INSECTS INJURIOUS TO THE ONION CROP.

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INTRODUCTION.

The onion and other bulb crops of similar structure are very seriously affected by insects when growing in the field. About six species of plants are included in this group—the common onion, Welsh onion, leek, garlic, chives or sives, and shallot. Of these only the common onion is grown to any extent in North America. Comparatively few insects appear to be especially attached to onions, but of these several are very important pests. All are of foreign origin. The list includes forms such as the onion thrips, the root maggots, and such general pests as cutworms, army worms, wireworms, white grubs, and a few other species such as the strawberry thrips. Those listed as general pests are all more or less omnivorous. Doubtless were it not for the pungent odor of the onion and its kind it would be resorted to for food by many insects other than those which have been mentioned. The most important of all of these insects is the onion thrips (Thrips tabaci Lind.).

A census of the years 1908, 1909, and 1910 shows a steady increase in acreage devoted to onion growing in different regions. In one centered about Stark County, Ind., the increase has been great. In 1910, 1,500 acres were planted to this crop, and in spite of serious injury sustained from the thrips and some other insects the growers realized such a high percentage of profit that the following year the acreage was doubled. As an example of the profit from onion growing in this region it was claimed by one prominent grower who farms in Indiana as well as in Illinois that his income on onions was 15 times as great as on wheat and corn. The damage due to the onion thrips in the Stark County (Ind.) region was estimated at $54,000 in 1910, and with double the acreage for 1911 this would have caused a loss of $108,000 for this region alone. Fortunately, however, this loss was not realized, since the insects were not so numerous as in the previous year.

THE ONION THRIPS.

(Thrips tabaci Lind.)

Our most serious onion pest is of almost microscopic dimensions, generally known as the onion thrips or "thrip." It is also called the
"onion louse." It causes injury to the onion crop practically throughout the country, producing a condition somewhat generally known as "white blast," "white blight," and "silver top." It is also the cause of "scullions," or "thick-neck"—undeveloped and unmarketable bulbs. In aggravated cases whole fields, and sometimes large areas, are rendered unproductive, and in extreme cases are completely destroyed. The whitened appearance of the onion leaves and tops is due to the extraction of the vital juice, first by rasping, followed by suction. In a short time after attack begins the leaves become peculiarly curled, crinkled, and twisted, and finally die down prematurely. (See Pls. XXIV and XXV, showing the difference between normal and thrips-infested onions.)

The importance which this thrips has assumed since about 1904 is such that a considerable proportion of those who have been engaged in investigation of truck-crop insects in the Bureau of Entomology have devoted more or less time to its investigation and in the practical application of remedies. This work has to date covered five years. The principal work in the field has been done by Mr. H. M. Russell in Florida, by Messrs. D. K. McMillan and H. O. Marsh in Texas, by Mr. Marsh in Colorado, and by Mr. M. M. High in Texas and Indiana.

**DESCRIPTION.**

The general appearance of both sexes of this thrips, which are very similar, is shown in figure 1, *a*, highly magnified. The adult insect is pale yellow in color, with the thorax somewhat darker. The wings are still paler yellow, with dusky fringes and bristles. A full-grown nymph or larva is shown at *d*, and a younger one at *c*. The egg is bean-shaped, semitransparent, and is deposited by the female just beneath the epidermis of a leaf.

**HISTORY AND HABITS.**

Onion thrips may now be found in practically all cultivated fields in the United States, as well as in many uncultivated areas where
suitable food plants for its sustenance are growing, so that there is always danger of infestation to onions and other susceptible crops, whether grown in new or in old land.

Observations tend to demonstrate that in some localities, at least, it makes little difference as to the previous crop. Nevertheless there can be no doubt that, taking the country at large, there is always grave danger of infestation to onion fields where crop rotation is not practiced and where onions follow onions or other susceptible plants, and where culls and other refuse from onion beds are allowed to accumulate in and near fields to be replanted in onions.

There is little evidence available that the quality of the soil has in itself much bearing on the degree of infestation.

