# MANUAL OF VEGETABLE-GARDEN INSECTS

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# MANUAL OF

# VEGETABLE-GARDEN INSECTS

BY

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AND

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To

JAMES FLETCHER

STUDENT AND TEACHER

FOR A QUARTER OF A CENTURY

ENTOMOLOGIST AND BOTANIST TO THE DOMINION OF CANADA,

NOTED

FOR HIS STUDIES IN ECONOMIC ENTOMOLOGY

AND FOR THE CLEARNESS AND ACCURACY OF THE

PRESENTATION OF HIS WORK TO THE PUBLIC

AND ENDEARED TO THE YOUNGER GENERATION OF WORKERS

BY HIS KINDLY INTEREST AND ENCOURAGEMENT,

THIS BOOK IS DEDICATED AS A TOKEN

OF THE AUTHORS' ESTEEM

# PREFACE

In the present work we have attempted to bring together in concise and usable form what is known in regard to the habits, life history and control of the insect enemies of vegetable-garden crops in the United States and Canada. Much of this information has been published in technical journals and in the bulletins and circulars of the State Experiment Stations and Federal Government, where it is available only to the special student who has access to the few large libraries that collect and preserve this type of literature. We have endeavored thoroughly to digest this mass of material and present it in a form adapted to the needs of the gardener and vegetable-grower.

In regard to methods of control we have tried to eliminate as far as possible useless and impracticable recommendations and include only those found to be effective under commercial conditions or such as would seem to be worthy of trial. It has seemed better to state frankly that the problem of control in certain cases has not been solved than to suggest remedies that would lead to disappointment.

The chapter on cutworms and the accounts of several others of the lepidoptera were written in collaboration with Dr. Robert Matheson. We are under great obligation to Dr. W. T. M. Forbes for criticism and aid with the lepidoptera; to Dr. E. C. Van Dyke for the determination of beetles; to Mr. Charles

W. Leng for the gift of specimens; to S. W. Frost for the use of photographs; and to many others for similar favors.

The drawings were made by Anna C. Stryke, Ellen Edmonson, Nellie H. Crosby and C. H. Kennedy. Several of the illustrations are from photographs previously published in bulletins by the late Prof. M. V. Slingerland, by Prof. G. W. Herrick and by H. H. Knight.

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CORNELL UNIVERSITY, ITHACA, N. Y.
May 28, 1918.

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## CHAPTER XIX

# MANUAL OF VEGETABLE-GARDEN INSECTS

## CHAPTER I

### GENERAL CONSIDERATIONS

It was estimated by C. L. Marlatt in 1909 that the annual loss caused to vegetable and truck crops in the United States by insect pests amounts annually to 20 per cent of their value, or $68,000,000. This sum includes the cost of insecticides and other expense incurred in fighting vegetable insects.

Insects affect vegetable crops in various ways. They feed on the leaves, devour the roots, tunnel the stems and infest the seeds and fruits. In many cases their injuries to succulent parts of the plant give entrance to decay-producing organisms which greatly augment the damage. Insects also act as carriers of specific diseases, the most remarkable instances of this kind being the transmission of the curly-leaf disease of the beet by the beet leaf-hopper and the carrying over winter of the bacterial wilt of cucurbits by the striped cucumber beetle.

The enemies of vegetables here treated are, with five exceptions, members of that class of animals known as insects. These exceptions are: the red-spider and the mite producing erinose of the tomato, which are Arachnids; snails or slugs, belonging to the molluscs; millipedes belonging to the Myriapoda and the root-knot nematode, one of the true worms.

Some vegetable insects are general feeders, attacking a great variety of plants, but the greater number are more or less restricted to a single family or other closely related group of plants, both wild and cultivated. Thus many beet insects also feed on weeds belonging to the goosefoot family, cabbage insects on weeds of the mustard family, potato insects on wild solanaceous plants and sweet potato insects on wild morning-glories. This fact, that certain insects form more or less definite associations with certain groups of plants, is of great practical importance and must be kept in mind when considering methods of preventing injury. It also explains why clean farming is one of the most important factors in preventing insect injuries to vegetable crops. In fact, clean farming together with proper cultural practices often makes it unnecessary to resort to special remedial measures, or at least renders it possible to obtain more effective results from the use of insecticides.

About 250 species of insects have been recorded as serious enemies of vegetable crops in the United States and Canada but a much larger number may occasionally become injurious. Only the more important species are treated in the following chapters, arranged under the crops to which they are most injurious. Flea-beetles, blister-beetles, cutworms and other general feeders are discussed in separate chapters.

# CHAPTER II

## INSECTS INJURIOUS TO CABBAGE AND RELATED CROPS

In this chapter are treated the more important insect enemies of cabbage, cauliflower, brussels sprouts, kohlrabi, kale, collards, radish, turnip, mustard and horse-radish. With the exception of horse-radish, these form a natural group of food plants that serves as the common host for a large number of insects, which, although showing a preference for certain crops, can also thrive on the others. Many cruciferous weeds are also food plants of these pests and may serve as centers of infestation from which the insects spread to cultivated crops. The most important enemies of cabbage and related crops in this country have been imported from the Old World but some of the native insects have found in these succulent vegetables satisfactory food plants. Of European origin are the cabbage root-maggot, the common cabbage worm, the diamond-back moth, the cabbage aphis, the cabbage curculio and the cabbage seed-stalk weevil. The cabbage webworm had its original home in the Old World tropics and the harlequin cabbage bug spread into the United States from Central America during the last half century.

Horse-radish has relatively few insect enemies, the most important being the harlequin cabbage bug and the horse-radish flea-beetle.

Cabbage and related crops are often seriously injured by cutworms and flea-beetles. These insects are treated in Chapters XV and XVII.

## The Imported Cabbage Worm

*Pontia rapæ* Linnæus

The common white cabbage butterfly of the United States and Canada is a native of the Old World. It was first introduced into America at Quebec about 1860. Later independent introductions occurred at New York in 1868, at Charleston, South Carolina, in 1873 and at Apalachicola, Florida, at about the same date. From these points as centers the insect spread rapidly and by 1885 it occupied practically the whole territory east of the Pacific slope. The favorite food plant of the imported cabbage worm is cabbage, but it also attacks cauliflower, turnip, horse-radish, radish, mustard, gillyflower, nasturtium and sweet alyssum and it also feeds on a number of wild plants belonging to the mustard family. The caterpillars are sometimes found abundantly on mignonette.

The imported cabbage worm hibernates in the pupal state and the white butterflies emerge in early spring, being among the first to appear in our fields and meadows. Their flight is low and unsteady and they alight at frequent intervals. The female deposits her eggs singly on the under surface of the leaves of the food plant. The egg (Fig. 1) is lemon yellow in color, nearly $\frac{1}{25}$ inch in length and attached to the leaf at one end. It is broadest two thirds of the distance from the base, and then tapers to the top, which is flattened. The surface is beautifully ridged lengthwise and crosswise. The egg hatches in about a week and the pale greenish yellow caterpillar begins feeding on the under surface of the leaf, which it skeletonizes. A little later the caterpillars are able to eat out holes in the leaves, only the larger veins remaining. When the plants are

Fig. 1. — Eggs of the imported cabbage butterfly (× 15).

heading, the caterpillars often burrow rather deeply into the head in search of the tenderest leaves. They become full grown in ten to fourteen days. The mature caterpillar (Fig. 2) is about an inch in length, velvety green in color and marked with a greenish yellow stripe down the back and an interrupted one on each side. When ready to pupate, it seeks some sheltered place — under a cabbage leaf or on the underside of fence boards — in which to transform to the chrysalis. When a cabbage patch is near a house, these chrysalids are often found in great numbers under the edge of the clapboards. When about to transform, the caterpillar first spins a carpet of silk over the surface chosen and fastens a delicate silken girdle around its body at the first abdominal segment, holding itself tightly in position (Fig. 3). After the transformation is complete the chrysalis is held in place by this girth. The pupa (Fig. 4) is about $\frac{4}{5}$ inch in length and of a pale green or yellowish brown color. Except in the case of those chrysalids which winter over, transformation to the butterfly takes place in a week to twelve days. The butterfly has an expanse of about $1\frac{3}{4}$ inches. The wings are nearly white in ground color often more or less suffused with yellowish. The tip of the

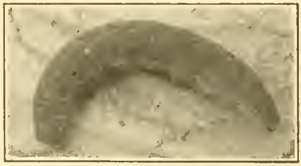

FIG. 2. — Full-grown imported cabbage worm ($\times 1\frac{1}{2}$).

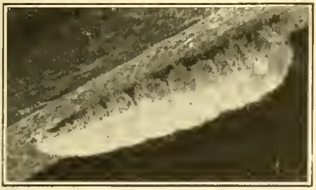

FIG. 3. — Imported cabbage worm suspended for pupation ($\times 1\frac{1}{2}$).

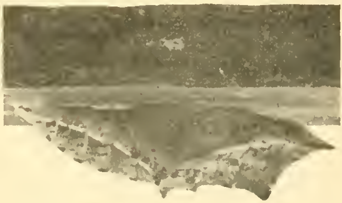

FIG. 4. — Chrysalis of imported cabbage worm ($\times 2\frac{1}{5}$).

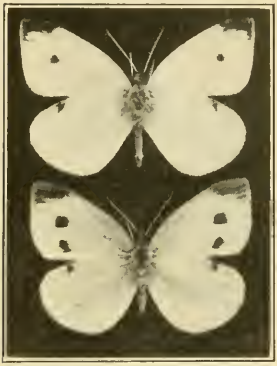

Fig. 5. — The imported cabbage worm butterflies, male above, female below (× 5/7).

front wing is grayish; there are two black spots on the front wing of the female and one in the male and in both sexes there is a black spot near the front margin of the hind wing (Fig. 5). Spring males are smaller and sometimes unspotted. In New England the cabbage butterfly has three broods annually and in the South there are said to be six.

*Control.*

Cabbage worms may be easily killed by spraying with paris green, 1 pound in 50 gallons of water, or arsenate of lead (paste), 4 pounds in 50 gallons of water. The first application should be made soon after the plants are set out and repeated whenever the worms become numerous. The poison may be applied in the form of a dust diluted with some inert material, such as flour, plaster or hydrated lime, but is not so effective when used in this way. Chemical analysis of sprayed plants has shown that there is practically no danger from eating cabbages that have been treated with an arsenical. In the home garden pyrethrum, hellebore or hot water (130° F.) will be found convenient remedies. When only a few plants are grown, hand-picking is often the cheapest and easiest way of destroying the worms.

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U. S. Bur. Ent. Circ. 60. 1905.
U. S. Farm. Bull. 766. 1916.

## The Potherb Butterfly

*Pontia oleracea* Harris

Before the introduction of the imported cabbage butterfly, this species was abundant in the northern United States and Canada east of the Rocky Mountains but soon became rare throughout the greater part of its range. The caterpillar of this species closely resembles that of the imported form but lacks the yellowish dorsal stripe. The butterfly has the upper surface of both pairs of wings and the under surface of the front wings nearly pure white. The hind wings are usually marked on the underside with gray stripes extending along the veins. Rarely the under surface is pure white (Fig. 6).

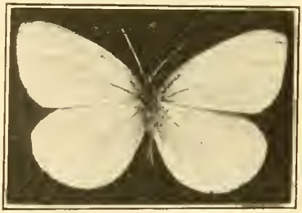

Fig. 6. — The potherb butterfly (× ¾).

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Riley, U. S. Ent. Rept. for 1883, pp. 115–117.
Scudder, Butterflies of Eastern U. S., 2, pp. 1191–1204. 1889.

## The Southern Cabbage Butterfly

*Pontia protodice* Boisduval and Le Conte

This cabbage-feeding caterpillar is widely distributed throughout the United States but is more common southward, where it often causes serious injury to cruciferous crops. As in the case of the potherb butterfly, this species has decreased in numbers and importance since the introduction of its European relative. The butterfly is known as the checkered white. The ground color of the wings is white in the male and dirty white in

FIG. 7. — The southern cabbage butterfly, male (× $\frac{5}{8}$).

the female and the upper side of the fore wings in both sexes is marked with several black spots (Fig. 7). The caterpillar is about an inch in length, purplish green in color marked with four longitudinal greenish yellow stripes and covered with small black dots.

The last two species may be controlled by the same measures as recommended for use against the imported cabbage worm.

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Riley, U. S. Ent. Rept. for 1883, pp. 114–115.
Scudder, Butterflies of Eastern U. S., 2, pp. 1163–1170. 1889.

## THE CABBAGE LOOPER

*Autographa brassicæ* Riley

This well-known cabbage pest is a native American insect widely distributed throughout the United States and occurring as far south as Mexico. In some localities, especially in the South, it is the most serious insect with which the grower of late cabbage and cauliflower has to contend. In addition to cruciferous plants such as cabbage, kale, cauliflower and turnip, the cabbage looper may also occasionally cause serious injury to lettuce, celery, beet, pea and parsley. It also feeds on tomato, potato, asparagus, dandelion and dock and sometimes attacks carnation and mignonette in greenhouses. On Long Island it is especially injurious to late cauliflower and to lettuce that has been transplanted from coldframes into the forcing houses.

The insect as a rule passes the winter in the pupal stage, although it is not improbable that occasionally some of the later emerging moths may hibernate. In any case, only a relatively small number survive the winter and consequently the first brood of the season is small and causes comparatively little injury. The female moth deposits her small whitish eggs singly or in small groups usually on the upper side of the leaves. The egg (Fig. 8) is about $\frac{1}{50}$ inch in diameter, pale greenish yellow or nearly white in color, nearly circular in outline and rounded above. The surface is beautifully marked with a series of ridges radiating from the apex. The length of the egg stage has not been determined but it is probably not far from a week or ten days. The young larvæ are pale green in color and feed at first on the outer leaves of the cabbage; as they grow older, they become darker green and are marked with distinct white longitudinal lines. At this time they work in toward the center of the plant, and often bore into the forming head. The full-grown caterpillar (Fig. 9) is about $1\frac{1}{4}$ inches in length. It is pale green in color with a white stigmatal stripe and two dorsal stripes extending the whole length of the body. On each side of the dorsal stripe there is a fine white line. The caterpillar is narrower in front and has the body enlarged toward the posterior end which is bluntly truncate. Although the caterpillars are close relatives of the cutworms, they crawl with a peculiar looping motion like the measuring-worms, due to no prolegs being present on the third and fourth abdominal segments. The caterpillars attain their growth in from two weeks to a month, depending on the temperature.

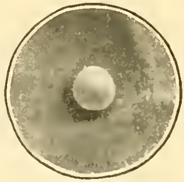

FIG. 8. — Egg of the cabbage looper ($\times$ 10).

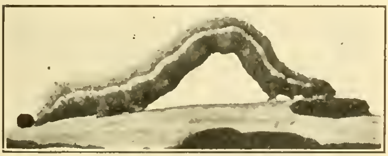

FIG. 9. — Full-grown cabbage looper ($\times$ $1\frac{2}{5}$).

When mature the caterpillar spins a light flimsy semi-transparent cocoon (Fig. 10) of white silk about $1\frac{1}{4}$ inches in length, usually on the underside of the leaf. It consists of two filmy layers, an inner one close to the pupa and an outer one connected with the other by many fine threads. Soon after completing its cocoon, the larva transforms to a dark brown or blackish pupa (Fig. 11) about $\frac{5}{8}$ inch in length. The moth (Fig. 12) emerges in ten days to two weeks; it has an expanse of $1\frac{1}{4}$ to $1\frac{1}{2}$ inches. The front wings are dark brown variegated with lighter brown and bear near the center two silver spots, one oval and the other shaped like a constricted U. Sometimes these spots are united and resemble an imperfect figure 8. The hind wings are mouse-colored with bronze reflections in certain lights.

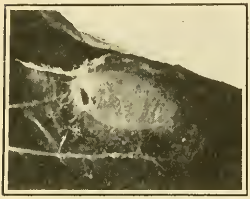

Fig. 10. — Cocoon of the cabbage looper from which the moth has emerged ($\times \frac{2}{5}$).

There are said to be three broods of the insect annually on Long Island, New York, and four at Washington, D. C. As only a relatively small number of pupæ survive the winter, the first brood caterpillars are generally not abundant enough to cause much injury and are usually overlooked entirely. The succeeding broods increase rapidly in numbers and importance, the last being the most destructive. Towards the end of the season, the broods overlap so that all stages of the insect are present on the cabbage plants at the same time.

Fig. 11. — Pupæ of the cabbage looper ($\times 2\frac{4}{5}$).

The cabbage looper is held in check by several parasites and by a disease. Diseased caterpillars at first turn yellowish and later take on an ashy hue (Fig. 13). They become inactive, stop feeding and soon die. After death the skin breaks open and the body contents which have become liquid oozes out and becomes smeared on the leaves. Sometimes a large proportion of the caterpillars are destroyed by this disease late in the season.

FIG. 12. — Moth of the cabbage looper (× 1⅓).

*Control.*

The cabbage looper is a difficult insect to poison because the caterpillars refuse to eat leaves coated with an insecticide and move quickly to some part of the plant that has been missed in spraying. Furthermore, it is not easy to spray a cabbage plant so as to cover all parts of the leaves, especially the underside of the outer leaves and those in the forming head. Experiments on Long Island have shown that good results may be obtained by thorough spraying with paris green, 1 pound in 80 gallons of water to which the resin-lime mixture has been added. Some growers dust the plants lightly with pure paris green and have reported satisfactory results from this treatment.

FIG. 13. — A diseased cabbage looper (× 1⅕).

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N. Y. (Geneva) Agr. Exp. Sta. Bull. 83, pp. 667–671. 1894.
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## The Diamond-Back Moth

*Plutella maculipennis* Curtis

In this country the diamond-back moth is rarely more than a minor enemy of cabbage and related crops, but in some parts of its extensive range its injuries are of considerable importance. Apparently introduced from Europe some time before 1854, the insect is now widely distributed throughout the United States and Canada; it also occurs in South America, Australia, New Zealand, South Africa, India, Greenland and Spitzbergen. It seems able to maintain itself wherever its food plants are grown, whether in the tropics or in the arctic region. In England the insect is also known as the turnip fly and in some parts of the United States it is called the shot-hole worm. Besides cabbage, cauliflower, brussels sprouts, rape, horse-radish, radish, kale, mustard, turnip and water cress, the insect attacks stocks, wall-flowers, sweet alyssum and candytuft. It sometimes becomes very troublesome on these plants in greenhouses.

The diamond-back moth hibernates in the adult condition hidden away under the cabbage leaves left in the field. The moths appear in the spring as soon as food plants are available on which to deposit their eggs. The moth (Fig. 14) has an expanse of about $\frac{5}{8}$ inch. In the male the front wings are ash-colored dotted with minute dark spots and have a yellow stripe outlined by a wavy dark line extending along the hind border. When the wings are closed, the united yellow stripes form a row of three diamond-shaped markings. In the female the front wings are a nearly uniform gray. The hind wings in both sexes are dull gray. When at rest the moth has the wings slightly turned up at the tip and the antennæ are held extended forward. The female moth deposits her minute whitish or yellowish eggs, $\frac{1}{75}$ inch in diameter, singly or in groups of two or three, usually on the leaves. Each moth is capable of laying on an average nearly 300 eggs during a period of one to two weeks. They hatch in three to six days and the young caterpillars first eat holes in the leaf from beneath but do not cut through to the upper surface. Later the upper epidermis dies, turns brown and drops out leaving the leaf riddled with holes. Sometimes in cool weather the young larvæ live as miners in the leaf for two to four days. The caterpillars are very active when disturbed, wriggle from the leaf and suspend themselves by a thread till the danger has passed. The larva reaches maturity in nine to twenty-eight days. It is then only about $\frac{3}{8}$ inch in length, pale green in color and sparsely clothed with small, erect black hairs; the head is brownish yellow mottled with black. The larvæ become mature in about a month and spin their beautiful open-work cocoons (Fig. 15), so loosely woven that the pupa can be plainly seen within, on the underside of the leaves. In the summer from four to thirteen days are spent in the pupal

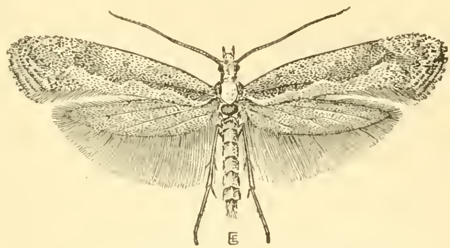

FIG. 14. — The diamond-back moth, male ($\times 3\frac{3}{5}$).

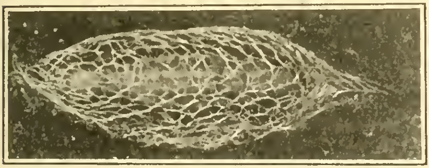

FIG. 15. — Cocoon of the diamond-back moth showing the larva within ($\times$ 4).

stage. In the northern states there are two or three broods annually, which overlap to a considerable extent, but in the tropics breeding is almost continuous. In Colorado there are seven generations annually. On Long Island, larvæ and moths are often abundant on cauliflower until early December. The insect is usually more destructive in dry seasons than when rains are abundant. On cabbage the greatest injury is usually inflicted early in the season while the plants are small, but in the case of cauliflower the late broods are the most troublesome.

A closely related species, *Plutella armoracia* Busck, has been reported as injurious to horse-radish in Colorado. Its habits are similar to those of the diamond-back moth.

*Control.*

Experiments in Colorado have shown that the diamond-back moth can be controlled by spraying with 2 pounds of paris green and 6 pounds of soap in 100 gallons of water, or arsenate of lead (paste), 8 pounds in 100 gallons.

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Quanjer, Tijds. Ent. 49, pp. 11–17. 1906.
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## The Cross-Striped Cabbage Worm

*Evergestis rimosalis* Guenée

While widely distributed throughout the United States except in the extreme north, the cross-striped cabbage worm is most abundant and destructive in the southern states. Locally in some years it often causes more injury than the imported cabbage worm and its native relatives. The caterpillars destroy the leaves in much the same way as the common cabbage worm and have an especial fondness for the tender central leaves and forming head, often burrowing into the latter. In addition to cabbage and related crops, this insect has been reported as feeding on nasturtium in California.

The insect hibernates in the pupal stage in a snug cocoon just below the surface of the ground. The moths emerge in early spring — in April in the District of Columbia. The moth (Fig. 16) has an expanse of about an inch. The front wings are pale ocher-yellow in color, marked with an indistinct zigzag brownish line and suffused with various shades of brown, darker towards the middle of the outer margin. The hind wings are nearly transparent towards the base, fuscous at the front angle and marked across the disk with a row of five or six small indistinct dusky spots. The female moth deposits her light yellow, rounded oval eggs about $\frac{1}{20}$ inch in diameter, in circular masses on the underside of the leaves. Each egg-mass contains twenty to thirty eggs which are flattened and overlap. They are semi-transparent and the green of the leaf shows through the mass. The eggs hatch in about six days and the young caterpillars begin feeding on the leaves, eating out long oval holes. The newly hatched larva is of a nearly uniform gray color. When full-grown it is about $\frac{6}{10}$ inch in length, bluish gray above with distinct transverse black stripes, three or more to each segment. On the side a wide stigmatal line of bright yellow extends from the second to the last segment. Beneath, the caterpillar is green mottled with yellowish. In the summer the caterpillars reach maturity in about a month, but in the cooler months a somewhat longer period is required. When full-grown the caterpillar descends to the ground and just below

FIG. 16. — The moth of the cross-striped cabbage worm ($\times 1\frac{3}{8}$).

the surface constructs a tight cocoon into the outer surface of which bits of dirt and sand are incorporated. The cocoon is $\frac{5}{8}$ inch in length by $\frac{3}{8}$ inch in width. The pupa is $\frac{3}{8}$ to $\frac{1}{2}$ inch in length and has the head and wing-cases dark brown and the abdomen light yellowish brown. The summer broods of the insect spend about ten days in the cocoon but the time in the pupal stage has not been determined. It is probably about six days. There are supposed to be three generations annually.

The cross-striped cabbage worm may be controlled by the measures suggested for the imported cabbage worm.

### Reference

U. S. Div. Ent. Bull. 33, pp. 54–59. 1902.

## The Cabbage Webworm

*Hellula undalis* Fabricius

Originally a native of the tropical and subtropical regions of the Old World, the cabbage webworm was introduced into the southern United States shortly before 1895 and now ranges as far north as North Carolina and west to Oklahoma, Texas and southern California. It also occurs in Australia and Guam. This webworm attacks cabbage, cauliflower, collard, turnip, radish, mustard, horse-radish and beet and will feed on shepherd's purse and purslane. It is sometimes destructive to plants in seed-beds.

In the southern United States, the insect hibernates as a pupa in a compact cocoon of white silk attached to the injured plant near the base or situated just below the surface of the ground. The early seasonal history is very imperfectly known and the number of generations annually has not been definitely determined. The moth has an expanse of about $\frac{5}{8}$ inch; the front wings are brownish yellow mottled with darker brown; the hind wings are pale fuscous. The female deposits her eggs singly or in small masses on the leaves of the plant. The egg is about $\frac{1}{50}$ inch in length, flattened and often provided with a distinct nipple-like projection at one end. When first laid it is light yellow or grayish but just before hatching takes on a pinkish brown color. Each female is capable of laying from 300 to 350 eggs. In warm weather the eggs hatch in three or four days.

The young caterpillars begin feeding on the underside of the leaves, eating off the epidermis in small irregular patches. The caterpillars often burrow into the leaf itself, into the leaf-stems and into the developing head. After the first molt, the caterpillar usually covers its feeding grounds with a web of silk on which the excrement and other dirt collect. The caterpillars often attack the bud or heart of the plant, stop its growth and in many cases kill it outright. They sometimes eat out holes in the upper part of turnip roots.

When full-grown, the caterpillar is about $\frac{5}{8}$ inch in length, dull grayish yellow in color, and marked dorsally with five conspicuous brownish purple longitudinal stripes. On the sides and below there are similar but less distinct stripes. The caterpillars become full-grown in about eighteen days and after constructing their cocoons transform in a day or two to pupæ. The pupa is about $\frac{3}{10}$ inch in length and light yellowish brown in color. In the summer the insect spends about six days in the pupal state. There are probably three or four generations a year but the exact number has not been determined under field conditions.

*Control.*

In regions in which the cabbage webworm is likely to appear in injurious numbers, the plants should be protected by frequent applications of arsenicals beginning soon after transplanting. In this way the young caterpillars will be killed before they are able to spin their protective webs. After the webs are spun, it is practically impossible to reach them with a poison spray. Paris green, 1 pound in 50 gallons of water, or arsenate of lead (paste), 4 pounds in 50 gallons of water, will be found effective. In cases of severe infestation it would pay to collect and destroy the stumps and other refuse in the field after the crop is harvested and thus greatly reduce the number of hibernating pupæ.

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## The Garden Webworm

*Loxostege similalis* Guenée

Many kinds of vegetables are injured by a small dark yellow caterpillar feeding under the protection of a silken web. The insect is widely distributed throughout North and South America and the West Indies but is most injurious in the southern states and in the Mississippi Valley. The favorite food plants of the caterpillar are pigweed and careless weed (*Amarantus hybridus*); it also attacks a wide range of cultivated plants, including cabbage, cucumber, melon, squash, pumpkin, sweet potato, potato, tomato, eggplant, beet, bean, pea, lettuce, onion, corn, tobacco, flax, sugar-cane, clover, alfalfa and many grasses.

How the insect passes the winter is not known, though judging from the habits of a closely allied species, *Loxostege sticticalis*, it probably hibernates as larvæ in silken tubes in the ground. In Texas the first brood of moths is on the wing in early May; in Illinois in late May and June. The moth has an expanse of about $\frac{3}{4}$ inch. The front wings are reddish buff marked with several transverse, interrupted lighter lines. The hind wings are lighter in color with darker marginal and discal bands. The eggs are laid on the surface of leaves in bunches of eight to twenty. Hatching takes place in three or four days and the young larvæ at first feed on the under surface of the leaves, skeletonizing them, and spin a silken web inclosing their food. The larger caterpillars devour the entire leaves. They become mature in three or four weeks. The full-grown caterpillar is nearly an inch in length, dull green above and greenish yellow below, marked on the dorsal surface with numerous shining black piliferous spots. The body is marked with a double pale median line and a whitish lateral line. Pupation takes place in a delicate silken cocoon spun among the débris at the base of its food plants. The pupa is brown in color. In the South there are probably as many as five generations while in Illinois Forbes records four broods annually.

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## The Purple-Backed Cabbage Worm

*Evergestis straminalis* Hübner

Although this insect is common throughout the northeastern United States and Canada, it has been reported as injurious only in the maritime provinces. The insect also occurs in Europe. Its food plants include cabbage, turnip and horseradish. When infesting the last, it is known as the horseradish webworm. The caterpillars feed on the leaves, often webbing them together, and sometimes attack the crown boring into the stems and roots. The full-grown caterpillar is about

$\frac{3}{4}$ inch in length, bristly, with the body tapering at both ends. The back is purplish brown to dark greenish black. There is a yellow stripe running through the spiracles and the underside of the body is dull greenish. The head is black, the cervical shield is black on the sides and the body is marked with numerous black tubercles.

The larvæ become full-grown in a little over a month and construct thin silken cocoons covered with dirt at or just below the surface of the ground. The larvæ of the summer brood soon transform to pupæ but those of the fall brood remain in the larval condition until the following spring. The pupa is about $\frac{1}{3}$ inch in length and brownish in color. The moth has an expanse of nearly an inch. The front wings are bright straw-yellow crossed with two fine brown lines and the veins are more or less lined with brown. On the outer margin of the wing there is a broad, brown shade inclosing a triangular straw-colored spot. The hind wings are straw-colored, translucent white at the base with brown marginal and submarginal lines, the latter usually incomplete and sometimes lacking. The moth deposits her eggs in small flat masses of three to more than a dozen, the eggs overlapping in the cluster. The egg is ovate and very flat when first laid but gradually swells with the development of the embryo. It is brownish yellow in color. The egg hatches in eight days. There are two and possibly three generations annually, the fall brood of caterpillars being the most injurious.

Fortunately the purple-backed cabbage worm rarely becomes sufficiently abundant to require remedial treatment. Spraying with arsenate of lead (paste), 2 pounds in 50 gallons of water, should give satisfactory results.

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## The Zebra Caterpillar

*Mamestra picta* Harris

In the northern United States and Canada east of the 100th meridian, a black, yellow-striped caterpillar is often seen in June and July and again in the fall feeding on the leaves of many garden plants. Its striking colors often attract attention but the insect rarely becomes injurious except occasionally on cabbage and celery. The full-grown caterpillar is about two inches in length, black, with bright yellow stripes on each side of the body (Fig. 17). The back between the yellow stripes is dotted with fine yellow spots and the space between the yellow bands on the side is crossed by fine slightly reticulated yellow lines. The head, legs and underside of the body are dark red.

Fig. 17. — Full-grown zebra caterpillar (× $\frac{7}{8}$).

Fig. 18. — Moth of the zebra caterpillar (× $1\frac{1}{4}$).

The caterpillars become mature in about a month and then enter the ground where in slight silken cocoons they transform to shining brown pupæ about $\frac{3}{4}$ inch in length. In the summer the pupal period is two or three weeks. The moth has an expanse of $1\frac{1}{2}$ to $1\frac{3}{4}$ inches. The front wings are purplish brown with a shade of light brown across the hind part of the wing. The round and reniform spots are gray. The hind wings are white edged with brown on the front and outer margins (Fig. 18). The moth deposits her globular, slightly flattened eggs in compact clusters of 125 to 150 or more on the underside of the leaves. The eggs hatch in a week or two and the young caterpillars feed for a time in colonies, skeletonizing the leaves, but later scatter and feed singly. They are at first nearly black but soon become pale or greenish and then develop the characteristic markings of the mature larva. There are two generations a year, the first brood of caterpillars being found in June and July and the second in the fall. The insect may hibernate either as partly grown caterpillars or in the pupal stage.

The zebra caterpillar rarely becomes sufficiently abundant to require remedial measures on crops grown under commercial conditions. The young caterpillars may be killed by spraying with paris green or arsenate of lead. In the home garden hand-picking is the most satisfactory remedy.

A closely related species, *Mamestra legitima* Grote, sometimes known as the striped garden caterpillar, has been reported as a general feeder on vegetable crops in the District of Columbia and in Georgia. The larva of this species differs from the zebra caterpillar in having the stigmatal yellow stripe broadly bordered with black above. In habits and life history, the two species are similar.

## The Cabbage Aphis

*Aphis brassicæ* Linnæus

The cabbage aphis is supposed to be of European origin, but now occurs over practically the whole world wherever its food plants are cultivated. It attacks cabbage, cauliflower, brussels sprouts, kohlrabi, collard, kale, brocolli, rape, turnip and radish. It also breeds to a considerable extent on a number of wild plants belonging to the mustard family. In the United States, especially in the northern and eastern states, it often takes first rank as an enemy of cabbage, cauliflower and related plants. In some seasons the losses are severe, the crops over large areas being so badly infested that the growers plow them under early in the season.

In that part of its range in which the winters are severe, the cabbage aphis hibernates exclusively in the egg stage; farther south many of the lice doubtless survive the winter. The elongate, oval, smooth, black, shiny eggs (Fig. 19), about $\frac{1}{38}$ inch in length, are found abundantly on the petioles and under surface of the leaves of cabbage plants left in the field over winter. Early in the spring the eggs hatch and the young lice find abundant food in the tender sprouts thrown out by the old cabbage stumps (Fig. 20). These lice of the first generation hatching from the eggs are all wingless females and are known as stem-mothers. As they increase in size, the lice molt four times, reaching maturity in about two weeks. A few days after the last molt they begin to give birth to living young. These stem-mothers may live for six weeks or more and give birth to forty or fifty young. The next generation of lice consists of wingless agamic females which resemble the stem-mothers very closely in form and color, being about $\frac{1}{10}$ inch in length, grayish green in color and covered with a whitish waxy bloom (Fig. 21). During the remainder of the season reproduction continues

FIG. 19. — Egg of the cabbage aphis ($\times$ 19).

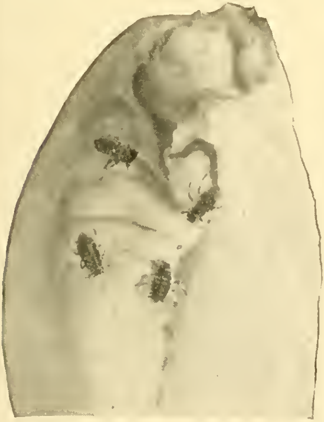

FIG. 20. — Stem-mothers of the cabbage aphis feeding on a sprout thrown out by an old cabbage stump (greatly enlarged).

parthenogenetically, no eggs are produced and the young are born alive. From April first to October first, sixteen generations have been known to develop. From time to time when the food supply becomes limited, either from overcrowding or from some injury to the plant, winged forms (Fig. 22) are developed which fly to other plants and start new colonies.

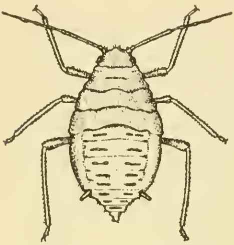

Fig. 21.— Wingless viviparous female of the cabbage aphis ($\times 8\frac{3}{4}$).

Cabbage plants often become infested in the seed-beds or very soon after transplanting. The lice soon become closely packed together in dense masses, often hiding the leaf from view. Their presence causes the leaves to curl, sometimes forming deep pocket-like depressions, the inner surface of which is completely covered with lice. The aphids also cluster in the forming head. Badly infested plants cease to grow, the larger leaves die, the heads do not develop and in some cases the plant is killed outright. Figure 23 shows a badly infested radish seed-stalk.

Late in the fall, true males and females are produced. The female is wingless and the male is winged. After pairing the female soon begins to deposit her eggs on the petioles and under surface of the cabbage leaves. When first laid, the eggs are pale greenish yellow in color but usually turn black in a few days.

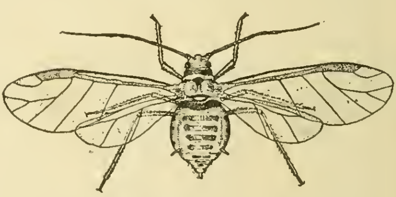

Fig. 22. — Winged viviparous female of the cabbage aphis ($\times 8\frac{1}{2}$).

*Control.*

Although cabbage lice are easily killed when hit by ordinary contact insecticides, it is difficult to control them economically under commercial conditions. The lice are protected in the curled leaves where it is difficult to hit them with a spray; their bodies are covered with a white waxy bloom so that the spray does not readily wet them; and they occur in dense masses or colonies, and considerable force is required in order to reach those beneath the others. Under commercial conditions, it is not possible to destroy all the lice by spraying. The best that can be expected is so to reduce their numbers that the plant will be able to continue its growth and develop the head. Efficient work can be done by spraying with the so-called whale-oil or fish-oil soap, 10 pounds in 100 gallons of water, or with "Black Leaf 40" tobacco extract, $\frac{3}{4}$ pint in 100 gallons of water with 4 or 5 pounds of soap added. The first application should be made as soon as the lice begin to cluster on the young plants. At least 100 gallons should be applied to each acre when the plants are young. The most effective and economical method of application is to use an ordinary potato sprayer (Fig. 24) equipped with a Y to which are attached two leads of hose 10 or 12 feet in length. At the end of each hose is an

FIG. 23. — A radish seed-stalk infested by the cabbage aphis (enlarged).

extension rod about 20 inches long, furnished with a Bordeaux or Vermorel nozzle, preferably the former. The pump should be able to maintain a pressure of at least 125 pounds. With this arrangement three men are needed, one to drive the horse and two to carry the nozzles. Attempts to use a potato sprayer with fixed nozzles have been unsuccessful. A stiff

Fig. 24. — Spraying for the cabbage aphis with a traction potato-sprayer and two leads of hose.

spray should be used, directed downward into the center of the plant. With sufficient force it will be driven into many of the curled leaves and will reach the lice.

If the plants become infested with lice in the seed-beds, they should be dipped in a solution of whale-oil soap, 1 pound in 8 gallons of water, before transplanting. The roots should not be wet with the solution and the plants should not be left in the sun after dipping for fear of burning.

Reference

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## The Turnip Aphis

*Aphis pseudobrassicæ* Davis

Although the turnip aphis has undoubtedly been causing serious injury to cruciferous crops for many years, particularly in the South, it has been confused with other forms and its injuries attributed to other species. This aphid was not recognized as a distinct species until 1914 when it was described from specimens collected in New York and Indiana. It has received careful study in Texas where it is a serious pest of turnip, radish, cabbage and mustard, but is also found on kale, collard, rutabaga, rape and lettuce. It has been reported as feeding on bean but this attack was probably exceptional. The turnip aphis is most destructive in the fall, winter and early spring. Reproduction is rapid and the plants soon become covered with the lice, especially on the underside of the leaves and on the tender leaves at the center of the plant. Badly infested plants are stunted and many of them killed outright. The insect is distributed from Massachusetts to California southward to Louisiana and Texas and has been found in South Africa.

So far males and egg-laying females (the so-called true sexes) of the turnip aphis have not been observed. In Texas the aphids pass the winter mostly on turnips. In that climate reproduction is considerably slower in the winter months but does not actually cease except for a few days at a time. Both wingless and winged forms occur at all seasons of the year but the relative abundance varies with the crowding of the plants and with their vitality. The wingless form when mature is a little over $\frac{1}{16}$ inch in length, pale greenish, with the antennæ pale, blackish towards the tip; the legs are pale with the tips blackish. The body is slightly pulverulent, but much less so than in the cabbage aphis. The winged form is a little less than $\frac{1}{16}$ inch in length, the head and thorax are black and the abdomen apple-green. The legs and antennæ are much darker than in the wingless form. Both forms give birth to living young. In the course of its development the aphis passes through four nymphal stages and becomes mature after the fourth molt. This requires from five to twenty-five days for the wingless forms and for the winged forms twelve to sixteen days, depending on the temperature. Rearing from the first born of each generation, thirty-five generations have been secured in one year in Texas. The number of young produced by each female varies considerably, from twenty-five to over one hundred, born over a period of eleven to twenty-seven days. During the summer in Texas, the turnip aphis is not found on cultivated plants, but its wild host plants have not yet been determined. In Indiana it is found abundantly on wild mustard and in Colorado on shepherd's purse.

*Control.*

The turnip aphis can be controlled by thorough spraying with "Black Leaf 40" tobacco extract, $\frac{3}{4}$ pint in 100 gallons of water to which 4 or 5 pounds of soap have been added. This material will kill all the lice wet by the spray, the great difficulty being in hitting them. Spraying should begin early, when the first colonies of lice are found. Good pressure should be used and the spray applied with upturned angle nozzles, so directed as to wet the underside of the leaves. Effective work can also be done by spraying with whale-oil soap or laundry soap, 1 pound in 7 gallons of water.

References

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Ind. Agr. Exp. Sta. Bull. 185. 1916.

## The Cabbage Root-Maggot

*Phorbia brassicæ* Bouché

Throughout the greater part of the United States and Canada and in Europe, cabbage, cauliflower, turnip, radish and related crops are subject to serious injury by a small whitish maggot that burrows in the roots. It is also destructive in Alaska. In the northern states and Canada it is especially injurious to early cabbage and is very troublesome in the seed-beds of late cabbage. Radishes also rarely escape attack. In some regions the growing of these crops has been abandoned temporarily because of the ravages of this pest.

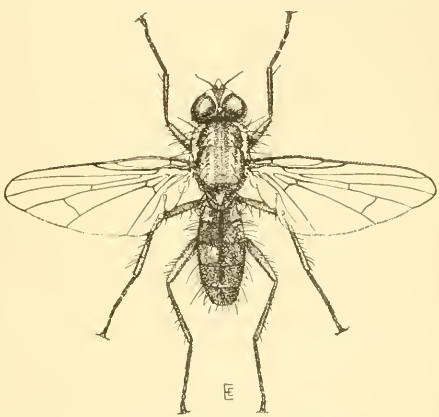

Fig. 25. — Male fly of the cabbage root-maggot (× 5½).

The parent flies, as a rule, emerge in early spring and have been recorded as feeding on the pollen of flowers. In the latitude of New York they emerge from the middle of May till the middle of June and may be seen around the plants searching for a favorable place in which to deposit their eggs. In British Columbia eggs have been found as early as April 10. The fly is about $\frac{1}{5}$ inch in length and resembles the house-fly in general appearance. The male (Fig. 25) is dark ash-gray in color with three blackish stripes on the thorax; there is also a wide black stripe on the abdomen, which is continued laterally along the edge of the segments. The female is lighter in color and the stripes are less distinct than in the male. This species is distinguished from its near relatives by the presence, in the male fly, of a small tuft of bristles on the underside of the base of the hind femur (Fig. 26 *A*). As yet no one has discovered any characters by which the females can be distinguished from those of the seed-corn maggot. The female deposits her small white eggs at the base of the plant, carefully tucking them down between the soil and the stem. Sometimes the eggs are attached to the stem above ground. The egg is slightly over $\frac{1}{25}$ inch in length, elongate, bluntly rounded behind and pointed and flattened anteriorly, whitish in color, longitudinally striate and deeply grooved on one side. The eggs hatch in four to ten days depending on the weather. On hatching, the young maggot works its way along the main root, on which it feeds by rasping out a channel in the surface. The maggots first attack the tender rootlets and then burrow into the main root where they may be found in slimy burrows just under the bark. They are sometimes seen in the stem above ground and even in the midrib of the leaves. Usually the first indication that

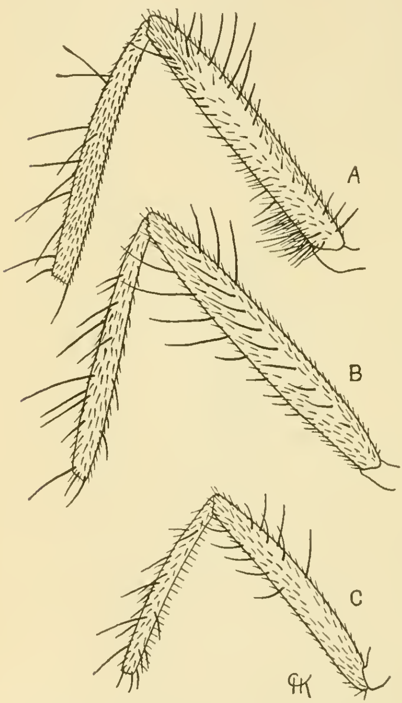


Fig. 26. — The femur and tibia of the hind leg of the male fly of: A, cabbage root-maggot; B, onion maggot; C, seed-corn maggot.

a cabbage plant is seriously infested is a tendency to wilt badly in the heat of the day; the leaves take on a bluish cast and then in a few days the plant droops and dies or it may survive in a sickly condition for some time. When the maggots are present in great numbers, the root is riddled with their burrows, decay sets in and the death of the plant quickly ensues. In such cases great numbers of the maggots may be found in the soil surrounding the root, moistened by the juices of the injured plant (Fig. 27). The maggots become full-grown in about three weeks. They are then nearly $\frac{1}{3}$ inch in length and shining white in color. The body tapers toward the head, being largest behind, where it is obliquely truncate. The mouth-parts consist of a pair of strong black hooks curved downward, by which the insect is able to rasp off portions of the plant tissue. The truncate surface at the posterior end of the body is surrounded by a row of twelve fleshy tubercles, of

Fig. 27. — Cabbage root-maggots at the base of an injured plant.

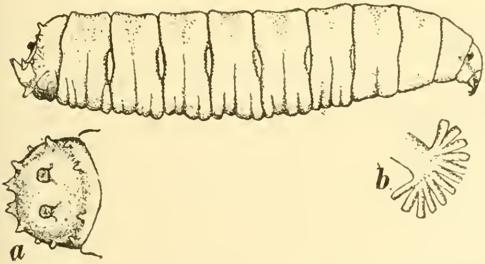


Fig. 28. — The cabbage root-maggot, side view (× 8); *a*, dorsal view of caudal segment, showing size, number and arrangement of fleshy tubercles, much enlarged; *b*, outline of a cephalic spiracle, greatly enlarged.

which the middle lower pair are two-toothed. At the side of the body just back of the head is located a pair of spiracles which appear as brownish fan-like projections each having twelve divisions. These characters are used in separating the cabbage maggot from its near relatives (Fig. 28).

When full-grown, the maggots work their way into the soil an inch or so, and there the skin contracts, hardens and turns brownish, thus forming the puparium (Fig. 29). Sometimes the maggots make this change in cavities in the roots. Within the puparium there takes place a remarkable series of changes whereby the tissues of the larva are broken down and rebuilt into the organs of the fly. The fly escapes from the puparium through a circular seam at one end; the length of the period passed in the puparium varies greatly; most of the flies emerge in twelve to eighteen days; a few may appear sooner, and a considerable number emerge irregularly throughout the remainder of the season. A few puparia of this first brood may hold over till the following spring. A second brood of flies appears the last of June and throughout July. A third brood emerges from August till October. In some seasons a partial fourth brood may occur. As a rule it is the first brood of maggots that is most destructive to cabbage, cauliflower, radish and turnip, although occasionally the second brood causes serious damage. The wild plants in which breeding takes place are hedge mustard, white mustard and winter cress or yellow rocket, and probably other members of the mustard family, although shepherd's purse seems to be immune. In Canada the flies have been reared from maggots infesting the roots of bean and beet. In the North, as a rule, the insect hibernates in the puparium stage, but occasionally a few of the flies emerging late in the season may pass the winter under the protection of the

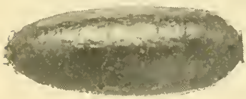

Fig. 29. — Puparium of the cabbage root-maggot (× 7).

cabbage plants in the field. It is quite probable that farther south a greater number of the flies hibernate.

*Control.*

The means employed for the control of the cabbage maggot vary greatly with the character of the crop infested.

*For early cabbage and cauliflower.* — When infesting these crops, the injury may be in great measure prevented by the use of carbolic acid emulsion. For this purpose the stock emulsion is diluted with thirty parts of water. About half a teacupful of the emulsion should be poured around each plant a day or two after transplanting. The application should be repeated every week for a month. Apparently the carbolic acid emulsion does not to any great extent deter the flies from laying their eggs, but is effective in killing the eggs and recently hatched maggots with which it comes in contact. This method has been used to a considerable extent by commercial growers, but has not on the whole been found so satisfactory as the use of tarred paper cards.

The value of the use of tarred paper cards to prevent maggot attack on early cabbage and cauliflower was demonstrated many years ago, but has not come into general use by commercial growers. This method of protection is more effective and at the same time less expensive than carbolic acid emulsion, and there is also no danger of injuring the plants. The cards are made of one-ply tarred felt roofing paper, and are cut in the form of a hexagon $4\frac{1}{2}$ inches in diameter. From one angle a slit extends to the center of the card and radiating from the center there are four to eight short slits whereby the card can be made to fit snugly around the stem of the plant (Fig. 30). The cards should be applied as soon as the plants are set out. To be most effective, the plants should be set on a ridge rather than in a depression because in the latter case the cards are likely to become covered with dirt. They cannot be used on short-stemmed plants set so deeply in the ground that the leaves are partly buried. After having been placed in position, the cards should be pressed down so as to rest smoothly on the soil and thus prevent the flies from working under them.

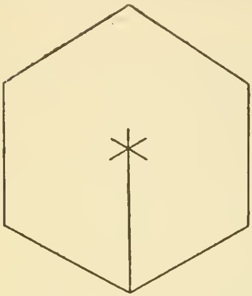

FIG. 30. — Outline of tarred paper card (× ⅓).

The tarred pads can be obtained from seedsmen and dealers in garden supplies or the grower can make them himself by using the tool shown in Fig. 31. The method is described by Goff as follows:

"The blade of the tool, which should be made by an expert blacksmith, is formed from a blade of steel, bent in the form of a half hexagon, and then taking an acute angle, reaches nearly to the center. The part making the star-shaped cut is formed from a separate piece of steel, so attached to the handle as to make a close joint with the blade. The latter is beveled from the outside all around, so that by removing the part making the star-shaped cut, the edge may be ground on a grindstone. It is important that the angles in the blade be made perfect, and that its outline represents an exact half hexagon.

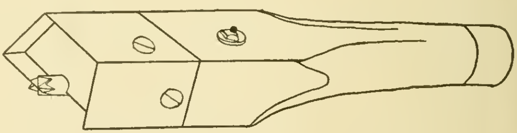

FIG. 31. — Tool for cutting the cards (× ¼).

"To use the tool, place the tarred paper on the end of a section of a log or piece of timber and first cut the lower edge into notches, as indicated in Fig. 32, using only one angle of the

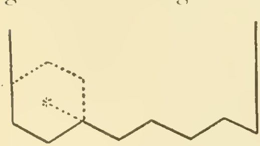

FIG. 32. — Diagram showing how the tool is used. The dotted line indicates the position of the edge of the tool.

tool. Then commence at the left end, and place the blade as indicated by the dotted lines, and strike at the end of the handle with a light mallet, and a complete card is made. Continue in this manner across the paper. The first cut of every alternate course will make an imperfect card, and the last cut in any course may be imperfect, but the other cuts will make perfect cards if the tool is correctly made, and properly used.

"The cards should be placed about the plants at the time of transplanting. To place the card bend it slightly to open the slit, then slip it on to the center, the stem entering the slit, after which spread the card out flat, and press the points formed by the star-shaped cut snugly around the stem."

*For late cabbage seed-beds.* — The depredations of the maggot in late cabbage seed-beds are often severe and necessitate the growers making much larger plantings of seed than would otherwise be required. Screening the beds with cheesecloth has been found an efficient and practicable method of protection and is now regularly practiced by cabbage growers in certain localities in New York. When this method is used, the seed should be drilled rather thickly in rows 6 to 8 inches apart. The corners of the bed should be staked out so that the cover can be applied before the plants come up. Boards, 6 to 10 inches wide, are placed on edge around the bed making a tight enclosure and a cheesecloth cover is stretched over the top. The cloth is supported on galvanized wires stretched across the bed every 4 or 5 feet. The wires are sometimes supported at the middle by short stakes. The cloth is fastened to the boards by strips of lath. Care should be taken to have the boards fit tightly at the corners and at the ends, and the earth should be banked up around the bottom so that the flies cannot work their way under. Even the cheaper, loosely woven grades of cheesecloth will exclude the flies, but as cloth having less than twenty threads to the inch is likely to stretch and pull apart so as to let in the flea-beetles, it is better to use cloth having twenty to thirty threads to the inch. Cloth that is too tightly woven will exclude too much sunlight and make the plants spindling. The screen should be removed a week or ten days before transplanting in order to harden the plants. Plants grown under cheesecloth cover are not only protected from the attacks of root-maggots and flea-beetles but, owing to the retention of warmth and moisture, make a much better growth than in the open. Screened beds do not have to be as large as open beds because under these conditions practically all the plants make the proper growth.

*For radishes.* — Carbolic acid emulsion has been used with some success on this crop, but better results can be obtained by growing the plants in beds screened with cheesecloth as described above.

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## The Seed-Corn Maggot

*Phorbia fusciceps* Zetterstedt

The injury caused by the cabbage root-maggot is often augmented by the presence of a closely related species which has received the rather inappropriate common name given above. The seed-corn maggot is generally distributed throughout the United States and Canada and also occurs in Europe. In addition to cabbage and related plants, it attacks sprouting seed corn, beans and peas, and has been recorded as feeding on seed potatoes and onions. The food of this species is not confined to vegetable matter, for at the time of the great outbreak of migratory locusts in the West, the maggots attacked the eggs of these grasshoppers which then occurred in great abundance. Generally, however, the maggots feed on planted seeds which have softened in germination or from decay. They are sometimes very destructive to seed beans especially in cold, wet, backward seasons. In some cases more than half of the crop is destroyed over large areas in this way. The maggots burrow into the seed-leaves, destroying them, and then mine into the stem. Some of the injured beans fail to germinate; more often, however, the seed-leaves push up through the soil, but as the bud is injured the plants fail to leaf out.

The flies of the seed-corn maggot closely resemble those of the cabbage root-maggot, but the males may be distinguished by lacking the tuft of hairs on the under side of the base of the hind femur, and by having on the under side of the hind tibia a row of short spines (Fig. 26 C). The females of the two species are indistinguishable. As far as known, the life histories of the two species are very similar.

*Control.*

The seed-corn maggot, when attacking cabbage and related crops, may be controlled by the means suggested for the cabbage root-maggot. The injury to germinating beans may be prevented in large measure by planting the seed shallow in cold wet seasons. Beans planted in this way come up more quickly and, being in a vigorous condition, are able to outgrow any slight injury to the seed-leaves.

## The Western Radish Maggot

*Phorbia planipalpis* Stein

On the Pacific Coast the cabbage root-maggot is replaced by a closely related species with similar habits. The maggots of this fly have been found infesting radish, cabbage, cauliflower, rutabaga and turnip and have also been observed abundantly in the pods of lupine and field peas, destroying the seeds. The fly closely resembles the adult of the cabbage root-maggot. The male is $\frac{1}{5}$ inch in length and the female about $\frac{1}{4}$ inch.

The insect hibernates both as adults and as puparia. The female deposits her white, elongate, slightly curved eggs, about $\frac{1}{16}$ inch in length, singly or in loose masses on the roots or on the leaves near the crown. On hatching, the maggots burrow into the radish roots rendering them unfit for food. Many maggots often infest the same root and sometimes kill the plant. The full-grown maggot is $\frac{1}{4}$ to $\frac{3}{8}$ inch in length and is whitish or yellowish in color. The body tapers toward the head and is truncate behind. When mature the maggots transform to puparia either within the root or in the surrounding soil. The puparium is about $\frac{1}{4}$ inch in length and brownish in color. There are said to be several generations annually.

A satisfactory method of control does not seem to have been worked out.

### Reference

Essig, Insects of California (Ed. 2), pp. 336–339. 1915.

## The Harlequin Cabbage Bug

*Murgantia histrionica* Hahn

In the last half century the harlequin cabbage bug has spread from its home in Central America and Mexico northward to Nevada, Colorado, the southern part of Illinois, Indiana, Ohio, Pennsylvania and New Jersey and to Long Island, New York. It also occurs in California. Except in the extreme northern part of its range, it is a most destructive enemy of cabbage and related plants. It is also known as the terrapin-bug, fire-bug and calico-back. When food is abundant, it usually confines its attacks to plants belonging to the mustard family, being especially fond of horse-radish, but when its favorite food plants have been destroyed the bugs will migrate to adjoining fields and feed on almost any plant available. Eggplant, asparagus, potato, tomato, okra, bean, beet and even nursery stock are sometimes severely injured under such circumstances. The insect also breeds on a large number of wild plants belonging to the mustard and caper families.

The harlequin bug hibernates as an adult under rubbish; in southern Florida the insect remains on the food plants during the winter, but its activities are more or less retarded. As soon as spring opens, the adults emerge from winter quarters and congregate on any cole plants available. The female deposits her eggs on the underside of the leaf in masses each containing normally twelve eggs arranged in two rows of six each. The females that have wintered over are more prolific than those of later generations; they are each capable of laying about one hundred eggs. Females of the next generation lay on an average only about seventy-five eggs. The egg is $\frac{1}{20}$ inch in length by $\frac{1}{30}$ inch in width, cylindrical, truncate at each end; the upper end is provided with a circular lid which is pushed off at the time of hatching. The egg is pearl-gray or pale yellow,

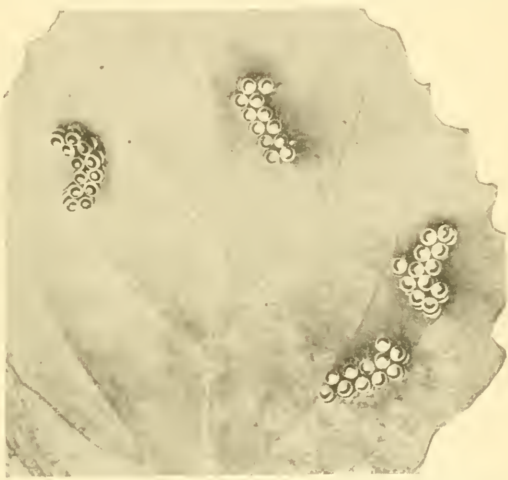

Fig. 33. — Egg-clusters of the harlequin cabbage bug on the underside of a leaf (× 2).

with two black bands, one broader and more distinct near the top and the other near the bottom. There is a black spot just above the lower band and sometimes the eggs are irregularly blotched with black. The cap of the egg has a semicircular black mark inside the marginal ridge. The egg has a striking resemblance to a small white keg with black hoops, the spot on the side suggesting the bunghole (Figs. 33 and 34). The eggs hatch in four to eleven days, depending on the temperature. The newly hatched nymph is pale green in color with black markings. The insect passes through five nymphal stages and acquires wings at the fifth molt. In its later stages, the nymph is brightly colored — black, orange or yellow, and red. About two months after hatching, the nymphs reach maturity and transform to adults. The adult (Fig. 35) is about $\frac{3}{8}$ inch in length, mottled red, black and yellow or orange. In all stages the bugs have a disagreeable odor and are distasteful to birds.

Fig. 34. — Eggs of the harlequin cabbage bug, side view (× 5).

In feeding, both adults and nymphs puncture the plants and suck out the juices. A half dozen bugs are enough to kill a cabbage or turnip plant. The severity of the injury inflicted seems to be out of proportion to the amount of food withdrawn from the plant and is supposed to be produced by a poison which the insect injects while feeding. Injured cabbage plants wither and turn brown as if scalded. The crop in whole fields is often completely destroyed. Many gardeners have been deterred from planting cabbage and collards because of the ravages of this pest.

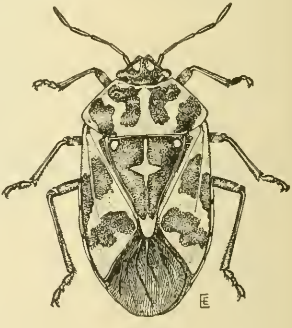

Fig. 35. — The harlequin cabbage bug, adult (× $3\frac{2}{3}$).

*Control.*

Both the nymphs and adults of the harlequin cabbage bug are very resistant to contact insecticides. In fact it is practically impossible to kill them in this way without injuring the plants. Loss may be prevented in large measure by practicing clean cultural methods of farming. After the crop has been harvested, all cabbage stumps and other refuse should be plowed under or destroyed in some other way. Hibernating shelter in the form of overgrown fence rows or patches of rank weeds should be reduced to a minimum. It is sometimes advised to leave a few piles of rubbish in the field in the fall as traps for the hibernating bugs. After they have collected in such shelter, the rubbish should be burned.

Very effective work can be carried on against the bugs in the spring by the use of trap crops. Kale, mustard and rape are often utilized for this purpose. If a few of these plants are sown so as to be available for food before the crop it is desired to protect is up, the insects will congregate on these plants where they may be killed by spraying with pure kerosene or in some other way. In the fall it is a good plan to leave a few cabbage, turnip or kale plants after the remainder of the field has been cleaned. The bugs will collect on these plants where they may be easily destroyed before going into hibernation. The destruction of the adults early in the spring is the most important measure for the control of the insect; if this work is done with thoroughness the crop will remain relatively free from attack for the remainder of the season. If the bugs are not destroyed in early spring, the only recourse is to hand-pick them into pans of kerosene — a tedious and laborious operation.

References

N. C. Dept. Agr. Ent. Circ. 8. 1904.
U. S. Bur. Ent. Circ. 103. 1908.
Smith, Jour. Ec. Ent. 2, pp. 108–114. 1909.

## The Green Soldier-Bug

*Acrosternum hilaris* Say

In the northern states the fruit of peach, apple and pear is occasionally seriously injured by the punctures of a large green stink-bug. The insect is widely distributed throughout the United States and Canada and southward to the West Indies and Brazil. It has also been recorded as attacking cabbage, bean, pea, corn, okra, tomato, eggplant, turnip and mustard, and it also feeds on a large number of shrubs and trees. The insect has been carefully studied as a fruit pest in Ohio.

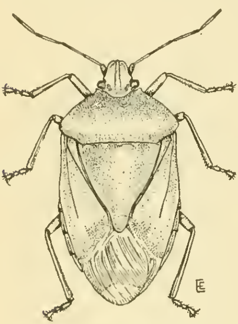

Fig. 36. — The green soldier-bug ($\times 1\frac{2}{3}$).

The green soldier-bug (Fig. 36) is from $\frac{1}{2}$ to $\frac{3}{4}$ inch in length, oblong, oval, bright green in color with the edges of the head, thorax and abdomen narrowly bordered with yellowish or reddish. The winter is passed by the adults hidden away in dry sheltered places, often under fallen leaves. The bugs emerge about the middle of May and egg-laying begins about the first of June continuing until the middle of July. The eggs are about $\frac{1}{16}$ inch in length, oval, largest toward the top which is provided with a small circular cap, surrounded by a single row of about sixty-five club-shaped spine-like processes. The eggs are usually light yellow in color but are sometimes light green. Just before hatching, they become pinkish or reddish. They are attached to the leaf by one end and arranged in clusters of twenty to fifty. Each female usually lays two batches of eggs and a few may lay a third. The first batch is usually the largest and the last very small. The eggs hatch in about a week and the young nymphs remain in a compact cluster near the egg-shells till after the first molt. They are about $\frac{1}{16}$ inch in length, with the head and thorax brownish black and the abdomen marked with transverse black and light blue bands. In the course of its development the insect passes through five nymphal stages and acquires wings at the fifth molt. In the fifth stage the nymph is nearly $\frac{1}{2}$ inch in length, with the head and thorax blackish marked with orange-yellow; the abdomen is yellowish green. The nymphs require from seven to ten weeks to reach maturity and adults of the new brood begin to appear the last of July, but some of the nymphs do not reach maturity until the first of October. There is only one generation annually.

A closely related species, *Nezara viridula* Linnæus, is sometimes injurious to cabbage in the southern states. The plants are injured in much the same way as by the harlequin cabbage bug. The adults so closely resemble those of *A. hilaris* that they are distinguished with difficulty. The most striking difference is that in the former there is a distinct, small black spot on the hind outer corner of the exposed part of each abdominal segment. In the latter these spots are very small and inconspicuous. The insect ranges from Virginia to Texas and northward to Indiana. It has also been reported as injuring tomato, sweet potato, okra, pepper, cotton and orange.

No satisfactory method for the control of the green soldier-bugs, other than hand-picking, has been suggested.

### Reference

Ohio Agr. Exp. Sta. Bull. 310. 1917.

## The Cabbage Leaf-Miners

There are three species of flies, the maggots of which develop within the leaves of cruciferous plants, producing large whitish blotched mines.

*The imported turnip leaf-miner, Scaptomyza flaveola* Meigen

Originally a native of Europe where it is known as the turnip leaf-miner, this insect was introduced into the United States some time before 1891, and is now widely distributed, ranging from Alaska to New Hampshire and south to Kentucky and Virginia.

Fig. 37. — A young cabbage leaf showing the work of the imported turnip leaf-miner.

Very little is known concerning its early seasonal history and the number of broods occurring annually has not been determined. The parent fly apparently deposits her eggs on the upper surface of the leaves. On hatching, the young maggot burrows into the leaf and feeds just below the upper epidermis, producing at first an irregular tortuous burrow which is suddenly widened to form a large blotch. The epidermis over the mine turns whitish and by a coalescence of several mines the whole leaf may take on this color (Fig. 37). The full-grown maggot is about $\frac{1}{5}$ inch in length, whitish in color and cylindrical in form, tapering towards the head and bluntly truncate behind. When mature the larval skin hardens and turns reddish brown to form the puparium within which the true pupa is to be found. This transformation may take place in the mines but usually the puparia are found under rubbish on the surface of the ground. In Kentucky the flies have been observed to emerge in late fall. The insect may, therefore, hibernate in the adult condition. The fly has an expanse of about $\frac{1}{4}$ inch and its general color is brown, the antennæ being yellow and the legs pale. This species has been recorded as feeding on cabbage, cauliflower, radish, turnip, Iceland poppy, horse nettle and mouse-ear.

### *The native cabbage leaf-miner, Scaptomyza adusta* Loew

This species is closely related to the preceding and has been reared in company with it. It injures the plant in a similar way. It is widely distributed from Maine to Florida and west to Illinois but is more abundant in the southern part of its range.

### *The imported cabbage leaf-miner, Scaptomyza graminum* Fallén

This European leaf-miner is now distributed in this country from New Hampshire to Texas. Its habits are similar to those of the two preceding species. In this country it has been reared from cabbage and in Europe it attacks several plants including chickweed, lamb's quarters, cockle and catchfly.

