Saving Garden Crops From Insect Injury

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University of Illinois
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The material in this circular is a contribution from the Illinois State Natural History Survey.
Saving Garden Crops From Insect Injury

By L. H. Shropshire and C. C. Compton

Most vegetable crops are highly susceptible to injury by insects, so that good yields of high quality vegetables cannot be economically produced unless insect pests are controlled. During an average season, insect pests cost Illinois vegetable growers between four and five million dollars.

Crops vary in their susceptibility to insect injury; on some the injury is very slight and on others it may equal more than 50 or 60 percent of an entire crop. Altho the use of insecticides is essential for the control of insects, cultural practices are of great benefit in reducing insect injury.

Occasionally injurious insects are held in check by insect parasites or predators, so that it is necessary that the grower be familiar not only with the injurious insects but with those that are beneficial.

This circular presents both the spraying and dusting and 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 effectively.

When insect pests with which the grower is not familiar become troublesome, specimens of the insects causing the injury should be sent with a description of the type of injury to Chief Entomologist, Illinois State Natural History Survey, Urbana, for identification and control recommendations. Insect specimens should always be mailed in boxes or cotton-stopped bottles; if sent in an envelop, they may become so crushed that identification is impossible.

INSECT PESTS OF CABBAGE AND RELATED CROPS

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

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.

**Imported Cabbage Worm**

*Pieris rapae* L.

The imported cabbage worm is a sluggish, velvety green caterpillar having a faint orange stripe down the middle of the back and a similar broken one along each side.

**Injury.** These worms are chewing insects. They attack cabbage, cauliflower, and related crops, eating large irregular holes in the outer leaves or boring into loose heads (Fig. 1).

![Fig. 1.—CABBAGE BADLY INJURED BY CABBAGE WORMS](image)

**Control.** Injury from cabbage worms can be easily prevented by dusting or spraying infested crops with derris, pyrethrum, or arsenicals. Derris, a relatively new agricultural poison, has the advantage of being highly poisonous to certain insects and only slightly toxic to man. Derris dust containing .5 percent of rotenone and applied at the rate of 20 to 30 pounds an acre will give good control of cabbage worms. This dust is most effective when applied during the late afternoon. The first application should be made before the worms become abundant and repeated at intervals of 10 days or as often as necessary to prevent injury. Derris products (page 52) are safe to use on cabbage and related crops up to the time of cutting. Derris sprays, altho not commonly used, are effective against cabbage worms. Such sprays should be used according to the directions of the manufacturer.
Pyrethrum, another of the plant poisons, is very poisonous to certain insects and relatively harmless to man. It can be used as a dust or spray. A good grade of ground pyrethrum flowers mixed at the rate of 1 part to 2 or 3 parts of talc, gypsum, or other inert carrier makes a good dust for cabbage worms. It is used in the same manner as the derris dust. Pyrethrum sprays should be made up according to the directions of the manufacturer.

Arsenicals such as Paris green and calcium arsenate can be safely used on cabbage during the early stages of growth. They should not, however, be applied to cabbage within 3 or 4 weeks of cutting or to cauliflower after the heads begin to form. A dust consisting of 1 part Paris green or calcium arsenate to 4 parts hydrated lime and used at the rate of 15 to 20 pounds an acre gives good control of cabbage worms. This dust should be applied early in the morning when the plants are wet with dew.

Because of its tendency to settle out in the spray tank, Paris green is not generally recommended in a spray mixture. Calcium arsenate can be used on cabbage at the rate of 3 pounds in 50 gallons of water to which 1 pound of cheap flour has been added as a sticking agent. The spray should be applied at the rate of 100 to 125 gallons an acre and directed over the top and to both sides of the plants. If a power sprayer is available, a pressure of 200 pounds or more should be maintained.

Calcium arsenate kills more slowly and is not so satisfactory for use on cabbage as is Paris green.

**Life History and Habits.** The imported cabbage worm spends the winter as a pale green to greenish brown pupa or chrysalis. It may be found on old cabbage plants or in sheltered places about the field. In the spring a white butterfly with a wing expanse of about 1¾ inches emerges from the pupa. The females fly about over cabbage and related crops during the day; they light at frequent intervals to deposit their small yellow eggs on the leaves.

**Cabbage Looper**

*Autographa brassicae* Riley

This pale green, lightly striped caterpillar "inches" along as it moves, in the same manner as a "measuring worm."

**Injury.** The cabbage looper is a chewing insect attacking cabbage, cauliflower, and related crops. Its feeding is very similar to that of the imported cabbage worm. The larva eats holes in the leaves and often bores into the cabbage head during the latter part of the growing season.

**Control.** The same control methods recommended for the imported or common cabbage worm are effective against the cabbage looper (page 4). During some seasons these worms are attacked by a disease so severe that other control measures are unnecessary.

**Life History and Habits.** The cabbage looper hibernates in a cocoon on the leaves of cabbage or on the ground beneath the plants. In the spring a dark brown moth with a wing expanse of about 1¾ inches emerges from the overwintering pupa. This moth deposits its eggs on
the leaves of cabbage and other plants where they hatch in about 10 days.

The cabbage looper can be distinguished from other caterpillars commonly found on cabbage by its habit of crawling with a peculiar looping motion similar to that of the "measuring worm" or "inch worm."

**Diamond-Back Moth**  
*Plutella maculipennis* Curt.

Cabbage and related crops are frequently attacked by small, light green caterpillars, which are very active when disturbed, wriggling backward off the leaves and suspending themselves by silken threads. These are the larvae of the diamond-back moth.

**Injury.** The larvae of the diamond-back moth, which is a chewing insect, occasionally become abundant enough to be very destructive. The worms feed from the underside of the leaves, but do not cut thru the upper surface. The uneaten layer, however, dries out, leaving the leaf full of holes. This pest injures young plants more severely than older ones.

**Control.** Injury from the larvae can be prevented by using the control methods recommended for the imported cabbage worm (page 4).

**Life History and Habits.** The diamond-back moth overwinters as an adult under cabbage stalks or other cover in the field. The moth is about 1/2 inch long, with a wing spread of 3/8 inch. Each wing is gray with an irregular yellow stripe along the upper border which forms three diamond-shaped markings when the wings are closed. The female moth deposits very small, yellowish white eggs on the leaves.

**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 the imported cabbage worm are applied (page 4). The character of the injury of woolly bear caterpillars and the southern cabbage worm (*Pieris protodice* B. and L.), the chief offenders, is similar to that of the imported cabbage worm. Woolly bear caterpillars are very hairy, or woolly, and range up to 2 inches in length. The southern cabbage worm is about 1 inch long, purplish green, marked with four longitudinal yellowish stripes, and covered with small black dots.

**Cabbage Maggot**  
*Hyalemyia brassicae* Bouche

During cool wet seasons these small legless maggots are often abundant enough on the roots of cabbage and related crops to cause severe injury.

**Injury.** The cabbage maggot feeds by rasping out channels in the stems and larger roots of cabbage, cauliflower, radishes, turnips, and related crops. Young maggots attack the plants in the seed bed or soon
after they are transplanted. They feed at first on the roots and later burrow into the main stem. This feeding stunts the plants and, if the infestation is severe, kills them outright. Decay, which sets in, hastens the death of the plants. The wilting of plants during the heat of the day in May and June is a good indication of cabbage maggot attack.

**Control.** Injury to cabbage and related crops can be prevented by treatment with a solution of corrosive sublimate (bichlorid of mercury), using 1 ounce of the poison to 10 gallons of water. Corrosive sublimate should always be dissolved in a small quantity of hot water in a wooden glass, or earthenware receptacle, and diluted as directed above. This chemical in a concentrated solution will corrode all metals. The stem

![Fig. 2.—Treating Early Cabbage With Corrosive Sublimate Solution With the Aid of a Transplanter](image_url)

of each plant and the soil around it should be thoroly wet with the solution. One gallon will treat 70 to 80 plants, or more when the plants are small.

The first application should be made a day or two after the eggs become abundant, usually during April or May. A second application should be made a week later and if weather conditions are very favorable to the maggot, a third application may be necessary for best results.

A knapsack sprayer is convenient and practical for applying the solution. By using the sprayer with a lead of hose, without the nozzle, it is possible to stand erect and apply the solution fairly rapidly while walking along the row. 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. The operator is seated as for transplanting. 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.

Side-dressing the plants with nitrate of soda or ammonium sulfate promotes vigorous growth and aids materially in reducing injury in the case of a light maggot attack.

Life History and Habits. The cabbage maggot overwinters in a puparium at a depth of 1 to 5 inches in the soil. The brown pupal case in which it is enclosed resembles a grain of wheat in shape and is about ¼ inch long.

In Illinois the adult fly emerges in early spring. It is about ½ inch long and ash-gray with several conspicuous black stripes running lengthwise on the back of the thorax and one on the back of the abdomen. When not in flight, the wings are folded back over the body so that the outer edges are just about parallel.

The female lays its small, oval, white eggs at the base of the plant or in cracks and crevices in the soil nearby.

Cabbage Aphids
*Rhopalosiphum pseudobrassicae* (Davis) and *Brevicoryne brassicae* (L.)

The cabbage aphids are rather small, soft-bodied insects varying in color from green to gray or powdery blue. They are most commonly found in close clusters on the leaves (Fig. 3).

Injury. Cabbage aphids are sucking insects, feeding entirely on the plant sap which they extract by means of their needle-like beaks. They attack cabbage, cauliflower, radishes, turnips, and other related crops. Plants upon which aphids are feeding become distorted in appearance and stunted in growth. On young cabbage, one or two aphids feeding on the tender leaves near the heart of the plant will permanently retard growth. The feeding of these insects curls the leaves and renders the mature head unattractive and sometimes unmarketable.

Control. Young plants as they are taken from the hot beds or cold frames should be carefully examined for the presence of cabbage aphids. If infested with plant lice, the plants should be dipped in a solution of
1½ teaspoons of nicotine sulfate and one cubic inch of laundry soap, or 4 teaspoons of Penetrol, in 1 gallon of water. Care should be taken to see that every plant is thoroly wet with the solution before it is planted. In the field infested plants should be thoroly sprayed with nicotine sulfate at the rate of 2½ pint to 50 gallons of water, to which has been added 3 pounds of laundry or potash fish-oil soap or 1 quart of Penetrol. These and other insects belonging to the sucking class must be hit with the spray if it is to be effective; the spray must therefore cover both upper and lower surfaces of the leaf. Control methods should be begun before the aphids have become abundant enough to curl the leaves.

If spraying is not practical, plants may be dusted with a 2.4 percent actual nicotine dust (page 51). This dust may be applied with a hand or power duster. The puff type of hand duster is best adapted to this work. Old cabbage stalks and other crop remnants should be destroyed to kill overwintering eggs.

Cabbage aphids have a large number of natural enemies, among which are the lady bird beetles, the larvae of Syrphid and lace-winged flies, and a tiny parasitic wasp which feeds within the body of the aphid. Occasionally these natural enemies become abundant enough to control an infestation of aphids.