Owing to the minute size of thrips, it is a matter of some difficulty to investigate their full life histories, and it is particularly difficult to generalize without knowing more of the habits of the important groups. The following, however, is approximate:

The parent thrips is usually found on the lower side of leaves or embedded in flowers. The female, by means of a tiny saw-like organ with which she is provided near the end of the abdomen, cuts a slit, in a leaf or stem usually, and in this deposits an egg, generally inserting it under the epidermis concealed from view. Here the egg hatches in a few days, and the young thrips works its way out and begins to feed. The thrips larvae suck the juices of the plants in the same manner as do the adults, and, since they feed continuously, their growth is rapid. In one or two weeks, depending upon the temperature, they cease feeding and seek a suitable location in which to transform to the final stage of the nymph and from that stage to the adult. The life cycle from the time of deposition of the eggs until the maturing of the adult has been found to require, under the most favorable conditions—that is, in a warm temperature—about three weeks. Half a dozen or more generations might thus be produced during a season.

It should be added in regard to the life history of this thrips that infestation may be complicated by the attacks of other insects, such as the red spider, when growing in greenhouses (see Pl. XXVI, middle figure) or by cutworms and wireworms in the field (see Pl. XXXII).

Besides onions and related plants, this thrips attacks cabbage, cauliflower, parsley, cucumber, melon, pumpkin, squash, kale, turnip, tomato, seed beets, blackberry, and strawberry.

Of ornamental plants it does much injury to carnations and roses and more or less injury to aster, blanket flower (Gaillardia), honeysuckle (Lonicera), daisies, nasturtium, narcissus, mignonette, candy-
tuft (Iberia), four-o’clock (Mirabilis), and cone-flower or golden-glow (Rudbeckia). Very serious injury is frequently committed to cucumbers and carnations in greenhouses, the damage sometimes amounting to the destruction of entire plantings.

Among field and forage crops, tobacco has been injured by this thrips in Europe, but not in America, so far as we know, and there are records of occurrences on timothy and other grasses, clover and sweet clover, and wheat. It also breeds on a great variety of weeds, a list of which would fill considerable space.

**NATURAL CONTROL.**

It is well known that rain, and especially sudden and driving storms, frequently destroys great numbers of this insect. This has come under the notice of practically everyone who has studied thrips. Among other methods of natural control are ladybirds of several species, the spotted ladybird (Megilla maculata De G.) (fig. 2) leading in this respect. About second in importance is the so-called insidious flower bug (Triphleps insidiosus Say). There is also a
natural parasite which has only recently been discovered by Mr. Russell, of this bureau. It is known as *Thripoctenus russelli* Crawf. (See fig. 3.) A long list of other insect enemies might be added.

**TREATMENT.**

The methods of treating onion fields affected by the onion thrips are complicated. Kerosene emulsion, whale-oil or fish-oil soaps, and tobacco or nicotine extracts are good remedies. Because of their minute size thrips are difficult to reach except in their younger stages; hence remedial measures should be undertaken early in the season to act as preventives rather than cures. The habit of the thrips of concealing themselves in flowers and other parts of plants, such as the sheaths of onion leaves, increases this difficulty.

Too great stress can not be laid on the value of clean methods of field management, as the onion thrips feeds on nearly all vegetables and many flowering plants and is a pest in greenhouses. It develops also on weeds of various kinds. After the onion crop is gathered, useless material—culls, tops, and injured plants (see Pl. XXVIII, fig. 2)—should be promptly destroyed by burning and not left where the insects can spread to neighboring plants, to reinfest onions or other susceptible crops when these are planted the following season.

Early planting is of service, especially northward. Manure and other fertilizers should be freely used to stimulate early growth. Plate XXVIII, figure 1, shows the age at which onions are usually first attacked by migrating thrips.

With an insect capable of sustaining life on such a variety of vegetation, it is difficult to find an alternate crop plant that is not likely to be injured. For alternates, cabbage, cauliflower, strawberry, and cucumber and other curcubits should be avoided; also ornamental plants, particularly roses and carnations, as all of these are much favored by thrips. These plants should not even be grown in the vicinity of onion fields. Certain other vegetables, however, such as potato, sweet potato, peas, beets, and spinach, although they may be attacked by the adults, are not, as a rule, materially damaged.

