3-1891

Injurious Insects

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SOUTH DAKOTA

AGRICULTURAL COLLEGE

AND

EXPERIMENT STATION

BROOKINGS, S. D.

Bulletin No. 22.

MARCH, 1891.

DEPARTMENT OF ENTOMOLOGY.

INJURIOUS INSECTS.

PRESS PRINT, BROOKINGS.

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Introduction.

I. H. ORCUTT, ENTOMOLOGIST. J. M. ALDRICH, ASSISTANT.

In the following pages the life history of several of our most injurious insects is explained, and the best remedies at present known are mentioned. It is hoped that by the aid of the illustrations all the species treated of can be readily recognized. A careful perusal of the article on insecticides ought to suggest practical ways of treating many insects which are not specifically mentioned in the Bulletin. In nearly all cases, our suggestions as to remedies are based on our own experiments and observations.

An extensive correspondence with the farmers of the State convinces us that the life histories of these insects, however well known to working entomologists, must be restated in order to make this Bulletin understood. In this restatement, we can lay no claim to originality, as we draw from a fund which has in most cases long been the common property of close observers. In the discussion of parasites and remedies, a number of points will be found which have not hitherto been published.

We are under obligations to Professor Lawrence Bruner, of the Nebraska Experiment Station, for the use of a number of electrotypes. We acknowledge with pleasure the assistance of many farmers. Their letters have been of value by suggesting remedies, giving notes on the occurrence of certain insects, and in other ways. The replies to the cut-worm circular, several hundred in number, have enabled us to give a much more authoritative treatment to the difficult and complicated cut-worm question.

The recent revision of our Station mailing list has been on a scale so extensive that only a small fraction of those who will receive this Bulletin have had either of our earlier ones. For this reason some portions of them are here reproduced.

It has been decided to page all the Bulletins of the Station consecutively and issue an index at the end of the year. It will therefore be impossible to page the Entomological Bulletins consecutively, as promised in No. 13.

THE ASH BORER.

(*Aegeria fraxini* Lugger.)

This insect has been very injurious to the ash trees in this city, including those on the College grounds. It is reported from other places near here. An examination of a grove of ash in Grant county showed that it is plentiful there. Mr. A. A. Powers states that it is found in Turner county. As it is quite different in appearance and habits from most of our injurious insects, it probably occurs in many localities where its presence is not noticed.

It strongiy resembles the common wasp which builds its little paper nests in the gables of houses. In spite of this fact, it belongs to an entirely different order of insects. It is a moth.

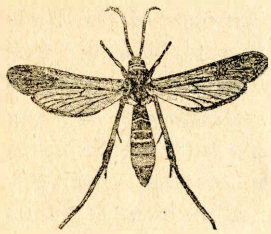

FIGURE 1.
The Ash Borer (*Aegeria fraxini* Lugger) Natural size. [Original.]

Figure 1 gives a good idea of the female. The male is smaller, but not otherwise very much different. The general color is yellow and black with intermediate shades. The front wings are brown, the back ones transparent. Both are fringed along the outer edge with fine, brown hair. The veins of the hind wings possess a few scales. Across the neck is a distinct collar of reddish scales, and just behind it another of yellow ones.

The eggs are very minute and of a brown color. The larva is a whitish worm, nearly cylindrical, about seven-eighths of an inch long when full grown.

This insect appears in the mature form from the last days of May to the tenth of July. Eggs are usually laid in cracks or wounds in the ash trees and especially in the holes from which the mature borers have lately emerged. The little insect, on hatching, bores through the bark and makes irregular paths for a time, apparently not being able to bore in solid wood at first. In branches or stems not over three-fourths of an inch through, it passes to the center. In larger timber it bores lengthwise at a variable distance from the surface. In this hole the insect grows till cold weather comes, when it lies dormant until the next spring. In May or June it becomes full grown, and it then re-

sorts to a peculiar method of providing for the exit of the future moth. As the latter cannot bore in wood, the larva curves its hole to a horzonital and continues it till it reaches the bark, which is removed until only a very thin scale remains to cover the hole within. The larva now retires to the vertical portion of its chamber, spins a thin cocoon and changes to the pupa state. This lasts only a few days, when the moth is ready to emerge. But for the moth to crawl unprotected to the mouth of the hole and burst through the outer scale of bark would surely result in scraping off a large share of the delicate scales with which it is clothed. To avoid this, the pupa skin is provided along the back of the abdomen with transverse rows of minute, stiff spurs, directed backward, so that when the pupa wriggles, it is gradually thrust forward. Leaving its cocoon it works its way out until about half its body projects from the mouth of the hole, the broken scale of bark helping to hold it in this position. Then the pupa case splits open along the back and the beautiful moth, so carefully protected hitherto, steps out, leaving the brown skin protruding from the hole.

In Brookings a number of trees, three to five inches in diameter, were so badly bored near the ground that they broke off at the injured spot in the hard winds of last summer, the broken part showing a perfect net-work of holes, leaving only a little sound wood. Many trees that were affected made little growth last summer, although they were able to stand against the winds.

The name of this species was determined for us by Dr. Lugger, of the Minnesota Station, who described it from specimens obtained there. He states that a related species (*Sciapteron syringæ* Harr), has long been injurious to the ash trees at Washington, D. C. Our own species, or another very much like it, is reported from Nebraska, and Professor Osborn, of the Iowa Station, has long known *Aegeria syringæ*, a similar insect, to be injurious to ash there.

REMEDIES AND PREVENTIVE MEASURES.—Direct remedies can with difficulty be applied to this insect. In fact, on a large scale, they are quite impracticable. Where one has only a few ash trees, conveniently located for observation, something can be done by watching carefully about the irregularities in the bark for the small quantity of "sawdust" which indicates

that the little insect has begun its work. This will be in June or July. At this time an exploration with a sharp jack-knife will probably reveal the intruder under the bark. It is better for the tree to make the incision necessary to kill the borer, than to let the latter continue its work. As before mentioned, the full grown larva bores its way almost to the surface, leaving only a thin scale of bark before it retires to enter the pupa stage. This thin scale is easily seen on examination of the tree, as it is lighter colored than the surrounding bark. It appears as a round disk, about a quarter of an inch in diameter. It is broken in by a slight pressure of the finger, revealing the hole, which curves downward and contains the pupa, enclosed in its thin cocoon, not much over an inch from the surface. A bent wire may be introduced into the hole and the pupa crushed. We have killed eight or ten in a single tree by this process. Of course it is only preventive, the hole being already completed; but on street trees and others which can receive an occasional examination it should never be neglected.

Dr. Lugger, in a letter referring to this insect, says: "Knowing the time when the moth is depositing eggs, the trunks of the trees should be thoroughly greased with a combination of soap, plaster, and a little Paris green. This would partly prevent the female from choosing such trees for oviposition, and the young from eggs laid notwithstanding would be killed while entering the bark by the poison. The holes of exit should be filled with the same material, as they seem to have a special attraction for the laying female."

The compound to be applied to the trees may be varied somewhat to suit the convenience, not omitting the Paris green, however. The object is to get something which will remain on the trees a long time, besides filling the cracks and making the whole surface repulsive to the moth. Very likely common coal tar would make a good ingredient. The application should be made June first or but little later, and the holes which are opened thereafter by the moths maturing must be looked for occasionally and filled. The egg-laying period for the whole brood lasts until at least the middle of July, so the protection must be kept up until then. This will not require much work after the

first application. Only the trunks need be treated, as the moths seldom attack branches.

No doubt a still better way, which would take no more time or money, would be to protect the trunks with cloth. Take a piece of cheap cotton cloth, long enough to reach from the earth at the base to the first branches, and wide enough to go around the tree and lap over two inches. Dip this cloth in a mixture of Paris green or London purple in water, of sufficient strength to give the cloth a perceptible tinge of green or purple. Then wrap it about the trunk of the tree, lap the edges together snugly and wind a string spirally from bottom to top, tying it securely *close* to the ground and at the top. This cloth serves two purposes: First, it effectually prevents the moths inside from getting out, thereby destroying them before they lay; and, second, it acts as a protection from the mature insects reared in other trees. It should be put on before June first, and may be removed any time after the middle of July.

If this method of preserving trees be thought too troublesome and expensive, compare it at the most liberal estimate for time and material, with the cost of the tree needing protection. Of course such measures need not be taken in localities where the borers do not occur. In such places as Brookings, however, where we face the prospect of having no ash trees left in two or three years, this remedy ought to be thoroughly applied.

It is worthy of note that the injuries by this insect are inflicted almost always on transplanted trees. This is to be accounted for by the fact that in transplanting the ash receives a serious set-back to its growth. At the same time bruises and close pruning leave places exactly suited for the attack of the borer. The conditions are then right for the greatest amount of injury.

THE CECROPIA EMPEROR-MOTH.

