Common Pest of Field and Garden Crops
Michigan State University Agricultural Experiment Station
Special Bulletin
R.H. Pettit, Entomology
Reprinted July 1931
77 pages

Oakley Lardie

Special Bulletin No. 183 Reprint, July, 1931

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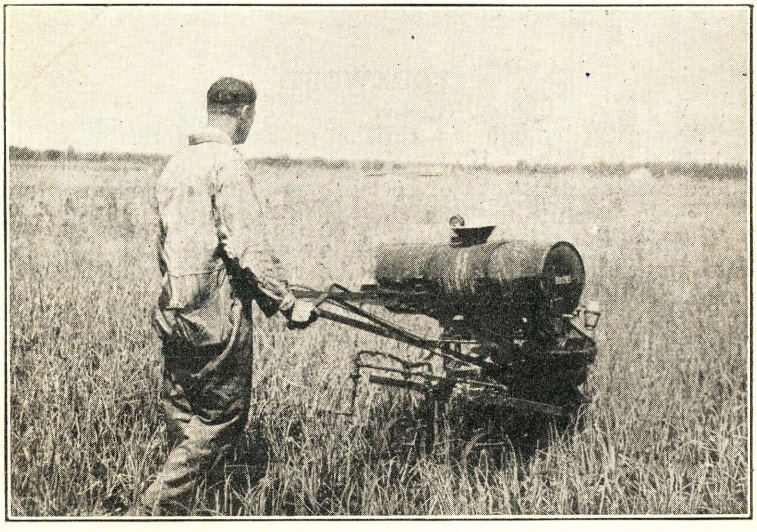

AGRICULTURAL EXPERIMENT STATION

MICHIGAN STATE COLLEGE
Of Agriculture and Applied Science

SECTION OF ENTOMOLOGY

East Lansing, Michigan

FOREWORD

The present bulletin is a revision of Special Bulletin No. 132, published in March, 1924. Some additional material has been added to the discussions of certain pests, and several new topics have been added to the ones covered in the earlier bulletin. This has seemed advisable because of the introduction of new pests into our State, and also because in the former bulletin certain important pests were omitted through oversight.

R. H. PETTIT,
Entomologist of Experiment Station.

COMMON PESTS OF FIELD AND GARDEN CROPS

By R. H. PETTIT

GRASSHOPPERS

Melanoplus fumur-rubrum, M. atlanis, and Camnula pellucida.

These three species of grasshoppers are always to be found in Michigan. Sometimes only a few are present, but always there are enough to multiply quickly whenever the weather produces favorable conditions or there is an absence of natural enemies. Their ability to destroy a wide variety of crops is too well known to need comment.

In northern Michigan we find conditions just suited to their needs, with occasional resulting infestations of great size, followed by periods marked by almost negligible quantities of the pests. Large areas of "wild land," which have not yet been brought under cultivation, furnish suitable places for the hoppers to multiply during the production of a "wave."

The grasshoppers under discussion lay their eggs in the soil, choosing sod land, wherever it is to be found. Each female may deposit several pods of eggs, each pod containing a score or more eggs. The eggs hatch out in the spring and the hoppers live and FEED until fall. The number deposited in an acre of "slash" is almost unbelievable. The writer has counted thousands to a square foot of sod.

If the grasshoppers are left to nature, their destruction is certain enough, but usually too slow to be of much aid to the farmer. Eventually, blister-beetles, whose larvae feed in the pods of eggs, will bring their number down, and bee-flies (Bombylids) will do their share; also, the tiny red mites which are found clinging near the bases of their wings help to weaken the hoppers. Besides these, hair-snakes appear and feed inside the body-cavity, resulting in the death of the grasshopper. In fact, these hair-snakes perform a very valuable service in destroying grasshoppers.* In one recent outbreak of grasshoppers in the Upper Peninsula of Michigan a teacupful of grasshoppers yielded half a teacupful of the tangled, threadlike hair-snakes. Wild birds, skunks, shrews, turkeys, and even fish feed freely on the pests, but after all the work of these natural control agents is too slow to help very greatly during periods of severe infestation.