There seems to be considerable doubt as to the determination of the three species just treated. Sturtevant, who has carefully studied these flies, does not believe that *S. flaveola* has been introduced into this country and is of the opinion that the studies on which the above account is based were made on a mixture of *S. adusta* and *S. graminum.*

*Control.*

Little is known as to the best measures for controlling these leaf-miners. Their injuries are rarely serious. It might be possible to kill the maggots in the mines by spraying with a strong mixture of nicotine sulfate and soap.

### References

Ky. Agr. Exp. Sta. Bull. 40, pp. 46–51. 1892.
Coquillett, Insect Life, 7, pp. 381–383. 1895.
U. S. Div. Ent. Bull. 33, pp. 75–77. 1902.

## *The serpentine leaf-miner, Agromyza pusilla* Meigen

The leaves of cabbage, turnip, radish and rape are sometimes disfigured by narrow, tortuous mines caused by a small, translucent yellow maggot about $\frac{1}{8}$ inch in length. This insect has also been found mining the leaves of potato, spinach, beet, watermelon, and pepper, as well as many wild and forage plants. When mature, the maggots transform within the leaf into brownish puparia about $\frac{1}{12}$ inch in length. In the summer about ten days are spent in this stage. The fly (Fig. 38) is from $\frac{1}{25}$ to $\frac{1}{14}$ inch in length, shining black and marked with yellow in a most variable way. The flies deposit their small, white, oval eggs, about $\frac{1}{100}$ inch in diameter, in the tissue of the leaf on the underside. The eggs hatch in three to eight days. The time required for each generation varies from twenty-three to forty days depending on the temperature. Breeding is continuous throughout the growing period and the number of generations depends on the length of the season.

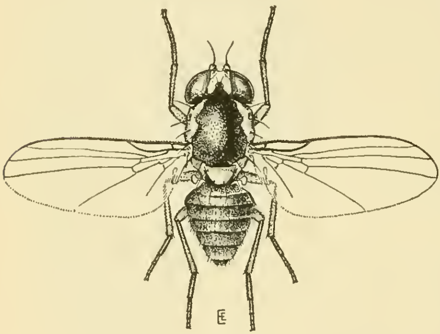

Fig. 38. — The fly of the serpentine leaf-miner (× 20).

### Reference

Webster and Parks, Jour. Agr. Research, 1, pp. 59–87. 1913.

## The False Chinch-Bug

*Nysius ericæ* Schilling

Cabbage, cauliflower, radish and turnip are occasionally subject to injury by a small grayish brown bug known as the false chinch-bug. This insect is widely distributed throughout the United States from California to New Hampshire and southward. It has been reported as most troublesome in the upper Mississippi Valley and in the western states. These bugs are very general feeders and sometimes injure beets, lettuce, mustard, potatoes, corn, strawberry, cotton and even apple nursery stock and young grape vines. Seed-beets during the second year's growth are sometimes severely injured.

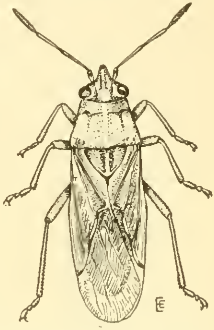

Fig. 39. — The false chinch-bug, adult (× 11).

The false chinch-bug hibernates as an adult in rubbish and under the leaves around the base of its food plants. The adult (Fig. 39) is about $\frac{1}{8}$ inch in length, grayish brown in color, sprinkled with blackish; the head is marked with two longitudinal black lines and there is a transverse black band across the front of the prothorax; the legs are yellowish brown. The bugs are most destructive in early spring when the adults come out of hibernation in great numbers and swarm on the young plants. In feeding, they puncture the leaves and suck out the sap, causing the plants to wilt, turn brown and die. The early spring and late fall broods deposit their eggs in cracks of the soil. The other broods place their eggs in the heads of various wild plants. The egg is described as being slender, cylindrical, irregularly wrinkled and tapering at both ends; it is yellow in color, orange-red at the anterior end.

The young nymphs are yellowish marked with indistinct longitudinal dark lines. They feed almost exclusively on weeds such as pepper-grass, shepherd's purse, Russian thistle and sage brush. The older nymphs are more distinctly marked with brown and reddish lines. When mature, the bugs scatter to all kinds of vegetation but in cases of drought are forced to congregate on cultivated plants. In Illinois the first brood nymphs mature in the latter part of May and the second in July. The broods overlap so that in midsummer all stages may be found together. In Kansas there are said to be at least five generations annually.

In Colorado there is a smaller race of the species which bears the name *Nysius minutus* Uhler. It has been recorded as very injurious to beets grown for seed.

*Control.*

Much can be done to prevent injury by the false chinch-bug by clearing the fields of all rubbish in the fall, thus depriving the bugs of hibernating shelter. This may be accomplished by burning over the fields. If the vegetation is not sufficient to carry the fire, straw may be scattered over the field. A gasoline torch may be used to kill the insects where they have congregated on weeds or clumps of grass. The insects may also be killed by thorough spraying with "Black Leaf 40" tobacco extract, 1 pint in 100 gallons of water to which 10 pounds of soap have been added. Burlap shields made sticky with a coat of crude petroleum are sometimes used to capture the bugs on plants that cannot be sprayed.

References

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## THE CABBAGE CURCULIO

*Ceutorhynchus rapæ* Gyllenhal

One of the minor pests of cabbage, cauliflower, kale, radish and horse-radish is a small ash-gray weevil about $\frac{1}{8}$ inch in length. This beetle is a native of Europe where it has never attracted attention as an enemy of cultivated crops. It was apparently introduced into America in New England about the middle of the last century but is now generally distributed throughout the northern states from New York to Virginia westward to Nebraska and Colorado. It also occurs in California.

The insect hibernates in the adult condition and the weevils appear in the field in early spring. They feed slightly on the leaves and also puncture the stems of their food plants, eating out a cavity as deep as they can reach with the beak. The female deposits her eggs singly in similar punctures in the stems. The tissue surrounding the egg-puncture becomes enlarged, forming a noticeable scar. The egg is about $\frac{1}{35}$ inch in length, oval and shining white. The eggs hatch in about a week and the grubs, several of which may infest a single stem, hollow out the contents, often causing the plants to turn sickly and die. The full-grown grub is $\frac{1}{5}$ to $\frac{1}{4}$ inch in length, milky white with a brownish head. The larvæ become mature in about three weeks, gnaw their way out of the stem and enter the ground where at a depth of less than an inch they transform to milky white pupæ in oval earthen cells. The beetles appear in about a week, or during the early part of June in the District of Columbia, and feed for a time on the stems and leaves of their food plants. Although the new brood of beetles appears at this early date, there is apparently only one generation annually.

Larvæ of the cabbage curculio have been found in the stem and crown of cabbage and cauliflower, the petioles of horse-radish and probably also infest the radish. Serious injury to cabbage and cauliflower plants in the hot-bed has been reported from Missouri. The beetles, however, prefer to deposit their eggs in the stems of wild pepper-grass, hedge mustard and shepherd's purse. When these plants are available for egg-laying, cultivated crops are not usually infested. In case wild plants are allowed to grow as a trap crop, they should be destroyed before the larvæ reach maturity else they will merely serve to increase the abundance of the pest.

### Reference

U. S. Div. Ent. Bull. 23, pp. 39–50. 1900.

## The Cabbage Seed-Stalk Weevil

*Ceutorhynchus quadridens* Panzer

Another European weevil closely related to the one last treated has been introduced into Massachusetts and Long Island, New York. On Long Island this weevil has proved a serious pest to cabbage grown for seed, hundreds of larvæ being found in a single stalk, their presence causing the plants to wilt and break over just before the seed begins to mature. Whole fields are often ruined in this way. The adult is slightly smaller than the cabbage curculio and the scales with which the body is covered are white intermixed with gray hairs. This weevil also infests kale and turnip and in Europe it is recorded as breeding in mustard, water cress, horse-radish and rape.

No satisfactory method of controlling this insect is known.

## The Red Turnip Beetle

*Entomoscelis adonidis* Pallas

In western Canada cabbages, radishes, turnips and beans occasionally have the leaves eaten by the larvæ and adults of a scarlet beetle about $\frac{1}{4}$ inch in length, marked with three black stripes down its back and with a black patch on the prothorax. The insect is native to the region, where it fed originally on wild cruciferous plants, particularly the prairie wall-flower, but it is also found in Europe and Asia. The beetles deposit their red to dark brown, elongate-elliptical eggs, $\frac{1}{20}$ to $\frac{1}{16}$ inch in length, in large loose masses under clods of earth. The mature larva is black above and yellowish beneath, slug-shaped and about $\frac{1}{2}$ inch in length. The larvæ are said to feed mostly at night. When full-grown they burrow into the soil for an inch or so and there transform to bright orange pupæ about $\frac{1}{4}$ inch in length. The winter is passed in the egg stage in the ground. The beetles become noticeable in the fields in July and August and may be found as late as November.

In Austria the winter eggs hatch in the early spring and the larvæ become full-grown in the latter part of April. The beetles appear in May and after feeding a few days go into æstivation in the ground where they remain till September or October. It is quite probable that when the habits of this beetle are thoroughly studied in America, its life history will be found to be much the same as in Europe.

Spraying with arsenate of lead (paste), 2 or 3 pounds in 50 gallons of water, will kill many of the beetles and their larvæ.

### Reference

Fletcher, Rept. Ent. Canada for 1892, pp. 10–13.

### Other Insects Injurious to Cabbage and Related Crops

Corn ear-worm: 211
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# CHAPTER III

## PEA AND BEAN INSECTS

The more important insect enemies of the pea are of European origin, while those of the bean are native. The seed weevils are, on the whole, the most troublesome pests of these crops, especially in the South. Peas are subject to widespread and destructive outbreaks of the pea aphis, especially where they are grown in large areas for the cannery. The seed-corn maggot occasionally causes serious damage to seed beans in seasons when the weather is cold and wet at planting time, and under similar weather conditions snails occasionally prove very destructive to the foliage.

### The Pea Weevil

*Bruchus pisorum* Linnæus

The pea weevil is a native of the Old World but was introduced into America more than one hundred and seventy years ago. Peter Kalm records having found it in Pennsylvania, New Jersey and southern New York in 1748 and states that because of its ravages the settlers had in large measure been forced to discontinue the growing of peas. The insect is now widely distributed in most parts of the world where peas are grown. The economic importance of this pest is indicated by the statement of James Fletcher in 1903 that in Ontario alone the annual loss amounts to more than a million dollars. In this province many of the farmers had given up the growing of peas because of the depredations of this pest. A similar condition obtains in many parts of Germany. The pea weevil is less abundant in the northern part of its range and a large proportion of the seed peas planted in the South are obtained from the northern states, Canada and northern Europe.

The pea weevil (Fig. 40) is considerably larger than the other species infesting the pea and the bean. It is about $\frac{1}{5}$ inch in length, brownish in color mottled with gray, white and dark brown. There is a white spot on the middle of the hind margin of the prothorax and the wing-covers are crossed by a more or less indistinct whitish band towards the tip. The wing-covers do not extend to the tip of the abdomen and the exposed part is white with two large black spots at the tip. When viewed from above, the prothorax has the appearance of being slightly notched on the sides. The base of the antennæ and the front and middle tibiæ and tarsi are reddish brown. There is a sharp tooth on the underside of the hind femur toward the tip.

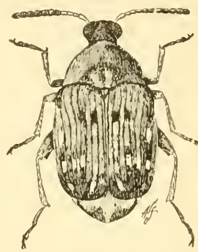

FIG. 40. — The pea weevil (× 6).

The weevils appear in the field about the time the peas are in blossom and after feeding slightly on the foliage, the female deposits her elongate, fusiform, yellow eggs singly on the surface of the newly formed pods. The egg is attached by a viscid substance that on drying becomes white and glistening. As many as fifteen to twenty eggs may be laid on a single pod. The eggs hatch in about twelve days and the young larva bores into the pod. In case it does not happen to enter the pod directly over a young pea, it may burrow through the tissue of the pod as a miner until it reaches one of the seeds. The hole through which the young larva enters soon heals over and is indicated merely by a small brownish dot. The newly hatched larva is yellow with a black head. The prothorax is armed with a series of six strong spines and a pair of prominent toothed plates which point backward. These structures are apparently of use to the larva in making its way through the pod and in entering the pea. It also possesses three pairs of small slender legs. Soon after entering the pea, the grub molts and the spiny structures on the prothorax are lost. The larva becomes proportionately shorter and thicker and lies normally in a curved position. It soon works its way to the center of the pea and there eats out a large cavity. When full-grown, it is about $\frac{1}{4}$ inch in length, white in color, with brownish mouth-parts. The short stumpy legs are easily overlooked. In Italy the larva reaches maturity about forty days after hatching. It then cuts out a smooth round hole to the surface of the pea, leaving only the outer hull as a covering. It lines the cavity with a paste-like substance, thus excluding all excrement from its pupal chamber. The pupa is dirty white in color. The insect remains in this stage from nine to seventeen days. Only one weevil is found in a pea. In the warmer parts of its range, many of the beetles emerge from the seeds soon after transformation but in the North a large proportion remain in the seeds until the following spring and are often planted with the seed peas. Weevils that emerge in the field hibernate in dry sheltered places and fly back to the pea fields the following spring. There is only one generation annually.

In the case of small peas, the weevil destroys about one half of the contents, in larger peas about one third. Infested peas are not suitable for planting. Experiments in Kansas have shown that in a germination test only about 25 per cent of the infested peas will sprout. In a field experiment in which thirteen varieties of peas were used, only 4.4 per cent came up and only 3.8 per cent produced fair sized plants. At the same time, 64 per cent of uninfested peas of the same varieties gave a good stand of strong plants. Experiments in Canada have shown that in the case of small peas, infested seed produced only 13 to 20 per cent of plants which bore pods and in the case of large peas 16 to 28 per cent.

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## The Bean Weevil

*Bruchus obtectus* Say

Probably the bean weevil is a native of the New World. It was first described in 1831 from specimens collected in Louisiana. It first attracted attention by its injuries in 1860 in Rhode Island. The insect is now widely distributed throughout southern Canada, the United States, Mexico, Central America, the West Indies and South America. It also occurs in the Mediterranean region, Persia, Indo-China, Madeira, the Azores and the Canaries. Its favorite food plant is the common kidney bean, *Phaseolus vulgaris*, but limas and cowpeas are sometimes attacked in the field, and in storage it will also attack the faba bean, peas, chick peas, lentils and the seeds of *Lathyrus sativus*. The bean weevil is a very serious pest in the South. It is not so destructive in the northern states and Canada and it is from this region that a large proportion of the seed beans are obtained.

The bean weevil (Fig. 41) varies considerably in size but averages about $\frac{1}{8}$ inch in length. The general color is light brownish. The wing-covers are mottled with light brown, dark brown, gray and black, arranged in narrow longitudinal stripes. On the middle of each wing-cover near the inner margin is a fairly distinct light gray longitudinal bar. The exposed tip of the abdomen, the base and last segment of the antennæ and the legs, except the hind femora below, are dull reddish brown. The hind femur is armed on the underside near the tip with one large and two small teeth. The beetles appear in the field about the time the beans are in blossom and feed slightly on the surface of the leaves. In cool weather the beetles are sluggish, but in bright warm days they can take wing quickly and fly to a considerable distance. As soon as the pods become nearly full-grown but while they are still green, the females begin egg-laying. The female first gnaws a slit through the pod close to the ventral suture and by means of her extensile ovipositor then deposits a cluster of eggs on the inside of the pod. The hole made by the beetle in the pod does not heal over but persists as a discolored spot even in the dried pod. The egg (Fig. 42) is translucent white, elongate-ovate, and about $\frac{1}{40}$ inch in length; the surface is slightly roughened. The eggs are sometimes inserted through an opening in the pod where it has been injured or where it has split in drying. The time required for the hatching of the eggs varies considerably with the temperature but apparently has not been accurately determined for eggs laid in fresh pods. On hatching, the young larva bears little resemblance to the mature grub. It is white, the head yellow, the mouth-parts brown and the eyes black. Three pairs of distinct, slender functional legs are present and the body is clothed with long hairs which serve to keep the larva upright when crawling.

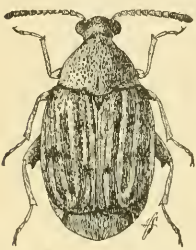

Fig. 41. — The bean weevil (× 9).

Fig. 42. — Egg of the bean weevil (× 40).

The young larva crawls actively about until it finds a bean which it enters through a small round hole about $\frac{1}{125}$ inch in diameter. In about three days after hatching, the larva molts and assumes the general appearance of the mature grub. The legs, eyes and the long hairs on the abdomen are lost, the body becomes proportionately shorter and thicker and the grub assumes a curved position. The larva burrows diagonally into the bean a short distance and there eats out a large cell covered in part only by the thin semi-transparent outer coat of the bean. It then lines the cell with a yellowish white paste, thus excluding all excrement from the pupal chamber. The length of the larval stage varies greatly with the temperature, or from eleven to forty-two days. The full-grown larva is $\frac{1}{8}$ to $\frac{1}{7}$ inch in length. The insect transforms to a white pupa within the cell and remains in this stage from five to eighteen days. Soon after transformation, the beetle neatly cuts out a circular lid through the seed-coat of the bean and makes its escape (Fig. 43). The entire life cycle requires from twenty-one to eighty days. The beetles emerging in the field soon begin laying eggs for another generation. The number of generations that occur in the field depends on the temperature and the length of the season. Breeding is continuous in stored beans provided the temperature is sufficiently high. In the vicinity of Washington, D. C., there are probably six generations annually. The number of weevils reared from a single bean depends on the size of the seed. In cases in which the beetles are allowed to breed in stored seed undisturbed, they often reduce the contents to a powdery mass held together by the hull. As many as twenty-eight weevils have been reared from a single bean. Weevily beans are unfit for planting. In a large proportion of

Fig. 43. — Beans showing exit holes made by the weevils.

such beans, the germ is destroyed and many of the others are so injured that they cannot produce healthy plants.

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## The Broad Bean Weevil

*Bruchus rufimanus* Boheman

The broad bean weevil is similar to the pea weevil both in the form and general appearance of the beetle and in its life history. It is a troublesome pest in Europe, northern Africa, Syria and Persia and has been recently introduced into California. By preference it attacks the European broad bean or horse bean but will also breed in peas and certain species of vetch. In California the weevils appear in the field by the last of March. The beetle closely resembles the pea weevil, both in form and markings. The latter are, however, more diffuse and the black spots at the tip of the abdomen are indistinct or lacking altogether (Fig. 44). The tooth on the underside of the hind femur is more obtuse than in the pea weevil. The female deposits her eggs on the outside of the bean pods, as many as thirty-four having been found on a single pod. The eggs are attached by a mass of sticky material. The egg is elongate-ovate, white to greenish yellow, smooth, a little over $\frac{1}{50}$ inch in length and about one half as wide. The eggs hatch in twelve to fifteen days. The larvæ leave the egg-shell through

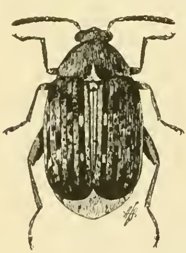

Fig. 44. — The broad bean weevil (× 9).

the side attached to the pod and soon find their way into the young beans. The point of entrance is indicated in the dried beans by a small black dot. The larva very closely resembles that of the pea weevil. It eats out a cell in the bean, its position being indicated by a transparent spot where the larva has eaten out the contents under the outer hull. In California the larvæ begin to pupate about the first of August and transform to adults the same season. Hibernation usually takes place in the beans but if they are kept in a warm room, many of the weevils will emerge in storage. From one to five larvæ may be found in a single bean. There is only one generation annually and the weevils do not breed in dried beans. Infested beans are lighter in weight and their value as food for stock is considerably lessened. Furthermore, the percentage of germination even of beans containing only one larva is considerably less than that of uninfested seed, and of beans that have been injured by four or five larvæ, only about one third will germinate.

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## The Four-Spotted Bean Weevil

*Bruchus quadrimaculatus* Fabricius

This weevil breeds by preference in the seeds of the cowpea but in storage will also attack peas and beans. The species is distributed throughout southern Europe, Africa, the East Indies, South America, the West Indies, Central America, Mexico and the southern states. The four-spotted bean weevil (Fig. 45) is about $\frac{1}{8}$ inch in length; the head and thorax are black; on the middle of the hind margin of the prothorax are two small spots of whitish pubescence. The markings of the wing-covers vary greatly but in typical specimens are brownish, black at the base and on each there is a large dark spot at the middle of the outer margin and another at the tip. The exposed tip of the abdomen is brownish, usually marked with two black spots. The antennæ are black, reddish brown at the base. The legs are brownish except the basal two thirds of the hind femora which is black.

Under cage conditions, the beetles have been observed to deposit their eggs singly on bean pods. The egg is oval, lemon-yellow and about $\frac{1}{40}$ inch long by $\frac{1}{60}$ inch wide. It is attached to the pod by a thin sheet of gelatinous substance which extends beyond the egg. Under cage conditions in New York, it required fifty days for the eggs to hatch. When breeding in dry beans, the eggs are glued to the surface of the seed and hatch in thirteen to twenty days. On hatching, the young larva bores directly through the pod and attacks the seeds within, or when the eggs are attached to the seed, it enters directly under the egg-shell. The young larva closely resembles that of the pea weevil but differs in the armature of the prothorax. The full-grown larva is very similar to that of the bean weevil from which it may be distinguished by the larger area of black on the head just above the clypeus. The larva also injures beans in much the same way as the bean weevil. Pupation occurs within the seed. The rate of development varies considerably with the temperature and moisture. Several larvæ may infest the same seed and successive generations may be produced until the food supply is exhausted.

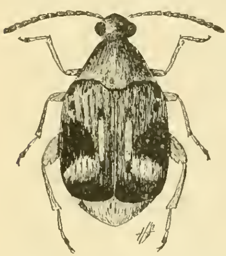

Fig. 45. — The four-spotted bean weevil (× 9).

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## The Cowpea Weevil

*Bruchus chinensis* Linnæus

Beans and peas in the southern states often become infested by the cowpea weevil. This insect is widely distributed throughout the tropics. In the United States its range extends northward to Maryland and Iowa. The beetle (Fig. 46) is from $\frac{1}{10}$ to $\frac{1}{7}$ inch in length, brownish in color and may be distinguished from the other species in this country by the two ivory-white spots on the middle of the hind margin of the prothorax. The wing-covers are brownish, dark at the base and usually crossed with a darker band at the middle. In the male the antennæ are pectinate.

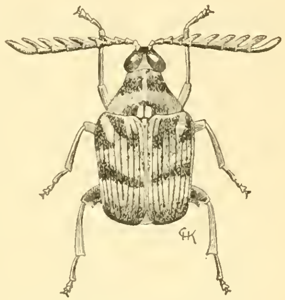

Fig. 46. — The cowpea weevil (× 8).

The female glues her eggs on the outside of the pods. The egg is ovate, flattened on the side of attachment, translucent, about $\frac{1}{50}$ inch in length by $\frac{1}{75}$ in width. The eggs hatch in four to ten days and the young larva bores through the pod and enters the seed. In the field, the larvæ become full-grown in two or three weeks in midsummer. They closely resemble those of the bean weevil and several larvæ may infest a single seed. Pupation takes place within the seed and transformation to the beetle occurs in four or five days in warm weather. Breeding continues in stored seeds and six or seven broods may develop annually in the District of Columbia.

### References

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## The Control of Pea and Bean Weevils

Seed infested by living weevils should never be used for planting, for it is in this way that many of the weevils gain access to the field. Neither is it good economy to use infested seed for planting in which the weevils have been killed, because the percentage of germination of such seed is low and the plants produced are weak and unproductive. In the case of the pea weevil and the broad bean weevil, species that do not breed in dried seed, the insects may be killed by holding over the seed until the second year before planting. The weevils will emerge in storage and, being unable to escape, will die without laying eggs. In the case of the bean weevil, the four-spotted weevil and the cowpea weevil, in which breeding continues in the dried seeds, holding over the seed would be useless. Fumigation with carbon bisulfid is the most efficient and practicable method of killing the weevils in stored seed. To be most effective, the treatment should be made in the fall soon after harvesting. The seed is placed in a tight barrel or box to which a cover has been fitted as nearly air-tight as possible. Carbon bisulfid is used at the rate of $\frac{1}{2}$ to 1 ounce to a bushel. In larger quantities in specially constructed fumigating chambers, the weevils can be killed by using carbon bisulfid at the rate of 3 pounds to 100 cubic feet. The liquid should be placed in some shallow dish like a pie tin on top of the seed. The fumigating box should then be covered tightly and fumigation should be allowed to continue for twenty-four to thirty-six hours. More satisfactory results will be obtained if the temperature is kept at 70 degrees F. or above. In fumigating, care should be taken not to smoke or to bring fire of any kind in contact with the gas, as the carbon bisulfid vapor is very inflammable.

When there is only a small quantity of seed to be treated and when it is impracticable to fumigate, the weevils may be killed by suspending the seed in a bag in a kettle of cold water and then heating the water to a temperature of 140 degrees F. The seed should then be spread out where it will dry quickly.

## The Bean Leaf-Beetle

*Cerotoma trifurcata* Forster

The bean leaf-beetle is a native American insect distributed from New York, southern Canada, Minnesota, Missouri and Kansas southward to Florida, Texas and New Mexico. It also occurs in Porto Rico. Its native food plants are the hog peanut, bush clover and tick trefoil. It has been reported as injurious to the bean, cowpea, pea, soybean, cultivated beggar-weed and corn.

The insect hibernates in the adult stage and in the South the beetles appear in the field in April, in the District of Columbia the middle of May, and in the more northern part of their range not until the last of June or the first of July. The beetle (Fig. 47) is about $\frac{1}{5}$ inch in length, yellowish to reddish in color; the head is black and each wing-cover has a black band running around its base and extending backward close to, but separated from, the margin nearly to the tip. Near the inner margin is a row of three black spots, larger in front and smaller behind. The antennæ are yellowish toward the base and darker toward the tip. The legs are marked with black and yellow, the hind pair being the darkest. The beetles usually rest on the underside of the leaves where they are easily overlooked. In feeding, they eat out holes in the leaves and when abundant leave only the larger veins. The plants are often defoliated and the crop is ruined. The beetles do not take wing readily but when disturbed fall to the ground. The female deposits her eggs in clusters in the soil at the base of the plants. Clusters of over forty have been observed but the average is about twelve. The egg is about $\frac{1}{36}$ inch in length, elliptical in outline, orange in color and the surface is sculptured with rows of hexagonal pits. One female has been known to deposit 795 eggs, but this is undoubtedly far above the average. The female continues to lay eggs for nearly a month. The eggs hatch in about eighteen days in the spring and in the summer in five to eight days. The larvæ feed on the roots, the stem underground, and are particularly fond of the bacterial nodules found on the roots of leguminous plants. The full-grown larva is $\frac{3}{10}$ inch in length, white in color, with the head, cervical and anal shields dark. The larva becomes mature in three weeks in summer to six or more in the fall, transforms to a white delicate pupa in a small earthen cell in the ground and in about a week the transformation to the adult takes place. In the North there is only one generation a year. In Virginia there are two, and farther south probably three.

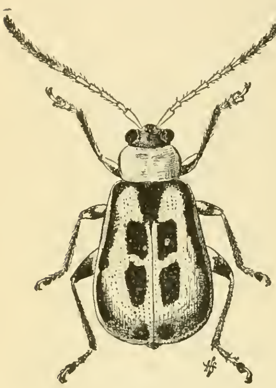

FIG. 47. — The bean leaf-beetle ($\times 3\frac{3}{8}$).

*Control.*

The beetles may be killed by spraying the vines with arsenate of lead (paste), 4 pounds in 100 gallons of water, taking care to apply the spray to the underside of the leaves. The application should be made at the first appearance of the beetles before they have had time seriously to injure the plants and in order to destroy the females before they have laid their eggs. In the home garden, the beetles may be collected by hand but spraying is the more convenient and practical treatment.

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## The Grape Colaspis

*Colaspis brunnea* Fabricius

This insect occasionally riddles the foliage of beans with holes, its work being similar to that of the bean leaf-beetle. The foliage of beet, cantaloupe and potato is sometimes eaten. The beetle is about $\frac{3}{16}$ inch in length, uniform yellowish brown with the wing-covers distinctly striate. The larvæ are found on the roots of strawberry, corn, timothy and other grasses. They are white with the head and cervical shield yellowish and $\frac{1}{6}$ to $\frac{1}{8}$ inch in length. They reach maturity in May or June and pupate in earthen cells. The beetles are common throughout the summer but are most abundant in June and July. The insect is generally distributed throughout the northern states and Canada east of the Rocky Mountains.

In case the beetles become sufficiently abundant to threaten serious injury, they may be poisoned by spraying the plants with arsenate of lead (paste), 2 or 3 pounds in 50 gallons of water.

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## The Bean Ladybird

*Epilachna corrupta* Mulsant

In the foot-hills from Wyoming through Colorado to Arizona, New Mexico, Texas and Mexico, bean plants are sometimes seriously injured by one of the ladybird beetles. The insect also occurs in western Kansas.

The bean ladybird passes the winter in the adult condition. In New Mexico the beetles appear in the field from early June to the middle of July. The beetle (Fig. 48) is about $\frac{1}{3}$ inch in length, oval in outline, strongly convex and pale yellowish to brownish orange in color. The eyes are black and each wing-cover is marked with eight small black spots arranged in three transverse rows. The beetles feed on the foliage, eating out holes in the leaves, and deposit their elongate, yellowish eggs in clusters of forty or more on the underside of the leaves. Each female lays on the average nearly 300 eggs and one beetle was observed to lay over 750. The egg is about $\frac{1}{20}$ inch in length, oval and yellow in color. The eggs hatch in four to nine days and the young larvæ begin feeding on the underside of the leaves, skeletonizing them. The larva passes through four stages in the course of its development and becomes full-grown in two or three weeks. It is then about $\frac{2}{5}$ inch in length, light yellow in color and clothed with stout branched spines. When mature it attaches the tip of its body to the leaf and transforms into a yellow pupa about $\frac{1}{3}$ inch in length. The pupal period occupies from three to five days. The entire life cycle is completed in three to four weeks in New Mexico. In Colorado there is said to be but one generation annually; in New Mexico there are two.

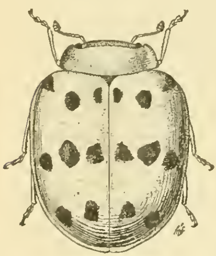

FIG. 48. — The bean ladybird (× 3).

The seasonal history of the bean ladybird has been studied most carefully in New Mexico. In that region the over-wintered beetles lay eggs from the middle of June to the first of August. The larvæ of the first brood are found until the latter part of August, producing a brood of beetles some of which may hibernate. The earliest beetles to mature of the second brood begin laying eggs about the middle of July and continue till the end of the season. The two generations thus overlap during July and August and it is at this time that the larvæ and beetles are most abundant and destructive. In many cases the plants are completely defoliated and the entire crop is ruined. The beetles also have the habit of eating into and destroying the green pods.

*Control.*

The bean ladybird may be controlled by spraying the plants with arsenate of lead (paste), 2 to 4 pounds in 50 gallons of water. In localities in which the beetle is annually destructive, much injury may be avoided by planting early so that the crop will mature early enough to escape serious injury. Clean farming to eliminate hibernating shelter for the beetles and a proper rotation of crops will accomplish much to prevent loss. In the home garden, hand-picking the beetles and eggs may be practiced to advantage and the larvæ may be brushed off on the hot ground during the heat of the day where they will perish without regaining the plant.

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## The Bean Thrips

*Heliothrips fasciatus* Pergande

In California beans are subject to serious injury by a species of thrips, the mature female of which is about $\frac{1}{24}$ inch in length, with the head and body black. The narrow front wings are black, white at the base and with a white band towards the tip. The antennæ are black and white and the wings are fringed with long white hairs. The male is somewhat smaller. Both young and adult thrips are found working on the leaves, stem and pods of the bean, which they injure by piercing the tissues with their sharp mouth-parts and then suck out the juices at the point of injury. The injured leaves turn yellowish or white, dry up and die. In some cases the plants may be entirely killed. The bean thrips has been most injurious in California but also occurs in Idaho, Utah, Nevada, Arizona and Tennessee. It is not confined to the bean but attacks many other plants, including beet, cabbage, lettuce, radish, potato, tomato, pea, pear, alfalfa and cotton. Among weeds, its favorite food plants are spiny lettuce, sow thistle and wild heliotrope.

The bean thrips hibernates in the adult condition on the underside of the leaves of nasturtium, beet, wild heliotrope and many other plants. It is also found in dried leaves and under rubbish. In the warmer parts of its range, the insect is active throughout the greater part of the year, feeding being interrupted only for a short time during cool spells. On emerging from hibernation, the adults immediately seek their food plants and after feeding for a short time the female deposits her minute translucent white, bean-shaped eggs, about $\frac{1}{100}$ inch in length in the tissue of the leaves, in the veins and even in the stems of beans. The eggs hatch in thirteen to eighteen days. The newly hatched nymph is about $\frac{1}{50}$ inch in length and uniform translucent white in color with the eyes reddish. In the second stage, the nymph is about $\frac{1}{25}$ inch in length with the head and prothorax light yellow and with the remainder of the body translucent white and stained on the side with crimson. During the first two stages, the nymphs feed on the leaves in the same way as the adults. When full-grown, they desert the plants and hide in rubbish and in cracks in the ground and there molt. In the third stage, the nymph or so-called prepupa is slightly smaller than in the preceding stage and the wing-pads are well developed. The insect does not feed in this stage but in from one to six days, depending on the season, it molts again. In the fourth stage or so-called pupa, the nymph is $\frac{1}{25}$ inch in length, yellow or orange in color, marked with crimson on the sides and across the abdomen and the antennæ are carried back over the head. In this stage the insect is sluggish and takes no food. In four to fourteen days, depending on the season, the nymph transforms to the adult. In California there are seven generations a year, the first and last being small. In the early part of the season the thrips are most abundant on their wild food plants. They do not become abundant on beans until later in the season, although a few may be found on this crop from the time it first comes up.

*Control.*

The injury caused by the bean thrips may be lessened by clean cultivation to destroy the weeds on which the insect breeds. Early planting and thorough cultivation will tend to produce a rapid and healthy growth and render the plants more able to withstand injury. In the garden the thrips may be controlled by spraying with "Black Leaf 40" tobacco extract, 1 part in 800 parts of water in which enough soap has been dissolved to produce a good suds.

### Reference

U. S. Bur. Ent. Bull. 118. 1912.

## The Pea Aphis

*Macrosiphum pisi* Kaltenbach

Without doubt the most serious insect enemy of the pea is this large green plant-louse. The insect was undoubtedly introduced into this country from Europe. Although there is evidence that it was present here as early as 1878, it did not attract attention as a pest until 1899 when there was an extensive and highly destructive outbreak in the Atlantic states, most serious in Virginia, Maryland, Delaware and New Jersey. The losses occasioned by this insect in the Atlantic states during the years 1899 and 1900 have been estimated at $7,000,000. While the pea aphis has not maintained this rate of destructiveness in recent years, it is still the most serious insect pest with which pea-growers have to contend. In England the pea aphis has been known as a pest since the early part of the nineteenth century. It received the scientific name under which it is now known in Germany in 1843, although it is quite probable that it had been more or less imperfectly described previously.

The pea aphis occurs generally throughout Europe and has been introduced into British India and South Africa. In North America it is widely distributed throughout the United States and Canada, being most abundant in the East, but has been reported from Colorado, Texas, New Mexico, Arizona and the states on the Pacific Coast. In addition to the pea the insect attacks red clover, crimson clover, white clover, alsike, vetch, sweet pea, sweet clover, bush clover, alfalfa and lentil. It also occasionally infests shepherd's purse. In Europe the aphis has been recorded as feeding on several other leguminous plants.

The pea aphis usually passes the winter on clover and breeding is resumed on this plant in the spring. At this time the aphis shows a decided preference for crimson clover on which it multiplies rapidly. In Virginia about the last of April or the first of May, winged aphids are produced that migrate to peas. These migrating forms are all females that reproduce by giving birth to living young without being fertilized. These winged viviparous females (Fig. 49) are $\frac{1}{8}$ to $\frac{1}{6}$ inch in length, pea-green in color, with the tip of the cornicles, tip of the tibiæ, and the tarsi black. The eyes are red. The antennæ are slightly longer than the body. The winged forms settle on the pea plants, usually on the stem, and begin to give birth to living young. In the course of its development, the young aphis passes through four immature stages, molting four times, and at the last molt becoming adult. On the average it requires about ten days for the young aphis to reach maturity, and when about twelve days old it begins to produce living young. Reproduction continues for an average period of eighteen days at the rate of one to eleven a day. The number of young produced by a single female averages eighty. Both winged and wingless forms are produced, the relative proportion of the two varying with the season and with the crowded condition of the plant. The wingless form (Fig. 50) resembles the winged viviparous female in color. The stems become covered with the lice, and the leaves, blossoms and pods are soon attacked. Infested leaves become slightly thickened and curled, infested blossoms are blasted and injured pods are stunted, deformed and rendered worthless. Badly infested plants take on a sickly yellowish appearance and may be killed outright. Sometimes whole fields are destroyed in this way. In such cases, the ground has a whitish appearance from the cast skins of the plant lice. Whenever the plants become crowded, winged forms are produced that migrate to other parts of the field or to other food plants. In Virginia it has been found that while breeding is more or less continuous throughout the year on clover, the insect migrates more or less regularly between its other food plants. Peas are infested from April to the first of July when many of the plant-lice migrate to bush clover, sweet clover, alfalfa and the clovers. Peas again become infested in August and the plant-lice remain here until the advent of cold weather when they return to clover. Counting from the first-born of each brood, twenty or twenty-

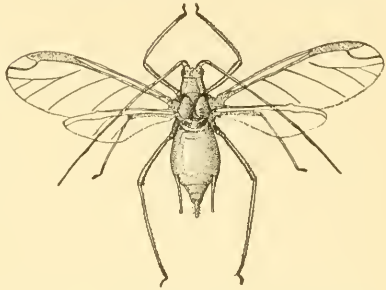

FIG. 49. — Winged viviparous female of the pea aphis (× 5).

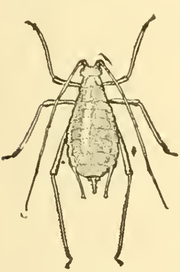

FIG. 50. — Wingless viviparous female pea aphis (× 5).

two generations of the pea aphis may develop annually in Virginia. In Indiana breeding experiments have shown that counting from the last-born, thirteen generations are produced annually. The insect hibernates on clover either as mature viviparous females, winged or wingless, or in the cooler part of its range in the egg stage. Males and egg-laying females are produced late in the fall only. The male is usually winged, is considerably smaller than the viviparous female and has darker markings on the head, thorax and abdomen. Only a few wingless males have been observed. The egg-laying female is wingless, and much smaller than the wingless viviparous form which it resembles closely in color. The hind tibiæ are considerably thickened basally and bear numerous sensoria. The winter eggs are usually found on red or crimson clover. The egg is about $\frac{1}{33}$ inch in length, elliptical oval in outline and pale when first laid, changing to jet black.

The pea aphis is subject to the attacks of several parasitic and predaceous insects and particularly to a fungous disease that often destroys a large proportion of the lice. These natural enemies are most effective during the warmer part of the season and often nearly exterminate the lice locally on certain food plants.

*Means of control.*

As the pea aphis lives over winter and begins breeding in the spring on clover, especially on crimson clover, the presence of these crops in the near vicinity of fields of early peas is a menace to the latter. In such cases, when crimson clover is being grown for green-manure and is seen to be infested, it should be plowed under before the migration of the lice to peas takes place, without waiting for it to reach its full growth. The ground should then be harrowed and rolled. In cases in which the clover is grown for hay, it might be well to sacrifice this crop in order to save the peas. Experience has shown that peas grown in rows about thirty inches apart are, as a rule, less seriously infested than when they are sown broadcast or in narrow drills. When the peas are grown in rows, the lice can be controlled by spraying with "Black Leaf 40" tobacco extract, 10 ounces in 50 gallons of water to which 4 pounds of whale-oil soap have been added. A traction sprayer is used, fitted with nine nozzles and arranged to spray three rows at a time. One nozzle is directed downward and the other two nozzles throw the spray slightly upward into the row. The pump should be able to give a pressure of 120 to 150 pounds when all nine nozzles are in operation. With this outfit it is possible to work effectively on twelve acres of peas a day. In spraying for the pea aphis, it is important to begin early, soon after the winged forms from the clover appear in the field. If the work is started on time, it is usually possible to control the pest with two or three applications at intervals of about a week. In Maryland, Delaware and New Jersey, it was found that much loss could be avoided by raising the main crop of peas for the cannery early in the season before the aphis became abundant.

At the time of the first serious outbreak of the pea aphis in this country, spraying machinery and insecticides were not as effective as those now on the market and spraying experiments at that time gave very unsatisfactory results. Methods were, therefore, devised for destroying the lice by mechanical means. The aphids were brushed from the plants to the ground during the heat of the day with pine boughs and a cultivator was immediately run between the rows. In this way many of the lice were either killed by the heat or buried in the soil. This method is now little practiced under commercial conditions but might be followed to advantage in the home garden.

### References

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Va. Truck Exp. Sta. Bull. 13. 1914.
U. S. Dept. Agr. Bull. 276. 1915.
Smith, 10th Rept. State Ent. Va., pp. 32–63. 1914–1915.

## THE BEAN APHIS

*Aphis rumicis* Linnæus

This black plant-louse is widely distributed throughout the greater part of the subtropical and temperate regions of the world. Its summer food plants include a great variety of vegetable crops: beans, especially the broad bean, lima bean, beet, pea, celery, asparagus, orach, onion, leek, rhubarb and horse-radish. In England it has been reported as attacking turnip and parsnip. It is almost certain to be found in great abundance on nasturtium late in the season. Its common wild food plants are dock, burdock, lamb's quarters, shepherd's purse and pigweed.

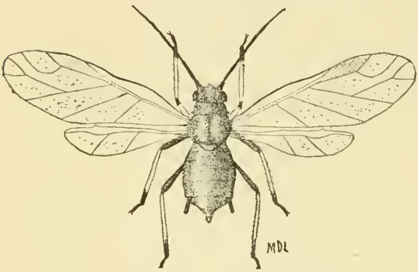


FIG. 51. — Winged viviparous female bean aphis (enlarged).

The winter is passed in the egg stage on Evonymus, syringa, snowball and Deutzia. The egg is about $\frac{1}{50}$ inch in length and shining black in color. The eggs hatch in early spring and the first generation develops on the tender foliage of these shrubs. When mature, the stem-mothers, as the aphids of the first generation are called, give birth to living young, a few of which acquire wings. In the third generation a larger proportion

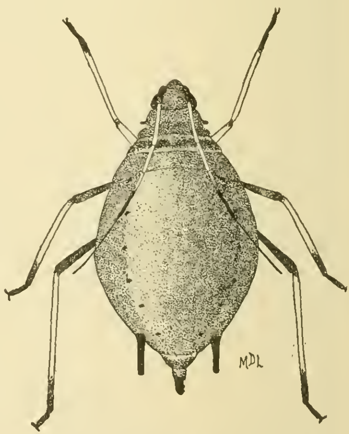


FIG. 52. — Wingless viviparous female bean aphis (× 20).

become winged. The winged forms (Fig. 51) migrate to their summer food plants but the insect is capable of breeding the entire season on the plants on which it passed the winter. Throughout the summer the aphids reproduce parthenogenetically, all the individuals being females. Whenever the host plants become crowded, winged forms are produced that migrate to fresh feeding grounds. The full-grown wingless viviparous female is about $\frac{1}{13}$ inch in length and blackish in color (Fig. 52). In the last nymphal stage of the winged form the abdomen is ornamented with five to seven pairs of white pulverulent spots (Fig. 53). In the fall the winged forms fly back to their winter host plants and there produce young that develop into wingless, egg-laying females. These are joined by winged males and after mating they deposit eggs in the crevices around the buds.

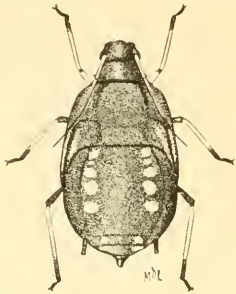

Fig. 53. — Last nymphal stage of the winged viviparous female bean aphis (enlarged).

The bean aphis can be killed by spraying with "Black Leaf 40" tobacco extract, 1 part in 100 parts of water in which enough soap is dissolved to give a good suds.

## The Garden Flea-Hopper

*Halticus citri* Ashmead

This small black plant-bug resembles the cucumber flea-beetle in size, form and in its habit of jumping when disturbed. The female is dimorphic. In one form the wings are fully developed and in the other they are short and lack the membranous portion at the end. The long-winged form (Fig. 54) is $\frac{1}{12}$ inch in length, black in color, with the thorax and wings covered with small tufts of yellowish scale-like hairs; the tip of the cuneus has a white spot. The legs and antennæ are pale, marked with black. The short-winged form (Fig. 55) is somewhat smaller and more ovate in outline. The front wings lack the membranous part, do not extend to the tip of the abdomen and are rounded behind, thus resembling the wing-covers of a beetle. The male (Fig. 56) is similar to the long-winged female but is much narrower.

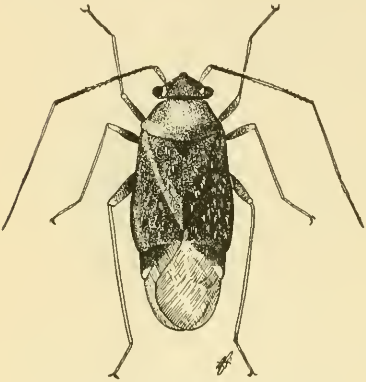

FIG. 54. — The garden flea-hopper, long-winged female (× 16).

The garden flea-hopper is generally distributed throughout the eastern United States and Canada, and westward to Kansas and Utah. It feeds on a great variety of plants including bean, pea, potato, tomato, eggplant, pepper, beet, cabbage, pumpkin, cucumber, squash, celery, lettuce, sweet potato, corn, clover, alfalfa, sweet clover and cowpea. Among its wild food plants may be mentioned beggarweed, ragweed, pigweed, plantain, smartweed, thistle, mare's tail, burdock, wild lettuce, vervain, sticktight, self-heal, mallow, aster, oxalis and convolvulus. The garden flea-hopper has also been recorded as a pest of chrysanthemums and smilax in greenhouses.

FIG. 55. — The garden flea-hopper, short-winged female (× 14).

The life history of the garden flea-hopper is very imperfectly known. It seems probable that hibernation takes place in the egg stage on some of its perennial host plants, but in the South it may pass the winter in other stages. In

Illinois the insects appear the middle of May, become abundant in July and are found on the plants until October. The eggs have not been described. The nymphs are pale green in color with darker wing-pads. The insects are found in all stages on the upper side of the leaves. They feed by puncturing the leaves and sucking out the sap, thus causing small round yellowish or whitish spots. The number of generations a year has not been definitely determined but there are probably more than one.

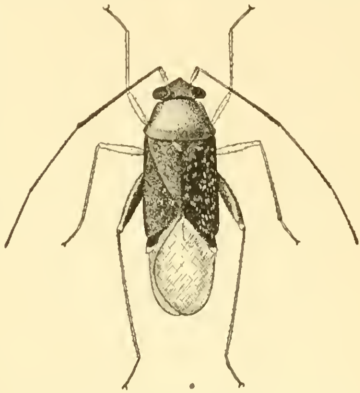

Fig. 56. — The garden flea-hopper, male (× 16).

*Control.*

When present in sufficient numbers to warrant the trouble the garden flea-hopper may be destroyed by spraying with "Black Leaf 40" tobacco extract, 1 pint in 100 gallons of water to which 5 or 6 pounds of whale-oil soap have been added.

Reference

U. S. Div. Ent. Bull. 19, pp. 57–62. 1899.

## The Pea Moth

*Grapholita nigricana* Stephens

The pea moth is a European insect introduced into Canada some time before 1893. It is now distributed throughout eastern Canada, being especially injurious in the maritime provinces, and was reported as destructive in Michigan in 1908. The moth has an expanse of about $\frac{3}{5}$ inch. The front wings are brownish gray with a metallic reflection. Along the front border is a series of short, oblique white and dark lines. The hind wings are black with a bronzy reflection; the fringe is white. The moths appear in late June and early July and lay their eggs during the evening on the recently set pods, depositing from one to three eggs on each pod. The eggs hatch in about two weeks and the young caterpillars immediately burrow into the pods. They feed on the developing peas, gnawing out irregular cavities and often webbing them together. The full-grown caterpillar is slightly hairy, about $\frac{1}{4}$ inch in length and yellowish in color, with a black head and brownish cervical and anal shields. Affected pods usually ripen prematurely. When the pods open, the caterpillar descends to the ground and spins a silken cocoon a short distance below the surface of the soil. Here the winter is passed either in the larval or pupal state, observers differing as to this point. There is but one generation annually.

*Control.*

In Canada it has been found that both very early and late peas are less liable to injury than mid-season varieties. Preliminary experiments indicate that the pest may be held in check by spraying with an arsenical at the time the pods are forming and by two later sprayings at intervals of ten days. It has also been suggested that deep fall plowing of the infested land would destroy many of the hibernating insects in their cocoons. Under ordinary farm conditions in America, the most practical measure is to adopt a crop rotation in which peas do not follow peas.

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Fletcher, Repts. Ent. Canada for 1894, p. 187; 1895, p. 138; 1897, p. 194; 1900, p. 214.

## The Bean Leaf-Roller

*Eudamus proteus* Linnæus

The bean leaf-roller is a tropical insect ranging from Paraguay through Mexico and the West Indies to Florida and northward sometimes to New York and Connecticut. In the United States it has proved injurious only in Florida. Its injuries are usually confined to beans, though it is recorded as feeding on cowpea, turnip, cabbage and several species of Desmodium. Sometimes entire fields have been ruined by the attacks of this leaf-roller.

Fig. 57. — The bean leaf-roller butterfly (× 1½).

In the extreme southern part of Florida and in the tropics, the insect breeds continuously throughout the year. In northern Florida it undoubtedly hibernates in the pupal stage. The first brood of butterflies appears in March. The butterfly has an expanse of about 1¾ inches. The wings are dark chocolate brown; the front wings are marked with several angular silvery white spots. The hind wings are furnished with long tails, somewhat similar to those of the swallowtail butterflies (Fig. 57).

The butterfly lays its eggs singly or in groups of four to six on the underside of the leaves. Occasionally three to four eggs are piled one above the other in a vertical column. The egg is nearly globular, slightly flattened at both ends and marked with a series of delicate longitudinal ridges. It is nearly $\frac{1}{25}$ inch in length. When first laid, the eggs are glistening white, gradually changing to a clear yellow. In summer the eggs hatch in four days and the young caterpillars immediately begin to eat out small patches in the surface of the leaves. Within a day after hatching, the larva constructs a retreat by folding over a flap of the leaf made by cutting along two lines converging from the margin. Within this retreat the larva lives, coming out only to feed. When about to molt, the edges of the retreat are sealed. In the third or fourth stage, the caterpillar constructs a new retreat by folding over a leaflet towards the middle on the upper side. During the course of its development, the larva passes through five stages. The mature caterpillar is over $1\frac{1}{4}$ inches in length. The head is brownish black and the body yellowish sprinkled with black, lighter below. The head is separated from the body by a distinct neck. The length of the larval period varies from two to three weeks. In Florida the life cycle requires about a month and there is, therefore, a possibility of eight or nine broods developing annually in that region.

Under cage conditions, pupation occurs within the retreats and it is probable that this is the case in the open. The pupa is nearly an inch in length, greenish yellow at first, changing to shining brown. In two or three days it is covered with a white flocculent secretion. The pupal period occupies from six to ten days.

*Control.*

Experiments in Florida have shown that the caterpillars can be killed on beans by spraying with paris green. As this poison is likely to injure the plants, it would be better to use arsenate of lead (paste), 4 pounds in 100 gallons of water.

References

Scudder, Butterflies of Eastern U. S., 2, pp. 1386–1393. 1889.
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## The Striped Green Bean Caterpillar

*Ogdoconta cinereola* Guenée

Bean vines are frequently stripped of their foliage and pods by a slender green caterpillar. This injury has been reported from Florida, Mississippi and Maine. The insect is generally distributed throughout Canada and the United States east of the Rocky Mountains.

Fig. 58. — The moth of the striped green bean caterpillar ($\times 1\frac{1}{2}$).

The light brown moth has an expanse of about an inch. The front wings are marked with a few wavy grayish white cross lines. Across the outer margin is a broad, light brownish gray band. The hind wings are brownish gray (Fig. 58). The moths are on the wing from June to September but it is not known where the eggs are deposited. The full-grown caterpillar is over one inch in length, pale green, striped with whitish and yellowish longitudinal lines. This insect is related to the cabbage looper and like it, the caterpillar has the habit of looping like a measuring-worm. When disturbed the larvæ give a series of violent jerks and fall to the ground. Pupation takes place in the soil. The pale yellowish brown pupa is slightly less than ½ inch long. Knowledge of the life history of this insect is very imperfect and additional observations should be made whenever opportunity offers.

When abundant, the caterpillars may be destroyed by spraying with arsenate of lead (paste), 5 pounds in 100 gallons of water. On snap beans tobacco dust may be used to drive them from the plants.

### Reference

U. S. Div. Ent. Bull. 14 (old ser.), p. 21. 1887.

## The Gray Hair-Streak

*Uranotes melinus* Hübner

One of the minor pests of the bean and pea is the slug-like caterpillar of a small, dainty butterfly, the gray hair-streak. It occurs throughout the United States, Central America, northern South America and the West Indies and is found rarely in southern Canada. It has been reported as injurious to beans or peas in New Jersey, Virginia, Maryland, Ohio and Colorado. In the South the caterpillars sometimes bore into cotton squares and okra pods and in the North they have been reported as feeding on the heads of the hop. Among wild plants, they feed on the following: Cratægus, St. John's-wort, hound's tongue, bush clover, loco-weed, tick trefoil, and Japan plum.

Fig. 59. — The gray hair-streak butterfly (× 1½).

The butterfly has an expanse of $1\frac{1}{4}$ inches. The upper surface of the wings is blackish tinted with blue-gray. The hind wings have near the hind angle a row of bluish spots, in the center of which is a large orange spot surrounding a small black one. On the outer margin there are in the male one, and in the female two, small tail-like processes. The under surface is gray with two blackish brown lines crossing each wing (Fig. 59). The butterflies are on the wing from May to September in the North and March to November in the South. The eggs are small and pea-green in color. Where they are deposited and the time of incubation have not been determined. The caterpillars bore into the pods of peas and beans and destroy the developing seeds. The full-grown caterpillar is green, about $\frac{1}{2}$ inch in length, and slug-like in appearance. The chrysalis is naked, and hangs freely, attached at the caudal end to a button of silk. The pupal period lasts from ten days to two weeks. In the North there are two, and in the South, three broods annually.

If necessary, the caterpillars may readily be controlled by spraying with an arsenical.

References

Scudder, Butterflies of Eastern U. S., 2, pp. 850–855. 1889.
U. S. Div. Ent. Bull. 33, pp. 101–102. 1902.

## The Green Clover Worm

*Plathypena scabra* Fabricius

This insect is common throughout the eastern United States and Canada. Its favorite food plant is clover but occasionally the caterpillars defoliate peas, beans and lima beans. They are also found on tickweed, soybeans, vetch and strawberry.

The moths have an expanse of 1 to 1¼ inches, the larger specimens usually being males. The palpi form a rather prominent snout. When at rest, the wings are closely appressed to the body. The front wings are blackish brown, the outer part of the wing in the female shaded with light gray and often with brown. The wing is crossed near the middle by a fine black line which is wavy and often very faint on the front half but straight and composed of raised black scales on the posterior half. At one quarter and at three quarters the distance from the base of the wing is a fainter wavy dark line and at one third the distance a raised black dot. Some females are marked with one or two longitudinal black dashes. The hind wings are blackish brown (Fig. 60).

The moths emerge from hibernation in early spring. In Washington, D. C., they are on the wing in warm sunny days even in the winter. In that latitude there are three generations annually; the first brood of caterpillars becoming mature about the middle of June, the second early in August and the third in late September or early October. The caterpillar is slender and loops with the front half of the body when walking. In the next to the last stage, it is nearly an inch in length, pale green in color and striped lengthwise with fine white or cream-colored lines. In the last stage it is nearly uniform pale green, the stripes having become much less distinct. The caterpillars mature in about twenty-five days and then construct cocoons in leaves webbed together with silk within which they transform to dark brown pupæ about $\frac{1}{2}$ inch in length. The moths emerge in eight days to two weeks and lay eggs for another brood. The egg is about $\frac{1}{50}$ inch in diameter, globular, flattened above and with coarse ridges radiating from the apex. The eggs hatch in four to six days and the young caterpillars feed on the underside of the bean leaves, eating out irregular holes and when abundant stripping the plants of their foliage. Sometimes the caterpillars also eat holes in the pods.

FIG. 60. — The moth of the green clover worm ($\times 1\frac{1}{4}$).

When attacking shell beans, the caterpillars may be poisoned by spraying the vines with arsenate of lead (paste), 2 pounds in 50 gallons of water, taking care to apply the spray to the underside of the leaves. On string or snap beans, tobacco dust or extract may be used. It has also been suggested that many of the caterpillars could be killed by spraying the underside of the leaves with a strong soap solution.

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Conn. Agr. Exp. Sta. Rept. for 1908, pp. 828–832.

## The Lima Bean Vine-Borer

*Monoptilota nubilella* Hulst

From Maryland to Florida and Alabama, pole varieties of lima beans are occasionally infested by a caterpillar that burrows in the stalk, causing a gall-like enlargement which is about $1\frac{1}{2}$ inches in length by $\frac{1}{2}$ inch in diameter. These galls may occur at any point from the surface of the ground to near the tip of the vine. The injury inflicted varies with the position of the gall and with the thriftiness of the vine. When the caterpillar enters a well-formed stalk, the plant is not seriously affected, but when the gall is formed in small stalks near the tip, the terminal portion often wilts and dies or at least is not able to produce full-sized pods. The full-grown caterpillar is about $\frac{7}{8}$ inch in length and of an unusual color for a borer, being a beautiful blue-green, tinged with pinkish above. When mature, it leaves the gall and pupates on or in the ground in an oval silken cocoon covered with particles of dirt. The pupa is dull olive-brown and a little less than $\frac{1}{2}$ inch in length. Some of the moths may emerge the same summer and lay eggs for a second brood. The moth has an expanse of about $\frac{7}{8}$ inch. The front wings are brownish gray shaded with whitish especially toward the base near the front margin and are marked with several small blackish streaks about one third the distance from the base of the wing. The hind wing is translucent white in the male and dark in female.

No better treatment is known than to kill the caterpillars with a knife while still in their burrows.

### Reference

U. S. Div. Ent. Bull. 23, pp. 9–17. 1900.

### Other Pea and Bean Insects

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Southern corn root-worm : 222

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## CHAPTER IV

### BEET AND SPINACH INSECTS

The insects attacking beet and spinach, as a rule, also feed on related wild plants, chiefly various species of Chænopodium and Amaranthus. Many of these plants are common weeds and serve as centers from which infestation spreads to cultivated crops. Over one hundred and fifty insects have been recorded as feeding on sugar-beets, about forty of which are considered as important pests. The sugar-beet is classed as a field crop and in this chapter only those insects are treated which have been found causing important injury to garden beets and spinach. The two principal insect pests of spinach are the leaf-miner and the aphis, their combined attacks often making the growing of this crop unprofitable in certain localities.

### The Spinach Leaf-Miner

*Pegomyia hyoscyami* Panzer

This troublesome pest of beets and allied crops is present in both Europe and America. In Europe the insect has been known for over a century and in this country it first attracted attention by its injuries about 1880. It is now generally distributed throughout the United States and Canada. The maggots infest the leaves of spinach, orach, beets, sugar-beets, mangels and chard. Its other food plants are lamb's quarters, and in the British Isles and Europe deadly nightshade, henbane, nettle-leaved goosefoot, common chickweed and lady's thumb (*Polygonum persicaria*).

The flies appear in the fields in April or May. They are about $\frac{1}{4}$ inch in length, grayish in color and clothed with numerous black setæ; the legs are yellowish with the tarsi blackish (Fig. 61). The female deposits her eggs singly or in rows of two to five placed side by side on the underside of the leaves (Fig. 62). The egg is about $\frac{1}{28}$ inch in length, white, cylindrical, and the surface is distinctly reticulated. The eggs are attached to the leaf by one side; they hatch in four to six days and the young maggot works its way into the tissue of the leaf where it eats out a mine between the upper and lower epidermis. The mine is at first thread-like but is soon enlarged to form a blotch. Several maggots usually occupy the same leaf and their mines usually coalesce. In the course of its growth the maggot molts twice, thus passing through three stages. If the food material in a single leaf becomes exhausted, the maggots may migrate to another leaf in order to complete their growth. In case the leaf dies, the maggots are able to complete their development on manure or humus, according to observations made in Hungary. The larva becomes full-grown in a week to sixteen days. It is then $\frac{1}{3}$ inch in length, white or yellowish with the hook-like mouth-parts black. The body

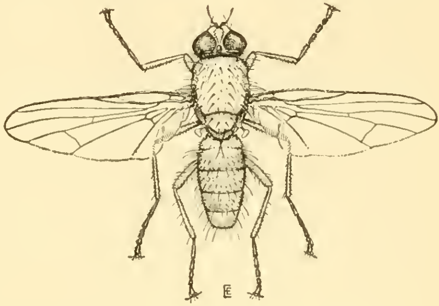

FIG. 61. — The spinach leaf-miner, adult ($\times$ 4).

FIG. 62. — Eggs of the spinach leaf-miner ($\times$ $3\frac{1}{2}$).

tapers towards the head and is obliquely truncate posteriorly. When mature, the larva usually deserts the leaf and enters the earth, where, at a depth of two or three inches, it changes to a brownish puparium, about $\frac{1}{5}$ inch in length. Sometimes the puparia are found in the dead and rotting leaves on the ground. The flies emerge in two weeks to twenty-five days and soon lay eggs for another brood. In central New York there are three generations and a partial fourth annually.

The spinach maggot is most injurious to spinach and chard, and beets when used for greens. The injury to the leaves of beets, mangels and sugar-beets also decreases the size of the root-crop. When these crops are grown for seed, the quantity produced is often seriously lessened by the partial defoliation of the plants by the maggots.

*Control.*

No satisfactory method of preventing the damage by the spinach leaf-miner has as yet been devised. Clean culture and the destruction of the insect's wild food plants, lamb's quarters and other weeds will be of some value in decreasing the degree of infestation. In some localities growers avoid a bad infestation in spinach by growing the crop late in the fall and early in the spring.

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## The Beet Leafhopper

*Eutettix tenellus* Baker

In the western states from Idaho, Nebraska and Texas, westward to the Pacific and southward into Mexico, sugar-beets, table beets and mangels are subject to a disease known as curly-leaf, the exact cause of which is not fully understood.

Diseased plants have the veins of the leaves enlarged, and the surface becomes warty, uneven, and the edges curl inward, bringing the under surface into view. The petioles are shorter and bowed outward. The leaves are more brittle than normal, although they have a leathery appearance. Young plants may be killed outright, others are badly stunted; the sugar-content of the roots is lessened and there is an abnormal development of rootlets. Cross-sections of the root often show dark concentric circles from the darkening of the fibrovascular bundles. Frequently large fields of beets so affected are not worth harvesting and in many localities the growing of sugar-beets has been abandoned for this reason. When beets are grown the second year for seed, the presence of this disease greatly reduces the crop.

The disease is transmitted by a small, creamy or greenish white leafhopper, sometimes tinged with red, about $\frac{1}{8}$ inch in length, both nymphs and adults being capable of infecting the plant on which they feed. This insect is a native of the same region where it feeds on several species of Atriplex and Russian thistle, sea blite and greasewood. Certain species of Atriplex seem to be its favorite wild food plants. The insect hibernates as an adult, appearing in the beet fields in late spring.

Beet fields do not, as a rule, become infested by leafhoppers that have hibernated in their immediate vicinity. Apparently the infestation comes from leafhoppers that have developed on their wild food plants in desert regions and that have hibernated near their breeding grounds. In late spring these insects migrate in great swarms, passing over high mountain ranges and traveling to distances of several hundred miles. In the course of the migration, the leafhoppers settle in any beet fields in which the plants are in condition to serve as food. If the crop in a field is not up at the time of the flight, it is not likely to become infested from adjoining fields but may be attacked by a later flight if a second migration occurs. Injury by the leafhopper is likely to take place in regions not infested the previous year and a season of severe injury may be followed by one in which practically no leafhoppers can be found. In most localities the disease is of a periodic nature, but in certain regions within the permanent breeding area infestation is almost sure to occur every year.

In feeding, the insect punctures the leaf with the slender needle-like bristles of its beak and sucks out the juices of the plant, at the same time inoculating it with the virus of the disease. When disturbed, the leafhoppers spring quickly into the air and take wing, but soon alight seeking shelter on another plant. When on the wing they appear white. The female inserts her eggs their full length singly in the stems, midrib and petiole of the leaves and sometimes in the larger side veins. The eggs are pale, elongate, slightly curved and narrower anteriorly. Before hatching the growth of the leaf usually forces the eggs part way out of the tissue. The eggs hatch in about two weeks and the minute, nearly colorless nymphs begin feeding on the leaves down in the center of the plant. The older nymphs vary from creamy white in color to nearly black, variously spotted and mottled with brown, buff and red. In about three weeks the nymphs become mature, having passed through five immature stages in the course of their growth. The eggs are laid during a considerable period, from late in June to the first of September in the northern part of the insect's range, but the greater number are deposited during the first half of July. Each female is capable of laying about 80 eggs. There is only one generation annually.

The control of this leafhopper and the consequent elimination of the curly-leaf disease is commercially unsolved. The adult hoppers are hard to hit and difficult to kill with contact insecticides and it is doubtful whether spraying would be commercially profitable. Something can be gained, however, by early planting and by good care of the crop early in the season so as to get the plants well established before the hoppers make their appearance in the field.

