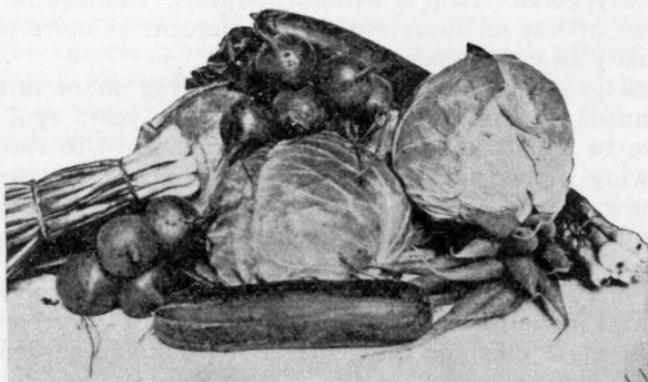


Insects Feeding on Truck and Garden Crops and How to Control Them

By CHARLES C. COMPTON



In order to produce high-grade, marketable vegetables, the gardener must constantly fight many insect pests by using insecticides and special cultural methods.

UNIVERSITY OF ILLINOIS
COLLEGE OF AGRICULTURE AND AGRICULTURAL
EXPERIMENT STATION

Circular 391

THE LIBRARY OF THE
JUN 30 1932
UNIVERSITY OF ILLINOIS

CONTENTS

	PAGE		PAGE
INSECT PESTS OF—		PEAS AND BEANS.....	34
CABBAGE AND RELATED		ASPARAGUS.....	37
CROPS.....	3	BEETS, SPINACH, LETTUCE,	
POTATOES.....	13	CELERY, AND DILL.....	39
SWEET CORN.....	18	CARROTS AND PARSNIPS....	40
TOMATOES AND EGGPLANT..	23	HORSE-RADISH.....	42
CUCUMBERS, MELONS,		SWEET POTATOES.....	42
SQUASH, AND PUMPKINS	26	INSECTICIDES.....	43
ONIONS.....	31	INDEX.....	47

A TAX of four or five million dollars is collected in Illinois each year by the insect pests that damage vegetable crops. No vegetable crop is without its pests. Damage ranges from 10 percent or less on some crops to 50 percent or more on others; occasionally an entire crop is lost.

Truck growers and gardeners are paying more attention to losses caused by insects than they did a few years ago, and they will have to devote more effort to insect control in the future if the growing of vegetables is to be profitable. It is essential that they know the life history and habits of the more destructive pests and that they become acquainted with the best known methods of insect control.

This circular describes both spraying and dusting systems and the cultural methods that have been found most effective for combating the more common insect pests of truck and garden crops in Illinois. Important points in the life history together with a brief description of each insect are given in order that the grower may apply control measures more intelligently. Each insect is considered in the order of its importance under the crop upon which it is usually most abundant and destructive.

no. 391

Insects Feeding on Truck and Garden Crops and How to Control Them

By CHARLES C. COMPTON, Entomologist, Illinois Natural History Survey, in cooperation with the Department of Horticulture, Agricultural Experiment Station

INSECTS may be divided roughly into two classes according to the nature of their feeding habits: (1) chewing insects, such as caterpillars and beetles, which bite off bits of the plant and chew their food; and (2) piercing-sucking insects,¹ such as aphids and true bugs, which pierce the plant surface and suck up their food by means of their beaks. To combat chewing insects, a stomach poison, such as arsenate of lead, is usually used, but if the insect is a piercing-sucking one, such poisons are of no value because the insect inserts its beak thru the poison and reaches a safe feeding place beneath. Contact insecticides, such as nicotine sprays and dusts, are used for controlling pests of the piercing-sucking class.

Altho the use of insecticides is essential to the maximum production of most truck and garden crops, cultural methods are of great importance as preventive measures in the control of many pests.

Among the insects most injurious to truck and garden crops are asparagus beetles, the cabbage maggot, cabbage worms, the corn ear worm, cutworms, the onion maggot, onion thrips, plant lice, the potato leafhopper, and the striped cucumber beetle.

INSECT PESTS OF CABBAGE AND RELATED CROPS

Among the major truck-garden crops grown in Illinois, cabbage is particularly susceptible to damage by a number of pests. The insects feeding on cabbage also attack cauliflower, kohlrabi, broccoli, Brussels sprouts, turnips, radishes, kale, and other related plants and weeds.

From the time cabbage, cauliflower, radishes, or turnips are sown in the frames or field until the crop is harvested, a succession of insects appear to damage the crop. As soon as the seeds start to germinate in the ground the seed corn maggot may start working. Almost before the two seed leaves are open the plants may be destroyed by the cabbage or other flea beetles or may be injured by the tarnished plant bug. By the time the plants are a week or 10 days old destruction by the cabbage maggot may begin. From the time the plants are a few inches high until they are harvested in the fall, the crop may be severely damaged by cabbage worms, cabbage aphids, cutworms, the harlequin bug, leaf miners, white grubs, and wireworms.

In the following discussion the insects that are major pests of cabbage and related crops are described and notes on their life histories and habits are given, together with control measures. Insects that are occasionally injurious are listed and cross references given to the discussions of crops on which they usually do their greatest damage.

¹Metcalf, C. L., and Flint, W. P. *Destructive and Useful Insects*. McGraw-Hill. 1928.

Imported or Common Cabbage Worm a Destructive Pest

Ascia rapae L.

Character of Injury. Of the several species of cabbage worms the imported cabbage worm is the most common and destructive in Illinois. The larva of the imported or common cabbage worm eats holes in the cabbage leaf or consumes practically all of it, leaving only the larger leaf veins (Fig. 1). Larvae may appear in destructive numbers any time after plants are set in the field.

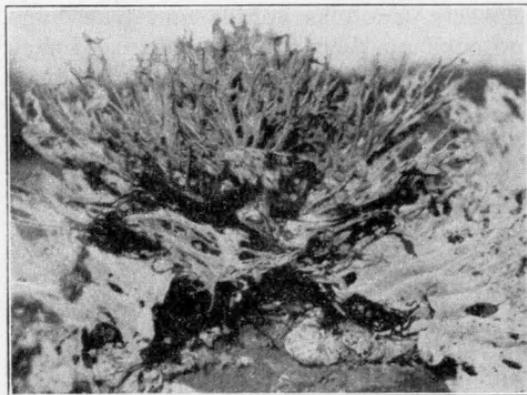


FIG. 1.—CABBAGE BADLY INJURED BY CABBAGE WORMS

Life History and Habits.

The adult of this worm is well known to truck growers. It is the white butterfly with a wing expanse of about $1\frac{3}{4}$ inches that flies low and fitfully over cabbage fields during the day. At frequent intervals it alights to deposit its small yellow eggs, usually on the underside of the leaves. In about a week small pale greenish caterpillars hatch from the eggs, and after feeding for 10 to 15 days become full-grown. When full-grown, the caterpillars are about 1 inch

long and velvety green, marked with a light stripe down the middle of the back with a broken stripe on each side. These caterpillars are very sluggish; they are seldom seen in motion and are not easily disturbed.

When mature, the larva transforms into a pale green to greenish brown pupa, or chrysalis, on the underside of the leaf. The butterfly emerges in 7 to 14 days, depending on the season, and another brood is started. In Illinois there are three or four broods each year.

Control. Cabbage worms are most easily and satisfactorily controlled by dusting the plants with a stomach poison. Such arsenicals as arsenate of lead, calcium arsenate, and Paris green are commonly used. Use 2 parts poison to 2 or 3 parts hydrated lime. Weigh ingredients before mixing. It is important that the poison and lime be thoroly mixed. When making a quantity of dust, run ingredients thru a mixer as directed for making nicotine dusts (page 44).

The dust is generally applied with hand-dusting machines of the blower or puff type and should be directed to both the upper and lower surfaces of the leaves.

Spraying is sometimes preferred to dusting for this pest. Soap or Penetrol should be used as a sticker and spreader in spraying any smooth-leaved plant. Use 2 ounces arsenate of lead and 3 ounces soap or 2 ounces Penetrol to each 3 gallons of water. It is not advisable to use calcium arsenate with Penetrol.

Nonarsenical poisons are coming into more general use and have some advantages under certain conditions. Barium fluosilicate (Dutox) and calcium fluosilicate are now available and are safe to use on plants, as directed by the manufacturer.

Apply dusts and sprays as soon as caterpillars appear, and repeat treatment as plants make new growth or as a new crop of worms appears. All arsenicals and fluosilicates are poisonous to man and care must be taken in using them. Vegetable crops ready for market should be free from spray residue. When treatments are necessary after the crop approaches maturity, the vegetables should be thoroly washed before marketing.

In spraying or dusting cauliflower, Brussels sprouts, or broccoli use special effort to have the plants free from worms before the heads start forming. After the heads are formed great care must be used in spraying or dusting with arsenicals. No arsenicals should be used on Brussels sprouts and broccoli for two or three weeks before harvest. Cauliflower should be dusted over the top in such a way that the dust is not blown into the heads. Hellebore or pyrethrum sprays may be used with success. The latter are recommended for use in the home garden.

Cabbage Looper Not Easily Poisoned

Autographa brassicae Riley

Character of Injury. The cabbage looper eats holes in the leaves and often bores into the cabbage head late in the season. It is usually most destructive in August and September.

Life History and Habits. The adult of the cabbage looper is not so well known to truck gardeners as is the common cabbage worm, since it is active only at night. This dark brown moth has a wing expanse of $1\frac{1}{4}$ inches, and near the center of each front wing is a silver colored spot shaped like an imperfect figure 8. The eggs are deposited at night on the underside of the leaves. They hatch in about 10 days.

The young cabbage looper is pale green and very slender. When full-grown, the caterpillar is $1\frac{1}{4}$ inches long, pale green, with two conspicuous longitudinal stripes on each side. It is noticeably larger at the posterior end and tapers to the head. Its habits of crawling with a peculiar looping motion similar to that of a "measuring worm" or "inch worm" helps to distinguish it from other caterpillars commonly found on cabbage. Unlike the common cabbage worm, it is active and easily disturbed.

When mature, the looper spins a light cocoon and transforms into a dark brown shuttle-shaped pupa within. Ten to 15 days later the moth emerges to start another cycle.

Control. Use same methods as for imported or common cabbage worm (page 4).

Diamond-Back Moth

Plutella maculipennis Curt.

Character of Injury. This minor pest of cabbage and related crops occasionally becomes numerous and destructive. It eats small holes in

the underside of the leaves, the upper surface dies, the brown areas drop out, and the leaf presents a shot-hole appearance.

Life History and Habits. The diamond-back moth is a small moth with a wing expanse of little more than $\frac{1}{2}$ inch. It gets its name from the diamond-shaped markings on its back when at rest. The full-grown caterpillar is about $\frac{1}{2}$ inch long, light green, and very active. When disturbed, it will usually wriggle off the leaf backwards and hang by a silken strand. There are generally three broods annually in Illinois.

Control. Use measures recommended for the imported or common cabbage worm (page 4).

Other Caterpillars

Cabbage and other truck crops are sometimes infested by caterpillars other than those discussed above, but they are of little importance commercially and are never troublesome where control measures for common cabbage worms are applied (page 4). The character of the injury of the woolly bear caterpillar, the chief offender, is similar to that of the common cabbage worm.

Cabbage Maggot Attacks Roots and Stems

Hylemyia brassicae Bouche

Character of Injury. About two years out of five the cabbage maggot is very destructive to cabbage and cauliflower and also attacks turnips, radishes, and other related crops. When cabbage plants wilt badly during the heat of the day in May and June, it is a good indication of cabbage maggot attack. The attack starts soon after the adult flies emerge from the overwintering puparia in the soil.

Upon hatching, the young maggots first attack the small roots and then burrow into the main stem. They feed by rasping out a channel in the surface of the stem and burrowing thru it. Infested plants are stunted in growth, wilt during the heat of the day, and if the infestation is severe, are killed outright. Decay sets in, hastening the death of the plants.

Life History and Habits. This small, slender fly with a conspicuous black stripe running down the middle of the abdomen is scarcely more than $\frac{1}{3}$ inch long. When not in flight, the wings are folded back over the body so that the outer edges of the wings are just about parallel.

The female lays its small, white, oval eggs at the base of the plant or in cracks and crevices in the soil near the plant. The eggs will frequently be found along the stem of a plant that leans to one side, tucked in between the stem and the soil.

The eggs hatch in 4 to 10 days into tiny white maggots which immediately work down along the stem. In most cases the young maggots travel pretty well down toward the base of the tap root to start work. They become full-grown in about three weeks and are, at this time, about $\frac{1}{3}$ inch long and shiny white in color. They taper from the hind end, which is very blunt, toward the head. On becoming mature, they leave the stems and work into the soil to a depth of 1 to 3 inches, where they transform into smooth, light brown, oval puparia. The time spent in this stage varies from 12 days to a year. The majority of flies emerge in about 2 weeks.

Control. Use 1 ounce corrosive sublimate to 10 gallons of water. One gallon of this solution will treat 70 to 80 plants. A day or two after the eggs become abundant (the latter part of May) give the first treatment. Allow the solution to run against the stem of the plant so as to wet the stem as well as the ground around the plant. Follow first treatment by another similar treatment about one week later. When weather conditions are very favorable to the maggot, a third application may be necessary for best results. However, two treatments are usually sufficient. Some growers side-dress the plants with nitrate of soda. This aids materially in the case of a light maggot attack.

Corrosive sublimate should always be dissolved in a small quantity



FIG. 2.—TREATING EARLY CABBAGE WITH CORROSIVE SUBLIMATE SOLUTION WITH THE AID OF A TRANSPLANTER

of hot water in a wooden, glass, or earthenware receptacle, for this chemical will corrode all metals when concentrated. A knapsack sprayer is convenient and practical for applying the solution. Use the sprayer with a lead of hose without a nozzle. It will then be possible to stand erect and walk along the row fairly rapidly. Immediately after using the sprayer, cleanse it thoroly. When the sublimate is used on a large scale, a barrel of it may be placed on a wagon drawn by a horse. By using two or more leads of hose without nozzles and a man for each lead to direct the stream on the plants, a field can be rapidly covered. No pump is needed; simply allow the solution to siphon out of the barrel.

After the plants are set in the field, the solution may be applied with the aid of the transplanter by removing the furrow opener and packing wheels and supplying two wheels in front to steady the machine. An extension on the watering hose allows the operator to regulate the flow of solution by holding the thumb over the end (Fig. 2).

Late cabbage plants that have been grown in the field or in unprotected cold frames should be dipped in the corrosive sublimate solution before they are transplanted, in order to kill any eggs and young

maggots adhering to the roots. In Illinois it does not pay to treat late cabbage after transplanting.

Seed beds may be protected from the maggot by covering with cheesecloth. The cheaper, loosely woven grades of cheesecloth, if they have at least 25 threads to the inch, will keep the flies out.