It is a well-known fact that grasshoppers like salty deposits. A sweat-grimed jumper or sweater is likely to be eaten if left in the harvest field for any length of time, and hoppers will gnaw salty binder-twine and fork-handles where perspiration has dried.

It is therefore, a good practice to add a little salt (not too much) to bran,

**Melanoplus femoratus.*

poison it, and broadcast it during the heat of the day where the pests can find it in their wanderings. In order to make this bait more attractive, add a little amyl acetate (banana oil) and a little molasses, both of which pay for themselves in making the bait more effective.

Old Formula

Mix very thoroughly
1 bushel of bran
½ gallon of cheap molasses
A little water
1 pound white arsenic (not arsenate of lead nor arsenate of calcium)
or—1 pound paris-green
When thoroughly mixed, stir in enough amyl acetate (banana oil) to scent the mass slightly—about two or three ounces, at most.

Bait prepared according to this formula is and has been in common use for years. It is now regarded as the standard killing agent for grasshoppers. Success depends on several factors but more than anything else on the thoroughness with which the mixture is stirred. A perfectly prepared bait would be so intimately mixed that each flake of bran would carry a tiny particle of arsenic, besides its quota of salt and molasses, which latter would be dissolved in the water used to moisten the mass. It is not so easy as one might think to accomplish this end, and, therefore, we find the following formula vastly superior to the one first given; since in this improved formula only such ingredients are used as will dissolve in the water. Moisten the bran with the water which carries all the other ingredients except the banana oil. It is advisable to prepare home-made arsenite of soda in advance by dissolving white arsenic and caustic soda (lye) together in water; store it away, and use it when the time comes.

Improved Formula for Grasshopper Bait

HOME-MADE ARSENITE OF SODA

Sodium arsenite containing eight pounds of white arsenic per gallon is made according to the following formula:

Water (68 pounds)	8½	gallons
Caustic Soda or Lye	32	pounds
White Arsenic	100	pounds

Use a tub or barrel that will have a capacity of at least 15 gallons. Measure eight and one-half gallons of water and pour into the barrel. Dissolve in the water 32 pounds of caustic soda or lye (the ordinary household grade of lye obtained in grocery stores). When the lye dissolves, it will be noticed that the water becomes warm. After all the lye is dissolved, stir in the powdered white arsenic a little at a time, as fast as it is dissolved, until the 100 pounds of arsenic has been added. The addition of the arsenic generates more heat and no external heat is required. This will make about 12½ gallons of a thick, syrupy liquid, containing eight pounds of arsenic per gallon. It is important to stir the solution constantly while the arsenic is being added.

In preparing the bait for use in killing grasshoppers, moisten 100 pounds of bran with the following mixture:

1 quart of the home-made arsenite of soda, described above
5 pounds of common salt
2 gallons cheap molasses
About 10 gallons of water
Stir in 3 ounces of banana oil

All of these baits are applied by broadcasting during the heat of the day so that they break up finely and remain on the surface of the soil. If allowed to spread in lumps, the bait may attract wild birds and poultry.

Bait prepared according to the improved formula is superior in that it is almost sure to work every time. Do not, however, expect grasshoppers to die immediately after feeding on the bait; since several days, or even a week, may elapse between the eating of the poison and the death of the grasshopper. It is an invariable rule, however, that the insects stop feeding once they get a little of the bait. Their power for harm ends with the taking of the bait, and they die after a few days.

BLISTER-BEETLES

Old-fashioned potato-beetle (*Epicauta vittata*)
Ash-gray blister-beetle (*Macrobasis unicolor*)
Black blister-beetle (*Epicauta pennsylvanica*)
Margined blister-beetle (*Epicauta marginata*)

We have in Michigan four kinds of blister-beetles; the ash-gray, the margined, the black, and the striped or old-fashioned potato-beetle. All of them feed on the beet and on various other plants. They seem to prefer members of the clover family—sweet clover, vetches, etc.—which they attack during the latter half of July and August. The black species is found in great numbers, late in the season, on golden-rod.