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U. S. Bur. Ent. Bull. 66, pp. 33–52. 1909.
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## The Larger Sugar-Beet Leaf-Beetle

*Monoxia puncticollis* Say

In New Mexico, Colorado and Montana, sugar-beets are sometimes attacked by the larvæ and adults of this leaf-beetle, but it has not yet been reported as an enemy of table beets. Its wild food plants are sea blite, Russian thistle and salt-bush. Both larvæ and adults feed on the leaves but the greater part of the injury is caused by the former. When disturbed they fall readily to the ground. The beetle occurs along the Atlantic and Gulf coast and westward to California, and northward through Colorado, Utah and Montana. It is $\frac{1}{4}$ to $\frac{1}{3}$ inch in length, and varies considerably in color, from uniform dull yellowish brown to nearly black; in some forms each wing-cover is marked with one or two more or less distinct dark stripes (Fig. 63). The insect hibernates in the beetle stage, appearing on its food plants early in the spring. The female deposits her eggs, a little less than $\frac{1}{25}$ inch in length, in irregular clusters of two or three to forty or fifty on the leaves. These

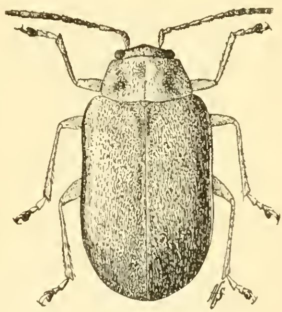

Fig. 63. — The larger sugar-beet leaf-beetle ($\times 4\frac{1}{2}$).

hatch in about a week and the larvæ begin feeding on the leaves. The young larva is about $\frac{1}{17}$ inch in length, dull gray, with the thoracic shield and the areas at the base of the tubercles dark brown. The larva becomes full-grown in nine or ten days. It is then about $\frac{2}{5}$ inch in length, dark olive brown with the tubercles pale yellow. The larvæ enter the ground for pupation and the beetles emerge a few days later. There are two generations annually.

It has been observed in Colorado that the insect is most troublesome on beets grown on or near alkali ground.

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## The Western Beet Leaf-Beetle

*Monoxia consputa* Leconte

This leaf-beetle ranges from California and Oregon east to the Dakotas and Kansas. It has been reported as injurious to beets and sugar-beets in California and Oregon. Both larvæ and adults feed on the leaves, leaving only the larger veins. The beetle (Fig. 64) is nearly $\frac{1}{5}$ inch in length, yellowish brown; the wing-covers are sometimes marked with small scattered black spots often arranged in rows.

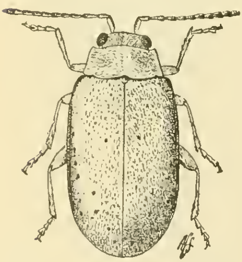

Fig. 64. — The western beet leaf-beetle (× $5\frac{1}{2}$).

The beet leaf-beetles can be controlled by thoroughly spraying the plants with arsenate of lead (paste), 5 or 6 pounds in 100 gallons of water.

## The Sugar-Beet Webworm

*Loxostege sticticalis* Linnæus

Although the sugar-beet webworm has attracted more attention as an enemy of the sugar-beet, it also attacks a large number of garden and field crops. It is widely distributed throughout Europe, Asia and North America and is particularly injurious in southeastern Europe. It did not attract notice in the United States until the beginning of the development of the sugar-beet industry. It has been destructive only in the Mississippi Valley and westward to the Rocky Mountains. In addition to the sugar-beet, it has been reported feeding on the following: pea, bean, potato, cabbage, onion, squash, pumpkin, cucumber, alfalfa and various grains and grasses. Its favorite wild food plants are pigweed (Amaranthus) and lamb's quarters.

Fig. 65. — The sugar-beet webworm moth (× 1⅓).

The winter is passed by the full-grown caterpillars in silken tubes in the soil. In late spring they transform within the tubes to yellow-brown pupæ about ½ inch in length. In about eleven days the moths emerge. The moth has an expanse of about an inch. The front wings are smoky brown with faint darker markings, a straw-colored spot below the middle of the front margin and a similarly colored band along the outer margin. The hind wings are paler with two blurred bands (Fig. 65). The females deposit their pale, pearly green or yellow, oval eggs about $\frac{1}{25}$ inch in diameter, singly or in overlapping rows of two to ten, usually on the underside of the leaves. The egg is flattened below and very convex above. Each female lays from 200 to 250 eggs. The eggs hatch in three to five days. The young whitish larvæ with black heads feed at first on the soft tissues on the underside of the leaves. As they increase in size, they become yellowish green in color with dark markings and consume almost the entire leaf. The caterpillars feed by preference on the older, outer leaves and do not attack the newer leaves at the center of the plant until the others have been consumed. Their feeding grounds are covered by a slight silken web. The full-grown caterpillar is about an inch in length, yellowish white with a broad black median stripe and a broader sub-dorsal stripe and marked with numerous piliferous spots surrounded by black rings. The larva becomes mature in about three weeks and constructs a silken tube in the ground within which it forms a cocoon and pupates. The winter cocoon is about three times the length of the larva and the summer cocoon only twice as long. There are usually three generations a year and in some cases a small fourth brood may occur. A few of the first, a considerable part of the second, and nearly all of the third generation caterpillars do not transform till the following spring. The first brood are destructive while the sugar-beet plants are small and easily killed. At this time the crown of the plant is often attacked. When the later broods appear, the plants are larger and rarely killed outright but the size and sugar-content of the roots are greatly decreased by the defoliation of the plants. The third brood is the least injurious because the plants are more nearly mature and the brood is smaller.

In some regions in which the sugar-beet is grown extensively, the caterpillars often occur in countless numbers and the moths attract attention by flying in clouds over the fields.

*Means of control.*

The sugar-beet webworm may be controlled on sugar-beets by thorough spraying with 3 pounds of paris green in 100 gallons of water to which 6 pounds of whale-oil soap or 3 pounds of lime are added as an adhesive. About 100 gallons of the mixture should be applied to the acre and the application should be made as soon as possible after the caterpillars have hatched. The spray should be applied with at least 80 pounds' pressure. Recent experiments in Colorado and Kansas have shown that paris green applied in this way will satisfactorily control the webworm on beets and is much more effective than arsenate of lead. In some cases in which the ground is too wet for the use of a sprayer, paris green may be applied in the form of a dust at the rate of 2 to 4 pounds in 100 pounds of air-slaked lime.

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## The Hawaiian Beet Webworm

*Hymenia fascialis* Cramer

In the southern United States beet leaves are sometimes skeletonized on the underside by a small, slender, pale green caterpillar which has received the rather inappropriate common name given above. The insect ranges throughout the southern states westward to California. It is also generally distributed throughout the warmer parts of the Old World. Its habits and life history have been studied carefully in Hawaii. In that climate, breeding is continuous throughout the year. Its food plants include table beets, sugar-beets, Swiss chard, mangels and *Amarantus gangeticus*, a Chinese pot-herb sometimes known as spinach. Among weeds, it feeds on purslane and numerous species belonging to Amaranthus and Chænopodium. The caterpillars reach maturity in nine days to two weeks and then enter the ground a short distance, where they form firm, oblong earthen cocoons composed of silk and particles of earth. The pupa is $\frac{2}{5}$ inch in length and pale brown in color. The moths emerge in a week or two. The moth has an expanse of about $\frac{7}{8}$ inch. The wings are uniform blackish brown. The front wing has a broad translucent white band across the middle, not quite reaching the front margin. Two thirds the distance to the outer margin a white bar extends halfway across the wing. The hind wing is crossed by a nearly even white band. The moths are shy and are usually to be found hiding under the leaves. In Florida they are often found in great numbers feeding on the nectar of catnip blossoms. The female deposits her minute elliptical flattened eggs, about $\frac{1}{40}$ inch in length, singly or in short rows on the underside of the leaves. The eggs hatch in about four days. The caterpillars sometimes spin a slight web over their feeding grounds but more often feed openly. It is believed that in Hawaii from six to ten generations may be produced annually.

This webworm can be controlled by spraying with arsenate of lead (paste), 2 pounds in 50 gallons of water, taking care to coat the underside of the leaves.

### Reference

U. S. Bur. Ent. Bull. 109, pp. 1–15. 1911.

## The Spotted Beet Webworm

*Hymenia perspectalis* Hübner

The spotted beet webworm is widely distributed throughout the warmer parts of the world and in the United States is sometimes found out of doors as far north as Virginia. In greenhouses it often proves a troublesome pest on Alternanthera. In the open it sometimes becomes destructive to beets, sugar-beets and Swiss chard. The moth has an expanse of about $\frac{7}{8}$ inch. The wings are blackish brown shaded with clay-color, especially on the hind wings. The markings are translucent white; on the front wing there is a narrow curved line near the base; a nearly square patch at the middle near the front edge; a line running from close to this to the hind margin, and two thirds the distance to the outer margin a white bar extends halfway across the wing. Across the middle of the hind wing is an irregular white band, narrower behind.

The moth deposits her flat, oval, semi-transparent, greenish eggs, about $\frac{1}{30}$ inch in length, singly on the stems of the plant, usually near the base. The young larvæ at first skeletonize the leaves but later devour the whole leaf. The full-grown larva is a little more than $\frac{1}{2}$ inch in length, shining green and marked with rows of small black spots. Pupation takes place in a thin loose silken cocoon on the ground at the base of the plants. The pupal period occupies from one to three weeks, depending on the season. Under greenhouse conditions the life cycle is completed in two or three months.

The spotted beet webworm may be controlled by the measures suggested for the preceding species.

### References

Davis, 27th Rept. State Ent. Ill., pp. 103–106. 1912.
U. S. Bur. Ent. Bull. 127, pp. 1–11. 1913.

## The Southern Beet Webworm

*Pachyzancla bipunctalis* Fabricius

In Georgia, Florida and Texas, this webworm has been reported as occasionally injurious to beets, cauliflower and cabbage. Its wild food plants include ragweed, spiny amaranth and *Amarantus retroflexus*. The insect ranges southward through the West Indies into South America and also occurs in South Africa. The caterpillars feed on the leaves of their food plants, folding and webbing them together with silken threads. The full-grown larva is about $\frac{3}{4}$ inch in length, dark, dirty green with the head and the sides of the cervical shield dark brown. The surface of the body is semi-transparent and glossy in appearance. The caterpillars become mature in two or three weeks and transform to mahogany brown pupæ $\frac{2}{5}$ inch in length. The posterior end of the body is prolonged into a bill-like process bearing four pairs of recurved hooks. The pupal period occupies about eight days in warm weather. The moth has an expanse of about an inch. The front wings vary from buff to pale yellowish gray, often tinged with purplish and crossed by two irregular brownish lines and marked with two black dots near the front margin. The moth deposits her eggs singly on the underside of the leaves. The eggs are flattened, irregularly oval, yellowish or greenish in color and about $\frac{1}{60}$ inch in length. They hatch in about a week. There are thought to be four generations a year.

This beet webworm may be controlled by the measures suggested for the Hawaiian beet webworm.

### Reference

U. S. Bur. Ent. Bull. 109, pp. 17–22. 1911.

## The Sugar-Beet Root-Louse

*Pemphigus betæ* Doane

In the western United States from western Kansas and Nebraska to California, sugar-beets, beets and mangels often have the roots infested with a small, pale yellow plant-louse. In the case of sugar-beets, not only does the presence of the plant-lice greatly decrease the weight but also the sugar-content of the roots, in many localities making it unprofitable to grow the crop. This root-louse is a native of the western United States, where it is found most abundant on the roots of lamb's quarters but has also been reported as infesting the roots of the following plants: yarrow, knotweed, dock, aster, goldenrod, horse-weed, winged pigweed, foxtail, salt-grass, blue-joint grass, wheat, flax and alfalfa.

The insect passes the winter in two forms, either as wingless viviparous females on the roots of its food plants or as eggs on the bark of two species of cottonwood (*Populus angustifolia* and *P. balsamifera*). The plant-lice that have survived the winter on the roots begin to give birth to living young in April or May, producing another generation of wingless viviparous females. Reproduction continues in this way until midsummer, when winged forms begin to appear. Only about half of the lice acquire wings, the others continue breeding on the roots throughout the season. The form found on the roots is about $\frac{1}{8}$ inch in length, pale yellow in color and has the posterior part of the abdomen clothed with a white flocculent mass of waxy filaments. The remainder of the body is dusted with a white powder. Infested roots appear to be covered with a white or grayish mold. The winged forms produced on the roots are slightly larger than the wingless forms. The abdomen is greenish, the thorax, head and antennæ bluish black, lightly dusted with the whitish powder and there is only a little of the white flocculent material on the tip of the body. These winged forms begin to appear in midsummer and continue until the end of the season but are most abundant in September and October. They migrate to the cottonwood, where, on the bark of the trunk, each female gives birth to four to seven young, part males and part females, the latter predominating. These forms lack functional mouth-parts and do not take food. They molt four times in as many days and after mating the female deposits a single pale yellow egg in a crevice of the bark, which usually rests on a mass of bluish white waxy threads. The eggs hatch about the first of the following May and the young plant-louse crawls out on the upper side of an opening leaf, where it establishes itself and begins feeding. A depression soon appears on the leaf at this point which gradually develops into a pocket-like outgrowth on the underside opening by a narrow slit in the upper side. Within this pocket-like gall, the plant-louse becomes mature and gives birth to seventy-five to one hundred and seventy-five young, all of which acquire wings and on escaping fly to beets or other food plants, where they produce young which descend to the roots. This migration from the cottonwood takes place mostly in July. Beets become infested both from lice living over in the ground on last year's crop or on weeds, and by the migrants from the cottonwood.

The only practicable measure so far suggested for the control of the sugar-beet root-louse can be employed only where irrigation is practiced. It consists in giving the plants the maximum quantity of water that they can stand, thus forcing the growth and at the same time producing conditions unfavorable to the multiplication of the insects.

Beets are also sometimes infested by another species of root-louse, *Tychea brevicornis* Hart. This peculiar plant-louse is wingless, with the abdomen very large and without cornicles. Corn, sorghum, salt-grass, pigweed, purslane, mustard, lettuce and dock have been recorded as hosts of *T. brevicornis*.

A closely related species, determined as the European *T. phaseoli* Passerini, has been reported as feeding on the roots of bean and clover. There is some doubt as to the determination of the species of plant-lice found on the roots of many of our common weeds and vegetables. They are in great need of further study.

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## The Spinach Aphis

*Myzus persicæ* Sulzer

The spinach aphis is also known as the green peach aphis, and as the common green-fly of greenhouses. It is found in both Europe and America. In some localities it is the most serious insect enemy of spinach and is sometimes injurious to potato, tomato, eggplant, cabbage, turnip, radish, cauliflower, cucumber, kale, mustard, beet, rutabaga, water cress, pepper, horse-radish, celery, rhubarb, okra and lettuce. Eggplant often becomes infested in the hot-bed before transplanting. Radishes and rutabagas are sometimes attacked as soon as they come up, the first pair of leaves being entirely covered on the underside by the lice. Such plants are badly stunted and sometimes killed. The spinach aphis also attacks a number of weeds, including pigweed, lamb's quarters, dock, shepherd's purse, dandelion, sow thistle, lupine and wild mustard. It is often found in greenhouses, where it infests the calla lily, carnation, rose, violet, oleander and many others. It has also been recorded from tulip, pansy, hollyhock, tobacco, peppermint, rape and several ornamental plants. It is also sometimes found in the summer on apple, pear and lilac.

The spinach aphis may pass the winter either in greenhouses or on its food plants out of doors, where the winters are not too cold, or in the egg stage on the peach, plum, cherry, apricot, sand cherry and choke cherry. In the last case, the eggs hatch shortly before the buds burst in the spring and the stem-mothers are ready to begin reproduction when the blossoms appear. They are wingless and of a pinkish color. In the second generation the plant-lice are for the most part wingless, but instead of being pink, are pale yellowish green and usually marked with three indistinct darker stripes on the abdomen. In the third generation, most of the lice acquire wings. They are then greenish with the head, thorax and a large spot on the abdomen black. These winged forms leave the tree and fly to their various herbaceous food plants where they found colonies of young. When the lice have survived the winter on weeds or vegetables, reproduction is resumed as soon as new growth starts in the spring. They multiply rapidly and the plants soon become covered with the lice. The wingless forms found on the summer food plants have the body a uniform greenish yellow, without the darker lines found on the forms on the peach or plum (Fig. 66). When the plant becomes crowded, winged forms (Fig. 67) are produced which migrate to new feeding grounds. The insects are most destructive to spinach late in the season when the cooler weather prevents the rapid multiplication of their predaceous and parasitic enemies, although they may become troublesome at any time. In the fall some of the winged females return to the peach, plum or cherry, establish themselves along the veins on the underside of the leaves and give birth to true or oviparous females. The latter are usually of a pinkish color, similar to the stem-mothers of the preceding spring. After pairing with the winged males, they deposit their eggs in the axils of the buds and in crevices of the bark. The eggs are small, oval and shining black, and closely resemble those of the common green apple aphis.

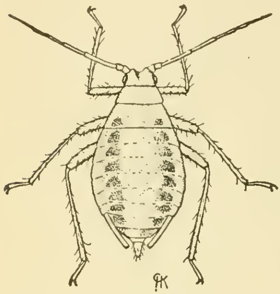

FIG. 66. — Wingless viviparous female spinach aphis (× 11).

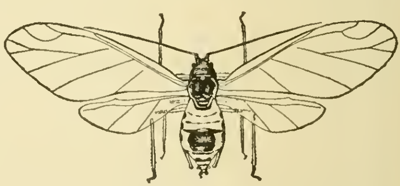

FIG. 67. — Winged viviparous female spinach aphis (× 7½).

*Control.*

The spinach aphis is readily killed when hit by spraying with "Black Leaf 40" tobacco extract, 1 pint in 100 gallons of water to which 5 or 6 pounds of soap have been added. On spinach, however, and other plants the leaves of which lie close to the ground, it is not easy to obtain satisfactory control owing to the difficulty of wetting the underside of the leaves with the spray.

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## Other Beet and Spinach Insects

Southern corn root-worm: 222
Cabbage looper: 8
Cabbage webworm: 16
Garden webworm: 18
Harlequin cabbage bug: 38
Serpentine leaf-miner: 46
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Carrot beetle: 185
Celery leaf-tyer: 189
Celery looper: 191
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Western twelve-spotted cucumber beetle: 114
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## CHAPTER V

# INSECTS INJURIOUS TO CUCUMBER, SQUASH AND MELON

Cucurbits are subject to attack by a large number of insects, the most important of which are: the cucumber beetles, the squash bugs, the squash-vine borer, the pickle worm, the melon worm and the melon aphis. Cutworms and flea-beetles also occasionally cause serious loss. The watermelon is singularly free from insect enemies but is sometimes seriously infected by the melon aphis.

### The Striped Cucumber Beetle

*Diabrotica vittata* Fabricius

This small, yellow, black-striped beetle is one of the most serious enemies of the cucumber, squash, melon and related plants. It is a native of America and is to be found in this country wherever its food plants are grown except in the far West. The greatest injury is to the young plants soon after they come up, by the beetles that have just emerged from hibernation; the larvæ also burrow in the stem both above and below the ground and often feed on the underside of the fruit when it lies on the soil; the beetles sometimes destroy the flowers by eating off the pistils and the new brood of beetles in late summer causes considerable injury to ripening fruit by gnawing holes in the rind.

The beetles hibernate under trash or, when such protection is not available, in the ground below the frost line. They emerge from hibernation in the spring from April to June, the exact date depending on the locality and the season. They usually appear before cucurbit plants are up and feed for some time on the pollen of flowers and on the leaves of certain plants, apple, horse-chestnut, wild thorn, elm, syringa, juneberry and many others. The beetles, hungry after their long winter's fast, congregate on squash and cucumber plants just as they are coming up and feed on the tender leaves and gnaw holes in the stems often just at the surface of the ground. Many plants are killed outright while others are so injured that they make only a sickly growth. Okra is sometimes attacked.

FIG. 68. — The striped cucumber beetle ($\times 5\frac{1}{2}$).

The beetle (Fig. 68) is from $\frac{3}{16}$ to $\frac{1}{4}$ inch in length; the head is black; the thorax yellow and the wing-covers yellow with three longitudinal black stripes, the lateral pair not extending to the tip. After feeding for some time, the beetles mate and the female begins egg-laying. Oviposition has been found to begin in Kentucky about the middle of June, on Long Island, New York, towards the last of June and in New Hampshire, about the first of July. Oviposition continues for about a month. Each female is capable of laying from seventy-five to one hundred eggs. The egg is about $\frac{1}{40}$ inch long, $\frac{1}{60}$ inch wide, oval or elliptical in outline and light yellow in color. Some of the eggs are deposited in crevices in the ground but many are dropped by the female wherever she happens to be feeding. Eggs are sometimes found caught in the hairs of the leaves at the tip of the vines. The eggs hatch in a week or more and the larvæ work their way down along the stem or under the vines or fruit where they lie on the ground. They burrow into the tissue, causing more injury in this stage than is usually thought. Squash vines have been observed practically killed in July and early August from the attacks of the grubs. The stem just below the ground is completely riddled by their burrows. The larva becomes mature in about a month. It is then about $\frac{3}{10}$ inch in length and very slender; the color is white with the head, thoracic and anal plates brown (Fig. 69). When mature, the larva constructs an earthen cell a few inches below the surface within which it soon transforms to a nearly white pupa. The pupal stage lasts a week or more. The beetles begin to emerge the last of August or in September in the more northern part of the insect's range and after feeding for some time on flowers, such as goldenrod and asters, go into hibernation with the occurrence of heavy frost. Late in the season the beetles sometimes injure melons by eating holes in the rind and have been known to eat holes in bean pods. In the North there is only one generation annually; in the South it is thought that the insect is double-brooded.

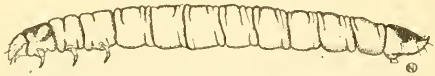

FIG. 69. — Striped cucumber beetle, larva ($\times 7\frac{1}{2}$).

The beetles also serve as carriers for a serious disease of cucurbits known as bacterial wilt. They not only transmit the disease from plant to plant in the summer, but the hibernating beetles carry over the wilt bacteria and infect the plants in the spring.

*Control.*

As a rule, attempts to poison the beetles have not been successful because the insects refuse to eat leaves covered with the poison. In many cases it is practicable to protect the young plants by covering them with some kind of screen. Cheesecloth, mosquito-netting and wire screen are often used for this purpose. Various methods are followed to hold the covering in place over the plants; sometimes a shallow wooden box is used, open at top and bottom and the screen is tacked over the top; sometimes a barrel hoop is cut into halves, the two parts crossed at right angles and the ends stuck in the ground; the screen is placed over the hoops and earth thrown on the edges to hold it down; sometimes the cover is made entirely of wire screen in the form of a cone and one grower successfully used wire pie-covers. The difficulty in using covers is that they have to be removed before the plants become very large and if the beetles are very abundant injury may follow.

Much may be accomplished to prevent injury by keeping the plants thoroughly covered with bordeaux mixture or arsenate of lead (paste), 3 pounds in 50 gallons of water. This renders the plants distasteful to the beetles and is especially valuable on cucumbers if used in connection with trap crops. Squashes are often more attractive to the beetles than cucumbers and have been used successfully for trap crops. When it is desired to protect a field of cucumbers, a few rows of squashes should be placed around the field about a week before planting the cucumbers; another planting of squashes should be made at the time the main field is set and if the beetles are abundant, more squashes should be planted about a week later. The beetles will collect on the squash plants, where it is sometimes possible to poison some when they first arrive and before they have had a chance to feed on unpoisoned foliage. Only a part of the trap crop should be sprayed or dusted with the poison for fear of driving the beetles to the cucumbers. Whenever a trap crop is used, it is important to keep the main crop well sprayed with bordeaux mixture or arsenate of lead. Experiments in New Hampshire have shown that arsenate of lead is just as effective as a deterrent for the beetles as bordeaux mixture and that it does not check the growth of the plants if applied while they are small as does the latter. Tobacco dust, air-slaked lime and land plaster are of value as deterrents and will be found useful in the home garden.

Much loss from beetle attack may be prevented by thorough cultivation and the use of the proper fertilizers to stimulate rapid growth. At the end of the season, all rubbish, including the old vines, should be collected and burned in order to reduce to a minimum the shelter for the hibernating beetles.

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## Western Cucumber Beetle

*Diabrotica trivittata* Mannerheim

On the Pacific Coast the striped cucumber beetle is replaced by a closely related form. This species may be distinguished from its eastern relative by its darker color and by having the antennæ and the greater part of the legs black. The habits and life history of the western form are very similar to those of the eastern species but it has not on the whole proved as injurious. There are said to be two generations annually. When attacking cucurbits, it may be controlled by the same means as suggested for that species.

## The Twelve-Spotted Cucumber Beetle

*Diabrotica duodecempunctata* Olivier

This beetle is also known as the southern corn root-worm and is discussed on page 222 as a corn pest. When attacking cucurbits, it may be controlled by the measures suggested for the striped cucumber beetle.

## The Western Twelve-Spotted Cucumber Beetle

*Diabrotica soror* Leconte

On the Pacific Coast the southern corn root-worm (page 222) is replaced by a closely related species which may be distinguished by having the entire underside of the body and the legs black; the antennæ are only slightly paler at the base. The two posterior spots on the wing-covers have a tendency to coalesce (Fig. 70).

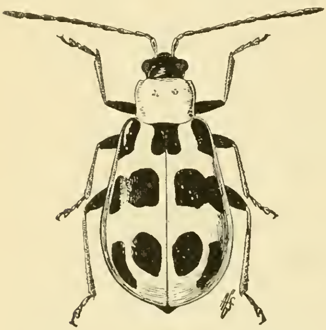

Fig. 70. — The western twelve-spotted cucumber beetle (× 5).

The beetles attack cantaloupe, watermelon, squash and cucumber plants just as they are coming up and also eat holes in the fruit. They are also destructive to beet, spinach, bean, pea, cabbage, turnip, potato, lettuce, mustard, peanut, corn, alfalfa and clover. They are especially troublesome on farms on which flowers are grown for seed. They sometimes defoliate young deciduous and citrus trees and cause considerable injury by eating holes in the fruit of the peach, prune and apricot. The beetles hibernate in sheltered places, emerging in early spring. After feeding for about eighteen to twenty-four days, the small, dirty white, oval eggs are deposited singly or in clusters of four or five to fifty in the ground near the base of the food plant, about one quarter to one half inch from the surface. The eggs are deposited over a period of about three weeks. They hatch in nine to twenty-six days with an average of about two weeks. The larvæ have been found feeding on the roots of pea, alfalfa, peanut and beet and are said to mine into the stems and rinds of melons, cucumber and squash where they touch the ground. The larvæ become mature in five weeks to two months, those hatching first requiring the longer period. The full-grown grub is a little less than $\frac{1}{2}$ inch in length, elongate, cylindrical, white or yellowish in color, with the head, thoracic shield and anal plate brown. The larvæ pupate in earthen cells in the ground and in about two weeks the beetles emerge. In Oregon the beetles of the new brood become abundant in early July; in California somewhat earlier.

The western twelve-spotted cucumber beetle can be controlled by the same measures as recommended for the striped cucumber beetle.

## The Belted Cucumber Beetle

*Diabrotica balteata* Leconte

In the lower Rio Grande Valley in Texas truck crops are often subject to attack by the belted cucumber beetle. This beetle is about $\frac{1}{4}$ inch in length, the head red and the prothorax and wing-covers bluish green, each of the latter marked with two spots in front, two transverse bands and a spot near the apex which are yellowish. The femora are greenish, the remainder of the legs blackish (Fig. 71). The beetles feed on pea, bean, potato, pepper, turnip, peanut, squash, cantaloupe, cucumber, watermelon, pumpkin, okra, spinach, beet, lettuce, onion, asparagus, corn, cotton, alfalfa, cowpea and other leguminous crops. They seriously injure

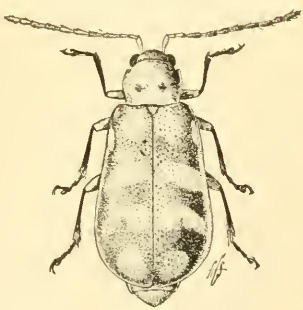

Fig. 71. — The belted cucumber beetle ($\times 5\frac{1}{2}$).

eggplant, tomato and cucurbits by destroying the foliage and by feeding on the blossoms and blossom buds.

The adults are active during the winter but do not lay eggs until March. The egg is oval, pale yellow in color and about $\frac{1}{40}$ inch in length. The eggs are laid in the ground near the base of the food plant singly or in clusters of four or five. They hatch in nine to eleven days. The larvæ have been found feeding on the roots of corn, sorghum and beans. The larva becomes mature in about twenty-five days. It is nearly $\frac{1}{2}$ inch in length, light yellow in color with the head and anal plate brownish. The light yellow pupæ, about $\frac{1}{5}$ inch in length, are found in small earthen cells two or three inches below the surface. About eleven days are spent in the pupal stage. In the second generation the time required for the insect to pass through its different stages is somewhat shorter; viz., egg stage five days, larval stage fourteen days and pupal stage five days.

Experiments in Texas have shown that truck crops may be protected from the attacks of this beetle by spraying with arsenate of lead (paste), 6 to 10 pounds in 100 gallons of water or bordeaux mixture.

Two other closely related cucumber beetles, *Diabrotica connexa* Leconte and *D. picticornis* Horn, occur in Texas and sometimes attack cucurbits and beans. The latter species deposits its eggs on the under surface of cucumber leaves.

### Reference

U. S. Bur. Ent. Bull. 82, pp. 76–82. 1910.

## The Squash Bug

*Anasa tristis* DeGeer

Throughout the whole United States, cucurbits are subject to the attacks of a large brownish bug that has a highly offensive odor, hence the name stink-bug by which it is known in many localities. The insect ranges from Canada to Central America. Its favorite food plants are squash and pumpkin, but melons and cucumbers are sometimes severely injured. As a rule the squash bug is more destructive in the small garden than in the fields of the commercial grower. The reason is that in the case of large tilled fields the quantity of hibernating shelter is relatively smaller, and as the insects are distributed over a larger area the injury is not so great to any particular plant. In the home garden the squash bug is a most troublesome and vexatious pest.

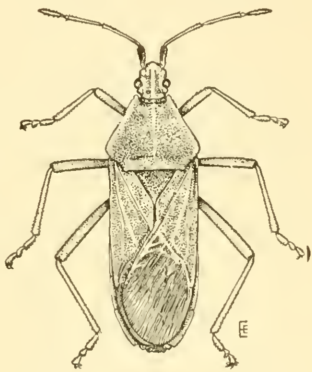

FIG. 72. — The squash bug, adult ($\times 2\frac{1}{2}$).

The adult bugs hibernate in rubbish, in board-piles or under any convenient shelter. They emerge from winter quarters rather late in the spring and are often found about gardens resting under pieces of boards or other shelter, apparently waiting for the squashes to come up. The adult bug (Fig. 72) is about $\frac{5}{8}$ inch in length and of a dirty brownish black color above and brown mottled with black below. The old bugs attack the plants as soon as they are well out of the ground and often kill them outright. In feeding, the insect punctures the plant with the bristles of its beak and sucks out the sap. At the same time it apparently injects into the wound some injurious poison. When the plants are small, a few punctures are enough to cause serious injury. After mating, the female deposits her eggs in clusters of three or four to fifty or more usually on the under surface of the leaves. The arrangement of the eggs varies greatly; usually they are placed in more or less regular rows, sometimes crowded closely together but more often rather widely separated. The egg (Fig. 73) is about $\frac{1}{17}$ inch in length and flattened on three sides; the side next to the leaf is somewhat concave. When first laid it is whitish, but soon turns to a yellowish brown and gradually becomes darker as the time for hatching approaches.

The eggs hatch in six to fifteen days. The young bug leaves the egg through an opening at one end made by pushing out a small circular disk-like piece of the shell. The newly hatched nymph is gayly colored; the body is green, the legs, antennæ and beak rose color and the head and the front part of the thorax another shade of rose. After a few hours the rose color changes to black. In the course of its development, the insect passes through five nymphal stages, molting its skin five times and acquiring wings at the fifth molt. After the first molt, the color of the nymphs is a pruinose gray, almost white. Four or five weeks are passed in the nymphal stage. The young nymphs hatching from a cluster of eggs remain together for some time feeding on the underside of the leaf. After the first molt, they move about more freely. When not feeding, the older nymphs and the adults often congregate around the base of the plant or hide under lumps of earth. The feeding of the nymphs causes the injured leaves to wilt, curl up, turn brown and die. Sometimes the bugs kill the plant outright but more often they merely injure it so that growth is checked and the vine is unable to mature a full crop of fruit. The nymphs begin to reach maturity in August but it often happens that frost kills the vines while many of the bugs are still immature. In such cases they often congregate on the unripe fruits, from which they are able to extract enough food to complete their growth. There is only one generation annually.

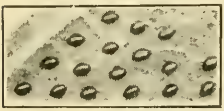

Fig. 73. — Eggs of the squash bug ($\times 1\frac{1}{2}$).

*Control.*

The adult squash bug is very resistant to contact sprays and recourse must be had to other methods of control. The number of bugs appearing on the plants in the spring can be greatly decreased by practicing clean farming and thus reducing the available shelter for the hibernating insects. After the crop is harvested, the vines should be raked up and either burned or converted into compost. This will prevent many of the later hatched nymphs from reaching maturity. The use of proper fertilizers and thorough cultivation will often enable the vines to withstand attack and outgrow the injury. After the ground has been fitted but before the plants are up, many of the bugs can be trapped under pieces of boards placed on the ground. They collect under such shelter during the night. The boards should be examined every morning and the insects killed by hand. It will also pay to keep watch of the plants for some time after they come up and hand-pick all the bugs found on them. All egg-masses should be destroyed by scraping them off with a knife or by crushing. When the nymphs are found, they too may be hand-picked or killed by spraying with "Black Leaf 40" tobacco extract, 1 part in 400 parts of water in which enough soap has been dissolved to make a good suds. An upturned nozzle will be found convenient for reaching the young bugs on the underside of the leaves.

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U. S. Div. Ent. Bull. 19, pp. 20–28. 1899.
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N. H. Agr. Exp. Sta. Bull. 89. 1902.

## The Horned Squash Bug

*Anasa armigera* Say

The horned squash bug is frequently associated with the preceding species, from Missouri to Maryland and southward.

The two species are very similar in general appearance but the horned squash bug may be distinguished from the common form by the prominent angles of the thorax, by the row of four white spots on each side of the upper surface of the abdomen and by the spine near the tip of each femur. There is also an acute horn just in front of each eye (Fig. 74). The nymphs are easily distinguished. In the earlier stages *A. armigera* has the legs banded with red or brown and the next to the last segment of the antennæ is widened; in *A. tristis* the legs are nearly uniform black and the antennal segments are of nearly the same width; in the later stages the sides of the thorax are strongly dentate in *A. armigera*, smooth in *A. tristis*. The life history and habits of the two species are nearly alike. The horned squash bug may be controlled by the same measures as are suggested for the common squash bug.

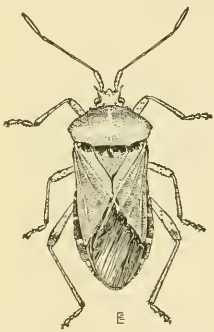

Fig. 74. — The horned squash bug (× 2).

In the South from Florida to Louisiana and New Mexico, another species, *Anasa andrewsi* Guérin-Méneville, closely related to the common squash bug, has recently been reported as injurious to cucurbits. The adult of this species is more slender and of a lighter color than the common form but the insect does not differ greatly in life history, habits or the nature of the injury inflicted. The egg and early stages have not been described in detail.

This subtropical squash bug may be controlled by the measures recommended for its northern relatives.

### Reference

U. S. Div. Ent. Bull. 19, pp. 28–34. 1899.

## The Melon Leaf-Bug

*Pycnode es quadrimaculatus* Guérin-Méneville

This leaf-bug has been reported as seriously injuring melons, squashes and beans in Arizona. The adult bug is about $\frac{1}{8}$ inch in length, black, mottled with gray and whitish. The legs are pale yellow with the outer two fifths of the hind femora black. The life history has not been recorded. The injury is caused by the feeding punctures of the insects. The adults are very active and difficult to hit with a spray. No satisfactory method of control has been devised.

## The Southern Leaf-Footed Plant-Bug

*Leptoglossus phyllopus* Linnæus

In the southern states, tomato, eggplant, melon, potato and artichoke are often injured by the feeding punctures of a chocolate-brown bug closely related to the squash bug. This insect is also well known to fruit-growers from its habit of puncturing oranges, peaches, plums and pears, causing them to decay. The adult (Fig. 75) is between $\frac{1}{2}$ and $\frac{3}{4}$ inch in length. The hind tibiæ are flattened and greatly expanded. The edge of the expanded portion is notched and toothed and flecked with yellowish white so as to resemble a bit of dried leaf. The wings are crossed near the middle by a yellowish white band. The adults hibernate and in the spring may be found in abundance on the yellow thistle, where they deposit their eggs end to end in a row along a stem or the midrib of a leaf. The egg is golden

Fig. 75. — The southern leaf-footed plant-bug ($\times 1\frac{1}{4}$).

brown, cylindrical and flattened at each end and on the side of attachment. The eggs hatch in a few days and the young nymphs may be found sucking the juices from the plant. The nymphs are more reddish than the adults and do not acquire the leaf-like expansion on the hind legs until nearly mature. They become full-grown in about three weeks, passing through five stages in the course of their development.

Most of the injury to cultivated plants is inflicted by the adults, the nymphs being usually found only on yellow thistle. They puncture the stems of cucumber, melon and asparagus, causing them to wilt and die. The tender growing tips of tomato, potato, pea and bean are injured in a similar way and the bugs sometimes attack the fruit of tomato. In Louisiana the insect has been reported as a serious pest of the globe artichoke. The bugs also puncture the bolls of cotton and are injurious to pepper.

*Control.*

In the small garden, hand-picking the bugs in the morning while they are sluggish is probably the most practical method of controlling the pest. Since the insect breeds largely on the yellow thistle, this weed should not be allowed to grow in abundance in the vicinity of susceptible crops. In some cases it might be advisable to leave a few thistles as a trap crop on which the adults will congregate and where they may be destroyed.

## The Northern Leaf-Footed Plant-Bug

*Leptoglossus oppositus* Say

From New Jersey to Indiana, Missouri, Oklahoma and southward, squash, cucumber, melon and tomato are occasionally attacked by a leaf-footed plant-bug closely related to the species last treated. The northern form is slightly larger and stouter and the band across the front wings is represented by two small whitish spots. The wild food plants of the insect have not been accurately determined. The bugs often puncture the fruit of peach, plum, cherry, pear, tomato and cucumber and sometimes attack cotton bolls. They also feed on the stems of cucumber, squash, cantaloupe, watermelon and tomato, causing the vines to wilt and die.

The insect hibernates in the adult stage but the bugs do not appear in the field until late in the season, about the first of July at Washington. The egg is bronze-brown, about $\frac{1}{18}$ inch in length, cylindrical and flattened at each end. The eggs are laid end to end in rod-like rows of six to twenty-six, attached to the stems or along the veins of the leaves. The eggs hatch in about a week and the young nymph leaves the egg-shell by forcing out a circular lid on the side near the end of the egg. The newly hatched nymph is coral-red in color with the legs nearly black. The basal half of the antennæ is black and the outer half red. The insect passes through five nymphal stages and becomes adult in twenty-five days to about a month after hatching. There is only one generation annually so far as known.

*Control.*

The nymphs can be killed with "Black Leaf 40" tobacco extract, 1 part in 500 parts of water to which enough soap has been added to make a suds. Kerosene emulsion and strong soap solutions have also been suggested for the control of this pest. In the garden the adults may be hand-picked in the cool of the morning while they are sluggish.


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## The Squash-Vine Borer

*Melittia satyriniformis* Hübner

In many localities the squash-vine borer is the most injurious insect enemy of the squash and pumpkin. It also attacks cucumber and melon. It is most destructive to late squashes, such as Hubbard and Marrowfat. The insect ranges from Canada, through the states east of the Rocky Mountains southward into South America.

The moths appear in the fields as early as April or May in Georgia and North Carolina, in early June in New Jersey and a little later in Connecticut, or at about the time that early cucurbits have come up. The moth has an expanse of 1 to $1\frac{1}{4}$ inches; the front wings are opaque, nearly black in color with metallic greenish reflections in certain lights; the hind wings are transparent and scales are present only along the margin and on the veins. The abdomen is marked with red or orange; the hind legs are long and ornamented with tufts of long orange, black and white hairs. The moths fly in the heat of the day and when on the wing are often mistaken for wasps. In the evening they may be seen resting on the leaves of the vines and are then easily caught. The female moth deposits her eggs on the stem of the vine near the base, while the plants are small and later at almost any point. The egg is about $\frac{1}{25}$ inch in length, dull red in color, oval in outline, flattened on the side of attachment and has an impressed area on the upper side. The shell is very brittle. Each moth is capable of laying over two hundred eggs, but the average number is probably somewhat less. The eggs hatch in six to fifteen days. The young caterpillar soon enters the vine and then burrows through the stem, preferably towards the root but often in the opposite direction. Later in the season the larvæ may be found in all parts of the stem and even in the leaf petioles and in the fruit.

The young caterpillar differs from the later stages in having the head larger in proportion to the body, in being more hairy and in having the body more tapering behind. When full-grown, the caterpillar (Fig. 76) is about an inch in length; the body is white and the head dark brown with an inverted V-shaped white mark. The burrows occupied by the larger larvæ are usually wet, slimy and partly filled with excrement; decay often ensues and hastens the death of the vine. The greater part of the excrement, however, is thrown out of the burrow

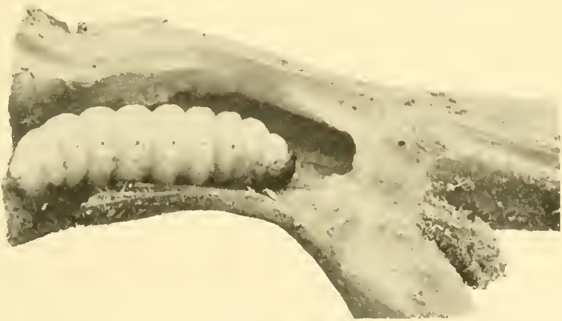

FIG. 76. — The squash-vine borer ($\times 1\frac{1}{2}$).

through holes in the stem. These coarse, yellowish grains of frass collect on the ground under the vine and are usually the first indication that the plant is infested. The caterpillars reach maturity in about four weeks in the latitude of New Jersey. When mature the caterpillar leaves the stem, enters the ground one or two inches and there constructs a tough silken brownish or blackish cocoon into the outer layers of which particles of dirt are incorporated. The cocoon is about $\frac{3}{4}$ inch in length. After making the cocoons, some of the caterpillars soon transform to pupæ, while the others remain in the larval condition until the following spring. Those that pupate soon after spinning the cocoon usually transform to moths the same season. The dark brown pupa is about $\frac{5}{8}$ inch in length; its head is armed with a sharp horn-like process by means of which it cuts its way out of the cocoon. After leaving the cocoon, the pupa works itself up to the surface of the ground in order to permit the escape of the moth. In the Gulf states the insect has normally two broods; in the latitude of Washington the second brood is only partial while farther north, in New Jersey and on Long Island, the second brood is much smaller, and still farther north there is only one generation annually.

*Control.*

The squash-vine borer cannot be controlled by applications of insecticides, but it may be held in check by practicing such of the following methods as are warranted by the severity of the outbreak or by other local conditions. As the insect passes the winter in the ground, it is not good policy to grow squashes in the same field year after year. If for any reason it is necessary to raise successive crops of squashes on the same ground, the land should be harrowed in the fall to expose the cocoons and then plowed deeply the following spring. In all cases the vines should be collected and destroyed as soon as the crop is harvested in order to prevent the late caterpillars from reaching maturity. If all the growers in a locality would co-operate in the early destruction of the vines, the number of moths appearing the following spring would be greatly reduced. In some cases much injury may be avoided by late planting in connection with heavy fertilization to promote rapid and heavy growth. In some localities the use of early squashes as a trap crop has been attended with success. A few early squashes, such as crooknecks, are planted early around the field and between the rows of the late varieties. The moths will deposit their eggs on the early squashes and the main crop, coming up later, will escape the greater part of the infestation. As soon as the early squashes are harvested, or sooner if they crowd the main crop, the vines should be pulled up and burned or composted in order to kill the borers they contain. After the borer has once entered the vine, there is nothing to be done but to cut it out with a knife. If care is taken to make the cut lengthwise of the stem and if the vine is immediately covered with earth at the injured point, the wound soon heals and the vine continues its growth. Some growers make a practice of covering the stem with earth two or three feet from the base in order to make the vine throw out a new root system, which will sustain the plant in case the main stem is injured at the base. In some cases it would pay to keep a sharp lookout for the moths in the evening when they are resting on the vines. They are easily seen and are not difficult to capture. For every female killed before she has deposited her eggs, there will be from one to two hundred less eggs laid on the vines.

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## The Pickle Worm

*Diaphania nitidalis* Stoll

The pickle worm and its near relative the melon worm are a serious drawback to the profitable growing of cantaloupes, squashes and cucumbers throughout the southern states. In some years the former appears in destructive numbers as far north as New York and Michigan and the moths have been taken in Canada. The insect ranges southward through the West Indies into South America. As far as known, its food plants are all members of the gourd family: cantaloupe, cucumber and squash. It has been reported as attacking the watermelon in Georgia; the pumpkin is said to be immune.

The pickle worm hibernates in the pupal stage in a flimsy cocoon in a curled leaf of the food plant usually lying on the ground. The moths do not emerge until rather late; the early part of June in Georgia and North Carolina. The moth (Fig. 77) has an expanse of 1 to $1\frac{1}{8}$ inches; the general color of the wings is yellowish brown with a purplish metallic reflection in certain lights; a large irregular spot on the front wing and the basal two thirds of the hind wings are semi-transparent yellow. In both sexes the tip of the abdomen is ornamented with a brush of long scales, larger in the male. The moths do not fly during the day or in the early part of the night; they are active and deposit their eggs after midnight and go into hiding at daylight. The egg is about $\frac{1}{20}$ inch in length, much flattened and elliptical in outline. It is nearly white when first laid but soon becomes yellowish. The eggs are deposited singly or in masses of three to eight on the flowers, flower-buds or on the tender opening leaves at the end of the vines. They are loosely attached to the plant-hairs and can be easily brushed off. They hatch in three or four days and the young caterpillars soon burrow into the tender tissue of the blossom or bud. The greater number do not reach the fruit until after the first or second molt. On squash many complete their growth within the blossoms, but on cantaloupes and cucumbers the caterpillars that are feeding in the blossom buds usually

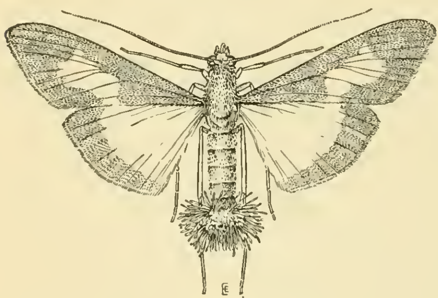

FIG. 77. — The pickle worm moth (× 2).

migrate to the fruit when about half grown. Many of those that start feeding on the cluster of terminal buds burrow down into the stem and complete their growth there; some are found in the leaf petioles. The vines are often riddled in this way but the greatest injury is caused by the burrows made in the fruit. On reaching the fruit, some of the caterpillars feed for a time in the rind while others burrow directly to the center. While the caterpillar is near the surface, the excrement is thrown out of the opening; later it is left in the burrow. The caterpillars often leave one fruit and enter a second or third and may even migrate to another vine. In the case of cantaloupes and squashes, decay is almost certain to result whenever a caterpillar has gnawed through the rind, thus greatly increasing the loss.

The newly hatched larva is about $\frac{1}{16}$ inch in length and yellowish white in color. After a short time a transverse row of brownish or blackish spots becomes apparent on each segment. These spots become more distinct with successive molts and persist until the fourth, when they are lost. In the fifth and last stage the caterpillar is about $\frac{3}{5}$ inch in length, the head and thoracic shield are yellowish brown and the body is whitish, yellowish or greenish, depending on the nature of the food. Most of the caterpillars take on a dull coppery color above soon after the fourth molt. The caterpillar becomes mature in twelve to sixteen days after hatching. It then spins a loose silken cocoon, usually in a curled leaf, and after resting for about a day transforms into a pale green pupa, $\frac{1}{2}$ to nearly $\frac{3}{4}$ inch in length, which after a short time changes to brownish. The head of the pupa is bluntly pointed and the caudal end is acute and armed with a group of short hooked spines. In the summer the duration of the pupal stage is a week to ten days. The time required for the complete life cycle of the insect as determined in North Carolina varies from twenty-three to thirty-one days. In North Carolina there are four generations annually with sometimes a partial fifth when the fall is warm. The first generation is always small in numbers and is usually entirely overlooked. In the second and third generations the caterpillars become very numerous and the loss is correspondingly great. Cantaloupes harvested before the appearance of the second brood of caterpillars usually escape injury, while those that mature later are often entirely destroyed.

*Control.*

Attempts to control the pickle worm by spraying with arsenicals have been unsuccessful. The caterpillars feed very little in the open and, therefore, do not eat enough of the poison to be killed. The number of moths appearing the following season can be considerably lessened by collecting and destroying the vines as soon as the crop is harvested. The waste fruits and fallen leaves should be raked up and destroyed with the vines either by burning or by turning them into compost. Early fall plowing of infested fields will also destroy a large proportion of the larvæ and pupæ. Rotation of crops and planting cucurbits at a distance from fields infested the previous season does not give as much relief as would be expected, because the moths are able to fly a considerable distance in search of plants on which to deposit their eggs. By planting the crop early, much injury may be avoided and this method should be adopted whenever practicable.

In the case of cantaloupes, excellent results in protecting the crop have been obtained by planting squashes as traps throughout the field. Squash vines with their large and odorous flowers are more attractive to the moths than other cucurbits. If enough squash vines are present in a field, the moths will deposit nearly all of their eggs on them and the cantaloupes will escape. For this purpose the squashes should be planted at intervals of about two weeks so as to furnish an abundance of buds and blossoms during July and August.

The earlier squash vines should be removed and destroyed before many worms have reached maturity on them. The use of squashes as trap crops seems to be the most practicable way of preventing injury to cantaloupes in many parts of the South.

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## The Melon Worm

*Diaphania hyalinata* Linnæus

The melon worm is occasionally found as far north as New York, southern Canada and Michigan but causes little or no injury north of North Carolina. In the southern states, it is a serious pest of cantaloupe, squash, cucumber and pumpkin and has been known to injure watermelon.

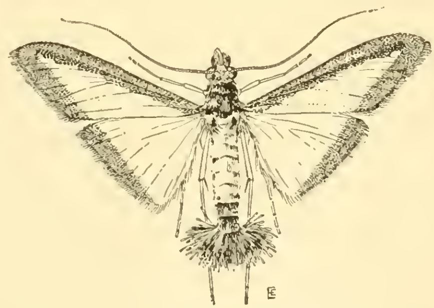

Fig. 78. — The melon worm moth (× 2).

The insect passes the winter as pupæ in loose silken cocoons in the dead leaves or under the shelter of any convenient rubbish. The moths do not emerge until rather late in the season, in June or July in North Carolina. The moth (Fig. 78) has an expanse of less than an inch to 1¼ inches. The wings are pearly white with a broad shining, iridescent brown band along the front and outer margins. The head and front part of the thorax are brown. The body is silvery white and the tip of the abdomen bears a conspicuous brush of elongate scales, yellowish at the base and white, brown or black at the tip. The eggs are laid on the buds, young leaves, stems and sometimes on the main stalk of the vine, singly or in groups of two to six, sometimes overlapping. The egg is oval, about $\frac{1}{35}$ inch in length, flattened and pearly white when first deposited but soon acquiring a yellowish tinge. The eggs hatch in three or four days in warm weather and the larvæ begin feeding on the underside of the leaves or among the buds and sometimes bore into the latter. The newly hatched larva is about $\frac{1}{25}$ inch in length, light straw-color with the head light brown. The two light stripes do not become apparent until after the first molt. In the second stage the color becomes yellowish or greenish from the ingested food. In the third stage the two white subdorsal stripes become more prominent and serve to distinguish the caterpillar from the pickle worm, in which they are not present. In the fifth and last stage the larva is $\frac{3}{4}$ to $1\frac{1}{4}$ inches in length and mottled greenish yellow in color. Shortly before pupation, the larva contracts to about $\frac{5}{8}$ inch in length and changes to a light yellow or straw-color, the white stripes having disappeared some days earlier. The caterpillars become mature in about two weeks and spin loose silken cocoons usually in a folded or rolled leaf in which they transform to brownish pupæ about $\frac{5}{8}$ inch in length. The moths emerge in a week or ten days. The life cycle requires a little less than a month in the summer in North Carolina. The first brood of caterpillars feeds to a considerable extent on the foliage and usually does not cause much injury to the fruit. The larvæ of the later generations at first feed on the buds or foliage and do not attack the fruit until the third stage. On reaching the fruit, they may feed for some time on the surface but soon burrow through the rind causing decay. In North Carolina there are three generations annually, the second, beginning the latter part of July, being the most destructive.

*Control.*

Cantaloupes and cucumbers may be protected from the melon worm by using summer squashes for a trap crop as recommended for the pickle worm. As the young caterpillars feed to a considerable extent on the foliage and on the surface of the fruit, many of them may be killed by spraying with arsenate of lead (paste), 3 pounds in 50 gallons of water. Usually the arsenate of lead can be applied to the greatest advantage in combination with bordeaux mixture as used for the control of fungous diseases. As soon as the crop is harvested, the vines and waste fruits should be gathered up and destroyed. Deep plowing and a rotation of crops will also tend to hold the insect in check.

Reference

N. C. Agr. Exp. Sta. Bull. 214, pp. 126–143. 1911.

## The Squash Ladybird

*Epilachna borealis* Fabricius

Nearly all the ladybird beetles are beneficial to man, feeding, both as larvæ and adults, on plant-lice, scale-insects and other small insects or on the eggs of larger ones. The squash ladybird, however, is an exception to the rule; both beetles and larvæ feed on the leaves of squash, pumpkin, cantaloupe, watermelon and cucumber. The insect is a native of America and ranges through the United States east of the Rockies and southward to Argentina. Besides the plants just mentioned, it feeds on the prickly cucumber or wild balsam apple and on the one-seeded bur-cucumber. While capable of causing serious injury to cucurbits, the insect is rarely abundant enough to become of economic importance.

The squash ladybird hibernates in the adult condition in sheltered places, often in large colonies. The beetles emerge about the middle of June in New Jersey. They are $\frac{1}{3}$ inch in length, hemispherical in form and dull yellowish in color. The thorax has four small black spots and the wing-covers have twelve large spots arranged in three transverse rows (Fig. 79). The yellow, elongate, subcylindrical eggs, $\frac{1}{17}$ inch in length, are deposited in clusters of six to more than fifty. They hatch in about a week. The larva is yellow in color and armed with six rows of long branched spines; when mature it measures about $\frac{3}{8}$ inch in length. The larvæ feed generally on the underside of the leaves, eating off the surface in circular clearly defined areas. They become mature in about three weeks and then crawl to the upper surface of the leaf where they transform to pupæ. The pupa is about $\frac{1}{3}$ inch in length, yellow in color and covered with short simple black spines most abundant on the head, thorax and appendages. It is attached to the leaf by the posterior end of the body. The pupal stage lasts from six to nine days. The beetles appear from the latter part of July throughout the remainder of the season. There is only one generation annually.

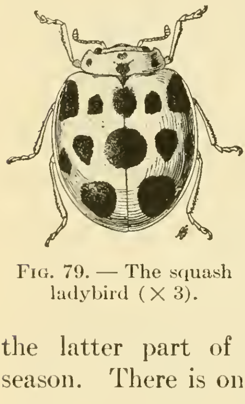

Fig. 79. — The squash ladybird (× 3).

*Control.*

The squash ladybird is usually present only in small numbers; in such cases hand-picking will be the easiest and cheapest method of control. When more abundant, it would be better to spray the vines with arsenate of lead (paste), 2 to $2\frac{1}{2}$ pounds in 50 gallons of water.

Reference

U. S. Div. Ent. Bull. 19, pp. 11–20. 1899.

## The Melon Aphis

*Aphis gossypii* Glover

This insect is also known as the cucumber aphis, cantaloupe aphis, cotton aphis and orange aphis. When occurring in greenhouses, it is known to gardeners as black aphis or black fly. It is widely distributed throughout the United States but has been reported as a serious enemy of cucurbits from Minnesota to New Jersey and southward. Its range extends to Brazil. It has attracted most attention in those localities where melons or cucumbers are grown on a large scale and in such cases the losses are often very great. It sometimes becomes of considerable importance as a cotton pest. The melon aphis has a wide range of wild food plants, including many common weeds and is occasionally found on a number of cultivated plants, such as spinach, okra, tomato, asparagus, eggplant, hop, morning-glory, bean and beet.

The life history of the melon aphis has not been fully worked out and there is considerable difference of opinion as to how the insect passes the winter. It has been commonly supposed that winter eggs are produced in the fall and deposited on some food plant that will survive the winter. In fact eggs found on portulaca and strawberry have been described as belonging to this species. Great doubt has been cast on this view by the studies of Sanborn, who has shown that in Oklahoma the insect is unable to survive the winter in the open, and that each year it migrates northward from southern Texas, where it breeds continuously the year round. If it is true that the melon aphis does not winter over in the northern part of its range and that the infestation is annually renewed by migrants from the South, its habits in this respect are very similar to those of the famous green-bug of wheat, *Toxoptera graminum*.

The date at which the melon aphis makes its first appearance on cucurbits varies considerably from year to year, but in the northern part of its range it is usually rather late in the season. Winged females fly or are blown into the field and, alighting on a vine, crawl to the underside of a leaf and begin feeding on the juices of the plant, which are extracted by means of the insect's beak. The female begins to give birth to living young at the rate of four or five each day and is soon surrounded by a numerous colony of young lice. When about six days old, these in turn reach maturity and begin to produce young. After remaining on one leaf two or three days, the female may move to another and found a new colony. The feeding of the lice causes the leaves to curl downward, turn brown, shrivel and die. When food becomes scarce, many of the wingless lice crawl to the tender leaves towards the end of the vine; these in time succumb to the attack and the vine is finally killed or stunted so that the crop is small and of inferior quality. A large proportion of the lice of each generation acquire wings while the others remain wingless. The former fly to other vines and start new colonies of aphids. In this way the whole field soon becomes infested and unless the aphids are checked by the attacks of their numerous insect enemies or killed by artificial means, the crop is sure to be destroyed.

FIG. 80. — Winged viviparous female melon aphis (× 10).

The wingless female is about $\frac{1}{25}$ inch in length, varying in color from yellow to green or black, the eyes are brown and the cornicles black. In the winged female (Fig. 80) the head and the greater part of the thorax are black with the abdomen varying from yellow to dark green. Breeding continues until frost. Males and egg-producing females — the so-called true sexes — have not been observed.

The melon aphis is held in check by the attacks of a large series of predaceous and parasitic insect enemies, most important of which are several species of ladybird beetles, syrphus fly larvæ, aphis lions and several species of parasites belonging to the family Braconidæ. Under favorable weather conditions, these foes of the melon aphis are able to keep it so well under control that little or no damage is done. In cool, moist weather, however, following a backward spring, the activities of these beneficial insects are retarded and as the aphis is able to breed rapidly under such conditions, the infestation becomes severe and it is not till late in the season that the enemies of the aphis regain their supremacy. Many of these enemies feed on other kinds of aphids having different food plants and it has been suggested by Sanborn that it might be a useful practice to plant cabbage early around fields intended for cucurbits. The cabbage plants soon become infested with the cabbage aphis which furnish food for great numbers of predaceous and parasitic insects. At the first appearance of the melon aphis in the field, they will be on hand in sufficient abundance to hold the pest in check.

*Control.*

The melon aphis usually makes its appearance in a field on isolated vines scattered throughout the patch. It is important that a close watch should be kept in order to locate and destroy these first colonies. Growers sometimes pull up and bury the vines first attacked. While the vines are small, it is possible to kill the aphids by fumigation with tobacco or carbon bisulfid. For this purpose portable covers are used made of oiled cloth stretched over a light wooden frame. The cover is placed over the vine and the tobacco fumes generated by burning strips of paper impregnated with nicotine. In case carbon bisulfid is used, the liquid is placed in a shallow dish under the cover and allowed to evaporate. About a teaspoonful is sufficient for one cubic foot of space. The cover should be made to fit tightly to the ground to prevent the escape of the gas. The fumigation method is of most value when only a small number of vines are to be treated and when the aphids make their appearance before the vines have begun to run so as to cover much space. In large fields, spraying is more practicable and more likely to give satisfactory results. For successful spraying it is necessary that the vines be trained to run in the rows; this also makes the cultivation easier. When the vines are trained in this way, it is not difficult to kill nearly all the aphids by using "Black Leaf 40" tobacco extract, $\frac{3}{4}$ pint in 100 gallons of water in which 5 or 6 pounds of soap have been dissolved. The spraying should be done as soon as the lice appear. A fine nozzle should be used, which, with good pressure, will produce a fine mist. It is important that the spray hit the underside of the leaves. This can be accomplished by using an upturned angle nozzle on a short extension rod. By doing careful and thorough work, it is possible to hit the underside of practically every leaf. In case the infestation has become severe, it may sometimes be advisable to use a stronger solution of the tobacco extract, 1 pint of "Black Leaf 40" to 100 gallons of water. Much stronger mixtures will not injure the foliage but are unnecessary and rather expensive. This method of fighting the melon aphis has proved practicable under commercial conditions.

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## The Squash Aphis

*Macrosiphum cucurbitæ* Middleton

Squash and pumpkin are sometimes found infested by a green plant-louse about $\frac{1}{10}$ inch in length. The body of the winged form is green with the thorax tinged with brownish and the abdomen has a median line of darker green. In the wingless form the body is green with few markings. This species has been reported as injurious in Connecticut, Ohio and Illinois and as infesting eggplant in Florida. Fortunately, it does not, as a rule, become abundant on the vines until late in the season when the crop is nearly matured. Its wild food plants include shepherd's purse, wild mustard and ground ivy. The aphids multiply parthenogenetically throughout the summer, both winged and wingless females being present. Males and egg-laying females are produced only in the fall. The oviparous female is wingless with the body green. The antennæ, except the first two joints, and the tip of the cornicles are black. The males are smaller than the females with the body black and the margin of the abdomen greenish. The antennæ are black, dark brown at the base. The winter is passed in the egg stage.

The squash aphis can be controlled by the measures suggested for the melon aphis.

## The Garden Springtail

*Sminthurus hortensis* Fitch

Many garden plants are subject to injury soon after they come up by a minute wingless insect that eats out very small holes in the epidermis of the leaves and enlarges the wounds made by other insects. The insect is about $\frac{1}{20}$ inch in length, dark purple in color spotted with pale yellow. The head is large, separated by a narrow neck from the nearly globular united thorax and abdomen. At the tip of the latter there is a forked, tail-like appendage which when at rest is held close to the underside of the body and by means of which the insect is able to throw itself into the air. This habit has suggested the name of garden flea for these insects.

The garden springtail has a wide range, having been reported from the northern United States, Europe, Japan and subantarctic America. It has been reported as injurious in Maine, Massachusetts, New York, Indiana and Virginia. It attacks cucumber, squash, watermelon, cantaloupe, lettuce, bean, pea, cabbage, radish, turnip, kale, onion, beet, spinach, carrot, potato, tomato and tobacco and has also been found infesting wheat, rye and clover. The insects appear in great numbers just as the plants are coming up and so injure the leaves as either to stunt or kill the seedlings. The insects disappear in two or three weeks, practically all of the injury being done by the time the second or third true leaves appear. The life history of this springtail does not appear to have been worked out.

Injury to seedlings by springtails may be prevented by dusting them with tobacco dust or air-slaked lime when they first come up and again in about a week if the insects are still present. The plants may be assisted to outgrow the injury by the application of a quick-acting fertilizer and by thorough early cultivation.

### Reference

Fitch, 8th Rept. State Ent. N. Y. for 1863, pp. 186–191 in 7th to 9th Repts. 1865.

### Other Cucumber, Squash and Melon Insects

Corn ear-worm : 211
Southern corn root-worm : 222
Western corn root-worm : 225
Stink-bugs : 232
Garden webworm : 18

Serpentine leaf-miner: 46
Yellow bear caterpillar: 357
Tarnished plant-bug: 192
Sugar-beet webworm: 97
Spinach aphis: 105
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## CHAPTER VI

### POTATO INSECTS

THE potato plant is a native of America and the insects affecting it are, with few exceptions, indigenous to the New World. In the East the most important potato insects are the Colorado potato beetle and the potato flea-beetle. The latter is treated on page 314. In California the potato tuber moth has in some localities threatened the potato-growing industry. Potatoes are especially subject to attack by blister-beetles. These pests are discussed in Chapter XVI.

### THE COLORADO POTATO BEETLE

*Leptinotarsa decemlineata* Say

The genus to which the Colorado potato beetle belongs occurs in greatest abundance in southern Mexico and Central America and it is supposed that this species originated in that region where it is now represented by closely related forms. It had, however, migrated northward so that by the early part of the last century it occupied a strip on the eastern slope of the Rocky Mountains from Texas and New Mexico northward to the Canadian boundary. The potato beetle was first described by Thomas Say in 1824 from specimens collected in the upper Missouri River Valley. The original food plant of the insect was the buffalo bur, *Solanum rostratum*. When the early settlers first began to plant potatoes in western

Nebraska, the beetles discovered in this new plant a food greatly to their liking. In 1859 the beetles were feeding on potato about one hundred miles west of Omaha in Nebraska. This marks the beginning of the rapid and destructive eastern spread of the species. The Missouri River was crossed about 1861 and the Mississippi by 1864. The main line of advance continued around the south shore of Lake Michigan, across Illinois, Indiana and Ohio, down through the natural highway of the lower Great Lakes through Ontario to the Province of Quebec and through Pennsylvania and New York and into New England. The Atlantic Coast was reached in 1874. In the early part of this great migration, the beetles averaged less than fifty miles a year, but after crossing the Mississippi River the yearly advance was considerably greater and the whole distance was covered at an average rate of about eighty-eight miles a year.

It is now difficult to realize the apprehension with which the farmers viewed the coming of the potato beetle. Spraying was then unknown and arsenical poisons had not yet been used for the control of injurious insects. Although the value of paris green for the destruction of this pest was demonstrated in 1869, suitable apparatus for its application was not to be obtained. The first dusting and spraying machines were crude, clumsy and generally inefficient. If one considers the enormous hordes in which the beetles appeared and the completeness with which they defoliated the plants in the newly infested areas, some idea can be gained of the serious situation that confronted the potato-growers of this period.