**Life History and Habits.** Cabbage aphids overwinter as eggs deposited on old cabbage stalks or other host plants. In the spring the young aphids hatch and begin feeding. Within 2 or 3 weeks they reach maturity, after which they give birth, without mating, to living young which develop as winged or wingless females. During the early summer, winged specimens fly to the cultivated crops, where they feed and reproduce. As many as 16 generations may be produced in a season.
Cabbage Flea Beetles
*Psylliodes punctulata* Melsh. and
*Phyllotreta vittata* Fab.

Flea beetles are common pests on cabbage. They are very active, tiny, black or black and yellow striped beetles that jump from the plants when disturbed.

**Injury.** Flea beetles are chewing insects. The adults eat numerous small holes in the leaves of cabbage, cauliflower, radishes, and related crops. These black or striped beetles (Fig. 4) injure the young plants, often feeding on them before the true leaves appear. The seedlings are subject to severe injury during the time they are in the hot beds or cold frames. Feeding may continue throughout the growing season, stunting the plants or killing them. The larvae of flea beetles often attack the roots and underground stems of plants upon which the beetles feed. However, as a rule they are not of so much concern to the grower as are the beetles themselves.

**Control.** Dusting the plants with a bordeaux-lead dust (page 53), if carefully done, will prevent injury from flea beetles. Barium or calcium fluosilicate, when used as recommended by the manufacturers of these materials, is very effective against flea beetles on young seedlings.

Screening hotbeds or cold frames with cheesecloth as for the cabbage maggot (page 8) will afford complete protection against injury from these pests.

**Life History and Habits.** Cabbage flea beetles commonly spend the winter under crop remnants and other debris which may be standing in or near the cabbage field. They emerge in the spring to deposit their eggs in the soil near the cabbage plant. The young grubs or larvae feed on the roots and stems of cabbage and related crops. Several generations are produced each year.

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1The hairlines on Figs. 4, 7, 10, and 26 represent the actual length of the insects.
SAVING GARDEN CROPS FROM INSECT INJURY

Cutworms
Several species of Noctuidae

This group consists of a large number of species of sleek, sparsely haired, dull-colored caterpillars which are troublesome at one point or another in Illinois every year (Fig. 5).

Injury. These pests are chewing insects, attacking practically all the garden crops. They cut off the stems of growing plants at or near the soil surface, consume the foliage and fruit, and feed on the roots, frequently destroying more of a plant than they actually consume. The injury caused by these worms is usually most noticeable during the early growing season when they cut off young plants in the hotbed or in the garden and field. The armyworm is a common leaf feeder.

Control. Cutworms or armyworms that feed at or above the soil surface can be effectively controlled with poison bran bait (page 50). It should be evenly distributed over the soil at the rate of 8 to 10 pounds an acre after sunset. Bait applied earlier in the day dries out and becomes less attractive to the cutworms. Land that is known to be infested should be baited for several consecutive nights before a crop is planted and afterwards if necessary.

The black cutworm and others that feed underground cannot be controlled by the use of poison bran bait. Land on which truck or garden crops are grown should be kept free of weeds and grass, especially during the fall months, in order to prevent egg laying by cutworm moths.
Crops planted on sod land are subject to severe injury from cutworms unless the sod is broken during the late summer or early fall and kept clean during the rest of the growing season.

In a small garden, cutworms can be dug out by hand, or small plants can be protected by tin or cardboard cylinders pressed into the soil around the plants.

**Life History and Habits.** Most cutworms spend the winter as partly grown or mature caterpillars in the soil, in clumps of grass, or under trash and rubbish left in the field. Feeding begins in the spring and continues until the worms are mature, at which time they enter the soil, change to brown, shuttle-shaped, pupae, and later to adult moths.

The dull-colored moths are seldom seen during the day. They fly at night and are often attracted to lights. The fore wings of most species are dark brown, streaked or mottled with yellow, gray, brown, or black. The hind wings are darker and not so distinctly marked.

The eggs are usually laid on garden plants, grasses, or weeds. The young cutworms for a few days after they hatch from the eggs are usually darker and more hairy than mature ones. During the summer they feed for about one month before becoming full grown. One or more generations is produced each year.

**Harlequin Bug**

*Murgantia histrionica* Hahn

The nymphs and adults of the harlequin bug are very conspicuous because of their bright markings of yellow, orange, and red mingled with black. These insects are flat, shield shaped, and have a very offensive odor characteristic of the stink bugs.

**Injury.** The harlequin bug is a sucking insect. Both the nymphs and adults accomplish their work of destruction by sucking the sap from the leaves and veins of cabbage, cauliflower, horse radish, and other garden crops. Badly infested plants wilt, wither, and die as if swept by fire.

In northern Illinois this insect is not a pest, but from St. Louis south severe damage is inflicted by it.

**Control.** The harlequin bug is difficult to control because even tho a sucking insect it is resistant to contact insecticides. A clean-up program is well worth following if 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 their bright colors and easy detection, hand-picking of the bugs 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 or 1 pint of Penetrol, will kill many of the youngest nymphs but will have little effect on the older nymphs or adults. There is some danger of burning the young plants with a solution of this strength.
In carrying out the foregoing recommendations the cooperation of neighbors is necessary for the best results, regardless of the method of control employed.

**Life History and Habits.** The harlequin bug passes the winter in the adult stage hidden under trash and rubbish. It is a little less than ½ inch long and vividly colored. The eggs are about 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 bung holes. The nymphs when first hatched are pale green with black markings. After the first molt they become brightly colored with black, orange, yellow, and red. Several generations occur annually.

**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 may deform the plants. 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 36) sometimes cause serious injury to cabbage, particularly if the cabbage field borders on a field of onion sets or early onions. When the onions are harvested, the thrips move over to the cabbage and loss of several acres of cabbage frequently results. Such loss can be avoided by separating the crops and if necessary spraying or dusting the cabbage as for cabbage aphids (page 9) at the time the thrips are migrating.

Other pests of cabbage and related crops include white grubs (page 17), wireworms (page 18), and the seed corn maggot (page 21).

**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 preventive or control measures are applied. Effective and economical control measures have been investigated and established so thoroughly, however, that a good crop of potatoes can be grown even in years of heaviest infestation.

**Potato Leafhopper**

*Empoasca fabae* Harr.

Most potato growers are familiar with the tiny yellowish green insects that swarm out from the plants when disturbed. These are leafhoppers, the most destructive pest of potatoes in Illinois.
Injury. Potato leafhoppers attack potatoes, beans, eggplant, tomatoes, alfalfa, and a large number of other cultivated and wild hosts. They feed on the underside of the leaves from which they extract the sap by means of sucking mouthparts. Affected leaves curl upward and turn brown, the injury appearing first on the tips and margins (Fig. 6). The plants become badly stunted and fail to produce good crops.

Control. Potato leafhoppers can be most successfully controlled by spraying with 5-6-50 bordeaux mixture (see directions for mixing, page 52). Besides its repellant action, enough of the copper from the spray is absorbed by potato leaves to poison leafhoppers that feed on the sap. The first spray should be applied as soon as the potatoes are 6 inches high or when the leafhoppers are first observed. The best results will be obtained from the use of five or more applications at intervals of 7 days. The spray should be applied at a pressure of 200 pounds or more, one nozzle directing the spray to the top of the plants and one on each side directing the spray slightly upward. At least 100 to 125 gallons an acre should be used. When flea beetles or Colorado potato beetles are present, 2 pounds arsenate of lead or calcium arsenate should be added to every 50 gallons of spray.

Where it is impossible to spray potatoes, they may be dusted with 16-84 bordeaux dust (page 53), or if flea beetles and the Colorado potato beetle are present, with 16-64-20 dust (page 53). These dusts when properly used will control potato leafhoppers but are not so effective as the bordeaux spray.

Life History and Habits. There is some question as to where the potato leafhopper overwinters. Early in the spring the small, pale green adults measuring about 1/8 inch in length appear in large numbers on
potato, alfalfa, and other crops. They feed for a time on these plants, where they lay their small, slightly curved eggs in slits made in the leaf veins, petioles, or stems. After 1 to 2 weeks tiny nymphs appear which are scarcely visible to the naked eye. They are very similar in shape to the adults but have no wings. They complete their growth and become adults in from 1 to 4 weeks. As many as three or four generations may occur in Illinois annually.

**Potato Flea Beetle**  
*Epitrix cucumeris* Harr.

The potato flea beetle is a very small, extremely active, black beetle that eats numerous small holes in the leaves of the potato and other plants upon which it feeds (Fig. 7). It jumps readily when disturbed.  

**Injury.** Potato flea beetles are chewing insects. They attack tomatoes, eggplant, turnips, horse nettle, ground cherry, and a number of other plants besides the potato. The leaves of plants that have been severely injured by the adult beetles look as if they had been peppered full of holes with fine shot. The larvae or young feed on the roots, tubers, and underground stems of potatoes; injury from the young, however, is seldom serious in Illinois.

**Control.** These insects can be controlled by spraying with 5-6-50 bordeaux to which has been added 2 pounds of arsenate of lead or calcium arsenate or by spraying with 3 pounds natural cryolite. Dusting the plants with 16-64-20 bordeaux dust (page 53) will give fair control of these insects. Dusting the plants with barium or calcium fluosilicate as recommended by the manufacturers will also give good control of flea beetles on potatoes.

**Life History and Habits.** The potato flea beetle hibernates as an adult under crop residues and other trash in and around the field. In the spring it feeds on potato foliage or other available food plants. The adults are from 1/16 to 1/12 inch long and jet black with brownish yellow antennae and legs. Egg laying begins during the early part of the summer. One complete and a partial second brood of flea beetles occur in Illinois annually.

**Colorado Potato Beetle**  
*Leptinotarsa decimlineata* (Say)

This is probably the best known of the potato insects, altho not nearly so injurious and difficult to control as the potato leafhopper or flea beetle.

**Injury.** The Colorado potato beetle is a typical chewing insect. Both young and adults feed on the foliage of potatoes, eggplant, tomatoes, ground cherry, and a large number of other hosts.
Control. This insect can be easily controlled by spraying with a 5-6-50 bordeaux (page 52) to which has been added 2 pounds arsenate of lead or calcium arsenate to each 50 gallons of spray. Where potatoes are regularly sprayed for leafhopper control, the poison is added as needed to keep the potato beetle in control.

The 16-64-20 bordeaux dust (page 53) will give a good kill of this insect when applied at the rate of 20 to 30 pounds an acre.

Life History and Habits. The Colorado potato beetle overwinters as an adult buried in the soil at a depth of several inches. In the spring the adults emerge and begin feeding. They are about 3/8 inch long, yellow, with ten black longitudinal stripes on the wing covers. After feeding for a time the females deposit their orange-colored, cylindrical eggs in masses of five or more on the leaves. One to two generations occur annually in Illinois.