The appearance of the blister-beetle is shown in Fig. 1. It is long and slender, has graceful legs and form, and is a little more than half an inch in length. These four species differ markedly in color. The one figured is known as the old-fashioned potato-beetle, because of its well-known love for that plant. It is striped, yellow and black, with black legs. Those of the black and grey species look very much like the striped one except for the color, and the margined beetle is dead black with the margins of the wing-covers grey. They all eat the foliage of beets when adult, and often cause serious damage.

One word in extenuation before pronouncing sentence of death on these small malefactors. Their larval stages, in all our common species, except the steel-blue ones, are passed in devouring the eggs of grasshoppers. In fact, the young blister-beetles of this group are not known to feed on anything else. The fact that the eggs of grasshoppers are laid in pods enclosed in water-tight shells, and containing from 20 to 30 eggs, makes it possible for the beetles to do a great deal of damage to the contents of the pods by devouring part of the eggs. If all are not eaten, fermentation and the consequent loss of the rest of the batch is sure to follow. From this we see that it is possible for the beetle to attain its maturity only at the expense of many grasshopper eggs. The beetles, then, are our friends if they occur

in anything like moderation, but, lest we be overrun by these well-meaning but hungry allies, it is often desirable to get rid of them.

Remedy: Before the days of paris-green, it was the custom of our forefathers, when the beetles came in droves, to drive them, by brushing them with the branches of trees, into windrows of dry straw, and then to burn them up. A dusting with arsenate of calcium or a spray of any one of the common arsenicals will dispose of the beetles.

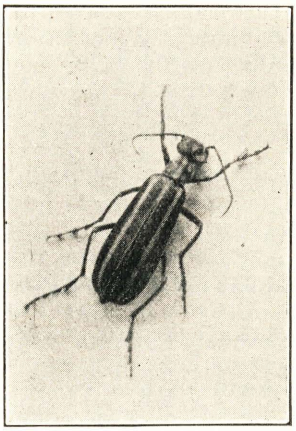

Fig. 1.—Old fashioned potato-beetle, enlarged

PLANT LICE IN GENERAL

Plant-lice are tiny, fragile creatures with bodies easily crushed. These pests depend on their fecundity to replace the individuals lost by constant inroads made on them by natural enemies and by disease. They are almost incapable of escaping disaster by flight, since their movements are so deliberate, but at the same time they are serious pests. They are immune to all ordinary stomach poisons used as sprays. Contact sprays and dusts alone prove adequate, and these are all high-priced. Plant-lice suck the juices from plants by means of beaks that penetrate through any surface-coating which may be spread on a plant, and in many instances the making of these feeding punctures is followed by results out of all proportion to the mechanical injury inflicted, or to that resulting from the loss of the plant juices. The plant responds just as if some toxin had been injected, leading sometimes to a stimulation of abnormal growth or to a stunting or even to the death of tissue.

Some of these insects carry the infections of various plant diseases, such as mosaic diseases and blights, from diseased to healthy plants, the virus of the disease clinging to the needle-like beaks of the lice and being introduced into healthy plants as the result of feeding. The importance of the control of plant-lice is, therefore, enhanced, since we may now regard them as carriers of plant diseases as well as insects whose attacks are directly injurious.

Plant-lice occur on many plants. Those on most of our garden plants and on shrubs, ornamentals, and greenhouse plants may be successfully treated by sprays of nicotine, derrisol, pyrethrum extracts, or by dusting with nicotine dusts. Some species are protected by wooly or waxy coats, and such forms are naturally more resistant to sprays than those having naked bodies.

The spray most commonly used at the present time against plant-lice living out of doors is 40 per cent nicotine sulphate. It does, however, leave a fairly permanent, poisonous residue, and it is not to be used on lettuce, spinach, or other plants having an extensive leaf surface, where the leaves are to be used as food. In such cases, substitute the straight volatile nicotine, which evaporates, leaving no appreciable residue; or else use one of the non-poisonous contact insecticides, such as derrisol or one of the pyrethrum extracts.