This large moth, represented in figure 2, is common nearly all over the State, although it is seldom seen, owing to its noc-

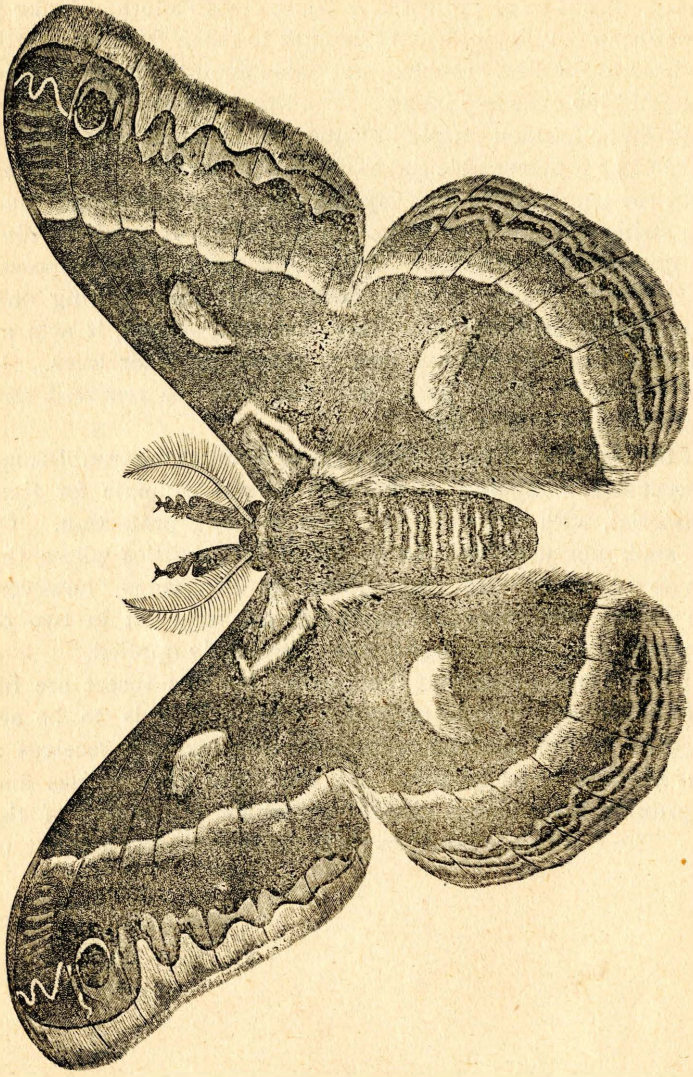

FIGURE 2.

The Cecropia Emperor-Moth (*Platysamia cecropia*, Linn). Male. Natural size. [After Riley.]

turnal habits. It makes its appearance about the first of June, frequently a little later, and lays a large number of eggs at night

on the leaves of trees, usually from three to five in a place. It prefers the box-elder, but also lays on the soft maple, willow, cottonwood, plum, apple, and some other trees. These eggs are less than a tenth of an inch in diameter, slightly oval, white, sometimes with a reddish tinge on one side. They hatch in about a week. The little larva is perfectly black at first, changing after a few days to a deep orange, then to yellowish green, and as it becomes larger, assuming the well known pea-green tint. The tubercles (knobs) on the body also change in color as the larva develops. At first they are all black, but they finally become blue, except the four on the back next the head, which are red or yellow. The full grown larva (Figure 3) spins a tough, silken cocoon of a grayish color, pointed at each end, attaching it tightly to the limb of the tree, or occasionally to other objects. Not very long after this is completed it changes to the pupa state, when it is simply a compact, reddish brown body with no power of motion except in the posterior part. The larvae are very injurious to the trees on which they live, often defoliating them. The mature insects do no direct damage.

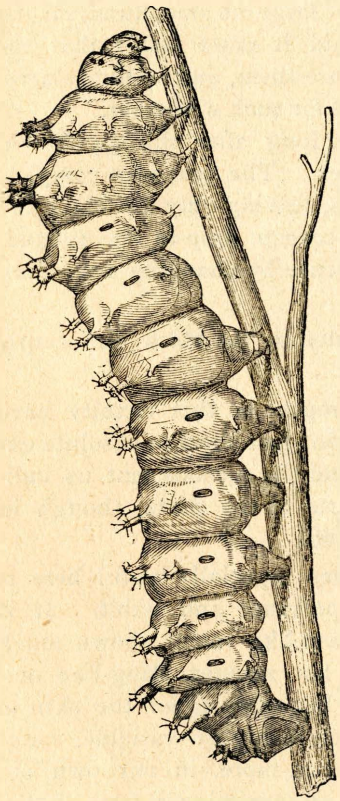

FIGURE 3.

Full grown larva of the Ceropia. Natural size. [After Riley.]

NATURAL REMEDIES. — Of these there is a goodly number. Our chief dependence in this region is upon two. One of them is a Tachina-fly (similar to Figure 4), resembling the common house fly. This insect lays its small white eggs on the back of the nearly mature worm, fastening them there by a sort of glue so

that they cannot easily be removed. These eggs soon hatch, the tiny maggot passing through the under side of the shell and the skin of the host, leaving the shell undisturbed. The only external sign of hatching is that a black mark extends from the shell down through the semi-transparent skin of the host, showing the path of the parasite.

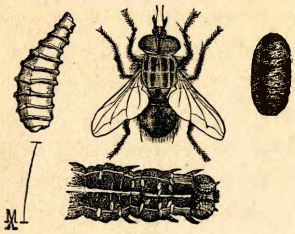

FIGURE 4.
The Army-worm, Tachina Fly. Larva on left; pupa on right. [After Riley.]

The number of eggs laid on a single host is very large, often above forty, and observed by us to be sometimes as large as one hundred and twenty. But where so many are laid it must result that the larvae have not enough food to mature them, and so they starve. A single host could not provide food for such a number.

The Cecropia larva does not live long after the eggs hatch. It spins a thin cocoon and then dies. The parasites complete their work by devouring the remains, leaving only the black and shriveled skin; when they leave the cocoon, drop to the ground, and complete the cycle of their existence by changing into flies, coming out the next season.

Their work can always be detected by the black and empty skin left in the cocoon.

For the last two years the Cecropias in this vicinity have been destroyed by this insect to a point just short of absolute extermination. Our correspondence and the cocoons sent us indicate that it also occurs in other parts of the State, though in many localities it has not yet appeared.

The other parasite which has been especially useful here is quite a different insect, both in appearance and habit. It is *Cryptus nuncius*, Say, a slender, wasp-like insect shown much enlarged in Figure 5. By means of her slender, sting-like ovipositor, (egg layer) the female lays her eggs under the skin of the host. The number placed in each is highly variable, ranging from a single one to two hundred or more, in our own observation. These eggs do not prove so immediately fatal to the host as those of the Tachina. The worm always completes its cocoon in the ordinary way, but goes no farther. If the cocoon

is opened a little later, instead of the pupa of the moth, a compact mass of little white cocoons is found containing the larvae of the parasite. (Fig. 6) The next year these larvae mature.

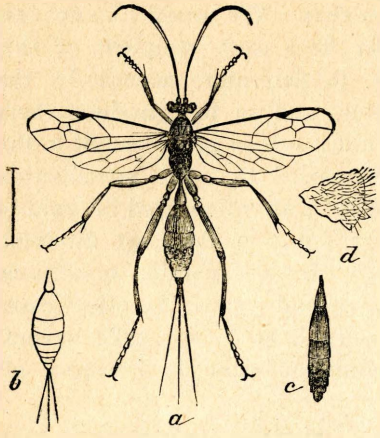

FIGURE 5.
Cryptus nuncius Say. Female. Enlarged [After Riley.]

Before the advent of the Tachina-fly, this parasite was very beneficial in the eastern section of the State, holding the Cecropia well in check in many localities. Around Brookings it has of late been almost entirely superseded by the Tachina. The cocoons sent us indicate that it is found in some other parts of the state. Singular as it may seem, this parasite is itself preyed upon at times by another—a very minute, four-winged insect of the genus Pteromalus, the species being as yet undetermined. This little insect cannot be regarded as a parasite upon Cryptus exclusively, as its period of development is very much shorter, there being several broods in a season, while of Cryptus there is but one. Part of the broods of Pteromalus therefore must be developed on other hosts. The effect of this upon their increase is doubtless unfavorable, but so little is as yet known of the matter that further speculation is useless. They are injurious insects, because they deprive us of the beneficial Cryptus.

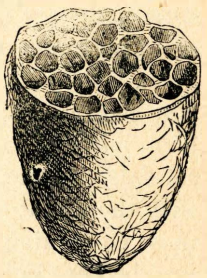

FIGURE 6.
Cross section of Cecropia Cocoon, showing Cryptus cocoons inside. [After Riley.]

The habit which the Cryptus has of wintering in the Cecropia cocoons makes it an easy matter to introduce it into new localities. Last year with this object in view, we requested farmers to send us samples of the Cecropia cocoons. When those sent from any locality contained no parasites, we mailed to that place a few cocoons full of Cryptus. In this way we introduced the insect into several places. The response to our request for cocoons was so limited

that we were unable to do as much good as we desired. Therefore the invitation is repeated this year. We would like not less than a dozen cocoons of Cecropia from each recipient of this Bulletin. This will enable us to determine accurately the regions where there are no parasites, and so to introduce them where needed—a work which would result in great benefit to the tree growers. It should not be supposed that the introduction will bring relief so soon that no farther attention need be paid to the worms. On the contrary, it will not in the least diminish the number of worms the first year. Under favorable conditions it will make a great difference the second year. In other cases the benefit may be even longer deferred, as it may take several years for the Cryptus to become numerous enough to destroy all the worms.

Cocoons should be sent by mail as early as May tenth, in a tin or wooden box, bearing the name and address of the sender as well as ours. The postage will be but little, and if we send parasites it will be at no expense to the recipient, who will have only to place the cocoons which we send in a place protected from rain and among his infested trees, of course leaving room for the exit of the parasites when they hatch. We offer to send these only to those who do not already have them, as shown by the cocoons they send. (See article on the Large Willow Sawfly.)

Artificial Remedies.—As the cocoons of these insects are conspicuous objects on the trees for half of the year, it does not seem necessary to enter into any lengthy discussion regarding the destruction of the worms. If the cocoons are collected in a given locality there will be no worms there the following season. The cocoons may be torn down from high trees by means of a hook fastened to a pole. By opening a number of cocoons and carefully comparing the weight of those containing healthy pupae with those that do not, it is not difficult to assort them. *Only* those containing healthy pupae should be destroyed. Cocoons may be kept in boxes, with half inch holes bored in them. The holes will not allow mice to enter but will allow small insects to escape. If the cocoons have not been assorted, moths will appear about June first. They may be taken out and destroyed. The parasites will not appear until some weeks later.

