous observation, I began to suspect that the eggs of *concavum* were deposited in a different way, and experience has sanctioned the suspicion; for, upon confining a number of pregnant females of *concavum*, I found that the eggs of this species are always thrust into some substance, or into crevices. When furnished with any soft material, such as cork, the females crowd it full of eggs.

To be brief—as I intend to give a more extended account of our Katydids in my next Report—we have in this latitude three species, which are quite common, viz: The two already named, and the Narrow-winged Katydid, (*Phaneroptera curvicauda*, DeGeer), easily distinguished by its narrower wings, and two conspicuous recurved appendages at the end of the male abdomen. If we examine the ovipositor of *oblongifolia*, we shall find that the terminal part is armed with strong thorns, or teeth, both above and below. By means of these and its jaws the female is able to rasp and roughen the stems on the outside of which her overlapping eggs are laid. The difference in size, and especially in thickness, which is so noticable in these eggs, depends on the variable size of the parent, and on the degree of maturity of the eggs. In the other two species, on the contrary, the ovipositor is perfectly smooth, and we find that the eggs are inserted. Those of *concavum* are 0.25 - 0.30 inch long, very flat, over thrice as long as wide, pointed at each end, with the edges beveled off or emarginate (Fig. 59, *a* side view, *b* front view, enlarged, *c*, *d* natural size). They are of a dark slate-color, and are thrust into crevices and into the softer parts of bark or of stems. The lower or first inserted end is protected by a dark, adhesive substance, which hardens and sometimes extends the whole length of one of the borders; and several eggs are usually pressed close to each other. Those of *curvicauda* are deftly inserted between the upper and lower epidermis, and along the edges of different leaves—those of oak being seemingly preferred. They are inserted contiguously, but not overlapping, and, though of about the same form as those of *oblongifolia*, are at first so much thinner as scarcely to cause any swelling of the leaf.

[Fig. 59.]

All these eggs swell or increase in thickness as they approach the hatching period. We may explain this fact on the principle of endosmosis with those which are imbedded in living plant tissue; but it is my experience that the wood or pith around such eggs is very generally deadened, and even if such an explanation were sufficient with the softer, imbedded eggs, it would not answer with the harder

ones of our Katydids. The increase in bulk is most apparent a few weeks before hatching, and in none is it so obvious as in those of *curvicauda*, which swell very materially, whether the dead leaves containing them have buffeted the winter's frosts and blasts, or been kept in a dry room. It is about as difficult to conceive the source of the matter causing this increase, as it is to understand the force which causes the continued revolution of the globular frog's egg while suspended in its gelatinous surroundings!

STINGING LARVÆ.

In the popular mind, nearly every creeping thing has the power to bite or sting. Through sensational items, which at certain seasons are the order of the day in many of our periodicals, the large Potato-worm (*Sphinx 5-maculata*), and some of its congeners which, like it, are ornamented with a horn near the tail, are looked upon with fear and trembling, under the delusive idea that said horn possesses poisonous and deadly stinging power. By the same false teaching most worms have become a scare to children, and even haunt and trouble "children of larger growth." So deeply have I known this superstition (for it can not be called anything else) to be rooted, that the good people of a certain household allowed their tomatoes to be utterly ruined rather than run the supposed risk of being mortally stung by handling the horned destroyers.

No class of animals, and few, if any, creeping things, are less deserving of this wide-spread fear and horror than are the larvæ of insects. Of the many thousand varied and distinct species which inhabit the United States, hardly more than two dozen have any power to cause inconvenience, and not one to do serious harm to man. In a few rare instances, the larvæ of some Diptera have been found in the human stomach, in the nostrils, or in flesh wounds; and Kirby and Spence mention, on other authority, that even Lepidopterous larvæ have been found in like situations; but it may be stated as a broad and very general rule, that insects in their larval state have no power to do direct injury to man, however annoying they may be in the perfect state. The few exceptions to the rule will be found among the Heteroptera and the Lepidoptera. It is of some of the latter which I propose at present to speak.

Many caterpillars will pinch a little with their jaws if they get a chance, and a few (such, for instance, as that of *Xylina cinerea*, 3d Rep., Fig. 57, and that of *Perophora Melsheimerii*) quite sharply, so as to draw a little blood from a tender part; but here there is nothing poisonous in the bite, and the great majority will not bite at all. A

few, again, have the power of causing a stinging sensation, which produces greater or less inflammation of the parts affected. Yet in every instance, this is a sort of urtication like that from a nettle, and not a voluntary sting like that of a bee or wasp. In no case is it dangerous, and the application of a little saleratus water (Reaumur found the rubbing of parsley beneficial) will soon allay the inflammation. Some of the larvæ possessing the power might be freely handled by the uninitiated without its being discovered.

Every one familiar with insects in Europe, will remember the irritating property of the hairs of the gregarious Processionary caterpillar (*Cnethocampa processionea*), or the so-called Yellow-tail Moth (*Liparis auriflua*). In these instances it is the irritating power caused by the fine barbed hairs, the tips of which get broken off after piercing the skin, and the dried hairs from a dead caterpillar or from an old web are more to be dreaded than those from the living larva, for they are more brittle.

I am acquainted in all with fifteen larvæ, inhabiting our State, whose spines have this urticating power,* but in every instance it is caused by the sharp prick and not by the points of the spines getting broken in the flesh. For lack of time to make the requisite illustrations, I shall at present give the history of only two, which, on account of their large size and acute sting, very naturally head the list. The first may be called the Black Stinger of the Oak, and I will now give its natural history.

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* These belong mostly to the slug-worms or Conchiliform larvæ, all of which, when furnished with spines or prickles, will doubtless prove to possess this urticating power. The following, I have, from personal experience, proved to possess it: *Lagoa crispata* (Smith), *L. opercularis* (Smith), *Euclea pœnulata* (Clem), *Euc. querciti* (H-S), and two other undetermined larvæ of precisely the same structure, *Parasa chloris* (H-S), *Phobetron pithicium* (Smith), *P. hyalinum* (Walsh), *Adoneta spinuloides* (H-S), *Monoleuca semifascia* G & R, and *Empretia stimulea* Clem. *Limacodes scapha* (Harr), and *Lithacodes fasciola* (H-S), have not this stinging power. The fifteenth stinging larva with which I am acquainted, belongs, strangely enough, to *Acronycta*. This species, as I learn from Mr. Lintner, is *xylinoides* Guen. It has the size and form of *occidentalis* Grote, or of the smaller specimens of *leutiocoma* G & R. In general appearance, some of the specimens bear a strong superficial resemblance to *oblinita*, but are easily distinguished by the smaller average size, the squarer wings, and the deeper, colder color, and heavier marks of the front wings. Guenée's description of the front wings, as "narrow and prolonged at the apex" would, I think, mislead, and he does not mention one character which is common to all my specimens (7), which is that the t. p. line is strongly relieved posteriorly, and blends with the ground-color basally. I append below a description of the larva and pupa.

While spending a day with Dr. Fitch, at Salem, N. Y., on the 24th of August, 1870, I found him feeding a larva of *Anisota stigma* (Smith), which he said had stung his little daughter badly; but though the spines of this larva produce a slight tingling sensation, it can not be likened to that of the true stinging larvæ, and is no more irritating than the prick from the spines of *Grapta*, or many other spinous larvæ.

The other species of the tribe to which *Maia* and *Io* belong, will doubtless prove to have the same properties in the larva state; and Mr. G. M. Levette, of Indianapolis, Ind., informs me that *Pseudohazis eglanterina* (Boisd), which, like *Maia*, deposits its eggs in a belt, also possesses urticating power; as he was cautioned against the too free handling of some larvæ received from California, and which fed on wild rose.

ACRONYCTA XYLINOIDES — *Larva* — Before last molt 1.10 inches long; diameter of middle joints, which are largest, 0.27 inch. Color of body lalaceous, mottled, and transversely dotted with dark brown, and with dark, interrupted, medio-dorsal, subdorsal and stigmatal lines, obsolete on thoracic joints, the medio-dorsal forming a series of Y-marks on the abdominal joints. Each joint with a transverse row of conspicuous warts, concolorous, except the superior abdominal ones, which are ferruginous, becoming paler on anal joints; 8 on jts. 1—3, 10 on the rest, the 4 superior on 11 quadrangularly arranged. Those in subdorsal space largest, more or less confluent, especially on the thoracic and anal joints, and with the space in front of them on abdominal joints, pale. Springing from these warts, a

THE BUCK MOTH OR MAIA MOTH—*Saturnia* [*Hemileuca*]. *Maia* (Drury).*

(Ord. LEPIDOPTERA, Fam. BOMBYCIDÆ).

This modest-looking but truly elegant moth was one of the first acquisitions to my cabinet many years ago. During a farmer's life of four years in Kankakee county, Ills., it was my fortune to spend many a day in the so-called "oak-ridges" lying along the Indiana line. Here, late in the months of October and November—when the still and hazy atmosphere, and the sombre brown of the craggy oaks, boded so eloquently the coming of cold to "rule the varied year"—when the rustling leaf under the horse's tread, or the modulated echoes of the woodman's ax were the only sounds of life, and animated nature seemed to have been wooed to Lethean slumber—this crape-winged moth would often flutter by as though loth to follow in the general sleep. It is one of the few moths which fly in mid-day, though in the breeding cage it shows a crepuscular habit, and is most active in the evening till dark, after which it remains quiet. It is because it is seen flying in the fall when the deer run that it has been commonly dubbed Buck Moth or Deer Fly. The wings are so lightly covered with scales that they are semi-transparent, and look like delicate black crape. The bands across them are cream-white, and broadest on the hind wings. These bands vary very much in width, and in nearly a hundred specimens

[Fig. 60.]

number of stiff, acute, rufous spines, (strongest dorsally) about ½ as long as the diameter of body, interspersed anteriorly, posteriorly and laterally with much longer bristles. Stigmata oval and bright yellow, (black in alcoholic specimen). Head small, dark copal-colored, with a yellow triangle in front. Venter concolorous, the legless joints with four small verrucose warts. Thoracic legs same color as head; prolegs same as body, both furnished with stiff, yellow hairs. The tips of spines are more or less black, as are the points on the warts from which they spring.

After last molt the warts are paler, except on joint 4, where they remain dark red, the subdorsal pale spaces in front of the confluent warts become more conspicuous, and are strongly relieved by the broadening of the dorsal and subdorsal dark lines, the Y-shape of the former being nearly obliterated.

Four specimens. Feeds on Oak, Willow and Rose, and I have also found it on *Rhus toxicodendron*, Persimmon and Peach.

Spins a dirty white, elongate, thin and compact cocoon within a leaf.

Chrysalis—like that of *oblinita*, dark brown, shagreened, coarsely and acutely on four first abdominal joints above, which joints have the hind borders raised and smooth. Anal joint unarmed. Like all other *Acronyctas* which I have bred, it wears away the head of its cocoon on emerging by persistent whirling—the moth secreting no liquid whatever.

The spines of the larva sting quite sharply, with slight inflammation of short duration.

* This insect and the succeeding one (*Io*) were both referred to the older genus *Saturnia* by Harris and other popular authors; but have since been very properly separated. Together with *Anisota rubicunda*, which follows, they belong to the very distinct subfamily *Ceratocampinæ* of the *Bombycidæ*. They rest with the wings closed, the hind ones extending a little in front of the anterior ones.

which I have bred at different times, those on the front wings more especially are sometimes narrowed so as almost to be obsolete, at others broadened so as to separate the discal spot from the black basal portion; and Mr. Lintner, who has recently given the most complete and minute account of the insect ever published,* figures and describes a bred male in which, on the front wings, they are entirely obsolete, and which, if it had been captured at large, would doubtless have furnished some describer the material for a new species. The female antennæ below, the hair on the thighs, and two small tufts behind the thorax, are brick-red, and the male differs from the female (Fig. 60) in having broader, black antennæ and a smaller abdomen, tipped with a large tuft of brick-red hair. The collar is cream-white, and the black hairs of the body more or less sprinkled with hairs of the same pale color.† It ranges from Maine to Georgia, and west to the western part of Kansas. Two closely allied species which may prove to be but geographical varieties are also described from California.