No satisfactory treatment is known for protecting radishes and turnips grown commercially from attack by this maggot. In the home garden or greenhouse radish seedlings can be protected with the corrosive sublimate solution.

Cabbage Aphids Often Serious Pests

Brevicoryne brassicae L. and *Rhopalosiphum pseudobrassicae* Davis

Character of Injury. The cabbage aphids are frequently destructive to late cabbage, cauliflower, radish, turnip, and other related crops. These

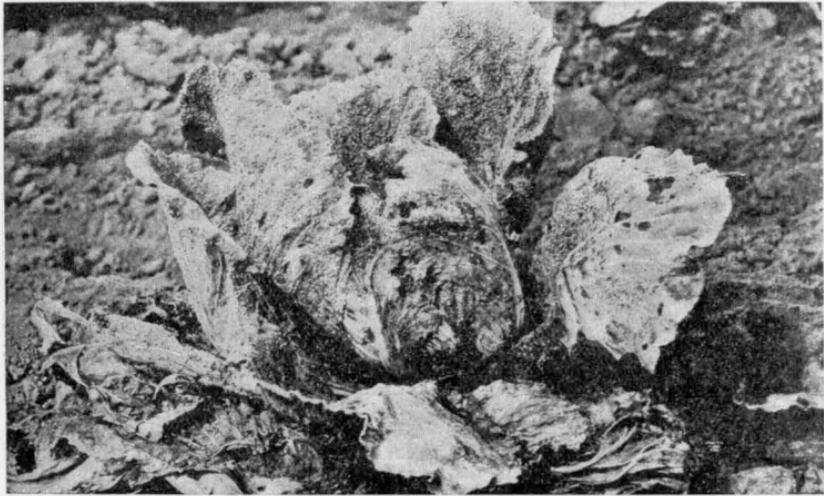


FIG. 3.—HEAD OF CABBAGE RUINED BY CABBAGE APHID

pests are sucking insects which feed by extracting the juices from the plant. The aphids feed at the heart of young plants just set in the field. Two or three aphids on a plant at this time will seriously stunt its growth. The aphids feed on both the upper and lower surfaces of the leaves of older plants and cause them to become curled and deformed. The entire plant may become deformed, the head cease to develop, or the plant may be killed outright. Growers should become acquainted with these aphids so that their presence may be detected before the leaves become curled (Fig. 3).

Life History and Habits. The full-grown aphids are green or green covered with a whitish powder giving them a bluish tint. When mature, they give birth to living young. The young look much like the wingless mother, altho smaller in size. In two weeks or less they become mature and in turn produce more living young. This rapid reproduction accounts for their destructiveness. In a colony of aphids there are usually a number of darker individuals with two pairs of

transparent wings; these winged females fly to other plants in the field to start new colonies.

In the fall, true sexual forms develop and the female deposits her eggs on leaves and other parts of the host plant. The eggs are oval, smooth, black, and shiny.

Control. Cabbage aphids are rather difficult to control. Those feeding on the undersurface of leaves are naturally protected; those feeding on the upper surface are protected by the curling of the leaves. Since they are sucking insects, they must be controlled with a contact insecticide, yet the waxy scales covering their bodies tend to shed any spray.

If treatments are started before the aphids have become thoroly established, they may be killed with a homemade nicotine dust containing 2.4 percent actual nicotine (page 44). This dust is applied with a hand duster of the puff type, which gives a puff of dust that may be directed just where it is desired. Cabbage and cauliflower fields should be watched during warm weather and infested spots treated before the aphids have spread over the entire field. This dust is equally effective in killing plant lice attacking other vegetable crops. Homemade nicotine dusts are much cheaper than commercial preparations.

It is sometimes advantageous to spray with a power sprayer rather than dust for the control of this insect. For this work use $\frac{2}{3}$ pint of 40-percent nicotine sulfate and 1 quart Penetrol to 50 gallons of water. It is usually advantageous to add the nicotine to the Penetrol and arsenate of lead spray described on page 5.

Since this insect passes the winter in the egg stage on old cabbage leaves left in the field, it is important that all crop refuse be destroyed by clean plowing or that the old cabbage stumps and leaves be gathered and burned.

Flea Beetles Injure Seedlings

Pyslliodes punctulatus Melsh.
and *Phyllotreta vittata* Fab.

Character of Injury. As soon as the two seed leaves of cabbage, cauliflower, radish, and other related crops are thru the ground, black or striped flea beetles chew holes in leaves and stems, crippling the plants and often killing them.

The greatest injury is done by adult beetles chewing seedlings in the field or in unprotected cold frames (Fig. 4). The loss may be especially great in the case of expensive cauliflower seedlings.

Life History and Habits. Like the common flea beetles that attack potatoes, tomatoes, and eggplant (pages 14 and 23), those that attack seedlings of cabbage and related crops are very active small beetles, capable of jumping considerable distances when disturbed. The species most troublesome are shiny black, sometimes having two irregular bright yellow stripes on its back.

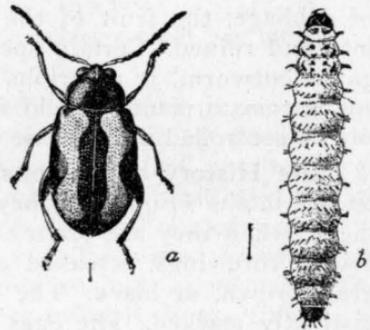


FIG. 4.—ADULT AND LARVA OF CABBAGE FLEA BEETLE

Control. Dust the plants rather heavily with a bordeaux-lead dust prepared by mixing 10 pounds arsenate of lead, 8 pounds monohydrated copper sulfate, and 32 pounds hydrated lime. For smaller amounts, use $2\frac{1}{2}$ pounds arsenate of lead, 2 pounds monohydrated copper sulfate, and 8 pounds hydrated lime. Where monohydrated copper sulfate is not available, 1 pound arsenate of lead to 4 pounds hydrated lime may be used. Excellent results have been obtained by dusting the plants with barium fluosilicate (Dutox) or with calcium fluosilicate.

Screening the frames with cheesecloth as for the cabbage maggot (page 8) affords complete protection.

All Garden Plants Subject to Cutworm Damage

Species of *Noctuidae*

This group of insects consists of a rather large number of species of caterpillars that are destructive every year at one point or another in Illinois. Probably all garden crops are subject to attack by cutworms. Their sleek, sparsely-haired, dull-colored bodies, from 1 to 2 or more inches in length, always have the appearance of being well fed. They are most active at night and usually spend the day coiled up under the surface of the soil at the base of the plant. They should not be confused with the corn ear worm (page 18), which cannot be controlled by poison bait.

Character of Injury. Cutworms cut off the stems of growing plants just above or below the ground or at the surface of the ground. Heads of cabbage, the fruit of the tomato, or ears of corn may be tunneled into and ruined. Certain species feed only on plant foliage. The variegated cutworm¹ is a serious pest, frequently stripping the leaves from young tomato plants in cold frames. Armyworms² are true cutworms and can be controlled in the same way as are cutworms.

Life History and Habits. Cutworm adults are dull-colored heavy-bodied moths (Fig. 5). They are rarely seen in the daytime but fly at night, when they are often attracted to lights. Most of them have dark brown forewings, streaked or mottled with various shades of yellow, gray, brown, or black. The hind wings are darker in color and not so distinctly marked. The eggs are usually laid on garden plants, grasses, or weeds.

Young cutworms, for a few days after they hatch from the eggs, are usually darker and more hairy than mature ones. They become full-grown after feeding for about a month. Then they change into pupae—naked, shuttle-shaped, dark brown bodies about 1 inch long—and are found in the soil. They remain in this stage about 2 weeks before they become moths, ready to lay eggs to start a new generation.

Control. The use of poison bait is the most practical and efficient method of cutworm control. (See directions for preparing bait, page 44.) Distribute bait very thinly over infested areas several consecutive nights before and after a crop is planted. Always distribute all bait

¹*Lycophotia margaritosa saucia* Hbn.

²*Cirphis unipuncta* Haw., *Laphygma frugiperda* S. & A., and others.

after sunset since it is more palatable to the cutworms if not allowed to dry out. When cutworms are known to be present in the soil, it is important to bait them before plants are set out. After the cutworms have started to work on the crop, they are not so easily lured to the bait. Chickens and other farm animals should not have access to the bait.

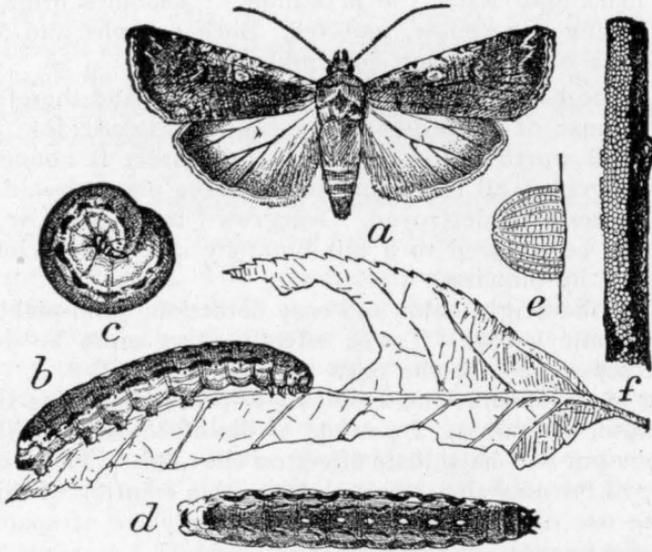


FIG. 5.—STAGES OF VARIEGATED CUTWORM
(a) Adult; (b, c, d) larvae; (e) egg, much enlarged; (f) egg mass.

Cutworms that feed entirely underground are difficult to poison, and it may be necessary to dig them up where they are hiding close to the injured plants and near the surface. Cutworms that feed on the leaves of plants can be killed by spraying with arsenate of lead at the rate of $\frac{2}{3}$ ounce to 1 gallon of water or 2 ounces to 3 gallons of water.

In the small home garden a loose paper collar placed around each plant in such a way that it will extend from an inch or so below the ground to an inch or more above will protect transplantings. Cutworms are more troublesome in home and farm gardens than in commercial trucking areas.

Harlequin Bug Serious Pest in Southern Illinois

Murgantia histrionica Hahn

Character of Injury. In northern Illinois the harlequin bug, also known as the terrapin bug, fire bug, or calico bug, is not a pest, but from St. Louis south, severe damage is inflicted by it. Cabbage, cauliflower, eggplant, horse-radish, asparagus, potatoes, tomatoes, beans, beets, and other garden crops are attacked. Both the nymphs and adults accomplish their work of destruction by sucking the sap from the leaves and veins of the host plant. The affected plants wilt, wither, and die as if swept by fire.

Life History and Habits. The adult bug passes the winter hiding under rubbish and trash about the garden. It is a little less than $\frac{1}{2}$ inch long. The eggs are about $\frac{1}{20}$ inch long, nearly cylindrical, and flattened at both ends. They have the general appearance of small white kegs encircled with black hoops, with black spots set in the proper position for bungholes. The nymph when first hatched is pale green with black markings. After the first molt, it becomes brightly colored with black, orange or yellow, and red. Both nymphs and adults have the disagreeable odor common to stinkbugs.

Control. The harlequin bug is a sucking insect and therefore difficult to control because of its resistance to contact insecticides. A clean-up program is well worth following where this insect is abundant. After the crop is harvested, all remaining parts of the plant should be plowed under or collected and destroyed. Overgrown fence rows or rank weed patches should be reduced to a minimum by cutting and burning, and where possible, by plowing.

Because of the bright color and easy detection, hand-picking is practical in the home garden. To be effective this must be done at the start of the season before the eggs are laid.

A strong nicotine solution—1 pint of 40-percent nicotine sulfate in 25 gallons of water containing 2 pounds of dissolved soap—will kill many of the nymphs but will have little effect on the adults. There is, however, some danger of burning the young plants with a solution of this strength. Probably the use of Penetrol at $\frac{1}{2}$ percent in place of soap would increase the effectiveness of this spray.

In carrying out the foregoing recommendations the cooperation of neighbors is necessary for the best results, regardless of the method of control employed.

Other Pests of Cabbage and Related Crops

Leaf miners often cause damage to young cabbage and cauliflower plants. These maggots, the young of small flies, work in the leaves between the two leaf surfaces. The inside or fleshy part of the leaf is eaten away as the maggots travel irregularly thru the leaf. This feeding greatly weakens and sometimes deforms the plants. In the case of cauliflower, losses are sometimes heavy. No practical control measures are known. If the attack continues after the plants are set in the field, however, a light application of nitrate of soda will serve to push the plants ahead of the leaf miners.

Onion thrips (page 33) sometimes causes serious injury to cabbage, particularly if the cabbage borders on a field of onion sets or early onions. When the onions are harvested, the thrips move over to the cabbage. Losses of several acres of cabbage frequently result. The cabbage should be inspected as soon as the thrips are concentrated on a few outside rows; at this time they can be controlled by dusting as for cabbage aphids (page 9) or by spraying (page 33).

Other pests of cabbage and related crops include white grubs (page 15), wireworms (page 16), and the seed corn maggot (page 19).

INSECT PESTS OF POTATOES

Potatoes are subject to attack by more pests of a serious nature than any other truck crop grown in Illinois. The potato leafhopper, flea beetles, the Colorado potato beetle, the potato aphid, white grubs, wireworms, and blister beetles are the principal potato pests, any one of which is capable of destroying the crop unless control or preventive measures are applied. Effective and economical control measures have been investigated and established so thoroly, however, that a good crop of potatoes can be grown even in years of heaviest infestations. As a result of these investigations the acreage devoted to potato growing has increased markedly during the past five years.

Potato Leafhopper Causes Heavy Losses

Empoasca fabae Harr.

Character of Injury. The potato leafhopper is the most destructive pest of potatoes in Illinois. In most seasons it is the limiting factor in potato production. The feeding of the leafhoppers on the underside of the leaves causes tipburn or hopper burn, the injured leaves first showing a triangular brown spot at the tip or on the margin of the leaf. Such leaves curl upward slightly and soon the entire tip and margin of the leaf becomes brown. Early planted potatoes suffer most. Both the young, or nymphs, and the adults are responsible for the damage inflicted.

Life History and Habits. The adult of the potato leafhopper is a very small, pale green insect about $\frac{1}{8}$ inch long. The markings are somewhat variable in number and arrangement. The adult is very shy and will hop a considerable distance when disturbed. The eggs, which are small, whitish, elongated, and slightly curved, are laid in slits in the leaf veins, petioles, or stems of the potato plants. Upon hatching, the nymphs are scarcely visible to the naked eye. They look much like the adults but have no wings.