In the newly occupied territory the beetles found few of their natural enemies and, therefore, for a time multiplied unchecked. In their eastward advance they moved through a region which was thickly settled, where their food was grown in great abundance and in a climate to which they easily adapted themselves. They were aided in their rapid advance by the prevailing west and southwest winds during the season when the beetles were on the wing. The rapid spread of the Colorado potato beetle across the eastern United States has had no equal in historic times, except possibly in the case of

FIG. 81. — Eggplant killed by the Colorado potato beetle.

the recent advance of the cotton boll-weevil through the cotton belt of the southern states.

After reaching the Atlantic Coast in 1874, the potato beetle gradually extended its range southward east of the Appalachian Mountains, but northern Florida was not invaded until about 1900. The advance down the Mississippi Valley had also been slow and the beetles did not appear in central Louisiana until about the same date. The potato beetle is now generally distributed east of the Rocky Mountains from Montana to New Brunswick and Nova Scotia and southward to northern Florida. It also occurs in New Mexico and Arizona and in Idaho, Washington and Alberta. Where the potato is not available for food, the beetles will sometimes attack eggplant (Fig. 81), tomato, pepper and even tobacco. Ground cherry, thorn apple, henbane, Jamestown weed, horse nettle, belladonna and petunia also serve to carry the beetles through periods of scarcity.

The potato beetle hibernates as an adult sometimes under rubbish but more frequently in the soil at a depth of several inches. The beetles emerge from their winter quarters in the spring just before early planted potatoes come up. At this time they will feed on pieces of seed potatoes left on the surface and will sometimes dig into the soil in search of the tender sprouts. They feed for a time on the tender foliage and then, after pairing, deposit their eggs on end in masses on the underside of the leaves (Fig. 82). Each mass contains from four or five to nearly seventy eggs with an average of about twenty-five. The egg is about $\frac{1}{14}$ inch in length, elongate oval and orange in color, with the surface smooth and shining. The egg is glued to the leaf with a small mass of orange-colored material. The female is capable of laying from 200 to over 1800 eggs with a probable average of 400 or 500. The eggs do not ripen continuously but in successive batches; all the eggs which ripen at a given time may be deposited in one or

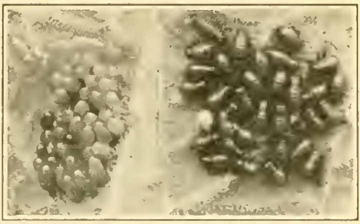

Fig. 82. — The Colorado potato beetle, eggs and newly hatched larvæ (enlarged).

more clusters. The average length of the egg-laying period in the field is probably between four and six weeks, but under cage conditions the beetles have continued to lay eggs for ten weeks or more. The eggs hatch in four to nine days. On hatching, the young larva begins at once to feed on the leaves. In the first stage it is about $\frac{1}{10}$ inch in length, dark red in color with the head, thoracic shield and legs black and with a double row of black spots along each side of the body. In the course of its development the larva passes through three or four stages according to different observers. In the last stage it is about $\frac{3}{8}$ inch in length; the head, legs and posterior part of the cervical shield are black; the body is red, lighter than in the first stage and there are two rows of distinct black spots on each side; the abdomen is strongly convex and is much larger than the head and thorax (Fig. 83). The larvæ become full-grown in ten days to three weeks and then enter the ground to a depth of several inches where they transform

FIG. 83. — Larvæ of the Colorado potato beetle ($\times \frac{5}{8}$).

FIG. 84. — Pupa of the Colorado potato beetle ($\times$ 4).

in earthen cells to pupæ. The pupa is a little over $\frac{1}{3}$ inch in length and orange-yellow in color (Fig. 84). After a pupal period of five to ten days the adults emerge. The beetle is about $\frac{3}{8}$ inch in length, strongly convex above and yellow in color. The head has a triangular black spot between the eyes; the prothorax is marked with two divergent elongate black spots near the middle and four to six smaller spots on each side. Each wing-cover has the sutural margin and five narrow stripes black, the second and third united at the tip; the knees and tarsi are blackish (Fig. 85). The beetles are often called hard-shells to distinguish them from the larvæ, which are known as slugs or soft-shells. After feeding a few days, the beetles may either go into the ground for a more or less extended period of æstivation or they may immediately lay eggs for a second generation. Owing to the long period over which egg-laying takes place, all stages of the insect may be found at any time during the latter part of the summer. There are normally two generations produced annually but in some cases a small third brood of larvæ may develop and in Montana it is claimed that there is only one generation.

FIG. 85. — The Colorado potato beetle ($\times 2\frac{2}{3}$).

*Control.*

For many years paris green has been the standard insecticide for the control of the Colorado potato beetle. It is sometimes applied in the form of a dust, 1 pound in 50 pounds of land plaster or hydrated lime. It is more effective, however, when applied in water, 1 pound in 50 gallons. To avoid burning the foliage, 2 pounds of lime should be added. Paris green is most effective and least liable to injure the vines when applied with bordeaux mixture as used for the control of fungous diseases. From 8 ounces to 1 pound should be added to each 50 gallons, depending on the thoroughness of the application. Arsenate of lead, 3 or 4 pounds of the paste to 50 gallons, has also been found satisfactory. It adheres to the foliage better than paris green but does not kill the insects so quickly. It may be used either in water or in bordeaux mixture. Arsenate of lead may also be applied in the dry or powdered form diluted with sulfur, gypsum or hydrated lime. Experiments in New Jersey, however, have shown that, on the whole, this treatment does not give as good results in yield as are obtained by spraying with bordeaux and arsenate of lead. When expense is an important item, sodium arsenite may be used instead of paris green or arsenate of lead with satisfactory results, at the rate of 1 quart of the stock solution to 50 gallons of bordeaux mixture. For the preparation of sodium arsenite see page 369.

The first application for the potato beetle should be made about the time the eggs are hatching. The larvæ are much harder to kill when nearly full-grown and they have then caused the greater part of the damage. It sometimes happens that the eggs are deposited in patches in the field so that the infestation is not general. In such cases it is a good plan to treat these areas early and not wait till the whole field can be sprayed. In Virginia, where potatoes are seriously injured by the over-wintered beetles, just as the plants are peeping through the ground, it is recommended that they be dusted with a mixture consisting of 1 pound of paris green and 20 to 30 pounds of hydrated lime. This application is intended to protect the plants until they are large enough to be sprayed.

In the home garden where only a few potatoes are grown, it is practicable to hand-pick the beetles into pans containing a little kerosene oil or the plants may be dusted with paris green or powdered arsenate of lead diluted with land plaster, hydrated lime or some similar substance.

For the protection of tomato plants, arsenate of lead should be used instead of paris green because of the danger of foliage injury by the latter.


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## The Three-Lined Potato Beetle

*Lema trilineata* Olivier

Throughout the United States and Canada east of the Rocky Mountains, potatoes and tomatoes are sometimes attacked by the larvæ of a yellowish leaf-beetle (Fig. 86) about $\frac{1}{4}$ inch in length. The head and thorax are reddish yellow, the latter constricted at the middle and usually marked with two black spots. The wing-covers are reddish yellow and marked with three black stripes. The antennæ are black, except the base, and the legs are reddish yellow with the outer half of the tibiæ and tarsi black. A closely related species, *Lema nigrovittata* Guérin-Méneville, occurs in California; by some it is considered identical with the eastern species.

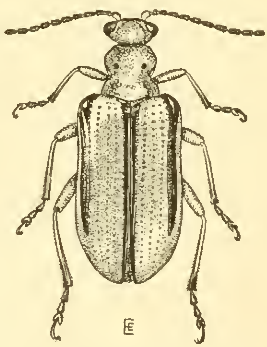

Fig. 86. — The three-lined potato beetle ($\times 3\frac{1}{2}$).

The three-lined potato beetle probably hibernates in the adult condition, the beetles appearing in early spring. They feed at first on various wild plants, preferring solanaceous weeds. As soon as potato and tomato plants are available, the beetles migrate to them and deposit their eggs usually on the underside of the leaves in clusters of six to ten. Each egg is about $\frac{1}{25}$ inch in length, smooth, oval and yellowish in color. The eggs hatch in about two weeks and the young larvæ at first feed in a row side by side, beginning at the edge of the leaf and moving backward as they devour the tissue. When mature the larva is about $\frac{1}{3}$ inch in length with the head, thoracic shield and legs black and the body yellowish. The body of the larva is kept moist and sticky by a secretion and is usually covered with a coating of excrement. The grubs become full-grown in about two weeks and then enter the ground where they construct earthen cells lined with a gelatinous secretion from the mouth. The pupal period occupies about two weeks. There are said to be two generations annually.

The three-lined potato beetle has never been reported as a very important pest but it may occasionally become troublesome when conditions are favorable for its development. It may be controlled by spraying with arsenical poisons as recommended for the Colorado potato beetle.

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## The Potato Aphis

*Macrosiphum solanifolii* Ashmead

Although the potato aphis is generally distributed throughout the United States and southern Canada, injurious outbreaks have been reported only from Maine, Connecticut, New York, New Jersey, Pennsylvania, Ohio, Illinois, Iowa, Kentucky, Maryland and Virginia and the provinces of Ontario, Quebec and Prince Edward Island. While the insect is doubtless present in small numbers each year in these states, it has appeared in destructive abundance only at intervals of several years. This plant-louse is not confined to potatoes but also injures tomato, eggplant, pea, turnip, beet, spinach, pepper, asparagus, sunflower and sweet potato and has been found infesting various weeds such as ground cherry, Jamestown weed, ragweed, lamb's quarters and wild lettuce. It is also found on canna, hollyhock, gladiolus, iris and matrimony vine. It was originally described from specimens collected on the pepper-vine, *Solanum jasminoides*, in Florida.

The potato aphis passes the winter in the form of shining brownish black eggs on the rose and possibly on other perennials. The eggs hatch about the time the leaf-buds are opening and the young aphids reach maturity on this plant. Probably in the second or third generation, most of the aphids migrate to the potato and other herbaceous food plants. Throughout the entire growing season, only female aphids are produced and these give birth to living young. Both winged and wingless females occur throughout the season. In warm weather a female reaches maturity in ten days to two weeks and may give birth to more than fifty young over a period of about fourteen days. The adult winged viviparous female is about $\frac{1}{8}$ inch, and the wingless form about $\frac{1}{6}$ inch in length (Figs. 87 and 88). Both forms are usually green but pink individuals are common. The potato aphis closely resembles the pea aphis but may be distinguished under the microscope by having the tip of the

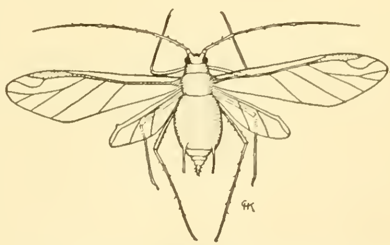

FIG. 87. — The winged viviparous female potato aphis (× 5).

cornicles reticulate for a short distance instead of being imbricated throughout. At the approach of cold weather, the winged forms migrate to the rose and there produce a generation of winged males and wingless egg-laying females. In Maine the winter eggs are laid in late September.

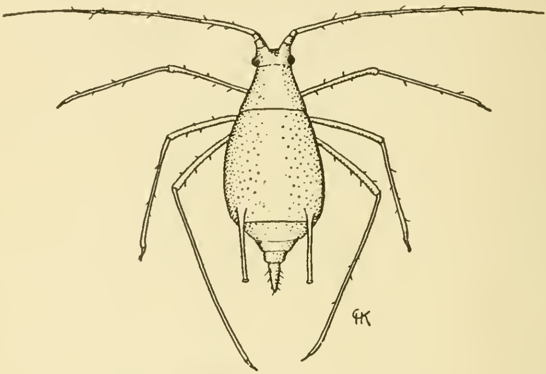


FIG. 88. — The wingless viviparous female potato aphis ($\times 7\frac{1}{2}$).

The time at which the pest becomes destructive to potatoes varies from year to year. In Maine it has been found most abundant in August, but in 1917, when the outbreak was the most extensive and destructive so far recorded, the attack became serious in New York in early July and in Ohio in late June. On potatoes the aphids cluster on the underside of the leaves, causing them to curl downward. They also infest the tender tips and the blossom stems. When badly infested, the vines soon become covered with the sticky honey dew secreted by the aphids. The tips are first killed, and in 1917 many large fields were observed in which all the plants were killed to the ground. Even when the vines are only partly killed, the size and quality of the crop is seriously affected. On tomatoes the lice also infest the leaves but cause their greatest injury by attacking the blossom stems and young fruits. The blossoms are killed, the fruit is dwarfed and the ripening period is delayed so that in many cases the crop is a total loss.

*Control.*

The potato aphis can be killed by spraying with "Black Leaf 40" tobacco extract, $\frac{1}{2}$ pint in 50 gallons of bordeaux mixture. If for any reason bordeaux mixture is not used, the "Black Leaf 40" may be diluted with water at the same rate but in this case 3 or 4 pounds of soap should be added to each 50 gallons. Since many of the aphids are on the underside of the leaves, it is necessary to have the spray directed upward. Some potato-sprayers have the nozzles arranged to do this. Other potato-sprayers may be adapted for this work by removing the nozzles and inserting a 1-foot extension directed downward. On the end of this extension a T-coupling is attached. To each side of the T-coupling is joined a piece of pipe 6 inches in length directed at right angles to the rows and equipped with a 45° angle nozzle, so attached as to throw the spray obliquely upward and backward. This outfit can be used to advantage as long as the plants are upright. After the vines are down, effective work can be done by using two leads of hose 10 or 12 feet in length equipped with 4-foot extension rods and angle nozzles. With this outfit a traction pump will not deliver the liquid in sufficient quantity and it is, therefore, necessary either to operate the pump by hand or with a gasoline engine. It requires at least 100 gallons of the spray material to the acre to be effective. It is usually better to use the tobacco extract in combination with the bordeaux mixture than with water and soap because of the value of the bordeaux in preventing potato blight. Furthermore, it has been observed that potatoes regularly sprayed with bordeaux mixture are less likely to be seriously infested with the aphid than untreated vines. Where there is any reason to fear an outbreak of the potato aphis, careful watch should be kept of the plants and when the lice begin to appear in any abundance, steps should be taken to destroy them before the vines become stunted.

The potato aphis is often aided in its destructive work on potato and other garden plants by the spinach aphis, for a discussion of which see page 105.

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## The Apple Leafhopper

*Empoasca mali* Le Baron

The well-known apple leafhopper, a troublesome pest on apple nursery stock, often breeds during the summer on potato vines. The insect passes the winter in the egg stage on the apple and the first brood of nymphs develops on this plant, reaching maturity about a month after hatching. Some of the adults of the second and later broods migrate to potato and there insert their small, whitish, elongate, slightly curved eggs about $\frac{1}{40}$ inch in length, in the tender parts of the potato vines. The eggs hatch in a few days and the young nymphs, in company with the adults already present on the vines, feed on the underside of the leaves, causing them to curl and stunting the tender growing tips. The injury is most noticeable in periods of drought. The young hoppers pass through five nymphal stages, acquiring wings at the fifth molt. The nymphs are pale greenish and in the last stage are about $\frac{1}{10}$ inch in length. The adult leafhoppers are about $\frac{1}{8}$ inch long and of a pale yellowish green color, with six or eight distinguishing white spots on the front margin of the pronotum (Fig. 89).

When disturbed the nymphs run in all directions but the adults can jump quickly and fly away, often rising in swarms as one walks through an infested field. About a month is required for the completion of the life cycle. There are three generations of the insect a season on the potato. In the fall the adults find their way back to the apple and there deposit the winter eggs in the bark of the smaller branches, just below the epidermis, two-year-old wood being most often selected. The position of the egg is indicated by a low blister-like elevation of the bark about $\frac{1}{30}$ inch in length and about half as wide.

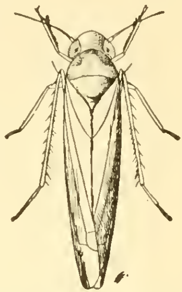

Fig. 89. — The apple leafhopper, adult (× 11).

The apple leafhopper has also been reported as causing spots on the white stalks of celery and as feeding on sugar-beets and beans. It is rarely of sufficient importance on potato to warrant special applications of insecticides. The nymphs may be killed by spraying with "Black Leaf 40" tobacco extract as recommended for the control of the potato aphis.

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## The Potato Stalk-Weevil

*Trichobaris trinotata* Say

Throughout the northern states from New York to North Carolina westward to Kansas, Nebraska, Texas and southern California, potatoes are subject to the attacks of a small weevil, the larva of which bores in the stalk. This insect has been found most injurious in Kansas, Nebraska and Iowa, but more or less serious outbreaks have occurred in southeastern Pennsylvania and in New Jersey. In New York the insect has been troublesome in the upper Hudson River Valley and in Ontario on Pelee Island in Lake Erie. Its wild food plants include a number of solanaceous weeds, such as ground cherry, Jamestown weed, buffalo bur and horse nettle and it has also been recorded as infesting cocklebur. Eggplant is sometimes attacked and there is at least one record of injury to tomato. Early potatoes are more subject to injury than late varieties.

The adult (Fig. 90) is a snout-beetle, about $\frac{1}{5}$ inch in length, bluish gray in color with the head and scutellum black and with a black spot on each side near the margin at the junction of the prothorax and the base of the wing-covers. The ground color of the beetle is black, its blue-gray color being derived from a thick covering of narrow scales. The beetles appear in the field in spring and feed for a time on the stems of the potato which they puncture with their beaks. The female inserts her eggs singly in the stalk or branches and sometimes even in the leaf petioles.

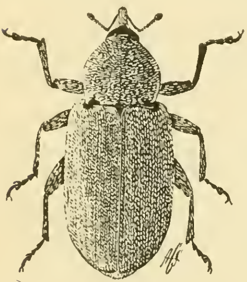

Fig. 90. — The potato stalk-weevil ($\times 6\frac{7}{8}$).

In ovipositing, she first hollows out a cavity with her beak and then turning around places the egg in the puncture. The egg is oval, yellowish white and about $\frac{1}{40}$ inch in length. The eggs hatch in a week to eleven days and the young grub burrows down through the pith several inches and then turning about retraces its course. When nearly full-grown, it eats out the entire pith for some distance. When mature the larva is $\frac{3}{8}$ to $\frac{1}{4}$ inch in length, yellowish white, with the head brownish. Legs are lacking. The presence of the grubs is indicated by a wilting and dying of the leaves, while the stem may remain green for some time. Several larvæ may infest the same stalk and often kill the entire plant. When full-grown, the grub eats out an exit hole for the future beetle nearly to the surface but does not penetrate the outer bark. It then constructs a cell or cocoon of fibers stripped from the wall of the burrow and then transforms into a creamy white pupa about $\frac{1}{4}$ inch in length. In Kansas the larvæ begin to pupate about the middle of July and in New Jersey the last of the month but some do not reach maturity till early fall and in a few cases have been known to enter the winter in this stage. The insect spends from eight to fifteen days or longer in the pupal stage. Although some of the beetles are to be found in the stalks in early August, they do not usually emerge until the following spring, but when the stalks are broken open they may be forced to seek winter quarters elsewhere. There is only one generation annually.

*Control.*

The potato stalk-weevil is best held in check by collecting and burning the vines soon after the crop is dug. If this is practiced regularly and if all solanaceous weeds in which the weevils breed are reduced to a minimum by clean farming, the pest can be prevented from doing any serious damage.

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## The Common Stalk-Borer

*Papaipema nitela* Guenée

The common stalk-borer is generally distributed throughout the United States and Canada east of the Rocky Mountains. Although the insect is usually present in small numbers, occasionally serious outbreaks occur locally. The borers attack potato, tomato, eggplant, pepper, corn, bean, rhubarb, spinach, cauliflower, dahlia, aster, chrysanthemum, lily, hollyhock, golden glow, peony, sunflower, castor bean and several other ornamental plants. Their wild food plants include ragweed, great ragweed, cocklebur, burdock and pigweed. Wheat, rye, barley, blue-grass and timothy are sometimes attacked as well as the tender shoots of raspberry, blackberry, currant and gooseberry.

The insect passes the winter in the egg stage on the stalks of such plants as ragweed, dock, pigweed and burdock. The egg is $\frac{1}{50}$ inch in diameter, brownish gray, globular, slightly flattened and with numerous ridges radiating from the tip. The eggs hatch in late May or early June and the young caterpillar begins feeding on the first suitable plant that it finds. It may first feed as a miner in the leaves for a few days and then burrow into the stem. Ragweed, pigweed, blue-grass and timothy, as well as wheat and other grains, are often attacked by the young larvæ. Many of these plants are soon killed and the caterpillars then migrate to other plants. It usually happens that the young larvæ get their start in the rank weeds surrounding the field or garden and when forced to migrate in search of fresh food attack the cultivated crops. It has often been noticed that corn is most subject to infestation along the edge of the field and that other crops, such as potatoes and tomatoes, are more liable to injury when grown in small gardens than when planted in large open fields. In New York the caterpillars usually attract most attention by their injuries to garden plants from the middle of June to the last of July. The caterpillar until the next to the last molt is dull brown, the head, cervical and anal shields honey-yellow, smooth and shining, with a black stripe on each side of the head and on each side of the cervical and anal shields. Each end of the body is grayish brown with a white dorsal stripe and two white stripes on each side. The integument is apparently thinner from the middle of the third thoracic segment to the middle of the fourth abdominal segment, dirty greenish gray with the white dorsal stripe only present, the lateral stripes being broadly interrupted. This caterpillar is distinguished from its near relatives by having but one tubercle behind the spiracle on the eighth abdominal segment; by lacking the large plates on the second and third thoracic segments and by the presence of a pair of small plates on the next to the last abdominal segment. The full-grown caterpillar is slightly less than $1\frac{1}{2}$ inches in length and similar to the preceding stages except that the stripes on the body gradually fade out into a dirty greenish gray and finally disappear shortly before pupation occurs (Fig. 91). The caterpillars reach maturity in August and transform, usually in the burrow, into a brownish pupa $\frac{4}{5}$ inch in length. The moths emerge in September and October and deposit their eggs on the stalks of their food plants. The pupal period lasts about three weeks.

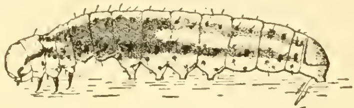

Fig. 91. — The common stalk-borer, larva ($\times 1\frac{1}{8}$).

Fig. 92. — Moth of the common stalk-borer, variety *P. nebris* ($\times 1\frac{1}{4}$).

There are two varieties of the moth. In the typical form (*P. nitela*), the front wings are grayish brown with a slight olive tinge, lightly dusted with white. The usual outer line is pale and bent inward about one fourth of the distance from the front margin of the wing and then runs nearly straight across the inner margin. The hind wings are slightly paler in color except towards the margin and on the veins. In the other variety (*P. nebris*), there are three distinct white spots nearly one third the distance from the base of the wing, the middle one being the smallest (Fig. 92). Just inside the outer line near the front margin of the wing is a fine yellow crescent with a yellow spot lying within its concavity and with three to five white dots on its lower and inner side. There is only one generation annually.

*Control.*

No satisfactory method of reaching the borers in their burrows is known. Much loss may be avoided, however, by destroying all rank weeds in which the caterpillars live growing in the vicinity of the garden and along the edges of fields planted to tomatoes, potatoes, corn and other plants especially subject to injury.

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## The Burdock Borer

*Papaipema cataphracta* Grote

Potato, tomato, rhubarb and corn have been reported in Canada as injured by a stalk-borer closely related to the species last treated. The insect ranges throughout the northern states and Canada westward to Minnesota. The favorite food plants of this caterpillar are burdock and thistle, but sunflower, ragweed, golden glow, hollyhock and many other ornamental plants are also subject to attack. The work of the borers becomes noticeable in July, specimens one third to full-grown being found till the first of August. The caterpillar is very similar to the common stalk-borer but the stripes run from end to end with no interruption in the middle. The caterpillars reach maturity in August and transform to brownish pupæ within the burrows. The moths are on the wing in September and October. They have an expanse of about $1\frac{1}{4}$ inches. The ground color of the front wings is light yellow, dusted with brown, the outer margin grayish, leaving a yellow spot at the apex. The outer line runs as in *P. nitela* and is double and the wing is spotted in much the same way as in the variety *nebris* of that species. The hind wings are light brown. The eggs are deposited singly in cracks and crevices on the stems of the food plants in the fall but do not hatch until the following spring. There is only one generation annually.

The injury inflicted by the burdock borer may be avoided by adopting the measures recommended for the common stalk-borer.

## The Potato Scab Gnat

*Pnyxia scabiei* Hopkins

Potatoes are sometimes injured by a small, white, black-headed maggot, about $\frac{1}{6}$ inch in length, that causes an injury similar to that produced by the scab fungus. Outbreaks of this insect have been recorded in West Virginia and in Ohio and infested potatoes have been shipped from Philadelphia. The adult insects have been found in New York and have been collected under dead leaves in the woods in Missouri. It is probable that the normal food of the scab gnat maggot is decaying vegetable matter. Under certain conditions, however, it will attack potatoes in the field and in storage. The maggots have also been found injuring peony bulbs in Pennsylvania. Potatoes are more subject to injury when grown in low ground where there is an abundance of humus or when stored in warm, damp cellars.

The female fly is $\frac{1}{25}$ to $\frac{1}{12}$ inch in length, pale in color and without wings. The male is somewhat dusky, smaller than the female and occurs in two forms, one with normal functional wings and the other with abbreviated wings. The fly deposits her small, white, oblong eggs, about $\frac{1}{100}$ inch in length, on the surface of the potato. The eggs hatch in five or six days and the young maggot works its way into the tuber, usually taking advantage of a scab spot or other injury. The maggots attack the healthy tissue and under favorable conditions of temperature and moisture will continue their work generation after generation until the tuber is completely destroyed. The maggots become mature in about a week and then transform to delicate white pupæ in flimsy silken cocoons either in the soil or on the surface of the tuber. The adults emerge in three or four days. From twenty to twenty-five days are required for the insect to complete its life cycle.

*Control.*

Serious injury by the potato scab gnat is of rare occurrence. Only uninfested seed potatoes should be planted and land on which the crop has been infected should not be used for potatoes the following year. Potatoes grown in dry, light soil are not likely to be attacked.

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## The Potato Tuber Moth

*Phthorimæa operculella* Zeller

Potatoes in California and Texas are subject to attack by a small whitish caterpillar about $\frac{1}{2}$ inch in length that riddles the tubers with burrows, causing them to decay. The potato tuber moth is also a troublesome tobacco pest and when feeding on this plant is known as the split-worm or tobacco leaf-miner.

The insect ranges from Virginia to Colorado and southward and on the Pacific Coast is present in California and Washington. It is also known as a serious enemy of the potato in Australia, New Zealand, the Mediterranean region and South Africa. Besides potato and tobacco, the insect sometimes attacks eggplant and tomato, mining the leaves and stalks and burrowing in the fruit. Its wild food plants include common nightshade, horse-nettle, Jamestown weed and several other solanaceous plants.

The potato tuber moth has been studied most carefully in California and in France. The caterpillars not only infest the tubers both in the field and in storage but also mine the leaves and petioles and bore into the stalks. The parent moth has an expanse of a little more than $\frac{1}{2}$ inch. The front wings are yellowish brown, more or less spotted and mottled with dark brown. The hind wings are light yellowish brown and provided with a long fringe. The moths appear in the field early in the spring and deposit their eggs singly, usually on the underside of the potato leaves. The egg is oval, about $\frac{1}{50}$ inch in length, pearly white with a faint iridescence, becoming leaden gray just before hatching. The eggs hatch in three to five days. On hatching, the young larva bores into the leaf where it produces a blotch mine. As it increases in size, it may migrate to another leaf or bore down through the petiole and into the stalk, causing the branch to wilt and die. When full-grown the caterpillar is about $\frac{1}{2}$ inch in length, white, tinged with pink or greenish above, with the head and cervical shield dark brown and with the small anal plate light brown. It reaches maturity in two weeks to seventeen days in warm weather. When ready to pupate, the larva constructs a small grayish silken cocoon about $\frac{1}{2}$ inch in length, which is covered with dirt and pieces of excrement. The cocoons are sometimes found in the opening of the burrow, in trash at the base of the plant or more commonly in the dried leaves still clinging to the vine. The pupa is brown, becoming darker with age and is about $\frac{2}{5}$ inch in length. The insect remains in the pupal stage from a week to ten days in warm weather. In two or three days after emergence, the moths lay eggs for another brood. Reproduction is continuous throughout the season.

After the tubers have formed, they may become infested in several ways. Some of the caterpillars may leave the stalks and migrate to the potatoes. When the soil is loose and the potatoes are near the surface, the moths may work their way down through the cracks and lay their eggs on the tubers. When the potatoes are planted shallow some of the tubers may become exposed and the moths will lay their eggs on them. Potatoes are most likely to become infested at digging time. If left exposed in the field during late afternoon or overnight, eggs are laid on them in abundance. When the piles of potatoes are covered with infested vines, the caterpillars may leave the stalks and enter the tubers. When infested tubers are placed in storage, the insect will continue breeding throughout the winter provided the temperature does not fall below 40° or 50° F. When deposited on the tubers, the eggs are usually placed around the eyes or on the edge of holes made by the larvæ. On hatching the young caterpillar soon works its way into the potato, throwing out a small mass of frass through the opening. The young caterpillars at first burrow just underneath the skin but when half grown or more work their way into the flesh, sometimes quite to the center of the tuber. The burrow is lined with a silken tube through which the larva can move back and forth readily. When about to pupate, the larva leaves the tuber and in some crack or corner or between two potatoes spins its cocoon. In storage the insect will continue to breed as long as any potatoes remain in condition to serve as food for the larvæ. Five or six generations may develop in the course of a year.

Under storage conditions, a longer period is required for the completion of the life cycle because of the lower temperature. Under such conditions the egg stage requires a week or ten days, the larva about six weeks and the pupa two weeks or over.

*Control.*

The injuries caused to the vines by the potato tuber moth are not in themselves serious. The great loss comes from the infested tubers. This may be prevented in large measure by planting the potatoes rather deep and by keeping them carefully hilled so as not to allow any of the tubers to be exposed on which the moths can deposit their eggs. Care should be taken at digging time not to leave potatoes exposed overnight while the moths are laying. Piles of potatoes should not be covered with infested vines since the larvæ will leave the stalks when they begin to wilt and enter the tubers. After the potatoes have been placed in storage, they should be examined at frequent intervals and if any are found to be infested, they should be fumigated with carbon bisulfid at the rate of 2 pounds to 1000 cubic feet of space, allowing the fumigation to continue for about forty-eight hours. This should be repeated at intervals of about a week in summer or two weeks in winter. Directions for fumigation will be found on page 380.

Where the potato tuber moth is abundant, it is not advisable to plant potatoes on the same land for two years in succession. By practicing rotation of crops and by destroying all solanaceous weeds on which the insect may breed, much loss may be avoided.

### References

Cal. Agr. Exp. Sta. Bull. 135. 1901.
Picard, Ann. Service Epiphyties, 1, pp. 106–176. 1913.
U. S. Farm. Bull. 557. 1913.
U. S. Dept. Agr. Bull. 59. 1914.
U. S. Dept. Agr. Bull. 427. 1917.

### Other Potato Insects

Corn ear-worm: 211
Southern corn root-worm: 222
Cabbage looper: 8
Garden webworm: 18
Seed-corn maggot: 36
Harlequin cabbage bug: 38
Serpentine leaf-miner: 46
False chinch-bug: 47
Yellow bear caterpillar: 357
Carrot beetle: 185
*Adelphocoris rapidus:* 195
Sugar-beet webworm: 97
Spinach aphis: 105
Tomato worms: 168
Western twelve-spotted cucumber beetle: 114
Belted cucumber beetle: 115
Southern leaf-footed plant-bug: 121
Garden springtail: 139
Grape colaspis: 67
Bean thrips: 69
Garden flea-hopper: 77
Eggplant tortoise beetle: 177
Eggplant lace-bug: 178
Spotted cutworm: 262
Greasy cutworm: 265
Dark-sided cutworm: 268
Striped cutworm: 270
Shagreened cutworm: 272
Clay-backed cutworm: 274
Variegated cutworm: 276
Army cutworm: 287
Fall army-worm: 292
Beet army-worm: 294
Yellow-striped army-worm: 295
Semi-tropical army-worm: 297
Striped blister-beetle: 302
Margined blister-beetle: 305
Gray blister-beetle: 306
Ash-gray blister-beetle: 306
Black blister-beetle: 307
Spotted blister-beetle: 309
Two-spotted blister-beetle: 309
*Macrobasis longicollis:* 310

Immaculate blister-beetle: 310
Segmented black blister-beetle: 310
Panther blister-beetle: 311
Crow blister-beetle: 311
Potato flea-beetle: 314
Western potato flea-beetle: 318
Tobacco flea-beetle: 319
Eggplant flea-beetle: 320
Pale-striped flea-beetle: 321
Red-headed flea-beetle: 323
Smartweed flea-beetle: 323
Hop flea-beetle: 335
Root-knot nematode: 338
Millipedes: 342
Wheat wireworm: 348
Sugar-beet wireworm: 349
Slugs: 354

## CHAPTER VII

# TOMATO INSECTS

Many potato insects also attack the tomato. The most important of these are the potato flea-beetle and the Colorado potato beetle. In the South, the corn ear-worm is usually the most destructive pest to be contended with and the tomato worms often cause serious loss.

### The Tomato Worms

Throughout the United States and southern Canada, tomatoes are subject to attack by large greenish or brownish caterpillars 3 or 4 inches in length which are provided with a sharp horn on the back near the hind end of the body. They are also known as horn-worms and tobacco worms. These tomato worms belong to two distinct species. The areas occupied by the two forms overlap to a considerable extent. Throughout the greater part of the United States, caterpillars of both species are found feeding together, the relative abundance varying from place to place and from year to year. The northern form ranges from Canada to Florida westward to the Pacific. The southern species breeds from Massachusetts, New Jersey, Ohio and Illinois southward through the West Indies to Patagonia. Both species occur in California. In addition to tomato, eggplant, potato and pepper are sometimes attacked.

### *The northern tomato worm, Phlegethontius quinquemaculata* Haworth

The adult of the northern tomato worm is a moth having an expanse of 4 to 5 inches (Fig. 93). The front wings are ashy

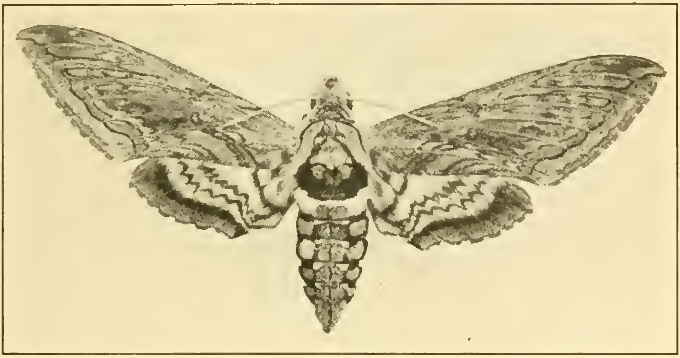

Fig. 93. — The northern tomato worm moth ($\times \frac{7}{9}$).

gray marked with irregular brown and black lines. The hind wings are whitish with a broad gray band on the outer margin and crossed with four black bands, the middle pair being sharply zigzag. The abdomen is gray marked with a narrow median black line and with a row of large yellow spots on each side which are surrounded with black. On the posterior margin of each segment are two white spots on each side, one above and one below the yellow spot of the succeeding segment. The moths appear on the wing in May or June. They fly in the evening or on dark days and may be seen hovering over flowers

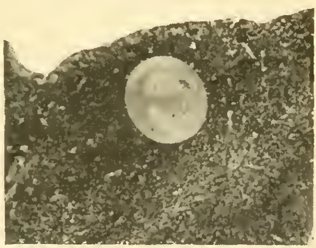

Fig. 94. — Egg of the northern tomato worm ($\times$ 7).

from which they suck the nectar. The mouth is provided with a long sucking tube from $2\frac{1}{4}$ to 5 inches in length which when not in use is coiled under the head. The eggs are deposited singly, usually on the underside of the leaves. The egg (Fig. 94) is globular, nearly $\frac{1}{16}$ inch in diameter and greenish yellow

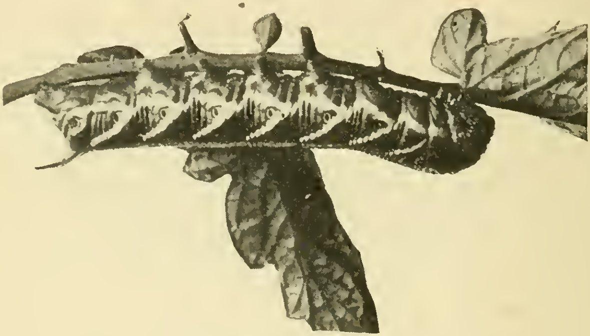

FIG. 95. — Full-grown northern tomato worm ($\times \frac{5}{8}$).

in color. The eggs hatch in three to eight days and the young caterpillars begin feeding on the leaves. They grow rapidly, reaching maturity in three weeks to a month. The larger caterpillars feed ravenously and will strip a tomato vine in a few days. The full-grown caterpillar (Fig. 95) is 3 or 4 inches in length and varies in color from green to dark brown. Each segment of the abdomen is marked on the side just above the spiracle with a greenish white oblique stripe which, with a similar horizontal stripe below the spiracle, forms a V with the apex pointed forward. The horn at the posterior end of the body is green with the sides black. When disturbed the caterpillar has the curious habit of elevating the front part

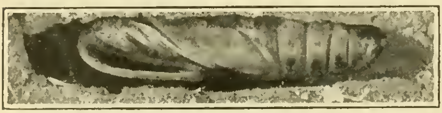

FIG. 96. — Pupa of northern tomato worm in its cell ($\times \frac{3}{4}$).

of the body and drawing in the head, in which position it will remain motionless for a long time. When mature the caterpillar goes into the ground a few inches and there in an earthen cell transforms to a dark brown pupa (Figs. 96 and 97) about 2 inches in length. The sucking tube of the future moth is inclosed in a separate case from one third to nearly half as long as the pupa, resembling the handle of a pitcher. The number of generations varies with the length of the season; in the North there is apparently only one, in Maryland and Kentucky there are two and in Florida there are said to be three or four.

Fig. 97. — Pupa of the northern tomato worm ($\times 1\frac{1}{8}$).

*The southern tomato worm, Phlegethontius sexta* Johannsen

The moth of the southern tomato worm is similar to that of the northern species but the ground color of the wings is brownish gray instead of ash-gray. There is usually a small white spot near the middle of the front wing and the intermediate lines on the hind wings are not zigzag and often coalesce. The life history of this species is similar to that of its northern relative. In Kentucky and Tennessee, the moths begin to emerge from over-wintered pupæ about the first of June and continue to emerge over a long period, until the latter part of August in some years. The oblique bands on the side of the caterpillar extend higher up on the back and are not V-shaped. The horn is usually strongly curved and reddish in color. The tongue-case of the pupa is somewhat shorter than in the northern species.

*Control.*

The presence of tomato worms is readily detected by the defoliation of the vine and by the droppings of the caterpillars on the ground, although it is not easy to see the caterpillar itself as it rests motionless on a stem, its colors blending with the green of the foliage and the light stripes on its side suggesting the veins on the underside of the leaves. In the small garden or in larger fields where the caterpillars are not numerous, hand-picking is the cheapest and most practical means of control. When the worms appear in considerable abundance, spraying with paris green or arsenate of lead will give good results. Arsenate of lead is to be preferred on tomatoes because it is not so likely to burn the foliage. It is usually used at the rate of 2 or 3 pounds of the paste to 50 gallons of water. The first application should be made while the caterpillars are still small because they are then killed more quickly and by a smaller quantity of the poison than later. There is no danger in spraying tomatoes until the fruit is half grown, and some growers apply paris green till within ten days of picking. The arsenate of lead may be applied in the form of a dust diluted with some inert material.

### References

Ky. Agr. Exp. Sta. Bull. 66, pp. 6–32. 1897.
U. S. Farm. Bull. 120, pp. 10–14. 1900.

## The Tomato Stilt-Bug

*Jalysus spinosus* Say

The tomato stilt-bug is generally distributed throughout the United States and Canada east of the 100th meridian and has been reported as injurious to tomato in Missouri. The adult (Fig. 98) is a slender, elongate, brownish bug with long, delicate, thread-like legs and antennæ. The last joint of the antenna is enlarged and black. The insects are found on low vegetation in woods and fields.

The female attaches her eggs singly to the stems of tomato plants. The egg is $\frac{1}{25}$ inch in length, cylindrical, rounded at each end, whitish to pale brownish in color and faintly ridged lengthwise. The eggs hatch in about five days. The nymphs are brownish green with the legs dark. In feeding, the bugs puncture the stems, the blossom stems, the ovaries and the young fruits, causing the blossoms and fruit to fall. There are supposed to be at least three generations annually in southern Missouri.

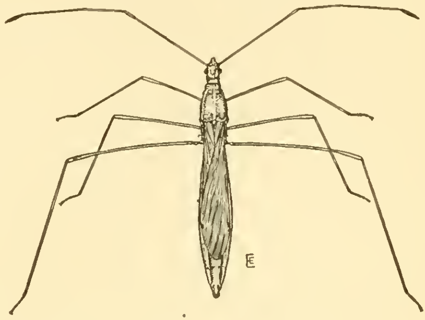

FIG. 98. — The tomato stilt-bug (× 4).

The bugs may be killed by spraying with "Black Leaf 40" tobacco extract, 1 part in 800 parts of water to which enough soap has been added to make a suds. The insects are more easily hit in the early morning or late in the afternoon.

REFERENCE

Mo. Fruit. Exp. Sta. Bull. 24, pp. 16–17. 1914.

FIG. 99. — The tomato wireworm (× 3).

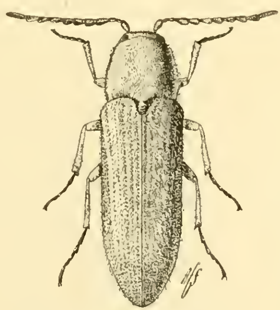

FIG. 100. — Adult of the tomato wireworm (× 4).

## THE EASTERN FIELD WIREWORM

*Limonius agonus* Say

In New York, young tomato plants are sometimes seriously injured by a wireworm that bores up through the stem, causing them to wilt and die. This wireworm (Fig. 99) is over $\frac{1}{2}$ inch in length and reddish brown in color. The parent beetle (Fig. 100) is $\frac{3}{8}$ inch in length, with the head and prothorax black, the legs brownish and the wing-covers reddish brown. The life history of the species has not been fully worked out.

Injury may be avoided by not planting tomatoes on land that was in sod or corn the previous year.

## The Erinose of the Tomato

*Eriophyes cladophthirus* Nalepa[1]

In Florida, Georgia and South Carolina, tomatoes are sometimes infested by a minute mite which attacks the growing tips and the blossom buds. The feeding of the mites causes an irritation of the tissue, inducing the plant to send out a dense growth of white hairs, giving it the appearance of being covered with a white mold. It is under the protection of this dense growth of plant-hairs that the mites live, lay their eggs and feed. Growth is stopped and the buds do not set fruit. The life history and habits of this mite have not been carefully studied. The adult is elongate, vermiform and nearly colorless. It is provided with two pairs of legs and the abdomen is transversely striate and apparently divided into about seventy narrow rings. The female mite is about $\frac{3}{500}$ inch in length and the male about $\frac{1}{250}$.

The erinose of the tomato may be controlled by spraying the plants with the soda sulfur spray commonly used against mites on citrus. The formula for this mixture is:

[1] The identity of this mite is somewhat uncertain. Rolfs (Fla. Agr. Exp. Sta. Bull. 47, p. 143, 1898) referred the species to *Phytoptus calcladophora* Nalepa, stating that the mite occurs in southern Europe. We have been unable to find any such species described by Nalepa. Apparently the *P. calcladophora* used by Rolfs is a misprint for *Phytoptus* (*Eriophyes*) *cladophthirus* Nalepa. The latter was described from bittersweet (*Solanum Dulcamara*) in France, on which it produced erinea. Kirchner states that it produces a similar condition on tomato in Europe.

| | |
|---|---|
| Caustic soda (98 per cent) | 10 pouuds |
| Flowers of sulfur | 20 pounds |
| Water | 20 gallons |

Mix the sulfur in cold water to a thick paste, add the soda and as it boils add water gradually to make 20 gallons. The water should be added fast enough to prevent burning, but not fast enough to stop boiling. The result will be a dark coffee-colored liquid. Strain through a fine-meshed cloth or spray-strainer. Keep in tightly-corked jugs. For use, mix one half gallon of this stock solution in 40 gallons of water.

Dusting the plants with finely ground sulfur has also been found of benefit.

### Other Tomato Insects

Corn ear-worm: 211
Southern corn root-worm: 222
Stink-bugs: 232
Cabbage looper: 8
Garden webworm: 18
Harlequin cabbage bug: 38
Green soldier-bug: 42
*Nezara viridula:* 43
Spinach aphis: 150
Belted cucumber beetle: 115
Southern leaf-footed plant-bug: 121
Northern leaf-footed plant-bug: 122
Garden springtail: 139
Colorado potato beetle: 142
Three-lined potato beetle: 149
Potato aphis: 150
Potato stalk-weevil: 155
Common stalk-borer: 157
Burdock borer: 160
Potato tuber moth: 162
Bean thrips: 69
Garden flea-hopper: 77
Spotted cutworm: 262
Greasy cutworm: 265
Dark-sided cutworm: 268
Striped cutworm: 270
Dingy cutworm: 271

Granulated cutworm : 273
Clay-backed cutworm : 274
Variegated cutworm : 276
Army cutworm : 287
Fall army-worm : 292
Yellow striped army-worm : 295
Semi-tropical army-worm : 294
Striped blister-beetle : 302
Margined blister-beetle : 305
Ash-gray blister-beetle : 306
Black blister-beetle : 307
Two-spotted blister-beetle : 309
Immaculate blister-beetle : 310
Potato flea-beetle : 314
Western potato flea-beetle : 318
Tobacco flea-beetle : 319
Pale-striped flea-beetle : 321
Striped cabbage flea-beetle : 324
Hop flea-beetle : 335
Root-knot nematode : 338
Millipedes : 342
Slugs : 354
Red-spider : 351

# CHAPTER VIII

## EGGPLANT INSECTS

The eggplant is subject to attack by most of the insects affecting the potato and tomato. Several species of flea-beetles attack eggplant and often cause serious injury, especially to the young plants. They are treated in Chapter XVII.

### The Eggplant Tortoise Beetle

*Cassida pallidula* Boheman

In the southern states, the eggplant is occasionally subject to injury by the larvæ and adults of a beautiful green or greenish yellow tortoise beetle about $\frac{1}{5}$ inch in length. This beetle is distributed throughout the southern United States from Maryland to Indiana and Kansas southward to Louisiana and westward to southern California. It feeds on eggplant, potato and horse-nettle and in California on nightshade. The beetles deposit their eggs singly or in groups of two to four, usually on the underside of the leaves. The egg is about $\frac{1}{20}$ inch in length, elongate oval and brownish in color. It is covered and fastened to the leaf with a transparent brownish substance which is usually composed of two layers. Each female is capable of laying 250 eggs or more. The eggs hatch in four days to two weeks and the young larva is greenish white with the head dirty brown. The body is armed on each side with sixteen branched spines and on the back near the hind end of the body two long spines arise and extend forward. On this fork the insect carries its cast skins and excrement, using this load as a kind of sunshade. The larva passes through five stages and reaches maturity in twelve to twenty days. Pupation takes place on the leaf, to which the pupa is attached by the hind end of the body and in two to ten days transformation to the beetle occurs. In Louisiana there are four or five generations annually. Both the larvæ and adults eat out round holes in the leaves and often seriously injure young eggplants.

The eggplant tortoise beetle rarely becomes sufficiently abundant to require remedial treatment but may be readily controlled by spraying with arsenate of lead (paste), 2 or 3 pounds in 50 gallons of water.

### Reference

U. S. Dept. Agr. Bull. 422. 1916.

## The Eggplant Lace-Bug

*Gargaphia solani* Heidemann

Throughout the southern states from Virginia, Missouri and Oklahoma southward, the eggplant is sometimes injured by a grayish or light brownish lace-bug. This insect is a native of America and fed originally on horse-nettle. It sometimes occurs in great abundance on potatoes.

The adult lace-bug is about $\frac{1}{6}$ inch in length, flat, and under a lens presents a striking appearance. The prothorax is developed into a hood that extends backward between the wings at the base, and its sides are expanded angularly. The front wings are broad, rounded at the tip, blackish at the base and apex, with a pale band across the middle and with the veins arranged so as to form a beautiful reticulated network, resembling lace. The expanded margin of the prothorax is similarly reticulated.

The female deposits her eggs on the underside of the leaves in circular clusters of 100 to nearly 200. The eggs are placed on end and lean in different directions. The mass is then covered with a protective secretion. The egg is bottle-shaped, greenish at the base and brownish towards the tip and about $\frac{1}{68}$ inch in length; the top is crater-like with a white lace-like border. The eggs hatch in five to nine days. In feeding, the nymphs insert the bristles of the beak into the leaf and suck out the juices. The mother lace-bug watches over her egg-mass until the young are hatched and then cares for the nymphs until they have reached a considerable size. A small area surrounding an egg-mass is killed and the feeding of the nymphs enlarges the injured part. The colony of nymphs then migrates to a new position and there repeats the process. When abundant, the whole plant may be killed or so injured that a crop of fruit is not produced. In the course of its development, the nymph sheds its skin five times, acquiring wings at the last molt. About ten days are required for the nymphs to reach maturity. The fifth stage nymph is yellowish in color with a dark spot at the tip of the abdomen and is armed with numerous spiny processes. In Tidewater, Virginia, there are six generations produced on eggplant and after this crop is harvested two or more generations develop on horse-nettle.

Both nymphs and adults can be killed by spraying with 7 or 8 pounds of whale-oil soap in 50 gallons of water.

### Reference

U. S. Dept. Agr. Bull. 239. 1915.

### Other Eggplant Insects

Corn ear-worm: 211
Southern corn root-worm: 222
Garden webworm: 18
Harlequin cabbage bug: 38
Green soldier-bug: 42
Yellow bear caterpillar: 357
Spinach aphis: 150
Tomato worms: 168

Belted cucumber beetle: 115
Southern leaf-footed plant-bug: 121
Melon aphis: 135
Colorado potato beetle: 142
Potato aphis: 150
Potato stalk-weevil: 142
Common stalk-borer: 157
Potato tuber moth: 162
Garden flea-hopper: 77
Greasy cutworm: 265
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Striped blister-beetle: 302
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Western potato flea-beetle: 318
Tobacco flea-beetle: 319
Eggplant flea-beetle: 320
Pale-striped flea-beetle: 321
Root-knot nematode: 338
Red-spider: 351

## CHAPTER IX

## INSECTS INJURIOUS TO CARROT, CELERY, PARSNIP AND RELATED CROPS

As a rule, these plants are relatively free from insect attack, but the carrot rust-fly, recently introduced from Europe and now gradually spreading over Canada and the northern states, promises to become a serious pest.

### The Carrot Rust-Fly

*Psila rosæ* Fabricius

The carrot rust-fly is a native of Europe, where it has been known since 1794. It was introduced into Canada probably in the early eighties, but first attracted attention at Ottawa in 1885. It soon became abundant in Quebec, New Brunswick and Nova Scotia. In New York it was first observed in Fulton County in 1901. It now occurs in the northern states from Maine to Michigan. It is a serious enemy of carrots and celery and also attacks parsnips, parsley, celeriac and wild carrot.

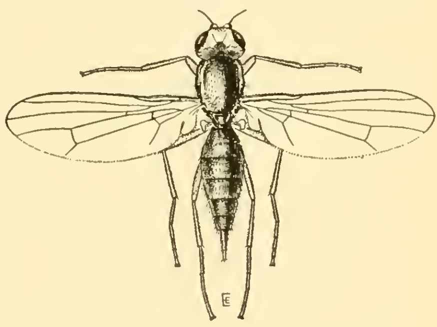

Fig. 101. — The carrot rust-fly ($\times 7\frac{1}{2}$).

The parent insect (Fig. 101) is a small two-winged fly about $\frac{1}{6}$ inch in length. The body is shining dark green; the head yellowish with the eyes red. The legs are pale yellowish. In New York the flies usually make their appearance some time in May, depending on weather conditions. Observation of the flies confined in cages has shown that they feed for about five days before they are ready to begin egg-laying. In the field they doubtless subsist on such drops of liquid as they may find. The mouth-parts are somewhat similar to those of the house fly, that is, they are developed into a fleshy, tongue-like organ with which the insect is able to lick or lap up liquids.

Fig. 102. — Egg of the carrot rust-fly (× 26).

The female fly has the tip of the abdomen provided with a sharp, extensile ovipositor by means of which she is able to tuck her eggs into crevices of the soil around the plant. Some of the eggs are laid between the base of the plant and the soil but many are found scattered about on the surface of the ground near the plant; others are attached to the plant itself. Females have also been observed depositing eggs in cracks at some little distance from the plant. The egg (Fig. 102) is about $\frac{1}{30}$ inch in length and about $\frac{1}{3}$ as wide as long. It is elongate oval, white in color and under the microscope shows a most beautiful sculptured pattern of delicate ridges and pits. Eggs have been found in abundance the last of May. The eggs hatch in about a week and the young maggot

Fig. 103. — Young carrots injured by rust-fly maggots.

works its way down along the root and at first feeds on the tender tip.

In the case of carrots and parsnips, the maggots at first feed on the tip of the tap-root and later the whole root is riddled with burrows which run in every direction. These burrows are of a rusty color, hence the common name of the insect. When badly infested, the carrot roots decay and when one

FIG. 104. — Two celery plants injured by the carrot rust-fly and an uninjured plant of the same age.

attempts to pull them the lower part will break off and remain in the ground (Fig. 103). The outer leaves of infested plants soon turn yellowish and the whole top may wilt down and die.

The injury to celery is of a somewhat different nature. Here the fibrous roots are eaten off and destroyed. Infested plants take on a sickly whitish color and remain stunted. The plants are often able to throw out a new set of fibrous roots near the surface of the ground and can thus outgrow the injury

FIG. 105. — Larva of the carrot rust-fly ($\times 7\frac{1}{2}$).

in a measure, but the size and quality of the crop are seriously impaired. In Fig. 104 are shown two injured plants in comparison with a healthy one.

The maggots become mature in about a month. When full-grown the larva is about $\frac{3}{10}$ inch in length, pale straw-colored, pointed in front with the posterior end of the body obliquely truncate. The mouth is provided with a pair of black, curved hooks with which the maggot is able to rasp off portions of the tissue of the root (Fig. 105).

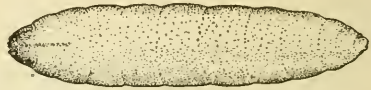

FIG. 106. — Puparium of the carrot rust-fly ($\times 9\frac{3}{8}$).

When mature, the greater number of the larvæ desert the roots and in the surrounding soil transform to puparia. The puparium (Fig. 106) is about $\frac{1}{5}$ inch in length, light brownish in color and in shape resembles somewhat a grain of wheat. From these puparia there emerges in late August a second brood of flies. The insects hibernate as puparia in the soil or as maggots in the roots.

FIG. 107. — A celery root injured by rust-fly maggots of the second brood.

It is quite probable that not all the puparia of the first brood transform the same season, but the second brood of flies is often large enough to produce a serious infestation of late carrots and to cause appreciable injury to celery in the fall. While the maggots of the second brood burrow in the tap-root of the celery plant, they very rarely ascend so as to enter the base of the leaves (Fig. 107).

Unfortunately no method of controlling this pest has been devised applicable to the conditions under which its food plants are grown in this country.

### References

U. S. Div. Ent. Bull. 33, pp. 26–32. 1902.
Felt, 18th Rept. N. Y. State Ent., pp. 99–103. 1903.

## The Carrot Beetle

*Ligyrus gibbosus* DeGeer

Throughout the United States, except in the extreme North, the roots of carrot, parsnip and celery are sometimes seriously injured by a medium-sized reddish brown insect which has much the appearance of a small June beetle. It is from $\frac{1}{2}$ to $\frac{5}{8}$ inch in length. On the front part of the thorax is a depressed area, in front of which is a small distinct tubercle (Fig. 108). The beetles feed mostly underground, gnawing out holes in the roots and underground stems. In addition to the plants mentioned above, the beetles have been known to attack beet, celery, sweet potato, potato, corn, dahlia, cabbage, sunflower and cotton, and among weeds ragweed and red-root.

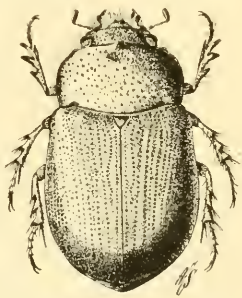

Fig. 108. — The carrot beetle ($\times 2\frac{1}{2}$).

The beetles hibernate in the soil at a depth of six inches to four feet and are found in the field in greater or less abundance throughout the growing season. The eggs are laid in the soil. They are similar to those of the June beetles, white, smooth and shining, nearly globular, grayish, and about $\frac{1}{14}$ inch in length when newly laid. They increase considerably in size before hatching, which takes place in one to three weeks. The larvæ feed on the roots of grasses and decaying vegetable matter and sometimes attack the same plants as do the beetles. When mature, the larva is $1\frac{1}{4}$ inches in length, bluish white with the head brown. From six to eleven weeks are spent in the larval stage. The mature grubs construct earthen cells within which to pupate and the beetles emerge two or three weeks later. There is apparently only one generation annually.

The measures suggested for the control of the carrot beetle are of little practical value. Clean farming and a short rotation of crops will under ordinary conditions prevent serious loss.

### References

U. S. Div. Ent. Bull. 33, pp. 32–37. 1902.
Hayes, Jour. Ec. Ent., 10, pp. 253–261. 1917.

## The Black Swallow-Tail Butterfly

*Papilio polyxenes* Fabricius

The caterpillar of this large black and yellow butterfly feeds on the leaves of celery, parsnip, carrot, parsley, caraway, fennel, sweet-fennel, dill, anise and nearly all wild umbelliferous plants. It is most destructive to young celery. The butterfly ranges throughout North America from southern Canada southward through Central America and the West Indies to Venezuela.

Fig. 109. — The black swallow-tail butterfly ($\times \frac{4}{7}$).

The butterfly (Fig. 109) has an expanse of $3\frac{1}{4}$ to nearly 4 inches. The

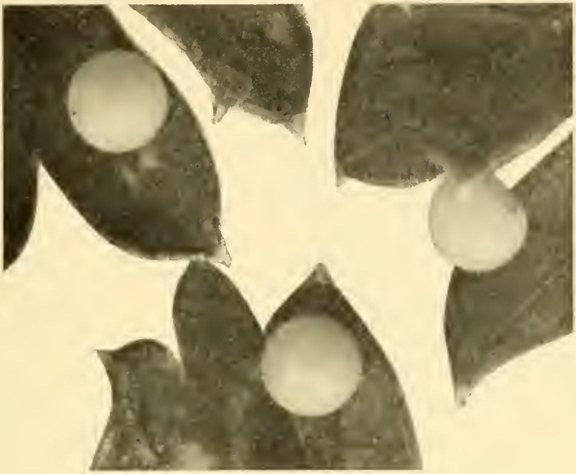

FIG. 110. — Eggs of the black swallow-tail butterfly (× 12).

male is somewhat smaller. The wings are black with two rows of yellow spots crossing both wings with a marginal row of yellow lunules. Between the rows of yellow spots on the hind wing and on the hind part of the front wing is a bluish band. On the posterior angle of the hind wing is an orange spot with a black center. In the male the yellow markings are

FIG. 111. — The black swallow-tail butterfly, a young caterpillar and one nearly full-grown with the osmateria protruded (× $\frac{5}{8}$).

more distinct and on the hind wing the inner row of spots is replaced by a broad yellow band. In the North the butterflies emerge from over-wintered pupæ in May and June and deposit their eggs singly on the upper side of the leaves of the host plants. In Florida the butterflies hibernate. The egg (Fig. 110) is globular, about $\frac{1}{25}$ inch in diameter, pale honey-yellow when first laid, changing to reddish brown in parts. The eggs hatch in about ten days. In the first stage the caterpillar is about $\frac{1}{10}$ inch in length, black, banded about the middle and rear end with white. When mature the caterpillar is about 2 inches in length, green, and each segment has a black band near the front margin inclosing six yellow spots. When disturbed this caterpillar has the habit of extruding a pair of orange-red horn-like scent organs from the dorsum of the prothorax (Fig. 111). These organs are known as osmateria and are probably for defense. The caterpillars become full-grown in three to four weeks and suspending themselves by a silken girdle (Fig. 112) transform to pupæ on some nearby support. The pupa (Fig. 113) is $1\frac{1}{4}$ inches in length, light dirty brown marked with black and dark green. It is attached to its support by a button of silk at the hind end of the body

FIG. 112. — Caterpillar of the black swallow-tail butterfly suspended for pupation ($\times \frac{3}{4}$).

FIG. 113.— Chrysalis of the black swallow-tail butterfly ($\times \frac{8}{10}$).

and held in place by a silken girdle around the thorax. The pupal period lasts from nine to sixteen days. There are two broods in the North and at least three in the South.

In California the black swallow-tail butterfly is replaced as a celery and parsley pest by a related species, *Papilio zolicaon* Boisduval.

*Control.*

As this insect rarely becomes abundant, it may be usually held in check by hand-picking the caterpillars.

### Reference

Scudder, Butterflies of Eastern U. S., 2, pp. 1353–1364. 1889.

## The Celery Leaf-Tyer

*Phlyctænia ferrugalis* Hübner

Celery is occasionally injured by a small greenish caterpillar that folds or webs together the leaves and sometimes bores down into the stalks. This insect is widely distributed in Europe, Asia and North America. In the United States it has been reported injuring celery, spinach and beet but is best known as a greenhouse pest, attacking a wide variety of hot-house plants. Its wild food plants include boneset, hedge nettle, strawberry

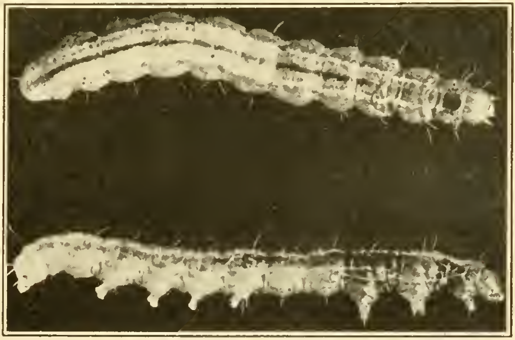

Fig. 114. — The celery leaf-tyer, caterpillar ($\times 3\frac{1}{3}$).

and burdock. The caterpillars have been occasionally found feeding on celery and beet in August and September.

Fig. 115. — The celery leaf-tyer, pupa ($\times$ 5).

The full-grown caterpillar (Fig. 114) is $\frac{3}{4}$ inch in length, translucent greenish white with a pair of black spots on the cervical shield. The body is marked with a dark green median stripe bordered by a much wider greenish white one. When disturbed the caterpillar has the habit of wriggling actively back and forth. The larva generally feeds openly on the under surface of the leaves, but sometimes it forms a retreat by webbing together several leaves loosely with silk. Under greenhouse conditions, the caterpillars mature in about three weeks. Pupation takes place within thin white, silken cocoons spun within folded leaves. The pupa (Fig. 115) is a little less than $\frac{1}{2}$ inch in length and dark brown or black. The pupal period varies from twelve to twenty days. In one instance the moth did not emerge until a year after the pupa was formed. The moth (Fig. 116) has an expanse of about $\frac{7}{8}$ inch and is rusty brown with somewhat obscure blackish markings on the front wings. The flight of the moths is short and jerky and on alighting they quickly hide on the underside of the object. The small, flat, elliptical, translucent eggs (Fig. 117), about $\frac{1}{50}$ inch in diameter, are deposited on the underside of the leaves in small

Fig. 116. — The celery leaf-tyer moth ($\times$ $1\frac{1}{2}$).

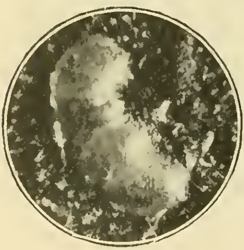

Fig. 117. — Eggs of the celery leaf-tyer ($\times$ 22).

clusters of two to twelve, often overlapping. The eggs hatch in twelve to fourteen days. Under greenhouse conditions, there are from seven to eight generations annually; in the open there are said to be only four.

The celery leaf-tyer has never been found causing serious injury in the open and no methods of controlling it under such conditions have been devised.

### References

Buckler, Ent. Mo. Mag., 14, pp. 200–204. 1878.
Fletcher and Gibson, Can. Ent., 33, pp. 140–144. 1901.
Cornell Agr. Exp. Sta. Bull. 190, pp. 159–164. 1901.

## The Celery Looper

*Autographa falcigera* Kirby

Throughout the United States and southern Canada east of the Rocky Mountains, celery, lettuce and sugar-beets are sometimes subject to the attack of a looping caterpillar. These caterpillars hibernate in a partly grown condition and complete their development in early spring. The full-grown larva is $1\frac{1}{4}$ inches in length, pale translucent green in color, and marked with a median dark line, on each side of which are three light lines. The stigmatal stripe is white bordered above by a dark green stripe. The spiracles are white, distinctly ringed with black, a character by which it may be distinguished from the cabbage looper. The body becomes gradually larger towards the posterior end, which is obliquely truncate. Although these caterpillars are closely related to the cutworms, they crawl with a peculiar looping motion owing to the absence of prolegs on the third and fourth abdominal segments. In Illinois the over-wintered caterpillars become mature in late April and pupate in silken cocoons. The pupal period occupies nine or ten days.

The moth has an expanse of about $1\frac{1}{4}$ inches. The front wings are purplish brown with an oblique band in the front angle and the area back of the silver spot velvety reddish brown. The silver mark is distinct and the hind margin of the front wing is scalloped so as to leave a rounded projection at the hind angle. The hind wings are yellowish brown, darker toward the margin, which is edged with white (Fig. 118).

Fig. 118. — Moth of the celery looper ($\times 1\frac{1}{5}$).

The egg is about $\frac{1}{60}$ inch in diameter, milky white, globular, slightly flattened and marked with delicate longitudinal ridges. The eggs hatch in about a week.

In Illinois there are apparently three broods annually, the moths flying in April and early May, in late July and early August and again in late September. The caterpillars of the summer brood require about three weeks to reach maturity.

The celery looper does not often occur in sufficient numbers to require remedial measures. As arsenicals cannot be used on celery or lettuce, hand-picking the caterpillars is the only measure available and will usually be found sufficient.