By this treatment, the relative number of parasites will be greatly increased, and they will be able to almost annihilate the Cecropia.

After the worms appear in the summer they may be picked off and destroyed. One man writes that he cut 12,000 in two with shears in one season. Another takes a light switch and gives each worm a single sharp cut with it. Two or three drops of kerosene on the back will kill the worm. A can with a very fine nozzle, attached to a long pole at an angle, may be used to reach the worms in high trees. Care should be taken not to use too much kerosene, as it kills the leaves.

SPHINX MOTHS.

The larvae of these moths are easily distinguished by having a horn at the posterior end of the body as shown by the figure. This is a characteristic of all the injurious species of this region. Figure 7 illustrates a species found farther south, but serves

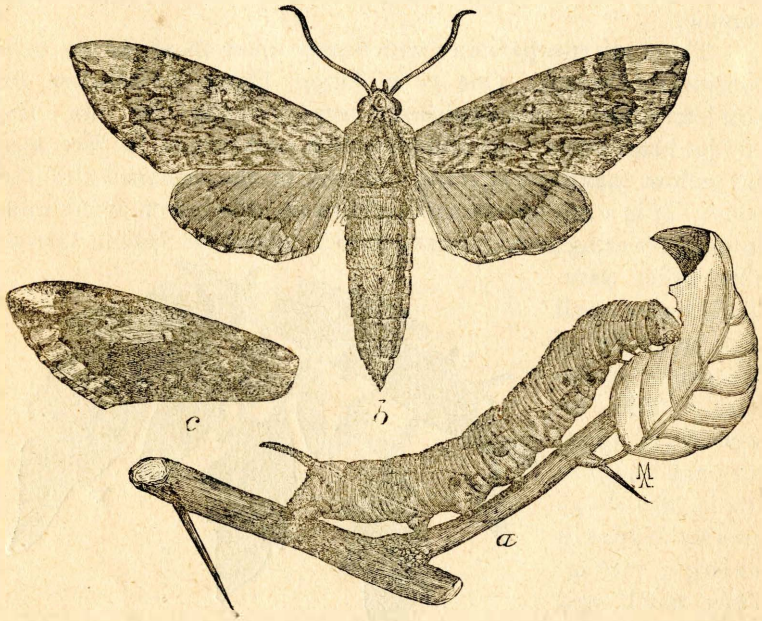

FIGURE 7.

The Osage Orange Sphinx (*Ceratomia hageni*). A, larva; b, moth; c, wing of a darker variety. Natural size. [After Riley.]

almost equally well for some of our own. About ten species of

this group are injurious to trees here. They are confined mainly to the ash, plum, elm and cottonwood.

The life history of all these species is so much alike that a single statement will answer for all. In June the moths lay their eggs at night, on their favorite variety of tree. They lay a few in a place so that each tree will have leaves enough to mature all the worms, unless by chance it is visited by several moths, which often happens. These eggs hatch in a short time and the larvae, during their growing period, which lasts over a month, do not differ materially in habits from the Cecropia, previously described. When full grown they do not spin cocoons but descend the tree to the ground, and burrow therein to a depth of two or three inches. Here each constructs for itself a little oval chamber by moving from side to side, and thus pressing back the earth. This being done, the insect sheds its skin and passes into the pupa stage, which lasts until the following summer.

There are two parasites which prey upon these worms to a considerable extent. One is a large black Ichneumon fly (Undetermined), distinguished very readily by its size and jet black color. Its antennæ, face, and part of its fore legs are yellow, making a striking contrast to the remainder of the body. It is a not uncommon sight to see this insect about midsummer hovering among the ash trees in search of Sphinx larvae. The other parasite is a very small Ichneumon fly of the genus Apanteles. This insect, like the Cryptus parasite of Cecropia, lays a large number of eggs in a single worm. They hatch and mature very rapidly, without killing the host. When full grown the little parasites pass out through the skin of

FIGURE 8.
Larva of Tomato Sphinx with cocoons of *Apantetes congregatus* attached. [After Weed.]

the worm and spin thin cocoons, attaching them firmly to the back of the host, which has been growing gradually more feeble and sickly, and dies soon after this stage. Figure 8 shows the cluster of cocoons on the back of the tomato sphinx. With us these little parasites occur on the plum sphinx.

It does not appear that either of the above parasites is likely to exterminate its host, though it gives some assistance. Artificial remedies, then, must be resorted to. Of these hand-picking is by far the easist and simplest, if only a few trees are to be protected. On a large scale, it might be found cheaper to spray with arsenites, for which see article on Insecticides.

THE LARGE WILLOW SAW-FLY.

This insect (*Cimbex americana* Leach) has usually been called the Elm Saw-fly. As it has not been observed to attack the elm in this locality, while it has been very injurious to willow, it seems desirable to refer to it by the name which heads this article.

It has proved to be one of the most injurious insects in the state the past year. Scarcely a willow in the vicinity of Brookings but was completely defoliated by its larvae. The accompanying figure (No. 9) gives a good idea of the appearance of the insect in its various stages of development. When mature, it resembles a large hornet, but is not so slender and of darker color. The sexes can be readily distingnished by the fact that the female has several white spots on each side of the upper surface of the abdomen, while in the male the abdomen is of nearly uniform color, though varying in different individuals from reddish brown to black. The larvae usually cling to the under side of the leaves, coiling themselves up somewhat in the form of a snail shell. Even when crawling from place to place, the body often retains this curve, at least near the end. Along the sides of the body the larva has several pores from which it is able, when disturbed, to eject a watery fluid, sometimes to a distance of a foot or more.

The mature insects make their appearance when the willow leaves have fairly unfolded in the spring. They are sluggish and clumsy, and are found upon or close to the willows. They are provided with very powerful jaws for cutting slits

in the bark, and with long tongues for lapping up the sap. One jaw is forced into the bark, the other is securely fastened a little to one side, when, with a powerful effort, the first jaw is drawn through bark toward the second. This operation may be repeated until the branch

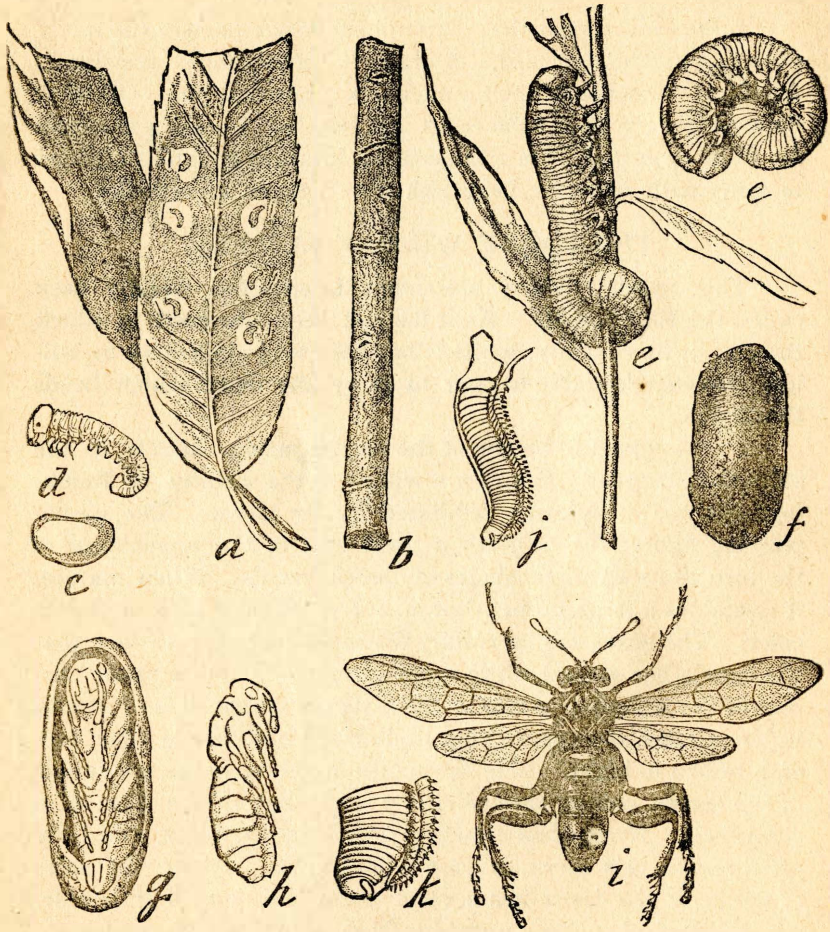

FIGURE 9.

The Large Willow Saw-fly (*Cimbex americana* Leach). A, willow leaves showing egg-blisters from above and below; b, twig showing girdlings; c, egg; d, newly hatched larva; e, e, full grown larvae; f, cocoon; g, cocoon cut open, showing pupa; h, pupa out of cocoon, side view; i, male fly; j, saw of female, side view; k, tip of same; c, d, j, k, enlarged, the rest natural size. [After Riley.]

is completely girdled. The sap is carefully lapped up as the operation progresses, and if the branch does not die the scars may be seen years afterward.