For ordinary spraying with nicotine when there is no danger in leaving a residue, use one pint of 40 per cent nicotine-sulphate to 100 gallons of water, with the addition of about four pounds of laundry soap, unless the nicotine is to be combined with lime-sulphur or with some other chemical that is incompatible with soap, in which case omit the soap. Always remember that each louse must be hit to be killed.

Dusts containing nicotine usually, if not always, contain volatile nicotine, and, while some dusts liberate the fumes more quickly than others, the fumes are still similar in all cases. In the case of extensive dusting operations, it is often advisable to drag a trailer of light-weight cloth over the plants to help keep the dust from blowing away too quickly and to retain the fumes for a short time.

LEAF BUGS

Miridae

Leaf-bugs are small, flat bugs, seldom more than one-fourth of an inch in length, which suck the juices from fruit and foliage of all sorts of vegetation. The damage due to leaf-bugs cannot be charged wholly to the loss of sap, nor to the mechanical injury caused by puncturing the plant. The damage is usually apparent only in the close vicinity of the puncture and shows as a small more or less regular dead spot in which the cells are killed and appear as if partially digested, so that they shrink down to a very thin layer, often with a raised ring bordering the killed spot but with the epidermis continuous over the entire lesion. The small areas of killed tissue often appear like pits eaten into the tissue, but under a lens one sees that the skin or epidermis extends down into and across the depression, showing that the cells are not eaten out, but that they are dead and shrunken instead.

The death of the cells would appear to be due to the action of the saliva of the bugs, probably to some digestive enzyme. The lesions are in many cases well defined and conspicuous.

Many species are known, of which two are probably the most troublesome in Michigan. One of them is the four-lined leaf-bug which multiplies on currants and gooseberries, both wild and cultivated. This creature passes the winter in the egg stage, several eggs being placed in a cluster in a slit cut in a twig. These eggs hatch out in the spring and the small, bright-red bugs suck their food from the undersides of the leaves, causing the leaves

to swell and curl. The bugs dwell in these curled leaves and are hard to reach, but they may be killed by spraying thoroughly with nicotine and soap, or with nicotine and bordeaux, shooting the spray upward from beneath so as to wet the undersides of the curled leaves. Later, when the bugs acquire wings and change to a bright-yellow color with four black longitudinal lines, they are almost impossible to kill, since they take wing on the slightest alarm.

The Tarnished Plant-Bug

Unlike the four-lined leaf-bug, the tarnished plant-bug produces four or five generations a year, and passes the winter under rubbish. This species is found everywhere in Michigan, where it injures all sorts of field crops and where it is one cause of "stop-back" or "bastard-top" in nursery stock.

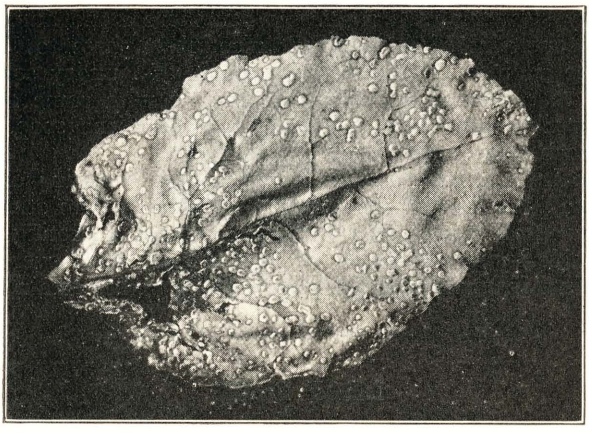

Fig. 2.—Work of Four-lined Leaf-bug on Beet.

Partial control may be obtained by means of contact sprays and probably also by the use of nicotine dusts.

The burning of rubbish late in the fall, and the consequent destruction of the pests' winter homes is to be encouraged.

The natural food plant, or rather the first choice for food and the plant chosen in preference to others for the reception of eggs, is said to be horseweed or mares-tail, *Erigeron canadense,* a plant which is everywhere common in northern Michigan. The insect also breeds freely on daisies, golden-rod, and wild asters.