Potato Aphid

Macrosiphum gei Koch

Potato aphids are small, soft-bodied insects varying from flesh pink to green. They resemble the cabbage aphid except in color.

Injury. Potato aphids are sucking insects, feeding on the sap of plants, which they extract by means of their tiny beaks. They feed on a large number of plants, including potatoes, tomatoes, eggplant, and related crops and weeds. When present in small numbers, these insects are not very noticeable and do little damage; during some seasons, however, they become abundant enough to cause considerable injury. On potatoes that are heavily infested, the leaves curl downward or directly opposite to the curling caused by the potato leafhopper. Infested plants become deformed and stunted and may die. Even tho the potato plants are not killed, yields are greatly reduced by aphid injury. On tomatoes this aphid sometimes causes serious injury by feeding on the buds and stems of blossom clusters and causing them to fail to set fruit.

Control. A careful watch should be kept for the first appearance of potato aphids. Before they become numerous enough to cause the leaves to curl, steps should be taken to control them. They can be controlled with a bordeaux spray to which has been added 1/2 pint of 40-percent nicotine sulfate to each 50 gallons of spray. If bordeaux is not used, this amount of nicotine sulfate in 50 gallons of water to which has been added 2 or 3 pounds of laundry soap or 1 quart of Penetrol will give effective control. Spray applications for the control of potato aphids should be repeated after 2 or 3 days in order to kill any aphids that remain on the plants.

Life History and Habits. The potato aphid overwinters in the egg stage on rose plants. In the early spring they hatch into young aphids similar in form to the adults. After a week or more of feeding they become mature females capable of giving birth to living young without mating. These adults may be winged or wingless, pink to green in color, and 1/8 to 1/6 inch long. The winged forms fly from the winter host to other crops, where they in turn feed and reproduce.
White Grubs

Several species of *Phyllophaga*

The large, fleshy, white grubs with curved bodies and brown heads are known to most gardeners because of their habit of chewing out cavities in the potato tubers or eating the roots of other plants (Fig. 8). These are the larvae of the large brown beetles called June bugs or May beetles.

**Injury.** White grubs feed entirely underground, cutting off the roots and underground stems and chewing into the tubers of potatoes or roots of other crops. When potatoes, corn, or strawberries are unthrifty and fail to make the proper growth during a normal season, some of the plants should be pulled up and the soil around the roots examined for the presence of white grubs. Trouble with these insects is most common where the above crops follow sod or a small grain crop or are planted on ground that was in sod or small grain in 1935, 1938, 1941, etc.

**Control.** There is no insecticide which is efficient or practical for use against white grubs in the garden. Much of the injury can be avoided, however, by the following practices:

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 such as corn and potatoes.

   Clean cultivated land that is not in sod or a small grain crop in the years 1935, 1938, etc., is not likely to contain grubs in damaging numbers. Grub injury is most likely to occur in the years 1936, 1939, and every three years thereafter, particularly in fields growing a grass crop in the years 1935, 1938, etc., of beetle injury. Watch for grubs in these years.

**Life History and Habits.** The species of white grub which is commonly most troublesome in gardens has a three-year life cycle. It spends the first two winters in the soil in the grub stage and the third as an adult in the soil. The brood which causes the most trouble in this state will emerge as adults in the spring of 1935, 1938, etc. The adults feed on the foliage of oak, hickory, elm, and other common forest trees. Feeding begins at nightfall and continues until dawn, at which time the beetles leave the trees and return to meadows and fields or grain, where they spend the day in hiding and depositing their eggs. The eggs are
oval, white, and about 1/12 inch in diameter. After 10 days or more, the young grubs hatch and feed for the remainder of the season on decaying organic matter and young grass roots. As cold weather approaches, the young grubs burrow into the soil and hibernate at depths of 12 inches to several feet. The following spring they return to near the surface, where they feed on the roots of plants throughout the entire growing season. In the fall they again burrow into the soil and hibernate for the second year. The following spring they return to the roots of their food plants, where they feed for several weeks, after which they transform to whitish pupae. During the latter part of the summer they transform into beetles which remain within the cell underground until the following spring, when they emerge to feed and lay eggs. The life histories of white grubs vary, some requiring one year, others as many as four, to complete their development. The more important species, however, go thru the stages mentioned above.

Wireworms

Several species of *Elateridae*

Hard-shelled, brownish worms up to 1 1/2 inch in length are often found with the head and forepart of their bodies buried in potato seed and larger roots of other vegetables (Fig. 9).

**Injury.** Wireworms feed entirely underground, attacking germinating seeds or the roots, stems, or tubers of growing plants. Potatoes, sugar beets, beets, cabbage, lettuce, turnips, onions, carrots, beans, corn, and other crops are subject to attack. Injury is greatest on land that has been in sod for several years.

**Control.** Special control measures for wireworms are usually not necessary in the commercial truck-growing areas in Illinois. 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 or newly formed adults can be killed. Wireworm injury is ordinarily associated with poor soil drainage. Since good drainage is essential to the successful growing of vegetables, growers should check up on the drainage in fields where wireworms are a continual
nuisance. A short rotation of crops is also beneficial. Soil fumigation is practiced in some sections, but usually is not necessary in Illinois.

**Life History and Habits.** Wireworms pass the winter either in the larval or adult stages in the soil. The adults are brown to gray or black and vary from ½ to ¾ inch in length. They are able to snap themselves into the air when disturbed. In the spring the adults emerge, feed for a while, and begin depositing their eggs around the roots of grass or other vegetation. From two to six years are required for the larvae to complete their development, during which time they feed on roots of plants and upon germinating seed.

**Blister Beetles**

Several species of *Meloidae*

Rather large, gray, black or striped beetles with prominent heads, long “necks,” and cylindrical bodies sometimes appear in swarms on garden crops (Fig. 10). They are typical of a group of insects which are beneficial in one stage of life and very destructive in the adult stage.

**Injury.** Blister beetles are usually found in large numbers moving slowly across a field, devouring plants as they go. They destroy both foliage and blossoms and can ruin a crop in a few days unless controlled. They are particularly destructive when abundant on potatoes, tomatoes, beans, peas, melons, corn, and beets. Legumes used for cover crops, such as alfalfa, clover, and vetch, are also subject to attack.

**Control.** Dusting infested plants with calcium or barium fluosilicate, undiluted or diluted with equal parts of talc, will give best results against blister beetles. Bordeaux mixture is repellant to the beetles and usually prevents injury to potatoes and other truck crops. These insects are not easily poisoned with arsenicals. 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 the use of sticks and brushes, if the growers work with the wind. Once driven from the field, the beetles are not likely to return.

**Life History and Habits.** The life history of most species of blister beetles is imperfectly known. The adult blister beetles may be gray, black, or yellow striped with black. They are long-legged, slender beetles from ½ to 1 inch long, with a fairly soft body which may cause blisters when crushed on the skin.

The striped blister beetles spend the winter as full-grown larvae. In the spring they transform to adult beetles. So far as known, the larva develops within the egg pod of the grasshopper.
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 14).

For description and control of the seed corn maggot, common stalk borer, and potato stalk borer, see pages 21, 23, and 28, 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**

*Heliothis obsoleta* Fab.

The green to brown, lightly striped worms found in the ears of sweet and field corn are the well-known corn ear worms. They are one of the most destructive pests of sweet corn.

**Injury.** This caterpillar attacks not only sweet corn, but tomatoes, eggplant, peppers, pumpkins, squash, cucumbers, potatoes, and other crops. On sweet corn, the larvae usually feed on the silks and kernels at the tip 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 plantings of corn. The fruit of eggplant and tomatoes is often eaten into, decay sets in, and the fruit is worthless.

**Control.** The corn ear worm is difficult to control because it spends the greater part of its life feeding in protected places. Dusting the corn silk with barium or calcium fluosilicate will kill some of the caterpillars before they enter the husk. These dusts should be applied as soon as the silk appears and should be repeated at intervals of three days until the silks have completely dried. The silks should be kept completely covered with the dust. Under the most favorable conditions, such treatment will probably not give better than 50 percent control of ear worms on sweet corn.

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 plantings of corn or early maturing varieties are less likely to be injured. In southern as well as central Illinois, medium-planted corn is injured less than late-planted. When the corn ear worm attacks tomatoes or eggplant, these plants should be thoroly dusted with a .5-percent rotenone dust (see derris, page 52), using talc as a carrier. This was found effective against the newly hatched worms during 1934, but of little value after the worms were
half-grown. Arsenicals or fluosilicates should not be used on tomatoes and
eggplant because of the danger from poisonous residues.

**Life History and Habits.** The corn ear worm, so far as known, does
not survive the winter in Illinois, but the moth migrates from the South
each year. The moths have a wing expanse of about 1¾ inches. The
female moth deposits its small, white, nearly round eggs on the fresh silk
or tassels of developing corn or on early tomatoes, eggplant, and other
vegetables.

The young larvae feed on the tips of corn ears or on the fruit of toma­
toes or eggplant, where they mature.

**Seed Corn Maggot**

*Hylemyia cilicrura* Rond.

When corn fails to germinate, an examination of the kernels in the
soil may show the presence of small, white, legless maggots which taper
toward the head (Fig. 11). They are known as seed corn maggots. If the
larvae have six legs and do not taper noticeably toward the head, they
may be an immature stage of the pale-striped flea beetle (page 22).

![Seed Corn Maggot](image)

**Fig. 11.—Seed Corn Maggot: Adult (a); Puparium (b); Larva (c)
(Much enlarged)**

**Injury.** Seed corn maggots eat out the germ and soft interior parts
of germinating corn and seeds of other vegetables, such as onions, beets,
beans, cabbage, and peas. Seeds that are attacked, if not killed outright,
produce deformed or weak plants. Injury is most likely to occur during
cold, wet, backward seasons, and on soil containing an abundance of
organic matter.

**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 hills, the corn may be replanted at once with a fair degree
of safety, for the second planting is not usually injured. Plantings should
be made only when the seed bed is well enough prepared to insure quick germination.

Life History and Habits. These insects probably spend the winter as maggots inside dark brown puparia in the soil. The flies emerging from these in the spring are very similar in appearance to those of the cabbage maggot described on page 8.

**Pale-Striped Flea Beetle**

*Systena taeniata blanda* Melsh.

The slender six-legged larvae of the pale-striped flea beetle are white worms about \( \frac{1}{4} \) inch long with light brown heads. Larvae of the pale-striped flea beetle are particularly injurious to germinating seed corn in the field.

**Injury.** Like all flea beetles, this is a chewing insect. 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 Harris\(^1\) 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.

**Control.** The damage from this insect can be largely prevented by keeping down the growth of weeds in a field one year prior to planting with corn or other substitute crops. Early plowing and the late planting of corn may also be of value. When sprouting corn is first found to be attacked, immediate replanting will give relief; that is, the replanted corn will not be attacked to any extent, for by this time the larvae have about finished feeding and are ready to pupate. The beetles may be controlled by dusting the plants with barium fluosilicate or calcium fluosilicate undiluted or diluted with equal parts of talc or cheap flour.