The male insects usually appear a few days before the females. The latter, soon after they emerge, begin the work of depositing their eggs. Their peculiar manner of doing this has given them the name of saw-flies. In place of a sting, each is provided with a fine, double-bladed saw. She takes her position on the edge of a leaf, the end of the abdomen is lowered till it touches the leaf on the under side near the margin, when the saw is protruded, and by a complicated series of movements a slit is cut in the epidermis. The ovipositor is inserted into this slit, and by a number of forward and backward movements the epidermis is loosened over a more or less circular area about three-sixteenths of an inch in diameter. The egg is passed down between the blades of the saw into the cavity thus prepared for it. The ovipositor is then withdrawn, and the outlet of the cavity carefully closed by pressing the epidermis back against the leaf. Sometimes six or eight eggs are placed on the same leaf. The young bluish-green larva soon emerges from the egg and remains for sometime within the cell or "blister," but finally leaves it through an irregular slit near the middle. It then begins to feed on the leaves. It does not attain its full size until the latter part of August, when it drops or crawls to the ground, buries itself under half an inch of loose dirt or decaying vegetation, and makes a cocoon of brown sticky substance which soon dries and hardens so as to be very strong. The worm, now very much shrunken, remains in this condition until warm weather returns next spring, when it sheds its skin and passes into the pupa stage. This lasts only about two weeks, when the mature insect thrusts its jaw through the cocoon near one end, and, turning round, cuts off a lid and emerges.

NATURAL REMEDIES.—During the fall and winter immense numbers of the cocoons are torn open by mice and the contents devoured. This has contributed more, no doubt, than any other natural remedy to keep the insect in check. It seems, however, that the mice always leave enough to pretty well cover the trees the next year.

Blackbirds are known to eat the worms during the summer. An insect parasite of the saw-fly has been observed in considerable numbers at the Station. It is a slender four-winged insect, shown in the accompanying illustration (Fig. 11). A specimen having been sent to the Division of Entomology at Washington, Professor Riley states that it is scientifically known as *Opheltes glaucopterus*, Linn, and is very nearly, if not exactly, the same as a species which is known to prey upon a corresponding saw-fly in Europe.

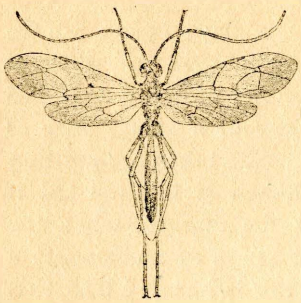

FIGURE NO. 10.

The Cimbex Parasite (*Opheltes glaucopterus*, Linn.) Female. Natural size. [Original.]

These parasites mature later than the saw-flies, not appearing until the larvae of the latter are nearly full grown. The females lay their eggs under the skin of the worms, one in each. The worm thus attacked is able to go on and make its cocoon, but at this point it succumbs to the larva of the enemy. The latter finishes its development on the remains of the former, leaving only the skin, and then makes a slim, black cocoon inside the saw-fly cocoon. of the same length, but only one-half or two-thirds as wide. From this comes the perfect insect the next season. The manner of egg-laying is very interesting, and was repeatedly observed last summer. The female parasite, an exceedingly active and sprightly fly, passes over the leaves, lighting here and there on one, and walking its length, continually moving her long antennae (feelers) up and down, and curling them over the edge of the leaf so as to feel on the lower side. She appears to have very little sense of sight, depending mainly on touch. Having found a worm, she strokes it with her antennae a few times, then, arching her abdomen, she brings the tip of it under her body, and thrusts it forward so as to touch the larva in front of her. In an instant the work is done, if the victim has not escaped by dropping to the ground, which is a common occurrence.

The practical importance of this parasite remains to be seen. Whether it will increase to such an extent to rid us of the saw-

flies cannot be predicted. In the summer of 1889 only two specimens of it were collected, although a very large number of saw-fly cocoons were examined. Two other specimens were seen but not captured. In the summer of 1890 about thirty were collected, and very many more were seen. Out of over one hundred cocoons collected last spring in one place, one-sixth contained the cocoons of this parasite. This is an encouraging record.

Dr. Otto Lugger, Entomologist of the Minnesota Station, has found that this saw-fly is also infested, though not to a very large extent, by a Tachina fly, similar to one mentioned in the article on Cecropia. We have also secured one cocoon containing half a dozen cocoons of another and as yet unknown parasite.

In connection with the request for Cecropia cocoons, we have decided to ask our readers to send also a supply of sawfly cocoons. There is good reason to suppose that the parasite which is plentiful here is not widely distributed. We should probably be able therefore to introduce it in a great many new localities. If sent with cocoons of Cecropia, any number from twenty up will be acceptable. If sent alone, a common tin pepper box will make a good mailing box, and will contain a suitable number. These cocoons have to be dug under the willows. Selecting a place where the worms were bad last season, rake off the leaves lightly and dig over the top of the soil to a depth of half an inch or so, especially in the little hollows. One can usually pick up a good supply in a few minutes. Send only those that are unopened when found.

ARTIFICIAL REMEDIES.—Of these it will be sufficient to mention only two. Paris green or London purple in water, one pound to one hundred gallons, has been perfectly effectual in several experiments which we have made. Our application was made by means of a spraying machine (see article on insecticides). A single application, as soon as the eggs have all hatched, is sufficient if well done for a whole season, as there is but one brood a year. It is a great pity that tree growers have not used this simple and cheap remedy before. Willow trees which are stripped of their leaves in the summer are quite likely to die before the next spring, and do not grow well if they survive.

THE SMALL WILLOW SAW-FLY.

(*Nemastus ventralis* Say.)

This insect (Figure 11) is less injurious in our State than the one just described, but only because it is less widely distributed. The female fly deposits her eggs on the lower side of the willow leaves in little pockets made by raising the skin. A single leaf may contain a hundred eggs. As the time for hatching draws near, the eggs swell and become black; the interval from laying to hatching is about a week. The little colony keep together until the leaf is devoured, when it gradually disperses over the surrounding leaves. In a week or little over, the voracious larvae are full grown. They then descend to the ground, and form cocoons of a glue-like material which soon dries and becomes tough. The cocoon is always double. The outer portion may be readily separated from the inner. In this respect it compares with that of the Cecropia.

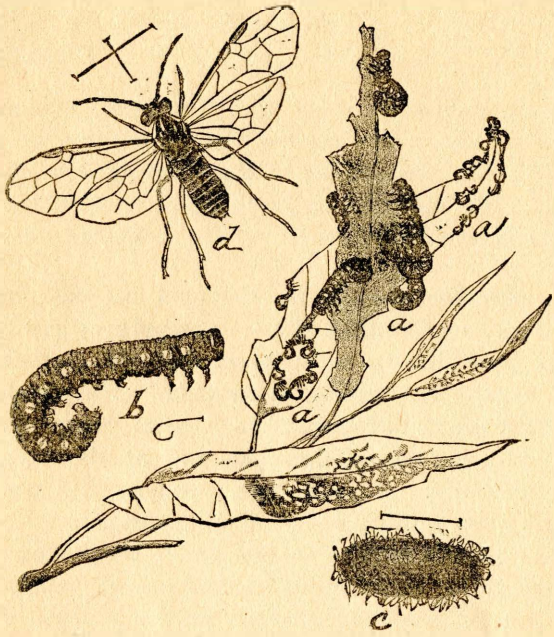

FIGURE 11.

The Small Willow Saw-fly (*Nematus ventralis* Say): a, a, a, young larvae; b, full grown larva; c, cocoon; d, adult fly. All somewhat enlarged. [After Howard.]

In about a week the mature insect comes forth and proceeds to lay eggs for another brood. Owing to the short time required for them to complete their growth, there are about five broods in a season in this locality. Thus they increase enorm-

ously in a single year. The time spent in the ground gives the tree just time to grow a new crop of leaves, before the next brood of larvae are ready to devour them. A tree cannot stand this strain very many times in succession and is likely to be killed before fall.

No parasites are known. The only natural preventive to their increase here appears to be the weather. On one occasion several hundred eggs on a little tree on the College grounds were under observation. They were nearly ready to hatch when a heavy rain occurred, with the result that none of them hatched.

This insect may readily be destroyed by the use of Paris green or London purple, as in case of the Large Willow Saw-fly.

THE ASH SAW-FLY.

(*Monophadnus bardus* Say).

In connection with the Willow Saw-flies it seems desirable to mention this insect. It has been observed at the Station for two years and is increasing in numbers. It feeds upon ash leaves, and has been quite injurious in Nebraska and Kansas. Figure 13 shows the various stages of its history. The eggs are laid, as shown, in the petiole (stem) and mid-rib of the leaf. The larvae are to be found during June. There is but one brood a year.

The observation of Professor Popenoe of the Kansas Station, show that this species is attacked by other insects, both parasitic and carnivorous as well as by birds and reptiles. This, together with the fact that there is but one brood a year, makes it less likely to become a serious pest here.

If it should become numerous enough to do noticeable damage, it may be destroyed very readily by the use of the arsenites.

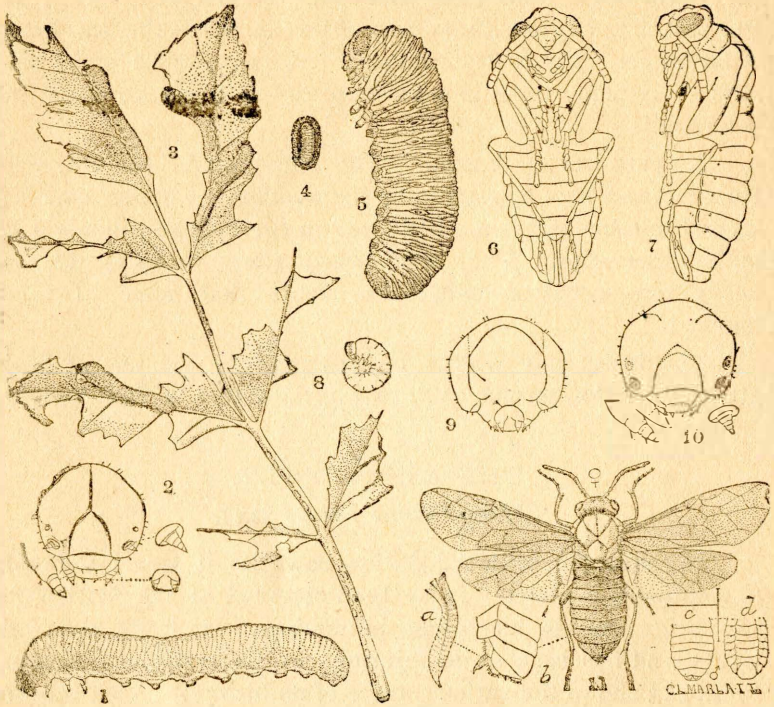

FIGURE 12.