Control. The potato leafhopper can be successfully and economically controlled by spraying with 5-6-50 bordeaux. (For directions for preparing bordeaux mixture see page 45.) Female leafhoppers are repelled by bordeaux and avoid laying eggs on leaves sprayed with this compound. Eggs laid on leaves that have been sprayed often fail to hatch. The solution is poisonous to the nymphs, particularly in the earlier stages, and many of them die as a result of being hit by the spray or from feeding on sprayed leaves. Spraying should be begun when the vines are about 6 inches out of the ground or when the hoppers are first observed on the vines. The best results have been obtained where five applications were made at 7-day intervals. When a small quantity of bordeaux is to be used, a commercial preparation is satisfactory. For spraying large areas, or fields of an acre or more, the bordeaux is usually mixed on the farm. To get the best results a sprayer capable of developing 150 to 200 pounds pressure is needed. The sprayer should be equipped with a boom carrying twelve nozzles, one directing the spray to the top of the plants and one to each side of four rows.

The side nozzles should be tilted slightly upward. At least 100 gallons of spray should be applied to the acre.

Dusting the plants with a commercial bordeaux dust, while not so effective as spraying, will give partial control. A very satisfactory home-made dust may be prepared according to the directions on page 46. Recent investigations in Illinois have shown that a bordeaux-oil dust is superior to a straight bordeaux dust. The dust is recommended for small plantings where spraying equipment is not available. It is applied with a hand duster of the blower type.

Potato Flea Beetle Attacks Many Vegetables

Epitrix cucumeris Harr.

Character of Injury. The potato flea beetle is primarily a potato insect, capable of destroying an entire crop of potatoes. It also attacks other vegetable crops, notably tomatoes and eggplant. The larvae feed on the roots, tubers, and underground stems of the plants. Serious injury by the larvae has not occurred in Illinois. The adult feeds on the leaves; it eats out minute holes and gives the leaves a shot-hole appearance. This feeding causes the leaves, and shortly the whole plant, to dry out and die. Feeding takes place on both the upper and lower surfaces of the leaves.

Life History and Habits. The potato flea beetle is one of the smaller flea beetles. It is about $\frac{1}{16}$ inch long and has a jet black body with brownish yellow legs and antennae. The third segment on each hind leg is much enlarged, enabling the beetle to jump a considerable distance when disturbed. The adult passes the winter in rubbish and trash about the garden or farm. Full-grown larvae, which are about $\frac{1}{5}$ inch long and white with a brown head, transform within an earthen cell into whitish pupae about $\frac{1}{12}$ inch long.

Control. This insect can be controlled by spraying with 5-6-50 bordeaux as recommended for the potato leafhopper (page 13). It is well to add 2 pounds of arsenate of lead powder to each 50 gallons of spray. For small gardens a prepared bordeaux mixture which contains a poison may be used. Dusting the plants with a bordeaux dust containing a poison will give fair control. Barium fluosilicate (Dutox) or calcium fluosilicate dusts are also effective.

Colorado Potato Beetle Easily Controlled

Macrosiphum gei Koch

Character of Injury. Most of the injury to the potato plant by the Colorado potato beetle is caused by the larvae, or grubs, which eat the plant leaves, sometimes stripping the plant. The adult also feeds on the leaves to some extent.

Life History and Habits. The adult beetle is about $\frac{3}{8}$ inch long, strongly convex above, and yellow in color. Each wing cover has five narrow black stripes running lengthwise. The eggs are oval, orange, $\frac{1}{14}$ inch long, smooth, and are laid on the potato leaf in groups of 5 to 75. The eggs hatch in 4 to 9 days. The larvae, when full-grown, are red

with two rows of distinct black spots on each side of the body. The body appears swollen and out of proportion to the size of the head. The larvae mature in 10 days to 3 weeks. When mature, they enter the ground and transform into orange-colored pupae about $\frac{1}{3}$ inch long. After 5 or 10 days in the pupal stage, the adult emerges. The adult spends the winter buried in the soil at a depth of several inches.

Control. Poison sprays are the standard treatment for the potato beetle. Two pounds arsenate of lead powder may be added to each 50 gallons of 5-6-50 bordeaux spray (page 13). In small gardens the plants may be sprayed with a commercial bordeaux mixture which contains a poison.

Potato Aphid Occasionally Serious in Illinois

Macrosiphum gei Koch

Character of Injury. The potato aphid is present in small numbers in Illinois every year and occurs in serious numbers at indefinite intervals. Besides potatoes, other plants such as tomatoes, eggplant, beans, peas, and peppers, are attacked. Like all other plant lice this aphid feeds by sucking the juices from the plant leaves. The leaves curl downward, or directly opposite to the curling caused by the potato leafhopper. The plant becomes deformed and stunted and may die. Even tho the plants are not killed, the crop is often greatly reduced.

Life History and Habits. The wingless females of the potato aphid are rather large for plant lice, being about $\frac{1}{6}$ inch long. They are usually light green, altho pink forms occur occasionally. The dark, almost black, shiny oval eggs are laid in the fall on rose plants. They hatch early in the spring into young aphids similar in form to the adults. One or two generations are produced on the rose plant before the winged females migrate to the potato and other plants.

Control. A careful watch should be kept for the first appearance of these pests. If they are present in sufficient numbers to start the curling of the leaves, steps should be taken immediately to control them. The aphids are killed when hit with a spray containing $\frac{1}{2}$ pint 40-percent nicotine sulfate solution to each 50 gallons of spray. The nicotine should be added to the regular bordeaux spray for potatoes (page 13).

White Grubs a Common Pest

Several species of *Phyllophaga*

Character of Injury. One of the most common garden pests is the white grub, or grubworm. A large variety of crops, such as potatoes, corn, sugar beets, and beets are subject to attack. The larvae, or grubs, are very injurious to garden crops as they feed on the tender roots. Corn roots may be so badly eaten that the plant is unable to stand, while potatoes, beets, and sugar beets are often seriously injured by the grub eating out great holes in tubers and roots. Other root crops are injured in like manner.

Life History and Habits. For practical purposes, the life histories of the common species of white grubs are the same. The adult or parent is a large brown beetle familiarly known as the June bug or May beetle

The size of the adult varies with different species, and the color varies from light to dark brown. These beetles fly around street lights in great numbers during the latter part of May and the month of June. The female beetle burrows into the ground and lays the eggs singly or in groups. They are oval, white, and about $\frac{1}{2}$ inch long. The larva is a large soft-bodied insect with brown head and legs. Two or three years

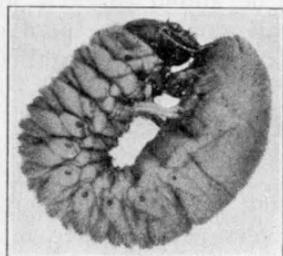


FIG. 6.—WHITE GRUB

are spent in the grub stage in the soil (Fig. 6). When the grub is mature, it constructs a cell in the soil and transforms into a delicate, brownish pupa. It transforms into a beetle in the fall, but remains in the ground until spring.

Control. There is no insecticide that is efficient or practical for use against white grubs. Much of the grub injury can be avoided, however, by using proper cultural methods:

- (1) *Plow in early fall, just before the grubs go down for the winter.* This exposes them to the weather, birds, and other natural enemies.
- (2) *Use a short rotation of crops.* Ground should not be left in sod for more than two years, for the female beetle prefers to lay her eggs in such places.
- (3) *Use more legumes in the rotation.* Grubs do not normally injure clovers and alfalfa, and the beetles do not normally lay their eggs in fields where there is a good stand of these crops free from timothy, other grasses, and weeds.
- (4) *Watch for grubs behind the plow when plowing.* If grubs are numerous, do not plant susceptible crops like corn and potatoes.

Clean, cultivated land that is not in sod or a small grain crop in the years 1932, 1935, 1938, etc., is not likely to contain grubs in damaging numbers. Grub injury is most likely to occur in the years 1933, 1936, 1939, etc. Watch for grubs in these years.

Wireworms Controlled by Cultural Methods

Several species of *Elateridae*

Character of Injury. Frequently wireworms cause serious injury to root crops and other vegetables by burrowing into them. Potatoes, sugar beets, beets, cabbage, lettuce, turnips, onions, carrots, beans, corn, and other crops are attacked. The larvae also bore into seeds planted in the soil and destroy them, often necessitating replanting. Disease and decay frequently set in where wireworms are working.

Life History and Habits. The adult of the wireworm is familiar to nearly everyone, altho it may not be known by that name. It is the click beetle which, when placed on its back, will jump into the air as it strives to gain footing. This jumping is accompanied by a snap, or click. The female lays the eggs in the soil, preferring sod land. The larvae are elongated, cylindrical, worm-like grubs, with a hard, smooth, shiny, reddish brown, distinctly segmented surface (Fig. 7). They vary in length from $\frac{1}{2}$ to $1\frac{1}{2}$ inches. Two to 5 years are spent in the soil. The pupae are white, very delicate, and are found in the soil.

Control. Special control measures for wireworms are not usually necessary in most of our commercial truck-growing areas; most of the

injury occurs when new land is broken. Greater control can be accomplished by employing suitable cultural methods than in any other way. By plowing in early fall and fallowing once a week for a month, large numbers of pupae and newly formed adults can be killed. In the majority of cases wireworm injury is associated with poor drainage. Since good drainage is essential to success in growing vegetables, growers should check up the drainage in fields where wireworms are a continual nuisance. A short rotation of crops is also beneficial.

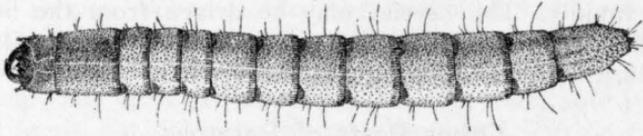


FIG. 7.—LARVA OF WIREWORM

Soil fumigation with calcium cyanide in connection with trap crops is practiced in some sections of the United States. In the small garden, wireworms can be trapped by planting corn, beans, or peas at a depth of 3 inches and in hills 4 to 5 feet apart. Moldy seeds are most attractive. In about a week the wireworms will collect around the seeds and can be dug up and killed.

Blister Beetles or Old-Fashioned Potato Bugs

Several species of *Meloidae*

Character of Injury. Blister beetles are frequently destructive to vegetables in Illinois, particularly to potatoes, tomatoes, beans, peas, melons, corn, and beets. Legumes used for cover crops, such as clover and vetch, are also subject to attack. The beetles often congregate in great numbers and move across a field defoliating plants as they go. A crop may be ruined in a few days unless immediate steps are taken to destroy these insects.

Life History and Habits. There are many species of blister beetles, all having certain characteristics which distinguish them from other garden insects. The adult is a long-bodied, long-legged, slender beetle (Fig. 8), with a fairly soft body which when crushed on the skin may cause a blister. The beetle may be gray, black, or yellow-striped. In its immature stages it has a rather complicated development and does not feed on vegetables but on grasshopper eggs. It is a good example of an insect which is beneficial in one stage

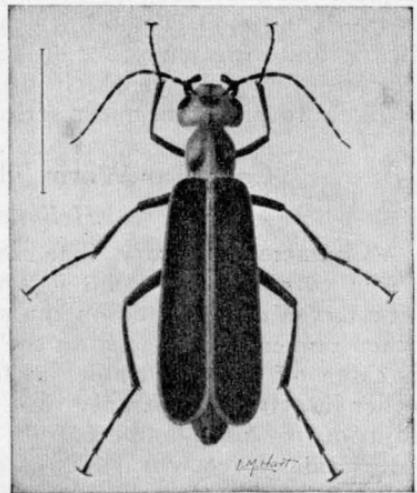


FIG. 8.—ADULT OF BLISTER BEETLE

of development and very destructive in another. The adults are the only stage commonly seen.

Control. Blister beetles are not easily poisoned with arsenicals. Dusting the plants with calcium fluosilicate or barium fluosilicate (Dutox) undiluted or diluted with equal parts of talc or lime will give best results. Bordeaux mixture 5-6-50 (page 45) is repellent to the beetles and usually no other treatment is necessary in truck garden areas.

In the home garden, brushing the insects into pans containing kerosene is effective and, if the plants are approached carefully, this can be done rather rapidly. The beetles may be driven from the field by use of sticks and brushes if the growers work with the wind. Once driven from the field, they are not likely to return.

Other Pests of Potatoes

No special treatment for the control of the tarnished plant bug, which sometimes attacks potatoes, is necessary if the crop is regularly sprayed with 5-6-50 bordeaux mixture as for the potato leafhopper (page 13).

For description and control of the seed corn maggot, stalk borer, and potato stalk borer see pages 19, 21, and 25, respectively.

INSECT PESTS OF SWEET CORN

Sweet corn ranks as the major truck crop in Illinois, occupying more acreage and producing more income than any other truck crop.

A crop of sweet corn is seldom produced entirely free from insect attack. Of the dozen or more pests attacking sweet corn, the corn ear worm is ever present and destructive. The other sweet-corn pests listed in the following pages are all capable of severely damaging a crop. The European corn borer, which is expected to appear in Illinois at any time, is likely to prove the most serious.

Corn Ear Worm Thrives in Dry, Hot Seasons

Heliothis obsoleta Fab.

Character of Injury. The corn ear worm is a very destructive pest of sweet corn; during some seasons it destroys a large part of the crop. The larvae usually feed on the silk and kernels at the tip of the ear, but when numerous will feed on the kernels on any part of the ear. The silk is eaten off and the whole ear looks uninviting. Decay often sets in or other insects gain entrance thru the burrows. The larvae are particularly injurious to late-planted corn.

Besides sweet corn, this caterpillar attacks tomatoes, eggplant, peppers, pumpkins, squash, cucumbers, potatoes, and other crops. The fruit of eggplant and tomatoes is often eaten into, decay sets in, and the fruit is worthless.

Life History and Habits. The adult of the corn ear worm is a moth with a wing expanse of about $1\frac{3}{4}$ inches. The front wings are straw-colored and more or less variegated with dark markings at the center

and at the tip. The hind wings are cream colored with a dark shaded area along the hind margin, near the center of which is a conspicuous white spot. The eggs are very small and white, nearly round with a flattened base, and are deposited on the fresh silk of developing corn or on early tomatoes, eggplant, and other vegetables. The surface of the egg is marked with a series of ridges radiating from the tip.

The young larvae feed on the tips of ears of corn, or on the fruit of tomatoes or eggplant, where they mature. The larvae varies in color from green to various shades of brown but is usually marked with longitudinal stripes. When mature, the caterpillar has a roughened body about $1\frac{1}{2}$ inches long and looks much like an armyworm. It burrows into the ground, where it transforms into a smooth, brown pupa nearly an inch long. The corn ear worm is seldom, if ever, able to survive the winter in Illinois, but the moth migrates from the South each year.

Control. This pest is difficult to control because it spends the greater part of its life feeding in protected places. Dusting the corn silk with arsenate of lead or calcium fluosilicate will kill many of the caterpillars before they enter the husk.

The adults are not usually abundant early in the season, and if the silk is dry and mature when they appear, they will look elsewhere for a place to lay their eggs. In northern Illinois, therefore, early planted corn or early maturing varieties are least likely to be injured. In southern and central Illinois medium planted corn is injured least.