**Life History and Habits.** The life history of this insect is not perfectly known, but it is thought that it spends the winter in the ground as a partly grown larva or as an adult. The adult is another of the jumping beetles, larger and more vividly marked than those found on potatoes and eggplant, about \( \frac{1}{4} \) inch long, and pale yellowish brown with two paler

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\(^1\)Drake, C. H., and Harris, H. M., Jour. Econ. Ent. 24, No. 6, 1132. 1931.
stripes running down the back (Fig. 12). There is probably only one generation each year.

**Grasshoppers**

Several species

Grasshoppers are too well known to gardeners to need description here. There are many species, any of which may be troublesome if abundant.

**Injury.** Grasshoppers are chewing insects. They feed on nearly all vegetables, taking their food by biting chunks out of the leaves. Both nymphs and adults are heavy feeders. From time to time they become serious pests on truck and garden crops, the time of attack varying from early spring until late fall.

**Control.** The poison bran bait recommended for use against cutworms is effective for controlling grasshoppers. Contrary to the method of distributing bait for cutworms, that used for grasshopper control should be evenly distributed in the early morning at the rate of 10 to 15 pounds an acre.

**Life History and Habits.** Many of the common species of grasshoppers overwinter in the egg stage. The eggs, deposited in clusters in small pockets in the soil, are most commonly found in sod land. The young grasshoppers which hatch in the late spring resemble the adults except in size and in the absence of fully developed wings. They usually reach maturity during the late summer or fall months.

**Stalk Borer**

*Papaipemia nebris* Guen.

The larvae of the common stalk borer are very active, slender, brown worms commonly found within the stems of weeds and cultivated plants. The back and sides of these worms are striped with white.

**Injury.** The stalk borers are chewing insects. They burrow in the stems of corn, potatoes, tomatoes, eggplant, cabbage, and other crops (Fig. 13). 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.

**Control.** Little trouble from the common stalk borer is to be expected if weeds are kept down in the vicinity of the garden or on the farm. Winter burning of the garden or field margins will aid in the control of this pest by destroying the eggs which have been laid on grasses and weeds.

**Life History and Habits.** The eggs are laid on various weeds and grasses and it is in this stage that the insect passes the winter. The eggs are round, about 1/50 inch in diameter, light brown, and heavily ridged. They hatch during the early spring into small brown larvae that are distinctly marked with five light longitudinal stripes. Most conspicuous are two broad stripes, broken in the middle, that extend along the sides. As the larvae mature, the stripes fade out and the body varies in color from light to purplish brown and is about 1 ¼ inches in length. Pupation takes place within the stalk of the host plant. The pupae remain within the
host plant until the adult emerges during the early fall months. The adult or moth has mouse-colored fore wings marked with white. The hind wings are paler with prominent vein markings. The wing expanse is about 1½ inches.

![Common Stalk Borer: Moth or Adult (a); Caterpillar or Borer (b and c); Pupa (e)](image)

**European Corn Borer**

*Pyrausta nubilalis* Hbn.

Small, slender, spotted caterpillars found burrowing in the stalks or ears of corn may be the European corn borer. The European corn borer was first discovered in the United States in 1917; it has since become well established in the states bordering on the east and north of Illinois. Altho this insect is not known to exist in Illinois, it has been found within 15 or 20 miles of the Illinois border to the north and east.

**Injury.** The injury inflicted by the corn borer is done entirely by larvae or worms (Fig. 14). 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. The stalks break over in heavily infested fields and the corn may be a complete loss. Ears that apparently are marketable may contain borers. A large number of cultivated crops and weeds are known to be attacked. So far as the truck gardener is concerned, corn is the principal crop injured. Other vegetable crops sometimes attacked are beans, tomatoes, celery, beets, peppers, rhubarb, Swiss chard, okra, parsnips, and spinach.

**Control.** In commercial truck-growing areas disposal of crop refuse will aid greatly in keeping the corn borer under control. The present
methods, however, will need to be improved. 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 thoroughly plowed under before May 15 of each year. This can be quite easily done with the small-stalked sweet corn. Putting the corn 

FIG. 14.—LARVA OF EUROPEAN CORN BORER (Enlarged)

in the silo is also an effective way of killing the borer, provided 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. The truck gardener, of course, seeks to produce early maturing corn, and this is just the corn the borer prefers. 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.)

**Life History and Habits.** The corn borer passes the winter as a full-grown worm or caterpillar in the stems of plants upon which it has fed. The full-grown larvae are about 1 inch long and ½ inch across. They are light gray to pink in color and are distinctly marked with two small dark spots on the back of each 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. In the spring these caterpillars transform to slender brown pupae. From these, pale yellow-tan or brown moths, with a wing expanse of about 1 inch, emerge. These moths are strong fliers, moving about chiefly at night. They lay their eggs in clusters on the underside of the leaves of corn and other food plants. A female may lay an average of 500 or more eggs during her life time. Only one brood of corn borers is produced annually in the corn-belt area. In some sections of the country, however, two broods are produced.

**Other Pests of Sweet Corn**

For description and control of other insects injurious to corn, see the armyworm (page 11), white grubs (page 17), wireworms (page 18), and the spotted cucumber beetle (page 30).
INSECT PESTS OF TOMATOES AND EGGPLANT

Tomatoes rank next to corn in point of acreage and value 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 cutworms. The major pests of eggplant are flea beetles, the potato stalk borer, and the Colorado potato beetle.

For a more complete discussion of the insects attacking tomatoes, see Illinois Circular 428, "Tomato Diseases and Insect Pests."

Eggplant Flea Beetle
*Epitrix fuscula* Crotch

The eggplant flea beetle is very similar in habits, size, and appearance to the potato flea beetle described on page 15.

**Injury.** The injury inflicted by the eggplant flea beetle is characteristic of all flea beetles. They perforate the leaves of tomatoes, eggplant, potatoes, sugar beets, strawberries, and other garden crops with small round holes that greatly weaken, if they do not kill, the plant (Fig. 15). Seedling plants suffer most severely from the feeding of these pests.

**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 thoroughly mixed. Practically as good results can be obtained by spraying as for the control of potato flea beetles (page 15). When spraying tomatoes with bordeaux mixture, use 4-4-50 bordeaux (page 52). Barium fluosilicate and calcium fluosilicate are also effective in controlling flea beetles. Poisons should not be applied to the plants after the fruits are half-grown unless the fruits are to be washed to remove the residue.

Hornworms

*Protoparce quinquemaculata* Haw. and *P. sexta* Johan.

The tomato and tobacco hornworms are the largest insects attacking truck crops in Illinois. The full-grown worms, which are 3 to 4 inches long, are green to brown in color, with a series of diagonal white bars or V-shaped markings along each side, and a prominent "horn" near the rear end of the body.

**Injury.** Hornworms are ravenous feeders, stripping large quantities of foliage from the plants upon which they feed.

**Control.** Hand-picking is an effective method of ridding a small garden of hornworms. This method, of course, is not practical where tomatoes are grown on a large scale. During most seasons tomato hornworms are held in check by tiny wasp parasites that feed within the body of the hornworms and stop injury before the worms are mature. The adults of these tiny parasites insert their eggs under the skin of the young hornworms. These hatch and feed within the body of the hornworm. When they become fully mature, the tiny parasite grubs eat their way
out of the body of the worm and spin small, white cocoons on its back and sides. Worms bearing these cocoons should not be destroyed, for they do no further damage and the immature parasites on their backs, if undisturbed, emerge later to infest other hornworms.

Arsenicals cannot be safely used on tomatoes because of the danger of poisonous residues being left on the fruit. Experiments conducted during 1934 indicate that a derris dust containing .5 percent rotenone (see derris, page 52) may be of some value in controlling the very young stages of the hornworm. However, further work will be necessary before definite recommendation can be made.

Life History and Habits. The hornworms spend the winter as large, dark brown pupae in the soil. During the early summer large, gray-to-brown hawk moths, mottled with white-and-black markings, emerge from the soil to lay eggs.

Garden Slugs

*Agriolimax* sp.

The presence of garden slugs can usually be detected by the glistening trails of slime that they leave in their paths. Slugs resemble snails in appearance except for the absence of a shell on their backs.

Injury. Garden slugs feed on most of the common garden crops, rasping out holes in the foliage and fruits. They may also feed on the roots and stems of many crops. The feeding of slugs is most noticeable during wet seasons or in wet or poorly drained parts of a field. Disease and decay often follow injury by slugs.

Control. Injury from slugs can be prevented or stopped by thoroly dusting plants with hydrated lime or bordeaux dust containing arsenate of lead (page 53). Bordeaux spray also acts as a repellant against these creatures. Where the slugs are abundant, it is often advisable to distribute poison bran bait as recommended for cutworms (page 11).

Life History and Habits. The eggs of slugs are deposited thruout the growing season in loose clusters in moist soil or other favorable loca-
tions. The length of time required for hatching depends somewhat on the weather. After hatching, the young slugs begin feeding, reaching maturity in six weeks to a year.

**Potato Stalk Borer**  
*Trichobaris trinotata* (Say)

During the growing season the stems of eggplant, tomatoes, and related plants are sometimes infested with yellowish white, legless grubs about \( \frac{3}{8} \) to \( \frac{1}{4} \) inch long. These are larvae of the potato stalk borer.

**Injury.** The presence of the potato stalk borer is indicated by plants wilting during the heat of the day and becoming yellowed and stunted in growth. Sometimes injured plants show no external signs of injury but fail to produce fruit. This injury is due to the feeding of the grubs within the stem of the plants.

**Control.** Because of its method of feeding the potato stalk borer cannot be successfully controlled by the use of insecticides. Injury can be reduced, however, by carefully collecting and burning the old stalks of eggplant, tomatoes, potatoes, horsenettle, buffalo burr, jimson weed, and related plants in which the borer develops. This should be done during the winter or early spring. Preventing the growth of weeds on which the borers lay their eggs is of value in holding this pest in check.

**Life History and Habits.** The potato stalk borer overwinters as an adult within the stems of infested plants. It emerges in the spring, feeds for a time, and deposits its eggs singly in the stalk or branches of the plant.

**Tomato Fruit Worms**  
*Heliothis obsoleta* Fab. and several species of cutworms

The green to brown, lightly striped worm found with its head embedded in the fruit of the tomato is the corn ear worm (page 20), sometimes called the tomato fruit worm.

**Injury.** Unlike hornworms, the fruit worms feed mainly on tomato fruit. The corn ear worms attack fruit of all sizes and usually do considerable damage when abundant. This worm does not confine its feeding to a single fruit but moves from one to another, destroying much more than it consumes. Damage to the tomato crop is greatest when corn ear worm moths are abundant and the supply of food plants is more or less limited. In northern Illinois the greatest injury occurs during the latter part of the growing season.