The Ash Saw-fly (*Monophadnus bardus* Say); 1. larva; 2. head of same, more highly magnified; 3. leaf showing work and larvae, natural size; 4. cocoon; 5. larva, shrunken, just before transforming to pupa; 6, 7. pupa; 8. larva curled up; 9, 10. head of another species; 11. female fly; a, its saw; b, portion of abdomen; c and d, male abdomen. All enlarged but Nos. 3, 4 and 8. [After Marlatt.]

THE COTTONWOOD LEAF BEETLE.

(*Lina scripta* Fab.)

This insect attacks not only cottonwood, but also balm of Gilead, the Russian poplars, and the laurel-leaved willow. It is said to injure the common willow, but no instance of this has come under our notice.

The accompanying cuts (Figures 13 and 14) give a good idea of the appearance of the insect, both in the mature and larval stages. The beetle is somewhat variable in markings as shown. The lighter forms are common and typical, the darker being rare.

HABITS.—The mature beetle passes the winter under vegetable *debris* and in similar situations. As soon as the buds burst on the cottonwood they leave their winter quarters and take to the trees. At this time it is quite easy, on small trees, to collect them. They are usually numerous on willow tips also, though they have not been known to damage the common willow in this section.

FIGURE 13.

The Cottonwood Leaf-Beetle (*Lina scripta* Fab). Showing variations in markings. [After Riley.]

Soon after this the eggs are laid on the under side of the leaves, in small bunches like those of the potato beetle, which they resemble, but are yellow instead of orange in color. The eggs hatch in about a week, the exact time depending on external conditions. The young larvae are nearly black, and keep close together at first, devouring the under skin and the parenchyma or "flesh" of the leaf, leaving the upper skin and the framework. As they grow larger they separate, eating the whole leaf, except the larger ribs. They also grow lighter in color. Along the sides of the body are little tubercles, at the tips of which, when the larva is disturbed, appear little drops of milky fluid of strong, unpleasant ant odor. This serves as a protection from birds and from some of the carnivorous insects. When fully grown the larva fas-

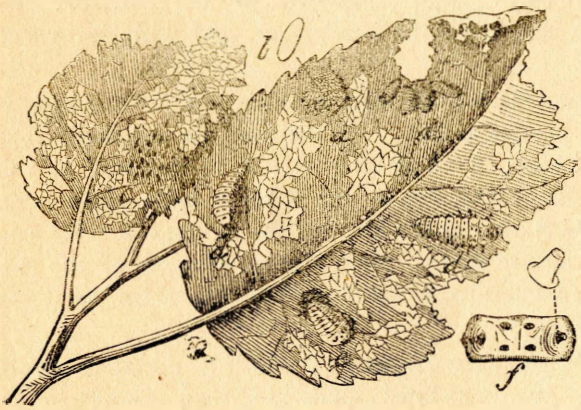

FIGURE 14.

The Cottonwood Leaf-Beetle: a, eggs; d, d, d, larvae of various sizes; e, pupa; segment with tubercle, enlarged. [After Riley.]

tens itself securely by the posterior legs, partially sheds its skin, and assumes the pupa state. For this change they usually descend to the lowest branches, or to the body of the tree within a foot or two of the ground. Sometimes hundreds of them will form a compact mass in such a situation, hanging so close as to touch each other. The whole cycle, from the egg to the mature insect, is passed through, on an average, in but little over a month. As there is some variation in time in all the stages, the later broods become somewhat merged into each other. For this reason it is not easy to ascertain just the number of broods from outdoor observation. In this State there are three broods, and probably four under very favorable circumstances.

Natural remedies are comparatively few. No birds or worms are known to eat them. The lady-bird beetles (see figures) eat the eggs and newly hatched larvae.

In treating this insect, one thing should be especially considered, *i. e.*, the earlier in the season the work is done, the better. With each new brood the number to deal with is enormously increased.

Accordingly, it is best to begin operations with the appearance of the first beetles in May. If the trees are not more than six or eight feet high, hand-picking is not be despised at this stage, though it is of little use to try it on a large scale later. The mature insects drop at the first alarm, so that a wide pan can be used to capture them. Even if these pioneers of the season are not very numerous, it will pay to destroy them, as it prevents the increase.

When the insects are allowed to multiply unnoticed until the middle of July or later, and are then found to be rapidly ruining the trees, the situation calls for immediate and energetic action. Spraying with Paris green or London purple in water must be depended upon. For this a force pump and spraying nozzle is neccessary. The poison should not be used stronger than one pound to one hundred gallons of water. In our experience we have been moderately successful with London purple at this strength. If the first application does not suffice, follow it in a week with another. No reasonable amount of time or expense should be withheld, as the attack of these in-

sects in large numbers is very likely to kill the tree unless attended to.

THE FALSE CHINCH BUG.

We have no evidence that the true chinch bug is present in any part of our state in destructive numbers. It seems probable that it has not been introduced unless in the extreme southeastern part. At the Station but one specimen has ever been collected, and that was found last fall, under circumstances that seemed to indicate that it had just alighted.

The insect which is responsible for most of the reports of chinch bug outbreaks is one which is called the False Chinch Bug. (*Nysius angustatus*, Uhl, Fig. 15). It is about the same size and general shape as the genuine chinch bug, has the same odor, and occurs quite plentifully in this section. It has rarely been known to do any damage. A conspicuous exception to the rule occurred in Colorado in the summer of 1888. It damaged market gardens, confining itself chiefly to radishes and turnips.

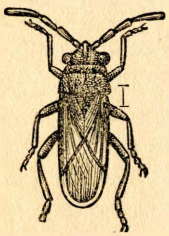

FIGURE 15.

The False Chinch Bug (*Nysius angustatus* Uhl. Enlarged. [After Riley.]

It may be distinguished from the true chinch bug by the fact that it is of a nearly uniform brown color. The white wings with a conspicuous black spot on each side are characteristic of the true chinch bug. The prevalent opinion that any little insect which "smells like a bed-bug" is a chinch bug, ought to be eradicated. This odor is not distinctive.

Any occurrence of the real chinch bug should be reported to us, and to avoid a possible error, a few specimens sent. See directions for sending insects.

CABBAGE INSECTS.

There seems to be no vegetable under cultivation which suffers from a greater variety of insect enemies than the cabbage. It may well be a matter of surprise that the cabbage is still a profitable crop when we consider how many species of insects live upon it. The following paragraphs give a brief account of some of them:

CABBAGE BUTTERFLIES.—Of these we have two species,

very similar in color, both being white, with a little black on the wings. Figure 16 represents the male of the Southern cabbage butterfly (*Pieris protodice* Boisd). The female has a little more black on the wings, but otherwise is not much different. The other species is the imported cabbage butterfly (*Pieris rapae* Schrank), so called because it was actually imported some years ago from Europe, where it has long been abundant. It had not previously been found in this country, but it spread very rapidly when once introduced, and has been for some time a worse pest than the native species. It may be distinguished from the latter by having never more than *two* of the black spots on each front wing (not counting the black on the tip of the wing), while the native has always *three* or more.) The white color of the imported species is tinged a little with yellow.

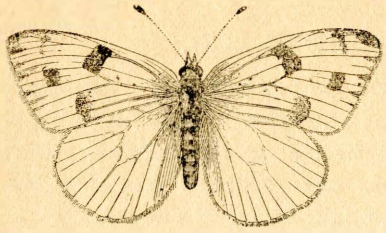

FIGURE 16.

Cabbage Butterfly (*Pieris protodice* Boisd.; [After Riley.]

Both these butterflies may often be seen flitting about our gardens. There are two broods a year, and the last one passes the winter in the pupa state. The larvae (Figure 17) are green, over an inch long when full-grown, somewhat thickened in the middle. They may be distinguished from other cabbage worms by the fact that they are covered with a whitish down, so thin and fine that it may easily be overlooked. When about to pass into the pupa state, the larva usually leaves the cabbage and looks about for a suitable place. It often chooses the lower edge of a weather board on the side of a house, or the under surface of some board near the earth. It has been observed to climb to the eaves of a two-story house, and go through its changes there. The pupa is attached to the surface by its posterior end, and also has a silken thread about the middle of its body (Figure 17). The pupa

FIGURE 17.

Larva and pupa of Cabbage Butterfly. [After Riley]

stage lasts six or eight days in the first brood of the season; in the other it lasts until the following spring.

REMEDIES.—Birds, toads, chickens, and parasitic insects contribute to keep these species in check; and yet artificial remedies have often to be resorted to. As the cabbage is a food plant, neither Paris green nor London purple can be applied. Pyrethrum has been used with good effect, both dry and in water. Hellebore is also recommended. Hot water (140° Fahrenheit) sprinkled on the plants has been found very successful. See article on Insecticides.

THE CABBAGE PLUSIA (*Plusia brassicae* Riley.)—This insect is a moth resembling the cut-worm moths. Its larva is a green worm which lives on the cabbage. It moves by looping its body like the "span worms." This characteristic serves to distinguish it from other larvae affecting cabbage. It passes through the pupa stage in a thin cocoon, through which it may be plainly seen. There are two broods a year.