When the corn ear worm attacks tomatoes or eggplant, it may be controlled by spraying or dusting with barium fluosilicate (Dutox) or with arsenate of lead. The poisons should be used according to directions on the containers. Avoid spray residues on fruits ready for market.

Seed Corn Maggot Serious in Cold, Wet Seasons

Hylemyia cilicrura Rond.

Character of Injury. In cold, wet, backward seasons the seed corn maggot may cause serious injury to planted corn seed and to other seeds, such as onion, beet, bean, cabbage, and pea, that have been placed in the soil. The larvae attack the seed about the time it is germinating and after eating the germ, feed on the soft interior of the kernel. If the seed is not destroyed, a deformed plant is produced.

Life History and Habits. The adult of the seed corn maggot is very similar to the cabbage maggot (page 6). The larvae, are footless, cylindrical, narrowed in front, and about $\frac{1}{4}$ inch long. Pupation takes place in the soil in a manner similar to that of the cabbage maggot.

Control. There is no satisfactory control for this pest. If corn fails to come up in the usual time and the small white maggots are found upon digging into the hill, the corn may be replanted at once with a fair degree of safety, for the second planting is not usually injured.

Pale-Striped Flea Beetle

Systema taeniata blanda Melsh.

Character of Injury. Larvae of the pale-striped flea beetle are particularly injurious to germinating seed corn in the field. The injury may

be mistaken for the work of the seed corn maggot. As soon as the kernel takes in water and begins to swell, the larvae bore into it and may eat out the entire seed. If the seed has germinated before the attack, they bore into the larger roots and young shoots, usually killing the plant. In northern Illinois the adult beetles emerge the latter part of June.

The beetles feed on a large number of weeds and vegetables, eating out small round holes until the leaves are riddled. According to Drake and Harris¹ the larvae are a serious pest of onion seedlings in Iowa during certain seasons. They are most troublesome where onions follow crops that were particularly weedy the previous season.

Life History and Habits. The adult is another of the jumping beetles, larger and more vividly marked than those commonly found on potatoes and eggplant. They are about $\frac{1}{8}$ inch long and pale yellowish-brown with two still paler stripes running down the back (Fig. 9).

The female lays her eggs in the soil around the roots of ragweed, pigweed, beets, and other vegetables and weeds. The life history of these insects is imperfectly known but it is thought that they spend the winter in the ground as partly grown larvae and as adults. The full-grown larva is very small, slender, and thread-like with a brown head.

Control. When sprouting corn is first found to be attacked in the field, immediate replanting will give relief; that is, the replanted corn will not be attacked to any extent, for by this time the larvae are about thru feeding and ready to pupate.

The beetles may be controlled by dusting the plants with barium fluosilicate (Dutox) or calcium fluosilicate undiluted or diluted with equal parts of talc or lime.

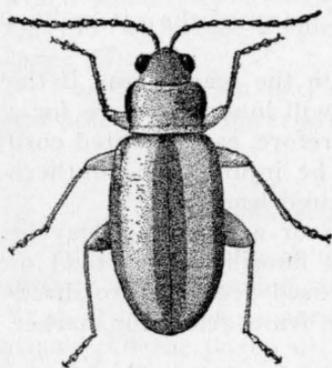


FIG. 9.—ADULT OF PALE-STRIPED FLEA BEETLE
(Much enlarged)

Grasshoppers Often a Serious Pest of Gardens

Various species

Character of Injury. From time to time grasshoppers become a serious pest to truck and garden crops, the time of attack varying from early spring to late fall. The grasshopper is a chewing insect; it feeds on nearly all vegetables, taking its food by biting chunks out of the leaves. Both the nymphs and adults are heavy feeders.

Life History and Habits. The adult is too well-known to need description. The eggs are laid in the soil in small pockets where they remain thruout the winter. The young grasshopper resembles its parents except in size and absence of wings.

Control. To kill grasshoppers spray plants on which they feed with arsenate of lead used at the rate of 2 pounds to 50 gallons of water.

¹Drake, C. J., and Harris, H. M. Jour. Econ. Ent. 24, No. 6, 1132. 1931.

Poison bait, such as used for cutworms (page 10), may be used to advantage in combating grasshoppers. Bait for grasshoppers should be distributed in the early morning.

Stalk Borer Sometimes Injures Corn

Papaipema nebris nitela Guen.

Character of Injury. Occasionally the common stalk borer becomes abundant and destructive to corn, and also to such crops as potatoes, tomatoes, cabbage, cauliflower, eggplant, beans, spinach, and strawberries. The larvae burrow into the stalks of corn and other plants. Young corn is most liable to injury. Infested plants wilt, break down, and die at the top. The larvae often travel from one plant to another, which increases their destructiveness.

Life History and Habits. The adult, or moth, has mouse-colored forewings marked with white. The hind wings are paler, with prominent vein markings. The wing expanse is about $1\frac{1}{2}$ inches.

The eggs are laid on various weeds and it is in this stage that the insect passes the winter. The eggs are round, about $\frac{1}{50}$ inch in diameter, light brown, and heavily ridged. The immature larvae are distinctly marked with five light, longitudinal stripes. Most conspicuous are two broad stripes, broken in the middle, that extend along the sides. This gives the larvae the appearance of having been pinched or injured in the middle. When they become mature, the stripes fade out and the body varies in color from very light brown to a purplish brown and is about $1\frac{1}{4}$ inches long. Pupation takes place in the stalk of the host plant. The pupae are naked, brown, and nearly an inch long.

Control. Keep down all weeds in the vicinity of the garden or on the farm. Where this is done, little trouble from this insect is to be expected. Winter burning of field margins will aid in the control of this pest.

European Corn Borer Principally a Corn Pest

Pyrausta nubilalis Hbn.

Character of Injury. The injury inflicted by the corn borer is done entirely by the larvae, or worms (Fig. 10). They bore into all parts of the cornstalk and ear, interrupting the normal growth of the plant, weakening the stem, and allowing organisms of decay to enter. Infested stalks fail to produce good ears, they break over, and in heavily infested fields the corn is a complete loss. Ears that apparently are salable may contain hidden borers.

A large number of cultivated crops and weeds are known to be attacked by the borer. So far as the truck gardener is concerned, corn is the principal crop attacked. Other vegetable crops sometimes attacked are beans, tomatoes, celery, beets, peppers, rhubarb, swiss chard, okra, parsnips, and spinach.

Life History and Habits. The European corn borer was first discovered in the United States in 1917. Since then it has become well established in the states bordering on or in close proximity to the eastern border of Illinois. At this writing (April, 1932) the nearest known infestation is about 15 miles from the Illinois state line, and the borer

can certainly be expected to invade this state within the next year or two, if it does not already exist here.

The adult of the European corn borer has a wing expanse of about 1 inch. The general color varies from pale yellow to tan and brown. The forewings are marked with lighter, irregular, wavy lines.

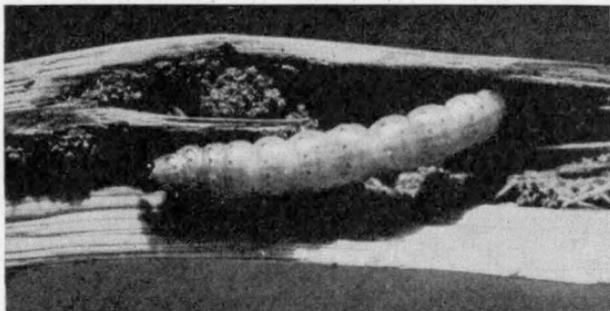


FIG. 10.—LARVA OF EUROPEAN CORN BORER
(Enlarged)

The eggs are laid during the latter part of June and July in small clusters mainly on the underside of leaves of corn and other host plants. The eggs are circular, nearly white, flat, and laid in such a way that they overlap one another. They hatch in 4 to 15 days depending on temperature and moisture conditions.

The young larvae begin feeding soon after they are hatched and seek shelter within the large leaf veins and stems of corn and other host plants. Full-grown larvae are about 1 inch long and $\frac{1}{8}$ inch across. They are light grayish to pinkish and distinctly marked with two small dark spots on the back of the body segment. There is also a row of spots along each side of the body and a faint stripe down the middle of the back. They complete their growth in late summer or early fall.

The pupae are brown, shuttle shaped, and about $\frac{3}{4}$ inch long. Pupation takes place in June within the burrow in the stalk.

Control. In commercial truck-growing areas disposal of crop refuse will aid greatly in keeping the corn borer under control. However, the present methods will need to be improved. The truck gardener naturally seeks to produce early maturing corn, and this is just the corn the borer prefers. In removing the stalks from the field the corn must be cut close to the ground. The stalks may be raked together and burned and the remnants of cornstalks and weeds cleanly and thoroly plowed under before May 15 of each year. This can be quite easily done with the small-stalked sweet corn. Putting the corn in the silo is also an effective way of killing the borer, providing the corn is cut close to the ground.

When the corn borer becomes established in Illinois, it will be of the greatest importance to truck growers to keep the infestation down to the lowest possible point. An infestation that would not cause a commercial loss to field corn may cause severe losses to the sweet-corn

industry. Further information regarding the European corn borer is given in Circular 384 of this Station.

Other Pests of Corn

For description and control of other insects injurious to corn see armyworms (page 10), white grubs (page 15), wireworms (page 16), and the spotted cucumber beetle (page 27).

INSECT PESTS OF TOMATOES AND EGGPLANT

Tomatoes rank next to corn in point of acreage and income as a major truck crop. Tomato yields are reduced every year thru the attack of flea beetles, tomato worms, garden slugs, the corn ear worm, and cut-worms. The major pests of eggplant are flea beetles, the potato stalk borer, and the Colorado potato beetle.

Eggplant Flea Beetle

Epitrix fuscula Crotch

Character of Injury. The injury inflicted by the eggplant flea beetle is characteristic of all flea beetles. The leaves are perforated with small round holes that greatly weaken, if they do not kill, the plant. This species shows a marked preference for eggplant, but also feeds on potatoes, tomatoes, sugar beets, strawberries, and other garden crops.

Life History and Habits. The eggplant flea beetle closely resembles the potato flea beetle (page 14). The general appearance, the habit of jumping when disturbed, and the color are the same.

Control. The eggplant flea beetle can be successfully controlled by dusting the plants rather heavily with a dust composed of 1 part arsenate of lead to 4 parts hydrated lime. Care should be used to make sure that the dust is thoroly mixed. Practically as good results can be obtained by spraying as suggested for the control of flea beetles on potatoes (page 14). When spraying tomatoes with bordeaux mixture, use 4-6-50 bordeaux (page 45). Barium fluosilicate (Dutox) and calcium fluosilicate are also effective in controlling flea beetles.

Tomato Worms

Tobacco Worm, *Phlegethontius quinquemaculata* Haw.

Tomato Worm, *Phlegethontius sexta* Johan.

Life History and Habits. The caterpillars of two species of moth are commonly included under the popular name of tomato worms. They are so nearly alike in all stages of their life history, habits, and general appearance that they will be taken up together. These worms, or caterpillars, are capable of inflicting serious damage on the tomato crop. They are the commonest pests attacking tomatoes and also the largest insects attacking truck crops. The adults of tomato worms have large bodies and a wing expanse of 4 to 5 inches (Fig. 11). The body is distinctly marked with a row of large yellow spots on each side of a narrow black longitudinal line; the wings are dark gray marked with irregular brown and black lines. The eggs are nearly round, $\frac{1}{16}$ inch in diameter, and

greenish yellow. They are usually deposited singly on the underside of the leaf and hatch in about a week.

The caterpillars are large green worms 3 to 4 inches long when full-grown. Along the side of the tobacco worm is a series of V-shaped white markings, while along the side of the tomato worm are simple

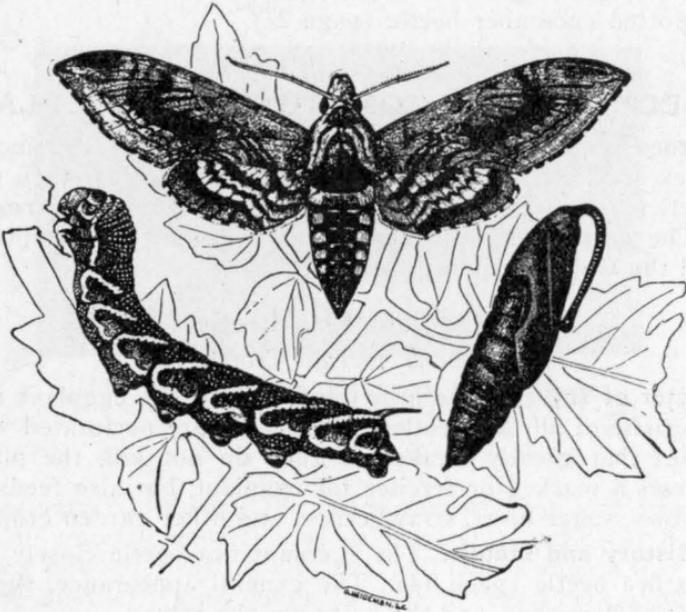


FIG. 11.—TOMATO WORM: ADULT MOTH, WORM, OR LARVA, AND PUPA
(Courtesy U.S.D.A.)

oblique white bands. The horn in the tip of the abdomen in the former is black and straight, while in the latter it is usually reddish and curved. The pupa of each is brown, and has a peculiar handle-like projection about 2 inches long.

Control. In small gardens or where the worms are few and scattered, hand-picking is recommended. Spraying with arsenate of lead at the rate of 2 pounds of powder to 50 gallons of water or to 50 gallons of bordeaux mixture is the most satisfactory method of control where tomatoes or eggplant are grown on a commercial scale and the worms are numerous. It is important to spray as soon as the worms appear in serious numbers, for they are capable of causing great destruction in a short time. Dusting the plants with arsenate of lead and lime using 1 part of poison to 5 parts of hydrated lime is just as effective as the spray and much more easily applied when the plants are large.

Tomato worms are often held in check by parasites that feed within the body of the caterpillar and, when full-grown, form small white cocoons on the outside of the body. These cocoons are often mistaken for the eggs of the worms. Caterpillars covered with these cocoons should not be destroyed, as they will do no further harm and the parasites upon emerging from the cocoons may parasitize other worms.

Garden Slugs

Several species

Character of Injury. Garden slugs feed on most of the common garden crops, eating holes in the foliage and leaving a trail of slime wherever they have traveled. They also feed on the roots and stems of many crops, on potato tubers, and on the fruit of tomatoes. Disease and decay frequently result.

Life History and Habits. Garden slugs are very annoying and destructive pests. They are slimy, slow-moving, repulsive creatures often incorrectly called snails. There are several species ranging in color from mottled gray to dark blue and in length from less than 1 inch to more than 4 inches.