CUT-WORMS

Cut-worms are naked caterpillars which are the larvae of medium-sized, night-flying, winged moths or "millers." These larvae or "worms" have a habit of cutting off food and eating it after it has wilted. They normally are produced most plentifully in grass sod, several generations being produced in a season, and pass the winter for the most part as partially grown larvae, ready when spring comes to attack plants just coming up from the ground.

Except for climbing cut-worms, which ascend trees and vines and feed on the swelling and opening buds, these pests can be kept from such plants as tomatoes, cabbage, cucumbers, and the like by enclosing each plant or hill of plants in a paper barrier, sometimes called a paper collar. It is merely

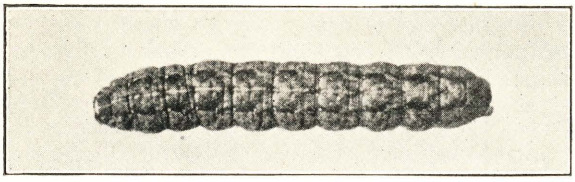

Fig. 3.—Climbing cutworm, *Lampra alternata.* Enlarged.

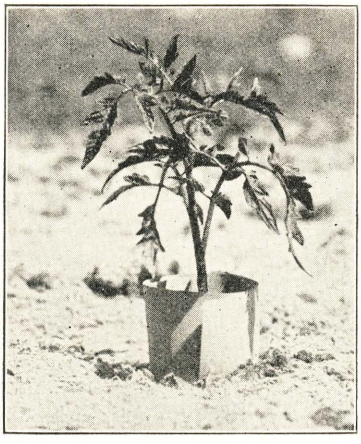

Fig. 4.—Tomato plant with collar of stiff paper for cut-worms.

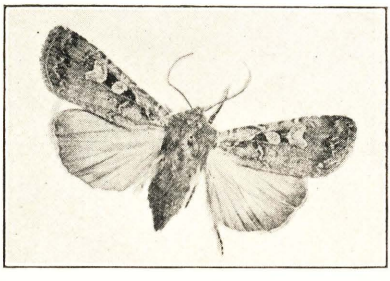

Fig. 5.—Adult moth of cut-worm.

a round collar of stiff paper placed about the plant and projecting into the soil for half an inch. It is effective because the common cutworms do not readily climb over such barriers.

Paper collars do very well for the protection of tomatoes, cabbage, and such plants, but when whole fields of potatoes, corn, and the like are to

be protected, paper collars are, of course, inadequate. In such cases, use may be made of poison bran bait, recommended for use in combating grasshoppers, merely omitting the salt. (See page 4.) Experience convinces us of the marked superiority of the improved formula.

The bait works best when broadcast in the evening in small particles and allowed to lie on the surface.

Fall plowing of grass sod is destructive to cutworms. For the climbing species, use the poison bran bait, and, in addition, place a band of tree-tanglefoot or some similar material about the trunk of the tree. In the case of grape vines, the wires near the posts must be similarly treated.

THE ONION MAGGOT

(*Hylemyia antiqua*)

The onion-maggot is a footless, white maggot, which tunnels in the bulbs and underground stems of onions, both seed onions and multipliers. The adults of these maggots are flies resembling house-flies, except that they are

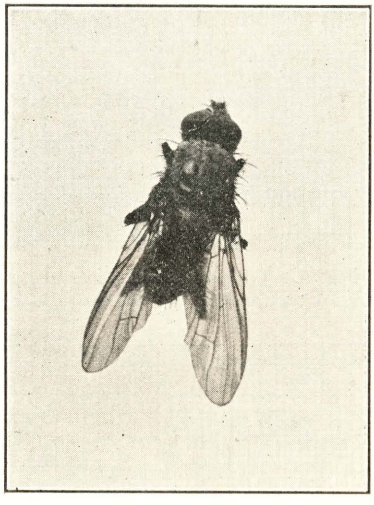

Fig. 6.—Onion maggot, adult fly. Enlarged.

much smaller. The flies lay their eggs on onion plants at the ground level, and from the eggs thus placed are hatched maggots that tunnel down into the onion bulbs. In a small way, it is possible to control the maggots just as one controls the cabbage-maggot in rows of radishes, using a solution of corrosive sublimate. (For directions see page 15.)