### Reference

Coquillett, 11th Rept. State Ent. Ill., pp. 38–43. 1882.

## The Tarnished Plant-Bug

*Lygus pratensis* Linnæus

The tarnished plant-bug is one of the commonest insects found on garden plants. It feeds on a great variety of trees, shrubs and herbs, showing a special liking for opening buds, flowers and tender new growth. It is widely distributed throughout the entire north temperate zone. The adult (Fig. 119) is an inconspicuous, brownish bug mottled with various shades of reddish and yellowish brown, $\frac{1}{5}$ to $\frac{1}{4}$ inch in length. The bugs are shy, taking flight at the slightest alarm, and are often overlooked by the gardener.

This insect hibernates as an adult in leaves, grass, stone piles and under other rubbish. The bugs emerge in early spring and are then often destructive to the buds of fruit-trees and nursery stock. They are also to be found abundantly in mullein rosettes and as soon as the days become warmer they begin feeding on various weeds. In New York the eggs become mature in the over-wintering females by the last of April or the first of May and a generation of young is produced, giving rise to a new brood of adults the latter part of June. The egg (Fig. 120) is nearly $\frac{1}{25}$ inch in length, flask-shaped and obliquely truncate at the anterior end. The eggs are inserted their full length into the tender tissue of the plant. They have been found in the petioles of peach leaves, the blossom buds of dahlias, the seed-stalks, stems and leaves of volunteer turnips and later in the season in the heads of composite plants such as daisies and asters. They hatch in about ten days. The nymphs are yellowish green to greenish, marked on the thorax with four black spots. In the older nymphs the thorax and wing-pads are variously mottled with brownish (Fig. 121). In late summer and fall the nymphs are very abundant on wild carrot, goldenrod and wild asters. There

Fig. 119. — The tarnished plant-bug, adult ($\times 4\frac{3}{8}$).

Fig. 120. — Eggs of the tarnished plant-bug in position in tender peach tip ($\times$ 11).

FIG. 121. — The tarnished plant-bug, fifth stage nymph (× 6).

are five nymphal stages, the insect becoming mature at the fifth molt. The life cycle requires from twenty-five to thirty days, and there are probably four or five generations annually.

Most of the injury to cultivated plants is caused by the feeding punctures of the adults, since most of the nymphs are to be found on weeds. In feeding, the bug punctures the plant with the sharp needle-like bristles of its beak and sucks out the juices, at the same time apparently injecting some substance poisonous to the tissue. The character of the injury varies with the nature of the plant attacked. In the case of potatoes, the injury is similar to that produced by several other insects and is known as tip-burn. This is most serious in years of drought. The bugs sometimes puncture bean pods, arresting growth at the point of injury. In the case of beets the punctures cause a curling or kinking of the leaves (Fig. 122) and in severe cases a stunting of the plants. The bugs often attack celery plants that

FIG. 122. — Beet leaf kinked by the tarnished plant-bug.

are blanching, puncture the tender stalks, producing large brown wilted spots and a blackening of the tissue at the joint. This trouble is known among celery-growers as black joint. The injury mars the appearance of the plants, lessens their market value and causes considerable loss. Cabbage, cauliflower, turnip, salsify and cucumber are also subject to attack, but serious injury to these plants is of rare occurrence.

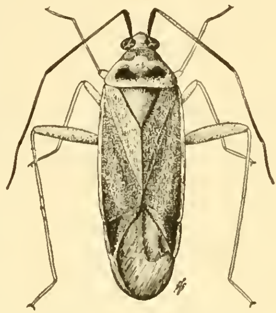

Fig. 123. — *Adelphocoris rapidus*, adult (× $5\frac{1}{2}$).

It is rarely possible to prevent attack by the tarnished plant-bug because the injury is inflicted by the adults that have developed on wild plants, common weeds that are everywhere present. They are too active to be hit by a spray and so resistant to insecticides that it is impossible to kill them without using some material that would injure the plants. Clean farming is often recommended as a means of reducing the numbers of the bugs, but under ordinary circumstances gives little if any relief.

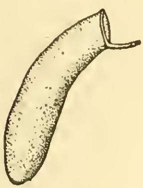

Fig. 124. — Egg of *Adelphocoris rapidus* (× 23).

Fig. 125. — *Adelphocoris rapidus*, fifth stage nymph (× 7).

Another plant-bug, *Adelphocoris rapidus* Say, is often associated with the tarnished plant-bug, feeding on potato, sugar-beets, celery and cotton. It also feeds on numerous weeds and is sometimes injurious to the fruit of the strawberry. The adult (Fig. 123) is a little over $\frac{1}{4}$ inch in length. The head, legs and prothorax are yellow; there are two black spots near the hind margin of the prothorax and the wings are dark brown except the edge, which is narrowly bordered with yellowish. The antennæ are black, broadly ringed with yellowish white.

The life history is similar to that of the tarnished plant-bug and the eggs are deposited in similar places. The egg is also similar but bears a small spine at the edge of the cap (Fig. 124). The insect passes through five nymphal stages. The nymphs are gayly colored with green, red and various shades of brown (Fig. 125) and are found abundantly throughout the growing season.

### Reference

Cornell Agr. Exp. Sta. Bull. 346. 1914.

## The Negro-Bug

*Thyreocoris pulicarius* Germar

A serious outbreak of this small black stink-bug occurred in the celery fields of Michigan in 1893, causing a loss of many thousand dollars. A similar outbreak took place in northern Ohio in 1906. It is surprising that attacks of this kind have not been more frequent, since the bugs are often abundant on their wild food plants over large areas every year. The insect ranges throughout the United States and Canada east of the Rocky Mountains southward to Florida and Arizona. The adult (Fig. 126) is about $\frac{1}{10}$ inch in length, shining black, strongly convex, short and broad, widest on the thorax and rounded behind. The scutellum is greatly developed and covers the abdomen; the exposed edge of the wing is yellowish white.

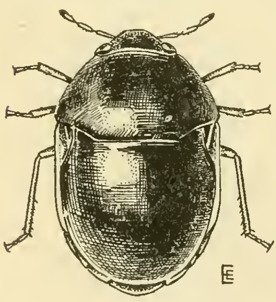

Fig. 126. — The negro-bug, adult (× 14).

The insect hibernates in the adult condition and the bugs appear on their food plants in the spring. In Illinois the eggs are laid in May and June. They are deposited singly on the leaves. The egg is $\frac{1}{40}$ inch in length, elongate, shining, light orange when first laid but deepening to bright red just before hatching. The egg has been observed to hatch in sixteen days. The older nymph is similar to the adult but has the abdomen blood-red. The nymphs become mature in July and the adults, after feeding for a few weeks, go into hibernation rather early. The insect breeds abundantly on various weeds, including beggar-ticks, tick-seed, red-root, ground-nut, great lobelia and neckweed (*Veronica peregrina?*). It has also been found injurious to corn, wheat and grass and the bugs often give an unpleasant flavor to raspberries and strawberries. There is only one brood developed annually.

The injury to celery has been caused almost entirely by the adults. They congregate in clusters at the base of the petioles on the highest stalks and suck out the sap, causing the leaves to wilt and die. Later they attack the lower leaves at the center of the plant. Celery so injured is stunted and the stalks more or less deformed, and much of it is rendered unsuitable for market.

When infesting celery, the negro-bug can best be controlled by spraying with "Black Leaf 40" tobacco extract, 1 pint in 100 gallons of water in which 5 to 6 pounds of soap have been dissolved. Much may be accomplished in preventing attack by keeping down all wild plants on which the insect may breed.

### Reference

Mich. Agr. Exp. Sta. Bull. 102, pp. 13–18. 1893.

## The Parsnip Webworm

*Depressaria heracliana* Linnæus

In growing parsnip and celery seed, much trouble is often experienced from the depredations of small greenish yellow caterpillars that web together and devour the unfolding blossom heads. The insect is widely distributed in Europe and eastern North America. It feeds on wild parsnip, wild carrot and other umbelliferous plants.

The insect hibernates in the adult stage. The small grayish moths are found under flakes of bark, in crevices, or in similar situations. The moth has an average expanse of about an inch. The front wings are brownish gray marked with interrupted longitudinal dark lines and a small black spot near the center. The hind wings are pearl-gray. Over-wintered specimens are usually much rubbed and are much lighter in appearance. The moths deposit their eggs singly in May, June and July on the leaves, stems and particularly on the sheath surrounding the flower-head. The egg is elongate, oval, pearly white, ribbed longitudinally, and about $\frac{1}{60}$ inch in length. The eggs hatch in about seven days and the young caterpillars enter the flower-buds, where they feed, webbing them together with silk. When the flower-cluster opens, the caterpillars remain in the protection of the web and continue to feed on the flowers and later on the seeds. They become full-grown in four to five weeks. The mature caterpillar is about $\frac{3}{5}$ inch in length, greenish yellow above, lighter yellow on the sides and beneath. The head, cervical shield and thoracic legs are shiny black. The body is sparsely clothed with hairs arising from small black warts.

When nearly mature, the caterpillars leave the flower-heads and burrow into the stems, usually in the axils of the leaves. After entering the stem, the caterpillar feeds for a short time and then constructs a slight cocoon of silk and excrement in which pupation takes place. The pupa is about $\frac{1}{2}$ inch in length, with a dark brown thorax and light brown abdomen. The moths emerge in about three weeks and soon go into hibernation in sheltered places.

No practical method of controlling this insect has been devised. After the flower-heads have opened, many of the caterpillars may be destroyed by spraying or dusting with an arsenical.

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Brittain and Gooderham, Can. Ent., 48, pp. 37–41. 1916.

## The Parsnip Leaf-Miner

*Acidia fratria* Loew

Sometimes the leaves of parsnip are disfigured by the mines of a small whitish maggot. This insect is never very abundant but is widely distributed throughout the whole United States and is probably identical with the European celery fly, *Acidia heraclei* Linnæus. The greenish translucent maggots are found in the leaves from May till July, where they produce blotch mines. Several larvæ occupy the same leaf and the mines coalesce. The mines are most abundant on the lower leaves or on plants grown in partial shade. When mature, the maggots are a little over $\frac{1}{4}$ inch in length. They transform to straw-colored puparia usually within the mine, and the flies emerge in about two weeks. The fly is about $\frac{3}{16}$ inch in length. The head, thorax and legs are pale yellow and the abdomen green. The wings are beautifully marked with yellowish brown curved bands. The number of generations annually has not been definitely determined.

### Reference

U. S. Bur. Ent. Bull. 82, pp. 9–13. 1909.

## The Parsley Stalk-Weevil

*Listronotus latiusculus* Boheman

This insect has been recorded as injuring parsley planted on low land in Virginia and in coldframes in Connecticut. The larvæ were found boring in the stems and roots, causing the death of the plant. This weevil breeds normally in the heads and stalks of the common arrowhead, a plant found growing in low, wet ground. Its attack on parsley was apparently more or less incidental.

### Other Carrot, Celery and Parsnip Insects

Cabbage looper: 8
Yellow bear caterpillar: 357
Spinach aphis: 105
Garden springtail: 139
Bean aphis: 76
Garden flea-hopper: 77
Spotted cutworm: 262
Striped cutworm: 270
Variegated cutworm: 276
Spotted-legged cutworm: 282
Army cutworm: 287
Army-worm: 288
Striped blister-beetle: 302
Black blister-beetle: 307
Potato flea-beetle: 314
Pale-striped flea-beetle: 321
Root-knot nematode: 338
Millipedes: 342
Wheat wireworm: 348
Slugs: 354

## CHAPTER X

### ASPARAGUS INSECTS

The important insects infesting asparagus are relatively few in number, and, like their host plant, are of European origin.

### The Common Asparagus Beetle

*Crioceris asparagi* Linnæus

This common beetle is a native of Europe and was first found in this country at Astoria on Long Island in 1860, although it had probably been present in that locality for several years. The insect has gradually extended its range until it is now widely distributed from North Carolina to Massachusetts and Canada and westward to Illinois. It was introduced into California about 1904 and is now widely spread throughout the central part of the state. It has also been reported from Colorado.

Fig. 127. — The common asparagus beetle ($\times$ 5).

The asparagus beetle (Fig. 127) is about $\frac{1}{4}$ inch in length. The head, under parts, legs and antennæ are bluish black frequently tinged with green. The tibiæ are reddish at base. The thorax is reddish usually with two black spots near the center. The markings on the wing-covers vary greatly even in specimens from the same locality. The inner margin of each wing-cover is bluish black; the outer margin and the tip are orange. The intervening space is yellowish white broken into three spots by bluish black bands which are usually connected with the inner marginal stripe. In some cases these bands are broken into spots. Sometimes the two wing-covers on the same insect are not marked alike. Variations in the pattern are shown in Fig. 128. There is a tendency in the South for the beetles to be lighter in color.

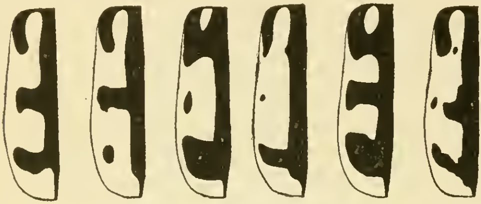

Fig. 128. — Diagram to show variations in the pattern on the wing-covers of the common asparagus beetle.

The beetles pass the winter under any convenient shelter such as piles of rubbish, under the bark of trees or in similar situations. They have often been found in great numbers in heaps of old asparagus roots where the field has been plowed up. The beetles emerge from their winter quarters at the time the young shoots are just coming up. They attack the tender tips, eating out holes and producing a brownish discoloration of the tissue. When abundant the crop may be seriously damaged. The beetles soon begin to lay their eggs on the young shoots. The egg (Fig. 129) is elongate oval, blackish brown and about $\frac{1}{16}$ inch in length. The eggs are laid on end singly or in rows from two to eight. Early in the season they are laid on the tips, but later are attached to the leaves and flower-stems. The eggs hatch in three to eight days and the young

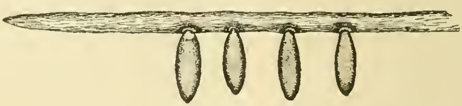

Fig. 129. — Eggs of the common asparagus beetle (× 6).

grubs begin feeding on the tender tips. The body of the newly hatched larva is gray and its head and legs are black. The grub becomes mature in ten days to two weeks. It is then about $\frac{3}{10}$ inch in length, dark gray in color, with the head and legs shining black. On the segment behind the head there are two shining black spots. The abdominal segments are provided with prolegs which are used by the grub in maintaining its hold on the plant (Fig. 130). When mature the grubs fall to the ground and there just below the surface construct a small earthen cell within which they transform to pale yellowish pupæ. Transformation to the beetles takes place in about a week, although in cool weather the pupal period may be much longer. In England the insect remains in the pupal state from fourteen to twenty days. After transformation the beetles require three or four days to harden before they are ready to make their appearance above ground. The entire life cycle requires from three to seven weeks depending on the climate. In the North there are at least two generations annually and in the South there are said to be four or five.

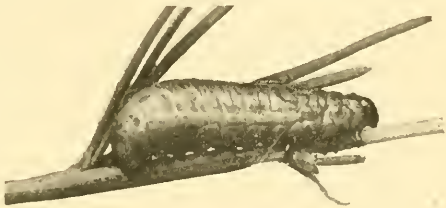

Fig. 130. — Full-grown larva of the common asparagus beetle ($\times 4\frac{1}{2}$).

In addition to the injury to the tender shoots in the spring, the beetles and larvæ seriously damage the plants after they have leafed out. Both beetles and grubs feed on the leaves and the epidermis is chewed from the stem. In this way the growth of the plants is seriously checked and the proper development of the roots is prevented. Plants stunted in this way are not able to send up large and vigorous shoots, and the size and quality of the crop are decreased. The common asparagus beetle is very troublesome in newly set beds. Frequent defoliation weakens the plants, making it difficult for them to become established.

The common asparagus beetle is held in check by a small Chalcid parasite, *Tetrastichus asparagi* Crawford, the life history of which is remarkable. The adult parasite appears in the asparagus field in the spring while the eggs of the beetle are being laid. The female inserts her eggs in those of the beetle. The beetle egg hatches and its larva, containing the larvæ of the parasite, reaches maturity, enters the ground and constructs its pupal cell but does not pupate. The parasites then complete the destruction of the host and emerge from its shriveled remains, pupate within the cell constructed by the beetle larva and later emerge as adults. From one to ten parasites have been reared from a single beetle larva.

*Methods of control.*

In asparagus fields in which the crop is being cut for market, the injury to the young shoots by the larvæ may be prevented by cutting the crop clean every three to five days. In this way all the eggs deposited on the shoots will be removed before or very soon after hatching. All volunteer plants should be destroyed but it will often pay to leave a row here and there uncut to serve as a trap on which the beetles will congregate, feed and lay their eggs. Here they may be poisoned with arsenate of lead (paste), 1 pound in 20 gallons of water, or the plants may be cut and burned, thus destroying the early stages of the beetle. After the cutting season is over, the plants may be protected from beetle injury by two or three applications of arsenate of lead (paste), 1 pound in 20 gallons of water. It is not an easy matter, however, to spray thoroughly a large field of asparagus when the plants have made a heavy growth. In newly set beds, spraying with arsenate of lead is often resorted to with satisfactory results. In this case the application should be made early in order to destroy the first brood of beetles and larvæ and thus give the plants a chance to make a strong growth early in the season.

The use of poultry for the destruction of the beetles was advised by T. W. Harris nearly eighty years ago. This method of control is still practiced with good results in some localities. The asparagus field is surrounded with a chicken-wire fence, and poultry are allowed the run of the field. Thirty or forty hens are sufficient to keep a two-acre field practically free from the beetles during the early part of the season. When the plants grow up, some of the beetles will keep out of reach and they may become abundant in the fall. It is rarely necessary, however, to resort to spraying in fields in which poultry are allowed to run. In the home garden the larvæ may be destroyed by dusting the plants with hydrated lime or land plaster.

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## The Twelve-Spotted Asparagus Beetle

*Crioceris duodecimpunctata* Linnæus

In this country, the twelve-spotted asparagus beetle (Fig. 131) was first noticed in 1881 in Maryland. It gradually spread northward, reaching New Jersey in 1892, New York in 1893 and Canada in 1898. Its range now extends from Maine to the Niagara peninsula in Canada and southward to Virginia.

This beetle is most injurious early in the season when the adults attack the growing tips and sometimes eat the buds as soon as they appear above the ground. The beetles also feed on the foliage and eat out irregular areas in the bark of the stems. The larvæ cause very little injury since they feed almost entirely inside the berries.

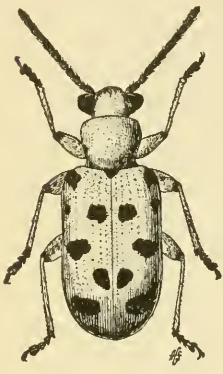

Fig. 131. — The twelve-spotted asparagus beetle (× 5).

The insect passes the winter in the adult condition, hidden away in dry, sheltered places. The beetles leave their winter quarters about a week later than the common asparagus beetle. They feed on the tender asparagus shoots in much the same way but do not deposit their eggs until about the time the plants begin to blossom or from three weeks to a month after appearing in the field.

The twelve-spotted asparagus beetle is slightly larger and more robust than the other species. Its general color is reddish orange. The antennæ, eyes, knees, tarsi and the underside of the thorax are black. On each wing-cover there are six distinct black spots. The eggs are deposited singly on the leaves of asparagus plants, usually those bearing fruit. The egg (Fig. 132) is about $\frac{1}{25}$ inch in length by $\frac{1}{60}$ inch in width and is pointedly rounded at each end. The surface is smooth, shining and without apparent sculpture. When first laid, the egg is nearly white, changing through yellow or orange to light green or brownish olive. It is attached to the leaf by one side. The eggs hatch in a week to twelve days. The young larva is about $\frac{1}{25}$ inch in length, pale yellow or orange in color, with the head, legs and a spot on each side of the first segment black. The young larva feeds

Fig. 132. — Egg of the twelve-spotted asparagus beetle (× 12).

very little if at all on the foliage but wanders about till it finds a berry, which it enters usually at the blossom end. The larva feeds on the seeds and migrates from berry to berry until full-grown. Sometimes three or four berries are attacked by a single larva. In the course of its development, the larva passes through three stages. When full-grown it is about $\frac{1}{3}$ inch in length and varies in color from light orange to brownish yellow. The legs and two spots on the prothorax are black. The larva becomes mature in three to four weeks. It then descends to the ground, where just below the surface it spins a tough silken cocoon into which particles of dirt are incorporated. In about two days after building its cocoon, the larva transforms to a yellowish pupa and in twelve to sixteen days the transformation to the adult takes place. In New York the beetles of the second brood appear in July and lay eggs for a second generation. The beetles of the next brood emerge in August and September and go into hibernation with the advent of cold weather. There are two generations annually in the North.

In Europe two other beetles attack asparagus, the fourteen-spotted and the five-spotted asparagus beetles (*Crioceris quatuordecimpunctata* and *C. quinquepunctata*). The larvæ of both species are said to feed on the foliage in much the same way as the larva of the common asparagus beetle.

*Methods of control.*

Since the larvæ live inside the berries, they cannot be reached with an arsenical poison but the beetles may be killed by spraying with arsenate of lead as suggested for the control of the common asparagus beetle.

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## The Asparagus Miner

*Agromyza simplex* Loew
(*Agromyza maura* var. *simplex* Loew)

In the present state of knowledge of this group of flies, it is impossible to indicate with any accuracy the geographical distribution of this species. There are several closely related forms in the genus Agromyza considered as distinct species by some authors and as varieties of *Agromyza maura* Meigen by others. The asparagus miner belongs to this group. As the habits and early stages of most of these varieties or species are still unknown and as it is very difficult to distinguish them from a study of the flies alone, it is at present impossible to determine the actual range of this pest. In America *Agromyza simplex* has been recorded from Massachusetts, Ontario and Illinois and southward to Georgia. It also occurs in central California. It has been reared in France and the flies have been captured in England and Germany. What is apparently the same species but determined as *Agromyza maura* was reared from asparagus in Hungary.

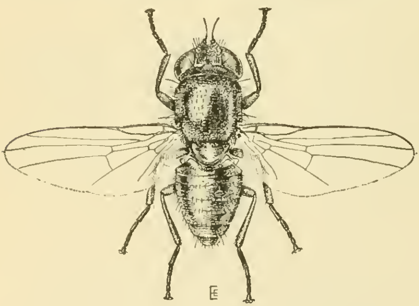

Fig. 133. — The asparagus miner, adult (× 8).

The adult of the asparagus miner (Fig. 133) is a small, metallic, black, two-winged fly, $\frac{1}{8}$ to $\frac{1}{6}$ inch in length and having an expanse of $\frac{1}{5}$ to $\frac{1}{4}$ inch. In New York the flies appear from the middle to the last of May. In about a week after emerging, the female inserts her eggs just under the epidermis of the asparagus stalk near the ground. The egg is elongate oval, slightly wider at one end and somewhat pointed at the other. It is about $\frac{1}{50}$ inch in length and when first laid is glistening white in color. The eggs hatch in twelve to eighteen days and the young maggot begins to mine just under the epidermis. At first the larva works upward, following a more or less sinuate course, but when nearly mature it turns downward towards the base of the plant. In the case of the first brood, pupation may take place aboveground but the maggots of the second generation usually work down from one to seven inches below the surface before transforming. The full-grown maggot is creamy white in color and is $\frac{1}{6}$ to $\frac{1}{5}$ inch in length. The maggots attain their growth in two or three weeks and transform into puparia within the mine. The puparium is $\frac{1}{6}$ to $\frac{1}{5}$ inch in length and brownish in color, becoming darker with age. The insect remains in this stage for two to three weeks and the flies of the second brood begin to emerge the latter part of July. The maggots of the second brood are most abundant in their mines during August but both maggots and flies are present until frost. The winter puparia are formed in late August and September. These are found under the epidermis of the stems below ground. There are two generations annually.

When, as is often the case, several maggots infest a single stem, their mines cross each other, thus girdling the shoot. Stems injured in this way take on a sickly yellowish appearance and die prematurely, thus weakening the plants to a considerable extent.

*Methods of control.*

The asparagus miner rarely does enough damage to warrant commercial growers making any serious efforts to control it, and no remedial measures satisfactory for commercial conditions have been devised. The insect causes little or no trouble in beds that are being cut, its injuries being chiefly confined to new beds. It has been recommended to pull up and burn infested stalks in the fall after frost or in the spring and thus destroy the over-wintering puparia. This is a laborious operation and, as many of the stems are broken off, enough puparia will be left to reinfest the field. It has also been suggested that the flies might be killed with a sweetened poison bait but as this method has not been tried under field conditions its value is very doubtful.

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### Other Asparagus Insects

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# CHAPTER XI

## CORN INSECTS

THE insects feeding on Indian corn are numerous, over two hundred species having been recorded as more or less injurious to some part of the plant. The roots are injured by wireworms, white grubs, corn root-worms, by the larvæ of bill-bugs and are infested by the corn root-aphis. The young plants are frequently eaten off by cutworms, the leaves riddled by flea-beetles and the crown tunneled by the stalk-borers. The unripe ears are attacked by the ear-worm, which is the most important insect infesting sweet corn. In this chapter no attempt is made to give a comprehensive account of the insects injurious to field corn; only the more important species are treated and only those most likely to attack sweet corn.

### THE CORN EAR-WORM

*Heliothis obsoleta* Fabricius

The corn ear-worm ranges throughout the United States and southern Canada, southward through Mexico and the West Indies to Argentina. In the Old World it is found throughout Africa and Europe eastward to China, India, the East Indies, Australia and New Zealand. In the southern states, this insect is a serious enemy of cotton and is there known as the cotton bollworm. Corn is the favorite food plant of this insect, serious injury to this crop being of annual occurrence from the vicinity of New York City southward east of the Appalachian Mountains; from Ohio, Illinois, Nebraska and Montana southward to the Gulf and in the warmer parts of the Far West. It occurs in the greatest abundance, however, and is most destructive in the cotton belt. From New Jersey southward, the corn ear-worm is considered the worst insect pest of tomatoes, and peas and beans are also subject to serious injury. Among tobacco-growers the insect is known as the bud-worm from its habit of boring into the roll of unopened leaves at the center of the plant. Other plants liable to more or less serious injury are okra, pepper, eggplant, pumpkin, squash, melon, cucumber, asparagus, peanut, collards and potatoes. The insect also attacks sorghum, sugar-cane, millet, cowpeas, vetch, alfalfa and clover. Its wild food plants are numerous; some of the more common are Jamestown weed, ground cherry, wild sunflower, cocklebur, bindweed, horse-nettle, velvet-leaf and hemp. Many ornamental plants are also attacked, such as gladiolus, geranium, mignonette, morning-glory and rose. When driven by hunger, the caterpillars will feed on almost any succulent vegetation they can find. Ripening fruits, such as peaches, plums and even quinces, are sometimes attacked.

Throughout the greater part of the United States and Canada, the corn ear-worm hibernates in the pupal stage, but in southern Florida some of the moths remain active during the winter. The moths emerge in early spring over a period of at least a month. The moth has an expanse of about 1½ inches. In the commonest form, the front wing is straw-color, usually marked with a spot in the middle and frequently with a darker area near the tip. The spots may be entirely lacking or the wing may be heavily shaded with brown, and the wings are sometimes tinged with reddish or greenish. The hind wings are creamy white with a diffuse blackish border containing a pale spot and there is usually a dark spot near the middle of the wing. The flight of the moths is low, swift and irregular. They lay their eggs mostly on dark days or at dusk. The eggs are deposited singly on the leaves and stems of tomato, tobacco and cotton, and on the leaves, tassels and silk of corn, the last being preferred above all others for oviposition. Each female is capable of laying from 500 or 600 to over 2500 eggs. The egg (Fig. 134) is a little less than $\frac{1}{30}$ inch in diameter, waxy white, faintly tinged with yellowish, nearly globular, with the base flattened and the tip depressed. The surface is marked with a series of ridges radiating from the tip. The first moths usually appear in the spring and are ready to lay their eggs before corn is available. Under such circumstances, eggs are deposited on early tomatoes, peas and beans. The time required for the hatching of the eggs varies with the temperature. In April they hatch in about a week, in the summer in two or three days and in the late fall in two weeks or over. The newly hatched larva is a little over $\frac{1}{25}$ inch in length, nearly white, with the head and cervical shield black and the body marked with numerous small black tubercles. In the course of its development, the caterpillar usually passes through six stages but sometimes may pupate after the fifth stage. In the spring the caterpillars reach maturity in about a month; in the summer, in from eleven days to three weeks, and in late fall, the larval period is again lengthened with the decreasing temperature. The corn ear-worm belongs to the same family as the cutworms and resembles them in general appearance. The full-grown caterpillar (Fig. 135) is $1\frac{1}{2}$ to 2 inches in length, varying from light green to brown. The coloration is highly variable but the caterpillar is usually marked with longitudinal stripes, the most distinct one being a pale stigmatal stripe edged above with blackish. There is a dark stripe along the

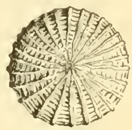

FIG. 134. — Egg of the corn ear-worm (× 30).

middle of the back divided by a narrow white line. The corn ear-worm might be mistaken for an army-worm of the summer brood, which it somewhat resembles, but may be distinguished by the granulose skin which under the microscope appears as if studded with minute hob-nails.

When mature, the caterpillar leaves its food plant, descends to the ground and burrows into the soil in a slanting direction to a depth of two to seven inches, leaving the passage filled with loose earth. It then constructs a tunnel almost to the surface of the ground for the emergence of the moth. This tunnel is lined with compacted soil and a thin layer of silk. After completing the exit tunnel, the larva retreats to the enlarged lower part of the burrow and there transforms to a pupa. The pupa is smooth, brownish, $\frac{3}{4}$ to nearly 1 inch in length and usually rests in a slanting position with the head upward. Pupæ formed by the summer broods are usually found nearer the surface than those which winter over. The period passed in the pupal stage varies with the season. In the summer it is about two weeks and in the fall three weeks or more. The number of generations produced annually varies with the length of the season. Throughout the cotton belt there are probably four generations and sometimes a few moths of a fifth brood may emerge. In southern Texas and Florida seven generations may develop. In New Jersey and in other northern localities where the insect is a serious corn pest, only two or three generations occur. Farther north there is probably only one brood. After the first generation, the later ones become badly mixed, owing to the overlapping of broods caused by the irregular emergence of the moths, and the unequal

Fig. 135. — The corn ear-worm, dorsal view (natural size).

development of individuals. The later generations are only partial, owing to the fact that some of the pupæ of these broods do not transform until the following spring.

As a rule, tomatoes are most seriously injured by the corn ear-worm early in the season. At this time corn is not large enough to be attractive to the moths and they are forced to lay their eggs on tomato. The young larvæ feed slightly on the leaves and may sometimes even burrow into the stem of the plant, killing it down to the point reached by the larva. The injury, however, is greatest to the fruit. The caterpillars bore into tomatoes of all sizes. A caterpillar does not, as a rule, remain long in one fruit but as soon as decay sets in leaves it, often entering several fruits in succession. It is not unusual in the South for half or more of the crop to be destroyed in this way. In New Jersey the injury is confined mostly to the early crop, but in Florida the attack may continue throughout the season.

Peas and beans are often attacked by the corn ear-worm when corn is not available. The caterpillars bore into the pods and devour the seeds and may sometimes tunnel in the stems as well as feed to some extent on the foliage. Cucumber, squash, melons and pumpkin are sometimes injured, the larvæ boring in the stems, and even entering the fruit.

Corn may be attacked while still quite small. The eggs are deposited on the leaves and the caterpillars eat out irregular holes, especially in the tuft at the center of the plant. The moths begin depositing eggs in the silk as soon as it appears. On hatching, the young caterpillar usually devours its egg-shell and then works its way through the silk and in about twenty minutes reaches the tip of the ear, having fed very little if at all during this time. It then begins feeding on the silk and after a time burrows down under the husk, continuing to feed on silk and the unripe kernels (Fig. 136). The injury may extend halfway down the ear. The injured kernels and the excrement left by the larva in its burrow under the husk serve as an excellent medium for the growth of various molds and bacteria, which greatly augment the injury inflicted by the insect. As many as six larvæ sometimes infest an ear but usually only two or three are present, in spite of the fact that normally a much larger number of eggs are deposited on each mass of silk. This is to be accounted for by the cannibalistic habits of the caterpillars. They feed voraciously not only on each other but on any other caterpillars that come in their way.

Fig. 136. — Two full-grown ear-worms on the tip of an ear of field corn (natural size).

Both field and sweet corn are subject to attack but the latter seems to be preferred by the insect. The loss to field corn is not so great because the uninjured kernels can be used, but in the case of sweet corn good prices cannot be obtained for wormy ears. The pest is most destructive in the latter part of the season, owing to the greater number of moths in the later broods. In the last crop of corn in the vicinity of New York, sometimes nearly every ear is infested, while the earlier plantings may be practically free. In many parts of the South, it is impossible to raise a clean crop of sweet corn because of the depredations of this insect. When full-grown, the caterpillar leaves the ear, usually by gnawing a round hole through the husk, but in some cases it may escape at the tip. Sometimes the larvæ desert the ear when only partly grown and migrate to other ears on the same or nearby plants. In the cotton belt the later broods of caterpillars produced after corn has become hard are to be found mostly on cotton. In Iowa and Nebraska, late brood caterpillars have been found on alfalfa and clover.

*Control.*

No practical method of controlling the corn ear-worm on field corn has yet been discovered. Experiments in New Jersey have shown that the injury to sweet corn may be greatly decreased by dusting the silk with a mixture of 50 per cent powdered arsenate of lead and 50 per cent finely ground sulfur. The first application should be made soon after the silk appears, followed by one or two others before the corn is ready to pick. Dust can be applied most conveniently by means of a small hand bellows carried under the arm and equipped with a piece of rubber hose about two feet long attached to the outlet by which the dust is directed downward into the tip of each ear.

When sweet corn is grown for the cannery, early planting is advisable, but cannot be practiced when corn is grown for the market because for this purpose a succession covering as long a period as possible is required. Much benefit may be derived from fall or winter plowing land on which an infested crop has been grown in order to destroy the pupæ. As large an area as possible should be included in this treatment as the moths are capable of flying a considerable distance.

The injury to tomatoes may be in part prevented by spraying the vines with arsenate of lead (paste), 4 to 6 pounds in 100 gallons of water, making one or two applications before the fruit is half grown. Later applications are likely to stain the fruit. Injured tomatoes should not be left in the field but should be picked along with the others, sorted in the packing-house and should then either be buried or dumped into a pond.

Tomatoes can also be partially protected from the corn earworm by using corn as a trap crop on which, in preference to the tomatoes, the moths will lay their eggs. Two rows of corn should be planted for every ten or twenty rows of tomatoes and so timed as to come into silk when the first tomatoes are forming. It should be cut and destroyed before the caterpillars reach maturity.

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## The Corn Root-Aphis

*Aphis maidi-radicis* Forbes

Although the corn root-aphis is generally distributed throughout the United States east of the 100th meridian, it is most injurious in the corn belt and in New Jersey, Delaware and eastern Pennsylvania. In the South Atlantic states, it has proved a troublesome pest of cotton and has also been known to infest the roots of cultivated asters in Illinois. There is some doubt as to many of the wild food plants of the corn root-aphis because of confusion with a similar species, *Aphis middletoni* Thomas, often found on the roots of certain wild plants such as asters and Erigeron. It is, however, definitely recorded from smartweed, knotweed, crab-grass, purslane, dock, foxtail, fleabane, mustard, sorrel, plantain, pigweed, great ragweed, thorny amaranth, green amaranth, Roman wormwood, dog fennel, shepherd's purse, lamb's quarters, poverty weed, buttonweed, purplish cudweed, sneezeweed, pineweed, dwarf dandelion, pepper-grass, toadflax, mild water pepper, cocklebur, vervain, common nightshade, skullcap, *Teucrium laciniatum*, *Leptochloa filiformis* and *Mentha arvensis*.

The corn root-aphis has been studied most carefully in Illinois. The insect passes the winter in the egg stage in the care of a little brown ant, *Lasius niger americanus* Emery. The ants tend the aphids in much the same way as man cares for domestic animals, being very fond of the sweetish liquid, known as honeydew, secreted by them. This aphis has become so dependent on the ants for the care of the winter eggs and for placing the young lice on the roots of their food plants that they would doubtless all perish were there no ants present to attend them. The eggs are stored in the ants' nest, where they are protected by the workers as carefully as are the young of their own species. Sometimes in warm days in early spring, the ants carry the eggs to the upper galleries of the nest or even lay them out in the sunshine and carry them back at night. This is probably done in order to keep the eggs in good condition and to hasten their hatching. In central Illinois the eggs begin to hatch in early April, just as the smartweed, pigeon-grass and ragweed plants are coming up. The young aphids are carried by the ants and placed on the roots of these weeds. Here they are attended by the ants, whose burrows are extended to include the roots. The young aphids pass through four nymphal stages in the course of their growth and reach maturity in about nineteen days, on the average, in Illinois. As the eggs hatch over a considerable period, usually from early April to the last of May, the last nymphs hatched will find themselves surrounded by representatives of three generations. All the individuals of the first generation are wingless but in the later generations there is a varying percentage of winged forms produced. The latter occur in greatest numbers when the roots are crowded and food is scarce. The winged forms leave the roots, come to the surface and take flight, seeking new feeding grounds.

During the summer only two forms of the aphids occur, wingless and winged viviparous females; males and egg-laying females are not produced till October or November and constitute the last generation of the season. From eleven to twenty-two generations are produced annually, each female giving birth to nearly fifty young. With the advent of cool weather, wingless egg-laying females and wingless, or rarely winged, males are produced. The small black eggs are deposited underground in the galleries of the ants where they are cared for till the following spring. The full-grown viviparous female (Fig. 137) is about $\frac{1}{12}$ inch in length, bluish green, dusted with a whitish waxy pulverulence. The head and transverse bands on the thorax are black. In the winged form, the head and thorax are black or dark brown and the abdomen is pale green with three distinct black spots on each side (Fig. 138).

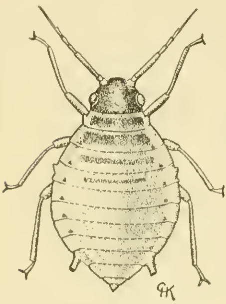

FIG. 137. — Wingless viviparous female corn-root aphis (× 13).

By the time the corn is planted and comes up, the aphids have become crowded on the roots of the weeds and many winged forms have developed. At this time the weed roots have become hardened and are thus less favorable for the development of the lice. The ants transfer many of the wingless

FIG. 138. — Winged viviparous female corn-root aphis (× 16).

aphids from the weeds to the corn roots and also seize any of the winged migrating forms that come their way and carry them down to the roots. In this way the corn soon becomes badly infested. The injury is ordinarily first noticed in irregular patches usually on the lower ground. The loss of sap caused by the feeding of the aphids lessens the vitality of the plant, causing the leaves to turn yellowish or reddish. The aphis is most destructive in years of drought because under such conditions the plants are least able to bear the loss of sap. Corn plants badly stunted by the root-aphis often fail to bear ears or produce only nubbins.

*Control.*

Experiments and the experience of practical corn-growers in Illinois have shown that the losses caused by the corn root-aphis may be in large measure prevented by plowing land intended for corn to a depth of six or seven inches early in the spring followed by thorough and repeated disking to break up the ants' nests and scatter the eggs of the aphis. This treatment also destroys the weeds on which the root-lice get their start. It also puts the soil in good tilth, making possible a strong and rapid growth of the corn. Corn is most likely to be injured by the root-aphis when the crop is grown on the same land for two successive years. Much injury may, therefore, be avoided by adopting a rotation in which corn does not follow corn. As a supplementary treatment, S. A. Forbes recommends the use of oil of tansy applied to each hill as a deterrent for the ants. One fourth pound of oil of tansy and 1 gallon of wood or denatured alcohol is mixed with 100 pounds of bone-meal. This is enough for an acre and should be applied with a fertilizer dropper attached to the planter. Careful preparation of the soil and thorough cultivation will tend to make the plants able to outgrow injury by root-lice.

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## The Southern Corn Root-Worm

*Diabrotica duodecimpunctata* Fabricius

The southern corn root-worm is also known as the twelve-spotted cucumber beetle and in the South as the corn bud-worm from the habit of the larvæ of killing the bud or central leaves of the young corn plant. The beetle is generally distributed throughout the United States and southern Canada east of the Rocky Mountains southward to Florida and Mexico. It is injurious to corn from southern Illinois to Virginia and southward.

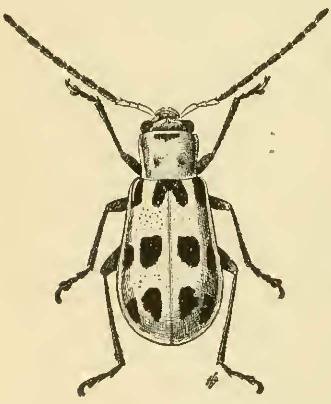

Fig. 139. — The southern corn root-worm beetle (× 5).

The beetle (Fig. 139) is about ¼ inch in length, with the head black and the thorax and wing-covers yellowish green. Each wing-cover is marked with six black spots arranged in three transverse rows. The antennæ and legs are black; the first three joints of the antennæ and basal half of the femora are pale. The beetles hibernate under any convenient shelter, often in alfalfa fields. In the

South they are dormant only for a few days at a time during periods of cold weather, and in southern Florida and Texas the beetles are active throughout the winter. The adults feed on a great variety of plants both wild and cultivated. They are often found in the blossoms of squash, pumpkin, melon and cucumber, feeding on the pollen. They also attack seedling cucurbits in much the same way as the striped cucumber beetle and often gnaw holes in the fruit. They sometimes seriously injure young beans, peas, cabbage, cauliflower, kale, turnip, mustard, rhubarb, asparagus, eggplant, potato, tomato and beet and there is a record of their being destructive to spinach in New Mexico. The beetles are often found in the spring feeding on the blossoms of fruit-trees and later in the season on the flowers of cotton and on the silk of corn, but they are probably most abundant on the flowers of various wild plants such as goldenrod, wild sunflower and many others. The larvæ are found most abundant on the roots of corn but they also attack the roots of bean, rye, wheat, millet, alfalfa, southern chess, barnyard-grass, Johnson-grass, golden glow, Jamestown weed and pigweed (Amaranthus).

The beetle deposits her eggs in early spring in cracks and crevices of the ground around the base of the plant. A single female has been known to lay over 500 eggs, but the average is probably much less. Only a few days are required for the beetle to lay her full complement of eggs, but as all the beetles do not mature at the same time, egg-laying will continue over a period of a month or more. The egg is dull yellow, oval and about $\frac{1}{40}$ inch in length. The eggs hatch in a week to over three weeks and the young larva begins feeding on the roots. In the case of young corn plants, the grubs often enter the stalk near the upper circle of roots, killing the bud or inner leaves, or they may eat out irregular holes in the root, often severing them from the plant. The injury is usually most severe to corn growing in low wet land. The larva becomes mature in fifteen to thirty-five days. It is then a slender grub, about ½ inch in length, whitish or yellowish in color with the head and cervical shield brownish. When full-grown, the larva leaves the plant and constructs a small earthen cell within which it transforms to a small whitish pupa, the beetles emerging in one to two weeks. Throughout the greater part of the insect's range, there are two generations annually. In the extreme South where the beetles are active during the entire year, an additional generation may develop. The larvæ of the second generation are not so injurious to corn as those of the first but they sometimes injure the roots so that the plants are easily blown over by storms and in some cases ripening is delayed and the size and quality of the crop reduced.

In the southwest, a variety of the southern corn root-worm has received the name of *tenella* Leconte. In this form the spots on the wing-covers are greatly reduced in size and the posterior ones may be entirely lacking.

*Control.*

Injury to corn by this insect may be in large measure prevented by planting late, after the beetles have deposited most of their eggs. Corn planted the first of May in Alabama will usually escape injury. Farther north the corresponding date would be somewhat later. In the case of sweet corn when it is desirable to plant the crop early, it is often possible to get a good stand in spite of the root-worms by planting an excess of seed. A rotation of crops has not proved of much value in preventing injury because the beetles are good fliers and readily find their way to corn fields for egg-laying. Since the injury to corn is usually most severe on low wet land, tile drainage is often the most practical method of solving the problem.

When attacking cucumbers, squashes and melons, the beetles may be controlled by the measures suggested for the striped cucumber beetle on page 111.

### References

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Quaintance, U. S. Div. Ent. Bull. 26, pp. 35–41. 1900.
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## The Western Corn Root-Worm

*Diabrotica longicornis* Say

The western corn root-worm is also known as the northern corn root-worm, neither name being especially appropriate; the former because there is no eastern corn root-worm and the latter because the species also occurs in the South. Although the insect ranges from Nova Scotia to Dakota and southward to Alabama and Mexico, it has been noticeably destructive to corn only in the specialized corn-growing region from Ohio to Nebraska and Kansas. The winter is passed in the egg stage in the ground, usually in fields in which corn grew the preceding year. The egg is about $\frac{1}{40}$ inch in length, oval and dirty white in color. The eggs are deposited by the beetles in late summer or fall in the ground within a few inches of the corn plant. The female burrows into the soil for oviposition and deposits her eggs in loose groups from three or four to eight or ten. The eggs hatch in the spring over a considerable period and the larvæ soon find their way to the roots of the young corn plants in case the field is again planted to this crop. They feed on the smaller roots and tunnel out the larger ones, making a slightly sinuate burrow on the side of the root just below the surface. Many of the roots are killed in this way and by the decay that often accompanies the injury. After destroying one root, the grub often attacks a second but as a rule does not burrow into the crown. As far as known, corn is the only food plant of the larvæ, but it is probable that they also feed on the roots of broom corn and sorghum. The injury to the roots inflicted by the grubs, if severe, may cause the plants to remain dwarfed and sickly or may merely weaken them so that few or imperfect ears are produced. When many of the roots have been destroyed, the corn is likely to be blown over by the wind. The larvæ mature from late June to late August. They are then elongate, slender, whitish grubs with the head, cervical shield and anal plate yellowish brown and are about $\frac{2}{5}$ inch in length. When full-grown, the larva leaves the root and transforms within a small earthen cell to a whitish pupa. The beetles of the new brood emerge over a long period, from about the first of July until September. They are about $\frac{1}{5}$ inch in length and grass-green in color with the antennæ brownish, paler towards the base (Fig. 140). In Illinois the eggs are mostly laid between the first of August and the early part of October. There is only one generation annually. The beetles feed on the pollen and silk of corn and are often found on the blossoms of buckwheat, goldenrod, smartweed, thistle and many other wild plants as well as in the flowers of cucurbits. They sometimes gnaw into the unripe kernels of corn where the husk has been broken and have been known to gnaw holes in the rind of pumpkin and squash and to feed on the leaves of radish and turnip.

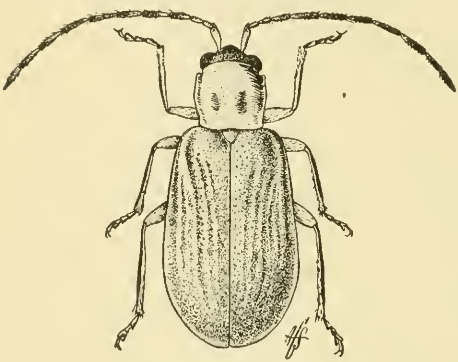

Fig. 140. — The western corn root-worm beetle (× 8).

*Control.*

Owing to the eggs of the western corn root-worm being deposited only in corn fields, injury may be avoided by not planting land to corn for more than two years in succession.

### References

Forbes, 12th Rept. Ill. State Ent. for 1882, pp. 10–31.
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## The Colorado Corn Root-Worm

*Diabrotica virgifera* Leconte

In Colorado, sweet corn is sometimes seriously injured by a larva similar to that of the southern corn root-worm that burrows into the stalk below ground. The female beetle is $\frac{1}{5}$ inch in length and closely resembles the striped cucumber beetle in general appearance, but in the male the wing-cover is black except for a narrow yellow margin and a yellow spot near the tip. The beetles are often troublesome in vegetable-gardens where they feed on a variety of plants. The eggs are pale yellow and about $\frac{1}{40}$ inch in length. They are laid in the fall in the ground near the corn plants and do not hatch till the following spring. The larva is a little less than $\frac{1}{2}$ inch in length, pale yellow, with the head and anal plate black. The insect is apparently single brooded in Colorado.

Injury by this species may be prevented in large measure by not growing corn for successive years on the same land.

### Reference

Gillette, Jour. Econ. Ent., 5, pp. 364–366. 1912.

## The Larger Corn Stalk-Borer

*Diatræa zeacolella* Dyar

In the southern states northward to Kansas and Maryland, corn is sometimes attacked by a whitish caterpillar marked with dark brown spots. This insect is closely related to the sugar-cane borer and until recently the two have been considered the same. These caterpillars bore into the stalks of young corn, causing the plants to become dwarfed and distorted. They often bore through the unopened leaves, producing groups of small holes symmetrically arranged on the two halves of the expanded leaf. The larvæ of the second generation burrow into the stalks below the second or third joint, weakening them so that the plants are easily blown over by the wind. The insect hibernates as a full-grown larva in a burrow in the tap-root below the surface of the ground. Pupation takes place in the spring within the burrow and the moths emerge in ten days or more. The straw-yellow moth, with an expanse of 1 to $1\frac{1}{4}$ inches, lays her eggs in clusters of two to twenty-five, either on the lower or more rarely on the upper side of the leaves of the young corn. The egg when first laid is creamy white, gradually changing to orange-brown, flattened, oval, slightly convex and about $\frac{1}{30}$ inch in length. In the cluster the eggs overlap and are usually arranged in two, three or four rows. The egg hatches in a week to ten days and the young caterpillars at first feed on the upper leafy part of the young plant but soon bore down into the stalk. There is considerable migration of the caterpillars from plant to plant and a borer may leave the stalk at one place only to re-enter at another point. The caterpillars mature in twenty to thirty days. The full-grown larva is about an inch in length, dirty white, usually marked with numerous dark brown spots. When about to pupate, the caterpillar cuts through the stalk an exit hole for the moth which is covered with silk and the burrow is plugged below with a mass of frass. The shining brown pupa is nearly an inch in length. The moths of the second brood emerge in six to ten days and lay eggs for another brood of larvæ. These borers riddle the stalks near the base with numerous burrows and when mature descend to near the surface of the ground, where they usually remain in the larval condition till the following spring. These hibernating larvæ are nearly pure white, the brown spots having disappeared. There are apparently only two generations annually.

*Control.*

The most practical measure so far suggested for the control of this insect is the adoption of a proper system of crop rotation. In this system corn should not follow corn. When it is necessary to plant corn after corn, the stalks and stubble should be raked up and burned before the moths emerge in the spring.

### References

Comstock, U. S. Ent. Rept. for 1880, pp. 243–245. 1881.
Howard, Insect Life, IV, pp. 95–103. 1891.
U. S. Farm. Bull. 634. 1914.
Holloway, Jour. Agr. Research, VI, pp. 621–625. 1916.

## The Lesser Corn Stalk-Borer

*Elasmopalpus lignosellus* Zeller

In the southern states, corn, sugar-cane, cowpea, bean and peanut are sometimes attacked by a small greenish, brown-striped caterpillar that burrows in the stalk at or just below the surface of the ground. It is most injurious on thin sandy or gravelly land. The insect has also been recorded as infesting crab-grass and Johnson-grass. It ranges from Maine along the coast to Pennsylvania westward to Iowa, Texas and southern California and southward to Patagonia.

Hibernation takes place in three stages: larva, pupa and adult. In South Carolina the insect usually enters the winter in the larval state but may transform to a pupa before spring. The egg is greenish white to reddish, ovate, about $\frac{1}{36}$ inch in length. The time and method of depositing the eggs in the field have not been recorded. The eggs hatch in about three days in the summer and in five days to a week in the fall. The caterpillars burrow into the young corn plant near the surface of the ground and kill the central tuft of leaves, often causing the plant to die or leaving it in a dwarfed, deformed condition, incapable of bearing a crop. The larva becomes mature in two or three weeks, depending on the season. In the late fall it may require nearly six weeks to reach maturity. In the course of its growth, the larva molts from four to six times. When full-grown, it is about $\frac{2}{3}$ inch in length, greenish in color, whitish above and the body is marked with nine narrow longitudinal brownish stripes and crossed by a broad brown band on the posterior margin of each segment. The head and cervical shield are shining dark brown, with a pale line running over the top of the head and crossing the shield. The larvæ do not remain in their burrows in the plant except when feeding but are usually found in a thin silken tube, in which bits of excrement and grains of sand are incorporated, attached to the side of the plant just below the surface of the ground. In feeding on the older corn plants, they not only burrow into the stalk but also girdle the plant, causing it to break over easily. Several larvæ may infest a single plant. When mature they construct oval silken cocoons covered with particles of sand and dirt in which they transform to brownish pupæ about $\frac{1}{3}$ inch in length. The moths emerge in one to three weeks, depending on the temperature. The moth has an expanse of $\frac{5}{8}$ to 1 inch. In the male the front wings are light brownish yellow, usually dark gray on the margins with two or three small dark spots on the disk. The hind wings are whitish, edged with light brown. In the female the front wings are darker, sometimes nearly black but forms occur in which they are reddish. The moths are inactive, feign death when disturbed, and fall to the ground with wings and antennæ drawn closely to the body. Their flight is swift but of short duration. There are apparently four generations annually in South Carolina.

The injury caused by the lesser corn stalk-borer may be prevented in part by clearing the field of crop remnants in the fall and by plowing the land in late fall or early winter to destroy the insects in their winter quarters. In some cases early planting will cause the crop to escape serious infestation.

### References

Riley, U. S. Ent. Rept. for 1881 and 1882, pp. 142–145.
U. S. Div. Ent. Bull. 23, pp. 17–22. 1900.
U. S. Dept. Agr. Bull. 539. 1917.

## The Brown Fruit-Chafer

*Euphoria inda* Linnæus

The ears of sweet corn are sometimes injured in the fall by a thick-set, yellowish brown beetle $\frac{1}{2}$ inch or more in length. Its wing-covers are sprinkled all over with small, irregular black dots. These beetles appear in late summer or early fall and feed on the pollen of flowers, ripe fruit and corn in the milk. They attack the tip of the ear, working down under the husk and devouring the unripe kernels. After feeding for some time, they go into hibernation and very early the next spring may be seen flying close to the ground with a loud buzzing sound.

The female deposits her white, nearly spherical eggs in the vicinity of manure heaps, in piles of rotting sod and other decaying vegetable matter. When full-grown the larva is somewhat over an inch in length, strongly curved and dirty white in color; the posterior part of the body has a dull leaden hue from the contents of the alimentary canal. It differs from the white grub (Lachnosterna) in its shorter and more robust form, in the shorter legs and smaller head, and in its habit of crawling on its back. In July the larvæ pupate within earthen cocoons of a somewhat angular external form. The beetles emerge during August and September. There is only one generation a year.

Hand-picking of the beetles is apparently the most practicable means of controlling this insect when it is found working on sweet corn.

## Stink-Bugs

Two species of stink-bugs, *Euschistus variolarius* Palisot de Beauvais and *E. euschistoides* Snellen van Vollenhoven, sometimes injure sweet corn by puncturing the kernels through the husk. They suck out the juice, causing the kernels to become sunken or to pop open. The injured kernels become infected with mold.

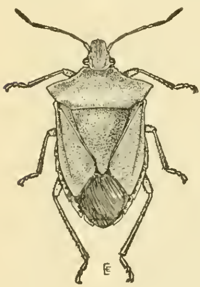

Fig. 141. — *Euschistus variolarius*, adult (× 2).

These stink-bugs are about ½ inch in length, dull grayish brown, sometimes tinged with reddish or greenish and dotted with numerous black punctures. In *E. variolarius* (Fig. 141) the sides of the prothorax are acutely pointed, while in *E. euschistoides* (Fig. 142) they are rounded. In the male of the former, there is a distinct black spot on the underside of the last abdominal segment.

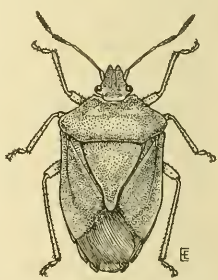

Fig. 142. — *Euschistus euschistoides*, adult (× 2).

The first mentioned of these bugs has also been recorded as injuring tobacco, raspberries, peaches and strawberries. It has been known to puncture ripening tomatoes and the stems of melon, asparagus and the pods of okra. The adults are to be found throughout the summer and the insect is said to hibernate in this stage. The life history of each species has not been fully recorded.

These stink-bugs are most abundant on corn and tomatoes raised in the vicinity of waste land grown up to rank weeds.

### Other Corn Insects

Potato flea-beetle : 314
Pale-striped flea-beetle : 321
Smartweed flea-beetle : 323
Western cabbage flea-beetle : 327
Desert corn flea-beetle : 334
Millipedes : 342
Slugs : 354
Wheat wireworm : 348
Sugar-beet wireworm : 349
Corn and cotton wireworm : 349

# CHAPTER XII

## SWEET POTATO INSECTS

The sweet potato in the United States is not, as a rule, subject to serious injury by insects, except in limited areas where the weevil has become established. When the plants are just set out, they are likely to be attacked by flea-beetles (see page 332) and by tortoise beetles. In Florida the late crop is often seriously injured by the sweet potato white-fly.

### The Tortoise Beetles

Sweet potato vines are subject to injury soon after transplanting by several species of tortoise beetles that eat out more or less circular holes in the leaves. These leaf-beetles are flattened below and convex above and have the margins of the prothorax and wing-covers broadly expanded and more or less semi-transparent, giving the insect a regularly oval outline. The head is concealed under the expanded margin of the prothorax. The beetles have a striking resemblance in form to miniature turtles — hence their common name. The larvæ are sometimes known as peddlers from their habit of carrying their cast skins and excrement in a pack over the back supported on two long spines arising at the posterior end of the body. Along the edge of the body is a row of rather large branched spines.

In New Jersey, the beetles appear on the sweet potato plants as soon as they are transplanted in late May or early June and, after feeding for a time, lay eggs from which a new brood of beetles is produced in July. The new beetles feed for a short time and then go into hibernation. There is only one generation a year, at least in the northern states.

*The striped tortoise beetle, Cassida bivittata* Say

This is the commonest and most injurious species attacking sweet potatoes in New Jersey and is widely distributed throughout the regions in which this crop is grown in the eastern United States. The beetle (Fig. 143) is about $\frac{3}{16}$ inch in length; the prothorax is reddish with the margin yellowish; the wing-covers are dull yellow marked with five longitudinal black stripes; the underside of the body and the legs are dark brown or black. The beetles appear in the field in early spring and feed for a time on wild morning-glory and attack the sweet potato plants as soon as they are set out in the field. The eggs are glued to the underside of the leaves singly and hatch in a few days. The larva is yellowish white with a grayish longitudinal line along the middle of the back. This larva differs from the other species infesting the sweet potato in not mixing excrement with the cast skins carried on the anal fork. This appendage is not carried close to the back but is usually elevated at an angle of about 45 degrees. When full-grown, the larva attaches itself to the leaf by the tip of its body and, after resting for two days, the larval skin splits along the back and is pushed back towards the hind end of the body where it is retained surrounding the point of attachment. When fully colored, the pupa is dull brownish and may be distinguished from the other species by the elongate whitish mass of cast skins on the anal fork which still adheres to the insect. The beetles emerge in July and after feeding a short time on the leaves of sweet potato and wild morning-glory go into hibernation early.

Fig. 143. — The striped tortoise beetle ($\times$ 5).

*The black-legged tortoise beetle, Cassida nigripes* Olivier

This beetle (Fig. 144) is a little over $\frac{1}{4}$ inch in length. When at rest in the sunshine, it is of a beautiful golden tint but loses its brilliancy when disturbed and after death fades to a yellowish brown. Each wing-cover is marked with three black spots arranged in a triangle. The legs and the tip of the antennæ are black. The eggs are laid in rows of three to twelve on the stems of the plant. The larvæ are bright straw-yellow with a curved black mark on each side of the prothorax. The spines along the side of the body are tipped with black. The anal fork is carried close to the back and the excrement is arranged in a characteristic manner with long shreds extending out sidewise. The pupa is dark brown with the lateral spines transparent white. The larvæ reach maturity in about two weeks and the pupal period is nearly as long.

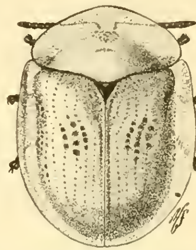

FIG. 144. — The black-legged tortoise beetle (× 5).

*The golden tortoise beetle, Coptocycla bicolor* Fabricius

When basking in the sunshine, this beetle has been likened to a drop of molten gold; the coloration becomes duller, however, when the insect is disturbed or in cloudy weather and after death fades to a light reddish brown. The scientific name, *bicolor*, was apparently given because of the contrast between the golden central part of the body and the thin semi-transparent margin. The beetle (Fig. 145) is a little over $\frac{3}{16}$ inch in length. The eggs are glued singly to the underside of the leaf. The egg is about $\frac{1}{25}$ inch in length, dirty white in color, rounded below, ridged on the sides above and is usually armed at one end with three sharp diverging spines. The

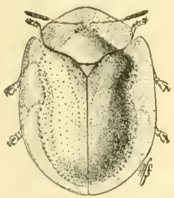

FIG. 145. — The golden tortoise beetle (× 5).

larva is dark brown in color, lighter on the back and is completely covered by the large mass of excrement carried on the anal fork. The larva becomes mature in about eighteen days and transforms to a brown pupa with three dark stripes on the transparent prothorax. The covering of excrement is retained during the pupal period, which lasts a week to eleven days. In addition to sweet potato and wild morning-glory, this insect occasionally feeds on bittersweet.

*The mottled tortoise beetle, Coptocycla signifera* Herbst

This beetle (Fig. 146), which is about $\frac{1}{4}$ inch in length, is readily distinguished from the others feeding on sweet potato by having the disk and the front margin of the wing-covers black, mottled with gold or yellow. The disk of the prothorax is black and contains two yellow spots. The larva is green in color, bluish along the back. The excrement is arranged on the anal fork in broad masses, sometimes with shreds extending from the sides. The larva becomes mature in about sixteen days and transforms on the leaf to a green pupa marked with a conspicuous black ring around the first abdominal spiracle. This species is not confined to sweet potato and wild morning-glory but also attacks buckeye and thorn.

Fig. 146. — The mottled tortoise beetle ($\times$ 4).

*The argus tortoise beetle, Chelymorpha argus* Herbst

This species has been reported as occasionally attacking the sweet potato. It is $\frac{5}{16}$ to $\frac{7}{16}$ inch in length and varies in color from brick-red to clay-yellow. The wing-covers are marked with thirteen black spots and the prothorax usually with six, arranged in two rows. It has also been reported as feeding on milkweed, sunflower, wild morning-glory and horse-radish.

*Control.*

Tortoise beetles are readily killed by spraying the vines with arsenate of lead (paste), 2 pounds in 50 gallons of water, taking care to spray the mixture on the underside of the leaves. The young plants may also be protected from injury by dipping them in a mixture of arsenate of lead and water as recommended for the control of the sweet potato flea-beetle on page 333.

REFERENCE

Walsh and Riley, Am. Ent., 1, pp. 234–238. 1869.

## THE SWEET POTATO WEEVIL

*Cylas formicarius* Fabricius

This highly destructive pest of the sweet potato is a native of the tropics. It was first seen in the southern United States in 1875 and now occurs from Georgia and Florida westward along the Gulf of Mexico into Texas. The insect is also found in India, Australia, Cochin China, Java, Madagascar and the West Indies. The adult is a slender snout-beetle about $\frac{1}{4}$ inch in length (Fig. 147). The head is dusky black; the prothorax and legs are reddish and the wing-covers a metallic bluish black. The prothorax is strongly constricted near the hind margin; the snout is stout and is carried projecting forward. The beetles are decidedly ant-like both in form and coloration. While they possess functional wings, they rarely use them, but are sometimes attracted to lights.

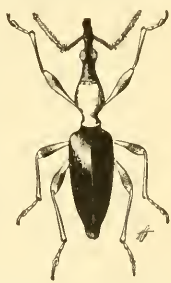

FIG. 147. — The sweet potato weevil ($\times 4\frac{1}{2}$).

The beetle deposits her creamy white, elongate oval eggs, about $\frac{1}{35}$ inch in length, singly in a small hollow eaten out in the stem or in a tuber that has become exposed. The eggs hatch in four to six days. The larvæ hatching in the stems burrow downward through the center to the tuber. On reaching the potato, its burrow becomes somewhat larger and winds aimlessly through the flesh. The full-grown larva is about $\frac{1}{13}$ inch in length, the body is white and the head yellowish or brownish. The grubs become mature in two to three weeks. The tissue surrounding the burrow becomes discolored and decay sets in, giving the tuber a peculiar odor. When mature the grub eats out an oval cavity and after resting a day or two transforms into a white pupa about $\frac{1}{5}$ to $\frac{1}{4}$ inch in length. The pupal period occupies five to eight days, and after waiting two or three days to harden, the beetle eats its way out of the pupal cell. The beetles may then either leave the potato or may deposit eggs for another brood in the same tuber. Several hundred larvæ may occupy the same potato and breeding may continue until all food material has been destroyed. Generation after generation follow each other as long as food is available, but the beetles are able to exist for a long period without eating and resume reproductive activity when food is again available. The life cycle is completed, under favorable conditions, in about a month. The beetles are rather general feeders and are often found feeding on species of wild morning-glory and it is believed they can breed in these plants.

The sweet potato weevil is a most destructive pest and has caused the abandonment of the growing of sweet potatoes in many localities. It is especially injurious to the potatoes in storage pits, where breeding may continue until the tubers are entirely consumed.

*Control.*

Under conditions obtaining in the southern states, the injuries inflicted by this weevil may be prevented in large measure by not planting sweet potatoes on or near infested fields. In some localities it would pay to abandon the crop over a large area for two or three years in order to starve out the weevils.

Infested tubers should not be left in the field. Those only slightly injured may be fed to stock but those more badly infested should be burned or buried deeply. Care should be taken not to introduce the weevil into uninfested localities by means of infested tubers used for seed.

REFERENCES

Tryon, Queensland Agr. Jour., 7, pp. 176–189. 1900.
Tex. Agr. Exp. Sta. Bull. 93.
Maxwell-Lefroy, Mem. Dept. Agr. India, Ent. Series, 2, pp. 155–159. 1910.