THE EGGS

Are deposited in naked belts (Fig. 61) of from 100 to 200, but not fastened together so tightly, nor in the same regular order, as those of [Fig. 61.] the Tent-caterpillar of the Forest (3d Rep., Fig. 52, *a*). Holding

firmly by all of her feet, the female stations herself upon a twig, with her head usually toward its end. She then stretches her abdomen to its fullest and fastens the first egg; another is then attached by its side, and so on, the body reaching round the twig without letting go the feet. In this manner, governed by the thickness of the twig, an irregular, somewhat spiral ring is formed and others added, until toward the last the abdomen is raised and the ovipositor brought up between the legs. The lower or first deposited rows, incline so as to almost lie on their sides. The color of these eggs is at first a pale greenish-cream, becoming more yellowish with age, and they contain a sticky, deep, blood-red fluid. Each egg is obovate, about 0.05 inch long, and compressed at the sides and at apex. The glutinous fluid, which covers them when deposited, gravitates toward the attached ends and sides, where, in consequence, it becomes thicker and dark. From experiment, Mr. Lintner proved that this gum was insoluble either in cold water, alcohol, ether or chloroform; and, boiled for an hour, it only softened a little to harden again upon drying.

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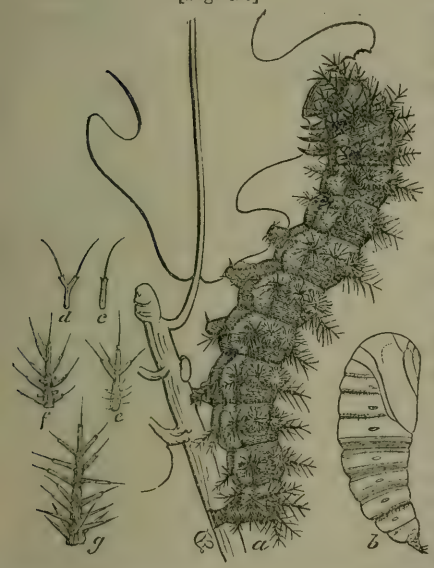
* *Entomological Contributions* in 23d Ann. Rep. N. Y. State Cab. Nat. Hist., 1869, p. 153.

† In three of my specimens these light hairs are very prominent, especially on the patagia, and these specimens approach so nearly *H. Nevadensis* Stretch (Illus. *Zygænidæ* and *Bombycidæ* of N. A., p. 107, Pl. 4, Fig. 10) that I should be much more inclined to consider the latter a geographical variety than a true species. Perhaps the same may be said of *Californica*, which appears to agree with Mr. Lintner's bred variety.

In confinement I have known them to be piled up on each other in a very irregular way, and I have found them on apple and received them on peach twigs from A. M. Shultz, of Troy, Mo., and R. H. Fitts, of Lawrence, Kansas. Yet the larvæ hatching from such eggs refused to eat the leaves of those trees, and commenced to die, until I gave them oak leaves—a fact which does not speak well for the supposed infallibility of instinct. Most of the moths, belonging to the same large family, deposit eggs readily whether impregnated or not; but in no instance where coition had not taken place have I known our Buck Moth to lay.

THE LARVA.

[Fig. 62.]



The ordinary appearance of the full-grown larva is given at figure 62. The color of the body is brown-black, covered with more or less conspicuous small oval yellow elevations or papillæ, and with a lateral yellow stripe, formed by the confluence of some of the papillæ, and by broken irregular yellow marks. The spines, during growth, exhibit all the forms in the figure, and I append, for those interested, a more minute account of the

LARVAL CHANGES.—The newly hatched larva is about 0.15 inch long. In the *first stage* it is black and granulated above, reddish-brown and smooth below, with a row of spots along the middle joints. The prolegs are brown. Head with a few scattering hairs. Spines placed in the normal position, namely, 6 (in longitudinal rows) on all joints except 11, where two dorsal ones are replaced by a single medio-dorsal one, an additional subventral one each side on jts. 1, 2, 3, 4, 5 and 10, and an additional medio-dorsal one on jt. 12. They consist of a thickened, sub-cylindrical, polished black stem, nearly as long as the diameter of the body, truncated at tip, which is coronated with three or four short points, and emits a long black bristle, which, under high magnifying power, appears barbed (Fig. 62, *c.*) On the thoracic joints the stem of the six superior rows is forked near its tip (Fig. 62, *d.*) In the *second stage*, the body remains the same, but the spines, which are now longest on thoracic joints, are more branched, with more hairs from the main stem, and the bristles from blunt ends comparatively short (Fig. 62, *c.*) In the *third stage*, the dorsal spines are still more branched, and often less truncated, so that the bristle is less distinctly separated and forms more nearly part of the tapering spine. The bristles also, especially on lateral spines, are longer and paler. During the latter part of this stage the characteristics of the mature larva are indicated. In the *fourth stage*, the two dorsal rows of spines on jts. 3—10, and the mesial one on jt. 11, are reduced to sub-conical tubercles or warts, fascicled with short stout, simple spines of a pale, fulvous color, tipped with black; those on jts. 1 and 2 remain much as before, but there is generally a fascicle of similarly fulvous spines a

the base of the latter. The other spines are somewhat stouter, with the blunt tips from which the bristles spring, more or less white. Characters of mature larva more patent. In the *fifth stage*, the granulations assume the form of whitish transverse-oval papillæ, each emitting from the center a minute dark bristle. These papillæ are mostly confluent around the stigmata, and, together with some irregular, pale yellow markings, produce a broad and pale stigmatal stripe. They are most sparse along the subdorsal region, just above stigmata, where, in consequence, the body appears darkest. In the *sixth stage*, at maturity, it may be thus described:

Average length, nearly 2 inches. Color, brown-black. Head, cervical shield, anal plate and legs polished chestnut-brown, the prolegs lighter, and inclining to venetian-red, with hooks more dusky and the true legs darker, inclining to black at tips. The dorsal fascicled spines, with the exception of a few short, black ones in the center of each bunch, are pale, rust-yellow, translucent, the tips mucronate and black; the other compound spines are black, with the blunt ends more or less distinctly white and translucent (but frequently crowned with minute black points, as in the first stage), and the sharp-pointed spinules arising from them dusky. They are generally enlarged and reddish at base, and an approach to the dorsal fascicles is made in the increased number and yellow color of the basal branches, especially in the subdorsal rows. Stigmata sunken, pale, elongate-oval; venter yellowish along the middle, the legs connected with red, and a reddish spot on the legless joints.

The above is the normal appearance of the larva in Illinois and Missouri; but it is quite variable. In some specimens the black predominates to such an extent, even in the sixth stage, that the papillæ are not very noticeable, and the lateral yellow band is obsolete;* while in others the yellow papillæ predominate over the black, and the lateral band is broad and continuous. The amount of light color in the spines is also very variable. It should also be stated that when just hatched, and after each subsequent molt, the color is at first uniformly brown; and that the spines for each coming stage are formed under the skin, and not within the old ones.

The young hatch with us about the middle of April, and are out sometimes before the leaves are ready for them; in which event, they survive many days without food. At this season they spin a moderate amount of web, by which they hold tenaciously to the twigs. They are gregarious, and in traveling have a fashion of following one another closely, and mostly in single file. As soon as the leader finds a suitable leaf, he crawls up the midrib to the tip, and the others follow and crowd each side along the edge. Should the leaf be too small to hold them all, the last remain on the twig; and—after the more fortunate ones have eaten and crowded back upon them—in their turn take the lead. The gregarious habit remains until after the last molt, though the original batch may divide into two or more. In the last stage they separate and scatter.

This is one of the few larvæ which pass through five molts, and it usually comes to its growth about the end of June, or in about two months from the time of hatching.

* All which Mr. Lintner reared seem to have been dark and without the lateral pale stripe; a fact which led him to question the accuracy of a brief description in the *American Entomologist*, (Vol. 1, p. 186), written by myself.

THE STING,

As already stated, is caused by the prick of the spines, and not by their getting broken in the flesh. From the fact that the spines appear hollow, one would naturally attribute their irritating power to some poisonous fluid which they eject into the puncture. But I have been unable to resolve any apical aperture, nor was Mr. Lintner more successful. Hence I infer that the irritating property belongs to the substance of which the spines are formed, and this opinion is strengthened by the fact that those of a dead larva, or of a cast-off skin which has been in my cabinet for several years, still retain the irritating power, though so brittle that it is not easy to insert them. All the spines have the same power, though the rust-colored, fasciculate ones along the back, being more acute and stouter, sting most readily; the aculei from the others being more fragile. The power is probably possessed from the time of birth, though the bristles in the first stage are too flexile to penetrate anything but the most delicate substance. In the second stage the sting is readily produced on the more tender portions of the body;* but until the rust-colored bunches of short porcupine-like spines appear on the back, in the fifth and sixth stages, the larva may be handled with impunity, and will hardly sting, unless the spines are pressed upon the more tender skin. Even when full grown, it may, with a little care, be handled without injury. The effect of the sting is a reddening of the punctured parts, and the early appearance of raised whitish blotches. These are replaced by purplish spots, which do not disappear for several days.

THE PUPA.

The larva, to transform, almost always enters the ground, and there, in a simple, ovoid cell, the prickly skin is shed, and the pupa state, outlined at figure 62, *b*, assumed. It is now of a deep brown-black color, heavy and rounded anteriorly, minutely shagreened or roughened, except at the sutures of legs and wing-sheaths, where it is smooth and polished. The margins of the three abdominal sutures next the thorax, and of that between the last two stigmata-bearing joints, are more or less crimped or plaited, while the three which intervene, and which are the only ones movable, are deep and transversely aciculate (as if scratched with the point of a needle) on the hind, and longitudinally and minutely striated on the front side. The body ends in a triangular, flattened, ventrally concave tubercle, tipped with a few curled, blunt, rufous bristles.

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* Mr. Lintner, in the paper already cited, only noticed the stinging properties after the third molt or in the fourth stage, and asserts that "the ability to inflict a sting does not belong to all the spines of the larva, but only to those of the two subdorsal rows on segments three to ten, and the dorsal spine on segment eleven." This is, however, quite incorrect, so far as my experience goes.

ISSUING OF THE MOTH.

The moths commence to issue the fore part of October, the males almost always appearing first. Though the great bulk issue at this season, a few do not appear till the following spring, and occasionally remain in the ground till the second fall—a period of over fifteen months. It is difficult to conceive what influences should so retard a few individuals, and enable them to pass the heat of a second summer unaffected, when the species normally develops in a so much shorter time; and, though the exceptional fact is recorded by two independent observers, Mr. Lintner very naturally found it difficult to believe it without additional evidence. I can add my own testimony; for, from a batch of larvæ, which had all entered the ground before July 1st, 1871, one moth did not issue till October 8th, 1872. Such abnormal occurrences in insect life are by no means uncommon, and, though we may not be able to account for them, we can understand how they prove of advantage to the species. The eggs of our Buck Moth are among the few which remain unprotected and exposed to the severe winter weather, and, indeed, I know of none which are so completely at the mercy of the elements. Now, I have always noticed that some eggs, in a batch, failed to hatch—their vitality having, perhaps, been destroyed during the winter; and Mr. Lintner has recorded a similar observation. An unusually intense cold might destroy all the eggs over large extents of country; and, in such an event, the few belated pupæ would alone survive to perpetuate the species. That species are occasionally reduced in this wholesale manner, we have abundant proof; and, in this light, what at first appears to us an abnormity, becomes an important and necessary feature of the insect's economy. Thus, even occasional irregularity plays its part in adapting a species to its surrounding conditions, and becomes a necessary concomitant of the universal order and harmony in Nature!