The high cost of the corrosive sublimate treatment, due to the cost of materials and the labor involved, has thus far operated against the popularity of the treatment and resulted in instituting a search for some agent which

can be applied rapidly as a spray, and which will not injure the plants if they also become wetted in the process of wetting the soil.

It has been found that several of the miscible oils used at the rate of two parts to 100 of water and that home-made emulsion prepared with caseinate of calcium or with Bordeaux mixture at the same rate serve well for this purpose. However, the main onion crop in Michigan is one of seed onions, and while one can effect a very satisfactory degree of control of the first generation of maggots by the use of these emulsions, when the second generation appears, the ground is so completely covered by the tops of the onions that it is impossible to get through with machinery to continue the treatment. Such a treatment has been found eminently satisfactory in Illinois, where "set onion" intended for use as green onions are grown in large numbers. It is believed that isolated fields of seed onions could be

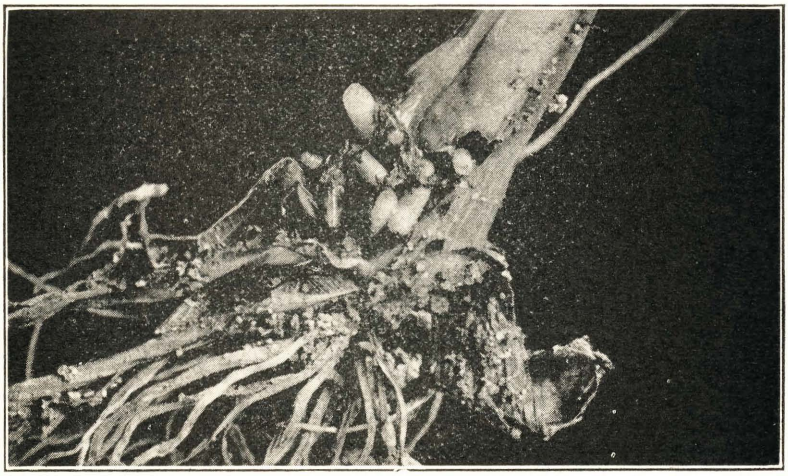

Fig. 7.—Onion maggott and its work in small onion, enlarged about twice.

so protected during the development of the first generation of maggots that the injury ordinarily done by the second generation could be ignored. However, the bulk of Michigan onions are grown in large tracts of muck land cut up into small holdings, so that almost continuous areas planted to onions extend for miles. It is obvious that under such conditions a redistribution of the pests will necessarily take place when the second generation of flies is developed so that little benefit is noticeable in treated plots at harvest time.

Recently made field observations conclusively prove that the most important source of infestation in Michigan commercial onion fields comes from cull onions left either on the ground, scattered or in piles, or about packing or sorting houses. An examination of such piles of cull onions discloses almost unbelievable numbers of pupae both in the piles of onions themselves or buried in the underlying soil. At the time when seed onions first appear above ground it is possible to stir up swarms of the adults of onion maggots from such accumulations of culls located at no great distance

from newly planted fields. One may observe flies laying eggs on the decaying onions, while others make their ways to new fields and deposit their eggs on the young plants. This process of laying eggs takes place over a considerable period of time. If onions free from maggots are to be grown, it is imperative that all cull onions be disposed of *immediately* after onion harvest. When cull onions are allowed to lie on the ground for even a few days, the maggots begin to leave the onions and to bury themselves in the soil a few inches beneath the surface, while others remain hidden among the culls. All culls should be disposed of immediately after harvest, and before the maggots have buried themselves in the soil. The destruction of the culls may be accomplished by burying under a foot or more of compacted soil, by fire, or in some special cases by boiling, either with steam or in some other manner.

Spring practice:—Early deep spring plowing will accomplish a good deal, although fall plowing is preferable.

It is obvious that any treatment should be followed out over large areas if best results are to be expected, although local treatment will more than pay for itself.

ONION-THRIPS

(*Thrips tabaci*)

The Onion-thrips is about one twenty-fifth of an inch long, having wings provided with rows of stiff bristles instead of membranes. These tiny, jumping creatures have mouthparts fitted for scraping and puncturing soft vegetable tissues, but not capable of truly chewing or of sucking in the ordinary sense. They peck and puncture and scrape, and then suck up the juices thus liberated.