**Control.** Tomato fruit worms are not abundant enough every year to necessitate regular dusting or spraying.

Experiments during 1934 indicate that heavy applications of derris dust containing .5 percent of rotenone will control fruit worms on tomato plants if applied before the infestation becomes heavy. This dust acts chiefly as a contact poison against the newly hatched worms and is not very effective against worms that are half-grown or larger. The first application should be made as soon as the worms appear to be causing injury and should be repeated at intervals of 7 to 10 days, as necessary to hold the worms
in check. The dust should be applied late in the afternoon or early in the morning.

Derris is a relatively new poison that is safe to use on tomato fruit at any time. It is not very dangerous to man and can be removed easily by washing. Further work with rotenone must be done before final recommendations regarding its use can be made.

Other Pests of Tomatoes and Eggplant

The Colorado potato beetle (page 15) is a troublesome pest on eggplant. Cutworms (page 11) and the potato aphid (page 16) are injurious to both tomatoes and eggplant.

INSECT PESTS OF VINE CROPS

The vine crops are very susceptible to insect attack and injury throughout the entire growing season. The most important insects feeding on vine crops in Illinois are the striped and spotted cucumber beetles, melon aphids, squash bugs, and squash vine borers. Because of these and other pests that occasionally become destructive, the truck gardener probably has more trouble in producing profitable crops of cucumbers, melons, squash, and pumpkins than of any other group of crops.

Striped Cucumber Beetle

Diabrotica vittata Fab.

The well-known striped cucumber beetle or “pickle bug” is the most destructive pest of vine crops in Illinois (Fig. 16).

FIG. 16.—FULL-GROWN LARVA AND PUPA OF STRIPED CUCUMBER BEETLE

(Much enlarged)

Injury. The striped cucumber beetle is a chewing insect. It attacks cucumbers, melons, squash, pumpkins, and other cultivated and wild plants. As a rule, injury is greatest during the early part of the season when the seedlings are just pushing thru the soil and before they have developed
true leaves. This first injury results from the feeding of the beetles on the stems and cotyledons, or seed leaves. Later they feed on the true leaves and may girdle the stem. After they have fed for a while, the beetles lay their eggs around the base of the plants. The larvae or grubs that hatch from these feed underground on the stem and root system. Later in the season, when the second-brood beetles emerge, the adults may cause serious injury to the leaves, blossoms, and fruits of vine crops.

Bacterial wilt and mosaic, two important diseases, are spread by the cucumber beetles.

Control. Tho striped cucumber beetles are difficult to poison, they can be prevented from feeding by keeping seedling plants heavily covered with a mixture of 1 part calcium arsenate and 15 parts burned gypsum. This dust should be applied as soon as the plants begin to break thru the soil and applications repeated as often as necessary to keep the plants heavily covered with the dust until the danger from beetle injury has ceased. A cheesecloth bag, a bucket with small holes punched in the bottom, or a rotary or puff type of duster can be used to apply the dust. Dusting with derris dust containing .5 percent rotenone is a very effective control.

As soon as a crop has been harvested, the vines and other crop remnants should be promptly plowed under or destroyed in some other manner. Hydrated lime, which is commonly used instead of burned gypsum, is a fair repellent against these beetles but is often injurious to the plants dusted with it. Copper sprays or dusts, such as a bordeaux mixture, usually cause a severe stunting of cucumbers and melons grown in the field.

Life History and Habits. The striped cucumber beetle hibernates as an adult under leaves and light trash in the edges of woodlands. In the spring the adults emerge, feed for a time on the blossoms of hawthorn, buckeye, and other plants, and then descend suddenly in large numbers on seedlings of the vine crops. The beetles, after feeding for a short time, begin egg laying.

**Spotted Cucumber Beetle**

*Diabrotica duodecimpunctata* (Fab.)

Yellowish green beetles with twelve distinct black spots on the back or wing covers are almost always associated with the striped cucumber beetle. These are the 12-spotted cucumber beetles (Fig. 17). They are about ¼ inch long and thicker than the striped cucumber beetle.

Injury. The 12-spotted cucumber beetle is a chewing insect that feeds in much the same manner as the striped cucumber beetle. It attacks
the vine crops and a large number of other crops, including corn, beans, potatoes, beets, asparagus, eggplant, and tomatoes. The larvae or young of this insect is a serious pest of corn in central and southern Illinois.

Control. The 12-spotted cucumber beetle can be controlled on the vine crops in the same manner as the striped cucumber beetle (page 30). On corn it can be most effectively controlled by late planting on land that has been plowed during the fall or early spring and kept free of all vegetation until planting time.

Life History and Habits. There is some question as to how this insect overwinters in Illinois. It is said that the beetle probably spends the winter in an active condition further south and migrates northward as the season becomes warmer. One to two generations occur in Illinois each year.

**Melon Aphid**

*Aphis gossypii* Glov.

Small, soft-bodied, green-to-black insects are often found closely clustered on the underside of the leaves of vine crops. These are likely to be melon aphids.

**Injury.** Like all other plant lice, the melon aphid is a sucking insect. It feeds in large colonies on the underside of the leaves, sucking sap from the leaves and causing them to become curled and deformed (Fig. 18). Both the young and adult aphids attack not only vine crops but eggplant, beans, beets, spinach, tomatoes, asparagus, cotton, and other plants. Injury is usually most severe during the latter part of the summer, when the weather is hot and dry.

As a rule, melon aphids are first seen on a few vines scattered over the field. These plants show typical signs of curling leaves and lack of vigor. The underside of the leaves on such plants will be found to be covered with hundreds of tiny, soft-bodied aphids. Under no circumstances should such plants be pulled and taken from the field before the aphids are killed, for to do so will merely spread the insects to other plants.

**Control.** Since the melon aphid is a sucking insect, it must be controlled by a contact poison. During the early part of the season, when injury from this insect first becomes apparent, an infestation may usually be cleaned up by thoroly spraying or dusting with nicotine sulfate. One ounce of nicotine sulfate and 6 ounces of soap to 6 gallons of water make an effective spray. The insects must, however, be hit by the spray if they are to be killed. This means that the underside of the leaves as well as the upper surface must be hit by the spray. The 2.4-percent nicotine dust described on page 51 is effective for use against the melon aphid if precautions are taken to secure complete coverage of the plants. Control measures are of little value unless thoroly and consistently carried out.

Plants should be thoroly treated and examined within a day or two for surviving aphids. Infested plants should again be carefully dusted or sprayed in order to kill any remaining aphids. Occasionally an infestation may be confined to a few heavily infested plants; these can be covered with soil and well packed so as to kill the insects present.

Even tho control measures are carefully practiced, further infestation
must be watched for, since winged females may fly into a field that has been treated and make an additional spray or dust necessary.

**Life History and Habits.** The life history of this species is very similar to that of aphids described on page 9.

![Fig. 18.—Section of Melon Vine Badly Infested With Melon Aphids](image)

**Squash Bug**

*Anasa tristis* DeG.

The squash bug or "stink bug" which attacks squash, pumpkins, and occasionally cucumbers and melons, is well known to gardeners (Fig. 19).

**Injury.** The squash bug is a sucking insect that secures its food by extracting sap from the stems and leaves of vine crops. Small plants are very quickly killed when fed upon by adult squash bugs. On older vines the feeding of young and adult bugs causes the leaves to wither, turn brown as if parched, and die. Occasionally an entire vine is killed; more often the plant remains alive but is so badly stunted that it cannot produce a crop of fruit.

Injury is most severe in small gardens but may become serious in large fields. Winter varieties of squash are most susceptible to injury.

**Control.** This insect is very difficult to control for two reasons: (1) a contact spray that will kill the adults will also kill the plants; (2) as the nymphs feed for the most part on the underside of the leaves, they are
hard to hit with spray materials. Young nymphs can be killed by spraying them with 40-percent nicotine sulfate at the rate of 1 fluid ounce to 3 gallons of soapy water. They should be sprayed while collected in masses along the stems. Hand picking of the adults and eggs is sometimes practiced in small gardens but is of little value as a practical control measure.

All vines and crop remnants should be plowed under or destroyed in some other manner as soon as the crop has been harvested.

**Life History and Habits.** Squash bugs overwinter in the adult stage under trash and rubbish in the field and in cracks and crevices around buildings. They are strong fliers and may overwinter in protected places at a considerable distance from fields where squash have been grown. Early in the spring they leave winter quarters and seek growing squash or other vine crops upon which to feed. After feeding for some time, the adults mate and lay their eggs, usually in clusters on the underside of the leaves. The newly hatched nymphs are brightly colored, the head, thorax, and appendages being a rose color and the body green. After the first molt they become gray. The nymphs have a habit of feeding in clusters, and when at rest are often found with the adults in clumps on the stems or on the ground nearby.

**Squash Vine Borer**

*Melittia satyriniformis* Hbn.

The stems of squash vines that wilt noticeably during the heat of the day may be infested near the ground with rather large, white, fleshy squash vine borers (Fig. 21).
Injury. The squash vine borer is a chewing insect. All varieties of squash are subject to injury by these pearly white grubs that bore into the stems of the plants, usually near the base, where they feed. In addition to destroying the inner portion of the stems, the tunnels of the squash vine borer afford easy points of entrance for organisms of decay. Injury becomes apparent early in the season and continues throughout the summer.

Control. The squash vine borer is a difficult insect to control because of its habit of feeding entirely within the plant. The eggs, which are deposited on the stems and leaves, can be destroyed by spraying with 40-percent nicotine sulfate at the rate of 4 ounces to 3 gallons of water to which has been added 2 ounces of Penetrol or soap. This spray should be applied within 10 days after the first eggs appear on the stems and repeated at intervals of one week for four weeks.

In the home garden the borers can be located and dug out of the plants with a sharp knife. Infested plants should be hilled up with dirt about the base in order to give the plants a chance to form new roots above the point of injury.

Life History and Habits. The squash vine borer spends the winter as a pearly white grub within a tough dark brown to black cocoon from 1 to 4 inches beneath the soil surface. In the spring the grubs transform to brown pupae within the cocoon, after which they work themselves out of the cocoon to a point near the soil surface, later transforming into adult moths. These are clear-winged moths with a wing expanse of about 1 1/4 inches. The moths are most active during the heat of the day and are often mistaken for bees or wasps. The eggs, which are laid on the stems and leaves of squash, are reddish brown, oval, and about 1/25 inch in diameter. They hatch in 10 days to 2 weeks, after which the young caterpillars bore into the vines.

INSECT PESTS OF ONIONS

Onions are subject to attack by relatively few insects but are often seriously injured by the onion maggot and the onion thrips.

Onion Maggot

*Hylemyia antiqua* Meig.