FOOD PLANTS.

The leaves of our different oaks are the most natural food of this insect, and the black masses of prickly larvæ are sometimes quite abundant on the young Post, Black and Red oaks along the Iron Mountain region. My first worms were found abundantly on the Scrub willow (*S. humilis*), in Northern Illinois, in 1862; and I have also found them on a rose-bush. Maj. J. R. Muhleman, of Woodburn, Ills., also tells me that he has found them abundantly on the common Hazel, and Mr. Glover gives, as food-plant, the wild Black cherry.

NATURAL ENEMIES.

The poisonous qualities of the larval spines, however objectionable they may be to man, do not shield the wearer from the attacks of

other animals. We do not know positively that any bird attacks them, even while young; but Mr. Lintner caught the Modest Soldier-bug (*Arma modesta* Dallas) in the act. This bug is congeneric with and of much the same size and appearance as the Spined Soldier-bug, illustrated in former reports. Of true parasites, *Limneria fugitiva* (Say), a small Ichneumon-fly, which preys on several other insects, (Rep. 4, p. 41), and an undetermined species of *Microgaster*, have been bred from it—the latter by myself, and both by Mr. Lintner. I have also noticed, in one instance, a number of Tachina eggs behind the head of a larva in the third stage; but, singularly enough, they were shed with the third skin before hatching—the only case of the kind that has ever come under my observation. From another larva, however, I bred 7 specimens of the same Tachina-fly, which I have designated *anonyma*, and bred from so many other larvæ (Rep. 4, p. 129).

THE IO MOTH—*Saturnia* [*Hyperchiria*] *Io** (Fabr.).

(Ord. LEPIDOPTERA, Fam. BOMBYCIDÆ.)

[Fig. 63.]

This is one of our most beautiful moths, receiving its name from two conspicuous eye-spots on the hind wings, in allusion to the ancient Greek heroine, Io, who, as the fable went, was jealously guarded by the hundred-eyed Argus. The sexes differ remarkably in coloration. The male, (Fig. 63), which is smaller, is also much brighter colored, being of a deep yellow, marked, as in the figure, with purple-brown, the body and hind wings being of a deeper ochre-yellow. In the female, (Fig. 64), the purple-brown color predominates, and she is somewhat differently marked. The species shows considerable varia-

* = *varia* Walker—see Lintner *Ent. Contributions* II, p. 45.

[Fig. 64.]

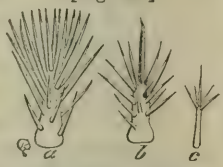
tion, both in color and pattern, and certain males in my possession range from pale cream-color to buff in the front wings.

The eggs are deposited in clusters on the under side of the leaf. The first description given of them is in the *Canadian Entomologist* (Vol. II, p. 29), by Chas. S. Minot, who describes them as "top-shaped." They are very much of the same form as those of *Maia*, being compressed on both sides and flattened at the apex—the attached end smallest. The color is cream-white, with a small black spot on the apical end, and a larger orange one on the compressed sides. A cluster found on Sassafras by Miss Murtfeldt contained about thirty eggs.

The larvæ begin to hatch about the end of June, and come to their growth in two months, after passing through five* molts, as in *Maia*. The hatching of eggs deposited at various times covers a considerable period, as larvæ are found as late as September first. As in *Maia*, the young larvæ are gregarious, feeding side by side, (like the Grape-vine Procris, 2nd Rep., Fig. 59), and they have a still more inveterate habit of following each other in single file. They differ from *Maia* in that they devour their cast-off, spinous skins, and in being less particular about their food. The full-grown worm presents the appearance of figure 65, and is of a green color, with the longitudinal stripes at the sides white and lilac-red. In my experience, the urticating properties of this larva, which exist from the first stage, are keener than in *Maia*. At all events it can not be handled with the same impunity; for it has fewer of the bristle-ending spines, and more of the stout and acute spines which prick most readily. For the most part, these larvæ remain at rest during the daytime; and they prepare for their dif-

[Fig. 65.]

[Fig. 66.]



* Harris erroneously says four.

ferent molts by drawing together, with a little silk, two or three of the leaves of their food-plant—thus forming a screen and shelter. They separate more and more as they get larger, but a few may always be found in proximity, even in the last stage.

LARVAL CHANGES. — The spines are situated as in *Maia*, viz.: 8 on jts. 1, 2, 3, 4, 5 and 10; 6 on jts. 6, 7, 8 and 9; 5 on jt. 11, and 7 on jt. 12. In the *first stage* the dorsal rows have much the same structure as in *Maia*, consisting of a stem or tubercle nearly as long as the diameter of body, and bifid on thoracic joints, but the set of mere points around truncated end in *Maia*, are here lengthened into spines, and the terminal bristle is reduced and stouter (Fig. 66, *c*). The body is smooth, bright orange, and the spines are of the same color, with the terminal half of the dorsal and tips of subdorsal ones black. The head varies from copal-yellow to black, with a few pale hairs around the trophi. In the *second stage* the body becomes paler, but with a darker medio-dorsal and three yellow lateral longitudinal lines. The tubercles are more bulbous and sprangling, those of the dorsal row having a stout central and terminal black spine (Fig. 66, *b*), and, except near head, having no bristles or aculei. The subdorsal spines have a little black at tips, and the lower ones are pale and weak, consisting, toward the basal part of the tubercles, of mere bristles. The labrum and a V-shaped epistomal mark on head are pale yellow, and the black ocelli are relieved by a pale surrounding. In the *third stage* the tubercles become more fasciculate, with few of the spines black, except at extreme tips and toward head, where the stems are longer, and the terminal halves of the four upper ones, on jt. 1 more especially, are black, with pale bristles. The body still inclines to orange, but the yellow longitudinal lines are broader, and two additional somewhat broken ones, appear between the dorsal spines. The head is green on top and on the cheeks, and dusky in front, while the black Y sutures separate the yellow V mark. The stigmata are dusky. In the *fourth stage* the bases of the tubercles are more bulbous and yellowish-white, the general color of the body is greener, the substigmatal line being pale and distinct, except on thoracic joints, where it is obsolete, and bordered above by a broader stigmatal orange-red stripe. The spines are greener, mostly translucent, but opaque toward tip — those on posterior half of body inclining, more and more, to fuscous; the extreme tips are dusky. Stigmata pale fulvous. In the *fifth stage* the body is pale green above stigmatal line, darker below, with the stigmatal stripe more pink, the spines having still less black, and the dorsal ones shorter and more evenly shorn (Fig. 66, *a*). In the *sixth stage* there is little change, except in size, and the mature larva may be thus described:

Average length 2 inches. Color pea-green, the sprangling spines more yellowish, and frequently tipped with black, especially anteriorly, posteriorly and laterally; all which are substigmatal, and those on the thoracic and anal joints terminate in pale aculei or bristles; the others mostly taper to a stout point. A conspicuous substigmatal white line, bordered above with a broader lilaceous stripe, obsolete on thoracic joints, and containing pale, piliferous dots. Stigmata elliptic-oval, yellow, with dark brown annulus; venter green, with a few scattering white hairs, and two pale, lilaceous patches on all but thoracic joints, each patch containing oval, pale-green, piliferous spots. Cervical shield, anal plates and a spot outside of prolegs of the same lilaceous color. Legs pale brown, with whitish bristles, the prolegs with brown hooks. Head polished green, with black ocelli.

Considerable variation is shown in individuals, and in one batch which I reared, a single larva, during the second stage, showed such exceptional coloring as to attract attention. The spines were almost white, and it had distinct dorsal and subdorsal red lines, not possessed by the others. These peculiarities were subsequently lost.

When about to transform, it draws a few leaves together, generally near the ground, and spins a thin, weak cocoon of a gummy brown silk. The pupa is of the same general form as that of *Maia*,

somewhat lighter colored, lacking the plaited edges on the sutures described in that species, and having the hind side of the deep mobile sutures longitudinally and broadly striate or carinate, instead of transversely aciculate. There are some sparse, rust-colored, curled bristles on the abdominal joints, and the anal tubercle terminates in quite a bunch of them.

The moths frequently issue in the fall of the year, and some as early as the middle of September; in which case it is not known whether they or their eggs hibernate. They more often issue, however, during the following May. Unlike the exceptional *Maia*, they are doubtless nocturnal, as I have never seen them flying during the day-time.

FOOD PLANTS.

The species is a very general feeder. I have found it myself on the so-called false Indigos (*Amorpha fruticosa* and *Baptisia*, two species), on Sassafras, Black locust, Indian corn, wild Black cherry (*Prunus serotina*), and Willows. It has likewise been found on Elm, Hop vine, Balsam, Poplar, Balm of Gilead, Dogwood, Choke cherry, Currant, Cotton and Clover.* I have also taken the full grown larva from Ironweed (*Vernonia*), but without any other proof that it feeds upon this plant.

PARASITES.

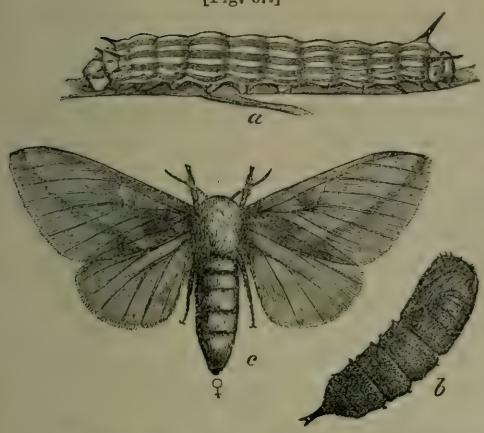
Parasitized larvæ are frequently met with, and the white cocoons intermingled with their spines, and of which I have reared great numbers, produce the same species of *Microgaster*, already referred to as parasitic on *Maia*. The Long-tailed Ophion (4th Rep., Fig 37) also breeds within it.

* For authorities, see Harrris (*Inj. Ins.*, 394); Fitch (N. Y. Repts. 2d Vol.); C. J. S. Bethune (*Can. Ent.* II, p. 20, and *Can. Farmer*, Sept. 15th, 1870); C. S. Minot (*Can. Ent.* II, p. 29); Mrs. H. C. Freeman (*Am. Ent.* II, p. 39); T. Glover (Monthly Rep. Dep. Agr., Nov. and Dec., 1866), and J. A. Lintner, as already cited.

THE GREEN-STRIPED MAPLE-WORM—*Dryocampa* [*Anisota*] *rubicunda* (Fabr.)

(Ord. LEPIDOPTERA, Fam. BOMBYCIDÆ.)

[Fig. 67.]



There is a striped worm (Fig. 67, *a*,) which at times very seriously affects our Soft and Silver maples, but more especially the former, and which was so unprecedentedly abundant last year in some of our western counties, and beyond into Kansas, that a brief notice will be looked for in this Report. To give some idea of the numbers in which it occurred in our sister State, I introduce the following letter:

DEAR SIR: We are very much troubled out here in Kansas with worms. You no doubt know some persons who are always afflicted with worms. Those, however, that I wish to ask you about (I mean the worms, not the people,) are those that are eating all the foliage off our shade trees—Soft Maples—they trouble none others.

About two years ago was the first I noticed; there were not a great many that year, but last year they came in increased numbers, so that many trees were eaten entirely bare, there not being a single leaf left. This year they are appearing by the million on the trees in my yard, and in fact on all the Soft Maples in this vicinity. The first you discover will be the eggs laid in clusters on the under side of the leaves, generally near the end of the limbs, on the new growth. They soon hatch and begin to eat, grow and spread over the trees, and when they have entirely stripped the tree they crawl down the body to the ground, under foot, into the houses and elsewhere in search of food. They grow to be about two inches long—great green worms.