Control. Garden slugs show a marked dislike for bordeaux mixture (page 45). Spray plants upon which the slug is feeding with bordeaux to which has been added 2 pounds of powdered calcium arsenate, or arsenate of lead, to each 50 gallons of spray. In addition to spraying, distribute poison bait. Use either of the bait recommended for cutworms (page 44). Dusting the plants with hydrated lime will have a tendency to keep the slugs away.

Potato Stalk Borer

Trichobaris trinotata Say

Character of Injury. Eggplant attacked by the potato stalk borer wilts during the heat of the day and the plant becomes yellowed and dwarfed. Some plants show no outward sign of attack, but if the stems are split open, they will be found hollowed out and in the burrow will be a small yellow grub or grayish appearing beetle. Many infested eggplants show little injury but fail to produce fruit.

Life History and Habits. The adult is one of the snout beetles. The body is black but thickly covered with bluish gray scales. In northern Illinois the insect passes the winter within the burrow in the plant, while farther south it sometimes leaves the burrow and seeks shelter in rubbish.

The oval white eggs are deposited singly in the stalk or branches of the plant. When mature, the larvae are about $\frac{1}{4}$ inch long, legless, and dirty white with a brown head. Pupation takes place in the burrow.

Control. There is no satisfactory control for this pest. It is advisable to collect and burn eggplant after harvest. Such weeds as ground cherry and horse nettle should not be allowed to grow around the margins of the field.

Other Pests of Tomatoes and Eggplant

If tomatoes are sprayed when the earliest fruits are about 1 inch in diameter with bordeaux mixture to which has been added 2 pounds of arsenate of lead, much of the corn ear worm damage can be avoided (page 45). It will usually pay to apply a similar spray 10 days later.

The Colorado potato beetle (page 14) is most troublesome to eggplant. Cutworms (page 10) and the potato aphid (page 15) are injurious to both tomatoes and eggplant.

CUCUMBERS, MELONS, SQUASH, AND PUMPKINS

Cucumbers, melons, squash, and pumpkins are extremely susceptible to damage by insects. There is no stage of growth when these crops are free from the danger of serious insect injury. Within a few hours after the first two seed leaves appear above ground the plants may be killed outright by the feeding of the striped cucumber beetle and leafhoppers. Cucumbers and melons are later subject to attack by the melon aphid. Pumpkins and squash are subject to severe injury or destruction by the squash bug. All varieties of squash are seriously injured, if not killed outright, by the squash borer. Because of these insects the truck farmer has greater difficulty in obtaining paying crops of cucumbers, melons, pumpkins, and squash than of any other group of related crops.

Striped Cucumber Beetle Most Destructive of All

Diabrotica vittata Fab.

Character of Injury. The striped cucumber beetle is the most destructive pest of cucumbers, melons, and squash in Illinois, and one with which the gardener must deal every year. Unless growers wage a con-

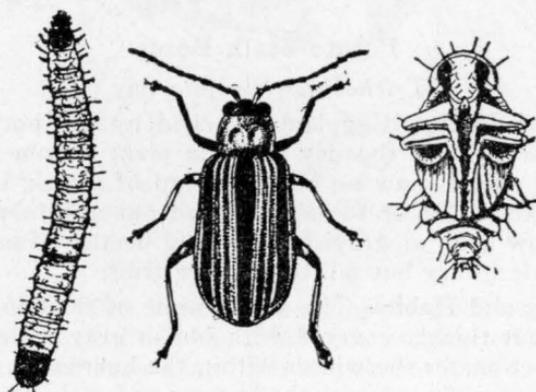


FIG. 12.—FULL-GROWN LARVA AND PUPA OF STRIPED CUCUMBER BEETLE

stant fight, the yield is greatly reduced by this insect, if it is not destroyed altogether. Plants may be killed shortly after they have pushed thru the ground. The leaves of older plants may be eaten to such an extent that they turn brown and die. The stem may be girdled or eaten off entirely. The fruit may be badly disfigured and deformed. Larvae, working underground, bore into stem and roots and into the fruit where it rests on the ground.

The adults are responsible for the spread of bacterial wilt, which may destroy a whole crop. The cucumber mosaic disease is also spread by this beetle.

Life History and Habits. The adult is light yellow, with a black head and three black stripes on the wing covers (Fig. 12), and is about $\frac{1}{4}$ inch long. It passes the winter in trash, rubbish, or in the soil. The

eggs, which are oval, light yellow, and about $\frac{1}{40}$ inch long, are laid in cracks and crevices in the soil about the base of the plant. In about a week they hatch into small larvae. When full-grown, a larva is close to $\frac{1}{4}$ inch long, very slender, white, and wormlike, with a brown head, thorax, and anal plate. When mature, it transforms into a white pupa within an earthen cell.

Control. Altho these beetles are heavy feeders, they are not easily poisoned, for they avoid poisoned plants or poisoned portions of the plant. Any control measure must therefore be thoroly carried out. Under Illinois conditions a dust composed of 1 pound calcium arsenate to 20 pounds burned gypsum has been found most satisfactory. A special grade of dusting gypsum (burned) can be obtained for this purpose. In no case use agricultural gypsum, for it is too coarse to dust properly. The gypsum and calcium arsenate (fresh) should be run thru a mixer, such as that used in preparing nicotine dust (page 44).

This dust may be applied with any good hand-dusting machine. For cucumbers grown in rows, a machine that will throw a steady stream of dust is preferred, while a puff duster is better where cucumbers are grown in hills. A practicable homemade duster may be used. To make this duster take a 2- or 4-quart pail with a tight-fitting lid and punch a number of small holes in the bottom. On two sides of the pail, nail a wooden strip 2 to $2\frac{1}{2}$ feet long, adjusting the length of the strips to the height of the person who is to use the duster. Between the strips, at the top, a section of a broom handle may be fitted to serve as a handle. Fill the pail half full of the mixed dust and apply by shaking over the plants.

The number of applications will depend on weather conditions, the period during which the beetles are active, and the throness of the dusting. It is important to dust all parts of the plant and when using a dusting machine, to direct the dust upward under the leaves. Seedlings just coming thru the ground should be kept well dusted, and the plants should be kept covered with the dust as long as the beetles are present.

Covering plants with a screen will keep the beetles off the young plants. This method may be used to advantage in the home garden.

Bordeaux mixture 2-4-50 (page 45) to which has been added 2 pounds of arsenate of lead powder for each 50 gallons of spray makes an effective spray. By rearranging the nozzles on a potato sprayer, it may be used for rapid spraying of cucumbers grown in rows.

Spotted Cucumber Beetle Sometimes Troublesome

Diabrotica duodecimpunctata Fab.

Character of Injury. The adult spotted cucumber beetle injures cucumbers, melons, pumpkins, and squash to a lesser extent but in much the same manner as the striped cucumber beetle. It also feeds on a number of other vegetables, including string and lima beans, potatoes, beets, asparagus, eggplant, tomatoes, and others. The larva is a serious pest of corn except in northern Illinois. It feeds on and destroys the corn roots.

Life History and Habits. This beetle is yellowish green with 12 black spots on its back. It is about $\frac{1}{4}$ inch long and noticeably thicker than

the striped cucumber beetle (Fig. 13). The adult beetle spends the winter hiding among rubbish and plant refuse and emerges in early spring. The females deposit their eggs in the soil around the base of host plants. The young larvae upon hatching bore into the roots and underground stems.

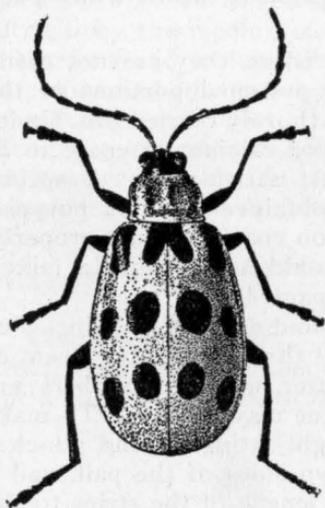


FIG. 13.—ADULT OF SPOTTED CUCUMBER BEETLE
(Much enlarged)

Control. This beetle is controlled in the same manner as the striped cucumber beetle (page 27). In areas where it is a serious pest of corn it is difficult to control. Planting corn on soil plowed late in the fall or early in the spring will help to prevent its being injured by this pest.

Melon Aphid Most Troublesome in Hot, Dry Weather

Aphis gossypii Glov.

Character of Injury. The melon aphid, or plant louse, at times is very destructive to melons and cucumbers. It also attacks eggplant, beans, beets, spinach, tomatoes, asparagus, and cotton. Like all aphids it is a sucking insect, feeding in colonies or clusters on the underside of leaves. The sucking of juices from the leaves causes them to

become curled and deformed (Fig. 14). The aphids are most troublesome rather late in the summer.

Life History and Habits. The life history of the melon aphid is much the same as that of most of the aphids, or plant lice (pages 8 and 15).

Control. Since the melon aphid is a soft-bodied sucking insect, it must be killed with a contact dust or spray. An underspray nozzle must be used or the vines must be so turned that all the insects may be covered. A constant watch should be kept for the first appearance of the pest and spray or dust applied before the aphids have curled the leaves. One ounce of 40-percent nicotine sulfate and 6 ounces of soap to 6 gallons of water makes a fairly effective spray. Derrisol, a commercial preparation containing extracts of derris, is effective against most aphids and should be used as directed by the manufacturers.

A 2.4-percent nicotine dust (page 44) may be used in place of the spray and is to be preferred to the spray if it is necessary to apply it by hand. The spray or dust must be driven under the leaves with as much force as possible since the value of a contact insecticide lies in thoroly wetting or covering the insect.

Squash Bug Damaging to Squash and Pumpkins

Anasa tristis DeG.

Character of Injury. The squash bug is a very destructive insect to squash and pumpkins and occasionally attacks cucumbers and melons.

By inserting its beak in the leaf and extracting the juice, it causes the leaf to wither; later the whole plant withers and dies.

Life History and Habits. The adult is a true bug, or sucking insect, brownish black in color and $\frac{3}{4}$ inch long. It is often called the stink-bug because of its offensive odor. Adults hibernate in trash and rubbish.

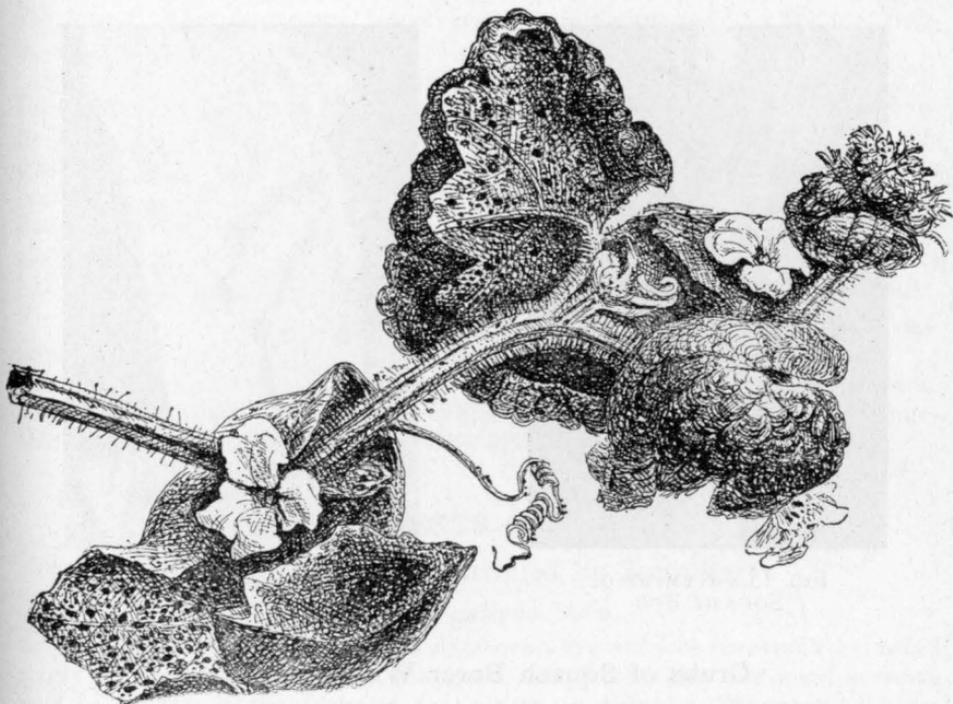


FIG. 14.—SECTION OF MELON VINE BADLY INFESTED WITH MELON APHIDS

The eggs are laid in clusters on the underside of leaves and, being comparatively large, are easily detected. They are oval, $\frac{1}{16}$ inch long, and when first laid are whitish to yellowish brown turning to reddish brown before hatching. The nymph when first hatched is a pinkish color. Later it turns to black and then, after the first molt, becomes gray.

Control. The problem of control is difficult for two reasons: (1) a contact spray that will kill the adults will also injure the plants; (2) as the nymphs feed for the most part on the underside of the leaves, they are hard to hit with a spray. Young nymphs may be killed with 40-percent nicotine sulfate used at the rate of 1 fluid ounce to 3 gallons of soapy water. They should be sprayed while collected in masses along the stems (Fig. 15).

If small strips of board are placed on the ground both before and after the crop is planted, the bugs will collect underneath them during the night. Early in the morning the boards should be turned and while the bugs are still sluggish, they should be collected and killed by being dropped in a can containing kerosene. In the home garden the egg masses may be removed and destroyed.

Clean farming is highly recommended for preventing attacks by this bug. By keeping trash, rubbish, and garden refuse cleaned up, the bugs will have fewer places in which to hibernate. After the crop has been harvested, the vines should be raked into piles, and in late fall after the bugs have collected under them, they should be burned.

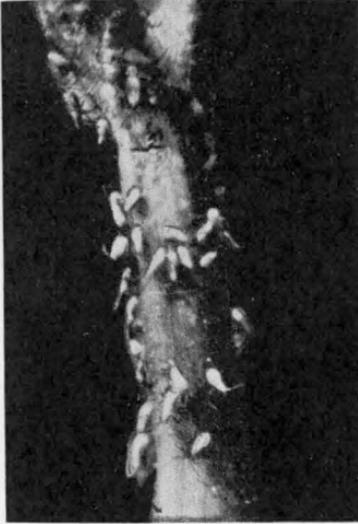


FIG. 15.—NYMPHS OF
SQUASH BUG

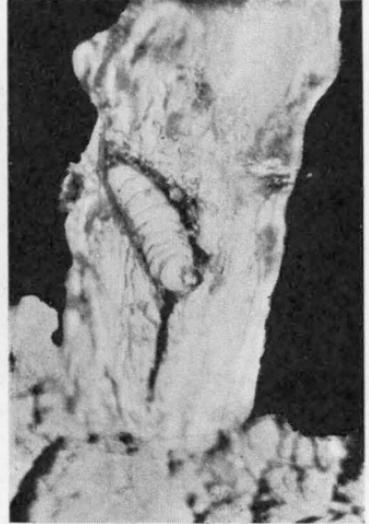


FIG. 16.—LARVA OF SQUASH
BORER

Grubs of Squash Borer Work in Vines

Melittia satyriniformis Hbn.