## THE SWEET POTATO LEAF-ROLLER

*Pilocrocis tripunctata* Fabricius

A leaf-roller has been reported as occasionally injurious to sweet potatoes in southern Texas. It is a native of the West Indies and occurs sparingly in Louisiana and Florida. The larvæ are bluish green in color with the head pale yellow, and when mature are almost an inch in length. The caterpillars feed on the foliage and fold the leaves, thus making a retreat within which the larva lives and within which it spins its cocoon. The pupa is dark brown and about $\frac{3}{5}$ inch in length. The moth has an expanse of about an inch and is light yellow in color. The front and outer edge of the front wings are grayish brown. There is a nearly straight brown line across the base of the front wing and a wavy line of the same color three quarters the distance from the base on both wings. There are two black spots near the front margin of the front wing and one on the hind wing. There are several generations annually, about twenty-five days being required for the completion of the life cycle.

This sweet potato pest may be controlled by spraying the vines with arsenate of lead (paste), 4 pounds in 50 gallons of water.

REFERENCE

U. S. Dept. Agr. Bull. 609. 1917.

## The Sweet Potato White-Fly

*Bemisia inconspicua* Quaintance

In southern Florida sweet potatoes, especially the late crop, are often subject to very serious injury by this species of white-fly, which in general appearance is similar to the common greenhouse white-fly. The eggs are deposited on the underside of the leaves and hatch in about a week. The nymphs are often abundant enough nearly to cover the entire under surface of the leaf, sucking out the sap and sometimes killing the plant.

This white-fly may be controlled by one or two applications of soap solution or kerosene emulsion applied to the underside of the leaves.

### Other Sweet Potato Insects

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*Nezara viridula:* 43
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Corn and cotton wireworm: 349

# CHAPTER XIII

## ONION INSECTS

ONIONS are subject to attack by a relatively small number of insects. The most important of these are the onion maggot and the onion thrips, but occasionally cutworms and wireworms may cause serious loss.

### THE ONION MAGGOT

*Phorbia ceparum* Meigen

In Europe and America, onions are often severely injured by the attacks of a small white maggot that feeds on the underground stem or in the bulb. The maggots may attack and destroy the plants soon after the seeds have germinated, and the failure to obtain a stand is, therefore, often attributed to poor seed.

The flies appear in the onion fields in the spring and the female deposits her smooth, white, elongate oval eggs, which are slightly grooved on one side and about $\frac{1}{25}$ inch in length, in the base of the leaf-sheath, on the side of the stem near the ground, and in cracks and crevices of the soil. The eggs hatch in three to ten days and the young maggot works its way down along the stem, usually within the sheath. If the plant is very young, the maggot may so injure the stem that the whole top dies. When the plants are older, the maggots burrow into the bulb and cause decay to develop. Several maggots are often found in a single bulb. The full-grown maggot is nearly $\frac{1}{3}$ inch in length, smooth, and dull whitish in color. The maggot is largest at the hind end of the body and tapers to a point at the head. Posteriorly the body is obliquely truncate. The flat surface is surrounded by a row of twelve fleshy tubercles, of which the middle lower pair are single-pointed and not two-toothed as in the case of the cabbage root-maggot. In the onion maggot, in addition to the two tubercles just back of the vent, there are two smaller ones on the ventral side just in front of the two large ventral marginal tubercles; they aid the larva in crawling.

The maggots become full-grown in two to three weeks in green onions. In second-year onions, they develop more slowly and sometimes require four or five weeks to reach maturity. When full-grown, they transform to pupæ within the hardened larval skin or puparium, generally in the ground surrounding the plant; sometimes the transformation takes place within the bulb. The puparium resembles a grain of wheat in form, is of a chestnut brown color and about $\frac{1}{5}$ inch in length. The flies closely resemble those of the cabbage and seed-corn maggots but the males may be separated by the characters given in Fig. 26. They emerge from the puparia in about two weeks and lay eggs for another brood. There are at least two or three broods annually. The insect hibernates principally in the form of puparia, but both maggots and flies sometimes survive the winter.

*Control.*

The onion maggot has been found rather difficult to control. Carbolic acid emulsion applied as described under cabbage root-maggot, page 33, has been found of some value for killing the eggs and young maggots. Clean cultivation and rotation of crops are widely recommended to prevent maggot attack. Recent experiments in Wisconsin have shown, however, that since the flies require from ten days to two weeks after emergence in which to mature their eggs for deposition, the insects can be more easily and satisfactorily controlled by killing them with a sweetened poison spray. The most satisfactory results have been obtained by using the following formula:

| | |
|---|---|
| Sodium arsenite . . . . . . . . . . . . . | $\frac{1}{5}$ ounce |
| Water . . . . . . . . . . . . . . . . | 1 gallon |
| Molasses . . . . . . . . . . . . . . . | 1 pint |

This material should be sprinkled over the plants and surrounding soil when the flies first appear so that they may be killed before laying their eggs. The application should be repeated at intervals of a week, or oftener during rainy seasons.

### References

Cornell Agr. Exp. Sta. Bull. 78, pp. 495–496. 1894.
N. J. Agr. Exp. Sta. Bull. 200. 1907.
Conn. Agr. Exp. Sta. Rept. for 1911, pp. 286–292.
Severin and Severin, Jour. Ec. Ent., 8, pp. 342–350. 1915.

## The Onion Thrips

*Thrips tabaci* Lindeman

Onions are subject to injury by a small yellowish thrips which punctures the epidermis of the leaves, sucks out the juices and causes the plants to turn whitish, wilt and fall down. This trouble is known among onion-growers as white blast. The onion thrips is almost cosmopolitan in its distribution, occurring in Europe, North America, South Africa and Australia. In the United States it has been reported from nearly all parts of the country and is present in southern Canada. In some seasons this insect is the most serious enemy of the onion crop on the muck lands of New York, Ohio and Indiana and in the Bermuda onion regions of Texas. It sometimes seriously infests cabbage and cauliflower and is found on many wild and cultivated plants including cucumber and melon. In Europe it is a serious enemy of tobacco.

The onion thrips passes the winter in both the adult and nymphal state on onion plants left in the field. It is also probable that the thrips hibernates in the rubbish around the edge of the field, since the infestation usually begins along the weedy borders and gradually spreads over the remainder of the field.

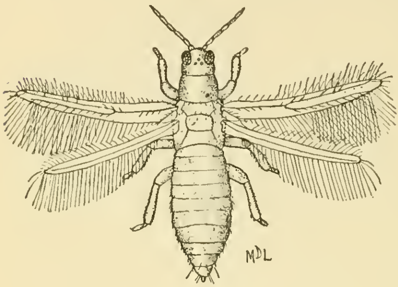

FIG. 148. — The onion thrips, adult female (× 30).

The adult female thrips (Fig. 148) is about $\frac{1}{25}$ inch in length and varies from light yellow to brownish yellow in color. The wings are long and narrow and bear on the hind margin a fringe of long hairs. The male is rarely found and the females normally reproduce without being fertilized. The egg is translucent white, irregularly bean-shaped and about $\frac{1}{100}$ inch in length. It is inserted nearly its full length into the tissue of the leaf; the tip of the smaller end projects slightly above the surface. The eggs hatch in five to ten days, the longer period being the more common. The newly hatched nymph is about $\frac{1}{50}$ inch in length and translucent white in color with the eyes bright red (Fig. 149). After feeding, the body assumes a greenish color from the ingested food. The first stage lasts about two days but in some cases the period is longer. In the second stage, the insect is about $\frac{1}{25}$ inch in length and varies in color from pale yellow to lemon-yellow (Fig. 150). These second-stage nymphs complete their growth in about ten days after hatching; they then leave the plant and

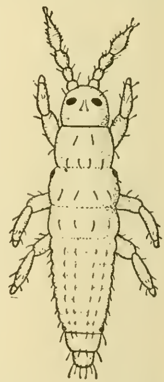

FIG. 149. — The onion thrips, first stage nymph (× 75).

enter the ground a short distance, where, by twisting and turning their bodies, they construct small earthen cells. In these cavities the insects molt and thus enter the third nymphal, or so-called prepupal, stage. These third-stage nymphs are yellowish white in color and the wing-pads extend to the middle of the second abdominal segment. They do not feed in this stage but remain quietly resting in their earthen cells. They are able to walk, however, and when disturbed soon crawl into hiding again. In two or three days the insect molts and enters the fourth and last nymphal stage (sometimes known as the popular stage). The fourth stage is whitish in color and the wing-pads extend to the eighth abdominal segment; the body is more spiny than in the preceding stages. In this stage, which lasts from one to six days, the insect remains in a quiescent condition and takes no food. At the next molt the thrips becomes adult, returns to the plant and resumes feeding. The life cycle is completed in about twenty-six days. There are five or six generations annually and breeding continues until stopped by cold weather.

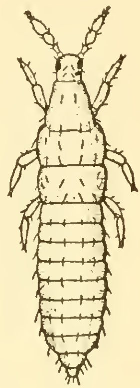

Fig. 150. — The onion thrips, second stage nymph (×45).

A careful examination of infested onion plants at any time during the summer will disclose the presence of four stages of the onion thrips, viz., eggs, first- and second-stage nymphs, and winged adult females. The first- and second-stage nymphs may be distinguished by the difference in size and by the more distinctly yellow coloration of the latter. Both the nymphs and adults feed on all parts of the leaves but are to be found in greatest numbers hidden under the sheath at the base of the leaves or between the young leaves at the center of the plant. In feeding, the thrips punctures the epidermis of the leaf with its sharp needle-like mouth-parts and then sucks out the juices of the plant, killing the cells and causing them to turn whitish. When the infestation is severe and the punctures consequently very numerous and close together, the leaves lose their dark green color and assume a dirty white or bleached appearance. The tender leaves at the center of the plant do not turn white when punctured by the thrips, but instead curl inward and downward and present a thickened deformed appearance.

Badly injured plants wilt and the leaves fall over on the ground; in such cases, the bulbs do not make the proper growth and the crop is of small size and inferior in quality. The plants are most susceptible to injury by thrips during June and July when they should be making their most rapid growth. Thrips are most destructive in years of drought because, under unfavorable conditions, the plants are less able to outgrow the injury. Onions grown on poor soil or when poorly cultivated are more likely to be injured by thrips than when planted on good ground and well cared for. When onions are grown for seed the thrips often infest the flower-heads in sufficient numbers greatly to reduce the crop.

Infested cabbage and cauliflower leaves turn brownish or rusty instead of dirty white, as in the case of onions. As a rule the injury is confined to the outer leaves, and is usually outgrown by the plants, provided other conditions are favorable.

*Control.*

Onion thrips can be killed by application of such contact insecticides as whale-oil soap, kerosene emulsion and tobacco extracts. The best results have been obtained by spraying early, before the leaves turn down, with "Black Leaf 40" tobacco extract, 1 pint in 100 gallons of water in which there have been dissolved 5 pounds of soap. There are great difficulties in applying the spray to large fields; heavy traction or power sprayers cannot be employed on the soft muck soil on which onions are usually grown. The knapsack sprayer can be used in the small onion patch but its use is too laborious and expensive to be practical in the large commercial onion field. To be effective, a considerable quantity of the liquid must be utilized thoroughly to wet the plants and a strong spray is needed to force the material down into the sheaths of the leaves and between the tender leaves at the center of the plant. Some better method of applying is needed in order to make spraying for the onion thrips a practical success under commercial conditions.

### References

N. Y. (Geneva) Agr. Exp. Sta. Bull. 83, pp. 680–683. 1894.
Fla. Agr. Exp. Sta. Bull. 46, pp. 103–114. 1898.
J. C. Faure, Unpublished thesis, Cornell University Library.

## The Barred-Winged Onion Fly

*Chætopsis aenea* Wiedemann

Onions are occasionally injured by a yellowish or whitish maggot about $\frac{1}{4}$ inch in length, that burrows in the bulbs, causing decay to ensue. The maggots of this insect have also been found injuring corn, wheat, oats, sorghum and sugar-cane and have been reared from the common reed. The larvæ have also been recorded as parasitic on the common stalk-borer and on a lepidopterous borer in cat-tail. The insect is native to America and ranges throughout the eastern United States from Canada to the West Indies. The fly is about $\frac{3}{16}$ inch in length with the head grayish and the thorax and abdomen metallic green. The wings are whitish crossed by three broad brown bands. The life history of this insect has been studied on oats. The female deposits her minute, elongate, pointed white eggs just under the edge of the leaf-sheath, singly or in groups of two to five. The maggots work down inside the leaf-sheath where, when mature, they transform into polished brown puparia about $\frac{3}{16}$ inch in length. In

Michigan the maggots were found to winter in the onions. There are said to be three or four broods annually.

### References

Insect Life, 7, pp. 352–354. 1895.
Mich. Agr. Exp. Sta. Bull. 200, pp. 206–208. 1902.

## The Black Onion Fly

*Tritoxa flexa* Wiedemann

Occasionally associated with the insect last treated are found the maggots of another fly. This species is native to America and ranges through the northern states from New Jersey to Minnesota. The fly is $\frac{5}{16}$ inch in length and dull black in color. The wings are dull brown marked with three oblique whitish bands. There are thought to be two broods annually. The maggots sometimes continue to work in stored onions, reducing them to mere shells.

No satisfactory control for this onion pest is known.

### Other Onion Insects

Cabbage webworm: 16
Seed-corn maggot: 36
Yellow bear caterpillar: 357
Sugar-beet webworm: 97
Belted cucumber beetle: 115
Garden springtail: 139
Bean aphis: 76
Spotted cutworm: 262
Greasy cutworm: 265
Dark-sided cutworm: 268
Striped cutworm: 270
Clay-backed cutworm: 274
Black army-worm: 275
Variegated cutworm: 276
Army cutworm: 287
Beet army-worm: 294
Black blister-beetle: 307
Root-knot nematode: 338

# CHAPTER XIV

## INSECTS INJURIOUS TO MINOR VEGETABLE CROPS

The crops treated in this chapter — rhubarb, okra, salsify, pepper, water-cress and lettuce — are not, as a rule, seriously injured by insects and the control of these pests is of less importance in the culture of these vegetables than in the case of those previously treated.

### Rhubarb

Rhubarb is not usually seriously affected by insects. Its most important enemies are the rhubarb curculio, the hop flea-beetle, the spinach aphis, the bean aphis and certain species of cutworms.

#### *The rhubarb curculio, Lixus concavus* Say

The leaf-stalks of rhubarb are often injured by the feeding and egg-laying punctures of a rather large black, yellow-dusted snout-beetle. The sap exudes from the wounds and collects as glistening drops of gum. Fortunately the eggs do not hatch when deposited in rhubarb but are killed by the flow of sap. This insect ranges from New England to Idaho and southward to Florida and Louisiana.

The beetle (Fig. 151) is about $\frac{1}{2}$ inch in length and black in color dusted with a yellowish covering which easily rubs off. The head is provided with a curved snout on the end of which the mandibles are borne. The insect passes the winter usually in the adult stage hidden away in dry sheltered places. The adults appear in the spring and are often seen resting on the stems and foliage of rhubarb and dock. They feed on the edge of the leaves and puncture the stems with their beaks. The female deposits her eggs singly in cavities about $\frac{1}{8}$ inch deep in the stalks of dock, sunflower, thistle and in the leaf-stems and flower-stalks of rhubarb. The eggs are oblong oval, yellowish white in color and about $\frac{1}{16}$ inch in length. They hatch in a week or ten days when deposited in their wild food plants but, as previously stated, are not able to develop in rhubarb. On hatching the larva burrows down through the stalk so that when it reaches maturity it occupies a cavity just below the surface of the ground. Although many eggs are often laid in the same stem, usually only one grub reaches maturity. The full-grown larva is a footless grub about $\frac{3}{4}$ inch in length and is white with a brownish head. As the eggs are laid over a considerable period from the first of June till the middle of July, the grubs do not reach maturity at the same time. The larval period occupies, on an average, eight or nine weeks. In New Jersey the greater number are mature by the middle of August. The pupa is white, about $\frac{1}{2}$ inch in length, and is found in a rather large cavity in the crown of the plant just below the surface of the ground. The pupal period occupies a little over a week. After transformation the beetle remains in the pupal chamber for several days until fully hardened and then gnaws its way out and after feeding a short time goes into hibernation. There is only one generation annually.

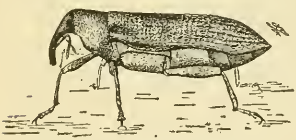

Fig. 151. — The rhubarb curculio ($\times 2\frac{1}{4}$).

The beetles are easily seen resting on the plants and may be readily captured and destroyed by hand. All wild plants in which the beetles breed should be destroyed in the vicinity of rhubarb beds or a few dock plants may be left growing as a trap in which the beetles will deposit their eggs, when they should be destroyed before the grubs reach maturity.

### References

U. S. Div. Ent. Bull. 23, pp. 61–69. 1900.
Weiss, Jour. Econ. Ent. 5, pp. 434–436. 1912.

*Other rhubarb insects*

Southern corn root-worm: 222
Yellow bear caterpillar: 357
Spinach aphis: 105
Common stalk-borer: 157
Burdock borer: 160
Bean aphis: 76
Spotted cutworm: 262
Striped cutworm: 270
Variegated cutworm: 276
Army cutworm: 287
Hop flea-beetle: 335

## Okra

The insect enemies of okra are not numerous. The pods are often attacked by the corn ear-worm and the buds and leaves are injured by the caterpillar of the gray hair-streak butterfly. The plants are also attacked by the spinach aphis and melon aphis and are often defoliated by the okra caterpillar.

### *The okra caterpillar, Anomis erosa* Hübner

Okra and roselle are likely to be defoliated by a green looping caterpillar related to the cotton worm. This insect also feeds on several species of hibiscus, abutilon, hollyhock and on *Urena lobata* and is occasionally found on cotton. It ranges throughout the southern United States, the West Indies, South Africa, Madagascar, Mauritius, the Oriental region and Australia.

The moth has an expanse of $1\frac{1}{4}$ to $1\frac{1}{2}$ inches. The front wing has the outer margin angled at the middle. The basal half is yellow usually shaded with light brown and the outer half is light pinkish brown often shaded with yellow. The hind wings are pale yellow shading into ocher yellow towards the outer border. The moth deposits her pale green, globular, slightly flattened eggs singly on both the upper and under side of the leaves. The egg is about $\frac{1}{30}$ inch in diameter and marked with a series of ridges radiating from the apex. The eggs hatch in about four days and the young caterpillar, after eating its egg-shell, begins feeding on the leaf in which it eats out small holes. The larger larvae eat out irregular areas from the side of the leaf and when abundant often defoliate the plant. The caterpillar passes through seven stages in the course of its development and reaches maturity in about twenty-four days in warm weather. It is then about $1\frac{3}{8}$ inches in length, pale pea-green in color, inconspicuously marked with five narrow broken yellow lines above and with a broader yellowish white stripe on each side. While young the caterpillars suspend themselves by a thread when disturbed and are able to climb back to the plant when the danger has passed. They walk with a peculiar looping motion owing to the fact that only four pairs of prolegs are present on the abdominal segments. When full-grown the caterpillar transforms in a folded leaf into a blackish brown pupa about $\frac{5}{8}$ inch in length and in five days to two weeks depending on the season the moths emerge. In Florida the life cycle requires nearly five weeks.

The caterpillars can be killed by spraying with arsenate of lead (paste), 2 pounds in 50 gallons of water. Recent experiments also indicate that effective work against the caterpillars can be done by spraying with "Black Leaf 40" tobacco extract, 10 ounces in 100 gallons of water in which 5 or 6 pounds of soap have been dissolved.

### References

Riley, Rept. U. S. Ent. for 1881 and 1882, pp. 167–170.
U. S. Bur. Ent. Bull. 126. 1913.
Dozier, Jour. Econ. Ent. 10, pp. 536–542. 1917.

*Other okra insects*

Spinach aphis: 105
Corn ear-worm: 211
Stink-bugs: 232
Harlequin cabbage bug: 38
Green soldier-bug: 42
*Nezara viridula:* 43
Striped cucumber beetle: 109
Belted cucumber beetle: 115
Melon aphis: 135
Gray hair-streak: 84
Semi-tropical army-worm: 297
Red-spider: 351

## Salsify

The insects affecting salsify have not been carefully studied and those that have been listed as injurious to this plant are, as a rule, general feeders and have not been recorded as causing any serious injury to this crop. The following insects treated under other crops have been reported as attacking salsify:

Yellow bear caterpillar: 357
Tarnished plant-bug: 192
Yellow-striped army-worm: 295
Root-knot nematode: 338

## Pepper

Peppers are subject to attack by a number of insects that infest the potato, especially flea-beetles and the spinach aphis and potato aphis.

*The pepper weevil, Anthonomus eugenii* Cano

In southern Texas and Mexico peppers are sometimes seriously injured by a small shining blackish or reddish black snout-beetle with a brassy luster, $\frac{1}{10}$ to $\frac{1}{8}$ inch in length. The weevils are injurious in late summer and fall. In feeding they puncture the buds and young fruits with their beaks and the female deposits her small white oval eggs, about $\frac{1}{50}$ inch in length, in the cavities so made. The eggs hatch in two to four days and the young grubs feed on the surrounding tissue. The injured buds are blasted and the infested fruits usually drop prematurely. The grubs become mature in about two weeks. They are then about $\frac{1}{5}$ inch in length, white and strongly curved. When about to pupate, the larva constructs a cell of excrement and bits of decayed tissue inside the fruit. The pupa is light amber in color, about $\frac{1}{6}$ inch in length and rather robust in form. From six to ten days are spent in this stage. Soon after transformation the beetle leaves the pupal cell but remains within the fruit until thoroughly hardened, when it gnaws out an exit hole through the pod.

The pepper weevil may be controlled by collecting and burning all infested fruits once a week during the egg-laying period of the weevils. It is not advisable to grow peppers year after year on the same land. In Mexico spraying with paris green is said to have been found of some value for the control of this pest.

### References

U. S. Bur. Ent. Bull. 54, pp. 43–48. 1905.
U. S. Bur. Ent. Bull. 63, pp. 55–58. 1907.

*Other pepper insects*

Corn ear-worm: 211
Serpentine leaf-miner: 46
Spinach aphis: 105
Southern leaf-footed plant-bug: 121
Tomato worm: 168
*Nezara viridula:* 43
Belted cucumber beetle: 115
Colorado potato beetle: 142

## Water-Cress

Owing to its semi-aquatic habit water-cress is comparatively free from insect attack. In certain localities its most serious enemy is a small crustacean, the water-cress sowbug.

### *The water-cress sowbug, Mancasellus brachyurus* Harger

In the eastern United States water-cress is often seriously injured by an aquatic species of sowbug that attacks the submerged portions of the plant, cuts off the roots and stems and causes large masses of the cress to float on top of the water. This form differs from the species found in greenhouses by having longer legs and antennæ and being shrimp-like in form when viewed from the side. It is about $\frac{1}{2}$ inch in length and gray in color. It often occurs in immense numbers so as to destroy practically the whole crop.

Where cress is grown in natural streams or ponds, no practical method of controlling the sowbugs has been devised. Some growers, however, have been able to overcome the difficulty by growing the plants in broad shallow beds sloping towards the center, where a trough ten inches square lined with boards extends the whole length of the bed. When the sowbugs become abundant, the water is shut off for twelve to twenty-four hours allowing the beds to drain. Water is retained in the trough, in which the sowbugs soon accumulate in great numbers. They may be destroyed by the addition of a liberal quantity of copper sulfate solution. Less injury will result to the plants if the water is drained off soon after the cress has been gathered.

### Reference

U. S. Bur. Ent. Bull. 66, pp. 11–15. 1907.

#### *The water-cress leaf-beetle, Phædon æruginosa* Suffrian

In the eastern United States water-cress is occasionally injured by the larvæ and adults of a small shining, bronzy black leaf-beetle about $\frac{1}{8}$ inch in length. The life history of this insect is very imperfectly known. The full-grown larva is about $\frac{1}{5}$ inch in length; the head is shining black and the remainder of the body is brownish black, lighter between the segments and below. Its body is provided with numerous prominent tubercles from which hairs arise. Both larvæ and adults feed on the underside of the leaves.

No satisfactory method of controlling this pest has been devised.

#### *Other water-cress insects*

Diamond-back moth: 12
Spinach aphis: 105
Striped cabbage flea-beetle: 324

## Lettuce

The most important insect enemies of lettuce are the cabbage looper, the celery looper and several species of cutworms. Several kinds of plant-lice infest the plants and are especially troublesome in greenhouses. Slugs and millipedes often attack the crop, sometimes causing considerable damage.

#### *The lettuce root-louse, Rhizobius lactucæ* Fitch

The roots of lettuce are often infested by a yellowish wingless plant-louse about $\frac{1}{12}$ inch in length which has the body dusted with a whitish powder and bears tufts of white waxen threads. The insects often occur in dense masses on the roots and may retard the growth of the plant. They are attended by ants and are probably carried by them to new feeding grounds. The life history of this species is very imperfectly known and its wild food plants have not been determined.

The lettuce root-louse rarely causes enough injury to warrant repressive measures.

### Reference

Fitch, 14th Rept. State Ent. N. Y., pp. 360–363. 1870.

#### *Other lettuce insects*

Cabbage looper: 8
Garden webworm: 18
Turnip aphis: 27
False chinch-bug: 47
Celery looper: 191
Spinach aphis: 105
Western twelve-spotted cucumber beetle: 114
Belted cucumber beetle: 115
Garden springtail: 139
Bean thrips: 69
Garden flea-hopper: 77
Dark-sided cutworm: 268
Striped cutworm: 270
Variegated cutworm: 276
Glassy cutworm: 279
Yellow-headed cutworm: 281
Spotted-legged cutworm: 282
Clover cutworm: 284
Pale-striped flea-beetle: 321
Root-knot nematode: 338
Millipedes: 342
Slugs: 354

## CHAPTER XV

### CUTWORMS AND ARMY-WORMS

Of all general crop pests, none is more ubiquitous nor persistent in its attacks on truck crops than a group of caterpillars of Noctuid moths which has received the name of cutworms or army-worms. Under favorable circumstances, almost any cutworm may become so abundant as to migrate from field to field in so-called armies devouring practically every green thing in its path. The name army-worm, however, has been restricted to two or three species in which the tendency to adopt this habit has been highly developed.

Cutworms are smooth, nearly naked caterpillars varying in length from 1 to 2 inches when full-grown, usually dull colored and indistinctly marked with spots and longitudinal stripes. The name cutworm has been well applied to these caterpillars because of the habit of many species of cutting off succulent plants near or just below the surface of the ground. Cutworms feed mostly at night and spend the day either in a burrow in the soil or under the protection of stones and rubbish near their food plants. Some species rarely come to the surface at all but feed on the roots and underground stems. Others, however, have the habit of climbing shrubs and trees to feed on the buds, foliage and even the fruit. Species possessing this habit to a marked degree are sometimes known as climbing cutworms.

When mature, cutworms transform through brownish pupæ into dull-colored, rather heavy-bodied moths. The wings are marked with bands and spots which for convenience in description have received the names indicated in Fig. 152. They are active only at night and many species are attracted to lights and to sugar baits. A large proportion of the moths which fly into our rooms in summer evenings belong to this family. Their glowing eyes and heavy tufts of scales and hairs on the thorax together with their nocturnal

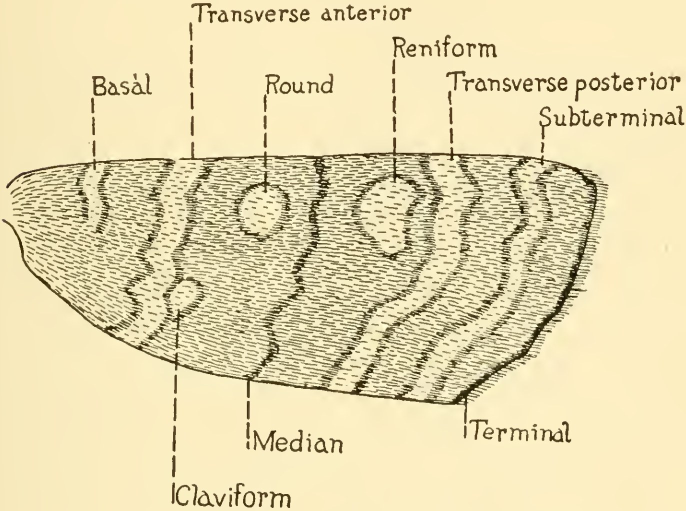


Fig. 152. — Diagram of the wing-pattern of a cutworm moth.

habits have given them the name of owlet moths. They are rarely seen by day, being hidden away in sheltered places, as under the loose bark of trees, in board piles and in crevices of fences.

The species treated in this chapter are those which have caused outbreaks of sufficient importance to attract the attention of entomologists. It is quite probable that other species may have been concerned but so far have escaped detection. These may at any time become so abundant as to cause serious damage. In this account all the more important facts known regarding each species are presented but much remains to be learned of their habits and life histories. Here is a fruitful field of investigation which warrants more attention than it has received in the past.

## The Spotted Cutworm

*Noctua c-nigrum* Linnæus

In the northern United States and Canada the spotted cutworm is one of the most common and troublesome species. It is generally distributed throughout the northern hemisphere. In Asia it is found as far south as northern India; it ranges throughout all of Europe and in North America is most abundant in the northern United States and Canada and has been reported from Mexico. This cutworm is a general feeder attacking cabbage, tomato, turnip, potato, celery, rhubarb, onion, pea, beet, carrot, mangel, corn, grasses, clover, violet, ferns, lobelia, helianthus and chicory. As a climber it is reported as injurious to the tips and buds of cranberry in Massachusetts; it also feeds on currant and gooseberry. The caterpillars of the July brood sometimes injure the fruit of the tomato. In years of great abundance they may assume the armyworm habit.

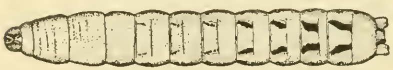

Fig. 153. — The spotted cutworm ($\times 1\frac{1}{3}$).

So far as known, the spotted cutworms pass the winter as partly grown caterpillars. They become mature in early spring. The larva is $1\frac{1}{2}$ inches in length, of a pale brownish to ashy gray color. This species may be easily recognized by a double row of oblique triangular black spots on the dorsal surface of the abdominal segments. These spots increase in size and distinctness towards the posterior end of the body (Fig. 153). On the side there is a more or less distinct dark stripe running through the spiracles below which the color is decidedly lighter than above. Pupation takes place in the ground. The pupa is $\frac{3}{4}$ inch in length and of a dark mahogany brown. The pupal period varies from two to four weeks.

The moths are on the wing from late May to October and apparently belong to two overlapping broods. The moth has an expanse of $1\frac{1}{2}$ to 2 inches (Fig. 154). The front wings are rich purplish to reddish brown. The kidney-shaped spot is usually tinged with reddish. From this spot there extends towards the base of the wing a black bar deeply incised by a triangular light area which often extends to the front margin of the wing. The hind wings are smoky, darker along the outer margin.

Fig. 154. — The spotted cutworm moth (natural size).

The moth deposits her eggs singly, in rows, or in compact clusters of 200 or more on leaves. The egg is hemispherical in shape, strongly ribbed, almost transparent and is about $\frac{1}{28}$ inch in diameter. There are probably two generations annually.

### References

U. S. Div. Ent. Bull. 27, pp. 54–59. 1901.
Dept. Agr. Canada Ent. Bull. 10, pp. 23–24. 1915.

## The Well-Marked Cutworm

*Noctua clandestina* Harris

This cutworm is distributed from Nova Scotia to Missouri and Colorado, and northward. It also occurs in Greenland and Kamchatka. It has been reported as injuring the following crops: corn, buckwheat, wheat, cabbage, cauliflower, bean, pumpkin and other vegetables. As a climbing cutworm, it attacks apple, currant and gooseberry. Among its wild food plants are included soft maple, box elder and wild endive.

These insects hibernate as partly grown caterpillars which become mature during May and June. The caterpillar is $1\frac{3}{8}$ inches in length and is easily recognized by a double row of distinct, oblique, black spots on the back of the abdominal segments (Fig. 155). The rows of black spots are bordered laterally by a distinct yellow stripe. The median yellowish stripe is distinct. The reddish brown pupæ are found buried a few inches in the soil. The moths emerge during June and July and have been collected as late as the middle of October.

FIG. 155. — The well-marked cutworm ($\times 1\frac{1}{2}$).

During the day they have the habit of hiding under loose bark, in crevices about buildings and in fences. When at rest the wings are folded closely one above the other, giving the moth a flattened appearance. The moth has an expanse of $1\frac{1}{2}$ inches. The front wings are of a dark, smoky brown color, the transverse lines paler and not very distinct. The inner spot is oval bordered with black; the reniform spot is marked with black on the inner side and the two are often united by a black line. The hind wings are smoky, darker towards the margin (Fig. 156). The eggs have not been described. So far as known, there is only a single generation annually.

FIG. 156. — The well-marked cutworm moth (natural size).

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## The Greasy Cutworm

*Agrotis ypsilon* von Rottenburg

The greasy cutworm is cosmopolitan in distribution, occurring in injurious numbers in Europe, Asia, Africa, North and South America, Australia, New Zealand, the East Indies and Hawaii. The caterpillar is a general feeder. Its food plants include many wild species and the following cultivated crops: corn, grasses, potato, tomato, cabbage, beet, eggplant, spinach, bean, squash, cauliflower, cucumber, radish, asparagus, onion, strawberry, tobacco and cotton. In the United States and Canada this cutworm is usually abundant, though on the whole not so injurious as some of the other species.

Owing to the wide distribution of the insect, including many life zones, its seasonal history presents many variations. In North America, hibernation occurs in either the larval or pupal stage. In Florida all stages of the larvæ have been found during mild winters and in Texas and Georgia moths have been reared from pupæ plowed up in cotton fields during the winter. It is quite probable that in the northern United States and Canada hibernation takes place most commonly in the larval stage, though winter pupæ have been recorded from Illinois.

The moths emerge over a considerable period, from June to October, being most abundant in July and August. The moth has an expanse of 1½ to nearly 2 inches. The front wings are dark brownish gray varying to dark brown, with the apical third lighter in color and are crossed by a diagonal light band in which are two black elongate spots. Near the outer margin of the dark area is a characteristic U-shaped black mark with a black dash extending from its outer side. The hind wings are light brownish gray with a pearly luster; the veins are brown (Fig. 157). From July to September the females deposit their eggs in small clusters on the leaves or stems of plants, usually near the ground. Each female may lay from 200 to 400 eggs. The egg is dome-shaped, about $\frac{1}{50}$ inch in diameter, and creamy white when laid, becoming darker before hatching. At the top there is a slight depression from which radiate many ridges extending to the base of the egg.

In Illinois, eggs laid in July were observed to hatch in twenty-two days, while in Hawaii they hatch in only two or four days. The young caterpillars are pale green, the black tubercles on the segments showing prominently. Later the pale longitudinal stripes become evident. When full-grown the caterpillar is $1\frac{1}{2}$ to $1\frac{3}{4}$ inches in length, of a nearly uniform dark greasy gray color with an indistinct mid-dorsal yellow line and two faint lateral stripes. It is dark greenish yellow beneath. In the summer the caterpillars require at least a month to reach maturity. They are voracious feeders and have developed to a high degree the habit of cutting off tender plants and dragging them to their burrows. They feed mostly at night and during the day remain hidden in burrows an inch or so from the surface of the ground.

FIG. 157. — The greasy cutworm moth (natural size).

The mature caterpillars transform in earthen cells a short distance below the surface into brownish pupæ about $\frac{3}{4}$ inch in length. Observations in Canada indicate that the length of the pupal period in late summer is about three weeks, while in Illinois in early summer it is four weeks; in Hawaii the pupal period is ten days to three weeks.

In Canada there are two broods annually, the larvæ of the second brood hibernating in a partly grown condition. This is probably general for the northern United States and Canada, though undoubtedly exceptions occur since pupæ of the first brood may not transform the same season.

### References

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Hawaii Sugar Planters' Exp. Sta. Div. Ent. Bull. 7, pp. 19–21. 1909.
Dept. Agr. Canada Ent. Bull. 10, pp. 16–17. 1915.

## The Red-Backed Cutworm

*Paragrotis ochrogaster* Guenée

This destructive cutworm ranges from Nova Scotia to British Columbia southward to Colorado and Missouri. It is more abundant in the northern part of its range, being the most injurious species throughout Canada. The larva is almost omnivorous in its tastes, attacking any succulent plant, especially cabbage, cauliflower, beet, radish and many annuals of the flower-garden. It is a serious pest in the West to grain crops, particularly oats, wheat and barley. This species may be distinguished from other common cutworms by the reddish color of the upper surface of the body.

In eastern Ontario, the red-backed cutworm has been found to hibernate in both the egg and larval stages. The over-wintered eggs hatch the latter part of April and the caterpillars become mature in about seven weeks. In its feeding habits it resembles the greasy cutworm. The mature caterpillar is 1½ inches in length, reddish above with a pale median stripe; the reddish area being bordered on each side with a darker band. The under surface is grayish to brownish. The head and cervical shield are yellowish brown, and there are two black spots on the vertex.

In Canada the caterpillars become mature during the latter part of June and pupate in earthen cells from one to two inches below the surface of the ground. The pupa is reddish brown and about $\frac{3}{4}$ inch in length. The moths emerge during the latter part of July and August and have an expanse of $1\frac{3}{8}$ to $1\frac{5}{8}$ inches. The front wings vary from pale clay to dark reddish or blackish brown. The wing is crossed on the basal third by two wavy light lines. On the outer half are two prominent light spots, the inner one nearly round, the outer kidney-shaped. The hind wings are brownish gray, lighter in the center (Fig. 158).

Fig. 158. — The red-backed cutworm moth ($\times 1\frac{1}{4}$).

Caterpillars hatching from eggs laid early in the season become partly grown before cold weather and hibernate in this condition; some of the eggs laid late in the season do not hatch till the following spring. There is apparently but one generation a year.

References

Fletcher, Rept. Canada Ent. for 1904, pp. 223–225.
Dept. Agr. Canada Ent. Bull. 10, pp. 15–16. 1915.

## The Dark-Sided Cutworm

*Paragrotis messoria* Harris

This species is a native of North America, ranging from New Jersey westward to Colorado and California and northward. It is reported as very injurious in Ontario and Quebec. It is especially destructive to garden crops and has the habit of climbing young fruit-trees to feed on the opening buds. It is recorded as feeding on the following plants: cabbage, spinach, lettuce, potato, tomato, bean, pea, radish, turnip, beet, onion, tobacco, sweet potato, corn, clover, buckwheat and grasses. It also attacks the opening buds of apple, currant, soft maple and grape.

So far as known, the dark-sided cutworm passes the winter in a partly grown condition. In the spring the caterpillars resume feeding and become mature in June and July. The full-grown caterpillar is slightly more than an inch in length. It is dull grayish in color with the sides of the body decidedly darker. Pupation takes place in the ground and the moths emerge in about a month. Sometimes the emergence is retarded, the pupal period extending over eight weeks. The pupa is about $\frac{3}{4}$ inch in length, light yellowish brown marked with darker brown.

Fig. 159. — The dark-sided cutworm moth ($\times 1\frac{1}{2}$).

The moth has an expanse of $1\frac{1}{4}$ to $1\frac{3}{8}$ inches. The front wings are brownish gray with darker, sometimes blackish markings consisting of a double line extending halfway across the wing at the base, a double wavy line one third the distance from the base, a fainter single wavy line near the middle, another double wavy line about two thirds the distance from the base and just inside the outer margin there is an inconspicuous line of the ground color lying in a blackish shade. The orbicular and reniform spots are both present, large and are outlined with black. All the markings are distinct, including the median shade, but are not contrasted. The hind wing is dirty white shading to brown towards the margin (Fig. 159). The eggs of this species have not been described. There is but one generation annually.

References

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Forbes, 23rd Rept. State Ent. Ill., pp. 32–33. 1905.
Dept. Agr. Canada Ent. Bull. 10, pp. 20–21. 1915.

## The Striped Cutworm

*Paragrotis tessellata* Harris

The striped cutworm is particularly a vegetable pest attacking potato, tomato, sweet potato, radish, squash, cabbage, lettuce, celery, spinach, bean, cucumber, melon, beet, carrot, parsnip, onion and rhubarb. It is a serious enemy of alfalfa in Colorado and may also feed on flax, buckwheat, clover and corn. In Iowa it has been found injuring root-grafts of apple, pear, plum and cherry. This cutworm is restricted to the northern United States and Canada.

Fig. 160. — The striped cutworm moth ($\times 1\frac{1}{3}$).

The striped cutworm hibernates in a partly grown condition and becomes mature in May and June. The full-grown larva is $1\frac{1}{2}$ inches in length, pale brownish tinged with yellow above, grayish on the sides and greenish below. It has a median pale stripe bordered with brown; a brownish subdorsal stripe, which is bounded below by a light line; a narrow distinct white lateral stripe and a broad white stigmal band. Pupation takes place in the soil, the pupal period occupying from two to three weeks. The moths are most abundant during July and August. The moth has an expanse of $1\frac{1}{4}$ to $1\frac{1}{2}$ inches. The front wings are grayish to blackish brown sometimes with a purplish tinge. The orbicular and reniform spots are distinct, and between these spots, and extending to the second cross line, is a contrasting dark brown or black area. There is a tuft of yellow hairs at the base of the front wing. The hind wings are brown becoming whitish towards the center and base (Fig. 160). There is but one generation a year.

References

Forbes, 23rd Rept. State Ent. Ill., p. 34. 1905.
Dept. Agr. Canada Ent. Bull. 10, pp. 29–30. 1915.

## The Dingy Cutworm

*Feltia subgothica* Haworth, *F. ducens* Walker, and *F. jaculifera* Guenée

Under the term dingy cutworm are included several forms, the moths of which have been given separate names by specialists as indicated above. So far as known, the early stages and habits of these forms are practically identical. This cutworm is widely distributed in the United States and Canada, being more abundant in the northern part of its range. It is a general feeder, its food plants including corn, wheat, grasses, clover, strawberry, bean, pea, squash, cucumber, tomato, sweet potato, cabbage and horse-radish. It sometimes assumes the climbing habit and feeds on the buds of various fruit-trees.

Fig. 161. — The dingy cutworm moth ($\times 1\frac{1}{2}$).

The dingy cutworm hibernates in a partly grown condition, completing its growth in the spring. When mature it is $1\frac{1}{4}$ inches in length, grayish brown, with a very wide buff-gray dorsal stripe outlined by a narrow dark stripe on each side. Pupation takes place in the soil. The pupa is nearly $\frac{3}{4}$ inch in length, honey-yellow, with dark brown markings.

The moths are on the wing from early July to late September, being most abundant in August. The adult has an expanse of $1\frac{1}{4}$ inches. The front wings are grayish brown marked with darker brown and suffused with purplish. The kidney-shaped spot is distinct and reddish brown; the round spot is open in front and confluent with a broad marginal gray band. The hind wings are whitish, darker toward the margin or in some forms entirely brownish (Fig. 161). The eggs are laid in August and September. The egg is about $\frac{1}{50}$ inch in diameter, dirty white with brown mottlings, dome-shaped and marked with numerous ridges radiating from the apex. There is but one generation annually.

### References

Cornell Agr. Exp. Sta. Bull. 104, pp. 574–579. 1895.
Dept. Agr. Canada Ent. Bull. 10, pp. 26–27. 1915.

## The Shagreened Cutworm

*Feltia malefida* Guenée

In the southern states cabbage, potato, cotton and clover are sometimes attacked by a caterpillar which, from its roughened skin, has received the name of shagreened cutworm. This cutworm does most of its work underground, living in a burrow into which it drags leaves and stems which it cuts off at night. The insect ranges from New York to New Mexico and California and southward to Argentina. The full-grown larva is nearly $1\frac{1}{2}$ inches in length, grayish brown in color with a very wide buff gray dorsal stripe. The head is pale brown with a curved, dark brown stripe on each side of the face. When mature, the caterpillar transforms within its burrow into a yellowish brown pupa about $\frac{3}{4}$ inch in length. The pupal period in Texas varies from fifteen to twenty-seven days. The moth has an expanse of nearly $1\frac{3}{4}$ inches. The front wings are powdery pale gray with the front margin dark

Fig. 162. — The shagreened cutworm moth ($\times 1\frac{1}{2}$).

gray. The reniform spot is conspicuous and dark gray. Just behind the so-called round spot, which in this case is shaped like a tennis racket, there is a distinct short black bar. The hind wings are white, often lined with brown along the veins and with a narrow brown margin (Fig. 162).

The seasonal history has not been carefully studied. The moths of the summer brood are abundant in Texas in late June and July. In New Jersey the moths are to be found in September.

## The Granulated Cutworm

*Feltia annexa* Treitschke

This species is most abundant in the tropics. It ranges through the West Indies, Mexico, Central America, southward to Chile and Argentina and northward to Nova Scotia and Minnesota. Among its food plants are tomato, cabbage, pea, bean, corn, wheat, grasses, clover, cotton and tobacco.

Fig. 163. — The granulated cutworm moth ($\times 1\frac{1}{4}$).

In the northern part of its range the winter is passed in the larval state. The caterpillars reach maturity in May and June. The full-grown caterpillar is nearly $1\frac{1}{2}$ inches in length, dark gray, with a pair of yellowish drab oblique marks on each segment and a substigmatal pale gray line bordered with yellowish; the underside of the body is pale greenish gray. Pupation takes place in the ground. The reddish brown pupa is nearly $\frac{3}{4}$ inch in length. The pupal period lasts from four to six weeks. In the North there are two generations annually. The first brood of moths is on the wing during June, July and August; the second brood in August, September and October.

The moth has an expanse of about $1\frac{1}{2}$ inches. In the female the front wings are dark grayish brown with the outer border and a broad costal band clay-color. The orbicular and reniform spots are small, distinct and connected by a black bar (Fig. 163). In the male the front wings are lighter and the hind wings are pearl-white with the front margin brownish. The eggs are white, about $\frac{1}{30}$ inch in diameter and beautifully ribbed, one third of the ribs reaching the apex. The eggs hatch in about four days.

### References

French, Can. Ent., 14, pp. 207–210. 1882.
Ill. Agr. Exp. Sta. Bull. 95, p. 362. 1904.

## The Clay-Backed Cutworm

*Feltia gladiaria* Morrison

The clay-backed cutworm is widely distributed in North America east of the Rockies. Its food plants include potato, tomato, sweet potato, bean, cabbage, onion, corn, clover, oats and grasses. This species. when abundant and lacking food, may adopt the army-worm habit.

Fig. 164. — The clay-backed cutworm moth ($\times$ $1\frac{3}{8}$).

This cutworm hibernates in the larval condition and matures in early spring. The full-grown caterpillar is nearly $1\frac{1}{2}$ inches in length, dull greenish to dark brown with a broad median dorsal stripe varying in color from straw-yellow to brown. This median stripe has given it the common name of clay-backed cutworm. The larvæ enter the ground in June and remain in the pupal condition for nearly six weeks. The moths are on the wing during September and October. The moth has an expanse of about $1\frac{1}{3}$ inches. The front wings are grayish brown, the orbicular spot small, the reniform spot inconspicuous. Through the middle of the wing there extends a pale narrow streak in which is a fine forked black line. Inside the subterminal line is a row of wedge-shaped black spots. The hind wings are brownish (Fig. 164). There is but a single generation a year.

#### References

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### The Black Army Cutworm

*Noctua fennica* Tauscher

Throughout the northern United States, Canada, northern Europe and Asia and in the Alpine regions the black army cutworm is found. It is more particularly a field crop pest, being especially fond of clover and peas, and occasionally assumes the army-worm habit, doing serious injury to grass-lands and sometimes, when other food is not available, climbs trees, feeding on the foliage and even the bark. Asparagus, onions and other vegetables are occasionally attacked.

The larvæ hibernate in a half-grown condition and reach maturity quickly in the spring. The full-grown caterpillar is nearly $1\frac{3}{4}$ inches in length, beautifully striped with black and white. The caterpillars transform to light brown pupæ in earthen cells in the ground and the moths emerge in about ten days. The adults are on the wing from late June to the last of August. The moth has an expanse of slightly more than $1\frac{1}{2}$ inches. The front wings are chocolate-brown; the spots are distinct, the reniform spot being reddish yellow and the round one gray. The hind wings are pale, brownish on the margin or entirely suffused with brownish. So far as known, there is but one generation a year.

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Dept. Agr. Canada Ent. Bull. 10, pp. 27–28. 1915.

## THE VARIEGATED CUTWORM

*Peridroma margaritosa* Haworth

The variegated cutworm is nearly cosmopolitan in its distribution, occurring in North and South America, the West Indies, Europe, northern Africa, southeastern Asia and Hawaii. In Europe it is of little economic importance but in the northern United States and Canada it is one of our most abundant and destructive cutworms. It is always present in greater or lesser numbers in this region and occasionally severe outbreaks occur when the caterpillars become so numerous that the food supply is exhausted and they assume the army-worm habit. The most striking instance of such an outbreak was in 1900 in the northwestern United States and British Columbia. This cutworm is a serious pest in greenhouses, where it gains entrance through the use of rotted sod containing the caterpillars. It has also the pernicious habit of climbing young trees and vines to feed on the buds, foliage and fruit.

The variegated cutworm has the widest range of food plants of any of its class. It has been recorded as seriously injurious to the following vegetable crops: cabbage, turnip, radish, beet, carrot, lettuce, celery, rhubarb, asparagus, onion, squash, cucumber, potato, tomato, sweet potato, bean and pea. Among field crops it injures corn, wheat, various grasses, clover, hops, sugar-cane and tobacco. Alfalfa is especially liable to attack in the western United States. Apple, cherry, pear, plum, prune, peach, currant, gooseberry, raspberry, blackberry, strawberry and grape are often severely injured. Of greenhouse and ornamental plants, it is known to feed on violet, pansy, carnation, smilax, rose, sweet pea, hollyhock, sunflower, nasturtium and chrysanthemum. It has also been recorded as attacking cedar, mulberry and box elder and such weeds as nettle, thistle, dog fennel, fireweed and dock.

In the northern part of its range this species hibernates either as pupæ or as partly grown larvæ. Farther south hibernation occurs principally in the larval stage. The overwintered larvæ emerge from hibernation in early spring and may cause serious damage before reaching maturity. The first brood of moths is on the wing in late May and early June, the second brood in late July, August and September. Occasionally in the more southern localities there may be a partial third brood.

FIG. 165. — The variegated cutworm moth (natural size).

The moth has an expanse of $1\frac{1}{2}$ to $1\frac{7}{8}$ inches. The front wings are brownish gray, washed toward the front margin with reddish in one form and with yellowish in the other. The round and kidney-shaped spots are distinct, the latter being the darker. The hind wings are pearly white with the veins and margin brown (Fig. 165). The females deposit their eggs in patches of sixty or more on the stems or leaves of low plants or on twigs or branches of trees. A single female may lay as many as 500 eggs. The egg is $\frac{1}{40}$ inch in diameter, dome-shaped, marked with about forty ribs radiating from the apex, cream colored when laid, changing to pinkish and becoming lilac just before hatching.

The eggs hatch in five to six days and the young caterpillars, after devouring the egg-shells, begin feeding on the leaves and buds. For the first week they may feed openly, crawling with a looping gait like a measuring-worm. Later they feed mostly at night and during the day remain hidden in the earth or under boards or rubbish. The caterpillar becomes mature in twenty-five or thirty days and is then from $1\frac{1}{2}$ to 2 inches in length. The general color is ashen or light dirty brown lightly mottled with darker brown. The underside is light gray. This cutworm may be distinguished from all other common species by the presence of from four to six yellow spots along the mid-dorsal line. Pupation takes place within an earthen cell just below the surface of the ground. The pupa is reddish brown and about $\frac{7}{10}$ inch in length. In summer the insect remains in the pupal stage from two to three weeks. Under greenhouse conditions the complete life cycle requires forty-five to fifty-four days.

### References

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## The White Cutworm

*Paragrotis scandens* Riley

From its habit of climbing fruit-trees and destroying the opening buds, the white cutworm has become notorious. In a severe outbreak in western New York in 1893 and 1894, over 90 per cent of the caterpillars found on fruit-trees were of this species. It is a native insect generally distributed over the northern United States and Canada east of the Rocky Mountains. In addition to injuring fruit-trees and grape vines,

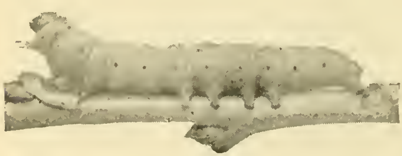

Fig. 166. — A full-grown white cutworm (natural size).

it has been recorded as attacking radish and cabbage though doubtless it feeds on other garden vegetables.

The partly grown caterpillars hibernate. They emerge in early spring and soon complete their growth, usually in the latter part of May and June. The mature caterpillar is $1\frac{3}{4}$ inches in length, of a very light yellowish gray with irregular whitish areas on the dorsal and lateral aspects of the body. There is a faint white stripe just below the spiracles (Fig. 166). Pupation takes place in the ground and the moths emerge during June and July. The pupa is $\frac{5}{8}$ inch in length. The moth has an expanse of $1\frac{3}{4}$ inches. The front wings are ash-gray suffused with either brownish, yellowish or reddish. There is a dark area at the posterior half of the reniform spot. The hind wings are whitish with a double dusky shade on the outer edge and have a dark discal spot (Fig. 167). The eggs of this species have not been described. There is only a single generation a year.

Fig. 167. — The white cutworm moth (natural size).

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Cornell Agr. Exp. Sta. Bull. 104, pp. 567–569. 1895.
Dept. Agr. Canada Ent. Bull. 10, pp. 21–22. 1915.

## The Glassy Cutworm

*Hadena devastatrix* Brace

This cutworm is more distinctly a forage crop pest but occasionally becomes injurious to vegetables. It is widely distributed throughout the United States and Canada, more abundantly in the North. It feeds on corn, grasses, wheat, oats, barley and strawberry. In mixed fields of timothy and clover, it is recorded that the former was destroyed while the clover remained uninjured. Beans, lettuce and cabbage are sometimes attacked. Unlike the more common cutworms, this species rarely comes to the surface, but works in a burrow, feeding on the roots and stems below ground. There is a case on record in Ohio of peach seedlings being destroyed in this way.

Hibernation takes place as partly grown larvæ. Some of them become mature in early May but the greater number during June and July. The full-grown caterpillar is $1\frac{1}{2}$ inches in length, dirty white with a greenish tinge and has a translucent glassy appearance; the head is reddish brown. Pupation takes place in earthen cells, $1\frac{3}{8}$ inches in length by $\frac{3}{4}$ inch in width. These cells are formed a few inches below the surface of the ground. The pupa is nearly an inch in length and of a reddish brown color.

FIG. 168. — The glassy cutworm moth ($\times 1\frac{1}{8}$).

The moth has an expanse of $1\frac{1}{2}$ to $1\frac{3}{4}$ inches. The front wings are pale ashy gray to dark brownish gray, mottled with darker brown. The subterminal transverse line is whitish and usually distinct. On the inner margin of this line is a row of five or six wedge-shaped black spots. The hind wings are brownish, darker on the outer third (Fig. 168). There is apparently but a single brood annually, the eggs being laid in the latter part of the season, the greater number after August first.

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## The Yellow-Headed Cutworm

*Hadena arctica* Boisduval

Like the glassy cutworm, this species lives from one to two inches below the surface of the ground, feeding on the roots and cutting off the underground stems of plants. The moths are attracted to lights in great numbers and are often seen; the caterpillars, however, have not elicited as much attention by their injuries as would be expected. It is primarily a field crop pest injuring grasses, oats, wheat and corn. It also feeds on cabbage, spinach, turnip, lettuce and the succulent shoots of roses and currants. The insect is widely distributed throughout the northern United States and Canada.

The winter is passed as partly grown caterpillars. The larvæ are most destructive in May and June. The full-grown caterpillar is $1\frac{1}{2}$ inches in length and closely resembles the glassy cutworm, from which it may be distinguished by its yellow head. Pupation takes place in the ground. The pupa in size and color is almost identical to that of the glassy cutworm. The adults emerge in about a month and are on the wing from June to September. The moth has an expanse of nearly 2 inches. The front wings are rich reddish brown, bluish gray at the base and with a broad transverse band of the same color near the outer margin. The whole wing is mottled with varying shades of deep brown and blue-gray, giving it the appearance of a rich brocade. The hind wings are brownish, darker on the outer third and with a dark discal spot. The thorax is ornamented with dense tufts of chestnut-

Fig. 169. — The yellow-headed cutworm moth (natural size).

colored hairs (Fig. 169). The eggs of this species have not been described. There is only one brood annually.

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## THE SPOTTED-LEGGED CUTWORM

*Porosagrotis vetusta* Walker

Although a rather uncommon species, this cutworm has occasionally appeared in destructive numbers in Virginia and North Carolina. It ranges from Nova Scotia south to Georgia and west to Colorado. Its food plants include cowpea, watermelon, cantaloupe, kale, spinach, lettuce, cabbage, cultivated dandelion, parsley and corn. It has also been recorded as climbing peach-trees to feed on the buds.

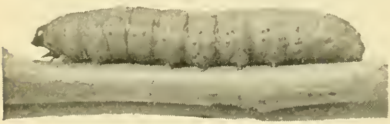

FIG. 170. — A full-grown spotted-legged cutworm ($\times 1\frac{1}{8}$).

In New York the winter is probably passed as partly grown caterpillars which complete their growth the following season and pupate in July. The moths are on the wing in late July, August and September. In the South the caterpillars are destructive in April and May and again in September. The full-grown caterpillar is about $1\frac{1}{2}$ inches in length; the whole body above the spiracles is a dull, dark grayish brown; the underside is lighter (Fig. 170). The body is marked with

FIG. 171. — The spotted-legged cutworm moth ($\times 1\frac{1}{3}$).

numerous black piliferous tubercles. The base of the true legs behind and the prolegs in front bear each a greenish black spot, whence the common name. The moth has an expanse of about 1½ inches and is easily distinguished from the other species here treated. The front wings are pale powdery ash-gray, sometimes tinged with pinkish. There is a small dark median spot and inside the submarginal line is a row of small triangular black spots. The hind wings are white (Fig. 171). The egg has not been described. The pupa is about ¾ inch in length and pale brown in color.

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## The Speckled Cutworm

*Mamestra subjuncta* Grote and Robinson

The speckled cutworm ranges throughout Canada and the northern United States southward to Colorado and New Mexico. So far it has been recorded as feeding only on cabbage and climbing fruit-trees to devour the buds and foliage.

Fig. 172. — The speckled cutworm moth (× 1¼).

It is not known in what stage hibernation takes place, though it is probably as partly grown caterpillars. The mature caterpillar is slightly over 1½ inches in length, reddish gray, minutely speckled with black and white, hence the common name. When they have completed their growth, the larvæ burrow into the ground and transform to dark brown pupæ from which the moths emerge from late June to September. The moth has an expanse of about $1\frac{1}{2}$ inches. The front wings are dull gray with the usual pattern lightly marked but distinct. There is a dark dash at the base of the wing and another below the middle. The subterminal line has two long teeth running to the margin. The hind wings are dirty white, darker towards the margin (Fig. 172).

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## The Clover Cutworm

*Mamestra trifolii* von Rottenburg

This cutworm ranges throughout the northern hemisphere and has been reported from Chile. It has been especially injurious to cabbage in the vicinity of Washington, D. C., and in Canada it has proved destructive to peas and clover. It also attacks mangel, turnip, beet, lettuce and spinach. Among its wild food plants are lamb's quarters and purslane.

Fig. 173. — The clover cutworm moth ($\times 1\frac{1}{4}$).

Unlike many cutworms, it passes the winter in the pupal stage. The spring brood of moths is on the wing in May and June and the second brood in August and September. The first brood of caterpillars is relatively small and does comparatively less injury. The second brood in August and September often proves very destructive to peas, clover and late cabbage. The mature caterpillar is about 2 inches in length, greenish yellow, mottled with brown and black, and has a broad pinkish band below the spiracles. Pupation takes place in the ground.

The moth has an expanse of $1\frac{1}{4}$ to $1\frac{1}{2}$ inches. The front wings are yellowish brown marked with gray and dark brown. The posterior half of the reniform spot is fuscous (Fig. 173). Apparently the eggs of this species have not been described.

### Reference

Dept. Agr. Canada Ent. Bull. 10, p. 26. 1915.

## The Bristly Cutworm

*Mamestra renigera* Stephens

The range of the bristly cutworm is from Georgia and New Mexico northward to Colorado, Ontario and Nova Scotia. It is mainly a grass and garden pest, feeding on clover, grasses, turnip, corn, cabbage, chicory, comfrey and garden flowers. It feeds chiefly on the roots.

Fig. 174. — The bristly cutworm moth ($\times 1\frac{7}{8}$).

The winter is passed as partly grown larvæ, which cause the most serious injury in April and May. The full-grown caterpillar is about an inch in length, yellowish gray marked with two distinct black lateral stripes. Scattered over the entire body are many black and yellow bristles — hence its common name. Pupation takes place in the ground. The moth has an expanse of about an inch. The front wings are rich brown, the reniform spot green margined with white and the orbicular spot inconspicuous. There are on each wing a distinct quadrate green patch on the hind angle and an elongate one near the middle of the base. The hind wings are smoky, darker towards the edge (Fig. 174). There are two generations annually. The moths of the first brood are on the wing from late May to the middle of July; those of the second, from August to October.

### Reference

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## The Bronzed Cutworm

*Nephelodes minians* Guenée

Although rarely injurious in vegetable-gardens, the bronzed cutworm is often destructive to corn, grain and grasses. This species ranges throughout the northern United States and Canada.

The winter is passed as partly grown caterpillars. They mature in June and are then nearly 2 inches in length, of a grayish brown or bronze color with conspicuous pale stripes extending the whole length of the body, a median stripe, and on each side two stripes above the spiracles, the upper one broader and more distinct. The dorsal stripes cross the cervical and anal shields. The caterpillars transform to dark brown pupæ in earthen cells. The pupal period may last as long as ten weeks. The moth has an expanse of about $1\frac{1}{2}$ inches. The front wings are rich reddish brown often suffused with violet, and crossed near the middle by irregular darker brown bands. The hind wings are brown suffused with reddish or violet (Fig. 175). The eggs of this species have not been described. So far as known, there is only a single generation annually.

Fig. 175. — The bronzed cutworm moth ($\times 1\frac{1}{4}$).

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## The Army Cutworm

*Chorizagrotis auxiliaris* Grote, *C. introferens* Grote, *C. agrestis* Grote

This is one of the most common and injurious species in Colorado, Montana, California and Alberta. It is generally distributed throughout western North America from Mexico northward and as far east as Louisiana, Kansas and Manitoba. It is distinctly a surface feeder, burrowing very little. When abundant this species assumes the army-worm habit to a marked degree; in California it is known as the western army-worm. Its food plants are cabbage, horse-radish, mustard, turnip, beet, corn, pea, celery, tomato, potato, onion, rhubarb, alfalfa, lupine, clover, timothy and other grasses, wheat, oats, barley, rye and strawberry. The caterpillars also climb and feed on the buds of fruit- and forest-trees.

The winter is passed as partly grown larvæ on or in the ground. In Montana they become mature in early April. The full-grown caterpillar is 1½ to 2 inches in length, dull green to greenish brown with the back broadly pale or with two broad, lighter dorsal stripes. The underside is lighter, nearly white at the level of the spiracles. The dark side is divided by a fine pale line and the light dorsum strongly shaded with white; the head is light yellow mottled with brown but without brown stripes on the sides. Occasionally the larva is almost uniform dark green above except for two rows of pale patches on the back. Pupation takes place in earthen cells in the ground two or three inches from the surface. The dark brown pupa is about ¾ inch in length. The moths emerge in about two months or from the last of June to the middle of July. The moth has an expanse of nearly $1\frac{3}{4}$ inches. The front wings are gray or clay-colored shaded with brown and marked with black. The orbicular and reniform spots are distinct, outlined with dirty white and the basal two thirds of the front margin of the wing has a broad light band. The hind wings are brownish, darker towards the margin (Fig. 176). In the *agrestis* form the markings are nearly all obscure. Although the moths emerge in late June and early July, they do not deposit their eggs until September and October. The yellowish white, globular, slightly flattened eggs, about $\frac{1}{40}$ inch in diameter, are deposited on the surface of the soil often in newly plowed fields and hatch in nine or ten days. The larvæ become partly grown before the advent of cold weather. There is only one generation a year in Montana and Alberta.

FIG. 176. — The army cutworm moth ($\times 1\frac{1}{12}$).

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## THE ARMY-WORM

*Heliophila (Leucania) unipuncta* Haworth

The army-worm is one of the most cosmopolitan of insects. It occurs in practically every region of the world except Africa but is most injurious in the northern United States and Canada. In this species the habit of migrating from field to field in large numbers, or so-called armies, is developed to a high degree and has attracted widespread popular interest. In North America periodic outbreaks have been recorded at intervals since 1743. One of the most widespread and injurious broke out in 1861 when the caterpillars appeared in greater or less abundance in twenty states. Other notable outbreaks occurred in 1896 and in 1914. The insect is always present in low pastures and meadows and nearly every year there are local outbreaks in some parts of the country. Many theories have been offered to account for these widespread and periodic manifestations but no satisfactory explanation has been advanced. Whatever factors are concerned in determining the abundance of this insect in any one year, they must be effective over a wide area. The abundance of the species in different years is undoubtedly dependent on a combination of circumstances, such as temperature, drought and moisture, and the prevalence of fungous diseases and parasitic insect enemies.

The army-worm feeds normally on grasses. When abundant it completely destroys its food supply in a given area and then migrates in armies, devouring almost every green thing in its path, although it eats clover only sparingly. Besides grains and grasses, it feeds on bean, sugar-beet, sweet potato, parsley, cucumber, watermelon, celery, pepper, strawberry, cranberry, sugar-cane and many weeds. The caterpillars feed at night or during cloudy weather; in the heat of the day they hide under any convenient shade.

In the North hibernation takes place as partly grown caterpillars, in the South in the larval and adult stages and exceptionally in the egg stage. The over-wintering caterpillars are rarely sufficiently abundant to attract much notice. In New York these mature in May; in New Jersey in April. The caterpillar (Fig. 177) is described by Slingerland as follows:

When full-grown, army-worms measure nearly $1\frac{1}{2}$ inches in length. They are of a general greenish black color, much lighter on the venter, which is more or less mottled with blackish, and each side bears several distinct stripes. Along each side of the body extend three stripes of about the same width; the one just below the spiracles is of a light greenish yellow with whitish edges; the one bordering on the dorsum is a little darker with a mottled greenish black center and narrow white lines along its edges; the central stripe, or the one with the spiracles in its lower edge, is black, sometimes lighter along its center. The dorsum is finely mottled with greenish black and closely resembles the dark stigmatal stripe in color; along the middle line of the dorsum there extends a narrow white stripe, usually quite indistinct except on the thoracic and anal segments. The six true legs are light brown in color, and each proleg is marked with a large, shiny, blackish spot. The head is of a greenish brown color, rather coarsely mottled with black which merges into distinct blackish stripes along the sutures. There is considerable variation in general color among the caterpillars, some being much lighter than others, due to differences in the intensity of the stripes and the mottlings on the body.