The eggs are evidently laid by some kind of fly. In our city, and in fact in all this country, the Soft Maple, on account of its rapid growth, has been almost universally set out for shade trees, and this worm-nuisance has come to be a serious question.

If they are a thing that has come to stay—to appear and reappear year after year—I propose to cut my trees down, and plant something that is worm-proof. You may be conversant with this matter, and able to tell us at once their nature, and whether they are likely to be a permanent pest, and if there is any remedy for the nuisance. Doubtless they are in other parts of the country, but I have never seen any except in Kansas. If you can tell us anything about the matter, a letter from you would be most gratefully received by

Your obedient servant,
HORACE J. SMITH.

OTTAWA, Franklin county, Kansas, June 24, 1872.

Any one traveling through Kansas last fall must have been struck with the absolutely naked appearance of the Soft maples, which are very extensively used, and highly prized for ornament and shade, and may be found in every thrifty town. A beautiful belt on the grounds of the Agricultural College at Manhattan was allowed to suffer like the rest, and by the middle of September, could scarcely boast of a leaf.

I have known this insect for many years, and it is a wide-spread species, extending throughout the Eastern States and Ontario. The fact that the Soft maple is indigenous along the streams, in the bottom lands of Kansas, will account for its excessive multiplication there, compared with the more eastern portions of the county.

The eggs from which the worms hatch are deposited in batches of thirty and upward, on the under side of a leaf. Each is about 0.05 inch long, sub-oval, slightly flattened, translucent, and pale greenish, becoming more yellow, and showing the black head of the inclosed larva just before hatching.

LARVAL CHANGES.—In the *first stage*, the larva is cylindrical, yellow, with a large black head, and the spines hereafter described forming little black tubercles of nearly uniform size, and without the greater prominence of those on joint 2. In the *second stage*, the head is browner and the spines and stripes of the mature worm more apparent. In the *third stage*, the mature characteristics are acquired, and there is subsequently little change. The full grown larva may be thus described:

Average length, 1.50 inches. General color, pale yellowish-green; longitudinally striped above alternately with eight very light (almost white) yellowish-green lines, and seven of a darker green, inclining to black, the medio-dorsal one usually darkest, and showing palpitations. Characterized by two black, blunt, anteriorly-projecting horns on joint 2; two lateral rows of posteriorly-projecting, more pointed, shorter spines, one (the largest) below and one above stigmata, and most prominent on joints 10 and 11, which are here somewhat dilated and tinged with rose-red. When examined with a lens the body, both above and below, is found to be thickly studded with transparent granulations, and there are four dorsal, polished, sub-obsolete spines, the anterior on upper edge, and the posterior on lower edge of second dark stripe, and most prominent on joints 11 and 12. Head more or less intense copal-yellow, the ocelli on a black ground; stigmata, in lower dark line, oval, black, with a pale central line; joint 1, with six black elevations on anterior edge; anal shield flattened, greenish, with a black blotch superiorly, and margined with eight black spines, the two terminal stoutest; venter black, with pale mesial line, and a prominent black spine each side, and sometimes others less prominent; legs greenish or yellowish, the thoracic and anal marked with black, the abdominal with rufous clasps.

Varies much; specimens in last molt often with black predominating, the dark lines being jet black, the two lowermost often coalescing; all sometimes coalescing on joint 1, and anal shield, and the legs being almost entirely black. Other specimens with the pale colors predominating.

Hundreds examined.

The worms are longitudinally striped with pale and darker green lines, and are chiefly distinguished by two anteriorly projecting black horns on the top of joint 2, and by having joints 10 and 11 a little dilated and rose-colored at the sides. They go through four molts

and come to their growth within a month, when they descend into the ground and become chrysalides.

The chrysalis (Fig. 67, *b*) is of a deep brown or black color, very much roughened, and coarsely punctate or pitted like a thimble, with curved horns about the head and thorax, especially at base of antennæ, a ring of sharp, conical teeth around the anterior edge of the movable joints, (stoutest dorsally), one around the middle of the penultimate joint, and several irregular thorns on the apical joint, which terminates in a long projection, bifurcate at tip. The movable sutures have a few coarse punctures on the posterior part, and very fine longitudinal striæ on the anterior part, which, at the edge, has a ring of small, blunt-pointed elevations.

In due time this chrysalis, by aid of the spines with which it is furnished, works its way to the surface and gives forth the perfect insect, which is a most delicate moth, of a pale yellow color, shaded with pink, as in the figure (*c*) which represents the female, the male having a somewhat smaller abdomen, and broader, more pectinate antennæ. This moth may be called the Rosy Dryocampa. It varies a good deal. In our western specimens the yellow predominates, the rose color being but faintly visible. Ordinarily the front wings might be described as rose-colored, with a yellow band running diagonally across the middle, and broadest on the anterior margin. I have seen eastern specimens where the rose color was quite intense on the front wings, and where the hind wings, which are more generally pure yellow, have a rosy band across them. Other specimens I have bred which were almost white or colorless.

With us there are two broods of this insect each year, the first brood of worms appearing mostly during the month of June, and giving forth the moths the latter part of July; the second brood of worms appearing in August and September, wintering in the chrysalis state, and not issuing as moths till the following May. I have bred the second brood from eggs laid by the first; and last year not a worm was to be found after the 15th of September, where a week previously they had been swarming.

Dr. Harris gave to the genus, to which this moth belongs, the name of *Dryocampa*, meaning "oak-caterpillar," because all the other species of the genus feed on oaks; and though our Maple worm prefers the Soft maple, it will nevertheless feed also on Oak, as it has been found thus feeding by my friend Wm. Saunders, of London, Ont., and I have myself fed it on Oak in confinement.

NATURAL ENEMIES.

How far this insect is controlled by birds is not known, but it has certain parasites which very effectually aid in this work, and whose existence explains the fluctuation in the increase or decrease of our Maple worm. Prominent among these parasites is the same *Tachina anonyma* (*ante* p. 133) which preys within so many other larvæ, and which has been reared by my correspondent E. A. Papineau, of To-

peka, Kas., and by myself. A second and more beautiful species of Tachina-fly (Fig. 68) also attacks it. It is easily distinguished from all other species of the genus with which I am familiar by the bright golden-yellow of the third and fourth abdominal joints, which have only the hind borders black, and it may be vulgarly called the Gold-banded Tachina-fly.

[Fig. 68.]

TACHINA [BELVOSIA] BIFASCIATA (Fabr.)—♂—Length, 0.50 inch; expanse, 1.00 inch. *Head* broader than thorax; face broad, silvery-white, with purplish reflections, and garnished with the usual black bristles; front more dusky, with two rows of large, incurved bristles, interspersed, as usual, with numerous smaller ones, and divided by a smooth, depressed, dark brown stripe; occiput dark, with the three triangularly arranged ocelli amber-colored; labium ferruginous, with hairs of same color; maxipalps ferruginous, with short black bristles; eyes smooth and dark purple-brown; antennæ with the two basal joints brown, the second nearly thrice as long as first, the third darker, flattened and nearly thrice as long as second, the setæ black; hind part of head covered with dense white hair. *Thorax* quadrate, polished, black, except at corners, which are brown, with a bluish cast inclining to pruinescence anteriorly, where alone the vittæ are distinct; the usual transverse suture distinct, and the larger bristles numerous around border and in four lines on dorsum; scutel tinged with brown: wings fuliginous, almost opaque, veins brown; alulæ dull white; legs strongly bristled, black, with ferruginous pulvilli. *Abdomen* stout, first and second joints deep blue-black, *third and last joints golden-yellow, with only the posterior borders black;* two stout medio-dorsal bristles from posterior edge of jts 1 and 2, (stoutest on 2), and a ring of them around 3 and 4.

One ♂ bred from *Anisota rubicunda*, and one captured by Mr. Lintner at Center, N. Y., in July.

This is evidently the insect briefly characterized as *Musca bifasciata* by Fabricius, (*Syst. Antl.* No. 78), and subsequently more fully by Wiedemann, (*Aussereuropæischer Zweifl. Ins.*, II, p. 305), who, however, describes the 3rd antennal joint as *four times as long as 2nd.* Still later it was referred to the genus *Nemoræa* by Macquart, and to the genus *Latreillia* by Robineau-Desvoidy. The last named author again referred it to a still different genus, *Lalage*, (*Dipt. des Env. de Paris*, I, p. 563), where it is described from Fabricius's typical specimen as having a golden band around the *middle of the second and third* abdominal joints. The genus *Lalage* is founded on the "absence of bristles on the apex of the first abdominal joint," so that I can not see how our insect could be referred to it. Macquart gives good reason for believing that his *Senometopia bicincta* and R-D's *Belvosia bicincta* represent the female, and, consequently, unites them into one species, under the name of *Belvosia bifasciata* (*Dipt. Ex.* Tom. II, Part 3, pp. 55–7).

The female (which I have not seen) differs in the somewhat broader face, in the 3rd joint of antennæ being only twice as long as the second, and in the abdominal bands being white instead of golden.

We thus see that this one species has been construed to represent four modern genera, and, though this may well be called pretty fine hair-splitting, the different characters which gave birth to it are important and conspicuous compared to those upon which some of our modern genera in other Orders have lately been founded. Is it any wonder, therefore, that the field-naturalist should get heartily disgusted at such unnatural, so-called generic distinctions!

It may be well to add that Meigen (*Beschr. d. bek. Eur. Zweifl. Ins.* Vol. IV, p. 381) described (in 1824) a *Tachina bicincta*, which has a white ring around the *base of the 2nd and 3rd* abdominal joints; and that Macquart's figure of *Belvosia bifasciata* (sex not indicated) shows the head and face, and the abdominal bands much narrower than in

my ♂. If, in the future, the specimen here described should prove distinct, it may be called *auricincta*, by which MS. name it has been ticketed in my cabinet. The fact mentioned by Macquart that, though found more particularly in Brazil, *Belvosia bifasciata* has been received from Philadelphia, and bred from *Citheronia regalis*, would strongly indicate that we have to do here with the same species, and that the differences just noticed are either defects in the drawing or variations. In the captured specimen in my possession the characteristic golden bands have become effaced by greasing.

Finally, the same little friendly Ichneumon-fly, (*Limneria fugitiva*, Say, Rep. 4, p. 41), which was already known to breed in a closely allied congener, (*Dryocampa stigma*, Sm.), has been bred from it by my lady correspondent, Mrs. Mary Treat, who has forwarded me specimens. The larva of this parasite forms its own cocoon within the disemboweled skin of its victim, which it kills almost always in the third stage.

REMEDIES.