Onion growers should be able to conduct remedial work with the aid of the instructions herewith, provided they employ the proper sprayers for the purpose. Agents who have been working on the onion thrips for four years past, and especially during the years 1910-1912, met with much success with the nicotine sulphate solutions. The formula first used in 1910 was—

*Formula No. 1.*

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<td><strong>Nicotine sulphate</strong></td>
<td><strong>10 ounces.</strong></td>
<td><strong>Whale-oil soap</strong></td>
<td><strong>5 pounds.</strong></td>
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<tr>
<td><strong>Water</strong></td>
<td><strong>50 gallons.</strong></td>
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1 Where nicotine sulphate is mentioned in the formula a solution containing 40 per cent nicotine is understood.
Afterwards it was ascertained by Mr. M. M. High, working in Texas and Indiana, that the solutions that have been most successfully used are formulas No. 2 and No. 3.

**Formula No. 2.**

- Nicotine sulphate: 3.2 ounces.
- Cresol soap: 3 pints.
- Water: 50 gallons.

**Formula No. 3.**

- Nicotine sulphate: 4.3 ounces.
- Whale-oil soap: 4 pounds.
- Water: 50 gallons.

In the case of formula No. 2 some time is saved because it is not necessary to dissolve the soap, it being a liquid. With No. 3 the whale-oil soap must be shaved into small particles and heated before a solution is formed. Where a semiliquid or "potash" soap is used, this difficulty is not encountered. The cresol soap is somewhat the better as a "spreader," but should be purchased with care and the correct strength obtained (85 per cent cresol soap) in order to secure the best results. A good quality of whale-oil soap gives good results, and it is only a question as to which soap is more available on the instant needed and how valuable time is with the grower. When spraying is once begun it should be continued at intervals of from 7 to 10 days, in case there is no heavy rainfall during this period, and no surrounding breeding host for the species. The spraying should, as a rule, be continued up to 3 or 4 weeks of harvest time.

In spraying for thrips the nozzles should be held well down upon the plants and the spray applied with as much force as possible. The addition of soap is chiefly for action as a spreader and as a "sticker" or adhesive, and the nicotine acts better at this strength. It does not adhere to the plants when used alone. The soap is also insecticidal.

Plants sprayed with nicotine sulphate combination present a striking contrast to those which are not so treated. In Maryland, near the District of Columbia, a single spraying of nicotine sulphate gave similar results, the plants doing better and the insects being killed to a larger extent than by the use of other insecticides. Kerosene emulsion has sometimes proved a failure in Colorado and elsewhere and is, moreover, difficult to make with hard or alkaline water. Experiments with other nicotine solutions, 1 part to 128 parts of water, gave in one case as high as 86 per cent of young thrips killed.

The practice of growing onions by starting them in sets is one of the chief causes of early injury by the onion thrips. Considerable
injury, however, may be prevented by dipping the sets, about a week before planting, in nicotine sulphate at about the same strength as is used in spraying, and then giving two dippings in the same insecticide at planting time, or in almost any other of the solutions which have been mentioned, including kerosene emulsion.

Knowing the preference which the onion thrips displays toward cabbage and cauliflower, neither of these two crops should be grown contiguous to onions. Plate XXVII, figure 1, shows plainly the undesirability of this, as each serves as a breeding place for the onion thrips, and if the thrips first attack the onions they will pass over to the cabbage fields adjoining. Such combination will prove, other things being equal, that the thrips will have abundant opportunity for wintering over to attack the early plants of the next year.
A high-growing crop like corn may be used as a protection for a field of onions from another field infested by the thrips.

The value of irrigation and the use of other remedies are shown in illustrations which follow.

Plate XXVII, figure 1, is a good illustration of the tops of onions nearly dead (at the left) and the thrips migrating, feeding, and spreading to the adjoining cabbage and shows the undesirability of growing onions alongside of cabbage.

The question of the best spraying machines, nozzles, and other portions of an outfit for use on onion fields has not been quite satisfactorily solved. What will do well in one district may not be so efficient in another. Plates XXIX and XXX, figure 1, illustrate a single horse or mule hand-sprayer used at Rocky Ford, Colo., by Mr. Marsh, which has been found by him the most suitable for use against the onion thrips in that locality, while Plate XXX, figure 2,

![Image of Seed-corn maggot](image_url)

**FIG. 6.—Seed-corn maggot (Pegomya fusceps):** 
- a, male fly, dorsal view;  
- b, female, lateral view;  
- c, head of female from above;  
- d, larva, from side;  
- e, anal segment of larva;  
- f, anal spiracles;  
- g, cephalic spiracles;  
- h, puparium. All much enlarged. (Author's illustration.)