Character of Injury. The squash borer is a very destructive pest in Illinois. In the southern part of Cook county it is almost impossible to grow early summer squash of the crooked-neck variety or pumpkins because of injuries by this insect. It also attacks cucumbers and melons to some extent. The caterpillars bore into the stalk and petioles of the leaves, decay sets in, and the stem rots off at or near the surface of the ground.

Life History and Habits. The adult is one of the clearwing moths. The front wings are nearly black; the hind wings are transparent. The wing expanse is about $1\frac{1}{4}$ inches. The moths are most active in the heat of the day and are often mistaken for bees or wasps. In northern Illinois there is but one full brood, while in southern Illinois there is probably a second brood. The eggs are laid on the stem of the plant and are red, oval, and $\frac{1}{25}$ inch long. They hatch in about 2 weeks into small caterpillars which bore into the vines of the plants. When full-grown, the caterpillars are white with a brown head and are about 1 inch long (Fig. 16). The mature caterpillars leave the stem and enter the ground where they construct a dark brown cocoon in which they pupate.

Control. Like all borers they are protected within the plant and are

very difficult to control. Worthley¹ has shown that it is possible to stop most of the injury by spraying the squash vines four times, at weekly intervals, using 40-percent nicotine sulfate at the rate of 1 part to 100 parts of water (1.3 fluid ounces per gallon of water). The plants should be examined carefully for eggs at frequent intervals after the middle of June, and the first spray should be applied about one week after the eggs are found. This treatment, however, is rather expensive. Late planting is recommended where practical.

In the home garden the borers may be cut out of the stem with a thin-bladed knife without permanent injury to the plants. The borer can be located by the hole in the stem and the brown frass which the insect pushes out of the burrow. Earth should then be hilled up around the plant above the wound. The eggs may also be removed by hand with little difficulty after practice.

Other Pests of Cucumbers, Melons, Squash, and Pumpkins

Seedlings dusted as recommended for the control of the striped cucumber beetle (page 27) will not be injured by flea beetles.

For description and control of other insects injurious to cucumbers, melons, squash, and pumpkins, see white grubs (page 15), wireworms (page 16), the garden flea hopper (page 35), and leafhoppers (page 40).

INSECT PESTS OF ONIONS

Onion Maggot Controlled by Spraying

Hylemyia antiqua Meig.

Character of Injury. Onions as a crop are subject to attack by relatively few insects. The onion maggot is unquestionably the most serious pest of onions, particularly of onion sets, in Illinois. When the young maggot hatches, it almost immediately enters the ground, usually by following down the stem or bulb. Entrance to the onion is most often made at the base of the bulb where the roots are attached. The maggots then burrow within the bulb and up the stem, sometimes to a distance of 2 or more inches above ground. A single maggot is capable of destroying a number of plants in the first two weeks when the onions are out of the ground. This results in places in the rows where the onions are entirely killed out. When the onions are larger, several maggots are commonly found in a single bulb. Infested onions never mature properly and they usually decay. Bulbs only slightly attacked toward the end of the season not only rot in storage but cause surrounding bulbs to rot. In some seasons this results in losses in storage as great as the losses in the field.

Life History and Habits. The adult of the onion maggot (Fig. 17) is a fly similar to the cabbage maggot (page 6). The thorax, or region back of the head, and the abdomen are grayish in color. A rather distinct, black stripe runs down the middle of the back; this stripe is less distinct in the female, the female being generally larger and lighter in color.

¹Mass. Agr. Exp. Sta. Bul. 218. 1923.

The female prefers cloudy days, the period following a shower, early morning, or late afternoon for egg deposition. The eggs are laid either singly or in groups of 5 to 20 on a single plant. As many as 52 eggs have been taken at one time from a single onion with a bulb less than 1 inch in diameter. Second- and third-brood females prefer infested areas or spots in the field in which to lay eggs but also prefer healthy onions to those already infested or onions that are infested with smut. White varieties are preferred to yellow, and red ones are least likely to be attacked. The eggs hatch in 2 to 10 days. The average for the first brood is 4 days and for the second and third broods, 2 days. The eggs are smooth, oval, and white. They are laid on the stem of the onion behind the leaf sheath or in cracks and crevices in the soil.

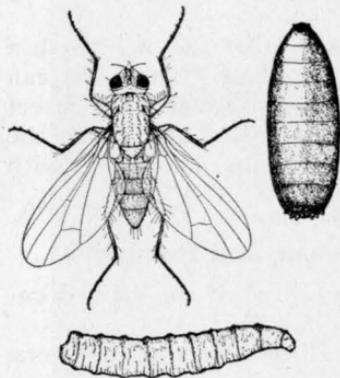


FIG. 17.—ONION MAGGOT:
ADULT, PUPARIA (RIGHT),
AND FULL-GROWN
LARVA

The larva is a small footless maggot, smooth and nearly white, closely resembling the cabbage maggot. When full-grown, it is about $\frac{3}{8}$ inch long.

When mature, the maggot forms a puparium, or sort of smooth cocoon, usually in the soil at a depth of $1\frac{1}{2}$ to 3 inches but occasionally within the onion bulb.

These puparia are most likely to be found in the bulb where onions are grown to maturity. About 2 weeks are spent in the puparia before the flies emerge. These insects normally pass the winter within the puparia in the soil and in puparia resulting, for the most part, from the second brood. Maggots are able to live over the winter in onion bulbs left in the field or in cull piles. Occasionally adults also survive the winter hidden in trash, buildings, etc., but normally die before laying eggs.

Control. A control for the onion maggot which is practical and efficient has been developed in Illinois. The onions are sprayed with a bordeaux-oil emulsion using the oil emulsion in 4-6-50 bordeaux. For this work $1\frac{1}{2}$ gallons of boiled fish-oil soap emulsion is used to each 50 gallons of spray. The oil should be added to the water first and then the bordeaux made up as directed on page 45. The emulsion is prepared by boiling together a light-grade lubricating oil, having approximately 90 percent viscosity and .88 specific gravity, with 2 pounds of fish-oil soap and 1 quart of water. The ready-made emulsion may be purchased at a reasonable price from reliable manufacturers. A number of commercial preparations have been tried out but the results have not been so good as with the boiled fish-oil soap emulsion.

This spray is applied with one of the small garden-tractor sprayers developed in this work and now in general use in Cook county, Illinois. The flow of liquid at the nozzles should be so regulated that a rather coarse spray is formed. The stems of the plants and the soil to the width of 1 inch on each side of the row must be wet with the spray. After the first application and when the onions have become thoroly

established, the pressure may be increased to advantage but a fine, misty spray should be avoided. The first application should be made when the onions are about 1 inch out of the ground or when the tops begin to straighten up. Subsequent applications should be made at intervals of not more than a week. In most seasons two applications have been found to be sufficient for the control of maggots on onion sets. In cold, wet seasons when onion maggot infestations are heavy and the onions are growing slowly, it will pay to make a third application. The first spray is by far the most important and should be timed to get the first lot of eggs and young maggots. About 150 gallons of spray should be applied to the acre. This treatment has resulted in the difference between an onion crop that was almost a total loss and one that yielded 680 bushels of sets an acre.

Cull piles often contain large numbers of over-wintering maggots and puparia and should be destroyed not later than April 1. This may be accomplished by drenching with used crank-case oil and burning. Spreading the culls and rotting onions on the field and then plowing is a bad practice and should be avoided. When onions are milled in the field, the piles of chaff contain many puparia and should be burned.

Onion Thrips Cause Whitening of Onion Leaves

Thrips tabaci Lind.

Character of Injury. Onion thrips rank close to the onion maggot as a major pest of onions in Illinois. In some seasons entire fields are destroyed by these insects. They are occasionally injurious to onions grown for sets but normally feed on large onions. Cabbage, cauliflower, and beans are sometimes attacked. Thrips do not feed like most insects; they scrape the surface of the leaf, and then suck the juices which collect. Whitish blotches show plainly on the green leaf where they have been feeding. Later the whole plant becomes bleached, dries from the top down, and finally dies. Infested plants become weak and unable to stand upright. The injury is more marked in dry seasons.

Life History and Habits. The adult is a very small, slender, yellow to yellowish brown insect, which when disturbed crawls rapidly over the surface of the plant. The wings are long and narrow with a fringe of long hairs on the hind margin. The female is capable of laying fertile eggs without mating. The eggs are white, nearly transparent, bean-shaped, and so small that it would require one hundred placed end to end to measure an inch. The egg is inserted nearly its full length into the leaf and hatches in 7 to 10 days. The nymph when first hatched is nearly white with bright red eyes. It develops rapidly, becomes yellow, and transforms to an adult in 15 to 20 days.

Control. Because of their rapid reproduction and their habits of feeding and remaining protected under the leaf sheath, thrips are difficult to control satisfactorily. A nicotine-Penetrol or Derrisol-Penetrol spray will kill all the thrips that are hit with it. Investigations in Illinois during the last several years have shown that 1 ounce of 40-percent nicotine sulfate or Derrisol and 4 ounces of Penetrol to 6 or 8 gallons of water makes a satisfactory spray. Penetrol is an excellent spreader and

sticker for spraying all smooth-leaved plants, and is more efficient than soap since it activates the poisons. To get the best results use a high-pressure sprayer and hold the nozzles close to the plants. A 2.4 percent nicotine dust (page 44) is also effective in killing all thrips not protected behind the leaf sheaths. It has been observed in the field that certain plants with well-formed bulbs have rather open tops with no protecting places for the thrips. An attempt is now being made to breed up a strain of onions with open tops which will greatly facilitate control of onion thrips. A number of materials would be effective in killing thrips if it were possible to hit them.

It is advisable to clean up weed patches near the onion field.

Other Pests of Onions

If onions fail to break thru the ground, an examination of the seeds along the drill row may show them to have been eaten out by a small white maggot similar to the onion maggot. This maggot is the larva of the seed corn maggot (page 19), and occasionally in Illinois destroys entire plantings of onions seeded for sets. It is usually safe to replant at once in the same ground.

For description and control of other insects injurious to onions see the woolly bear caterpillar (page 6), cutworms (page 10), white grubs (page 15), wireworms (page 16), and the pale-striped flea beetle (page 19).

INSECT PESTS OF PEAS AND BEANS

Peas and beans are not so severely injured by insects as are many Illinois truck and garden crops. The principal pest of peas is the pea aphid, and the most destructive pest of beans is the potato leafhopper. Other pests prove destructive locally every year and in certain seasons become major pests. The Mexican bean beetle, a new pest of beans, has not been found in Illinois to date, but it is a very serious pest of beans in near-by states and will probably make its way into Illinois soon.

Potato Leafhopper Injures Late Beans

Empoasca fabae Harr.

Character of Injury. When late beans are attacked by the potato leafhopper, the tips and margins of the leaves turn upward slightly, wilt, and finally become brown. The young growth becomes deformed, and beans may be severely injured as soon as the first true leaves appear.

Control. Experiments conducted in Illinois during the past two years indicate that it does not pay to spray beans with bordeaux mixture, as severe injury to the plants is likely to result. Satisfactory results have been obtained by dusting with a bordeaux dust (page 46).

Aphids Difficult to Control Commercially

Character of Injury. Peas and beans are subject to attack by aphids,¹ or plant lice. The type of injury is typical of aphid feeding (see cabbage aphids, page 8, and the potato aphid, page 15).

¹The bean aphid, *Aphis rumicis* L.; the pea aphid, *Macrosiphum pisi* Kalt; and others.

Control. It is seldom practicable to attempt control by means of insecticides of aphids on peas or beans grown on a commercial scale. They may be killed by dusting with a 2.4-percent nicotine dust as recommended for cabbage aphids (page 8).

Garden Flea Hopper Sporadic in Attack

Halticus citri Ashm.

The garden flea hopper often injures plantings of bean, cabbage, celery, cucumber, eggplant, pepper, potato, squash, sweet potato, tomato, and other truck crops. It has the same general appearance as the black aphid, or plant louse, but is much more active.

Control. An excellent preventive measure consists in keeping all weeds cut. These insects may be killed by spraying with 40-percent nicotine sulfate at the rate of 1 ounce of nicotine and 5 ounces of soap to 5 gallons of water. A 2.4 percent nicotine dust is also effective (page 44).

Weevils Injure Pea and Bean Seed

Acanthoscelides obtectus Say, and others.

Character of Injury. The bean weevil is a serious pest of beans, especially in the South. In storage several species of weevils attack both pea and bean seed. When green beans are infested, the pods are stunted and deformed, and the beans are unfit for food and will not make seed. Seed beans and peas are also attacked and are hollowed out until they are unfit for seed or food.

Life History and Habits. The adult of the bean weevil is about $\frac{1}{8}$ inch long and light brown with light and dark brown spots on its back. The female gnaws a hole thru the bean pod and deposits the egg within. In shell beans the eggs are laid loose among the beans or in the holes made by the beetles when they leave the bean. The egg is white, almost transparent, nearly round, and about $\frac{1}{40}$ inch long. The larva, or grub, is about $\frac{1}{8}$ inch long, white, and footless. The grub transforms into a white pupa within the bean. Other species of weevils have the same general life histories.

Control. Do not plant infested seed. The germination will be poor and the insects will also be distributed in the field. Other than planting good seed, there is no control for the weevil in the field. To control the weevil in bean and pea seed, carbon bisulfid may be used. Place the seed in a tight box or bin with the temperature about 75° F. Use the carbon bisulfid at the rate of 1 ounce to a bushel of seed, or 3 pounds to 100 cubic feet of space. The carbon bisulfid is a liquid, and should be placed in shallow pans on top of the seed. Place a small amount of burlap in the pans with the liquid to hasten evaporation. Leave the box or bin tightly closed for 24 to 36 hours. *Carbon bisulfid is very inflammable and should not be used near a fire or by anyone who is smoking.*

Further work of the weevil in beans may be stopped if hydrated lime is mixed with the seed at the rate of 1 pound to 4 pounds of seed. This method can be best used where a small quantity of beans is stored.

Mexican Bean Beetle a New Pest of Bean

Epilachna corrupta Muls.