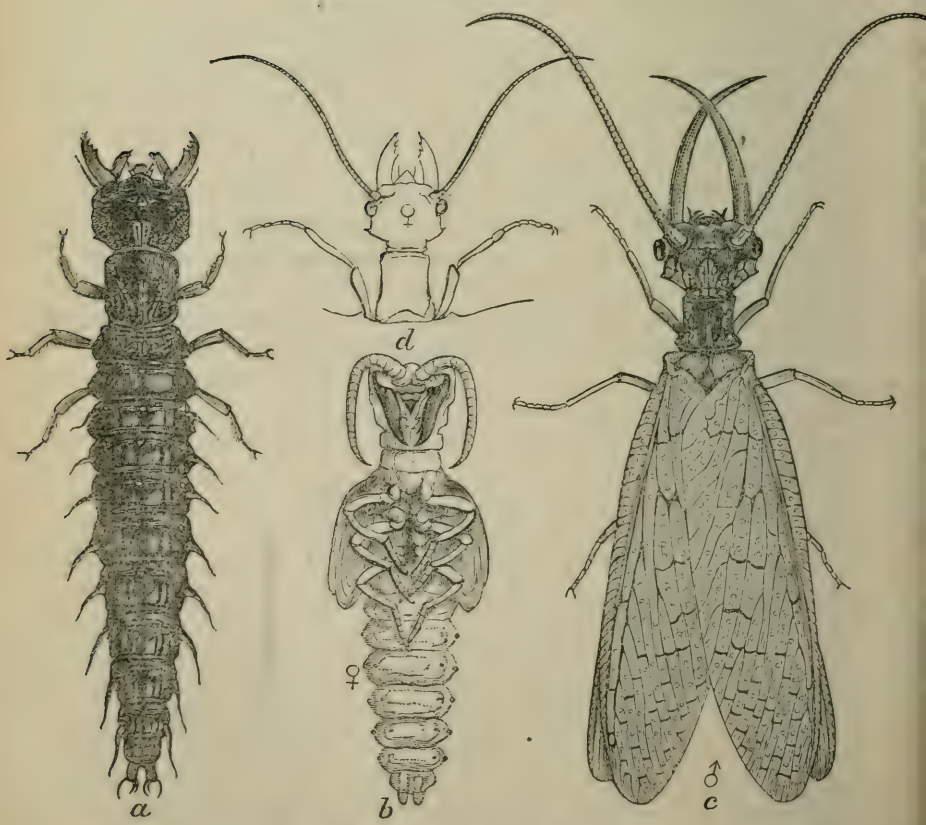
This insect is seldom so exceedingly abundant two years in succession. In 1867 it stripped the soft maples around Peoria, Galesburg, Princeton and Monmouth, in Illinois, but attracted no particular attention the following year. The worms hold on to the tree tenaciously, and are not easily jarred down; and, before entering the ground, they scatter great distances away from the trees, so that it is impracticable to hunt for and destroy them while in the chrysalis state. The best way to counteract their injuries is to keep a close watch for the moths and eggs during the latter part of May, when they may be destroyed in great numbers. The worms, when about to leave the trees, may also be entrapped, by digging a trench either around the individual tree or around a grove or belt. The trench should be at least a foot deep, with the outer wall slanting under. Great numbers of worms will collect in it, or bury themselves in its bottom, and may easily be killed.

INNOXIOUS INSECTS.

THE HELLGRAMMITE FLY—*Corydalus cornutus* (Linn.).

(Ord. NEUROPTERA, Fam. SIALIDÆ.)

[Fig. 69.]



This immense fly and its larva have been sent to me by Walker Evans, of Moselle, R. E. Pleasant, of Louisiana, and others in differ-

ent parts of the State. It is the largest of our Nerve-winged insects, and is tolerably common throughout the Eastern and Middle States, and into Ontario. It is so conspicuous and so characteristically marked that, with the accompanying figures, which are of natural size, no detailed descriptions are necessary.

[Fig. 70.]

Its eggs (Fig. 70) are oval, about the size of a radish seed, and of a pale color, with some dark marks. They are deposited in the summer months in closely-set patches of fifty and upward, upon reeds and other aquatic plants growing along running streams, and the newly-hatched larvæ drop or crawl immediately into the water, which they inhabit till the end of the following spring. The young larva has not been described, but, judging from analogy, it will resemble the full-grown form, (Fig. 69, *a*), which is of a dark-brown color, variegated with lighter brown—the abdominal joints being tough and leathery, and the head and thoracic joints horny and polished.

Most aquatic larvæ transform to the pupa state within the water, but this larva quits the water when full-fed, as do the others of the same family, and crawls about for days seeking a place wherein to transform. We find, therefore, that nature has abundantly fitted it for living in both elements, by giving it, first, two rows of nine breathing holes or spiracles, placed in the usual way along the sides of the body, (the first between joints 1 and 2, and the others on the anterior portion of joints 4–10), which enable it to breathe out of the water; and, secondly, two sets of nine gills or branchiæ, which enable it to breathe in the water. These gills or respiratory filaments are placed just below the spiracles, and one on each side of each abdominal joint, except the 9th, and on the terminal subjoint. They are more or less covered with fine hairs, (inadvertently omitted in the figure), and between them may be noticed small tufts of such hairs. Besides these lateral filaments, there is, ventrally, a pair of rust-brown, spongy masses of short fibres, one on each side of joints 4–10, and a somewhat similar central patch on the terminal joint and subjoint. Dr. Hagen supposes these to be the true gills, but they may be looked upon as accessory gills. The lateral filaments assist in swimming, and we shall also notice, at the tip of the body, a pair of curved, double hooks, which assist in climbing or in moving backward.

This larva feeds on other aquatic insects, such as the larvæ of May-flies (*Ephemera* family) Shad-flies (*Perla* family), etc. It abounds most in rapid-flowing streams, and generally in such as have a rocky bottom, upon which it moves slowly about. After leaving the water, about the beginning of June, it travels, in the night-time, sometimes to comparatively great distances—having been found nearly a hundred feet from its former habitat. At this season, it is sought as

fish-bait, and is called by fishermen a "crawler" or "hellgrammite." It can pinch with its formidable-looking jaws, but not forcibly enough to draw blood. Mr. Walsh mentions a most curious incident in connection with its larval wandering,* which I quote in full:

"A most respectable man, who keeps the toll-bridge over Rock River, where this insect is very abundant, informed me that on several occasions its larvæ had fallen down one of his chimneys. His idea was that they must have bred there, but that, of course, is out of the question. The statement was confirmed by his wife, and I have no doubt of its truth. In 1863, I threw a larva of this insect into the Mississippi to examine into its customary mode of progressing in the water, which, as I found, was by crawling along the bottom, not by swimming. As it emerged from the water, it climbed with ease up the stump of a large white elm, which was stripped of its bark, and as smooth as any carpenter could have planed it. The stump was three feet high and upright, and when it had reached the top it commenced descending on the opposite side; but, after a while, lost its foothold and fell into the water again. The pair of 2-clawed appendages at the tail are used with much effect to assist it in climbing. The building which it must have climbed to reach the chimney, down which it is stated to have fallen, was only a low, one-story wooden one."

In preparing for the pupa state, this larva burrows into the earth, where it forms an oval cell, or hides under some large stone, piece of wood or other substance. Here, in about two weeks, it casts its tough larval integument, and assumes the form of figure 71, lying in a curved position in its cell, with the head, wing-pads and legs deflexed on the breast. Figure 69, *b*, was made from a spread and straightened skin before I had become acquainted with the living larva; and though it does not convey a truthful impression, will serve to better display the appendages. The color is yellow, with traces of the brown mottling of the larva, rudiments of the lateral appendages, but not of the spongy masses, and a few hairs scattered over the exposed parts. The spiracles are more conspicuous, and the upper jaws stronger and olive-green. The pupa state lasts but a few days, and the perfect insect issues during the month of July. It is nocturnal in habit, and hides, for the most part, in obscure places during the day. It is sluggish at this time, and, if approached, will drop sooner than fly, or raise its head and abdomen, and open its jaws menacingly.

[Fig. 71]

There is no perceptible sexual difference in larva or pupa, unless it is, as stated by Haldeman,† in the rather larger size of the jaws of the male. This similarity of the sexes, especially in the pupa, is the more remarkable that in the imago state they differ so greatly. The

* *Proc. Phil. Ent. Soc.*, Vol. II, p. 265.

† History and Transformations of *Corydalus cornutus*, by S. S. Haldeman, A.M., communicated to the "American Academy of Arts and Sciences," Nov. 18th, 1848. In this paper the transformations of the species are for the first time given, and the anatomical structure well illustrated.

male (Fig. 69, *c*) is remarkable for having his upper jaws — which in the female (Fig. 69, *d*) are normal and fitted for biting — prolonged into incurved, prehensile appendages of the form of a grain-cradle finger, and smooth and cylindrical, except at tips, which are pointed and minutely notched. As Mr. Walsh first pointed out,† this modification is evidently to enable him to embrace the soft body of the female, as it can not well have any other use. The body of the Hellgrammite fly is soft, and were the jaws of the male horny, and armed with teeth, in securing the female they would injure her, and thus defeat rather than aid procreation. In the large Stag-beetle or "Buck-bug" (*Lucanus elaphus* Linn.), on the contrary, where both sexes have very hard, horny bodies, the upper jaws in the male are greatly prolonged, but very stout, and armed with sharp prongs, the better to enable him to seize the female.

In these two cases we see how wonderfully the homologous organs have been modified in opposite directions to accomplish the same end. We find in Nature innumerable such curious contrivances and modifications, which at once excite our wonder and admiration. To quote Mr. Walsh's own eloquent words: "In so elaborate and diversified a manner does Nature adapt her plans and patterns to the ever-varying conditions of animated existence; and with such consummate care has she provided that the great fundamental law shall everywhere be effectually carried out — 'Increase and multiply and replenish the earth.'"

It is worthy of remark that in both these large insects in which the male upper jaws are so modified, this sex is far more common than the other. It is probably owing to the fact that the female seldom wanders away from her breeding place, and is, therefore, less often seen than her more restless and adventurous mate.

THE GOAT-WEED BUTTERFLY—*Paphia glycerium* Doubleday.

ADDITIONAL FACTS IN ITS HISTORY.

[Fig. 72.]

In my second Report (pp. 125–8) I gave an illustrated account of this insect, which was, however, incomplete, and in some few respects imperfect. Having since reared hundreds from the egg to the imago state, and otherwise carefully observed its habits, I am now able to supplement and complete the natural history of one of the most interesting of our N. A. butterflies.

† *Practical Entomologist*, Vol. II, p. 107.

THE EGG.

The egg, now described for the first time, is usually fastened singly, (though I have found as many as six on one leaf,) and not very firmly, to the under side of a leaf. It is perfectly smooth, shiny, globular, translucent, pale yellowish-green, and 0.035 inch in diameter—often (unnaturally) flattened at top. It has always hatched, with me, within five, and sometimes in four days after deposition.

Thus, while the larva of *Paphia* reminds us of *Goniloba* and the chrysalis of *Danais*, the egg recalls *Papilio*.

THE LARVA.

The newly hatched larva is of the same color as the plant, and invariably commences feeding at the tip of a leaf, stripping it down the midrib, upon which, between meals, it rests exposed, (Fig. 72, *a*), and in this respect much resembles the young *Limenitis dissippus* at the same age. The leaf-case which it inhabits later in life is not made till after the first, and sometimes not till after the second, molt; and from the facts that the young larva does not need it, and that the full-grown larva is often seen feeding under a broiling sun, I infer that the case is not so much intended for shelter, (the opinion formerly held), as for a shield against enemies, hereafter mentioned.