Small, white, legless maggots similar to those found on the roots of cabbage sometimes cause serious injury to seedling onions grown for sets and to larger bulbs grown in the field and garden (Fig. 22).
Injury. Onion maggots, during years when they are abundant, cause serious injury by feeding on the roots, bulbs, and stems of growing onions. In Illinois they are most troublesome on young seedling onions grown for sets. If the maggots begin their attack when the onions are quite small, a single maggot may destroy a large number of seedlings. This destruction of seedlings not only reduces the stand but causes those remaining to be much less uniform in size.

When onion maggots attack larger onions, they usually gain entrance near 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 aboveground. Several maggots may be 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 those in the field.

In Illinois the onion maggot has not been an important pest of commercial onions in the areas where onion sets are grown. The onions grown for sets are much more attractive to the adult flies during the egg-laying period. Second- and third-brood females prefer infested areas in the field in which to lay their eggs but also prefer healthy onions to those already infested with maggots or already infected with smut. White varieties are preferred to yellow, and red ones are least likely to be attacked.

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 use 1½ gallons of boiled lubricating oil emulsion 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 52. The ready-made emulsion may be purchased at a reasonable price from reliable manufacturers. Directions for making boiled lubricating oil emulsions can be obtained upon request to the Illinois Agricultural Experiment Station or the Illinois State Natural History Survey, Urbana. A number of commercial preparations have been tried but the results have not been so good as those with the boiled lubricating oil emulsion.

This spray is applied with a small garden-tractor sprayer. 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 either side of the plants must be wet with the spray. After the first application, and when the onions have become thoroughly established, the pressure may be increased to advantage, but a fine, misty spray should be avoided. The first application, which is the most important, 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 growing slowly, it will pay to make a third application. About 150 gallons of spray should be applied to an acre. This treatment has resulted in the
difference between an onion crop that yielded 680 bushels of sets an acre and one that was almost a total loss.

Cull piles often contain large numbers of overwintering 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.

**Life History and Habits.** The onion maggots usually overwinter as brown puparia buried in the soil or piles of cull onions or screenings. The adults that emerge are flies similar in appearance to those of the cabbage maggot. 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. The eggs hatch in 2 to 10 days.

The larvae are small, footless maggots, smooth and nearly white, closely resembling the cabbage maggot (page 8). Full-grown onion maggots are about \( \frac{3}{8} \) inch long. They form puparia, or smooth brown cocoon-like cases, in the soil or occasionally within the onion bulb. Two weeks or more are spent in the puparia before the adult flies emerge. Several generations of onion maggots occur annually in Illinois.

**Onion Thrips**

*Thrips tabaci* Lind.

The onion thrips or "onion louse" is one of the most common and destructive pests of onions in Illinois. This insect is active, light yellow to brown in color, and almost too small to be seen with the naked eye (Fig. 23).
Injury. Onion thrips are occasionally injurious to onions grown for sets but normally they cause the greatest injury to large onions. They sometimes attack cabbage, cauliflower, beans, and other garden crops. This insect, unlike most others, scrapes the leaf surface upon which it feeds and sucks up the sap that flows from the wounded tissue. Whitish blotches appear where these feeding punctures have been made. When thrips are abundant on onions, the leaves gradually become bleached, dry back from the tips, and finally die. Heavily infested plants become stunted in growth, produce abnormally thick, stiff necks, and the bulbs fail or cease to develop. It is not uncommon for entire fields of onions to be destroyed by the onion thrips during July and August. Injury is usually most severe during hot, dry seasons.

Control. Because of their rapid reproduction and their habits of feeding and remaining protected under the leaf sheaths of the onion, thrips are difficult to control satisfactorily. A nicotine-Penetrol or Derrisol-Penetrol spray of the proper dilution will kill thrips that are hit with it. Investigations in Illinois during the last several years have shown that 1 ounce of nicotine sulfate or Derrisol and 4 ounces of Penetrol to 6 or 8 gallons of water makes a fairly satisfactory spray but will not give complete control if the infestation is extremely heavy. A high-pressure sprayer is most suitable for the application of these sprays. The nozzles should be set so that the spray is driven into the center of the onion plants where large numbers of thrips feed.

It has been observed that certain strains of onions are more or less resistant to attack by onion thrips. An attempt is being made to breed up and select a strain of onions adapted to commercial production that is highly resistant to thrips.

Life History and Habits. The adults and nymphs of the onion thrips overwinter on onions and other food plants or under rubbish around the margins of fields. The adults are small, slender, yellow to yellowish brown in color, and very active when disturbed. The wings are long and narrow with a fringe of long hairs on the hind margin. The characters cannot be observed without magnification. The nymphs when first hatched are nearly white with bright red eyes. They develop rapidly, become yellow, and transform to an adult in 15 to 20 days.

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 21). In Illinois it occasionally 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 11), white grubs (page 17), wireworms (page 18), and the pale-striped flea beetle (page 22).
INSECT PESTS OF PEAS AND BEANS

These crops are subject to some insect injury almost every season, but are usually not so badly injured as many other crops. The principal pest of peas is the pea aphid, and the most destructive pest of beans is the potato leafhopper. The Mexican bean beetle now occurs in southern and eastern Illinois and as it becomes established in the state will no doubt be the most destructive of the insect pests attacking beans.

Potato Leafhopper on Beans
{\textit{Empoasca fabae} Harr.}

The small, slender, apple green leafhoppers that swarm from bean plants when disturbed often cause severe injury. They also attack potatoes (page 14).

Injury. Injury to beans is caused by the adult and young leafhoppers feeding on the plants by means of their needle-like beaks. Where these insects are abundant, they cause the tips and margins of the leaves first to turn upward and later to become dry and brown as if burned. This feeding causes the plants to take on a stunted appearance and produce a poor crop.

Control. Leafhoppers can be controlled on beans by spraying with 3-6-50 bordeaux mixture (page 52), or by dusting with a 16-84 bordeaux (page 53). Either of these materials gives good control of leafhoppers but is likely to injure the foliage if applied during the heat of the day.

The first application should be made as soon as the beans have developed true leaves and should be repeated at intervals of one week for five weeks. About 100 gallons of spray an acre should be applied each time.

Pyrethrum dusts or sprays can be used for leafhopper control on beans. These materials are perfectly safe to use on bean foliage and are effective against leafhoppers that come in contact with the pyrethrum. This material has the disadvantage that it is effective for only a few hours after being applied. Such dusts or sprays should be used according to the directions of the manufacturer.

Life History and Habits. See potato leafhopper, page 13.

Mexican Bean Beetle
{\textit{Epilachna corrupta} Muls.}

Yellow to yellowish brown Mexican bean beetles with 16 black spots on the back or wing covers may be observed feeding on beans. They are about \(\frac{1}{4}\) inch long and very closely resemble common lady bird beetles, to which they are related. The young are yellow to orange in color and are covered with small, branching spines which are black at the tips (Fig. 24).

Injury. Mexican bean beetles attack practically all varieties of beans, cowpeas, and soybeans to some extent. They are especially injurious to lima beans. The beetles and larvae feed upon the leaves, eating away the
lower part of the leaf surface, which causes the upper skeleton work of
the leaf to dry out. Severely injured leaves usually dry out and die,
dropping from the plant. As a rule, the pods are not attacked, tho
they may be eaten when the infestation is extremely heavy.

**Control.** Calcium arsenate at the rate of $\frac{1}{2}$ pounds to 100 gallons
of water is recommended for spraying beans to control this insect. Three
pounds of hydrated lime should be added to this spray to prevent burning.
Calcium arsenate mixed at the rate of 1 pound of poison with 9 pounds
of hydrated lime will give control of the Mexican bean beetle. Lead

![Image: FIG. 24.—MEXICAN BEAN BEETLE: EGGS, LARVA, PUPAE, AND
ADULTS ON BEAN LEAVES
(Courtesy Alabama Experiment Station)

arsenate is injurious to bean foliage and should not be used. Magnesium
arsenate at the rate of 3 pounds to 100 gallons of water or as a dust at the
rate of 1 pound to 5 pounds of hydrated lime is also effective against the
bean beetle. With either treatment the underside of the foliage should
be thoroughly covered with the poison. Applications of the spray should be
made at intervals of one week until control is accomplished. Where the
pods have begun to form, arsenical sprays should not be used unless the
beans can be washed.

For late spray applications or in home gardens where the beetles are
abundant, pyrethrum as recommended by the manufacturer can be used
successfully to control these insects but is much more expensive than the
stomach poisons mentioned above. Recent experimental work has shown
that derris compounds are effective in controlling this insect.

All crop remnants should be thoroughly destroyed by plowing them under
or burning. Field margins and other places where the beetles might find
suitable shelters should be burned over during the late fall or winter in
order to destroy as many of the beetles as possible.

**Life History and Habits.** The Mexican bean beetle spends the win-
ter in the adult stage under trash, rubbish, and in other dry protected places. It emerges in the spring and begins feeding on bean or other food plants. Its pale orange eggs are laid on the underside of the leaves in much the same manner as those of the Colorado potato beetle, which they resemble. The young larvae are yellowish to orange in color. They feed almost entirely on the underside of the leaves, eating away the lower part and leaving only the upper layer and the veins which support it. Feeding continues for about 20 days, after which the insect pupates on the under­side of the leaf on which it feeds. After about a week spent in this stage, during which it does no feeding, it transforms to the adult stage.

**Bean Leaf Beetle**
*Cerotoma trifurcata* (Forst.)

Tan to reddish yellow beetles with six black spots on the back or wing covers sometimes occur in large numbers on beans. These are bean leaf beetles.

**Injury.** Injury to the plant by the bean leaf beetles is usually greatest in the early spring. The adults eat out holes in the foliage and stems of the seedling bean plants and if abundant may destroy an entire stand. Injury occurs from early spring throughout the season, tho the larvae which feed on the roots, nodules, and underground stems are less injurious than the beetles. The bean leaf beetle attacks garden beans, cowpeas, soybeans, and other cultivated and wild host plants.

**Control.** Dusting or spraying beans with calcium or magnesium arsenate as recommended for the control of the Mexican bean beetle (page 39) is effective against the bean leaf beetle. The first application should be made on seedling plants as soon as injury is apparent and repeated as often as necessary. Keeping down the growth of weeds in and around the garden or field is of value in preventing injury from this pest. Some of the beetles may be killed by plowing under or burning trash and clumps of grass in which the adult beetles pass the winter.

**Life History and Habits.** This insect passes the winter in the adult stage, hibernating in trash or clumps of grass which are fairly dry. It emerges during the early spring and feeds for a time on beans or other plants. The young or larvae of this insect feed entirely underground, living on the roots of the plants.

**Bean Weevil**
*Mylabris obtectus* (Say)

Bean seeds infested with one of the bean weevils (Fig. 25) show small circular holes penetrating the interior. Injury to beans in the field is indicated by stunted and deformed pods.

**Injury.** Weevil injury in the field is not so great in the northern states as it is further south. Green beans which are infested become stunted and deformed so that they are unfit for use. Because the punctures made in the beans by the adult beetles are small and the young feed within beans, the presence of these insects is usually not suspected.
Kidney beans, lima beans, and cowpeas are most commonly attacked in the field. Beans and peas that are stored are very likely to become infested with weevils unless they are treated as outlined below. Injury to beans in storage is continuous as long as the temperature is suitable for the development of the insects.