...a two-horse power-sprayer, is shown in operation against onion thrips, with nozzles properly held. This was used successfully by Mr. High in Texas.

Two-row and four-row attachments for an onion sprayer are shown in figures 4 and 5, and the types of nozzles most suitable for use on an onion sprayer in Plate XXVII, figure 2.

**ROOT MAGGOTS.**

Several forms of root-feeding maggots have a special tendency to attack onions; some of them, however, are general feeders. The imported onion maggot (Pegomya cepetorum Meade) is very destructive to nearly all forms of the onion family. Nevertheless there are quite as many, if not more, records of the seed-corn maggot doing the more abundant injury to onions, as well as to root crops in general and to many seeds.
INSECTS INJURIOUS TO THE ONION CROP.

The seed-corn maggot. 

(*Pegomya fusciceps* Zett.)

The seed-corn maggot (*Pegomya fusciceps* Zett.) has been so named because it was first observed attacking the sprouting seeds of corn, but it often attacks onions and cole crops, working in the roots and stalks beneath the earth’s surface. When seeds are found which fail to develop, the grower, if careful, will discover a small white maggot of this species or of the related cabbage maggot. It is about equally injurious to beans and has been named the “bean fly.” Other plants which it particularly injures are cabbage, turnip, radish, peas, beets, seed potatoes, and many others. The insect has been introduced from abroad and is well diffused throughout the United States, from Maine to Washington State and southward. It resembles the common house fly very much in appearance. It is evident that this species, since its first coming into prominence, in about 1902, although known here many years before, is greatly on the increase.

In its earlier stage the seed-corn maggot resembles the house fly. The maggot is footless and cylindrical, presenting in profile the appearance of the letter **d**. It measures, when clear, about 0.25 inch in length and about 0.04 inch in width. The color is pale yellowish or white. The maggot transforms to a dark larval puparium, shaped as shown in figure 6 at **h**. The difference between the sexes is quite prominent, as evidenced by figure 6, **a** and **c**.

The imported onion maggot. 

(*Pegomya cepetorum* Meade.)

The imported onion maggot is nearly as troublesome in the northern belt as is the seed-corn maggot. Its injury, which constitutes a very important drawback to the culture of onions, is accomplished.
by the consumption of the bulb (fig. 7), inducing subsequent decay of the affected portions and their very frequent destruction.

The fly (fig. 8, a) and the maggot resemble the preceding species, although their average size is a little larger. The length of the fly's body is about three-sixteenths and the wing expanse nearly three-eighths of an inch. The male is gray, with black bristles and hairs; he has a white face with black hairs, and there are three dark lines on the body between the wings and a row of black spots on the abdomen. The female is a little the larger, and inclined to dark yellowish, with a pale yellowish face. The other stages, with particulars, are also illustrated by figure 8.

Two or three generations annually are evidently the rule.

The methods of control prescribed for maggots in general (p. 331) are about all that are necessary for this species. In case of severe
NORMAL ONION PLANTS GROWN IN LARGE POT TO PREVENT INFESTATION BY THRIPS IN VICINITY. (ORIGINAL.)
INFESTED ONION FIELD, SHOWING DEFECTIVE BULBS COMPARED WITH NORMAL BULB. REDUCED. (ORIGINAL.)
Onion leaves showing injury by Onion Thrips at right, Uninjured leaf at left, and leaf injured by Red Spider at middle. (Original.)
FIG. 1.—ONION AND CABBAGE FIELDS ADJOINING, EACH SERVING AS A BREEDING PLACE FOR ONION THRIPS. (ORIGINAL.)

FIG. 2.—TYPES OF NOZZLES USED IN SPRAYING FOR THE ONION THRIPS. REDUCED. (ORIGINAL.)
FIG. 1.—Onions when first infested by migrating thrips in June. (Original.)

FIG. 2.—Onions in crates, with the tops left in piles highly infested with thrips eggs and adults. (Original.)
Two-Row Field Sprayer Used Against the Onion Thrips. (Original.)
FIG. 1.—Two-Row Field Sprayer in Action Against the Onion Thrips. (Original.)