This insect may be treated by the same methods as the cabbage butterflies.

THE ZEBRA CABBAGE WORM (*Mamestra picta*, Harr).—This is the larva of a moth which also resembles the cut-worm moths. The larva is recognizable at a glance by its peculiar color, being black, with bright yellow markings. The eggs are laid in groups instead of singly, so a number of larvae are often found together.

Remedies, the same as for the preceding.

THE CABBAGE LOUSE (*Aphis brassicæ* Linn).—This insect (Figure 18) is often found in immense numbers in the latter part of the season. It increases at a very rapid rate in the course of the summer. Like all plant lice it subsists, not by eating the tissues, but by sucking out the juices of the plant. Its

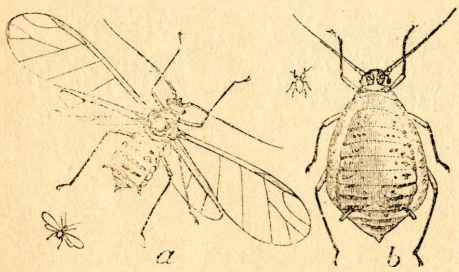

FIGURE 18.

Cabbage Louse (*Aphis brassicae*, Linn); a, winged form; b, wingless form. Small figures natural size. [After Riley.]

mouth organs are so constructed as to form a slender tube for this purpose.

These pests should be looked for on cabbages as early as mid-summer. At first they will probably be found in little colonies of six to twenty individuals. If these are carefully destroyed, and the search repeated two or three times at intervals of ten days, they will be prevented from making such a great increase as to ruin the plants later. If this preventive measure is neglected till too late, and the cabbages are covered with lice, spraying with strong-whale oil soap solution should be tried. Any remedy must be thoroughly applied, or it will do but little good, as the lice are under the leaves, and between them so as to be pretty well protected.

Figures 19 to 23 show a number of insects which are very beneficial in ridding us of the plant lice. They all feed, in the larval state, upon the cabbage lice.

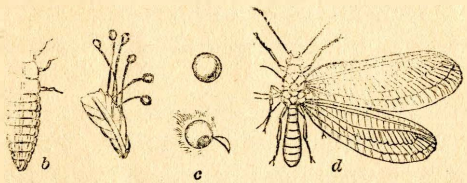

FIGURE 19.

Lace wing Fly; a, eggs on leaf; b, larva; c, cocoon; d, mature insect. Enlarged. [After Riley.]

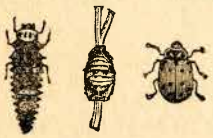

FIGURE 20.

Lady-bird (*Hippodamia convergens*) larva, pupa and mature beetle. [After Riley.]

FIGURE 21.

Lady-bird (*Hippodamia 13-punctata*) [After Riley.]

FIGURE 22.

Lady-bird (*Megilla maculata*). [After Riley.]

FIGURE 23.

Lady-bird (*Coccinella 9-notata*). [After Riley.]

CUT-WORMS.

It appears unmistakably from the testimony of hundreds of farmers that cut-worms stand next to drouth and hot winds as a cause of loss to the agricultural interests of the State. Insects so destructive as this are deserving of the most careful study by all farmers. We have to thank many of our correspondents for detailed accounts of their experiences, which have been of great value, either by adding cumulative evidence on an important point, or, on the other hand, by contradicting evidence which might otherwise have been made the basis of an erroneous theory.

The life history of cut-worms is a matter which must be more fully known before some questions of prevention can be altogether settled.

There are many species. Our injurious ones belong mostly to the genus Agrotis. There is a striking resemblance among them, so that great care is often necessary to distinguish one species from another. In the mature state they are plain brown moths (often called millers) usually about seven eighths of an inch long and a little over an inch across the outstretched wings (Figure 24). These moths are abundant from mid-summer un-

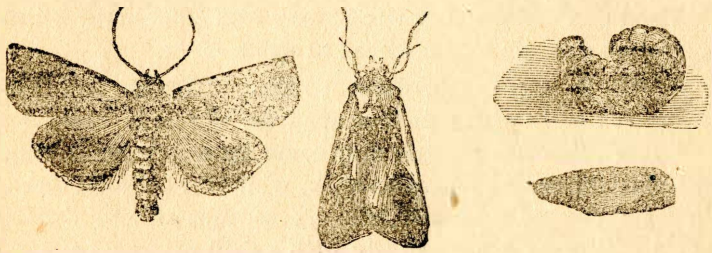

FIGURE 24.

A cut-worm moth (*Agrotis sub-gothica*) with larva and pupa. [After Riley.]

til late autumn. Those cut-worms which injure the cultivated crops usually cease work in June, so they are among the earlier moths which appear. There is but one brood a year. The period between the maturing of the moth and the appearance of the half-grown cut-worm the next spring is very little known, but the eggs must be laid soon after the moths appear. The observations heretofore recorded on the eggs and newly hatched

young are so very few and meagre as to throw practically no light at all on the phase of the subject which presents itself to us. Last season, other work of an imperative nature interfered with our investigations in this line, so that we cannot report anything definite.

The larvae in the spring appear to be omnivorous. Cabbages, tomatoes, lettuce, onions—all garden vegetables, are attacked. Field crops suffer in the same way. Seedling trees are a favorite diet. Most weeds are as readily eaten as the cultivated plants. Where the ground is kept clean they will climb young trees three feet high and strip them even to the topmost leaves.

When they occur in land that has a variety of plants growing on it, they usually exhibit a marked preference for certain kinds. For instance, in a garden, cabbages are apt to be attacked first.

In fields it has often been observed that certain weeds attract them more than the crop itself. On this head some of our correspondents give suggestive and important observations.

Mr. Geo. Steele, of Claremont, writes: "I first discovered them (cut-worms) in my wheat. We were going to drag it up on account of wild buckwheat, but the worms ate all of the buckwheat out. Then they went to my oats and ate them clean. They did no damage in the wheat to speak of."

Mr. C. R. Case, Aberdeen, writes: "Wheat and other grains sowed early with a drill escaped the worms in this vicinity. I think this was because they came up and became toughened before the worms began to work, while the broadcast seeded grain did not come up until late, on account of dry weather. For that reason grain sowed early with a drill produced a partial crop, while that sowed with a seeder was destroyed by worms when it came up, which was three or four weeks after it was sowed. Upon examination we found plenty of worms among the early drilled grain, but they took the weeds instead of the grain, as the weeds were just starting and were tender."

H. J. Hansen, Gem, writes: "I noticed here last year that where the cut-worms came into a field where there was an abundance of wild buckwheat, they would destroy the buckwheat first. There are farmers in this locality who would

not have raised a bushel of wheat, had it not been for the cut-worms. That is, on those places where there was much wild buckwheat.''

These letters are only a part of what we might quote to the same effect.

It has often been observed that the worms possess a considerable power of traveling. Fields are sometimes eaten into from one side so as to show plainly that the worms are advancing from that direction. The fact that they almost always eat by night and remain quiet under the surface of the ground by day interferes a great deal with observing their methods of work.

Several correspondents have espoused the theory that cut-worms are produced from the little round galls, as large as a pea, which are borne on the stalks of a certain weed. Any one can easily disprove this by gathering a few galls and placing them in a tumbler covered with a bit of glass. In May the mature insects come forth, having transformed from the ''worms'' that were in the galls. They will prove to be only minute and harmless gallflies.

FIGURE 25.

Ground-Beetle (*Harpalus caliginosus*). [After Riley.]

FIGURE 26.

Ground-Beetle (*Calosoma calidum*, Fab.) [After Riley.]

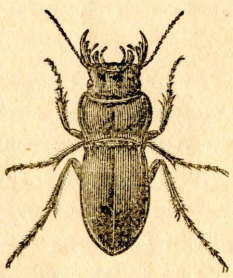

FIGURE 27.

Ground-Beetle (*Pasimachus elongatus.*) [After Riley.]

FIGURE 28.

Tiger-Beetle (*Cicindela sexguttata*). [After Riley.

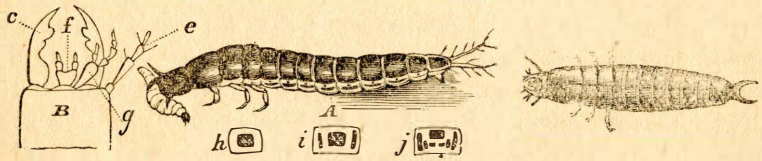

FIGURE 29.

Larvae of Ground Beetles. [After Riley.]

NATURAL REMEDIES.—Nature has provided numerous ways of lessening the numbers of these pests. The ground beetles and tiger beetles are very beneficial in this way. The larvae of the former class will valiantly sieze worms several times their own size and hold on until they kill them.

Figures 25 to 29 show a number of these species.

Birds are very helpful when the ground is stirred, as by dragging. At this time they doubtless eat many of the worms.

The ordinary parasitic insects do not often attack the cutworm, owing to its habits of remaining concealed by day. A few cases have come under our observation, but we were not successful in rearing the parasites.

REMEDIES.—First let us consider those remedies which are applicable to gardens. Of these hand picking is a prominent one. In a badly infested piece of ground, the worms can be dug out at a rapid rate by simply stirring the soil at the base of each plant. The results of this method, it is needless to say, are positive and immediate. It is not usually practicable except on a small scale, however, on account of the amount of work it requires.