**Control.** Infested seed should never be planted. Such seed provides a means for reinfestation of fields and produces stunted and unthrifty seedlings. Planting of seed that is free from weevils is the only known method of controlling this insect in the field. Beans can be freed of weevils by fumigating with carbon bisulfid. The dry beans should be sacked and placed in a tight container and carbon bisulfid at the rate of 1 ounce to 1 bushel of beans, or 3 pounds to 100 cubic feet, should be placed in shallow pans on top of the piles of seed and the container tightly closed for a period of 24 to 36 hours. *Carbon bisulfid is very inflammable and should be kept away from fire.*

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.

Weevil damage can be stopped in seed beans to be used for food by heating the beans to 130° F. for 4 hours. The germination of the beans will be injured by this treatment.

**Life History and Habits.** In the spring the adults escape from the beans in storage or are taken to the field in the seeds which are planted. They remain in the field, where they feed slightly on the foliage. The eggs are deposited in tiny holes eaten in the pods by the females. The young grub hatches and crawls around in the pod until it finds a bean. It enters thru a very small hole, loses its eyes and legs, and starts feeding within the bean. Feeding continues until the larva is full-grown.

**Pea and Bean Aphids**
*Macrosiphum pisi* (Kalt.) and *Aphis rumicis* L.

The pea aphid is the most destructive insect pest attacking peas. All stages of the insect may be found on the plant during the growing season. These insects are about 1/6 inch long, pea green, with black markings on the appendages. Both winged and wingless forms occur. The bean aphid is sometimes destructive on beans, peas, celery, and a number of other crops and weeds. It is much smaller than the pea aphid and nearly black in color. Other species of aphids sometimes attack peas and beans.

**Injury.** All the aphids are sucking insects. They attack the stems, leaves, blossoms, and pods of peas, beans, and other plants. The leaves
become curled and thickened, the blossoms fail to develop, or the pods become deformed from having these small insects suck sap from them. Heavily infested plants become yellow and even tho not killed are unproductive.

**Control.** It is seldom practicable to attempt control of aphids by means of insecticides on peas or beans grown on a commercial scale. In small gardens they may be killed by dusting with a 2.4-percent nicotine dust (page 51), or by using the spray recommended for cabbage aphids (page 9).

**Life History and Habits.** The life history of the pea aphid is very similar to that of the cabbage aphid described on page 9.

**Garden Flea Hopper**

*Halticus citri* Ashm.

Garden flea hoppers are found on beans, cabbage, celery, cucumbers, eggplant, peppers, potatoes, squash, sweet potatoes, tomatoes, and other truck crops. They are small black insects having the same general appearance as aphids or plant lice, but which jump like flea beetles when disturbed (Fig. 26).

**Injury.** The feeding of these insects causes the plants to become

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**Fig. 26.—Garden Fleahoppers:** Nymph (*a*); Short-Winged Adult (*b*); Long-Winged Adult (*c*); Mouth Parts (*d*)
stunted and eventually to die if the infestation is severe. Pale whitish spots are common on leaves where these insects have fed. Weeds become heavily infested with garden flea hoppers and if allowed to grow in or near a garden constitute a serious source of infestation for cultivated crops.

**Control.** Keeping down the growth of weeds in or near the garden or field is very important in preventing injury from flea hoppers. These insects may be controlled by spraying plants thoroughly with 40-percent nicotine sulfate at the rate of 1 ounce in 5 gallons of water containing 5 ounces of laundry soap or 3 ounces of Penetrol. For larger amounts use 11 ounces of 40-percent nicotine sulfate to 50 gallons of water to which has been added 1 quart of Penetrol or 2 to 3 pounds of laundry or potash fish-oil soap. Dusting the plants thoroughly with a 2.4-percent nicotine dust is also effective.

**Life History and Habits.** The garden flea hopper hibernates as an adult. It emerges from hibernation about the middle of May and feeds for a time before beginning egg laying. The greenish nymphs hatch and feed on the underside of the leaves. Two kinds of adults occur, short-winged and long-winged.

**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 11), wireworms (page 18), blister beetles (page 19), corn ear worm (page 20), seed corn maggot (page 21), grasshoppers (page 23), slugs (page 27), spotted cucumber beetle (page 30), and the melon aphid (page 31). Onion thrips can be controlled with nicotine dust (page 51).

**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; it is always present, as is the 12-spotted asparagus beetle, tho the latter is not so destructive.

**Common Asparagus Beetle**

*Crioceris asparagi* L.

Metallic blue or black beetles marked with orange or yellow and sluggish, slate-colored grubs about 1/4 inch long often collect on asparagus to feed. These are common asparagus beetles and their young (Fig. 27).

**Injury.** When the adult beetles are abundant in the early spring, they cause considerable injury by eating holes in the young shoots of asparagus. The market value of the shoots is also reduced if the beetles are allowed to deposit their unsightly eggs on them.

The larvae or young grubs are not troublesome during the early spring on asparagus that is cut regularly. Later in the season, however, they may completely strip the foliage from the plants. The greatest amount of injury is done to fields of seedling asparagus.

**Control.** Asparagus shoots that are to be cut should never be sprayed or dusted with arsenicals or fluosilicates on account of the danger from
poisonous residues. In home gardens the beetles can be controlled by spraying the infested shoots with pyrethrum according to the directions of the manufacturer.

After the cutting season, asparagus beetles can be easily controlled by spraying infested plants with arsenate of lead at the rate of 3 pounds to 50 gallons of water. To this should be added 1 quart of Penetrol or 2 to 3 pounds of laundry soap as a spreader. Applications should be repeated as necessary at intervals of 10 days in order to kill any beetles that might appear. When a power sprayer is used, the boom should be raised and the nozzles set so as to give complete coverage of the plants. Preventing injury is much easier than cleaning up a severe infestation of asparagus beetles. Their control during the latter part of the growing season will do much to prevent injury during the following season.

Life History and Habits. Asparagus beetles spend the winter as adults in piles of rubbish, behind the bark of posts and trees, and in other protected places. The adult is about 1/4 inch long. The head, legs, and underside of the body are bluish-black and may be tinted with green. Usually a yellow or orange inverted letter E is present on each wing cover. The eggs are about 1/16 inch long, dark gray to black in color, and more or less cylindrical. They are fastened by one end to the asparagus plant. The young larvae are slate-colored with black heads and legs. They feed for about two weeks before becoming full-grown. Two or more generations occur annually in Illinois.

**Spotted Asparagus Beetle**

*Crioceris duodecimpunctata* (L.)

Reddish orange beetles with twelve distinct black spots on the wing covers are often found with the common asparagus beetle on asparagus. These are the 12-spotted asparagus beetles.
Injury. The adult beetles injure asparagus tips and foliage in about the same manner as the common asparagus beetle. Eggs are not laid on the growing shoots. The larvae or grubs attack only the berries or seed of asparagus, causing no commercial damage.

Control. The same control methods recommended for the common asparagus beetle are sufficient to take care of this insect (page 44).

Life History and Habits. The 12-spotted asparagus beetles spend the winter in the adult stage hidden under trash and rubbish. The yellow to orange grubs with black head and legs mature within the berries.

Other Pests of Asparagus

Several other pests attack asparagus but are usually of little importance. The most important of these are cutworms (page 11), the corn ear worm (page 20), the woolly bear caterpillar (page 6), the melon aphid (page 31), and the harlequin bug (page 12). Control measures for these are not usually necessary.

INSECT PESTS OF BEETS, SPINACH, LETTUCE, CELERY, AND DILL

Altho there are a large number of insect pests that attack beets, spinach, lettuce, celery, and dill in Illinois, injury is not usually severe. Occasionally a crop may be seriously damaged. Since many of the insects attacking these crops also feed and reproduce on related weeds, it is important to keep weeds from growing in or around fields or gardens.

Celery Looper

*Autographa falcifera* Kby.

The celery looper can be distinguished from the cabbage looper by its conspicuous white spiracles ringed with black.

Injury. The celery looper is a leaf-eating insect which feeds by chewing holes in the leaves. It 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. If the worms are not numerous, this same practice may be followed on celery. Sugar beets and young celery may be sprayed or dusted with arsenicals, care being taken not to apply poisons on celery within 3 or 4 weeks of blanching. Use calcium arsenate at the rate recommended for cabbage worms (page 5).

Life History and Habits. The life history and habits of this insect are very similar to those of the cabbage looper described on page 5.

Tarnished Plant Bug

*Lygus pratensis* L.

The tarnished plant bug is one of the commonest insects found in vegetable gardens. The adult is brown mottled with various shades of reddish and yellowish brown and is about \(\frac{1}{4}\) inch long.
Injury. The tarnished plant bug is a sucking insect. Both young and adults cause damage to celery, cabbage, cauliflower, turnips, potatoes, tomatoes, beans, and cucumbers. 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.

Control. Use control measures recommended for the garden flea hopper (page 43).

Life History and Habits. This insect spends the winter in the full-grown stage under trash and rubbish, such as leaves, stone piles, and garden refuse. It emerges during early spring and feeds on the twigs of trees or other vegetation that may be available. The young nymphs are small, colored with various shades of green with four black spots on the back. As they become older the fore part of the body becomes mottled with brown. The bugs become full-grown in about a month. There are four or five generations annually in Illinois.

Garden Webworm

*Loxostege similalis* Guen. and others

The full-grown garden webworm is a yellowish green, hairy caterpillar about 1 inch long, covered with numerous black spots along the back and sides.

Injury. The webworm is a chewing insect that eats holes in the leaves and stems of beets, beans, and other cultivated and wild plants. It is usually protected by a thin silken web which is spun about the food plant.

Control. When beets or beans become infested, they should be sprayed or dusted with calcium arsenate used as for the control of cabbage worms (page 5). Beet tops sprayed with arsenicals must not be used for food. Keeping down weeds and other wild host plants along the margins of gardens or fields is of considerable value in preventing webworm injury.

Life History and Habits. The garden webworm spends the winter as a dark brown pupa in the soil. In the spring the eggs are deposited in masses on food plants. The young caterpillars hatch in about a week. They are very active and drop to the ground when disturbed. Several generations are produced annually.

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 15).

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

For description and control methods for other insect pests injurious to these vegetables, see cutworms (page 11), white grubs (page 17), wireworms (page 18), blister beetles (page 19), and slugs (page 27).
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 at the large markets, 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. The spoiled vegetables thus obtained have usually come considerable distances. There is in this practice great danger of bringing in new insect pests and diseases which may cause serious losses in the future.

The carrot beetle, carrot weevils, and the carrot rust fly are three of the most important insect pests attacking carrots and parsnips. Since all three of these insects are very difficult to control, every effort should be made to prevent infestation of fields or gardens.