FIG. 2.—Power Sprayer in Operation Against the Onion Thrips, the Nozzles Properly Held. (Original.)
CUTWORM MOTH.

[The form shown below is one of the commonest forms of Euxoa, known as E. tessellata. The upper form is known as E. punctigera. Enlarged. (Original.)]
ONION PLANT FROM KNOX, IND., SHOWING SO-CALLED PATHOLOGICAL CONDITIONS AFTERWARDS FOUND TO BE DUE TO WORK OF WIRE-WORMS AT ROOTS. REDUCED. (ORIGINAL.)
infestation other remedies might be necessary. The flies are probably attracted to old onion beds and to crop remnants; hence clean field methods are advisable.

THE BLACK ONION FLY.

*(Tritoxa flexa* Wied.)*

The black onion fly (*Tritoxa flexa* Wied.) has been noted as an enemy to onions as early as 1865, which fully accounts for its ravages. The probabilities are that it is often confused with the other two species which feed on onions, *Pegomya fusciceps* Zett. and *Pegomya brassicae* Bouché, as it is likely to be mistaken for them unless a strong lens is employed. The fly was given its scientific name by Wiedmann in 1830. Its injury to onions in this country was first noted in Illinois. Unlike most of the other species, it is native and is recorded as occurring in New Jersey, Ohio, Illinois, Pennsylvania, and Minnesota. It is evidently nearly restricted to the Northern and Middle States, and no injuries have been observed in New Jersey to the writer's knowledge. The adult belongs to the family Ortalidae. It is almost entirely black, with the exception of three narrow, oblique, hyaline white stripes on each wing. The body is slender, as are also the legs, head, and eyes, the latter being somewhat prominent. The fly measures fully one-third inch in length and has a wing expanse of one-fourth inch. Its appearance is sufficiently indicated in figure 9, at *a*, the larva at *b*, and the pupa at *c*. The cephalic tubercles shown at the apex number 11. This species differs practically from the others which have been and will be mentioned by the fact that it continues to live in onions in storage, and also that it appears to be restricted to this plant, with the possible exception of garlic.

In regard to remedies, it is reported that water applied boiling hot to the young onion plants will destroy the maggots without harming the plants. Another suggested remedy is the pulling up of affected plants when, from their drooping state, it becomes manifest that maggots are at work in their bulbs, the pulled plants to be promptly destroyed by burning.

Although no test of remedies has been found possible in this bureau, we can conveniently assume from analogy that remedies advised for root maggots (p. 331) will be found of value. When the insects are attacking stored onions bisulphid of carbon can be used as a fumigant.

THE BARRED-WINGED ONION FLY.

*(Chatopsis anea* Wied.)*

The barrel-winged onion fly is evidently, like the seed-corn maggot, a species which may breed normally in decomposing vegetation, but
which at times, and less frequently than in the case of the species just cited, is injurious to useful crops. Its first identification with injury was to oats in Ohio in 1886. It is frequently associated with injuries by other species, following the attack of more injurious insects, such as the sugar-cane beetle\(^1\) in corn and cane. Until a decade ago (1902) known injury was confined to cereals, including wheat, but during 1899 onions were considerably injured by this maggot in southern Michigan.\(^2\) One grower at Climax, Mich., composted 700 bushels of onions because of the ravages of this insect. His entire crop for 1900, amounting to 2,000 bushels, was destroyed, and he was obliged to abandon onion raising for a time. Other onion growers in that region experienced similar trouble with this pest.

This species belongs to the dipterous family Orthidae. The adult is a common, metallic, grayish-black, two-winged fly, with the wings banded. The larva is whitish or yellowish and measures about five-sixteenths of an inch in length; and the puparium is darker, polished brown in color.

The insect ranges from Canada on the north to Cuba and the Bermudas in the south, and from the Atlantic to the Pacific.

The eggs have been observed in central Ohio during the second week of May, and, according to the observations of Mr. W. B. Alwood, they are inserted just under the edge of the leaf sheath in groups of from two to five, and sometimes singly. The egg is pearly white, five times as long as wide, and tapers to a point at each end.

As soon as the maggots are hatched they distribute themselves under the sheath, sometimes to the number of 10 or 15, thus exhausting the juices of the plant, the outer leaves becoming brown and seared, after which the whole stalk finally withers away. Here they transform to puparia and in due time issue as adults.