The use of tins about cabbages, tomatoes, and so forth is becoming very common. A gardener near the Station had over 1200 in use in a single season. They were made of common fruit cans by simply melting the ends off. He found that the worms occasionally climbed over by means of the paper labels, which were not in all cases entirely removed from the cans. Such protectors as these need not be set deep in the ground. Our experience is that half an inch is ample. For use in the horticultural department we had tins made at a tinshop. They were eight by two and a half inches in size with a narrow lap at each end, so as to form a tube when the ends are bent around and hooked together. This is a perfect protector, if properly applied. It should be inserted in the ground but slightly. It is sufficient if it barely reaches below the surface. Lumps close outside sometimes helped a worm over, so care had to be taken to leave the earth smooth near the tube. The cost of these tins was seventy-five cents per hundred. They will last

many years, as they are taken up and stored away when the cut-worm season is past.

POISONING the worms before the vegetables are planted has been effected by the use of bunches of fresh clover or any of their favorite food plants, dipped in water containing Paris green or London purple and placed at intervals in the piece of land infested. This should be done at dusk, so that the bait will remain fresh all night. Our own experience with this treatment has not been very successful, but with some it has given excellent results. As it costs almost nothing, it is worthy of trial.

DRIVING AWAY the worms by placing some repulsive substance on the ground around the plant, has been tried in many cases. Lime, ashes, soot, kerosene, solution of hen manure, and combinations of the first three, have been used with some success.

Akin to these is the remedy used by Frederic Iltis, of Chaska, Minn., which he describes in a letter, as follows: "I simply take a barrel of water and put in a handful of wormwood (which I gather and dry the year before), let it soak a few days, and, instead of taking pure water to water my plants, I use the water with wormwood. One application is always sufficient. Cutworms will never go near it."

On field crops the question of destroying the worms is much more serious. Here all the above remedies are more or less inapplicable, and the question of remedy resolves itself into a question of prevention. What treatment, if any, will prevent the moths from laying in a particular piece of land; or, when the eggs have been laid, what will prevent their hatching, or the growth of the larvae? These are the inquiries that present themselves.

MILLET. It is certain that the young worms must have something to eat after harvest, although it is likely that they are capable of fasting for quite long intervals. It would therefore appear that they would be less likely to follow a crop which leaves the ground bare and clean for the greater part of the fall. This theory is perfectly sustained by the facts. A good crop of millet is without an equal to leave the land clean; and our observation and correspondence shows that, of all crops, it is least likely to be followed by cut-worms. We made a special point of

millet in our cut-worm circular, and out of five hundred replies only about three per cent. had known cut-worms to follow a thrifty crop of it. In part of these few cases, the worms had evidently crawled in from adjacent land, the field being small or narrow. Some other reports were probably due to a mistake in regard to the loss of flax. Sometimes young flax dies suddenly when cut-worms have had nothing to do with it. This is caused by a disease, which is as yet but little studied*; but in most cases the injury is erroneously attributed to cut-worms. This disease will account for the loss of flax in a number of cases mentioned by our correspondents, where they were unable to find any worms.

Culver Bros., Cavour, give the following experience with millet: "In 1889 we planted forty acres of corn, some on fall and some on spring plowing. Ten acres of thrifty millet had grown across one end of the field the previous year. We harrowed the corn, but of no avail; the cut-worms took the corn except where the millet had been and the ten acres of spring plowing. They took all of the fall and some of the spring plowing, (while the year before they took some of the spring and none of the fall plowing). With the exception of the millet, wheat grew on the land the previous year. * * * The summer of 1890 we again planted forty acres of corn. Twenty acres was on millet ground; the remainder had had wheat (after corn without plowing) the previous year. The latter was partly fall and partly spring plowing. The cut-worms took the corn planted on wheat ground, but left that on millet ground, except one or two small places, where they seemed to work down from the corn ground. * * In the summer of 1889 we also sowed twelve acres of late millet (June 28th). It came up thick, but on account of drouth did not get high enough to mow. The cattle ate it off in the fall, and in the spring of 1890 we cultivated it into oats. It was free from weeds. The cut-worms took about half of the oats, and in places ate them off until the ground was bare."

This last part of his letter shows that a light crop of millet, not cut, was no protection.

*This disease was studied last season at Windom and St. Anthony Park, Minn., by Dr. O. Lugger, Botanist of the Minnesota Experiment Station. An exhaustive series of experiments led to the conclusion that something in the straw of the flax caused the disease to appear on land that had raised flax. The liability to disease lasts for several years, though dry weather may prevent its appearance. Rotation of crops, allowing a number of years to intervene between flax crops, seems to be the only remedy.

E. W. Cleveland, Gann Valley, says: "I had twenty acres of corn on land that was plowed early in July the year before and sowed to millet. Not a hill was taken by the cut-worms. Eighteen acres beside it, following oats, very little taken; another field, following barley, half taken."

A number of similar letters have been received.

A perfectly clean crop of corn is useful in keeping down the cut-worms. Few farmers keep corn so clean as to reap the full benefit of it as a preventive. As generally raised, it cannot therefore be compared with millet.

TIME OF PLOWING.—Late fall plowing has been recommended by some entomologists. This is on the theory that, as the worms pass the winter in little oval chambers below the surface, they would be turned up to the surface at a time when it would be too late to make this preparation again, and would consequently perish. It is not claimed that the period in which this preventive plowing may be done extends over more than a very few days, just before the final freezing up. The measure is therefore applicable only to a small extent, and even then would seem to require an advance knowledge of the approach of winter.

Our own experience and observation does not lead to definite conclusions. An extensive correspondence with farmers shows that every possible time of plowing has been, in some cases, apparently ineffective., and in other cases apparently successful. On the whole, we have received about four times as many favorable reports of spring plowing as of fall plowing, which must be regarded as a significent and valuable point. A few extracts from letters are given, more to illustrate intelligent methods of observation and curious diversity of cut-worm habit, than as a support to any particular theory.

Carl B. Krogstad, Bruce: "Flax on fall plowing was taken clean by the worms, and afterward they kept the weeds down too, for about three weeks, when it was sown to millet. The land is a high ridge, but one end, extending down to a slough, is quite low, and did not seem to be so badly infested, as not all the flax was taken. In the middle of the fall plowing was a piece of spring plowing, about two acres, which at first was left untouched by the worms, but after a while they began to work

into it and almost half was taken. One of my neighbors had a similar experience, while others who sowed flax very early on fall plowing had a full stand."

C. M. Yegge, Alpena: "Some say plow early, but I know better. I commenced to plow early and plowed late, and my earliest and latest plowing is where the worms took the crop cleanest."

Louis Schaff, Elrod: "I had seventeen acres of corn. Five acres were plowed in the fall, and the rest in the spring. The fall plowing was all cut down in one day and night. I got a fair crop off the spring plowing."

F. T. Sellers, Howard: "In 1889 I plowed a thirty acre field for corn; used a sulky plow and did excellent work, going eight inches deep. Finished October 15th, and a shower started the weeds and grain to growing. Early in the spring I dragged it thoroughly, then let it lie until May, when it was green again with weeds. Worked it both ways with an Acme pulverizer; after two days dragged again, then planted to corn with a horse planter, putting the seed in deep; dragged twice. When the corn was up two inches dragged again; field looked splendid. A few days later I went to show some neighbors my corn field, and I can make affidavit that we could not find a hundred hills above ground on the thirty acres—it was all cut off. We found from three to twelve worms to a hill."

D. H. Eastman, Plankinton: "The cut-worms injured my corn on fall plowing, my neighbor's on the north on spring plowing, and the neighbor west of him suffered about 80 per cent. on both fall and spring plowing."

W. R. Carroll, Woonsocket: "A neighbor one mile west did his plowing for corn in the fall, except a strip a few rods wide in the centre of a land; finished in the spring; all plowed shallow and planted at the same time. The fall plowing was all taken, but the strip of spring plowing was a fair stand. Land in wheat the year before. A neighbor on the south planted forty acres plowed shallow in the fall; planted it three times and gave it up. Afterward sowed part to millet. Previous crop, wheat and oats. Another on the east had a fair stand on spring plowing. Previous crop wheat."

David S. Lantaff, Canton: "I had five acres of corn on fall plowed land all taken to a row, while spring plowed land in the same field was not injured; and my neighbor had five acres taken off spring plowed land, while his fall plowed was not injured."

T. L. Peck, Wessington: "I know of one piece of fifty acres in my neighborhood that was plowed in the fall, and cut-worms didn't take a hill of it, while the same man had land plowed in the spring that was badly damaged."

BURNING OFF.—This is unquestionably a valuable remedy. When it can be applied other remedies are generally unnecessary. The best time to burn is probably October, though late spring seems to do as well. Very late fall or very early spring burning is less likely to prove effective, as the worms are underground then.

This remedy was not mentioned in our circular, but more than thirty farmers gave it hearty endorsement in their replies, only two giving an unfavorable report, and one of them was from hearsay. Some of the letters give positive testimony to the success of the measure in the cases mentioned.

D. J. Pruyn, Wolsey, says: "When plowing stubble in the spring I burn it off if possible. Have never been troubled where this was done. A patch or strip is sometimes missed, and the crop on that is sometimes injured, while the burnt part is all right."

C. C. Vanneman, Wolsey: "I planted forty acres in corn last spring. Fifteen acres had been in oats the previous year. Part was fall and part was spring plowing. Planted about the 25th of April, and the cut worms hardly left a hill. The other twenty-five acres I plowed in the spring and burnt off before plowing. It was not disturbed, except a strip all around the piece *that I plowed as a fire guard.*"

W. H. Youel, Huron: "Last spring my neighbor had a piece of ground that had lain idle for two years, that he burned off the second of May and put in corn. A few places did not burn, and there the worms took all the corn; that burned off clean they did not touch."

David Owens, Mt. Vernon: "We had twenty-three acres of corn planted on wheat ground. I burned off all the stubble that I could before plowing. Five or six acres would not burn, and

on that spot they took almost all the corn. On the burned part I had a perfect stand."