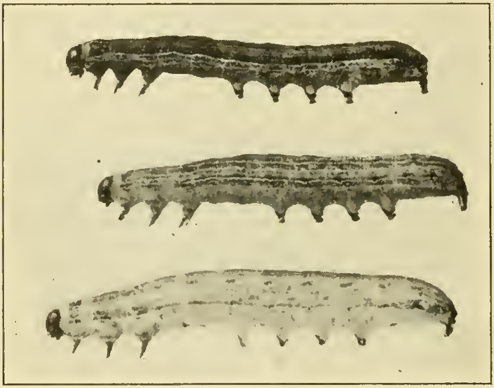

FIG. 177. — Army-worms, showing variation in color (slightly enlarged).

The moths deposit their eggs in the sheath or unfolded base of the leaves of grains and grasses. The eggs are laid in rows of ten to sixty and covered with a white, gelatinous substance which fastens them together and folds the edge of the leaf closely around them. Each female moth lays from 500 to

750 eggs. The egg is about $\frac{1}{40}$ inch in diameter, spherical, nearly smooth and very light yellow in color. The eggs hatch in six to ten days. The young caterpillar is translucent whitish, with a dark brown head and is about $\frac{1}{12}$ inch in length. In the course of its development the larva passes through six immature stages, molting five times. In the first two stages the first two pairs of prolegs are not fully developed and the young larvæ consequently loop along like measuring-worms. When disturbed they drop by means of a silken thread. In the third stage they begin to acquire the characteristic stripes of the mature caterpillar. From twenty to thirty days are usually spent in the larval stage. When full-grown the caterpillars enter the ground, where at a short distance below the surface they transform to mahogany brown pupæ about $\frac{3}{4}$ inch in length. In about three weeks the moths emerge (Fig. 178). They have an expanse of about $1\frac{3}{4}$ inches. The front wings are brown and are marked with two more or less distinct lighter spots near the middle. In the reniform spot there is a small, distinct white dot. The hind wings are dull gray, paler at the base.

Fig. 178. — The army-worm moth (natural size).

In New York there are usually three broods of caterpillars annually; the first brood or over-wintered larvæ in April and May, the second in July and the third in September, the last not maturing until the following spring. There are thus only two generations a year in this state. In the South there are as many as five or six generations annually. In the North the second brood is the most injurious but in the South either the first, second or third may prove the most destructive.

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## The Fall Army-Worm

*Laphygma frugiperda* Smith and Abbot

The range of the fall army-worm extends from Canada southward through Central America and the West Indies to Argentina, it being most injurious in the warmer parts of its range. It is called the fall army-worm because in the United States it usually appears in armies later in the season than the true army-worm. Destructive outbreaks have been recorded from Nebraska to Indiana and southward in the Mississippi Valley and in the Gulf states to Georgia. Along the Atlantic Coast outbreaks of lesser importance have been reported as far north as Connecticut. Its favorite food plants are certain grasses and in the South it is known as the grass-worm. When abundant and migrating it becomes a general feeder. Serious injury to the following crops has been reported: rice, teosinte, kaffir corn, millet, cowpea, chick-pea, velvet bean, clover, corn, alfalfa, oats, rye, barley, cotton, tobacco, strawberry, sweet potato, spinach, cabbage, tomato, potato, cucumber and turnip. It also occasionally climbs trees and has been recorded as injuring orange, peach and apple.

Normally hibernation takes place in the pupal stage, at least in the northern part of its range. It is quite probable, however, that in the South the larvæ and moths may also hibernate. In southern Nebraska the moths emerge in late May and June. They have an expanse of $1\frac{1}{4}$ inches. The front wings are dull grayish brown with the orbicular spot oblique; in one form all markings are indistinct; in the other there is near the tip of the wing a bluish white spot and the orbicular spot is crossed by a diagonal white bar; the cross lines are also more distinct. The hind wings are pearly white margined with brownish (Fig. 179). The moth deposits its eggs in clusters of fifty to one hundred or more on the leaves of its food plants. They are arranged in two layers, one above the other, and covered with fine gray down from the moth's body. The egg is nearly spherical, white to pinkish, about $\frac{1}{30}$ inch in diameter and marked with about sixty vertical ribs, crossed with smaller ones. The eggs hatch in ten days or less and the caterpillars reach maturity in about a month. The full-grown caterpillar is $1\frac{1}{2}$ inches in length, varying in color from pale yellowish brown to blackish and is marked with three narrow pale yellow stripes on the back and a broader yellowish line on each side. The larvæ transform to dark brown pupæ, about $\frac{1}{2}$ inch in length, in earthen cells slightly below the surface of the ground. The pupal cells are placed vertically and the pupæ lie with their heads directed upward. The cells in which hibernation takes place are heavily lined with silk.

FIG. 179. — The fall army-worm moth ($\times 1\frac{1}{2}$).

Recent observations have shown that in southern Nebraska there are three generations a year. The spring brood of moths appears in May and June. The caterpillars of this brood occur in July and give rise to a second brood of moths in late July and early August. The caterpillars of the second brood mature in August and early September. The third brood of moths appears in September and eggs are deposited within a short time. The last or fall brood of caterpillars does the greatest damage during September and October. In the South another generation probably occurs but definite information in regard to this point is not available.

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## The Beet Army-Worm

*Caradrina exigua* Hübner, *C. flavimaculata* Harvey

This cosmopolitan army-worm is represented in North America by a variety (*C. flavimaculata*) which, by some authorities, is considered as a distinct species. In North America it is found only in the western United States and Mexico. Its favorite food plant is the sugar-beet but it also feeds on corn, alfalfa, potato, pea, onion, cotton and many weeds. In Egypt and the Sudan it is very destructive to cotton and lucerne, while in India it does serious injury to the indigo plant.

The hibernation habits are not known with certainty. In Colorado it would appear from the late emergence of the moths in the fall that the winter is passed in the adult state. In California the first brood moths appear in April; in Colorado in May. The moth has an expanse of about an inch. The front wings are grayish brown; the small, round, orbicular and reniform spots are pale. The hind wings are opalescent white with the veins and margin brown (Fig. 180). The eggs are deposited in masses of twelve to fifty on the underside of the leaves and covered with grayish down. The egg is pyramidal in shape, the upper third in the form of a cap and separated from the remainder by a white band. The eggs hatch in about four days. The young larvæ live in small colonies and skeletonize the leaves under the protection of a web spun over their feeding ground. When half grown they abandon their webs and feed openly, devouring the whole leaf except the larger veins. They feed only at night, during the day remaining hidden in the soil. In about two weeks the caterpillars become full-grown and are then slightly over an inch in length. They vary considerably in color but are usually green with a broad, gray or black lateral band bordered on the upper side by a narrow white line. The mature caterpillars burrow a short distance into the soil and there in earthen cells transform to yellowish brown pupæ a little less than $\frac{1}{2}$ inch in length. The insect remains in this condition for about two weeks. In California there are two or three broods a season, the second being the most injurious.

Fig. 180. — The beet army-worm moth ($\times 1\frac{7}{8}$).

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## The Yellow-Striped Army-Worm

*Prodenia ornithogalli* Guenée

This species ranges throughout the United States from Massachusetts to California and southward to Costa Rica and the West Indies. It is more injurious in the southern part of its range, where it attacks cotton and tobacco. It also feeds on beet, cabbage, potato, tomato, salsify, asparagus, watermelon, cucumber, corn, wheat, alfalfa and clover. As a climber it attacks peach, raspberry and grape. It is reported as also feeding on cotton bolls and the heart of young corn plants in the same way as the cotton boll-worm.

Hibernation takes place either as larvæ, pupæ or adults. In California the spring brood of caterpillars is most abundant in May and June. The full-grown larva is from $1\frac{1}{2}$ to 2 inches in length (Fig. 181). There are two varieties; one is velvety black above and reddish brown beneath with two prominent and many fine bright yellow lines on the side; the other is reddish gray and has the back marked with a pair of triangular black spots on each segment, the lateral markings not being so distinct. In late May and June the caterpillars transform in earthen cells to rich reddish brown pupæ and the moths emerge two or three weeks later.

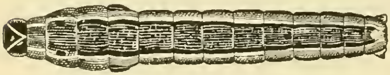

Fig. 181. — The yellow-striped army-worm (natural size).

The moth has an average expanse of $1\frac{1}{2}$ inches. The front wings are brownish gray with a beautiful and complicated pattern. The reniform spot is small and pyriform; the orbicular is elongate oval, and is placed in a light-colored bar extending towards the hind angle of the wing. In the middle of the wing there is a small sharply defined white V. The hind wing is opalescent white, narrowly margined with brown (Fig. 182). Nothing is known as to the egg-laying habits of this species. In California it is said to be double brooded, the spring brood being the more destructive.

Fig. 182. — The yellow-striped army-worm moth ($\times 1\frac{1}{4}$).

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## The Semi-Tropical Army-Worm

*Prodenia cridania* Cramer

The semi-tropical army-worm ranges from Georgia, Florida and Texas southward through Central America and the West Indies to Argentina. In Florida it has been reported as injurious to tomato, potato, sweet potato, eggplant, pepper, okra, collard and cowpea. The caterpillars commonly climb the plants on which they feed and when abundant may assume the army-worm habit.

In this species breeding is almost continuous throughout the year, there being four or more generations annually. The moth has an expanse of about $1\frac{1}{2}$ inches. The front wings are dull gray, sprinkled and dotted with brownish and black. The hind wings are pearly white. The eggs are laid in irregular masses, sometimes in two layers, and are covered with whitish down from the female's body. The egg is about $\frac{1}{40}$ inch in diameter, hemispherical, finely ribbed and pale green in color. The eggs hatch in about six days and the caterpillars mature within three weeks. The full-grown larva is 1 to $1\frac{1}{2}$ inches in length and varies in color from dark grayish to nearly black. It is marked with a median, subdorsal and lateral yellow stripes. The mahogany brown pupa, about $\frac{3}{4}$ inch in length, is to be found in the ground a few inches from the surface. The insect passes about ten days in this stage.

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## Other Cutworms

*Paragrotis atomaris* Smith

This cutworm is abundant in California where it is reported as feeding on weeds and garden crops. It also climbs grape vines and prune trees to feed on the buds and foliage. The full-grown caterpillar is $1\frac{1}{2}$ inches in length and light gray in color. This species is said to hibernate in both the larval and pupal stages. The almost uniform gray moths emerge in April.

The following species have been recorded as occasionally injurious:

*Dargida procinctus* Grote. In British Columbia.
*Feltia venerabilis* Walker. In Manitoba.
*Leucania albilinea* Hübner. In the eastern United States.
*Paragrotis detersa* Walker. In Manitoba.
*Paragrotis insulsa* Walker. In Manitoba.
*Paragrotis perexcellens* Grote. In British Columbia.
*Porosagrotis orthogonia* Morrison. In Alberta. Injurious to grain.
*Rhynchagrotis alternata* Grote. In Missouri.
*Rhynchagrotis placida* Grote. In Michigan.

## The Control of Cutworms and Army-Worms

The means employed for the control of cutworms will vary according to the crop, the conditions under which it is grown and the habits of the species causing the injury.

In small vegetable-gardens and greenhouses, hand-picking may be used to advantage. Careful watch of the plants should be kept and whenever injury is noticed, the soil around the base of the plants should be searched and the cutworms destroyed. Shingles or small boards laid about the beds will form attractive hiding places for the worms during the day; here they may be easily found and destroyed. When such plants as tomatoes are transplanted, they may be protected by using cardboard or tin cylinders sunk a short distance in the soil. Tin cans with the top and bottom removed are convenient for this purpose. Greenhouses often become infested by cutworms in the rotted sod used in the beds. This may be prevented by sterilizing the soil by steam before using.

Probably the most practical, cheap and convenient method of cutworm control is the use of poisoned baits. These may be employed equally as well in the home garden, greenhouse or in the field. For general field work, a bait made according to the following formula has been found effective against the variegated cutworm and others of similar habits:

| | |
|---|---|
| Bran . . . . . . . . . . . . | 20 pounds |
| Paris green . . . . . . . . . | 1 pound |
| Molasses . . . . . . . . . | 2 quarts |
| Oranges or lemons . . . . . | 3 fruits |
| Water . . . . . . . . . . | $3\frac{1}{2}$ gallons (about) |

The dry bran and paris green are thoroughly mixed in a tub or similar receptacle. The juice of the oranges or lemons is squeezed into the water; the remaining pulp and peel are chopped into fine bits and added to the water. The molasses is dissolved in the water and the bran and poison wet with it, the mixture being constantly stirred so as to dampen the mash thoroughly. Only enough water should be used to just moisten the mash but not enough to make it sloppy.

This quantity of bait will treat about three acres. The material should be scattered broadcast evenly over the infested area at nightfall. If applied during the day, it dries out and is not then attractive to the cutworms. In the garden or greenhouse a small quantity of the bait may be placed near each plant.

Another formula which has given excellent results in western Canada is as follows:

| | |
|---|---|
| Shorts | 50 pounds |
| Paris green | 1 pound |
| Molasses | 2 quarts |
| Water | 2½ gallons |

The ingredients should be mixed as in the preceding formula and applied in the same way. This is said to give better results under dry conditions.

Fig. 183. — A furrow with post-holes in the bottom, along the edge of a corn field to stop an army-worm invasion.

These baits are also effective in the control of army-worms. In such case, the baits should be sown liberally in the path of their march.

A bait may be made of bundles of fresh clover, grass or other tender vegetation dipped in or sprinkled with a mixture of paris green and water. Small piles of this material are then distributed in the evening at short distances in the infested fields.

Much may be done to prevent injury from cutworms by fall plowing of land intended for vegetable crops. In this way hibernating shelter is reduced to a minimum and many of the caterpillars are either killed or exposed to the attacks of their enemies. Clean farming through the destruction of weeds along fences and ditch banks will also do much to prevent the prevalence of cutworms.

Whenever cutworms assume the army-worm habit, their advance may be stopped by plowing a furrow across their line of march (Fig. 183). The vertical side of the furrow should be next to the field to be protected and should be smoothed by means of a spade. Every ten or fifteen feet along the bottom of the furrow post holes a foot or so in depth should be dug. When the migrating caterpillars reach the furrow and find themselves unable to climb up the smooth side, they crawl along the furrow and drop into the post holes, where they may be easily and readily killed by crushing or with kerosene oil. Any caterpillars that succeed in crossing the barrier may be killed by the free use of the poison baits described above.

# CHAPTER XVI

## BLISTER-BEETLES

The blister-beetles are elongate, long-legged insects which in the adult stage frequently attack cultivated crops in swarms. They devour the foliage and blossoms and frequently defoliate the plants. They usually feed in colonies moving slowly across the field and destroying the plants as they go.

As far as known, the larvæ of blister-beetles feed on grasshopper eggs but the life history of most species has not been studied. C. V. Riley has given a good account of the early stages of the striped blister-beetle, but even in the case of this species much remains to be learned. About two hundred species of blister-beetles are known to occur in America north of Mexico. Less than a score of these have been recorded as injurious to cultivated plants, but it is quite probable that many of the others may on occasion become destructive.

Most blister-beetles contain a substance, cantharidin, which has the property of blistering the skin. The spanish-fly of commerce consists of the dried bodies of certain species of blister-beetles.

### The Striped Blister-Beetle

*Epicauta vittata* Fabricius

The striped blister-beetle has long been known as an enemy of the potato, on which it was formerly more destructive than it has been since the invasion of the Colorado potato beetle. It is generally distributed from New England, Quebec and Ontario to Montana and southward to Texas and Florida but is most abundant in the central and southern states. The beetle (Fig. 184) is $\frac{1}{2}$ to $\frac{3}{4}$ inch in length. In the typical form, the head, prothorax and wing-covers are dull yellow or reddish yellow. On the head there are two black spots; on the prothorax two black stripes, and on each wing-cover two broad black stripes. In the variety known as *lemniscata* there are three black stripes on each wing-cover. In Illinois the beetles are to be found from the first of June to the first of September and are most abundant during the last half of July and the first part of August. They feed ravenously on the foliage and blossoms of their food plants but have a tendency to be scattered more uniformly through the fields than is the more usual habit among blister-beetles. They attack potato, tomato, beet, eggplant, carrot, cabbage, turnip, radish, bean, pea, melon, corn, buckwheat, clover, and in Oklahoma have been found very destructive to ripening tomatoes. They also feed on cotton, clematis, arrow-leaf and pigweed.

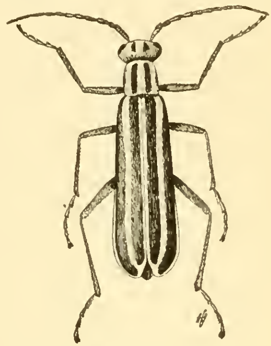

FIG. 184. — The striped blister-beetle ($\times 1\frac{5}{8}$).

In Missouri egg-laying begins in July and may continue until October. The female deposits her eggs in clusters of about 130 in small excavations in the ground which she hollows out and then covers them with earth. The same beetle may lay several batches of eggs in the course of her life. The egg is about $\frac{1}{12}$ inch in length, smooth and shining, elongate, cylindrical, rounded at the ends and of a pale yellowish color. The eggs hatch in ten to twenty-two days. The newly hatched larva is about $\frac{1}{8}$ inch in length and yellowish brown in color; the head is large and provided with a pair of strong jaws. The legs are long and slender and the body is elongate and tapers toward the tip, which is provided with two long setæ. On hatching, the young larvæ run actively about and burrow into the soil, seeking for grasshopper eggs. They possess great vitality and can survive without food for at least three weeks. As soon as an egg-pod is found, the larva gnaws its way into the capsule and begins feeding on the eggs; about eight days after beginning to feed, the larva molts. The second stage larva is white, has a smaller head, shorter legs, and the two long setæ at the tip of the body have been lost. When in its natural position, the larva has its abdomen curled beneath. The larva continues to feed on the grasshopper eggs and in about a week molts a second time. The third stage larvæ have the mouth-parts and legs much more reduced, the body becomes stouter and thicker and is strongly curved, with the head proportionately smaller. The larva grows rapidly and takes on a yellowish color, becoming full-grown within the egg-pod of the grasshopper. In about ten days after entering the egg-pod the larva molts for the third time and about nine days later becomes full-grown. In the fourth stage the body is more distinctly yellowish. When fully fed, the larva leaves the egg-pod and works its way some distance into the surrounding soil. It there constructs a smooth cavity in which it molts again but does not completely shed its skin, the latter being attached to the posterior part of the body. In this stage the insect remains in a dormant condition. The legs and mouth-parts are much reduced and are not functional. The skin becomes leathery and acquires a deep yellow color. It is about $\frac{3}{5}$ inch in length. In this condition the insect usually hibernates, and in some cases may remain in this state during a second and even sometimes a third winter. In the spring the insect molts again. This time the larva resumes the form in which it left the egg-pod but is somewhat smaller and paler. After moving about in the soil for a few days, it transforms to a pupa. The pupal stage lasts about two weeks. There is only one brood annually, at least in Illinois and Missouri. The striped blister-beetle is a striking instance of an insect that is beneficial in one stage of its development and highly destructive in another.

### References

Riley, Trans. Acad. Sci. St. Louis, 3, pp. 544–562. 1878.
Iowa Agr. Exp. Sta. Bull. 155, pp. 377–380. 1915.

## The Margined Blister-Beetle

*Epicauta marginata* Fabricius

This blister-beetle (Fig. 185) is a little over ½ inch in length, black, with the head and sides of the thorax ashy gray. The wing-covers are black, the inner and the outer margin with a narrow stripe of gray. This beetle is distributed throughout the eastern United States and occurs sparingly in Canada. The larva has been found feeding on the eggs of the differential locust. The first stage larva is about $\frac{1}{10}$ inch in length and similar to that of the striped blister-beetle.

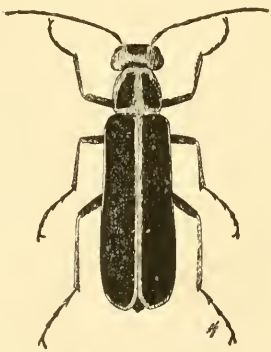

Fig. 185. — The margined blister-beetle (× $2\frac{3}{4}$).

The beetles are found from June to October. They feed in colonies. They have a special fondness for beet, but also attack bean, potato, tomato, cabbage, pumpkin, clematis, aster, pigweed, ground cherry and wild sunflower.

## The Gray Blister-Beetle

*Epicauta cinerea* Forster

The gray blister-beetle (Fig. 186) closely resembles the ash-gray species with which it has often been confused. It is distinguished by having the second segment of the antennæ less than one half as long as the third. The ash-gray blister-beetle is a duller, darker gray; the gray blister-beetle is a lighter gray with a slight tinge of yellow. This latter beetle has also been confused with the margined species, some writers even considering the two as merely varieties of the same species. While the gray blister-beetle is recorded as occurring sparingly in the East, it is much more abundant in the West in Iowa, Colorado, Kansas, Nebraska and Texas. It attacks bean, lentil, lupine, potato and clover and in western Nebraska has been recorded as feeding on the hornbean, locust and honey locust. It has been reared from the egg-pods of the Rocky Mountain locust. The egg is pale clay-yellow in color, elongate elliptical in outline, and about $\frac{1}{18}$ inch in length.

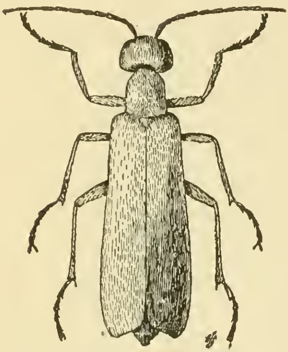

Fig. 186. — The gray blister-beetle ($\times 3\frac{1}{4}$).

## The Ash-Gray Blister-Beetle

*Macrobasis unicolor* Kirby

The species known as the ash-gray blister-beetle (Fig. 187) is $\frac{1}{3}$ to $\frac{3}{5}$ inch in length. The ground color is black but the insect is clothed with a grayish pubescence so that its general appearance is dark gray. The insect is distributed throughout

Canada and the United States westward to Kansas and Nebraska.

The life history of this insect has never been fully worked out. The beetles appear in swarms in May or June and are more or less abundant until autumn. The female lays her eggs in irregular masses in the ground an inch or so below the surface. The beetles have been reared from larvæ feeding on the eggs of the Rocky Mountain locust. In Minnesota there are said to be two generations annually, the adults of the first brood appearing about the middle of June, those of the second from the middle of August to early in September. These beetles are especially fond of leguminous plants, pea, bean, soybean, cowpea, clover, alfalfa, black locust, honey locust, wild indigo, lupine and astragalus. They also attack potato, tomato, sweet potato, beet, radish, flax and several wild plants.

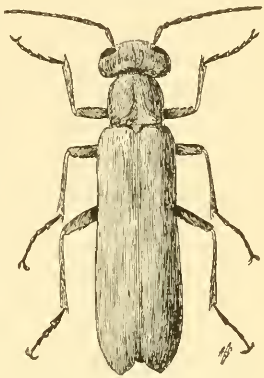

Fig. 187. — The ash-gray blister-beetle (× 4½).

## The Black Blister-Beetle

*Epicauta pennsylvanica* De Geer

This insect (Fig. 188) is ½ inch or less in length and of a uniform, dull black color. It is widely distributed throughout the eastern United States and Canada east of the Rocky Mountains. It attacks a large variety of plants, including potato, tomato, carrot, mangel, cabbage, corn, onion, chrysanthemum, pink, aster, clematis, passion flower, zinnia and alfalfa. It also feeds on pigweed, thoroughwort, ragweed and meadow rue.

This blister-beetle usually becomes abundant a little later in the season than the other common species. The egg is pale clay-yellow, elongate elliptical and slightly less than $\frac{1}{20}$ inch in length. The eggs are deposited in clusters of eighty to over one hundred in the ground in late summer or fall. They hatch in two or three weeks. The first stage larva is black, about $\frac{1}{12}$ inch in length and in structure resembles that of the striped blister-beetle. The larvæ feed on grasshopper eggs, adults having been reared from larvæ found in the egg-pods of the Rocky Mountain locust. There is only one brood annually.

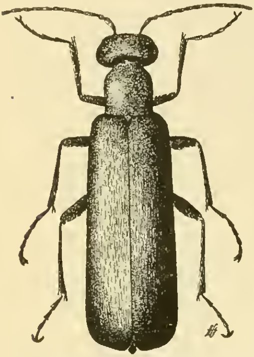

FIG. 188. — The black blister-beetle ($\times 3\frac{1}{4}$).

On the Pacific Coast a closely related black blister-beetle, *Epicauta puncticollis* Mann, has been reported as injurious to potato and aster.

## NUTTALL'S BLISTER-BEETLE

*Cantharis nuttalli* Say

The head and prothorax of Nuttall's blister-beetle (Fig. 189) are green, often with coppery or purplish reflections, and the insect is from $\frac{3}{4}$ to 1 inch in length. The wing-covers vary from dark purplish green to a rich bronzy purple. The antennæ and legs are dark greenish or bluish. The underside of the body is dark green. This beautiful beetle ranges from Saskatchewan southward west of the Mississippi and east of the Rockies to New Mexico. The life history has not been worked out but the larvæ are supposed to feed on grasshopper eggs. The beetles often appear in swarms and devour

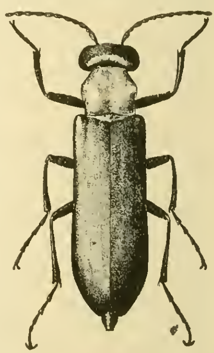

FIG. 189. — Nuttall's blister-beetle ($\times 1\frac{1}{2}$).

the foliage of beans, beets, alfalfa, vetch, oats and barley. The beetles appear at irregular intervals, some years being very rare. In the northern part of their range, they may be expected from the middle of June to the last of July and sometimes continue until fall.

## The Spotted Blister-Beetle

*Epicauta maculata* Say

The spotted blister-beetle (Fig. 190) is ½ inch or less in length, light gray in color with the wing-covers marked with numerous small round black spots where the pubescence is lacking. This blister-beetle ranges from western Canada southward through Montana, South Dakota, Kansas, Nebraska and Oklahoma to New Mexico and westward to Washington, Oregon and California east of the Cascade Mountains. The beetles attack potato, bean, beet, cabbage, spinach, alfalfa and clover. They have also been recorded as feeding on lamb's quarters and grease-wood. In British Columbia the beetles are abundant from the middle of May till the middle of August. The early stages have not been described.

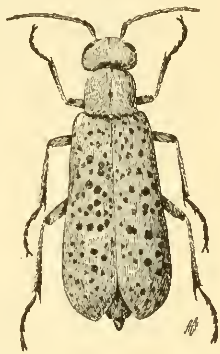
Fig. 190. — The spotted blister-beetle (× 3).

## The Two-Spotted Blister-Beetle

*Macrobasis albida* Say

This beetle (Fig. 191) is nearly an inch in length, uniform light gray, with two elongate black spots on the prothorax. The basal part of the antennæ is yellowish or reddish. This species ranges from Kansas to Texas and westward to Arizona. It has been reported as injurious to potato, tomato, pea and sugar-beet.

A closely related species, *Macrobasis longicollis* Leconte (Fig. 192), lacking the two black spots on the prothorax, has

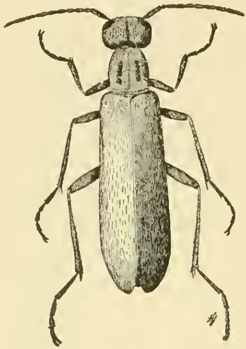

FIG. 191. — The two-spotted blister-beetle ($\times 1\frac{1}{2}$).

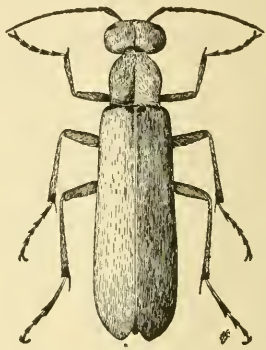

FIG. 192. — *Macrobasis longicollis* ($\times 2$).

been recorded as very destructive to potatoes and alfalfa in New Mexico.

## MISCELLANEOUS BLISTER-BEETLES

*The immaculate blister-beetle, Macrobasis immaculata* Say, is uniform yellowish gray in color and is nearly an inch in length. It has been reported as injurious in Kansas and Colorado. It feeds on potato, tomato and cabbage.

*The segmented black blister-beetle, Macrobasis segmentata* Say, is large and black, from $\frac{5}{8}$ to an inch in length. It has been recorded as injurious to beet, potato, tomato and cabbage in Kansas. Its range extends into Mexico. The beetle is dull black in color, usually with a narrow band of lighter hairs on the front and hind margins of the prothorax. The underside of the abdomen is ringed with a narrow band of light hairs on the hind margin of each segment.

*The large black blister-beetle, Lytta insperata* Horn (Fig. 193). In southern California sugar-beets are sometimes seriously injured by this shining black blister-beetle, about $\frac{3}{4}$ inch in length. The dorsal surface often has a rich, bluish metallic luster and there is a small red spot on the middle of the face just above the eyes.

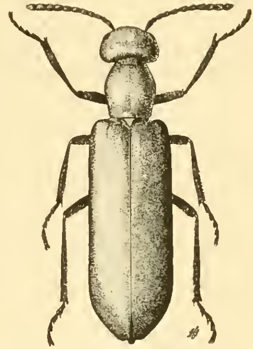

Fig. 193. — The large black blister-beetle (× 2).

*The panther blister-beetle, Epicauta pardalis* Leconte (Fig. 194), is a little less than $\frac{1}{2}$ inch in length, light silvery gray and covered with numerous confluent black spots on which the pubescence is lacking. It has been reported as a serious pest of potatoes in Arizona, where it appears in the fields about the first of July.

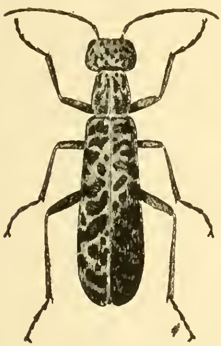

Fig. 194. — The panther blister-beetle (× $2\frac{3}{4}$).

*The crow blister-beetle, Epicauta corvina* Leconte, is large and black, nearly an inch in length. It has been reported as injurious to potatoes in Arizona.

## Means of Controlling Blister-Beetles

Blister-beetles are difficult to control because they are injurious in the adult stage. They fly readily from one plant to another and are not easily poisoned with arsenicals. In the garden, screening choice plants with mosquito netting and hand-picking the beetles into pans containing a little kerosene are practical methods of preventing injury. On potatoes and other crops on which paris green and arsenate of lead can be safely used, spraying is the most practical measure to be employed. The poison should be applied at the first appearance of the beetles, using 1 pound of paris green or 3 or 4 pounds of arsenate of lead (paste) to 50 gallons of water. One pound of lime should be added to each pound of paris green to lessen the danger of burning the leaves. The arsenicals may be used to advantage somewhat stronger, provided the plants are not injured. In some cases in which it is not possible to use an arsenical poison, the beetles may be driven before the wind into windrows of hay or straw along the edge of the field and then burned.

## CHAPTER XVII

### FLEA-BEETLES

Among the most troublesome of garden pests are several species of small, usually dark-colored leaf-beetles which have the hind femora enlarged for jumping. When alarmed they spring suddenly into the air to a distance of a foot or more and thus escape the pursuer. This habit of jumping has given the insects the highly appropriate name of flea-beetles. Flea-beetles, as a rule, eat out pits or holes in the leaves, causing the death of the surrounding tissue. Badly injured leaves become riddled with holes, turn brown and die. The beetles are most destructive to young plants early in the season. In most species the larvæ feed on the roots, but in some cases they may live as miners in the leaves or as borers in the petioles. Usually the beetles hibernate in dry sheltered places, under the bark of trees, under rubbish and in hedgerows. It often happens that their injuries to cultivated crops are first apparent along the edge of the field nearest to such shelter. Some species are closely restricted to one or two food plants, while others attack a large variety of plants in widely separated families. As a rule, however, each species shows a decided preference for some particular group. For instance, one prefers the cabbage, turnip, mustard and their relatives, another is more or less restricted to the potato and other solanaceous plants, while a third is partial to the beet, spinach, lamb's quarters and others of the same family.

## The Potato Flea-Beetle

*Epitrix cucumeris* Harris

This insect is also known as the cucumber flea-beetle because it was first described from specimens feeding on that plant. But, as it is an important pest of the potato and feeds only sparingly on cucumbers, it is more appropriately called the potato flea-beetle. This species is distributed throughout the United States and Canada from the Atlantic to the Pacific and has been reported from Porto Rico. It is, as a rule, more abundant and destructive in the more northern part of its range. It is second only to the Colorado potato beetle as an enemy of the potato and in many localities has proved itself, on the whole, more injurious. It also attacks tomato, eggplant, wonderberry (*Solanum nigrum*), peppers, turnip, radish, cabbage, celery, beet, watermelon, cantaloupe, tobacco, cucumber, petunia, bittersweet (*Solanum Dulcamara*), Jerusalem cherry, horse-nettle (*Solanum*

Fig. 195. — Potato leaves injured by the potato flea-beetle.

*carolinese*), common nightshade, ground cherry (Physalis), Jimson weed and sunflower. It has also been recorded as injuring young corn plants. The beetles feed on both the upper and under surface of the leaves, eating out small round holes through the epidermis and parenchyma but usually leaving the epidermis on the opposite side intact. This soon dies and breaks away, leaving the foliage riddled with small holes. Badly injured leaves first turn yellow, then brown, curl up and die (Fig. 195).

The potato flea-beetle is one of the smallest species of the group. It is from $\frac{1}{16}$ to $\frac{1}{12}$ inch in length, black, with the antennæ and legs brownish yellow. The hind femora and part of the middle and front femora are black. The prothorax has a deep transverse depression near the hind margin (Fig. 196). The posterior femora are greatly enlarged, giving the insect the power to jump a considerable distance. The beetles pass the winter in sheltered places under rubbish and are found in the spring on plantain and other weeds as well as on the foliage of apple, wild cherry and maple. As soon as their cultivated food plants come up or are transplanted into the field, they are subject to attack. Tobacco and cabbage plants may be seriously injured in the seed-bed. On Long Island the beetles begin egg-laying the early part of June and in Maine the latter part of the month. The egg is about $\frac{1}{100}$ inch in length, elongate ellipsoidal and white in color. The eggs are deposited in the soil around the plants. At this time the beetles are sometimes found four or five inches in the ground but whether they enter the soil for egg-laying is not known. The larvæ feed on the roots, tubers and underground stems of the plant and are sometimes found on the piece of potato used

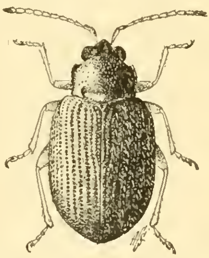

FIG. 196. — The potato flea-beetle (× 14).

for seed. The full-grown larva is about $\frac{1}{5}$ inch in length with a brown head and yellowish brown thoracic shield. The larvæ are sometimes found with the front part of the body inserted into the tuber, from which the remainder of the body projects. The tissue surrounding the larva in the tuber becomes hardened and turns blackish. Under some conditions the presence of the grub causes an abnormal growth on the surface of the tuber about $\frac{1}{8}$ to $\frac{1}{5}$ inch in diameter, low, convex and scurfy at the top. Tubers so affected are called pimply potatoes and their market value is considerably lessened. The larvæ have also been found feeding on the roots of tomato, eggplant and the common nightshade. When mature they transform within small earthen cells to whitish pupæ about $\frac{1}{12}$ inch in length and in six to eight days transformation to the adult takes place. On Long Island the beetles of the new brood begin to appear in early July and in Maine about the middle of the month. Some of the beetles continue feeding until cold weather, when they go into hibernation. Nearly all the females do not oviposit until the following spring, but it is quite probable that a few of them soon after emerging lay eggs from which there is produced a small second brood of beetles in late summer or early fall. This second brood goes into hibernation with those of the preceding generation.

The beetles that have hibernated feed ravenously until the eggs have been laid and then gradually decrease in numbers. Thus, during late June and early July, they are much less abundant in the field than earlier in the season or a little later when the beetles of the new brood begin to appear. The dying off of these over-wintered beetles has often misled growers into thinking that they had been killed by spraying.

While the larvæ are sometimes injurious to the tubers, this type of injury is not common. The most serious injury is to the foliage. Not only is the leaf surface greatly reduced by the feeding of the beetles and the consequent killing of the leaves, but the punctures serve as points for infection by the early potato blight fungus. The injury to the foliage also has a direct influence on the size and quality of the tubers. Injury by flea-beetles is most pronounced during dry seasons when the plants are least able to withstand the loss of their foliage. Tomato plants are most subject to injury when first transplanted.

*Means of control.*

On potatoes flea-beetle injury is best held in check by keeping the plants well covered with bordeaux mixture. Frequent and thorough spraying with this material not only makes the plants distasteful to the beetles but also protects them from infection by the potato blight fungus. Experience has shown that spraying with paris green or arsenate of lead, as for the Colorado potato beetle, is of little or no value in destroying the potato flea-beetle, because the latter either avoids the poison or eats so little of it as to be unaffected. Where an arsenical is used in bordeaux mixture for the control of the Colorado potato beetle, it is quite probable that many of the flea-beetles are also poisoned, but it is a question whether enough of them are killed to make it worth while to add the poison for flea-beetles alone. It has been suggested that sweetening the poison might make it more attractive but experiments on Long Island have shown that repeated applications of sweetened arsenate of lead in bordeaux mixture are injurious to the potato plants. When potatoes are thoroughly sprayed every ten to fourteen days with bordeaux mixture for the control of potato blight, a practice now commonly followed by commercial potato-growers, it is possible to raise a good crop in spite of the flea-beetle. Tomato plants are most seriously injured by flea-beetles soon after transplanting and should be kept well sprayed with bordeaux mixture until the danger is past.

Cabbage plants are often seriously injured in the seed-bed. This may be avoided by screening the beds as described for the control of the cabbage root-maggot (page 35).

### References

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Maine Agr. Exp. Sta. Bull. 211. 1913.
Iowa Agr. Exp. Sta. Bull. 155, pp. 367–376. 1915.

## The Western Potato Flea-Beetle

*Epitrix subscrinita* Leconte

On the Pacific Coast, the potato flea-beetle is replaced by this closely related species which may be distinguished by its bronzy brown color (Fig. 197). It has been reported from California to British Columbia, where it is an important pest of the potato, tomato, pepper and eggplant. It also attacks the bean. Among its wild food plants are many common weeds. The beetles spend the winter under rubbish. They appear in March and April, feeding at first on weeds and later on cultivated crops. The larvæ feed on the roots and tubers of potato and also bore a short distance into the latter. The full-grown larva is about $\frac{1}{8}$ inch in length, slender, and white with a brown head. In Oregon the larvæ become mature in late June, transform to small white pupæ within earthen cells early in July, and the beetles begin to emerge the latter part of the month. These beetles soon lay eggs for a second brood of larvæ, which pupate in September, giving rise to another brood in October. After feeding for a time on the foliage,

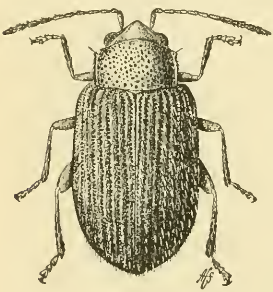

Fig. 197. — The western potato flea-beetle (× 16).

these insects go into hibernation probably in company with some of the beetles of the previous generation. There are probably two broods annually.

This western potato flea-beetle may be controlled by the measures suggested for its eastern relative.

On the Pacific Coast potatoes are also attacked by another flea-beetle, *Glyptina cerina* Leconte.

### Reference

Ore. Agr. Col. Bull. 91, pp. 11–13. 1913.

## The Tobacco Flea-Beetle

*Epitrix parvula* Fabricius

This near relative of the potato flea-beetle ranges from Maryland to Michigan, Colorado and Wyoming and southward to Texas, Florida, Central America and the West Indies. It also occurs in California and Hawaii. This flea-beetle is a serious enemy of tobacco but also attacks potato, tomato, eggplant, and among wild plants feeds on horse-nettle, ground cherry and Jimson weed. In California it has been known to attack almond, orange and squash. In Hawaii it injures the cape gooseberry. Its injuries to potato, tomato, and eggplant are similar to those inflicted by the potato and eggplant flea-beetles with which it is often associated.

The tobacco flea-beetle is about $\frac{1}{16}$ inch in length, yellowish brown, usually with a darker band across the middle of the wing-covers; the antennæ and legs are also yellowish brown except the femora, which are somewhat darker. The transverse depression near the hind margin of the prothorax is only faintly indicated (Fig. 198). The beetles emerge from hibernation in the spring and attack the plants as soon as they come up. The eggs are probably deposited in the soil at the base of the

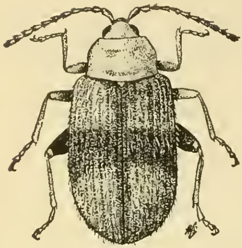

Fig. 198. — The tobacco flea-beetle (× 18).

plants. The egg is about $\frac{1}{60}$ inch in length, pale yellowish gray in color and elongate oval in outline. The larvæ feed on the roots and stems below ground and pupate in the soil an inch or so from the surface. After about a month from the time the egg was laid the beetle appears. The number of generations annually has not been determined but in California there are said to be several.

The tobacco flea-beetle can be controlled by the measures suggested for the potato flea-beetle.

Reference

U. S. Div. Ent. Bull. 19, pp. 85–87. 1899.

## The Eggplant Flea-Beetle

*Epitrix fuscula* Crotch

This species is also closely related to the potato flea-beetle. It ranges from New Jersey through Illinois, Nebraska and Utah to California and southward to Georgia and Louisiana. In size and general appearance, it closely resembles the potato flea-beetle but all the femora are black, the transverse depression near the hind margin of the prothorax is less distinct and the wing-covers are slightly more hairy (Fig. 199). The beetles come out of hibernation in early spring, as early as March 20th in Indiana. They show a decided preference for eggplant but have also been found injurious to potato and have been recorded as feeding on horse-nettle, hazelnut, poke-weed, sugar-beet and strawberry.

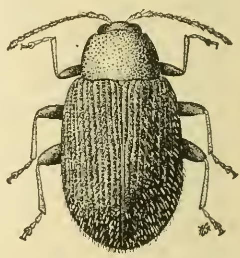

Fig. 199. — The egg-plant flea-beetle (× 16).

This flea-beetle may be controlled by the same measures as suggested for the potato flea-beetle.

## The Pale-Striped Flea-Beetle

*Systena tæniata* Say

This abundant and widely distributed flea-beetle is very variable in coloration and sculpture. Several varieties have been described, some of which are considered as distinct species

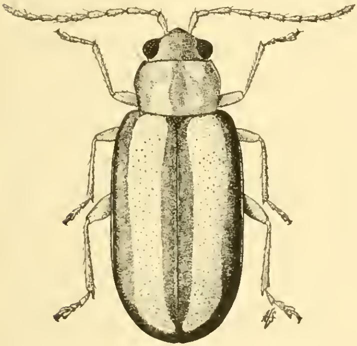

Fig. 200. — The pale-striped flea-beetle (× 13).

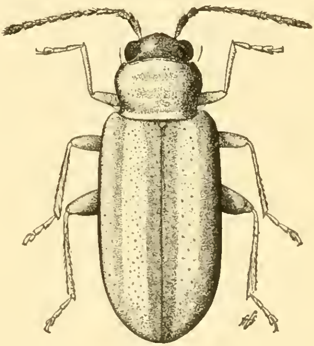

Fig. 201. — The pale-striped flea-beetle, variety *blanda* (× 13).

by certain writers. The beetle is about $\frac{1}{8}$ inch in length; the antennæ and legs are reddish or yellowish brown; the head is reddish, and the thorax brownish. In the typical form the wing-covers are black with two pale yellowish longitudinal stripes. In the light-colored variety, *blanda*, the thorax and wing-covers are paler and the wing-covers have the pale stripe much broader, often leaving but little of the dark markings. In some specimens the wing-covers are uniformly pale. All gradations occur (Figs. 200 and 201).

The insect ranges from New England through Canada to California and southward to Georgia, Alabama and Mexico. It has been found most destructive to young beets and recently transplanted tomato plants. It also attacks potato, carrot, parsnip, cantaloupe, cucumber, pumpkin, cabbage, turnip, radish, pea, bean, eggplant, lettuce, summer savory, sweet potato, peanut, corn and cotton. It feeds on a large number of wild plants, among which are pigweed, lamb's quarters, purslane, ragweed, cocklebur, horse sorrel and wild solanaceous plants. It also sometimes injures newly set aster plants and apple and pear nursery stock.

It is not definitely known where or in what stage the insect passes the winter. The beetles appear on the plants in the spring. In feeding they eat out small holes in the epidermis and parenchyma but do not eat through the leaf. Young beet plants are often killed in this way, it sometimes being necessary to replant. The egg is about $\frac{1}{40}$ inch in length, elliptical in outline, and yellowish in color. The eggs have not been observed except under cage conditions. Larvæ have been found on the roots of lamb's quarters and probably occur on several other common weeds. A single larva was once found on a sprouting corn plant. This may have been accidental. The full-grown larva is elongate, about $\frac{1}{8}$ inch in length, white, with a yellowish head. The body is broadest posteriorly. At Washington the eggs are laid during June and July and the adults of the new brood begin to emerge in late July. The number of generations annually has not been definitely determined but there is probably only one, at least in the North. The insect probably hibernates as a larva, pupates in the spring and transforms to the adult in May or June.

REFERENCES

U. S. Div. Ent. Bull. 23, pp. 22–29. 1900.
Ill. Agr. Exp. Sta. Bull. 60, pp. 468–470. 1900.

## The Red-Headed Flea-Beetle

*Systena frontalis* Fabricius

This species closely resembles the smartweed flea-beetle from which it may be distinguished by its reddish head (Fig. 202). It ranges throughout the United States and Canada east of the Rockies and south to Florida. Outbreaks of this beetle are usually more or less local but serious injury may sometimes result. It attacks potato, beet and bean, and in Canada is sometimes destructive to the second crop of clover. Young grape vines are occasionally nearly defoliated by the beetles. They have also been known to attack cranberry, rose mallow, marsh mallow, Japanese honeysuckle, weigela, aster and chrysanthemum. Among weeds they are known to feed on smartweed, lamb's quarters and pigweed.

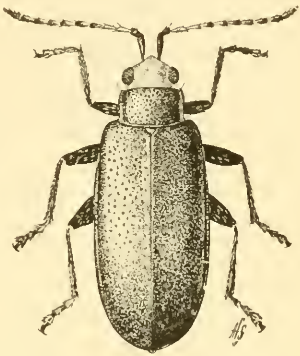

Fig. 202. — The red-headed flea-beetle (× 8).

The beetles have been found hibernating under the loose bark of trees and in mullein rosettes. The early stages have not been described.

## The Smartweed Flea-Beetle

*Systena hudsonias* Forster

This elongate bluish black flea-beetle is generally distributed throughout the United States and Canada east of the Rocky Mountains where it has been recorded as injurious to potato, bean, corn, beet and cabbage plants in the seed-bed. It has also been known to injure cranberries and grapes as well as apple and pear grafts. The beetles feed on a wide variety of weeds, including smartweed, pigweed, daisy, fleabane, ragweed, plantain, catnip, dock and goldenrod.

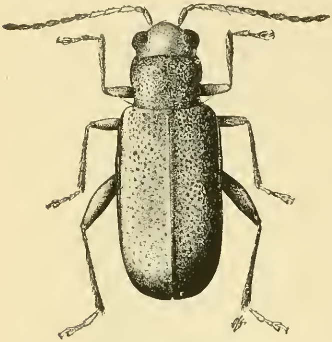

Fig. 203. — The smartweed flea-beetle (× 11).

The beetle is slightly more than $\frac{1}{8}$ inch in length, and bluish black in color, with the antennæ having the two basal segments dark, the next three or four light and the remainder dark (Fig. 203). They are most abundant in midsummer. The immature stages have not been described and the number of broods occurring annually is not known.

When attacking cabbage in the seed-bed, the injury is best prevented by screening the bed with cheesecloth as is often done for protection against the cabbage root-maggot (page 35).

## The Striped Cabbage Flea-Beetle

*Phyllotreta vittata* Fabricius

The striped cabbage flea-beetle shows a preference for cruciferous plants, attacking cabbage, radish, turnip, horse-radish, water-cress, stock and wall-flower. It is also recorded as injurious to tomato and strawberry. Its most important uncultivated food plant is the wild mustard, but it also feeds on charlock, shepherd's purse and rocket. The insect ranges throughout the United States and southern Canada east of the Rocky Mountains. The beetles hibernate in sheltered places and appear in the fields in the spring, in western New York about the middle of May. The adult is about $\frac{1}{12}$ inch in length, black, with each wing-cover marked with a wavy yellowish stripe, narrowed in the middle and incurved at each end (Fig. 204). The beetles are most destructive to cabbage plants before the fourth leaf has appeared or during the first week after they come up. They gnaw pits in the leaves but do not eat out holes except in very thin leaves. Young cabbage, turnip and radish plants are often killed in this way. The females deposit the minute, oval, whitish eggs at the base of the plant in irregular excavations gnawed out in the root near the crown. The larvæ feed on the roots of cabbage and radish and in New York have been found especially abundant on the roots of the wild mustard. The larvæ eat off the smaller roots and riddle the main one with tunnels, sometimes excavating the entire root. The full-grown larva is about $\frac{1}{3}$ inch in length, whitish with a light brown head. In Illinois the larvæ are present in late May and June and give rise to a brood of beetles in August. The over-wintered beetles mostly disappear in June and in the North turnips sowed after this date are likely to escape injury. In North Carolina a second brood of larvæ has been observed on turnips in October. In Illinois there is said to be but one generation annually but in North Carolina there are at least two.

Fig. 204. — The striped cabbage flea-beetle (× 13).

Cabbage plants in the seed-bed are very liable to injury by this flea-beetle. They may be protected by screening the beds with cheesecloth as recommended for the cabbage root-maggot (page 35).

Reference

Shimer, American Naturalist, 2, pp. 514–517. 1869.

In California a closely related species, *Phyllotreta ramosa* Crotch, in which the yellowish stripe on the wing-cover has a short branch just back of the middle, has been reported as injurious to turnip, radish and mustard.

The four-spotted cabbage flea-beetle, *Phyllotreta bipustulata* Fabricius, is sometimes found feeding on cabbage and turnip in the Atlantic states. Its wild food plants are hedge mustard, charlock and shepherd's purse. It has never been known to cause any serious injury. In this species each wing-cover is marked with two large yellowish spots.

In California cabbage, radish, mustard and turnip are sometimes attacked by a small, dark, metallic green flea-beetle, *Hemiglyptus basalis* Crotch.

## The Sinuate-Striped Flea-Beetle

*Phyllotreta sinuata* Stephens

This flea-beetle is often found in company with the striped cabbage flea-beetle, feeding on cabbage, turnip and radish. The insect was probably introduced from Europe but is now widely distributed throughout the United States and Canada. The beetle averages somewhat larger than the striped cabbage flea-beetle and the yellowish stripe on the wing-cover does not turn inward toward the base, being nearly parallel with the inner margin (Fig. 205). The eggs are deposited singly on the upper surface of the leaf along the midrib. The egg is $\frac{1}{125}$ inch in length, dull greenish white, depressed, oblong and glued to the leaf by one side. The larvæ have been found as miners in the leaves of wild peppergrass, cress and rock cress. The young larvæ enter the leaf,

Fig. 205.—The sinuate-striped flea-beetle (× 14).

where they eat out a mine of the blotch type, often being numerous enough to kill the plant. The full-grown larva is about $\frac{1}{6}$ inch in length, orange, with the head, pronotum and anal segment dark brown. The other segments are marked with numerous brown spots. When mature, the larva descends to the ground, where in an earthen cell, it transforms to a white or yellowish pupa. In May and June in Missouri the life cycle from egg to adult requires about three weeks. This species has not been recorded as causing any very serious injury. This may be explained in part from its being frequently mistaken for the striped cabbage flea-beetle.

### Reference

Riley, U. S. Ent. Rept. for 1881, pp. 304–308.

## The Western Cabbage Flea-Beetle

*Phyllotreta pusilla* Horn

Along the eastern slope of the Rocky Mountains from Dakota to Mexico and in New Mexico and southern California, the wavy-striped flea-beetle is replaced by this pitchy black, slightly bronzy beetle from $\frac{1}{16}$ to $\frac{1}{12}$ inch in length (Fig. 206). It has been recorded as injurious to cabbage, radish, turnip, horse-radish, mustard, rape, pea, sugar-beet and corn. It also feeds on hedge mustard and the bee plant. The beetles hibernate and are most destructive to the young plants soon after coming out of hibernation. The early stages have not been described.

Fig. 206. — The western cabbage flea-beetle (× 16).

## The Horse-Radish Flea-Beetle

*Phyllotreta armoraciæ* Koch

Imported from Europe about 1893, this horse-radish pest is now present in the northern states from New York and New Jersey to Iowa and Nebraska. It has also been found at Montreal, Canada. In some localities it has already proved itself a serious enemy of horse-radish, making it necessary to replant the beds yearly. In contrast to the habits of many other flea-beetles, this insect has a very restricted list of food plants, including only marsh cress in addition to horse-radish. The winter is passed by the beetles in dry sheltered places. The adult (Fig. 207) is about $\frac{1}{8}$ inch in length, oval, strongly convex, black in color, with each wing-cover yellowish, except a narrow black stripe along the outer margin and a wider one on the inner margin, the latter broadest at the middle. The antennæ are yellowish at the base. The legs are yellowish except the hind femora and all but the tip of the front and middle tibiæ, which are black. The beetles appear on the plants early in the spring and eat out holes in the leaves and cavities in the midribs. The female deposits her smooth, oval, orange eggs, about $\frac{1}{30}$ inch in length, in clusters of twenty or more, loosely attached to the petioles of the young leaves. Egg-laying begins in late April or May and may continue until August. Each female usually lays several batches of eggs and the total number laid by a single individual may exceed 400. The eggs hatch in a week or two. On hatching, the young

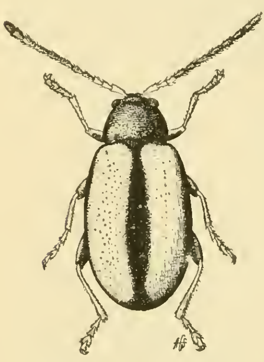

Fig. 207. — The horse-radish flea-beetle (× 9).

larva enters the petiole, where it burrows through the tissue, often causing the death of the leaf. Its presence is indicated by brownish, dead areas where the larva has come near the surface. The mature larva is nearly $\frac{1}{5}$ inch in length, slender, pale yellowish white, with the head, thoracic shield and anal plate dark brown. From seven to over nine weeks are required for the larva to reach maturity. It then descends to the ground, where it transforms to a small white pupa in an earthen cell and in ten days to two weeks the beetles emerge. There is only one brood annually. The beetles are more destructive early in the season and the larvæ later. The foliage is injured to such an extent that the roots do not develop and the crop is consequently shortened.

*Control.*

The plants may be made distasteful to the beetles and some of them poisoned by thorough spraying with bordeaux mixture containing 4 or 6 pounds of arsenate of lead (paste) in 50 gallons. When the pest is abundant, several applications at intervals of two or three weeks may be found necessary. In some cases it is advisable to change the location of the beds yearly to new land in order to escape attack by the beetles.

### Reference

U. S. Dept. Agr. Bull. 535. 1917.

## The Spinach Flea-Beetle

*Disonycha xanthomelæna* Dalman

So far as known, this flea-beetle has been injurious only to beet, spinach and salt-bush. Its wild food plants include lamb's quarters, pigweed and chick-weed. The insect is distributed throughout the United States and Canada east of the Rocky Mountains.

The beetle is about $\frac{1}{5}$ inch in length, greenish black in color with the prothorax yellow (Fig. 208). The insect hibernates in the adult stage and appears in the field early in the spring. The female deposits her elongate, elliptical, orange eggs, from $\frac{1}{20}$ to $\frac{1}{17}$ inch in length, on end, in clusters of about thirty on the ground at the base of the plant. Each female may lay several batches of eggs at intervals of a few days. The larva escapes through a slit in the side of the egg near the base. The young larva is nearly $\frac{1}{2}$ inch in length, uniform light gray and armed with numerous black spines which are white at the tip. The young larvæ crawl to the plants and feed on the underside of a leaf, at first gnawing off only the surface but later eating out holes. When alarmed, the larvæ fall to the ground, where they remain hidden until the danger is past. The young larvæ have the habit of feeding in colonies but when older become scattered. After the tops are killed, they may feed on the roots. The mature larva is a little more than $\frac{1}{3}$ inch in length, leaden gray, with head and mouth-parts brownish. When feeding on beets, it acquires a purplish color. The larva becomes full-grown in ten days to a month. It then enters the ground and transforms to a grayish pupa in a slight earthen cell near the surface. In six to nine days the transformation to the adult takes place and after waiting a day or two to become hardened the beetle emerges. At Washington there are two generations annually. Egg-laying by the new brood of beetles begins the latter part of July and continues until September.

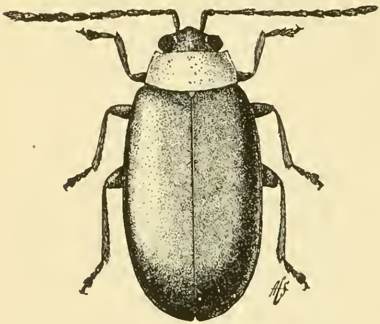

FIG. 208. — The spinach flea-beetle ($\times 7\frac{1}{2}$).

### Reference

U. S. Div. Ent. Bull. 19, pp. 80–85. 1899.

## The Yellow-Necked Flea-Beetle

*Disonycha mellicollis* Say

This beetle is found from New Jersey, Indiana and Colorado southward to Florida and Texas. It is closely related to the spinach flea-beetle, from which it may be distinguished by having all the femora reddish or yellowish. It has been recorded as injurious to beets and spinach in Texas and Florida. Its wild food plants are amaranth and purslane. The beetles come out of hibernation early in the spring and deposit their blood-red eggs, similar to those of the spinach flea-beetle, in clusters of forty or fifty on the leaves or on the ground at the base of the food plants. The eggs hatch in four to ten days. The larvæ feed on the underside of the leaves, injuring the plant in much the same way as do those of the spinach flea-beetle. They become full-grown in about eleven days and are then dull yellowish red. Pupation takes place in the ground and the beetles emerge in about five days.

### Reference

U. S. Bur. Ent. Bull. 82, pp. 29–32. 1909.

## The Three-Spotted Flea-Beetle

*Disonycha triangularis* Chevrolat

This closely related species ranges through the United States and Canada east of the Rocky Mountains. It has been reported as injurious to beets, mangels and sugar-beets. Its wild food plants are lamb's quarters and spiny pigweed. The beetle is $\frac{1}{5}$ to $\frac{1}{4}$ inch in length, bluish black; the prothorax is

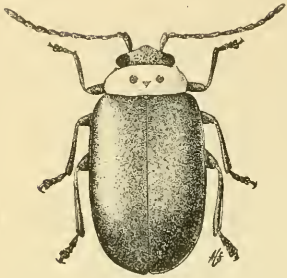

FIG. 209. — The three-spotted flea-beetle (× 5).

yellow, marked with three black spots arranged in a triangle (Fig. 209). The insect hibernates as a beetle in sheltered places. The early stages have not been described.

## THE LARGER STRIPED FLEA-BEETLE

*Disonycha crenicollis* Say

This species occurs in the United States east of the Rocky Mountains, ranging from New York to Nebraska and south to Mexico. The beetle is about $\frac{1}{4}$ inch in length, yellow, with two black spots on the prothorax and has each wing-cover marked with a narrow marginal and sutural, and a broader median black stripe (Fig. 210). It has been found on beet, melon and strawberry in Illinois. It hibernates in the adult condition and the early stages are unknown.

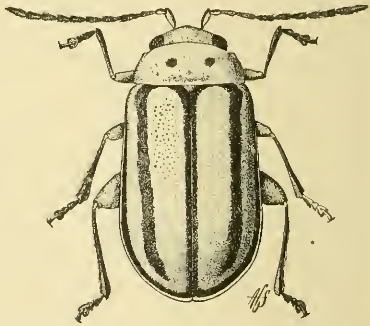

FIG. 210. — The larger striped flea-beetle (× $4\frac{3}{4}$).

## THE SWEET POTATO FLEA-BEETLE

*Chætocnema confinis* Crotch

Although this flea-beetle is widely distributed throughout the United States east of the Rocky Mountains and has also been taken in California, it has attracted most attention by its injuries to the sweet potato in New Jersey. In some localities and in certain seasons, it has proved itself the most important insect enemy of that crop. It has been observed feeding on sugar-beet, corn, wheat, oats, timothy, blue-grass, buckwheat, red clover, raspberry and box elder.

The beetle is about $\frac{1}{16}$ inch in length, pitchy black with a faint bronzy reflection. The antennæ and legs, except the hind femora, are reddish yellow (Fig. 211). The winter is passed by the beetles in rubbish, especially along hedgerows and woodlots. In New Jersey they appear on the sweet potato plants as soon as transplanted in May. They do not eat holes through the leaves but eat out grooves or channels in the upper surface, usually beginning along the more prominent veins. Later a large part of the surface may be eaten off; the leaf wilts, turns brown and dies. Young plants are often killed in this way or so badly stunted that they do not produce a good crop. In New Jersey the beetles are most abundant in May and the first part of June, when they begin to leave sweet potato, and by the first of July very few are left. On leaving the sweet potato, they migrate to bindweed, which is often found growing as a weed in the fields or along the fences. It is on this plant that the larvæ have been found feeding on the fine roots but not tunneling the larger roots. When full-grown, the larva is about $\frac{1}{8}$ inch in length, white, with a brownish head. The whitish pupæ are found in earthen cells in the ground. The beetles of the new brood begin to appear in late July but do not return to the sweet potato in large numbers until the following spring. There is only one generation annually.

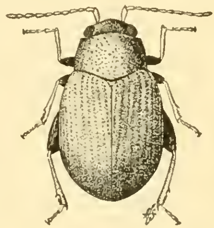

Fig. 211. — The sweet potato flea-beetle (× 15).

*Control.*

Fortunately this flea-beetle does not attack sweet potato plants in the seed-bed to any appreciable extent. Most of the injury to the young plants may be avoided by dipping them before transplanting in arsenate of lead (paste), 1 pound in 10 gallons of water. Dipping is much more effective than spraying the plants because both sides of the leaves are covered with the poison. Flea-beetle injury may also be avoided, in large measure, by late planting.

### Reference

N. J. Agr. Exp. Sta. Rept. for 1908, pp. 343–348.

## The Desert Corn Flea-Beetle

*Chætocnema ectypa* Horn

In the semi-arid regions of the Southwest, beans are sometimes seriously injured by this small, shining black flea-beetle, a little less than $\frac{1}{12}$ inch in length. Its food plants are grasses, grains and corn but it occasionally attacks cantaloupes and sugar-beets. The beetles appear in the field about the middle of February and begin egg-laying in about a month. The minute, bean-shaped, whitish eggs, about $\frac{1}{75}$ inch in length, are deposited at or near the surface of the ground on or near the food plant. The eggs hatch in three to fifteen days with an average of five or six. The larvæ feed on the roots, often causing considerable damage to the roots of alfalfa, barley, oats, wheat and corn. They become full-grown in a little over three weeks. The mature larva is whitish, elongate, slender, and from $\frac{1}{7}$ to $\frac{1}{5}$ inch in length. When mature, the larva constructs an oblong, earthen cell within which it transforms to a shorter thickened form known as the prepupa and a few days later to a delicate, soft, whitish pupa. The pupal period varies from three to twelve days with an average of about six. There are three generations annually and in some years a partial fourth may develop. The beetles go into hibernation in November under rubbish and clumps of grass in waste places.

REFERENCE

U. S. Dept. Agr. Bull. 436. 1917.

## THE HOP FLEA-BEETLE

*Psylliodes punctulata* Melsheimer

Although this flea-beetle is best known as a destructive enemy of hops in the Northwest, it is widely distributed throughout the northern United States and southern Canada from the Atlantic to the Pacific and also attacks several garden plants, including beet, rhubarb, potato, tomato, turnip, radish, cabbage, cucumber, watermelon, mustard and clover. Its wild food plants are numerous, including hedge mustard, lamb's quarters, pigweed, dock, sorrel, tumbleweed and nettle.

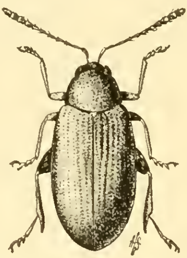

FIG. 212. — The hop flea-beetle (× 10).

The hop flea-beetle is about $\frac{1}{10}$ inch in length and bronzy black in color. The antennæ are brownish, pale at the base. The legs are reddish yellow with the middle and front femora black and the hind pair bronzy (Fig. 212). The beetles hibernate under any convenient shelter, such as cracks and crevices of posts or poles, in the hollow stems of plants, under grass or weeds, and in the soil itself. In British Columbia they emerge in March or April and soon begin feeding on the foliage of their food plants, eating out pits, but usually do not perforate the leaf. The injured area soon dries, however, and may break away, leaving a hole through the leaf. The foliage is often riddled in this way and in the case of hops the leaves are reduced to mere shreds.

The females enter the soil to lay their eggs on the roots of the hop. The egg is about $\frac{1}{75}$ inch long, elliptico-cylindrical, and yellowish in color. They are found at a depth of one to two inches in the soil. The eggs hatch in about three weeks or a little less, depending on the temperature, and the young larva begins feeding on the roots. Although the larvæ have only been found on hop roots, they undoubtedly feed on other plants. They become full-grown in about three weeks. They are then about $\frac{1}{5}$ inch in length, white, with the head, thoracic shield and anal plate darker. After reaching maturity, the larva becomes somewhat shorter and thicker and rests in a dormant condition for nearly two weeks before transforming to the white pupa. Pupation takes place in the soil but not in an earthen cell. The pupal period averages about sixteen days. There are two generations annually. From eggs deposited in the early spring by over-wintered beetles, a new brood of adults is produced the last of May or early in June, and another brood appears the last of July or the first of August. The latter go into hibernation with the advent of cool weather.