The observations conducted on this insect by Prof. R. H. Pettit in Michigan show that the maggots pass the winter inside of the onions, and since adults are to be seen at widely different seasons this affords evidence that the insect, like other root-feeding maggots, may produce several generations annually.

The remedies mentioned as of greatest value in the treatment of maggots in general (p. 331) are indicated for this species. As soon as plants show infestation they should be pulled up and destroyed. The fact that hibernation takes place inside the onions makes it desirable to destroy, in the fall, all onions too much injured for food, and to disinfect the better ones with bisulphid of carbon.

Owing to the difficulty of destroying root maggots and other subterranean pests and the cost of chemicals for the purpose, growers depend largely upon methods of prevention. To be thoroughly effective these methods should be employed before the fly's eggs are laid.

A common method for deterring the parent flies from depositing eggs consists in placing sand soaked in kerosene—a cupful (6 fluid ounces) to a bucket of dry sand—at the base of the plants, along the rows. This mixture will also kill young maggots attempting to work through it.

For all forms of root maggots which we are considering a carbolized form of kerosene emulsion is effective. This is prepared by adding to 1 pound of soap, boiled in 1 gallon of water, one-half gallon of crude carbolic acid, and diluting the whole with from 35 to 50 parts of water. This mixture is applied about the stalks of the plants affected. It is best to use it a day or two after the plants are up, or are transplanted, and to repeat every week or 10 days until about the third week in May in the North. Farther south these applications must be made earlier in the season.

Mineral fertilizers are useful as deterrents, particularly when employed just before or after a shower has thoroughly wet the ground. The principal fertilizers for this purpose are kainite, nitrate of soda, and sulphate or chlorid of potash. They may be used as top dressings before planting, or if not employed until afterwards they should be applied as nearly as possible to the roots, the earth being turned away from the plants for this purpose. These fertilizers, also, by stimulating plant growth, facilitate recuperation from root-maggot attack.

There is great danger in the use of other fertilizers, such as stable manure, cottonseed meal, and organic fertilizers comprising moldy leaves, dead plant life, and even fish scrap. In an account of this species published several years ago the writer stated that numerous instances had come to his notice—and still more noticeable instances have accumulated lately, and a long list could be furnished—where the presence of the insect could be traced to the causes above mentioned. It is advisable, therefore, to avoid the use of manure of any kind, rotted leaves, or other organic fertilizer, and, above all, to avoid further planting in fields which have been infested or contain diseased onion plants, or where cabbage, cowpeas, or any other plants have been turned under.

As soon as seed fails to appear at the proper time or the plants show signs of wilting and maggots are found to be present, the seed
may be hoed out or the injured plants pulled and destroyed, together with the younger maggots.

Most of the methods mentioned above have been used with success against onion maggots and other root-feeding species, and are all that are required in many cases of ordinary infestation of vegetable roots.

Other remedies have been tested; mostly, however, without avail.

**CUTWORMS.**

Onions are subject to serious attacks by certain cutworms. These appear sometimes in great numbers in spring and early summer and frequently do severe injury before their ravages are noticed. Their method of attack is to cut off young plants at about the surface of the ground, and as cutworms are voracious feeders, they may destroy many plants in a single night, frequently more than they can devour. During the past two years these insects, working generally throughout the United States, destroyed hundreds of thousands of dollars worth of crops. By the timely application of remedies in some of the principal trucking regions, e. g., in southern Texas, in the vicinity of Rocky Ford, Colo., in California in the vicinity of Sacramento, in Stark County, Ind., and in some other regions, these insects were readily controlled, large areas being successfully treated.

Of the cutworms which were most injurious in Stark County, Ind., the most abundant in 1911 was *Euxoa punctigera* Walk. Of other species, *Euxoa tessellata* Harr. and *Euxoa messoria* Harr. occurred in about equal numbers but were not so numerous as the one first mentioned. The last is called the dark-sided cutworm, and has been an important onion pest, to our knowledge, since 1885. Another very injurious species in some years is the variegated cutworm (*Peridroma margaritosa* Haw.). No very careful attention has been paid to the principal species injurious to onions in other regions. There is perhaps a slight difference in the habits of all of these species in regard to the time of attack. The adult, or moth, of *Euxoa punctigera* is shown in Plate XXXI, above, and the adult of *Euxoa tessellata* in the same plate, below.