Larval Changes.—In the *first stage* the mature characteristics are already indicated, and there is less change in this than in most Lepidopterous larvæ with which I am familiar. The form is less cylindrical, and the head is smoother, with the tubercles sub-obsolete (Fig. 72, *b*); but it is similarly mottled with brown. The ocelli—5 in number, 3 of them larger than the others—are black, and placed some distance back of the antennæ; the sutures are well defined by dark lines, and there is a dark line on the neck, behind the head. The papillæ on the body are *less* numerous, and arranged more in transverse rows, there being four tolerably distinct transverse wrinkles to each joint. The dark spots between the papillæ, *and which are mere surface marks*, though minute, are distinctly visible, and two of the pale dorsal papillæ on the anterior wrinkle of each joint are larger than the rest. In the *second stage* the head (Fig. 72, *d*, enlarged) is more warty and more bilobed, with the three black ocelli still more separated from the others; it is pale laterally and behind, but dark on the flattened face, with the papillæ white, and conspicuous among them four large conical ones, in a transverse row, above epistoma, which is itself marked with a more or less cordate, pale figure, and another V-shaped, narrower, pale line along the suture; on the top are two prominent, black, bluntly-bifid tubercles, with two smaller but similar white ones between and just behind them, and laterally between them and the ocelli a simple, conical dark one. On joint 5 dorsally, and 8, 9 and 10 laterally, there is considerable black between the papillæ, while the whole dorsum of 11 and 12 is dark, and the anal shield is brownish: the four more or less distinct transverse rows of papillæ to each joint are now interspersed with more minute ones. In the *third stage* the head is proportionally larger than before, with the tubercles relatively reduced in size, and some of the formerly white ones are fulvous, except at tip. The papillæ on the body are more numerous, with the intervening non-elevated dots, pale rust-brown. Usually these coalesce into 3 darker spots dorsally on joint 5, and into one each side of 8, 9 and 10, (Fig. 72, *c*, enlarged), while the dorsum of 11 and 12 is frequently black. In the *fourth stage* the tubercles of the head are again reduced (Fig. 72, *e*, enlarged) very much as in the first

stage; the papillæ are more numerous and more uniform in size, and in some specimens sub-obsolete; the dark markings are more often lacking, as before described, (Rep. 2, p. 127), but sometimes so prominent as to give the worm a brown hue. Considerable variation in the markings of the head may also be noticed in different individuals of the same age.

Like the larva of the Archippus butterfly, it goes through but three molts, and, like that larva, it furnishes an excellent illustration of the fact that the head increases in size between the molts. It matures very rapidly, and often acquires its full growth within three weeks. In suspending for the transformation to chrysalis, the body is bent almost in a circle, the head being brought close to the anus; and so rapid is the transition, during hot weather, that by five o'clock P. M., I have had the dry and hardened chrysalis from larvæ which were not suspended till 10 A. M., of the same day. During the suspension of the larva, a pale transverse elevation (corresponding to that of the future chrysalis) appears distinctly across the middle of joint 7, and it is very patent that the head of the chrysalis is formed under the head of the larva — that the pro, meso and meta-thorax correspond to joints 1, 2 and 3, and that the second pair of larval spiracles is covered by the hind wing-sheaths in the chrysalis, while the ninth larval pair becomes obsolete and closed.

The transverse ridge across the abdomen, and the ridges around the wing-sheaths and the head, are white, with a lilaceous tint in the fresh chrysalis, and the dusky spots are arranged in eight longitudinal rows, two dots to a joint. The anal clasp consists of a rounded knob, densely covered with short, dark brown barbs, and connected with it ventrally is a conspicuous black cordate mark.

NEW FOOD PLANT.

The Goat-weed occurs very sparingly in the immediate vicinity of St. Louis, and not till we reach Highland, Illinois, on the Vandalia railroad, is it found in profusion. The butterfly is, nevertheless, quite common. Suspecting, from these facts, that it must breed on some other plant, I soon discovered such to be the case. While *Croton capitatum* is rare, another species of the same genus, the *Croton monanthogynum* Michx., is very abundant, and especially just over the river, at East St. Louis. This plant is rather more woody, grows a little lower, and has a much smaller, deeper green leaf than *capitatum;* and, though separated from *Croton* by some botanists, and called *Engelmannia* by one of them, Dr. Engelmann himself considers it a good enough *Croton.*

Unless very well grown on rich soil, several leaves are necessary to make a case, and the larva knows well how to adapt itself to the circumstances.

The perfect imitation of the food-plant by the larva is remarkable, for those found on *capitatum* are generally paler than those on *monanthogynum.* It is upon this last plant, later in the season, that I

have found so many dark specimens, the dark spots characteristic of the third stage enduring till the fourth, and the purple-brown frecklings between the papillæ so numerous as to make the sides, more especially, quite dark. Suggestively enough, the leaves of the plant at that season are almost universally covered with freckles of exactly the same color. On this plant, also, the chrysalis is invariably suspended under a parasol of leaves connected by silken threads, and so effectually is it hidden from view that a person not acquainted with the insect might travel for a day over ground where he would necessarily disturb one at every step, and yet remain perfectly unconscious of the fact.

TWO BROODS EACH YEAR.

It is generally believed that the species is single-brooded;* but this is evidently a mistake. Though I have not reared one generation from the other, I have no doubt that, like *Archippus*, it is double-brooded, because I have watched females depositing the fore part of September, which, from their fresh appearance, could not have hibernated. The females, in all probability, deposit as soon as the food-plants appear; and as this is rather late in the season, we seldom find any larvæ before the middle of July. Butterflies are produced from this first brood of larvæ during the month of August, and during that month, September and often into October—or until the plants dry up or are frozen—the insect may be found in all stages. Last year, on the 3rd of October, I found eggs and young larvæ, which were doomed to a sorry death, since a few days later a frost killed and blackened the plants upon which they occurred. The second brood of worms, as would naturally be expected, is far more numerous than the first, and, as in so many other species, the two broods doubtless overlap each other.

ITS WINTER QUARTERS.

That, as with *Archippus*, the butterflies hibernate, there is no longer any doubt whatever, as I have kept them throughout the winter, and so has Mr. Muhleman. Mr. Hayhurst also writes:† "During winter, (1870,) in February, a tree was felled on the line of the railroad on which I was at work. As it fell it split open and was found to be hollow. The cavity was partly filled with dirt and hickory-nut shells; but among the stuff that fell out were some twenty butterflies, mostly *Vanessas—Antiopa* and *Atalanta*. But among these were

*Mr. L. K. Hayhurst, of Sedalia, writes to Mr. Wm. H. Edwards (Butterflies of N. A., Vol. I, p. 139,): "This species has but one brood." Mr. J. R. Muhleman *(ibid)* writes: "I am satisfied there is but one brood." I think I can safely say that Mr. Muhleman is now of a different opinion, having himself had the chrysalis as early as the 5th of August.

†In Edwards's "Butterflies of N. A.," previously mentioned.

seven specimens of *glycerium*." In the fall of the year this butterfly is of frequent occurrence around persimmon trees, attracted by the sweet of the cracked and ripened fruit. Later in the season it congregates in small bevies around willows, collecting on wounded parts of the boughs, where the sap is exuding; and such congregations are usually accompanied by a few *Graptas*. The flight of *Paphia* is swift and strong, and specimens are difficult to capture. They rest suddenly, and then the leaf-like form and protective coloring of the fast-closed wings effectually screen them from sight. Faded, and often dilapidated, specimens may be seen flying, on warm days, early in the month of April.

NATURAL ENEMIES.

I have, on several occasions, found the newly hatched larva stiff and dead—apparently ichneumonized. The Spotted Ladybird (*Hippodamia maculata*, Rep. 1, Fig. 49) is abundant in all stages on *Croton*, and probably feeds on the eggs and young larvæ of *Paphia*, as well as upon a pale *Aphis* commonly found on the plant. In the breeding cage I have also had the eggs destroyed by *Syrphus* larvæ, while several insectivorous wasps, and notably the Painted-wing Digger-wasp, (*Ammophila pictipennis* Walsh, Fig. 73), are constantly seen exploring the Paphia-inhabited plants. But the most persistent of the enemies is the selfsame *Tachina archippivora*, (Rep. 3, p. 150), which infests *Danais Archippus*, and which I have bred quite numerously from late specimens of *Paphia*—the parasites issuing from their victims, sometimes while these are in the larva, but more often after they have assumed the chrysalis state; then entering the ground and issuing as flies early the following spring.

[Fig. 73.]

ON A

NEW GENUS IN THE LEPIDOPTEROUS FAMILY TINEIDÆ:

WITH

REMARKS ON THE FERTILIZATION OF YUCCA.

[Read before the St. Louis Academy of Science, at its regular meeting, September 2nd, 1872.]

PRONUBA. Nov. Genus.

GENERIC CHARACTERS.—*Front wings* (Fig. 74, *h*) elliptical, the apex subacuminate; disc closed, though somewhat indistinctly between marginal veins 5–8: 12-veined, exclusive of submedian (1 *a*); costal vein stout, connected with subcostal near base, and not extending beyond middle of wing; the subcostal vein sends, from about one-fourth its length from base, a branch which reaches costa where the latter commences to round off; it also sends, from about the middle of the wing, a branch through the discal space, forming an accessory discal cell, and sometimes considerably passing the disc, and forking outside, so as to form marginal veins 7 and 8, though more often forking just at the transverse discal vein; a feeble disco-longitudinal veinlet starts independently near the base, forks near the middle, and forms a second accessory discal cell; submedian vein distinct only near the margin, and indicated by an opaque line along the basal half of the fold; internal vein feeble, and bifid at basal third. *Hind wings* (Fig. 74, *i*) broad, subacuminate at tip; shoulder slightly produced and armed, in the ♂, with a long spine, and in both sexes with a tuft of long scales; 8-veined, exclusive of submedian, (1 *a*), which is distinct; disc entire; costal vein extending three-fourths the length of wing; an independent, feeble, disco-longitudinal veinlet, forking about the middle of the wing, the upper branch sometimes considerably passing the disc, and then forking into marginal veins 5 and 6, but more often forking at transverse vein; internal vein feeble and simple. *Head* (Fig. 74, *a*, ♀) free, sparsely haired; epicranium flattened or depressed; ocelli obsolete; clypeus large; eyes round and salient; antennæ filiform and simple in both sexes, nearly one-half as long as front wing, the basal joint long, bulbous, and twice as stout as the others; maxillary palpi (Fig. 74, *b*) very long, 5-jointed, *the basal joint in the ♀ produced*

[Fig. 74.]

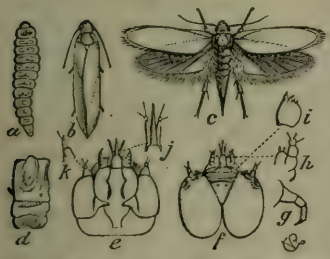
into a long, stout, cylindrical, prehensile tentacle, armed with spines springing from flattened tubercles (c); this joint in the ♂ a mere blunt-pointed tubercle (Fig. 74, *d*); the other joints almost smooth; 2nd, short, stout, and directed backward; 3rd, more slender, and as long again as 2nd; 4th, thrice as long as 3d; 5th, as long as 2nd, slender and subfusiform; labial palpi (Fig. 74, *g*) moderately covered with hair-like scales, reaching nearly to base of antennæ; 3-jointed; basal joint curved and stout; 2nd, half as long and straight; 3d, short and fusiform; tongue long and smooth. *Legs* with the usual single spur on the front, a pair on the middle, and two pair on the hind tibiæ. *Abdomen*, ♀ with the terminal joint laterally compressed, long, horny, bare; the sheath of the ovipositor acute; the ovipositor when extended very long, fine, and thread-like; ♂ shorter, blunt, and slightly swollen at tip; the genital hooks large, symmetrical; the upper edge entire and thickened, the lower edge excavated about the middle, with a dark tooth in middle of excavation.

Approaches in the venation of the wings such genera as *Anaphora* Clem. and *Amydria* Clem., but is at once distinguished from all other known genera by the characters given, and especially by the maxillary palpi. The variation in the wing venation affords another illustration of the unsoundness of the principle of founding genera on the pterogostic characters alone, especially when taken from one or two individuals only.

PRONUBA YUCCASELLA, n. sp. (Fig. 75, *c*).

Average expanse, ♀ 1 inch; ♂ 0.90 inch. *Front wings*, above, uniformly silvery-white, the scales loosely set; fringes concolorous; beneath, pale fuscous, with a brassy reflection; paler internally; fringes either concolorous or paler; costa with a brush of dark hairs. *Hind wings* semi-transparent, pale fuscous both above and below; paler internally, the fringes white and the brush on shoulder dark. *Head* white; antennæ and tongue dingy yellow; maxillary palpi of same color, with the exception of tentacle, which is darker; labial palpi with scales on 2nd joint dark brown above; eyes black. *Thorax* white. *Legs* dingy yellow, more or less covered with pale scales. *Abdomen* with the terminal joint in ♀ always bare, with the exception of a few short, stiff hairs near tip, and the scales on the other joints very loosely attached.