In localities where cut-wormn were very bad last year it would probably pay to spread a thin coating of straw and burn off, before plowing for corn or flax, at least on land which has already nearly enough stubble to burn,

HEADING OFF the worms where they are working into a field may be done by plowing a furrow a little ahead of them, leaving the perpendicular side toward the field to be protected. This has several times been done successfully, to our knowledge.

CONCLUSION.—In gardens, hand-picking, tins, and repelling agents like lime, ashes, soot, etc., are of value in the order named. In fields, burning off, absolutely clean culture, (this includes millet raising,) and spring plowing, are the best measures as yet known.

INSECTICIDES AND MODES OF APPLYING THEM.

The remedies used must vary with the habits of the insect to be destroyed. The injurious species may be divided into two classes—those which injure by devouring the foliage, and those which injure by sucking out the juices, leaving the tissue entire. To one or the other of these classes belong all the injurious insects of this region, except the ash borer, and a few less important borers, root eaters, gallmakers, etc.

The first of these classes—those eating leaves—includes nearly all the insects mentioned in this bulletin. For these there are two standard remedies—Paris green and London purple. The first is an arsenite of copper; the second chiefly an arsenite of lime. They are often spoken of as "the arsenites." Both are deadly poisons. Paris green contains a somewhat larger proportion of arsenic, but London purple seems to be just as effective. The latter, costing only about fifteen cents a pound at retail, is far cheaper than Paris green, and is largely superseding it in use. It seems to be especially liable to injure the leaves of some trees, (with us the plum in particular,) and on such it is better to use Paris green. Aside from this there is no great difference except in price. Both are best applied by mixing in water at the rate of one pound to at least a hundred gallons of water. Paris green is a heavy substance, and the particles rapidly settle to the bot-

tom of the water. In order that the mixture may be of uniform strength when it is being applied, it is necessary to stir it often. With London purple this tendency to sink is much less, as it is a lightea material. Still it needs some attention.

In applying these poisons to potato and other low plants, a garden sprinkling pot with a fine rose nozzle is very good. For large vegetables and especially for trees, it is necessary to have a spraying machine. This consists essentially of a force pump, a short piece of hose, and a nozzle suitable for dividing the water into a fine spray. Instead of purchasing a tank, it is cheaper to use a kerosene barrel, attaching the pump to the top. Figure 30 shows the Perfection outfit, manufactured by the Field Force Pump Co., Lockport, N. Y. Price, without barrel, $12. (Hardware dealers can secure a discount on spraying machines.)

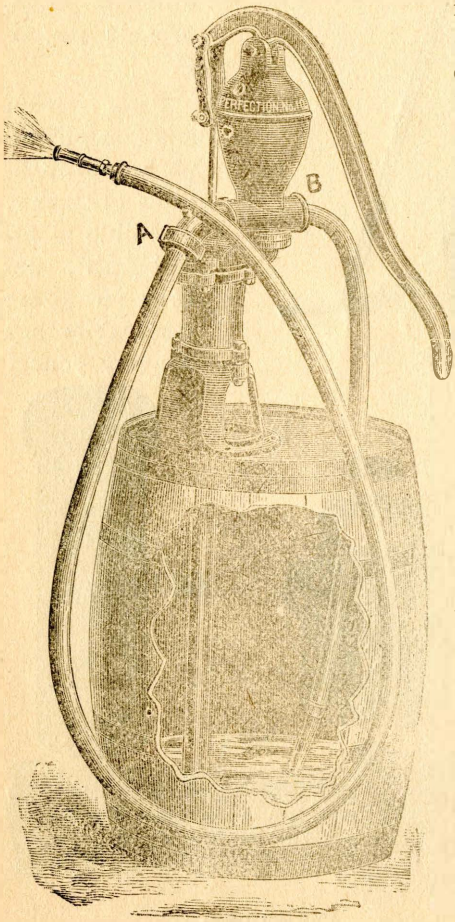

FIGURE 30.

Figure 31 shows "The Little Climax," made by the Nixon Nozzle and Machine Co., Dayton, Ohio. It is also made in larger sizes to use with a barrel.

Figure 32 shows the Nixon nozzle, one of the best spraying nozzles in the market.

The following firms, besides the ones previously mentioned, are well known manufacturers of spraying machines, and will send their catalogues upon application :

Wm. Stahl, Quincy, Ills.; Rumsey & Co., Seneca Falls, N. Y.; J. A. Whitman, Providence, R. I.; Gould Manufacturing Co., Seneca Falls, N. Y.; P. C. Lewis, Catskill, N. Y.; Thos. Somerville & Sons, Washington, D. C.

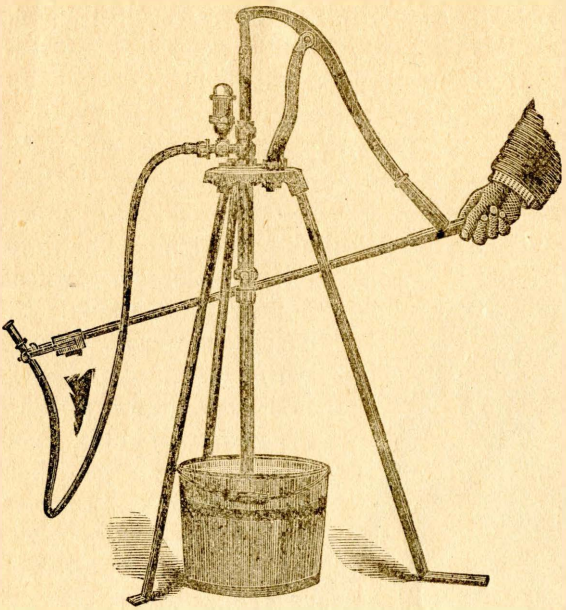

FIGURE 31.

Paris green and London purple are not applicable of course, on edible plants and fruits, unless in some cases while they are very young. On such plants remedies that will kill by application to the outside of the insect must be used. Of these kerosene emulsion is generally regarded as the best. As is well known, kerosene alone is instant death to any insect, but it is equally fatal to plants. By mixing it properly with soap and water, a permanent compound is formed, which, when diluted,

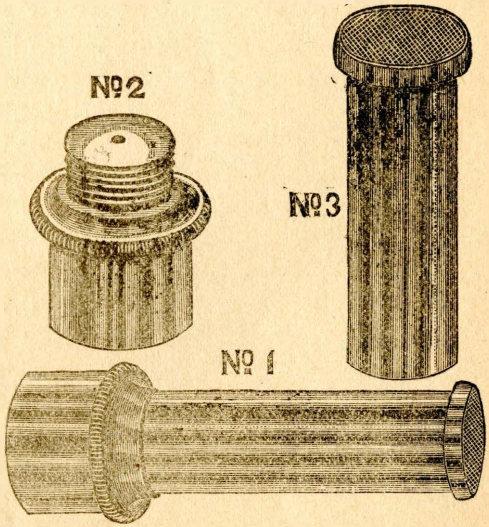

FIGURE 32.

will kill insects but not foliage. To secure the best results in preparing it, the Hubbard formula, as here given, should be carefully followed : Kerosene, 2 gallons; water, 1 gallon; common washing soap, ½ pound. Heat the water and dissolve the soap in it; add the solution, boiling hot, to the kerosene, and churn or agitate the whole violently for ten minutes or more. The best method is to put the mixture into the tank of the spraying machine and pump it rapidly back into the tank. The emulsion, if perfect, forms a cream, which on cooling should adhere without oiliness to the surface of glass. Dilute, before using, one part of the emulsion with nine parts of cold water. The above formula gives three gallons of emulsion, and makes, when diluted, thirty gallons of wash." A spraying machine is indispensable in applying. A perfect emulsion and thorough application are the two prime requisites.

Persian Insect Powder, Dalmatian Insect Powder and Buhach are three insecticides of essentially the same composition, and all covered by the general term Pyrethrum. They consist simply of the pulverized flower heads and stems of plants of the genus Pyrethrum. Buhach is made in California, and is perhaps the best of the three.

The usual method of application is dry, dusting it from a cheese cloth bag. or blowing it from a small bellows made for the purpose. It is also applied wet, a heaping spoonful to two gallons of water, but some entomologists consider the former method best. This powder is an excellent remedy for vermin in the house. In a tightly closed room, the flies may be killed without discomfort to human occupants, by blowing the powder into the air. It loses its strength on exposure to the air for any length of time, and so should be kept in a tight tin can. It is best not to buy in larger quantities than can be speedily used.

The powdered root of White Hellebore is a wonderfully effective remedy for currant worms, and is also used on sawfly and other larvae. Apply same as Pyrethrum. It is a poison, however, and should be used with due caution.

In this connection the following extract from a letter written by Daniel Lower, Howard, is well worthy of attention : "In 1887 and 1888 the Cottonwood Leaf-beetle destroyed nearly all the trees

of the cottonwood variety in this part of the country. I have five acres ot cottonwood trees. The beetles came to me as well as to my neighbors. I got two pounds of sulphur, and one evening when the air was rather heavy or damp and the wind in the right direction, I took some hay and put it in bunches across one end of the piece; put sulphur on each bunch; divided the two pounds of sulphur into about ten parts, then set the bunches on fire. The smoke settled down among the trees. One man that passed the other end of the piece said he thought he was pretty close to the infernal regions. The beetle left the trees, and I have the best grove in the country as the result."

DIRECTIONS FOR SENDING INSECTS.

Send insects by mail in a tin or wooden box, bearing the name of the sender on the outside. Postage is one cent per ounce. With live insects, inclose a little of their food plant. Air-holes are not needed. The more specimens sent the better. We will furnish all the information in our power, when requested to do so.