The usual method of control is by the use of poisoned baits. To a bushel of bran 1 pound of arsenic or Paris green is added and mixed thoroughly into a mash with 8 gallons of water, in which has been stirred half a gallon of sorghum or other cheap molasses. After the mash has stood several hours it should be scattered in lumps of about the size of a marble over the fields where injury is beginning to appear and about the bases of the plants set out. It should be applied late in the day, so as to place the poison about the plants over night, which is the time when the cutworms are active. The application should be repeated if necessary.
When cutworms occur in unusual abundance, which happens locally, and sometimes generally in some seasons, they exhaust their food supply and are driven to migrate to other fields. This they do, literally in armies, assuming what is called the army-worm habit. At such times it is necessary to treat them as army worms. While the methods which have been advised are valuable in many cases, they may be too slow to destroy advancing hordes of cutworms, and other methods must then be employed. These include trenching, ditching, the plowing of deep furrows in advance of the traveling cutworms to trap them, and the dragging of logs or brush through the furrows. If the trenches can be filled with water, the addition of a small quantity of kerosene, so as to form a thin scum on the surface, will prove fatal. In extreme cases barriers of fence boards are erected and the tops smeared with tar or other sticky substance to stop the cutworms as they attempt to crawl over.

Clean cultural methods and rotation of crops are advisable, as also fall plowing and disk ing. Many cutworms can be destroyed where it is possible to overflow the fields. This is particularly applicable where irrigation is practiced.

Cutworms caused considerable damage to onions in northern Indiana in 1911 and 1912 just after the plants had emerged from the soil. In the sections where injury was greatest the growers were no more familiar with the cutworm problem than with the culture of onions—this being their first year in growing this crop for market. In the regions where onions were grown previously the cutworms were prevalent also, but were controlled by the use of the bran-mash bait that was used so successfully last year in the same fields. About 1,000 acres were treated for cutworms by the use of the bran mash, the formula being as before, 1 pound white arsenic, 1 bushel bran, and from $\frac{1}{2}$ to 1 gallon corn sirup with enough water for moistening. Some used Paris green instead of the white arsenic and obtained excellent results. Some growers suffered a loss of from one-third to one-half of their crops from cutworm ravages alone. This could have been averted by the use of the bran mash in time.

**WIREWORMS.**

The term "wireworm" is applied to numerous forms of elongate wirelike creatures, the larvæ of snapping beetles or "snap bugs," and is given them because of their firm texture, so different from that of many insect larvæ.

There are many species of these insects and quite a number of them have shown some preference for onions. More often, however, they do their greatest damage to truck crops following land which has

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1 Coleoptera, family Elateridæ; genera Drasterius, Melanotus, Cardiophorus, et al.
been in grass or meadowland. One of these species, known as the wheat wireworm (*Agriotes mancus* Say), has been found very injurious to onions in Stark County, Ind. It is shown in figure 10 about four times natural size. The life histories of the different genera have not been thoroughly worked out. Wireworms injure plants by the destruction of the roots and are very difficult to treat satisfactorily. Among direct applications some forms of salts and even brine, not too strong, have been used successfully in some regions. Salty fertilizers, such as kainit and nitrate of soda, are of value. (See p. 331 for discussion.) Clean cultivation, crop rotation, and poison baits, the latter discussed on page 332, are always to be recommended, as for cutworms. According to recent observations made by Mr. J. E. Graf on the sugar-beet wireworm in California, clean culture against the adults, compelling them to seek shelter elsewhere and exposing them to the attacks of their natural enemies such as birds, appears to be for that species the most practicable remedy, the efficiency of which may be increased by fall plowing and early planting.

In Plate XXXII an injured onion plant is illustrated to show so-called "pathological conditions," found afterwards to be due to wireworms at the roots.

**OTHER INSECTS.**

Onions at present are little injured by insects other than those which have been mentioned in the foregoing columns. We might add such common pests, however, as the tarnished plant-bug, some forms of true bugs, and the strawberry thrips. The last-mentioned has, however, been frequently misquoted in mistake for the onion thrips, the two species being quite different.