[Fig. 75.]



Described from 9 ♂s, 15 ♀s.

I take the present occasion to describe this new genus, not because it is so characteristic and anomalous, but because, firstly, the species belonging to it has such very interesting habits; and secondly, there is much yet to learn of these habits, and I wish to draw the attention of entomologists to the subject.

Of late years, and more especially since the publication of Mr. Charles Darwin's interesting work on the fertilization of Orchids,* we have come to understand more and more the important part which

* On the various Contrivances by which British and Foreign Orchids are fertilized by Insects London, 1862.

insects play in the fertilization of plants; and the old idea, that color and perfume in flowers were intended for man's especial pleasure, is giving way to the more natural and philosophic view that they are useful to the plants by attracting the needed insects.

In Dr. Asa Gray's recent little work, "How Plants Behave," etc., instances enough are given, in an admirably plain and lucid style, to show the manner in which many flowers are curiously and elaborately constructed so as *just not to do* of themselves what must necessarily be done for them in order to prevent degeneracy or extinction of the species. Some plants, as Fritz Müller proved, are so self-impotent that they never produce a single seed by aid of their own pollen, but must be fertilized by that of a distinct species, or even of a supposed distinct genus; while in some cases the pollen and stigma mutually act on each other in a deleterious manner.* The wind is an important agent in the fertilization of certain plants, and some are fertilized even by the higher animals; but by far the greater number are fertilized, or more strictly speaking, pollenized, by insects; while the number of species (termed *Entomophilæ* by Delpino) which absolutely depend for pollenation on insect agency is not inconsiderable. These insect pollenizers belong to several Orders, but mostly to the Hymenoptera and Lepidoptera. A familiar example is furnished by our milk-weeds (*Asclepias*), the pollen-masses of which may often be found adhering in pairs to the legs of bees and other insects, and sometimes in such quantities as to prove a real detriment and incumbrance to the bearers. Every year I receive specimens of such pollen-burdened bees, which are generally supposed to be infested with some parasite; and Mr. James D. Meador, of Independence, lately sent me a very gloomy account of the dangerous condition of his apiary from this cause. Each of the numerous flowers which constitute the well-known umbels is curiously constructed so that the pollen-masses, which look like little flattened, ovoid pieces of wax, can only come in contact with the stigma by artificial means; and we find that they hang by a bent stalk, attached to a flattened, ovoid, brown organ, having a cleft which catches the claws or tarsal hairs, or the fine hairs surrounding the trophi, of insects climbing over the umbels.

With most of the plants of this kind now known, fructification may be brought about by the aid of more than one species of insect; and none, perhaps, offer a more striking instance of dependence, or more curious floral mechanism to allure, than do the Orchids. They display an infinitude of curious contrivances and adjustments for the purpose. In the genus *Habenaria*, for instance, the peculiarities of which are described by Dr. Gray, we find flowers that, in some cases, strongly recall butterflies; a separate pocket for the nectar; the pollen bound together in masses by elastic threads, so as to lessen the

* See Darwin's "Animals and Plants," etc., II. p. 132.

chances of loss; and the base of the stamens forming flattened, sticky discs, placed in the best possible position for adhering to the head parts of a moth or butterfly endeavoring to reach the nectar. In all these features, and others that might be mentioned, there is remarkable adaptation; and the flowers of many species, as they unfold their petals, seem not only to invite, but to court and crave, the intervention of some scaly-winged marriage priest of "glorious color and glistening eye," who shall at once procure a suitor and perform the nuptials.

Yet here we have adaptation of the plant only, and, except in one or two rare instances, as, for instance, in that of a Madagascar Orchis (*Angræcum sesquipedale*), where the nectary is so deep that its nectar can only be reached by a moth with a very long tongue, our Orchids are not dependent for pollenation on any one Lepidopterous species, but may be aided by many which have tongues of sufficient length. Our Yuccas, on the contrary, seem to depend for assistance, so far as we now know, on the single little Tineid which I have described, and, for this reason, are among the most interesting of entomophilous plants. At least such is the case with the capsule-bearing species, i. e., those which have dry, dehiscent pods; and I will here premise that my observations have been made* upon a filamentose-leaved species in common cultivation about St. Louis, and which Dr. Engelmann takes to be *Y. puberula* or *Y. glauca*.

Dr. Engelmann has made some interesting observations on the fertilization of Yucca,† and to him I am indebted for drawing my attention to the fact that the plants of this genus must rely on some insect or other for fertilization. The sagittate anthers open a little earlier than does the perianth, and expel the pollen grains, which, being glutinous, remain attached in different sized lumps to the inside of the flower. The stigmatic tube contains nectar, and is connected with the ovarian cells, and the pollen must be introduced into the tube, but can not be so introduced without artificial aid.

There are several insects that frequent our Yuccas about flowering time. Some, doubtless, feast on the pollen, while others feed either by gnawing into the young fruit or pumping the juices there-

* The fructification of such *Yuccas* as bear fleshy, pulpy fruit, of which *Y. aloifolia* may be taken as the type, has not been studied; but, even with this last-mentioned species, the facts, so far as known, strongly indicate that *Pronuba* is principally if not solely instrumental in bringing it about. Its seeds are infested with our *Pronuba* larva, though not to the same extent as those of the dehiscent species. It would be premature to speculate until we have further facts; but it is not at all unlikely that the seeds of the fleshy pods are less congenial to the larvæ, and that a smaller percentage is produced from the eggs consigned to such pods by the moth. In addition to the *Pronuba* larva in the seeds, the fruit of *Y. aloifolia* nourishes a smaller, white, apodous larva, which is found in the pulp, sometimes in considerable numbers. It may be traced from slight depressions on the outside, and shows Hymenopterous affinities. It occasionally gnaws into the seed from the outside, but its legless character will at once distinguish it from the larva of *Pronuba*, which will be described further on.

† See Bulletin of Torrey Botanical Club, Vol. III, No. 7.

from;* but the only insect which I have found actively engaged in the pollenation is our little Tineid, which may be known in popular language as the Yucca Moth.

During the day-time, we may, by knowing what and where to seek, often find this moth, either singly or in pairs, resting with folded wings (Fig. 75, *b*) within the half-closed flowers. It is then not only hidden, but well protected by the imitative color of the front wings with that of the flower. If we visit the plants after

> " * * * * the garish day
> Has sped on his wheels of light away,"

and when, with full-blown perianths, the Yucca stands in all her queenly beauty, and sends forth her perfume more strongly upon the night air, we shall, with a little patience, meet with this same moth flitting swiftly from flower to flower and from plant to plant—the dusky nature of the hind wings and of the under surface of the front wings almost completely offsetting and neutralizing, when in motion, the upper silvery whiteness of the latter, and thus still rendering the insect a little difficult of detection. It is principally the male which we thus see flying, and, by aid of a "bull's eye," we shall find the female for the most part busily at work in the flowers. *He*, with stronger wing-power, can afford to pass in the most pleasurable way the few brief days allotted him; but *she* is charged with a double duty, and loses little time in its performance.

Before she can carry out the maternal task of continuing her race, she must act as foster-mother to the plant in order to insure a proper supply of food to her larvæ, which feed on its seeds. With her maxillary tentacle, so wonderfully modified for the purpose, she collects the pollen in large pellets, and holds it under the neck and against the front trochanters. In this manner she sometimes carries a mass thrice the size of her head (Fig 74, *a 1*). Thus laden, she clings to the top of the pistil, bends her head, thrusts her tongue into the stigmatic nectary, and brings the pollen-mass right over its mouth. In this position she works with a vigor that would indicate combined pleasure and purpose—moving her head and body from side to side, and apparently making every effort to force the pollen into the tube. Such is the method by which our Yuccas are fertilized.

*I have taken the following insects from the flowers: COLEOPTERA—*Anthonomus signatus* Say, whose larva I have known to feed on certain Aphidan Hickory galls—*Chauliognathus Pennsylvanicus* (DeGeer), and *C. marginatus* (Fabr.). Both these insects have the maxillæ peculiarly modified into slender, pilose, extensile setæ or feelers, which doubtless resemble in function the tongue of moths, and enable them to lap honey. I once thought these might have something to do with the pollenation of the plant, and possibly they do in a small degree; but I could never find them near the stigma, and their sole object seemed to be to feed upon the pollen, for which purpose their jaws are well suited. They are found on a variety of pollen-bearing plants, such as *Spiræa*, *Rubus*, *Solidago*, etc., while as larvæ they are carnivorous—the first named being one of the principal enemies of those notorious fruit depredators, *Conotrachelus nenuphar* (Herbst) and *Carpocapsa pomonella* (Linn.)—*Euryomia melancholica* Gor. & Perch, a chafer very fond of eating into the flowers and fruit of a variety of plants. HETEROPTERA—*Lygus robiniæ* Uhler—*Ortholylus discoidalis* Uhler—*Cyllocoris scutellatus* Uhler—*Theognis phyllopus* Uhler (=*albicinctus* Say). The last is notably found on Yuccas, but the others more commonly on other plants, and they all derive nourishment by puncturing and sucking—their punctures causing little rusty specks on the fruit.

The foregoing account of the insect's habits is founded on repeated observation; but we now come to that portion of its career to which I more especially wish to call attention, and which must be considered hypothetical until confirmed by future investigation. Yet I feel as certain of the correctness of my conclusions as though they had been demonstrated.

For want of sufficient time, I have been unable to catch the moth in the act of oviposition; but from careful examination, I am satisfied that the eggs are not deposited on the outside of the fruit. They are either thrust into it from the side or from the stigmatic opening, following, most probably, the course of the pollen tubes. I strongly incline to the latter view, for, though many Lepidoptera are furnished with extensile ovipositors, which enable them to thrust their eggs into crevices and other orifices, I know of none which actually puncture. Nor have I been able to discover any trace of punctures leading to eggs.

Neither have I been able to discover the egg *in situ;* which is not to be wondered at, however, as when examined in the female abdomen it is found to be long, narrow, soft and flexible, and of the exact color of the flesh of the young fruit. The ovipositor is so very fine and extensile that it may be thrust into the most minute and narrow passage.

If, a day or two after the flowers have withered, (between June 15 and July 5 in the latitude of St. Louis with the species mentioned), we carefully dissect the young fruit, we shall often find it to contain from one to a half dozen, but more generally two, young larvæ. They are always found within the nascent seed, and their bodies are, at this time, so much of a color and consistence with the surrounding pabulum, that we could hardly detect them but for the comparatively large, dark jaws. The larva retains its white color till after the last molt, when it acquires the carneous tint so common, at that age, to fruit-boring moth larvæ. It is then characterized as follows:

Description of Larva.—Average length 0.55 inch. Broadest on thoracic joints, thence gradually decreasing to extremity, which is quite small. (Fig. 75, *a*). Color carneous, with a paler greenish tint below. No piliferous spots, but a few very minute and short stiff hairs springing from the ordinary positions of such spots. A transverse dorsal wrinkle, on each of the principal joints, more or less distinctly divided in two by a medio-dorsal depression, which is sometimes slightly bluish. Joints deeply incised and with a lateral, substigmatal, longitudinal wrinkle. (Fig. 75, *d*). Thoracic legs stout, but short, with three joints and a claw. *No prolegs.* Stigmata (9 pair) forming a small rufous circle on anterior portion of joints 1 and 4–11. *Head* (Fig. 75, *e*, *f*, *h*, *i*, *j*, *k*) partially retractile, copal-colored; epistoma sharply defined; labrum slightly pilose; mandibles stout, rounded, and with four acute teeth, each diminishing in size from without; maxillæ with the inner lobe rounded and furnished with (usually 2) short fleshy hairs, the palpi 4-jointed, the terminal joint with bristles; labium prominent, with the spinneret conspicuous and the palpi 2-jointed—the first joint long, with a fleshy hair at tip, the second small, spherical, and also terminating in a fleshy hair;

antennæ 2-jointed, the terminal joint with a bristle; ocelli pale, around a dark crescent. Cervical shield flattened and not well defined.