Character of Injury. The Mexican bean beetle (Fig. 18), another new and destructive pest, will undoubtedly appear in Illinois soon. It is now well established in Indiana, Michigan, and Kentucky within a few miles of the Illinois border. All varieties of beans and, to some

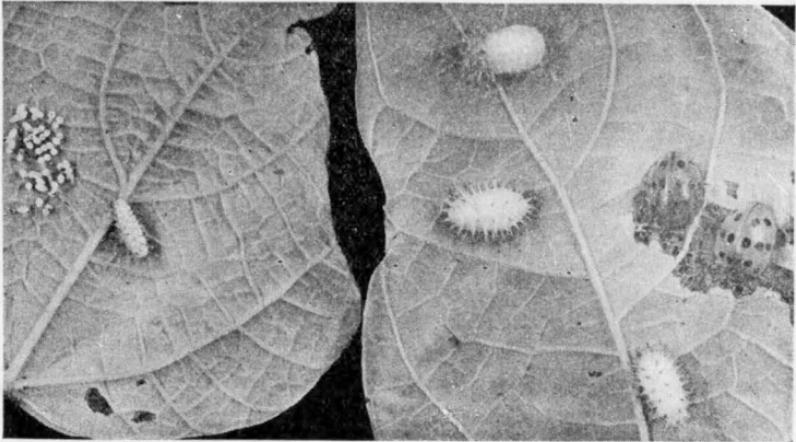


FIG. 18.—MEXICAN BEAN BEETLE: EGGS, LARVA, PUPAE, AND ADULTS ON BEAN LEAVES

(Courtesy Alabama Experiment Station)

extent, cowpeas and soybeans are subject to attack. Both the larva and the adult beetle feed on the foliage of the plant. The larva feeds almost entirely on the underside of the leaves, eating off the lower layers and leaving only the skeletons. Injured leaves soon die and drop from the plant. In severe infestations the pods may be eaten.

Life History and Habits. This beetle is capable of multiplying rapidly and reaches damaging proportions in two years or so after it invades new territory.

The adult is yellow to light brown with 16 spots on the back and wing covers. It is about $\frac{1}{4}$ inch long and strongly convex on the upper side. It can easily be distinguished by these markings from other insects found feeding on beans in Illinois.

The pale orange eggs are laid in groups on the underside of leaves in much the same manner as the eggs of the Colorado potato beetle or of the common potato bug.

The larvae, when full-grown, are about $\frac{1}{4}$ inch long, dark yellow, and are covered with a heavy armor of spines which are much branched and colored black at the tips. Pupation takes place on the underside of the leaf, where the pupa may be seen hanging. The entire life cycle is completed in about a month.

Control. Arsenate of lead, the standard poison for most leaf-eating insects of the garden, is likely to burn the bean foliage, hence other

poisons must be used. Calcium arsenate at the rate of $1\frac{1}{2}$ pounds to 100 gallons of water is recommended in areas where this insect is found. Add 3 pounds of hydrated lime to this spray to prevent burning. Calcium arsenate may also be used as a dust by mixing 1 pound of poison with 9 pounds of hydrated lime.

Magnesium arsenate is also recommended. Use as a spray at the rate of 3 pounds to 100 gallons of water, and as a dust, 1 pound to 5 pounds of hydrated lime. Direct the spray or dust to the underside of the foliage. Apply spray every 10 days or dust every week until the insect is brought under control. Fluosilicates of calcium or barium are being used extensively in areas where this insect has become established.

Rake together and burn all remnants of the bean crop. Burn over weedy lots and field margins during the winter to destroy hibernating adults.

Other Pests of Peas and Beans

For description and control of other insects injurious to peas and beans see the woolly bear caterpillar (page 6), cutworms (page 10), wireworms (page 16), blister beetles (page 17), corn ear worm (page 18), seed corn maggot (page 19), grasshoppers (page 20), slugs (page 25), spotted cucumber beetle (page 27), and the melon aphid (page 28). Onion thrips can be controlled with nicotine dust (page 34).

INSECT PESTS OF ASPARAGUS

There are only a few important insects feeding on asparagus. The common asparagus beetle is the most destructive in northern Illinois, and is always present, as is the twelve-spotted asparagus beetle, tho the latter is not so destructive.

Asparagus Beetle Always Present and Destructive

Crioceris asparagi L.

Character of Injury. Injury may be inflicted by both the adult asparagus beetle and the grub. The beetle eats holes, or pits, in the asparagus when it is ready to cut. The grub may defoliate leafed-out plants. This latter feeding is very injurious to young asparagus grown from seed and will destroy a considerable number of the plants within a short time. The eggs are laid on the asparagus about cutting time, thus making the produce objectionable to the buyer (Fig. 19).

Life History and Habits. This beetle is about $\frac{1}{4}$ inch long and is beautifully colored and marked. The head, underpart of the body, legs, and antennae are bluish black usually tinted with green. The thorax, or region next to the head, is reddish, while the markings on the back vary greatly. On each wing cover is a more or less distinct inverted letter E, with the intervening spaces of yellow shading to orange.

The beetles pass the winter in rubbish piles and protected places. The eggs are oval, grayish brown, $\frac{1}{16}$ inch long, and very conspicuous. They are laid on end, singly or in rows, on almost any part of the plant aboveground. The larvae, or slugs, when full-grown are about $\frac{1}{4}$ inch

long and are slate colored with the head and legs shiny black. When the grubs are mature, they enter the ground and transform into pale yellowish pupae.

Control. It is a common practice in asparagus-growing areas to cut the stalks every other day, or every day when the weather is warm, and thus, to a great extent, to keep one jump ahead of the beetles. However, nothing but the destruction of the beetles will keep them from depositing their unsightly eggs on the shoots. They may be killed by covering thoroly with arsenate of lead occasional shoots which have been left to grow, in addition to keeping the rest of the crop closely cut. A solution of 3 pounds arsenate of lead to 50 gallons of water to which has been added 3 pounds of soap is recommended for this work.

After the cutting season is over and the plants have leafed out, this beetle can be satisfactorily controlled by spraying with arsenate of lead at the rate of 2 pounds to 50 gallons of water, to which has been added 3 pounds of soap or 1 quart of Penetrol. It has been found that this spray can be applied with an ordinary potato sprayer, using 100 gallons of spray to an acre. The booms should be raised so as not to touch the plants. Young asparagus grown from seed should be sprayed two or three times during the summer. Mechanical injury to the plants by the sprayer has been negligible.

Spotted Asparagus Beetle

Crioceris duodecimpunctata L.

Character of Injury. Injury by the spotted asparagus beetle is the same as that made by the common asparagus beetle (page 37).

Life History and Habits. This beetle can be distinguished from the common asparagus beetle by its red color and by the 12 black spots on its back. The larvae feed on the asparagus berries, eating out the seeds.



FIG. 19.—ADULT OF ASPARAGUS BEETLE FEEDING ON TIPS; EGGS AND SLUGS SHOWN ON LEAVES

Control. Use measures recommended for the common asparagus beetle (page 38).

Other Pests of Asparagus

For description and control of other insect pests injurious to asparagus see the woolly bear caterpillar (page 6), cutworms (page 10), harlequin bug (page 11), corn ear worm (page 18), and aphids (page 34).

BEETS, SPINACH, LETTUCE, CELERY, AND DILL

Celery Looper a Pest of Lettuce, Celery, Beets

Autographa falcifera Kby.

Character of Injury. The celery looper is a leaf-eating insect which feeds by chewing holes in the leaves.

Life History and Habits. This insect is closely related to the cabbage looper. The larva may be distinguished from that of the cabbage looper by its conspicuous white spiracles ringed with black. The adult of the celery looper is about the size of the cabbage looper, but the silver spot on the forewings does not resemble a figure 8 as does the spot on the cabbage looper. The celery looper attacks lettuce and sugar beets as well as celery and is frequently as numerous as the cabbage looper in Illinois.

Control. Hand-picking the larvae should be resorted to if lettuce becomes infested. This same practice may be resorted to with celery if the worms are not numerous. Young celery may be sprayed with arsenicals since the poison will wash off before the celery is bleached. Sugar beets may be treated in the same way. Use 1 pound arsenate of lead to 50 gallons of water in which has been dissolved 3 pounds of soap. The poison may be added to the bordeaux spray.

Tarnished Plant Bug a Pest of Celery

Lygus pratensis L.

Character of Injury. Celery, cabbage, cauliflower, turnips, potatoes, tomatoes, beans, and cucumbers are often damaged by the tarnished plant bug. Injury is inflicted by both the nymphs and adults. This bug often injures celery by inserting its beak into the tissues and sucking the juices from the plant near the joint, causing what is known as "black joint." The celery is thus marred and the market value greatly reduced.

Life History and Habits. The adult of the tarnished plant bug is often overlooked by the gardener, for it is easily disturbed and flies at the slightest alarm. The bug is brown mottled with various shades of reddish and yellowish brown and is about $\frac{1}{4}$ inch long. The adult passes the winter in rubbish, such as leaves, stone piles, and garden refuse.

The yellowish white flask-shaped eggs are inserted by the female in the tender tissues of the plant. They hatch in about 10 days. The young nymph is colored in various shades of green and has four black spots on the back. As the nymphs become older the thorax becomes

mottled with brown. The bugs become full grown in about a month. There are four or five generations annually in Illinois.

Control. Use measures recommended for the garden flea hopper (page 35).

Garden Webworm a General Feeder

Loxostege similalis Guen., and others

Character of Injury. The webworm caterpillar eats holes in the leaves and stems of beets, beans, and other vegetables.

Life History and Habits. The full-grown caterpillar is a yellowish green hairy worm about 1 inch long, with numerous black spots along the back and sides. This active caterpillar will drop to the ground when disturbed. Late in the fall it pupates in the soil. The adult moth emerges from the pupa in early spring to deposit its eggs on the leaves of food plants.

Control. When beans or beets become badly infested, they should be dusted or sprayed as for the control of cabbage worms (page 4).

Other Pests of Beets, Spinach, Lettuce, Celery, and Dill

The spinach flea beetle attacks spinach and beets. It is similar in life history and habits to the potato flea beetle (page 14).

Leafhoppers of several species attack lettuce, beets, and spinach. Their general appearance, life histories, and habits are the same as those of the potato leafhopper (page 13).

For description and control of other insect pests injurious to these vegetables see cutworms (page 10), white grubs (page 15), wireworms (page 16), blister beetles (page 17), slugs (page 25), and the tarnished plant bug (page 39).

INSECT PESTS OF CARROTS AND PARSNIPS

Carrots and parsnips grown in Illinois are generally free from serious insect attacks, at least in the large trucking areas. There are, however, several insects that attack these crops which may cause considerable losses if they become established. There is a practice in the Chicago district, in order to obtain cheap baskets, of loading up at the market with baskets containing spoiled vegetables and carrying them home. The contents of these baskets are sometimes spread on the fields. In most cases the spoiled vegetables thus obtained have come a considerable distance. There is in this practice great danger of bringing in new insect pests and diseases which may cause serious losses in the future.

Among the insects attacking carrots and parsnips which truck growers and gardeners should watch for as most likely to cause trouble are the carrot beetle, carrot weevils, and the carrot rust fly.

Carrot Beetle

Ligyris gibbosus DeG.

Character of Injury. The carrot beetle has been injurious to carrots and parsnips in the Atlantic Coast states and Gulf states in the past

but, altho known to occur in Illinois, has not been of primary importance in this state. In addition to carrots and parsnips, it also attacks corn, celery, sweet potatoes, and other crops. Most of the injury is caused by the adult, which eats out rather large holes in roots below the surface of the ground.

Life History and Habits. The adult is $\frac{1}{2}$ to $\frac{5}{8}$ inch long, reddish brown to black, and looks much like a small June bug.

Control. Control of this insect has not been fully worked out on a commercial scale. Lime scattered over the ground is reported to drive the insects away but such a procedure carried on year after year might prove injurious to certain soils. A short rotation of crops is beneficial.

Carrot Weevils

Listronotus latiusculus Boh. and *Listronotus rudipennis* Blatchley

Serious infestations of these two species of carrot weevil were first brought to the attention of entomologists in 1925. The former species



FIG. 20.—CARROT INJURED BY CARROT WEEVIL

was found to be injuring carrots seriously and parsley to a lesser degree in the East St. Louis trucking district. It has since been reported from Rock Island, Champaign, Sangamon, Wabash, and Jackson counties. The latter species was found to be seriously injuring carrots in the vicinity of Burlington, Iowa. It has also been found on carrots from Clinton county, Illinois.

The adults are weevils, or snout beetles, about $\frac{1}{8}$ inch long and have a coppery appearance. The injury is caused by the larvae or grubs which tunnel into the roots (Fig. 20).

Control. No control has been worked out for this insect altho field observations indicate that late carrots are less likely to be injured.

Carrot Rust Fly

Psila rosae Fab.

Character of Injury. The carrot rust fly is a serious pest in the Eastern states and occurs as far west as Michigan. It has not been found in Illinois. Rust-red burrows in the roots of carrots and parsnips indicate the work of the carrot rust fly maggots. The roots of celery are also attacked causing the plants to wilt.

Life History and Habits. This insect is a very slender, whitish

maggot about $\frac{1}{3}$ inch long when full-grown. The green-bodied adults with conspicuous red eyes emerge in May and deposit their eggs around the base of their food plants.

Control. No satisfactory control has been developed for this insect.

Other Pests of Carrots and Parsnips

See insect pests of beets, spinach, lettuce, celery, and dill, page 39.

INSECT PESTS OF HORSE-RADISH

Horse-Radish Flea Beetle

Phyllotreta armoraciae Koch

Character of Injury. Horse-radish is comparatively free from pests with the exception of the horse-radish flea beetle, which is capable of inflicting serious losses to the crop. Water cress is the only other crop known to be attacked. Injury is inflicted by both the adult and the larva. The adult beetle is most destructive early in the season when it gnaws small circular holes in the leaves, causing them to dry out and die. The larva is most destructive later in the season when it burrows into the petioles or leaf stems, killing the leaf and retarding the growth of the root.

Life History and Habits. The adult is about $\frac{1}{8}$ inch long, oval, with a black body. Each wing cover is yellow with a black strip on both the outer and inner margins. The adult passes the winter in dry, sheltered places. When full-grown, the larva is less than $\frac{1}{4}$ inch long, very slender, dirty white, with a dark head and thoracic shield.

Control. Use measures recommended for the potato flea beetle (page 14) or the eggplant flea beetle (page 23). It is important to start spraying or dusting when the beetles are first noticed in order to prevent egg-laying and subsequent larval injury. Treatments should be repeated every week or 10 days until the beetles disappear. Rotation of crops will bring relief when flea beetles become numerous.

INSECT PESTS OF SWEET POTATOES

Sweet potatoes are an important crop in Illinois, truck farmers receiving for this vegetable over a million dollars annually. A relatively large number of insects feed on sweet potatoes, tho none of them compare in severity of attack with the insect pests of the white potato.

Sweet-Potato Beetles

Several species of *Chrysomelidae*

Character of Injury. Small holes are eaten in the leaves of sweet potatoes or the entire leaf is devoured by both young and adults of several species of sweet-potato beetles.

Life History and Habits. The beetles feeding on the leaves of sweet potatoes are $\frac{1}{4}$ to $\frac{1}{3}$ inch long, with rather square tortoise-shaped or

flat oval-shaped bodies. For the most part they are highly colored, either golden hued, spotted, striped, or mottled. They spend the winter in protected places and emerge in May or June to lay their eggs singly or in clusters on the plants.