**Carrot Beetle**

*Ligyrus gibbosus* DeG.

The carrot beetle is reddish brown to black in color and resembles a small June bug.

**Injury.** Most of the injury caused by this insect is caused by the adult, which eats out rather large holes in the roots of carrots, parsnips, corn, celery, sweet potatoes, and other crops. Although the carrot beetle occurs in this state, it has not been of primary importance as a pest.

**Control.** No successful control method is known for the carrot beetle. Hydrated lime scattered over the ground is reported to drive the beetles away, but such a procedure carried on over a period of years might be injurious to certain soils. A short rotation of crops is beneficial.

**Life History and Habits.** The carrot beetle spends the winter as an adult in the soil. In the spring it emerges and lays its eggs in the soil. These hatch into larvae that resemble common white grubs. They feed largely on decaying vegetable matter contained in the soil but may also attack the roots of growing crops. One generation is produced annually.

**Carrot Weevils**

*Listronotus latiusculus* Boh.
and *Listronotus rudipennis* Blatchley

The carrot weevils are coppery colored snout beetles about \( \frac{1}{8} \) inch long. The larvae are small dirty-white grubs and are found in the soil or in the roots of infested crops.

**Injury.** The larvae or grubs of the carrot weevils tunnel into the roots of carrots and to some extent in parsley. Early carrots are usually most severely injured.

**Control.** No control method has been worked out for this insect. Field observations indicate that late carrots suffer less injury than early ones.
Carrot Rust Fly  
*Psila rosae* Fab.

The slender white maggots of the carrot rust fly are about $\frac{1}{3}$ inch long when full grown. The adults are small, green-bodied flies with conspicuous red eyes.

**Injury.** 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 and the outer leaves to become yellowed. This insect has not been found in Illinois but is known to occur in the Eastern states and as far west as Michigan.

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

**Life History and Habits.** The rust fly overwinters in a slender brown puparia in the soil or as a maggot in the roots of its food plant. The flies emerge during early spring and lay their eggs at the base of carrots or other food plants.

Other Pests of Carrots and Parsnips

See insect pests of beets, spinach, lettuce, celery, and dill (page 45).

INSECT PESTS OF HORSE-RADISH

Of the insect pests that feed on horse-radish only one, the horseradish flea beetle, is particularly destructive. This insect, when present in large numbers, is capable of inflicting serious losses to the crop. Water cress is the only other crop known to be attacked.

**Horse-Radish Flea Beetle  
*Phyllotreta armoraciae* Koch**

The adult of the horseradish flea beetle is about $\frac{1}{8}$ inch long, oval, with a black body. Each wing cover is yellow with a black stripe on both the outer and inner margins.

**Injury.** Injury is inflicted by both the larva and adult of this flea beetle. The adult is most destructive during the early part of the season, at which time it eats 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.

**Control.** Use the control measures recommended for the potato flea beetle (page 15) or the eggplant flea beetle (page 26). It is important to start spraying or dusting when the beetles first appear, 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 the flea beetles become abundant.

**Life History and Habits.** The life history and habits of this flea beetle are very similar to those of the potato flea beetle (page 15).
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 compares in severity of attack with the insect pests of white potatoes.

Sweet-Potato Beetles
Several species of *Chrysomelidae*

For the most part the sweet-potato beetles are highly colored insects—either golden-hued, spotted, striped, or mottled—with rather square tortoise-shaped or flat, oval bodies.

Injury. Both young and adults of several species of these beetles attack sweet potatoes. They may eat small holes in the leaves or destroy them entirely. Injury to newly set plants may be severe.

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

Life History and Habits. The sweet-potato beetles hibernate as adults under trash or in other dry, sheltered places. After emerging in the spring they begin feeding and laying eggs.

Sweet-Potato Flea Beetle
*Chaetocnema confinis* Crotch

The sweet-potato flea beetle resembles the potato flea beetle in general appearance, life history, and habits (page 15). It feeds on a number of plants other than the 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

For control of cutworms attacking sweet potatoes, see page 11.

INSECTICIDES

Insecticides play an important part in the control of insect pests on vegetable crops. While their use is essential, insecticides should be used with considerable caution since excessive or careless applications on vegetables may endanger human health or even life. For this reason, certain poisons such as arsenate of lead and the fluosilicates are not recommended for use on crops where the treated portions of the plant are to be eaten. On crops where these poisons should not be used, suitable substitute poisons have been recommended.

There are a number of good insecticides on the market and a larger number that are of little or no value. In this connection it should also be borne in mind that different groups of insects have to be killed by
different kinds of poisons and that certain crops are more susceptible to spray injury than are others. These points have been taken into consideration in making the recommendations for the control of the different pests that are troublesome on vegetables.

Thousands of dollars are wasted every year in the improper use of insecticides on vegetable crops. Much of this loss can be avoided by (1) proper identification of the insect, (2) selection of a suitable insecticide, (3) starting control measures at the right time, and (4) thoroughness in application of the treatment.

**Stomach Poisons**

**Calcium arsenate** is fairly effective for most truck crop insects, but may cause burning on tender foliage. It may be used either as a spray or as a dust but should not be used in sprays containing Penetrol. The addition of hydrated lime to sprays containing calcium arsenate will reduce the danger of burning the plants. Calcium arsenate should not be used on crops the treated portions of which are to be used for food, unless they are thoroughly washed before being eaten or sold to the public.

**Paris green** is a quick-killing insecticide for use on the hardier crops such as potatoes and cabbage. It is not safe to use on tender crops. It is most satisfactory as a dust mixed with hydrated lime as directed in the text under control measures. Paris green should not be used on any crop the treated portions of which cannot be washed before being eaten or sold to the public.

**Arsenate of lead** which has been widely used on vegetable crops is a good insecticide, but should not be used on crops the treated portions of which are to be used for food. It can be used as a spray or dust in combination with other insecticides and fungicides as indicated in the text under control measures.

**Barium fluosilicate** (Dutox) may be used as a dust or spray. It is particularly effective against beetles that feed on the foliage. It may be found to be corrosive to the porcelain lining used in some spraying equipment. Hydrated lime must not be used with barium fluosilicate. Heavy residues must be removed by washing before plants are marketed.

**Calcium and sodium fluosilicates** are used in much the same manner as barium fluosilicate. Sodium fluosilicate is very likely to injure tender foliage. All the fluosilicates have the disadvantage at the present time of not always being available locally. Fluosilicates should not be used on the edible portion of vegetables unless they are to be washed before they are eaten or sold to the public.

**Poison Bran Bait**

Poison bran bait may be made according to the following formulas:

<table>
<thead>
<tr>
<th>Large quantity</th>
<th>Small quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bran...........................</td>
<td>25 pounds</td>
</tr>
<tr>
<td>Molasses.....................</td>
<td>2 quarts</td>
</tr>
<tr>
<td>Water.........................</td>
<td>10 quarts</td>
</tr>
<tr>
<td>Paris green...................</td>
<td>1 pound</td>
</tr>
<tr>
<td></td>
<td>5 pounds</td>
</tr>
<tr>
<td></td>
<td>3/4 pint</td>
</tr>
<tr>
<td></td>
<td>2 quarts</td>
</tr>
<tr>
<td></td>
<td>3 1/2 ounces</td>
</tr>
</tbody>
</table>
SAVING GARDEN CROPS FROM INSECT INJURY

The dry bran and Paris green should be mixed thoroly, after which the molasses and water, previously mixed, should be added slowly, with constant stirring. The bran should be coated thoroly with the poison and molasses. The finished bait should contain just enough water to make it hold together, and not enough to make it sloppy.

An oil bait recently worked out by J. H. Bigger, Illinois State Natural History Survey, shows much promise as a substitute for the above bait for the control of cutworms. Tests with it, however, have not yet been completed. It may be prepared from the following formula:

<table>
<thead>
<tr>
<th>Large quantity</th>
<th>Small quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bran</td>
<td>25 pounds</td>
</tr>
<tr>
<td>Lubricating oil</td>
<td>2 quarts</td>
</tr>
<tr>
<td>(medium heavy-viscosity, SAE 20)</td>
<td>5 pounds</td>
</tr>
<tr>
<td>Paris green</td>
<td>1 pound</td>
</tr>
</tbody>
</table>

Mix bran and poison and add oil as for the molasses and water above.

Contact Poisons

The contact poisons are, as the name indicates, those that kill by coming into contact with the body of an insect or by entering its breathing apparatus. The most important of these poisons used on truck crops are nicotine, pyrethrum, and derris or related 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 is an example 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, Nikoteen, and Black Leaf 50 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.

To make a 2.4 percent nicotine 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 smooth stones 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, by weight, 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.

**Derris** contains rotenone and several other toxic materials that are very effective against certain classes of insects. It acts both as a stomach and contact poison, first paralyzing and later killing insects treated with it. Altho it is slow in killing, it is a very effective poison and has the advantage of being only slightly poisonous to man.

Derris as a spray may be used in the form of liquid extract or finely ground root with neutral spreader. The derris dust is one of the best arsenical substitutes for use against cabbage worms during the latter part of the growing season.

**Pyrethrum** is another of the plant poisons that is relatively harmless to man and highly toxic to certain insects. It acts much more quickly than derris but is effective for a shorter length of time.

Pyrethrum may be obtained either as a liquid or dust. The liquid extract should be used according to the directions of the manufacturer printed on the container.

**Bordeaux Mixture**

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 4-4-50 or a 3-3-50 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.

When a very small quantity is needed, a ready-mixed commercial bordeaux may be used. It should be used according to the directions of the manufacturer.

For a considerable quantity, bordeaux can be prepared by the grower according to the following formula:

- 4 pounds copper sulfate (blue vitriol)
- 4 pounds hydrated lime
- 50 gallons water

Copper sulfate is available in lump or powdered form. Because of greater ease in handling, the powdered form is preferable.

For mixing bordeaux, *agitation should be provided throughout the operation*. After the spray tank has been partially filled with water, the proper amount of lime should be added in the form of a thin paste or sifted directly into the tank as a powder. The copper sulfate, previously dissolved in a small amount of water, should then be poured slowly into the tank and the remainder of the water added.

**Caution.**—Copper sulfate should *not* be dissolved in metal containers. The mixture is most effective if used within a few hours after it is made, since it settles out and changes in composition upon standing.
Bordeaux Dust

A copper dust without a stomach poison can be prepared according to the following formula:

16 pounds monohydrated copper sulfate
84 pounds hydrated lime

For some pests that attack vegetables, a copper dust containing a stomach poison gives effective control. The dust can be prepared according to the following formula:

16 pounds monohydrated copper sulfate
64 pounds hydrated lime
20 pounds arsenate of lead

Ordinary copper sulfate should not be substituted for the monohydrated form. Only the best grade of hydrated lime should be used. After the ingredients have been weighed, they should be thoroughly mixed, using the proportions given. This dust should not be allowed to stand in open containers for long periods before using.
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