### References

U. S. Bur. Ent. Bull. 66, pp. 71–92. 1909.
U. S. Bur. Ent. Bull. 82, pp. 33–58. 1910.

## Means of Controlling Flea-Beetles

It is usually difficult to prevent injury by flea-beetles because the attack is made by the adults, most of which feed only slightly on the surface of the leaf and are more or less resistant to poisons. They also avoid the poison and attack the leaves where the spray has not been applied. The attack is usually most severe on young plants early in the season when the beetles are most voracious after their long winter's fast and when the plants are least able to withstand injury. Contact insecticides have been found of little value because of the difficulty of hitting the insects, since the beetles jump from the plants at the slightest alarm only to return when the danger is passed. Bordeaux mixture has been found the most efficient and inexpensive deterrent for most flea-beetles. The presence of this material on the leaves makes them distasteful to the beetles. When combined with paris green, 2 pounds in 100 gallons, or arsenate of lead (paste) at the rate of 4 or 5 pounds to 100 gallons, it makes the most effective treatment. As bordeaux mixture is used on many plants for the prevention of fungous diseases, its use serves a double purpose. In some cases in which the plants are started in seed-beds and then transplanted into the field, dipping the plants in arsenate of lead (paste), 1 pound in 10 gallons of water, before setting has been found the most effective way of protecting from flea-beetle attack. When the injury is done to the plants in the seed-bed, it is sometimes found advisable to screen the beds with cheese-cloth or tobacco-cloth as described under the cabbage root-maggot on page 35. Special methods of treatment applicable to certain species will be found in the account of these forms.

# CHAPTER XVIII

## UNCLASSIFIED PESTS

Some of the insects and insect-like animals are so miscellaneous in their feeding that they cannot be associated clearly with any one crop. A few of these are treated together here. Some of them are very troublesome and are difficult to combat.

### The Root-Knot Nematode

*Heterodera radicicola* Greef

A great variety of plants is subject to serious injury from the attacks of minute nearly transparent worms that bore into the roots, causing gall-like knots or outgrowths to develop. In England these are known as eel-worms. The swellings on the roots are produced by the plant in its attempt to repair the injury caused by the presence of the worm. The normal growth of the root tissue is disturbed, with the result that the sap-tubes are distorted and unable to carry their load of raw plant-food up to the leaves. Badly infested plants take on a weak, unhealthy appearance, become stunted and sometimes die.

The root-knot disease is prevalent throughout the tropics, sub-tropics and the warmer parts of the temperate zone. In the United States it is occasionally found as far north as New York, Michigan and Nebraska but is of little importance except in the southern states and in central and southern California.

It is especially troublesome in irrigated districts and in greenhouses even in districts where it does not occur in the open.

Different species of plants vary greatly in their degree of susceptibility to the root-knot disease. Among vegetable crops those most susceptible to injury are potato, tomato, eggplant, celery, beet, carrot, lettuce, pepper, endive, cantaloupe, cucumber, watermelon, squash, pumpkin, lentil and salsify; the following also are sometimes seriously attacked: asparagus, onion, cauliflower, cabbage, kale, collard, turnip, pepper, bean, pea, radish, spinach and sweet potato. In some localities potato tubers become badly infested and acquire a warty appearance. Infested potatoes are unsuitable for market and should never be used for seed.

The organism that causes the root-knot disease is not an insect but a nematode worm. The young are produced inside the old gall, from which they escape through cracks or by working their way through the tissue. In this stage the worm is about $\frac{1}{75}$ inch in length, slender and eel-like in form. The young worms can live for several months in moist earth and are able to move readily about among the soil particles. When one of these worms finds a young and tender rootlet, it breaks its way through the tissue by means of a spear-like organ located in the mouth and then passes a short distance into the substance of the root. The worm then becomes inactive, swells up and the female finally assumes a pear-shaped form. The male becomes broadly spindle-shaped and then molts but remains within the discarded skin. It then assumes a very elongate form and becomes coiled in three or four folds within its cyst. It finally escapes and, passing through the tissue of the root, finds a female with which it mates before she has become fully mature. The fully developed encysted females are pear-shaped, about $\frac{1}{25}$ inch in length and a little more than half as broad and when the gall is broken open appear as little pearly white globules embedded in the tissue. Each female is capable of producing about 500 eggs, which are laid at the rate of ten or fifteen a day. The eggs form a mass often as large as the female and are surrounded by a gelatinous substance. The eggs are ellipsoidal or sometimes kidney-shaped, about twice as long as broad and vary greatly in size, being from about $\frac{1}{375}$ to $\frac{1}{200}$ inch in length. Sometimes the eggs hatch while still within the body of the mother. The female begins to lay eggs about twenty-five days after entering the root. The winter is passed in the larval stage in the galls and in the surrounding soil.

The galls produced on different species of plants are variable in size and shape, but as a rule the amount of enlargement depends on the number of worms entering a root near the same point. Plants growing in light sandy soil are more subject to injury than when on heavy land. The worms cannot survive a thorough drying of the soil as is the case with many related forms and are killed if the soil remains saturated with water for a long time.

*Means of control.*

Vegetables susceptible to the root-knot disease should not be planted on land known to be infested. To free fields of the root-knot nematode, they should be planted for one or two years to some crop not susceptible to the disease and which has a sufficiently rank growth to crowd out all weeds that might harbor the pest. Certain varieties of cowpeas, particularly the Iron, are not susceptible and are sometimes used for this purpose. After the cowpeas are harvested, the ground should be plowed and sowed to some winter grain such as rye or wheat. The next season another crop of cowpeas should be sown to be followed again by grain the second winter. Under certain conditions velvet beans or Florida beggarweed may be used instead of cowpeas. Care should be taken not to allow weeds to grow in the field at any time while attempting to eradicate the disease, since many of them serve as hosts for the worms.

Where greenhouse soil has become infested by the root-knot nematode, it should either be renewed with fresh uninfested soil or may be sterilized with live steam under pressure. This is performed by having the beds equipped with lines of pipe running through the soil in which at intervals are small holes about $\frac{1}{16}$ inch in diameter for the escape of the steam. The beds are covered with straw or with some other material and the steam is applied until the soil is thoroughly sterilized. This may be determined by placing potatoes in the soil near the surface and when they are found to be cooked the steam may be turned off. Rows of tiles are sometimes used instead of pipes, the steam escaping through the joints.

More or less satisfactory results can be obtained in shallow beds by applying a weak solution of formaldehyde, 1 part of the 40 per cent commercial solution in 100 parts of water, using 1 to $1\frac{1}{2}$ gallons for every square yard of surface.

Recent experiments in Florida indicate that land may be freed of root-knot nematodes by the application of commercial sodium cyanamid at the rate of 1000 to 5000 pounds to the acre. This material should be applied dry and then worked into the soil. The land should then be irrigated and the crop should not be planted until several weeks later depending on the amount of material used. Sodium cyanamid is too expensive for use on large areas but may be employed to advantage on seed-beds and on plots under intensive cultivation.

### References

Ala. Agr. Exp. Sta. Bull. 9. 1889.
Mass. (Hatch) Agr. Exp. Sta. Bull. 55. 1898.
U. S. Bur. Plant Ind. Bull. 217. 1911.

## The Sugar-Beet Nematode

*Heterodera schachtii* Schmidt

This near relative of the root-knot nematode has been known for many years as an important enemy of the sugar-beet in Europe and has recently seriously infested sugar-beets in the western United States. It also infests other kinds of beets, as well as cabbage and related crops. Its life history is similar to that of the species last treated, the most important difference being that there is a resting stage in which the eggs may survive in the soil for at least six years. The sugar-beet nematode is, therefore, a much more difficult pest to eradicate, since to rid land by crop rotation it would be necessary to keep it free from all susceptible crops for a period of several years.

## Millipedes

There are several species of millipedes injurious to sprouting seeds, seedlings and root-crops, such as radishes, turnips, carrots, parsnips and beets (Fig. 213). They sometimes eat out holes in potato tubers and often infest the heads of cabbage, cauliflower and lettuce. Seed beans are attacked underground and the millipedes may eat off the tender shoots. Sprouting corn and peas are injured in a similar way. The millipedes often bore into melons, cucumbers, squashes and tomatoes where they touch the ground.

Millipedes are not insects but belong to a closely related class of animals. They are elongate, more or less cylindrical creatures, having a distinct head and a body consisting of a series of similar segments which is not divided into a thorax and abdomen. Each segment, excepting the first four, bears two pairs of legs.

It is often stated that the mouth-parts of millipedes are not fitted for feeding on healthy plant tissue, but a dissection of these organs has convinced the writers that they are well adapted for this purpose. It is true that millipedes prefer decaying vegetable matter but it is also well known that they will attack healthy roots when their favorite food is not available. Under such conditions they select, wherever possible, a part that has already been injured by some insect or that is affected with some disease. Roots or tubers that have been eaten into often become infected with fungi or bacteria, causing decay.

Fig. 213. — A carrot injured by slugs and millipedes.

Numerous species of millipedes belonging to several genera have been found injurious in America but their life history and habits do not appear to have been carefully studied.

The greenhouse millipede, *Orthomorpha gracilis* Koch, is of tropical origin and is common in greenhouses in Europe and America. In this form the body is somewhat flattened and the segmentation is very distinct. On the side of each segment is a thin horizontal plate which in the posterior segments is acutely pointed behind. The full-grown millipede is nearly an inch in length, chestnut-brown above, with the lateral plates yellowish.

The commonest millipedes that are injurious in the field belong to Julus and related genera. These forms are elongate, cylindrical and usually piceous in color with the legs and under parts pale. When at rest they are usually coiled in a circle. Reproduction is by means of eggs, which the female deposits in a mass covered with pellets of earth glued together to form an egg-cocoon. The eggs are laid in the spring and again in the fall and hatch in about two weeks. The young differ from the adults in size and in having a smaller number of body segments and fewer legs.

In New York a common and troublesome species is *Julus cœruleocinctus* Wood. It is nearly an inch in length and has been found injurious to peas, beans, tomatoes, melons and many other vegetables (Fig. 214).

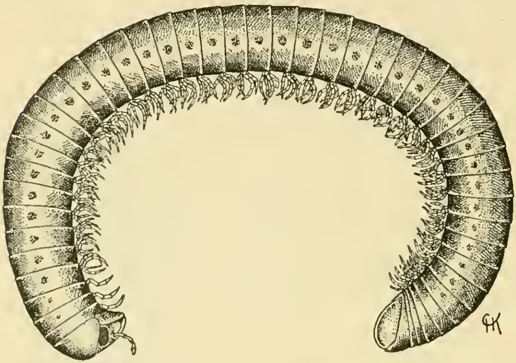

FIG. 214. — A millipede, *Julus cœrulcocinctus* (× 5).

No satisfactory method for the control of millipedes under field or garden conditions has been devised. In the garden they may be trapped under pieces of boards or slices of vegetables laid on the ground. In the greenhouse they may be trapped in the same way or by using lumps of dough sweetened with molasses. Lime or tobacco dust applied around the plants will have a tendency to keep the pest away.

## WHITE GRUBS

*Lachnosterna* (several species)

Vegetable crops are often seriously injured by large white curved grubs that are found in land that has recently been in sod. These grubs (Fig. 215) are the larval form of the large brown June beetles or June bugs (Fig. 216) that come blundering around lights on summer evenings. In the United States there are nearly one hundred species, but the greater part of the injury is caused by a relatively small number.

The parent beetles are most abundant in May and June. They feed at night on the leaves of various trees, but at daybreak they desert these and return to the fields. The females burrow into the soil to a depth of two or three inches and there deposit their eggs singly or in small groups. Each female is capable of laying from fifty to one hundred eggs. The eggs are oval, white, and have a diameter of about $\frac{1}{12}$ inch. They lie in small cells composed of soil particles glued together with a sticky substance secreted by the beetle. The eggs hatch in ten days to several weeks. The young grubs feed throughout the remainder of that season on the roots of grasses a short distance below the surface of the ground. With the approach of cold weather, they burrow deeper into the soil and hibernate at a depth of ten or twelve inches. The following spring they return to the grass roots, on which they feed throughout the season. The grubs of some species reach maturity at the end of the second summer, but in the case of our more common species the grubs are not full-grown at that time. In the latter case, the grubs again descend into the soil for hibernation and return to the grass roots in the spring of the third year. After feeding for a period, they become full-grown in June or July. The grub then constructs an oval earthen cocoon in which it

FIG. 215. — A white grub ($\times 1\frac{1}{2}$).

FIG. 216. — Two species of June beetles, the adults of the white grub *Lachnosterna ilicis* and *L. hirticula*.

transforms to a delicate whitish pupa. The insect remains in this condition until the latter part of the summer and then transforms into a beetle. It remains in the earthen cell until the following spring, when it emerges from the ground. While certain species emerge the second spring after the eggs are laid, and a few do not emerge until the fourth spring, the greater number of the injurious species do not emerge until the third spring. For instance, in the last case the young grubs that hatch from eggs laid in the spring of 1918 feed until the fall of that year, hibernate during the winter of 1918–19, feed again through the summer of 1919, hibernate again as grubs during the winter of 1919–20, complete their growth, pupate, and transform to beetles that season and hibernate as beetles during the winter of 1920–21; the beetles emerge in the spring of 1921. It will be seen from the foregoing account that the grubs are most destructive during the second season, because it is then that they feed for the longest period and make their greatest growth. The first year the grubs feed only during the latter part of the season and are very small. The third summer they feed only during the early part of the season and only enough to prepare themselves for pupation.

In case infested sod land is broken up and planted to vegetable crops, the white grubs are forced to concentrate their feeding on the latter. Corn, potato, beet and other root crops are especially liable to attack; in fact, there is scarcely a vegetable crop that is not subject to injury when grown on infested land.

Crops liable to injury by white grubs should not be planted on land known to be infested. Much trouble may be avoided by adopting a short rotation of crops in which land will not be left in sod for more than two or three years. White grubs are likely to be abundant in old strawberry beds and when these are plowed up they should be treated the same as sod land. Buckwheat, alfalfa, clover and other leguminous crops are not relished by white grubs and may be used as intermediate crops between sod and vegetables. As previously stated, the grubs do the greatest injury during the season following that in which the eggs are laid. Observations in Illinois have shown that the beetles prefer to lay their eggs in ground that is well covered with vegetation. Pasture land, wheat, and oats are chosen in the order named. Clover is a relatively immune crop, very few eggs being laid in fields where there is a heavy stand. These facts should be kept in mind when planning a rotation of which vegetable crops are a part.

In some parts of the country, white grubs appear in more or less definite broods and are destructive in three-year cycles. In localities where this tendency is well developed, this knowledge may be utilized to avoid injury.

## Wireworms

*Several Species of Elateridæ*

Many vegetable crops are liable to attack by wireworms especially when planted on land previously in sod. Wireworms (Fig. 217) are elongate, hard-shelled, brownish larvæ, the immature stages of medium-sized, dull-colored, snapping beetles or click-beetles. They are underground insects that eat off the smaller roots, bore into tubers and fleshy roots and destroy germinating seed. The beetles appear in May and June, and the females deposit their eggs in the soil. The beetles are from $\frac{1}{3}$ to $\frac{1}{2}$ inch in length, dull grayish brown in color, and have the peculiar habit of snapping themselves into the air when laid on their backs. The larvæ feed on the grass roots for several seasons, the various species differing in the length of their life cycle from three to

Fig. 217. — A wireworm, *Monocrepidius lividus* (× 1⅔).

six years. The wireworms reach maturity early in July. They are then from $\frac{1}{2}$ to $1\frac{1}{2}$ inches in length, depending on the species. They transform to delicate whitish pupæ in earthen cells within six inches of the surface of the ground. Transformation to the beetle takes place in three weeks to a month, the beetles remaining within the earthen cell until the following spring. There are many species of wireworms that may attack vegetables but only the most important can be treated here.

FIG. 218. — A potato infested with wheat wireworms.

The wheat wireworm, *Agriotes mancus* Say, is about an inch in length when full-grown, pale yellow in color, cylindrical in form and may be recognized by the two dark spots at the base of the last segment of the body. This species feeds normally on the roots of grasses but when the sod is broken up will seriously injure corn, wheat, potato, carrot, turnip, bean, cucumber and cabbage. Injured potatoes are shown in Figs. 218 to 220.

FIG. 219. — Potato injured by the wheat wireworm.

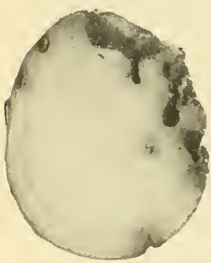

FIG. 220. — The same potato cut open to show the burrows made by wireworms.

The adult of the wheat wireworm is about $\frac{1}{3}$ inch in length, dull reddish brown, darker on the head and thorax. The beetles are to be found in the field from April to June. The female enters the ground to deposit her eggs. The larvæ become about half-grown by the end of the season; they resume feeding the following spring and become nearly full-grown by the second winter. They reach maturity in July of the third summer and construct earthen cells in which they transform to small whitish pupæ and a little later change to beetles. The beetles do not emerge the same season but remain in the pupal cells till the following spring. Three years are required for the completion of the life cycle.

The corn wireworm, *Melanotus communis* Gyllenhal, is $1\frac{1}{4}$ inches in length when full-grown, cylindrical, reddish brown in color and the last segment of the body is provided with three lobes. The beetle is about $\frac{1}{2}$ inch in length and of a dull reddish brown color. In this form the life cycle may require six years for its completion. Corn wireworms are most troublesome on heavy, poorly drained soils.

The sugar-beet wireworm, *Limonius californicus* Manneheim, has been reported as injurious to sugar-beet, lima bean, potato, corn and alfalfa in California. The beetle is a little less than $\frac{1}{2}$ inch in length, and brown to dusky black in color. The adults appear in the field in early spring and after remaining in a sluggish condition for some time the females burrow into the ground to deposit their eggs. Most of the eggs are laid between the middle of April and the middle of May and hatch in a little less than a month. Three years are spent in the larval state. The full-grown wireworm is about $\frac{3}{4}$ inch in length and shiny, waxy, yellowish brown in color.

The confused wireworm, *Limonius confusus* Leconte, has been recorded as attacking potato, tomato, onion, cabbage, radish, horse-radish and corn in Illinois. A related species, *Limonius agonus* Say, is treated as a tomato pest on page 173.

The corn and cotton wireworm, *Horistonotus uhlerii* Horn, is sometimes injurious in the South to corn, oats, rye, cowpeas, peanuts, cotton, tobacco, sweet potatoes and watermelons.

This species is an exception to the general rule and is most destructive on light sandy soil in the higher parts of fields. The beetle is $\frac{1}{5}$ to $\frac{1}{3}$ inch in length and brownish red in color. The larva is very slender, soft and has the body apparently composed of twenty-six segments.

*Control.*

Wireworm injury to vegetable crops can be prevented in large measure by practicing a short rotation of crops in which the land is not left in grass for more than two, or at most, three years. Peas and buckwheat are relatively immune to wireworm attack and may sometimes be used to advantage between sod and corn or other susceptible crops. Deep and thorough cultivation of the soil in late July and August will break open the pupal cells and destroy the pupæ and recently transformed adults, thus reducing the number of beetles the following spring. Late fall-plowing is of little value in destroying wireworms.

In the garden poisoned baits are sometimes used for killing the wireworms as well as the beetles. Small bunches of clover or other succulent plants are dipped into paris green water and then placed in the field covered with earth or pieces of boards. Sweetened corn-meal dough poisoned with paris green or other arsenical may be used instead of the clover. These baits should be distributed after the ground has been fitted but before the crop is planted and should be kept fresh by frequent renewals.

## Grasshoppers

Nearly all vegetable crops are subject to injury by various species of grasshoppers when grown in localities where these insects are abundant. Grasshoppers are most likely to be destructive in regions where the soil is sandy and where there are large areas of waste land, because it is in such situations that they find conditions most suitable for depositing their eggs.

An effective and practicable method of destroying grasshoppers is by the use of a poisoned bait made according to the formula given on page 299.

## The Red-Spider

*Tetranychus telarius* Linnæus

It has often been pointed out that the common name of this pest is inappropriate because it is neither a spider nor is it always red, but as this name has been in use for many years it would seem unwise to designate it as the spider mite as has been suggested recently. The red-spider is a mite belonging to the class Arachnida. On hatching, this mite is provided with three pairs of legs but before reaching maturity acquires a fourth pair. The mouth-parts are adapted for piercing the epidermis of the leaf on the juices of which the animal feeds. The red-spider attacks a great variety of plants both in the greenhouse and in the open. Of the former, roses, chrysanthemums, violets and carnations are particularly liable to injury while of the latter, arbor-vitæ, juniper, lilac, snowball and red sage should be mentioned. In the nursery some cherries may be attacked. The red-spider is also an important enemy of cotton and sometimes becomes troublesome on okra, cucumber, melon, eggplant, bean, tomato, pepper, sugar-beet, hops and orchard trees. Bramble fruits are especially liable to attack. The red-spider is almost cosmopolitan in its distribution, occurring wherever suitable food plants are found and being most abundant in those regions where the climate is dry. The mite is usually most troublesome in seasons of drought or in greenhouses where the moisture is deficient.

The full-grown female red-spider (Fig. 221) is a little less than $\frac{1}{50}$ inch in length; the male measures about $\frac{1}{75}$ inch.

The mite varies greatly in color from greenish through yellowish to orange or reddish; some are brownish. Usually the body is marked with one to three pairs of black spots. In some cases the spots are confluent and the mite appears black. The eyes are red. The legs are pale and in the male the two front pairs are usually tinged with reddish. Seen from above the mite's body is broadly ovate in outline. It is not divided into three regions as in insects. The mouth-parts consist of a pair of sharp needle-like protrusile bristles and a pair of shorter fixed spines. In feeding the mite pierces the epidermis of the leaf with its mouth-parts and through the puncture extracts the juices of the plant. This mite covers its feeding grounds with a maze of delicate silken threads. The silk is produced by glands opening near the tip of the body. The claws at the tip of the legs are especially adapted to enable the mite to travel over the web.

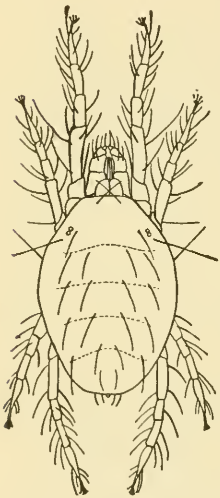

FIG. 221. — The red-spider (× 66).

The female deposits her spherical, pearly white eggs, about $\frac{1}{250}$ inch in diameter, singly on the underside of the leaves, to which they are usually attached by strands of silk. As the eggs develop they take on a reddish hue and the eyes of the embryo become evident as small red spots. Each female is capable of laying from 50 to 100 eggs over a period of nearly a month. The eggs hatch in three to eight days. On hatching the young mite is provided with only three pairs of legs; it is about $\frac{1}{125}$ inch in length and the body is nearly spherical in outline when viewed from above. The young mite soon begins feeding near the egg-shell and in about three days molts its skin. In the second stage the mite is provided with four pairs of legs; it is nearly $\frac{1}{80}$ inch in length. It feeds actively and in about three days molts again. The third stage nymph averages $\frac{1}{70}$ inch in length. In this stage the mite develops the habit of spinning a web. In about three days the mite molts for the third and last time and assumes the adult condition. It is thus seen that in the course of its development the mite passes through three immature stages and reaches maturity in nine or ten days after hatching from the egg. In about three days the females begin egg-laying. The number of generations produced annually varies with the length of the season and with the condition of temperature and moisture. When the weather is dry and hot the time elapsing from the laying of the egg to the time at which the mature female lays her first egg may be only nine or ten days, but in the cooler weather of the spring and autumn this period may be lengthened to over a month. Observations of the mite on cotton in South Carolina have shown that breeding from the first egg laid by the females of each generation as many as seventeen generations may be produced annually but owing to the fact that the mites may continue egg-laying for a month or more several of the later generations must be only partial. Under greenhouse conditions breeding may be continuous throughout the year.

The injury caused to most plants by the red-spider is indicated by small light-colored spots on the leaves, the result of the death of the plant cells around the feeding punctures. When numerous these spots coalesce and the leaves take on a whitish appearance. Injured plants usually become paler or take on a reddish cast and finally the leaves may shrivel and die.

*Control.*

In the greenhouse the red-spider may be held in check by watering the plants frequently with a nozzle that gives a stiff spray without delivering enough water to drench the beds.

Liberal watering of plants in the open will also have a beneficial effect on preventing red-spider injury. "Black Leaf 40" tobacco extract, 1 part in 1000 parts of water in which soap has been dissolved at the rate of $\frac{1}{4}$ pound to 5 gallons will also be found useful in freeing the plants of the pests. The tobacco extract is also effective when combined with the oil emulsions or with bordeaux mixture. The mites may also be held in check by dusting the plants with finely ground sulfur.

### Reference

Ore. Agr. Exp. Sta. Bull. 121. 1914.

## Slugs

Slugs are closely related to snails, from which they differ in having the shell reduced to a thin plate or wanting altogether. The commonest species injurious to vegetables in the eastern United States is the gray field slug, *Agriolimax agrestis* Linnæus (Fig. 222) and has apparently been introduced from Europe. It is about $1\frac{1}{4}$ inches in length when fully extended, spindle-shaped in outline, ashy gray in color mottled with darker gray. On the head are two pairs of fleshy tentacles; the upper pair is the longer and bears the eyes at the tip. When at rest or when disturbed the tentacles are withdrawn and the body contracts into a dull gray lump. Slugs are found in cool, moist situations. During the day they are hidden away under stones or boards and come out to feed only at night or on damp cloudy days. Their bodies are kept moist by a slimy secretion a trail of which is left behind wherever they go. These glistening snail tracks are often seen on boards left lying on the ground.

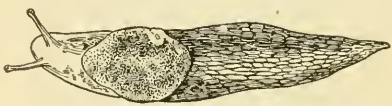

Fig. 222. — The gray field slug ($\times 1\frac{1}{2}$).

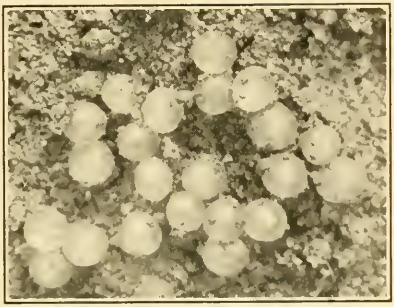

FIG. 223. — A cluster of eggs of the gray field slug (× 3).

When irritated as by an application of lime, they throw out a copious quantity of this protective secretion. The slug's mouth is provided with a tongue-like organ thickly studded with minute sharp teeth by which the animal is able to rasp off tender plant tissue. Slugs are hermaphroditic, both male and female organs being present in the same individual. The eggs are deposited from spring till late fall in loose clusters of thirty or forty in moist ground, under stones or other shelter. The eggs (Fig. 223) are nearly spherical, translucent and about $\frac{1}{12}$ inch in diameter. They hatch in three to ten weeks depending on the weather. If dried they shrink considerably but regain their size when moistened. The time required for a slug to reach maturity depends on conditions of moisture and food and varies from six weeks to nearly a year. They are said to live for several years.

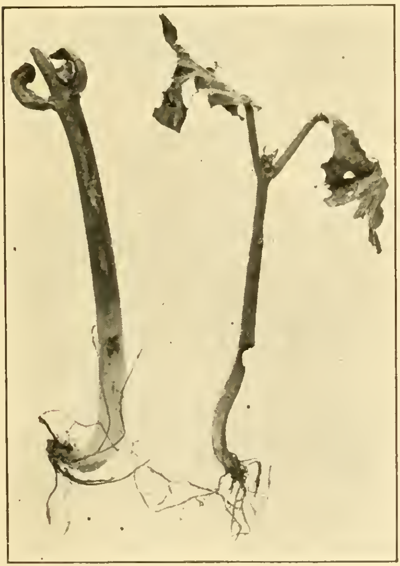

FIG. 224. — Seedling bean plants injured by slugs.

Slugs are most troublesome in seasons of abun-

FIG. 225. — Base of a cabbage leaf riddled by slugs.

dant moisture and on heavy soil that does not dry out quickly. They sometimes eat out holes in potato tubers and in the roots of radishes and carrots (Fig. 213). Corn and tobacco seedlings are sometimes destroyed and they may cause serious injury to bean plants (Fig. 224) by eating into the stems, devouring the buds and riddling the leaves with holes. They may also bore into the unripe pods. The leaves of celery, lettuce, cabbage, cauliflower, radish and the sprouts of potatoes are frequently attacked (Fig. 225).

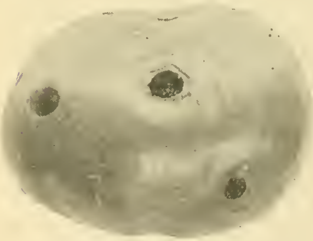

FIG. 226. — A green tomato injured by slugs.

Slugs often bore into ripening tomatoes but sometimes attack them while still green (Fig. 226) and are often found resting in cavities eaten out in ripening strawberries.

A smaller, nearly black species, *Agriolimax campestris* Binney, is often associated with the gray field slug. It closely resembles that form in habits and inflicts similar injuries.

*Control.*

Slugs may be killed by using the poison bait recommended for the control of cutworms on page 299, or by poisoning sliced potatoes with paris green or other arsenicals. Dusting the plants and the surrounding ground with air-slaked lime or land plaster will have a tendency to keep them away. Bordeaux mixture also has a deterrent effect and on some crops may be used to advantage. In some cases the plants may be sprayed with arsenate of lead either alone or in combination with bordeaux mixture.

## The Yellow Bear Caterpillar

*Diacrisia virginica* Fabricius

Many vegetables are occasionally subject to attack by large hairy caterpillars which from their shaggy appearance and clumsy gait have received the suggestive names of yellow and woolly bears. The yellow bear is widely distributed from Nova Scotia to California southward to Mexico and Cuba. The caterpillars are very general feeders attacking asparagus, bean, pea, beet, salsify, cabbage, cauliflower, radish, turnip, carrot, celery, eggplant, onion, parsnip, corn, peanut, cantaloupe, pumpkin, squash, potato, rhubarb, sweet potato, watermelon, grasses, alfalfa, grape, currant, gooseberry, raspberry, canna, dahlia, hollyhock, hyacinth, morning-glory and various other plants.

Hibernation takes place in the pupal state and the moths emerge from early spring to June. The moths have an expanse of $1\frac{1}{4}$ to 2 inches. The wings are pure white; the front wings marked with a small black dot near the center; the hind wings usually with three black dots. The head and thorax are clothed with white down; the abdomen is white with two orange bands and three rows of black spots. The eggs are deposited in clusters of fifty to sixty or more on leaves. The egg is spherical, about $\frac{1}{40}$ inch in diameter and shining white to golden yellow in color. The eggs hatch in seven days. The young caterpillars feed at first in colonies on the underside of the leaves, skeletonizing them, but later scatter and riddle the leaves, leaving only the ribs. They become mature in about four weeks. The full-grown caterpillar is from $1\frac{1}{2}$ to 2 inches in length, covered with fine soft hairs intermingled with larger ones and varying from pale yellow to deep reddish brown, shading to blackish in front. They then leave their food plants and seek shelter under the loose bark of trees, under boards or similar situations, where they construct cocoons mostly composed of hairs from their bodies fastened together with a few threads of silk. The reddish brown pupa is about $\frac{5}{8}$ inch in length. The pupal period lasts from one to two weeks. In the northern United States there are two broods annually.

*Control.*

The larger caterpillars feed in exposed situations and are readily controlled by hand-picking. The smaller ones are easily poisoned by spraying with arsenate of lead (paste), $2\frac{1}{2}$ pounds in 50 gallons of water.

References

Riley, 3rd Rept. Ins. Mo., pp. 68–69. 1871.
Dickerson, Moths and Butterflies, pp. 192–195. 1901.

## The Salt-Marsh Caterpillar

*Estigmene acræa* Drury

Nearly a century ago, T. W. Harris made a careful study of the life history and habits of this insect, which he named the salt-marsh caterpillar because of its injuries to hay grown on the salt marshes of the Massachusetts coast. This name has been retained though somewhat misleading, as the caterpillars are not confined to salt marshes but also feed on a great variety of grasses and garden crops including cabbage, beans and peas. The insect is distributed throughout North America from Hudson Bay to Central America.

Hibernation takes place in the pupal stage and the moths emerge in late May and June. The moth has an expanse of $1\frac{3}{4}$ to $2\frac{1}{4}$ inches. In the female the wings are white and marked with numerous small black spots. In the male the hind wings and under surface are yellow and spotted as in the female. The abdomen above is orange with three rows of black spots; the tip is white. The yellow, nearly spherical eggs, about $\frac{1}{40}$ inch in diameter, are laid in patches about the middle of June, a single female laying as many as 1200 eggs. The eggs hatch in about a week and the young caterpillars feed at first in colonies but soon scatter. They reach maturity in about seven weeks, that is, about the middle of August. The caterpillar is then about $1\frac{3}{4}$ inches in length and covered with long mouse- and fox-colored hairs arising from large tubercles, twelve tubercles to a segment. The nearly mature caterpillars are often seen wandering about in search of food or places in which to pupate. The cocoons are hidden away in any sheltered place and are largely composed of the caterpillar's hairs interwoven with silk and lined with a layer of silk. The pupal period in the summer lasts from two to three weeks. In New England there are two generations annually.

This caterpillar may be controlled by the same measures as suggested for the preceding species.

### Reference

Harris, Mass. Agr. Rept. and Jour. 7, pp. 322–333. 1823.

# CHAPTER XIX

## INSECTS AND INSECTICIDES

In order successfully to prevent insect injury to any crop, it is necessary to take into consideration various factors, as for instance: the life history of the insect; its habits and structure in its various stages; the method and rate of reproduction; how, when and on what part of the plant it feeds, both in its immature and adult condition; where and in what stage it passes the winter; and its susceptibility to the action of poisons and contact insecticides, as well as the effect of these substances on the plant concerned. In order to devise a practical means of control, it is also necessary to take into consideration the conditions under which the plant is grown, the methods of propagation, cultivation and harvesting as well as the commercial value of the crop.

In the preceding chapters, an attempt has been made to give the more important facts known touching on these points. In the present chapter are presented some general considerations in regard to the structure and development of insects that are of interest from the standpoint of control, followed by a discussion of the more important insecticides used against vegetable insects.

### Structure of Insects

Insects possess an external skeleton or shell composed of a series of segments or rings which is divided into three well-defined regions, — head, thorax and abdomen (Fig. 227). The head bears a pair of antennæ, a pair of compound eyes and often three simple eyes or ocelli. On the thorax are borne three pairs of legs and in the adult condition two pairs of wings, except

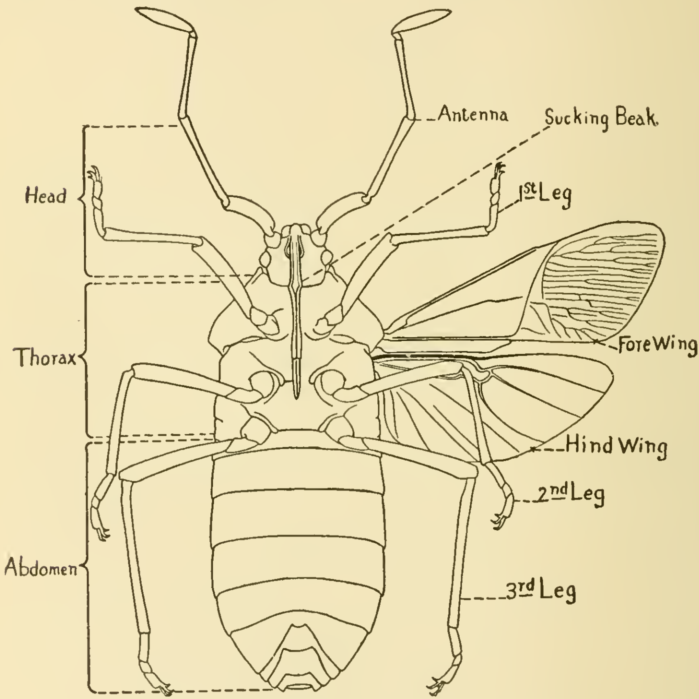


Fig. 227. — Ventral view of a squash-bug.

in the flies, when the hind pair is represented by a pair of knobbed appendages known as poisers. The legs (Fig. 228) consist of a series of segments named as follows, beginning with the one nearest the body: coxa, trochanter, femur, tibia and tarsal joints.

The wings are modified in various ways; in the butterflies and moths they are usually covered with scales; in the beetles the front wings are hard and horny and are known as wing-covers under which the hind wings are folded when in repose. In many true bugs the front wings are of a leathery texture except the tip, which is membranous.

In the female the abdomen is often provided with a sharp ovipositor by means of which she is able to insert her eggs into the tissue of plants.

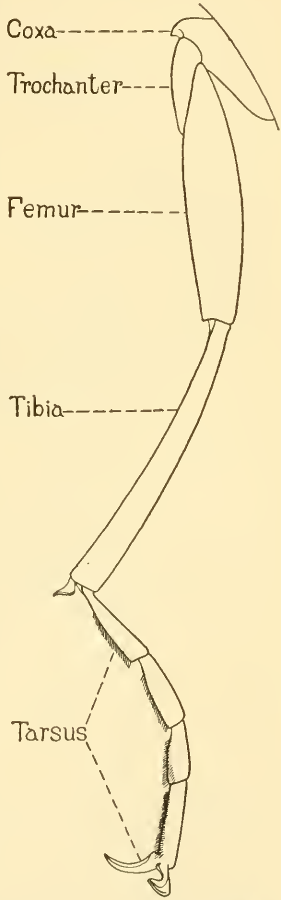

FIG. 228. — Leg of a blister-beetle.

*How insects feed.*

The mouth-parts of insects are adapted for feeding in various ways and on all kinds of plant tissue. In order to make intelligent efforts to control insects, it is necessary to know exactly in what way they take their food. For purposes of control, insects may be roughly divided into three classes as follows:

1. *Chewing insects:* In this group the mouth is provided with a pair of hard horny jaws or mandibles (Fig. 229) with which the insect is able to bite off portions of plant tissue, which are then swallowed. Beetles and caterpillars belong to this class. It is usually possible to kill such insects by poisoning their food. Arsenic in some form is generally employed for this purpose.

2. *Sucking insects:* This term is usually applied to insects which have the mouth-parts modified to form a beak containing four bristles united into a slender tube with which they puncture the tissues of the plant and suck out the juices (Fig. 230). Plant-lice and other true bugs possess this type of mouth-parts and are controlled by the use of contact insecticides.

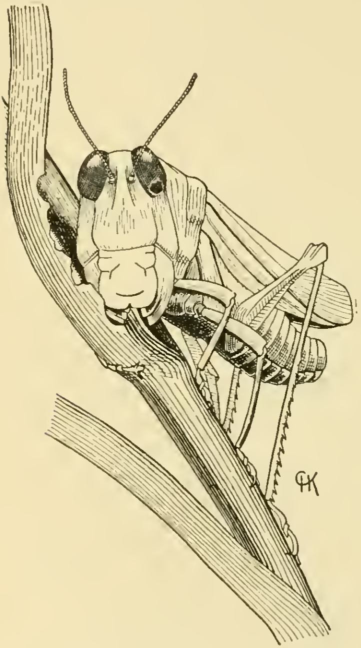

Fig. 229. — A grasshopper feeding, showing the biting type of mouth-parts.

3. *Lapping insects:* In some flies the mouth-parts are developed into a tongue-like organ with which they are able to lap or lick up liquids but which is not fitted for piercing plant tissue (Fig. 231). Sweetened arsenical baits have been used successfully for the control of some insects belonging to this class.

*How insects breathe.*

Insects breathe through a series of openings called spiracles extending along the side of the body. These openings connect with tubes called tracheæ which, subdividing again and again, extend to all parts of the body. Some contact insecticides, such as soaps, are supposed to clog the spiracles and kill the insect by suffocation; others, like the oils, are said to penetrate the thin walls of the tracheæ and thus reach a vital part; and it is thought that the fumes of nicotine arising from the spray applied to the insect are carried through the tracheæ to the nervous system where they cause death by paralysis.

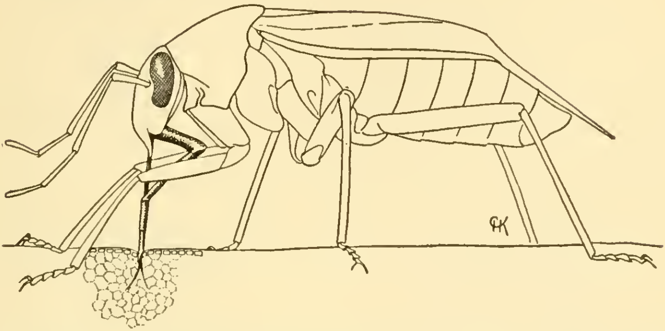

FIG. 230. — A tarnished plant-bug feeding, showing the sucking type of mouth-parts.

*The development of insects.*

Most insects, with the exception of some scale insects and certain forms of plant-lice, reproduce by means of eggs. The newly hatched insect usually bears little resemblance to the adult. As it increases in size, its skin becomes too small, a new skin is formed beneath the old one and the latter is discarded; this is known as molting. The period between two successive molts is called an instar. The number of instars varies in different insects from three to six or seven; five is the more common number. In some insects the change from the immature condition to the winged adult takes place without any material change in form; in

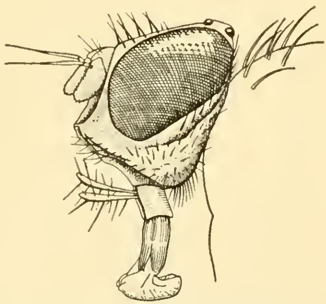

FIG. 231. — Head of the onion maggot fly, showing the lapping type of mouth-parts.

others the transformation is abrupt and striking. In the former case the insect is said to have an incomplete metamorphosis; in the latter a complete metamorphosis.

*Incomplete metamorphosis.*

In this type of development, the immature stages resemble the adult in form. The wings develop externally as pad-like outgrowths of the thorax but do not become functional till the adult stage is reached. The immature forms are known as nymphs. In this type of development, the life cycle of the insect consists of three stages, viz., the egg, the nymph (three to five instars) and the adult. The true bugs and grasshoppers have incomplete metamorphosis.

Some authors refer to the early nymphal stages of plant-lice as larvæ and to the last nymphal stage, in which the wing-pads are present, as pupæ. According to this system in the thrips, the first two nymphal stages are called larvæ, the third stage a prepupa and the fourth a pupa. These terms are somewhat confusing and are not followed in the present work. It is preferable to restrict the terms larva and pupa to the early stages of insects having a complete metamorphosis. The various stages of an insect with incomplete metamorphosis are shown in Fig. 232.

*Complete metamorphosis.*

In this case the immature stages of the insect bear little or no resemblance to the adult. The wings develop internally in pockets formed by an infolding of the body-wall of the thorax. The immature stages are known as larvæ. The larva molts five or six times, and when full-grown transforms to an inactive pupa, often in a cocoon or earthen cell prepared by the larva. The pupa is a resting stage in which the organs of the larva are more or less broken down and made over into those of the adult. In the pupa, the antennæ, legs and wings of the adult

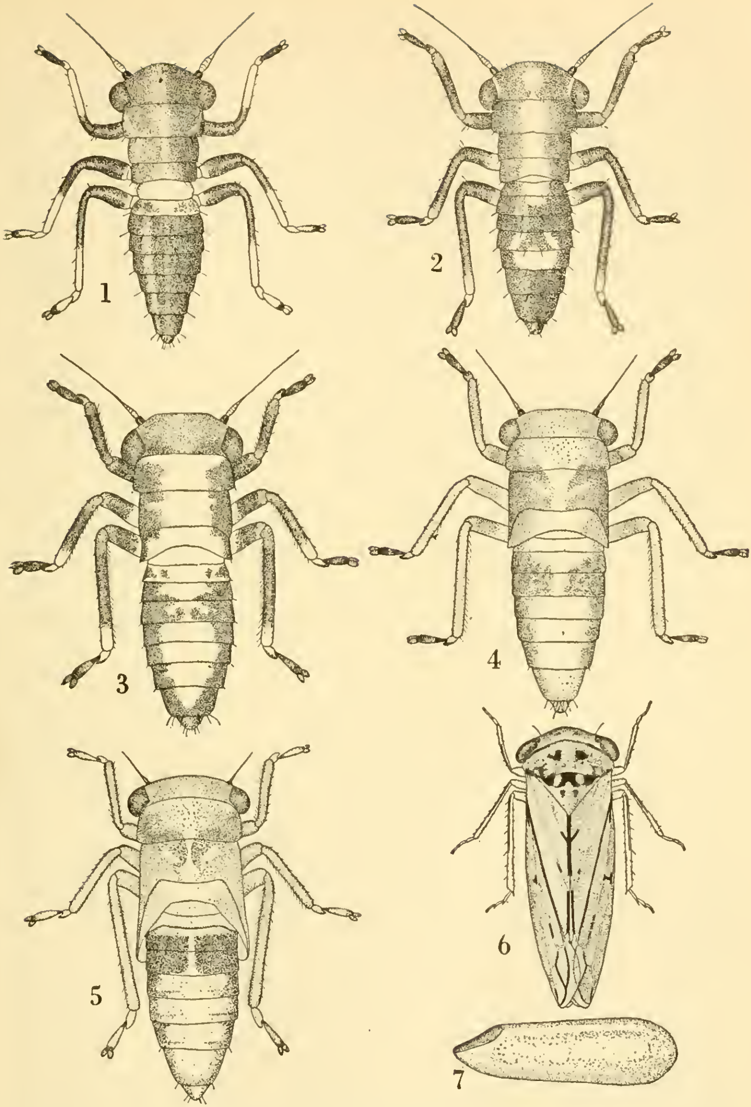


Fig. 232. — The various stages in the development of *Idiocerus scurra*, a leaf-hopper on poplar, an insect with incomplete metamorphosis. 1 to 5, first to fifth nymphal stages; 6, adult; 7, egg. (All enlarged but not in the same proportion.)

are usually evident, closely applied to the body and covered by the pupal skin. When the remarkable internal structural changes in the pupa are complete, the adult winged insect emerges. In this type of development there are four stages, viz., egg, larva (five to six instars), pupa and adult. Butterflies, moths, beetles and flies have complete metamorphosis. The four stages of an insect with complete metamorphosis are illustrated in Figs. 93 to 97 of the tomato worm.

The larvæ of flies are commonly known as maggots; those of butterflies and moths as caterpillars, and the larvæ of beetles as grubs. The pupa of a butterfly or moth is often called a chrysalis.

## Insecticides

Injuries to vegetable crops by insects may be prevented by various cultural practices, such as clean farming to reduce hibernating shelter and to destroy the weeds and other wild plants on which injurious species breed, and from which they spread to cultivated crops, and by a proper system of rotation in which the same crop is not planted on the same land for a series of years and in which crops that are attacked by the same insects do not succeed each other. In some cases, collecting and destroying crop remnants is of great importance in preventing injury in the same or near-by fields the following year. Taken all in all, clean farming in combination with a proper crop rotation is the most important and practical method of preventing loss from insect attacks to vegetables.

In the case of some crops, cultural practices can usually be relied on to prevent serious insect injury, but with most crops recourse must be had to special applications of materials that either poison the insects or kill them by coming into contact with their bodies. Such substances are known as insecticides.

Insecticides are usually divided into two classes, internal poisons and those that kill by contact. The former are used against chewing insects and kill by being taken into the digestive tract; the latter are not eaten but are applied directly to the insect's body and produce death in various ways, either by suffocation, by corrosive action or by fumes that penetrate the breathing pores of the insect.

Insects infesting stored seeds and tubers may be killed by fumigating with poisonous gases.

*Arsenic.*

White arsenic, arsenious oxid ($As_2O_3$), is a white powder. It is the cheapest form in which arsenic can be obtained. It is soluble in water and therefore very injurious to foliage. Sodium arsenite, a cheap and efficient insecticide, may, however, be prepared from it by the following method:

| | |
|---|---|
| Sal soda . . . . . . . . . . . | 2 pounds |
| Water . . . . . . . . . . . | 1 gallon |
| Arsenic . . . . . . . . . . . | 1 pound |

Mix the white arsenic into a paste and then add the sal soda and water, and boil until dissolved. Add water to replace any that has boiled away, so that one gallon of stock solution is the result. Use one quart of this stock solution to fifty gallons of bordeaux mixture. This material is little used, except for potato spraying, and should always be applied in combination with bordeaux mixture and even when so used care should be taken that there is enough lime in the mixture to neutralize the caustic action of the asenic.

*Paris green.*

Pure paris green, $3Cu(AsO_2)_2 \cdot Cu(C_2H_3O_2)_2$, is composed of copper oxid, $CuO$, acetic acid, $HC_2H_3O_2$, and arsenious oxid, $As_2O_3$, chemically combined as copper-aceto-arsenite as follows:

| | |
|---|---|
| Copper oxid . . . . . . . . . . | 31.29 per cent |
| Arsenious oxid . . . . . . . . . | 58.65 per cent |
| Acetic acid . . . . . . . . . . | 10.06 per cent |

The commercial grades often contain impurities and vary somewhat from the above. By the National Insecticide Law of 1910, paris green must contain at least 50 per cent of arsenious oxid, and must not contain arsenic in water-soluble form equivalent to more than $3\frac{1}{2}$ per cent of arsenious oxid.

Paris green is most widely used for spraying potatoes and is usually combined with bordeaux mixture. When used in water, an equal weight of lime should be added to neutralize any soluble arsenic present and thus prevent burning of the foliage. For many purposes paris green is now largely replaced by arsenate of lead, which is less likely to burn the leaves but is a little slower in its effect on the insects.

Paris green is sometimes applied in the dry form and may then be diluted with hydrated lime or land plaster.

*London purple.*

London purple is an arsenite of lime obtained as a by-product in the manufacture of aniline dyes. Its composition is variable, the arsenic content varying from 30 to 50 per cent. It is a finer powder than paris green and, therefore, remains longer in suspension in water. It is used in the same way as paris green, but owing to the presence of much soluble arsenic, is likely to cause foliage injury. This can be averted by the use of lime as advised under paris green. London purple is now little used as an insecticide.

*Arsenate of lead.*

Arsenate of lead has practically replaced paris green for spraying orchard trees and its use on vegetable crops is rapidly becoming more widespread. It contains less soluble arsenic and, therefore, does not have as great a tendency to burn the foliage; it adheres better to the leaves but is a little slower in its action on the insects.

Chemically, arsenate of lead may be either triplumbic arsenate, $Pb_3(AsO_4)_2$, or plumbic hydrogen arsenate, $PbHAsO_4$. The commercial product usually consists of a mixture of these two forms, the proportion depending on the method of manufacture employed. The triplumbic arsenate of lead is prepared by combining normal sodium arsenate, $Na_3AsO_4$, with either lead acetate, $Pb(C_2H_3O_2)_2$, or lead nitrate, $Pb(NO_3)_2$. If any di-sodium hydrogen arsenate, $Na_2HAsO_4$, be present, there is then formed some of the plumbic hydrogen arsenate. Arsenate of lead is sold in two forms, a thick paste and a fine powder.

Under the National Insecticide Act of 1910, arsenate of lead paste must not contain more than 50 per cent water and must contain the arsenic equivalent of at least $12\frac{1}{2}$ per cent arsenic oxid, $As_2O_5$. The water-soluble arsenic must not exceed an equivalent of $\frac{3}{4}$ of one per cent of arsenic oxid. Some of the commercial preparations contain a larger percentage of arsenic than required by the law. In the best grades of arsenate of lead paste, the chemical is in a finely divided condition, and thus when diluted for use remains in suspension for a considerable time. If the paste contains less than 50 per cent water, it is likely to be lumpy and requires considerable time and labor to get it into condition for use.

Powdered arsenate of lead is usually considered to contain twice as much arsenic as the paste. It is often stated on theoretical grounds that powdered arsenate of lead does not adhere as well to the foliage as the paste form, but practically there is little if any difference. The powder is more convenient to use, it mixes more readily with water and broken packages are not injured by drying out or by freezing. In the preceding chapters the quantity of arsenate of lead to be used has been given in terms of the paste form but in most cases the powdered form may be used with equally good results and only one half the quantity is necessary.

*Zinc arsenite.*

Arsenite of zinc, $Zn(AsO_2)_2$, is a light fluffy powder and contains the equivalent of 40 per cent arsenious oxid. It is sometimes used as a substitute for arsenate of lead. It has a greater tendency to burn the foliage when used in water but is fairly safe if combined with bordeaux mixture. It is probable that foliage injury by zinc arsenite is due to the solubility of this poison in water containing a small quantity of carbonic acid; the latter is usually present on the leaves, being derived from the respiration of the plant. One pound of zinc arsenite is equivalent in effectiveness to about three pounds of arsenate of lead paste.

*Calcium arsenate.*

Commercial calcium arsenate consists of a variable mixture of acid calcium arsenate, $CaHAsO_4$, and basic calcium arsenate, $Ca_3(AsO_4)_2$. It is sold in two forms — a thick paste and a powder. It may be used as a substitute for arsenate of lead and is considerably cheaper. Unfortunately, when used alone there is some danger of burning the foliage. This may be overcome by adding an equal weight of quicklime, or by using it with bordeaux mixture. Calcium arsenate contains a larger percentage of arsenic than arsenate of lead and it is, therefore, not necessary to use so large a quantity.

*Hellebore.*

Hellebore is a light brown powder made from the roots of the white hellebore plant (*Veratrum album*), one of the lily family. It is applied both dry and in water. In the dry state, it is usually applied without dilution, although the addition of a little flour will render it more adhesive. In water, 4 ounces of the poison are mixed with 2 or 3 gallons, and an ounce of glue, or thin flour paste, is sometimes added to make it adhere. A decoction is made by using boiling water in the same proportions. Hellebore soon loses its strength, and a fresh article should always be demanded. It is much less poisonous than the arsenicals, and, therefore, may be used on vegetables soon to be eaten. It is of especial value in the home garden.

*Soaps.*

Soap solutions are often used as contact insecticides for killing plant-lice and other small, soft-bodied insects. The so-called whale-oil or fish-oil soaps are most widely used for this purpose. The commercial brands are usually by-products and contain many impurities; furthermore, many of them contain an excess of free or uncombined alkali and are consequently very likely to injure young and tender foliage. An excellent fish-oil soap may be easily prepared at home by the following formula:

| | |
|---|---|
| Caustic soda . . . . . . . . . . . | 6 pounds |
| Water . . . . . . . . . . . . . | $\frac{1}{2}$ gallon |
| Fish-oil . . . . . . . . . . . . | 22 pounds |

Completely dissolve the caustic soda in the water, and then add the fish-oil very gradually under constant and vigorous stirring. The combination occurs readily at ordinary summer temperatures and boiling is unnecessary. Stir briskly for about twenty minutes after the last of the oil has been added.

*Sulfur.*

Sulfur is commonly sold in two forms, — flowers of sulfur and flour of sulfur. Flowers of sulfur or sublimed sulfur is a fine, impalpable yellow powder insoluble in water, and is formed by condensing sulfur vapor in a large chamber of brick work. If the sulfur vapor is condensed to the liquid form in a cold receiver, roll sulfur is formed. Flour of sulfur is made by grinding roll sulfur to a fine powder.

In the form of a powder or dust, sulfur is especially valuable against red-spider. For this purpose it is often diluted with hydrated lime and may be applied mixed with water at the rate of 1 pound in 3 gallons, in which a little soap has been dissolved to help keep the sulfur in suspension. The sulfur settles quickly and should be agitated constantly during spraying. The sulfur will remain in suspension longer if first made into a paste with water containing ½ of one per cent of glue.

*Emulsions.*

Emulsions are sprays in which oils are suspended in water in the form of minute globules, a condition brought about by the addition of soap. They form an important class of contact insecticides useful particularly against plant-lice and other soft-bodied insects.

Kerosene emulsion is one of the oldest of contact insecticides. It is prepared by the following formula:

| | |
|---|---|
| Soap . . . . . . . . . . . . . | ½ pound |
| Water . . . . . . . . . . . . . | 1 gallon |
| Kerosene . . . . . . . . . . . | 2 gallons |

Dissolve the soap in hot water; remove from the fire and while still hot add the kerosene. Pump the liquid back into itself for five or ten minutes or until it becomes a creamy mass. If properly made the oil will not separate on cooling.

For killing plant-lice on foliage, dilute with 10 to 15 parts of water. The strength of oil emulsions is frequently indicated by the percentage of oil in the diluted liquid:

For a 10 per cent emulsion add 17 gal. water to 3 gal. stock emulsion.
For a 15 per cent emulsion add 10½ gal. water to 3 gal. stock emulsion.
For a 20 per cent emulsion add 7 gal. water to 3 gal. stock emulsion.
For a 25 per cent emulsion add 5 gal. water to 3 gal. stock emulsion.

Carbolic acid emulsion is sometimes used against root-maggots.

| | |
|---|---|
| Soap | 1 pound |
| Water | 1 gallon |
| Crude carbolic acid | 1 pint |

The soap is dissolved in hot water, the crude carbolic acid is added and the mixture is agitated into an emulsion. For use against root-maggots, this stock solution should be diluted with 30 parts of water.

*Tobacco.*

Tobacco is one of the most useful insecticides. The poisonous principle in tobacco is an alkaloid, nicotine, which in the pure state is a colorless oily fluid, slightly heavier than water, of little smell when cold and with an exceedingly acrid burning taste even when largely diluted. It is soluble in water and entirely volatile. It is one of the most virulent poisons known; a single drop is sufficient to kill a dog.

Commercial tobacco preparations have been on the market for many years. The most important of these are "Black Leaf 40" and Nicofume.

"Black Leaf 40" is a concentrated tobacco extract containing 40 per cent nicotine in the form of nicotine sulfate. Its specific gravity is about 1.25. In this preparation the nicotine is in a non-volatile form, it having been treated with sulfuric acid to form the sulfate. "Black Leaf 40" is used at strengths varying from 1 part in 500 parts of water to 1 part in 1600 parts. It can be satisfactorily combined with other sprays, as, for instance, bordeaux mixture, arsenate of lead and the various soap solutions. When used with water, 4 to 8 pounds of soap should be added to each 100 gallons to make the mixture spread and stick better.

Nicofume is a tobacco extract containing 40 per cent of nicotine in the volatile form. It is intended primarily for use in greenhouses. Strips of paper soaked in this preparation are smudged in greenhouses to destroy aphids.

Tobacco is also used in the form of a dust for the same purpose. It is especially valuable against root-lice on asters and other plants. Tobacco extracts can be made at home by steeping tobacco stems in water, but as they vary greatly in nicotine content and are sometimes likely to injure tender foliage, it is better to buy the standardized extracts.

*Bordeaux mixture.*

Bordeaux mixture is widely used on potatoes and many other plants for the prevention of fungous diseases. In addition to its fungicidal properties, it also acts as a deterrent to many insects, especially flea-beetles. Arsenate of lead, paris green and "Black Leaf 40" may be used in combination with it.

Bordeaux mixture is prepared by mixing a solution of copper sulfate, $CuSO_4$, and milk of lime (calcium hydroxid) according to the following formula:

| | |
|---|---|
| Copper sulfate . . . . . . . . . . | 4 pounds |
| Lime . . . . . . . . . . . . . . | 4 pounds |
| Water . . . . . . . . . . . . . . | 50 gallons |

In some cases a weaker mixture is used, containing 3 pounds of copper sulfate and lime respectively. These formulas are often abbreviated thus: 4–4–50 and 3–3–50.

When needed in large quantities, bordeaux mixture is most conveniently prepared by using stock solutions of copper sulfate and milk of lime and storing them in tubs on an elevated platform from which the desired quantity of each can be easily drawn off into the spray tank.

The required quantity of copper sulfate should be dissolved in water in the proportion of one pound to one gallon. This may be most easily accomplished by suspending the copper sulfate crystals in a sack near the top of the water. A solution of copper sulfate is heavier than water. As soon, then, as the crystals begin to dissolve, the solution will sink, bringing water again in contact with the crystals. In this way, the crystals will dissolve much sooner than if placed in the bottom of the barrel. In case large quantities of stock solution are needed, two pounds of copper sulfate may be dissolved in each gallon of water, making the stock solution twice as strong.

Slake the required quantity of lime in a tub or trough. Add the water slowly at first, so that the lime crumbles into a fine powder. If small quantities of lime are used, hot water is preferred. When completely slaked or entirely powdered, add more water. When the lime has slaked sufficiently, add water to bring it to a thick milk or to a certain number of gallons. The amount required for each tank of spray can be secured approximately from this stock mixture, which should not be allowed to dry out. Hydrated or prepared lime of good quality may be substituted for the stone lime. Place the required quantity in the barrel or tank and add water. No slaking is required. Do not use air-slaked lime.

To make a 5–5–50 bordeaux mixture, take 5 gallons of stock solution, containing one pound of copper sulfate to a gallon (or one half as much of the stronger solution) for every 50 gallons of bordeaux mixture required. Pour this into the spray-tank. Add water until the tank is about two thirds full. From the stock lime mixture add the required quantity. Stir the mixture and add water to make 50 gallons. Experiment stations often recommend the diluting of both the copper sulfate solution and the lime mixture to one half the required amount before putting them together. This is not necessary, and is often impracticable for commercial work. It is preferable to dilute the copper sulfate solution. Never pour together the concentrated stock mixtures and dilute afterward. Bordeaux mixture of other strengths as recommended is made in the same way, except that the amounts of copper sulfate and lime are varied according to the requirements.

It is not necessary to weigh the lime in making bordeaux mixture, for a simple test can be used to determine when enough of a stock lime mixture has been added. Dissolve an ounce of yellow prussiate of potash in a pint of water and label it "poison." Cut a V-shaped slit in one side of the cork so that the liquid may be poured out in drops. Add the lime mixture to the diluted copper sulfate solution until the ferrocyanid test solution *will not turn brown* when dropped from the bottle into the mixture. It is always best to add a slight excess of lime.

*Sticker.*

The foliage of onions, cabbage and some other plants is so smooth that it is difficult to make a spray adhere to it. The following preparation will be useful for this purpose:

| | |
|---|---|
| Resin . . . . . . . . . . . . . . | 2 pounds |
| Sal soda (crystals) . . . . . . . . . | 1 pound |
| Water . . . . . . . . . . . . . . | 1 gallon |

Boil in an iron kettle in the open one to one and one half hours, or until the liquid takes on a clear brown color. Add this amount to each 50 gallons of bordeaux mixture.

*Fumigation.*

Two gases are in common use for killing insects, hydrocyanic acid gas and carbon bisulfid. The former is much used for the destruction of vermin in houses, for fumigating nursery stock and for the destruction of greenhouse insects, particularly the white-fly and plant-lice. The latter is more generally used for killing insects infesting seeds and tubers in storage.

Hydrocyanic acid gas is generated by placing either potassium cyanid ($KCN$) or sodium cyanid ($NaCN$) in dilute sulfuric acid. The ingredients are combined in the following proportions:

| | |
|---|---|
| Potassium cyanid (98 per cent) . | 1 ounce avoirdupois |
| Sulfuric acid . . . . . . . . . . | 1 fluid ounce |
| Water . . . . . . . . . . . . | 3 fluid ounces |

Potassium cyanid is a white, deliquescent, highly poisonous substance. The commercial article is usually in the form of rather hard irregular lumps which are readily soluble in water. Because of its tendency to draw moisture from the air, it is usually sold in tight tin cans or drums. Small amounts may be kept in glass fruit-jars. For fumigation purposes, only potassium cyanid that is at least 98 per cent pure should be used.

The sulfuric acid need not be chemically pure, a good commercial grade being entirely satisfactory.

When sodium cyanid is used, the proportions are as follows:

| | |
|---|---|
| Sodium cyanid . . . . . . . . . | 1 ounce avoirdupois |
| Sulfuric acid . . . . . . . . . . | $1\frac{1}{2}$ fluid ounces |
| Water . . . . . . . . . . . . | 2 fluid ounces |

When pure, sodium cyanid contains 53 per cent cyanogen (CN), which is about 33 per cent more than is present in potassium cyanid. It is customary to indicate the strength of sodium cyanid in terms of potassium cyanid; that is, pure sodium cyanid is said to be 133 per cent pure. This means that 100 pounds of sodium cyanid will yield as much cyanogen as 133 pounds of potassium cyanid. For fumigation purposes, sodium cyanid should be at least 124 per cent pure and should not contain more than one per cent of common salt, as its presence causes the decomposition of the hydrocyanic acid gas. Owing to its higher cyanogen content, only three fourths as much sodium cyanid is required for fumigating a given space as of potassium cyanid.

In generating the gas, the proper procedure is to place the water in an earthen jar of suitable size. Butter crocks are convenient for this purpose. The acid is then added to the water, generating considerable heat. The water should never be poured into the acid, since the steam produced will cause a vigorous bubbling and the acid may be spattered on the operator. After the acid has mixed with the water, the proper quantity of cyanid is placed in the liquid. The rapidity with which the gas is generated will depend on the temperature of the liquid and on the size of the lumps of cyanid.

For destroying white-fly on tomatoes and cucumbers grown under glass, potassium cyanid should be used at the rate of 1 ounce (or sodium cyanid, $\frac{3}{4}$ ounce) to 3000 cubic feet of space contained in the house and the fumigation should continue all night. Fumigate only on dark dry nights when there is no wind. The house should be as dry as practicable and the temperature not above 60 degrees F.

Carbon bisulfid is often used for fumigating peas and beans infested with weevils and potatoes infested with the tuber-moth. Carbon bisulfid ($CS_2$) is a thin liquid that volatilizes at a low temperature, the vapor being very destructive to animal life. It is very inflammable and care should be taken not to bring it in contact with fire or with a lighted lamp. One should not smoke while fumigating. In fumigating peas and beans infested with weevils the seed should be placed in a tight box or barrel to which a cover has been fitted as nearly air-tight as possible. Carbon bisulfid is used at the rate of $\frac{1}{2}$ to 1 ounce a bushel. In larger quantities in specially constructed fumigating chambers, the weevils can be killed by using the liquid at the rate of 3 pounds to 1000 cubic feet. The material is placed in a shallow dish on the top of the seed. The box should then be covered tightly and the fumigation continued for twenty-four to thirty-six hours.

In fumigating potatoes to destroy the tuber-moth, the material should be placed in tight bins lined with tarred paper and with the seams painted. The carbon bisulfid is used at the rate of 2 pounds for each 1000 cubic feet and the fumigation is continued for forty-eight hours.

The carbon bisulfid is placed in shallow tin pans on top of the material to be treated. The vapor is heavier than air and will be gradually diffused through the mass. Fumigation with this material is more effective if the temperature is kept near 70 degrees F. At lower temperatures the insects are less active and much more difficult to kill.

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