The spiny larvae are found on the underside of the leaves. Some look like moving pieces of dirt. When full-grown, they are $\frac{1}{3}$ to $\frac{1}{2}$ inch long. Pupation takes place on the plants.

Control. It is seldom necessary to apply control measures in the field. In the seed bed these beetles can be controlled by spraying with arsenate of lead at the rate of 2 ounces to 3 gallons of water.

Sweet-Potato Flea Beetle

Chaetocnema confinis Crotch

The sweet-potato flea beetle resembles the potato flea beetle in general life history and habits (page 14). It feeds on a number of plants other than sweet potato and may be controlled in the seed bed by spraying as for the sweet-potato beetles (see above). Control measures are seldom necessary in the field.

Cutworms

Cutworms attacking sweet potatoes may be controlled as described on page 10.

INSECTICIDES

All insecticides should be considered as deadly poisons. Keep them in air-tight containers plainly labelled and out of reach of children, irresponsible persons, and animals.

Stomach Poisons

Arsenate of lead is the standard insecticide for chewing insects attacking truck crops. It can be used with other insecticides and fungicides, as indicated in the text, and is effective either as a spray or as a dust.

Calcium arsenate is as effective as arsenate of lead for most truck-garden work and in some cases is superior to it. Use as spray or dust as recommended in the text. Do not use calcium arsenate in sprays containing Penetrol.

Paris green is sometimes used as a dust undiluted or diluted with 4 to 5 parts hydrated lime. It is not satisfactory for use in sprays. It is very efficient when used in poison bait.

Calcium fluosilicate is used as a dust or spray as a substitute for arsenate of lead and calcium arsenate. It is particularly efficient in killing beetles that feed on the foliage. The effects of this material on plants and insects has not been fully worked out. It is not so effective as arsenate of lead and calcium arsenate for use on truck crops in Illinois.

Sodium fluosilicate is used in much the same manner as calcium fluosilicate. It is more likely to injure tender foliage than the latter.

Barium fluosilicate (Dutox) is comparable to calcium fluosilicate for use on truck crops. It has been reported as corrosive to the porcelain lining used in some spraying equipment.

Poison bran bait. The following formula is recommended:

Bran.....	25 pounds
Molasses.....	2 quarts
Water.....	10 quarts
Paris green.....	1 pound

(For small amounts)

Bran.....	5 pounds
Molasses.....	$\frac{3}{4}$ pint
Water.....	2 quarts
Paris green.....	$3\frac{1}{2}$ ounces

Thoroughly mix dry bran and Paris green. Then mix molasses and water, and slowly add to bran, stirring constantly. It is important to get an even distribution of the poison and molasses in the bait.

Chopped vegetable bait is another satisfactory bait. It is made of finely chopped vegetables poisoned with arsenate of lead or Paris green, using 1 pound of poison to 10 pounds of chopped leaves.

Contact Poisons

Nicotine sulfate is manufactured in concentrations of 40 percent and 50 percent and should be used according to the instructions on the container unless otherwise stated in the text. Black Leaf 40 and Black Leaf 50 are examples of nicotine sulfate. Nicotine sulfate is preferred for spraying truck crops.

Free nicotine is more active than nicotine sulfate. It may be used in preparing nicotine dust. Nicofume and Nikoteen are examples of free nicotine.

Nicotine dust. Hydrated lime is used as a standard base for nicotine dust prepared for use in the home garden.

When making large amounts of dust, place 47 pounds of hydrated lime in a barrel having a tight-fitting cover. Pour 3 pounds of 40-percent nicotine sulfate over the lime, add about 30 pebbles the size of an egg, and roll the barrel back and forth over the floor or rotate it by mounting the barrel in a frame with a rod attached to the center of the barrel. This kind of frame has a crank at one end by which it may be turned, and the barrel should be rolled or turned at the rate of 35 or 40 revolutions a minute. If it is turned rapidly, the mixing is not so complete as when it is moved at the suggested rate of speed. A churn may be substituted for the barrel as a container for mixing the dust.

To make the dust in small quantities, place 1 pound of hydrated lime in a small keg or bucket having a tight-fitting lid. Pour 1 ounce of 40-percent nicotine sulfate over the lime. Place 12 to 15 pebbles about the size of a walnut in the container, close the lid, and rotate for about 10 minutes.

Be careful upon opening the container not to hold the head close to the opening, as a large amount of nicotine is given off, which may cause

a severe headache or nausea. It is best to mix the dust just before it is to be applied. If for any reason this is impossible, the dust should be stored in tight containers as soon as it is mixed. If allowed to stand for 3 or 4 weeks it will lose some of its strength, altho if the container is air-tight it may be held for a month or two without any great depreciation in insecticidal value.

Boiled lubricating oil emulsion may be made according to the following formula:

Paraffin oil ¹	1 gallon
Water (preferably soft).....	1 quart
Potash fish oil soap.....	2 pounds

Place water, soap, and oil in a kettle or other receptacle and heat to the boiling point. Boil the mixture for about 2 minutes, being careful not to burn it. Remove from the fire and run twice thru a pump such as a bucket or barrel pump. Do not allow the mixture to cool before pumping. A properly made stock emulsion will keep for a considerable time but should not be allowed to freeze.

Derrisol, a commercial product derived from certain tropical derris plants, is highly toxic to soft-bodied insects. The poison first paralyzes and then kills, so that the full effect of the spray is not evident for several days. Derrisol is more pleasant to handle than nicotine extracts and is also nonpoisonous to man.

Pyrethrum extracts. Numerous extracts of pyrethrum are now on the market. They are pleasant to handle and are not poisonous to man. They have a wide margin of safety for use on vegetable crops and are effective against certain sucking and chewing insects. At present the cost of pyrethrum sprays prohibits their extensive use on a commercial scale in truck gardens for the control of insects.

Bordeaux mixture is made in several strengths. For spraying such crops as potatoes a 5-6-50 bordeaux is recommended. For more tender crops a 4-6-50 or a 3-6-50 bordeaux gives better results. The first number in the formula always refers to pounds of copper sulfate, the second to pounds of hydrated lime, and the third to gallons of water.

Directions for mixing 5-6-50 bordeaux.² Following are formula and directions for preparing 5-6-50 bordeaux:

Copper sulfate ³	5 pounds
Hydrated lime.....	6 pounds
Water.....	50 gallons

¹Any oil with the following approximate requirements:

Specific gravity at 20° C.....	.87-.93
Volatility at 110° C. for 4 hours.....	not above 10 percent
Viscosity at 100° F.....	90-250 seconds (Saybold test)

²From Circular 388 of this Station, "Directions for Spraying Fruits in Illinois." Only the highest grade of lime should be used.

³The copper sulfate referred to here comes in lump or crystal form and is sometimes called bluestone. Copper sulfate is now being sold in a finely ground form which goes into solution very readily. When using the finely ground copper sulfate, it is not necessary to get it into solution beforehand. Simply sift the copper sulfate into about half a barrel of water and stir for a minute or two. Then add the hydrated lime as directed above.

For making small quantities of bordeaux use:

Copper sulfate.....	8 ounces
Hydrated lime.....	10 ounces
Water.....	5 gallons

Place the required amount of copper sulfate in a burlap bag and suspend in a wooden or stone vessel just at the surface of the water which has been measured into it. Do not stir before the copper sulfate has been dissolved. For convenience, use 1 gallon of water to each pound of copper sulfate. Stir the required amount of hydrated lime into enough water to make a thin paste.

The copper sulfate and lime are then ready for mixing. First partly fill the sprayer with water and then add the lime paste, using 6 pounds of lime to each 50 gallons of spray. Continue to fill the sprayer until it is about two-thirds full. Start the agitator and after the lime is thoroly mixed, add 5 gallons of the copper-sulfate stock solution for each 50 gallons of spray. Then add water to make up the required volume.

Bordeaux dust. Thoroly mix together the following ingredients:

Monohydrated copper sulfate.....	16 lbs.
Hydrated lime.....	84 lbs.

Bordeaux dust with stomach poison. Thoroly mix together the following ingredients:

Monohydrated copper sulfate.....	16 pounds
Arsenate of lead.....	20 pounds
Hydrated lime.....	64 pounds

Hydrated lime is used as a carrier in preparing homemade dusts and in the preparation of bordeaux mixture. Care should be used to obtain a fresh supply that has not become lumpy. Special spray lime, which is much finer than ordinary hydrated lime, is now available and should be used in the preparation of bordeaux mixture and homemade dusts whenever possible.

INDEX

Numbers in bold face type indicate the pages on which the most complete discussion of a subject occurs.

- Aphids 3, 8, 12, 13, 15, 25, 26, 28, 34, 35, 37, 39
 Armyworms **10**, 19, 23
 Arsenate of lead 3, 4, 9, 10, 11, 14, 15, 19, 20, 23, 24, 25, 27, 36, 38, 39, 43, 44, 46
 Asparagus, insect pests of, 11, 27, 28, **37-39**
 Asparagus beetle, common, 3, 37, 38, 39
 Asparagus beetle, spotted, 3, 37, **38**
 Barium fluosilicate 5, 10, 14, 18, 19, 20, 23, 37, 44
 Beans, insect pests of, 11, 15, 16, 17, 19, 21, 27, 28, 33, **34-37**, 39, 40
 Bean aphid **34**
 Bean beetle, Mexican, 34, **36**
 Bean weevil **35**
 Beets 11, 15, 16, 17, 19, 20, 21, 27, 28, **39-40**
 Blister beetles 13, **17**, 37, 40
 Bordeaux dust 14, 34, 46
 Bordeaux-lead dust 10
 Bordeaux mixture 13, 14, 15, 18, 23, 24, 25, 27, 32, 34, 39, 45, 46
 Bordeaux-oil dust 14
 Broccoli **3-12**
 Brussels sprouts **3-12**
 Cabbage, insect pests of, **3-12**, 16, 19, 21, 33, 35, 39
 Cabbage aphids, 3, **8**, 12, 34, 35
 Cabbage flea beetles 3, **9**
 Cabbage looper **5**, 39
 Cabbage maggot 3, **6**, 10, 19, 31, 32
 Cabbage worm, imported, 3, **4**, 5, 6, 40
 Calcium arsenate 4, 25, 27, 37, 43
 Calcium cyanide 17
 Calcium fluosilicate 5, 10, 14, 18, 19, 20, 23, 37, 43, 44
 Carbon bisulfid 35
 Carrots, insect pests of, 16, **40-42**
 Carrot beetle **40**
 Carrot rust fly 40, **41**
 Carrot weevils 40, **41**
 Caterpillar, woolly bear, 6, 34, 37, 39
 Cauliflower, **3-12**, 21, 33, 39
 Celery, insect pests of, 21, 35, **39-40**, 41
 Celery looper **39**
 Cheesecloth 8, 10
 Copper sulfate 10, 45, 46
 Corn borer, European, 18, 21
 Corn ear worm 3, 10, **18**, 23, 25, 37, 39
 Corrosive sublimate 7, 8
 Cucumbers, insect pests of, 18, **26-31**, 35, 39
 Cucumber beetle, spotted, 23, **27**, 37
 Cucumber beetle, striped, 3, **26**, 27, 28, 31
 Cutworms 3, **10**, 21, 23, 25, 34, 37, 39, 40, 43
 Derrisol 28, 33, 45
 Diamond-back moth 5
 Dill **39-40**
 Eggplant, insect pests of, 11, 14, 15, 18, 19, 21, **23-25**, 27, 28, 35
 Eggplant flea beetle 9, **23**, 42
 Flea hopper, garden, 31, **35**, 40
 Grasshoppers 17, **20**, 37
 Gypsum 27
 Harlequin bug 3, **11**, 39
 Hellebore 5
 Horse-radish, insect pests of, 11, **42**
 Horse-radish flea beetle **42**
 Insecticides 43-46
 June bug, *see white grubs*
 Kale **3-12**
 Kerosene 29
 Kohlrabi **3-12**
 Leaf miners 3, 12
 Leafhoppers 26, 31, 40
 Lettuce 16, **39-40**
 Lime, hydrated, 4, 10, 18, 20, 23, 24, 25, 35, 37, 41, 43, 44, 45, 46
 Magnesium arsenate 37
 Melons, insect pests of, 17, **26-31**
 Melon aphid 26, **28**, 37
 Nicotine dust 3, 9, 28, 34, 35, 37, 44
 Nicotine, free, 3, 44
 Nicotine sulfate 3, 9, 12, 15, 28, 29, 31, 33, 35, 44
 Nitrate of soda 7, 12
 Oil emulsion 32, 45
 Okra 21
 Onions, insect pests of, 16, 19, 20, **31-34**

- Onion maggot 3, 31
 Onion thrips 3, 12, 33, 37
- Pale-striped flea beetle 19, 34
 Paris green 4, 43, 44
 Parsley 41
 Parsnips, insect pests of, 21, 40-42
 Peas, insect pests of, 15, 17, 19, 34-37
 Pea aphid 34, 39
 Penetrol 4, 9, 12, 33, 38, 43
 Peppers 15, 18, 21, 35
 Poison bait 10, 21, 25, 43, 44
 Plant lice, *see aphids*
 Potatoes, insect pests of, 11, 13-18, 21, 23, 25, 27, 35, 39
 Potato aphid 13, 15, 25, 34
 Potato beetle, Colorado, 13, 14, 23, 25
 Potato flea beetle 9, 13, 14, 23, 40, 42, 43
 Potato leafhopper 3, 13, 14, 15, 18, 34, 40
 Potato stalk borer 18, 23, 25
 Pumpkins 18, 26-31
 Pyrethrum 5, 45
- Radishes 3-12
 Rhubarb 21
- Screen 27
 Seed corn maggot 3, 12, 18, 19, 20, 34, 37
- Soap 4, 12, 28, 29, 32, 34, 35, 38, 39, 45
 Sodium fluosilicate 43
 Slugs, garden, 23, 25, 37, 40
 Spinach 21, 28, 39-40
 Spinach flea beetle 40
 Squash, insect pests of, 18, 26-31, 35
 Squash borer 26, 30
 Squash bug 26, 28
 Stalk borer 18, 21
 Sugar beets 15, 16, 23, 39
 Sweet corn, insect pests of, 10, 15, 16, 17, 18-23, 27, 28, 41
 Sweet potatoes, insect pests of, 35, 41, 42-43
 Sweet-potato beetles 42
 Sweet-potato flea beetle 43
 Swiss chard 21
- Talc 18, 20
 Tarnished plant bug 3, 18, 39, 40
 Tobacco worm 23
 Tomatoes, insect pests of, 10, 11, 14, 15, 17, 18, 19, 21, 23-25, 27, 28, 35, 39
 Tomato worm 23
 Turnips 3-12, 16, 39
- Water cress 42
 Webworm, garden, 40
 White grubs, 3, 12, 13, 15, 23, 31, 34, 40
 Wireworms 3, 12, 13, 16, 23, 31, 34, 37, 40