White when young. Mostly curved in the fruit like the larvæ of *Curculionidæ*. Described from many specimens.

Two larvæ are seldom found in the same seed-row, and each one, on attaining full growth, consumes only the inside of from fifteen to twenty seeds. Each pod contains, on an average, upward of two hundred of these seeds, disposed in six rows, and might consequently sustain a dozen larvæ; so that when, as is usually the case, there are not more than two such larvæ to a pod, an abundance of perfect seed remains to perpetuate the plant. Yet sometimes every seed will be destroyed, especially in the species with smaller capsules.

It is quite possible that the moth may, at times, introduce the pollen into the stigmatic tube without consigning any of her eggs to the fruit, and we should naturally expect to find some capsules uninfested with her larvæ. But I have this year examined hundreds of capsules around St. Louis, and some in South Illinois, and not more than four or five per cent. were uninfested. Sometimes every pod on the same plant had its worms, while at others half the pods on a given panicle would be free of them. From the very large per centage of infested pods, I conclude that oviposition naturally and immediately follows fertilization, unless the moth be disturbed.

When mature, the larva bores a hole through the capsule, drops by a web to the ground, burrows a few inches below the surface, and constructs an oval cocoon of earth, lined on the inside with silk. Here it doubtless rests in the larva state through the fall, winter and spring months, and completes its transformations about the time the Yuccas begin to bloom; for it is a very general rule with Tineidæ that when they hibernate in the preparatory state, it is as larvæ—the term of the chrysalis state being brief.

The only natural enemies of the larva that I yet know of are ants. These omnivorous creatures often get into the capsule and devour the worm when it is about to leave, and its burrow may frequently be found crowded with them.

Though another year must roll around before the latter part of our Pronuba's history, as here given, can be positively substantiated, let me hope that the next blooming-season of our Yuccas will find other eyes than my own watching her ways and methods.

We have in this little moth a remarkable adaptation of means to an end. There is between it and its food-plant a mutual interdependence which at once excites our wonder, and is fraught with interesting suggestions to those who are in the habit of reasoning from effect to cause. Whether we believe, as I certainly do, that this perfect adaptation and adjustment have been brought about by slow degrees through the long course of ages, or whether we believe that they always were so from the beginning, they are equally suggestive of that same law and harmony so manifest throughout the realm of Nature.

The peculiar structure of the flower which prevents self-fertilization, though on a superficial view it strikes one as a disadvantage, is in reality a great benefit; while the maxillary tentacle of the female moth is very plainly an advantage to her species in the "struggle for life;" and it is quite easy to conceive, on Darwinian grounds, how both these characters may gradually have been produced in the course of time from archetypal forms which possessed neither. These peculiarities are, moreover, mutually and reciprocally beneficial, so that the plant and the animal are each influenced and modified by the other, and the same laws which produced the beneficial specialization of parts would maintain them by the elimination of all forms tending to depart from them.

It may be that the glutinous nature of the pollen renders consectaneous its accumulation by the spinous maxillary tentacles of the female moth; and that, when she is sipping nectar, the vigorous working of head and body from side to side is simply an effort to get rid of an incumbrance. It may be that all her actions are the result merely of "blind instinct," by which term proud man has been wont to designate the doings of inferior animals; but for my part, I have not been able to watch her operations without feeling that there is in all of them as much of purpose as there is in those of the female *Pelopœus*, who so assiduously collects, paralyzes, and stores away in her mud-dabs, the spiders which are to nourish her young; or in the many other curious provisions which insects make for their progeny, which, in the majority of instances, they are destined never to behold. Nor can I see any good reason for denying these lowly creatures a degree of consciousness of what they are about, or even of what will result from their labors. They have an object in view, and whether we attribute their performances to reason or instinct depends altogether upon the meaning we give to these words. Define instinct as "congenital habit," or "inherited association," and most of the doings of the lower animals may be very justly called instinctive. But I can not help thinking that the instinctive and reasoning faculties are both present, in most animals, in varying proportion, the last being called into play more especially by unusual and exceptional circumstances; and that the power which guides the ♀ *Pronuba* in her actions differs only in degree from that which directs a bird in building its nest, or which governs many of the actions of rational man.

I will conclude by referring to one practical phase of this subject. As the insect and its food-plant are inseparable under natural conditions, the former doubtless occurs wherever the latter grows wild. Pods of *Y. angustifolia* which I gathered on the Black Hills of Colorada, in 1867, all show the unmistakable holes of egress of the larvæ; while those of *Y. rupicola* from Texas, of *Y. Whipplei* from California, and of others from South Carolina and Texas, now in the herbarium of Dr. Engelmann, all show this infallible sign of having been

infested. Through the courtesy of the same gentleman, I have also received the moth, taken around Yuccas, from South Carolina, and the pods of several species from the same State and from Texas, while the larvæ were yet working in them. There is every reason to believe, however, that beyond the native home of these plants the insect does not occur, except where it has naturally spread or been artificially introduced; and it is an interesting fact that, so far as I am able to learn, the dehiscent species in the northern parts of this country and in Europe never produce seed.

The cocoons containing the dormant larvæ can be very conveniently sent by mail from one part of the world to another, and by their aid our transatlantic florists may yet have the satisfaction of getting seed from their Yuccas without any personal effort.

[I have been led to reproduce this article from the Academy Transactions: first, because I wish to lay the facts before the reader; secondly, because I fear that, through unavoidable delay in the publication of said Transactions, it would otherwise not be given to the public in time to lead to relevant observations in other parts of the country the coming summer. I have given but an inkling of the interest attaching to the subject, and made but a commencement in the record of facts.

From an abstract of the paper, made at the Dubuque meeting of the American Association for the Advancement of Science last August, the leading thoughts have been published in several periodicals both of this country and Europe, and have elicited the following facts:

J. W. B., of Flushing, L. I., says: "In my own garden, the *Y. filamentosa*, Gray, blooms and matures its seed annually. I have never been able to discover the intervention of any insect to assist fertilization, nor have I ever failed to secure the prompt germination of seed taken from any well-matured capsule."—[*Bulletin Torrey Bot. Club, Aug.* 1872.

It does not strike me as strange that J. W. B. should have failed to observe the moth, when it had hitherto escaped the notice of both botanists and entomologists. As, however, after more carefully examining his capsules, he subsequently found the perforations of the larvæ, (*ibid*, Nov., 1872), he will no doubt find the moth next year by properly seeking it.

Three large plants of the Adam's-needle, or Beargrass, (*Yucca filamentosa*), in our garden near New York, produced fine clusters of capsules this autumn; upon examining them we found that apparently every seed-vessel either contained an insect, or had a hole showing where one had escaped. The capsule of this Yucca consists of three cells, and generally but one of them was inhabited by the larva,

which destroyed the seeds in that, while the contents of the other two cells were untouched. All the capsules were one-sided or contorted, owing to the presence of the caterpillar. * * * A very observing friend who made extensive experiments with seedling Yuccas, in the hope of obtaining some new varieties, is quite sure that he has obtained crops of seed without any of the distortion of the capsule to which we have referred. * * * During a recent visit to Georgia, we found *Yucca gloriosa* in fruit. The fruit of *Y. filamentosa* is a dry capsule, while that of *Y. gloriosa* is pulpy, and when quite ripe is as soft as a banana. We examined a number of fruits of *Y. gloriosa*, and failed to find any distortion, perforation, or other indication that an insect had entered or made its exit.—*American Agriculturist*, Dec., 1872.

Yuccas Seedling.—I think there must be an error in regard to Yuccas not producing seed in Europe, owing to the non-attendance of the fertilizing insects. I remember, while at Dulwich, in the summer of 1868, some plants of *Y. filamentosa* produced a good crop of seeds, which germinated freely, and gave us a nice lot of plants, which seems to indicate either that the little moth is in the country, or that at least during warm summers the plants can manage very well without it. I dare say the Messrs. Smith could confirm the above statement.—T. Smith, Newry, in *Gardeners' Chronicle*, (London), Oct. 19, 1872, No. 42, p. 1390.

These extracts prove that the Yucca moth occurs on Long Island, and around New York, and indicate that other insects occasionally pollenize the flowers. The experience of Mr. Smith, in England, is as interesting as it is exceptional; but until we learn whether or not the work of the larva was manifest, no safe conclusions can be drawn. Other insects may have been the pollenizers, or *Pronuba* may have been locally introduced with seed from America. This last view may not appear very plausible, but if both sexes of the insect were, by some chance, introduced into a locality where Yuccas of blooming age were growing, there is no reason why they should not multiply; and such chance introduction is not impossible, since the larva not unfrequently remains in the capsule after the seed is ripe, where it fastens a number of the riddled seeds together into a sort of cocoon, which might easily pass unnoticed in gathering seed; and, if buried in the ground with such seed, would in time give forth the moth.

As bearing on the subject of the insect's range, I will add that I have since examined the wild *Y. angustifolia* around Manhattan, Kansas, and always found traces of *Pronuba*; but that of seventy plants, including several species in the garden of Meade Woodson, of Kansas City—a gentleman who is a great admirer of the genus—not one has yet produced seed. Mr. Edgar Sanders, of Chicago, tells me that plants of *Y. flaccida* do not there produce seed. Mr. Henry Wheatland, of Salem, Massachusetts, says that *Y. filamentosa* never produces seed there; and I learn from Professor Gray that it is equally barren at Cambridge. We have seen how irregularly some insects develop, and how this irregularity (*ante p.* 132) becomes excessive when the

species may be benefited thereby. Now the blooming season of our Yuccas is comparatively brief, and it is quite evident that those *Pronubas*, which do not issue within the appropriate time, must perish without leaving progeny. We might, therefore, expect to find the habit of issuing at the proper season, inherited through no one knows how many generations, very strongly fixed and difficult to break up; and such is the case to a remarkable extent. Some insects I have had no difficulty in forcing or causing to give out the imago prematurely, by submitting them to artificial conditions of heat and moisture. Not so with *Pronuba!* for, while I was quite anxious to breed a few to the chrysalis state before publishing this Report, and, for that purpose, kept a number at a mean temperature of about 80° all through the winter, every one of them is, at this writing, (April 10th), yet in the larva state.

Thus my inference, that it hibernates as larva, proves correct, and we may likewise infer that the chrysalis will be furnished with teeth or spines, by aid of which to work itself to the surface of its earthy shroud.

The following extract from a letter by Mr. H. T. Stainton, of England, and dated September 25th, 1872, will prove valuable as the opinion of our greatest micro-lepidopterist: "The *Pronuba yuccasella* is a most curious insect. The bare, horny hinder segments of the female remind me of some of the females of the genus of Long-horns *Nemotois*, such as *scabrosellus*, which lays its eggs at the bottoms of scabrous flowers, where a thickly scaled abdomen would be ill-suited to its purpose. The remarkably bull-headed appearance of your *yuccasella* is very striking, and the more I look at the creature the more puzzled I seem as to its affinities. We have no European genus at all analogous."]

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ERRATA.

Page 8, in the explanation of figure 1, first line, for "and" read "the."
Page 33, in figure 15, for "cloroform" read "chloroform."
Page 50, line 4, add a period after "Cress"
Page 100, last line, strike out comma before "Say."
Page 103, line 9, for "*Caryæ*" read "*caryæ*."

Missouri. State Entomologist

Report on the noxious, beneficial, and other insects of the State of Missouri