The onion-thrips feeds freely on a long list of other plants, including cabbage, cauliflower, tobacco, alfalfa, and blue-grass. It passes through the winter on crop residues, and, no doubt, also under fallen leaves and rubbish. The insects are found also near greenhouses and often spread from greenhouses to the fields.

They so scrape and injure the surface of an onion top that it turns white and later wilts and "goes down," producing a condition known to the growers as "white blast." They are characteristically pests of hot, dry seasons, not thriving under cool or wet conditions. They produce five or six generations a year, each requiring from about three weeks to a month for development. Of this period, a part is passed in the egg stage, embedded in the tissue of the leaf. From the eggs come nymphs which are active and which mingle with adults and feed on the leaf surface. Between this active stage and the adult winged condition, there intervenes a period of underground existence, during which the nymph remains quiescent in a tiny cell under ground. There are, therefore, four stages in the development of each thrips. In order, they are:—the egg stage, the egg being embedded in the leaf tissue, and, therefore, safe from sprays; the active nymph stage, during which the insect feeds, and is exposed to danger from sprays; the quiescent nymphal stage, passed underground and protected from sprays; and, finally, the adult winged stage, active and exposed to sprays. Consequently, if a spray were to be applied in such a way as to kill practically all the thrips in sight, the field might, nevertheless, be full of thrips again in less than

a week. It is advisable to put on two applications of whatever contact insecticide is used, a few days apart, in order to kill the active thrips with the first application, and then to rely on the second application for the thrips that were either in the egg stage or in the resting stage at the time of the first application.

If a spray is used, it must be applied under high pressure in order to reach the axils of the leaves and to wet the insects thoroughly; hence a high pressure spraying outfit would be necessary, and such an outfit would damage the plants if dragged through the field.

A power duster also would leave its mark in an onion field, especially in a muck field, but a good hand duster can be made to do pretty well when the acreage is not too large, without very high pressure. For this reason, when one relies on nicotine treatments, the large-sized hand duster offers certain advantages over other rigs.

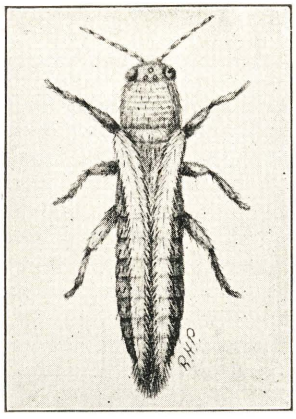

Fig. 8.—Onion thrips, greatly enlarged.

The most successful application thus far developed, and the application now in general use, consists of a spray or a dust of nicotine. If a spray is to be used, apply at the rate of one pint of nicotine-sulphate (40 per cent) to 100 gallons of water, with the addition of four pounds of laundry soap. If a dust is preferred, apply nicotine dust in the regular way. The writer would advise that two applications be made six or seven days apart.

CABBAGE-LOUSE

(*Brevicoryne brassicae*)

This insect is commonly found on cabbage, cauliflower, rape, and other plants of the mustard family, both cultivated and wild. It goes through the winter in the egg stage in cold climates and on plant refuse and wild plants in warmer climes. The control of the cabbage-louse is made difficult because of the waxy bloom or coating on the body of the insect, which pre-

vents the spray material from reaching vulnerable parts of the insect. On cabbage, where the outer leaves are to be removed before using, nicotine-sulphate (40 per cent) used at the rate of one pint to 100 gallons of water, in which five pounds of cheap laundry soap has been dissolved, is effective if applied under high pressure by means of a power rig. In case of cauliflower, after heads are formed, poisoning and scenting the exposed head must be avoided. Preliminary experiments with derrisol, used at a similar rate with Ivory soap, and applied warm, almost hot, give results of good promise. Freshly prepared, hot nicotine dust (2 per cent), applied through a large tin funnel-shaped chamber which is set down over the plant for a brief interval and which confines the fumes, has been successfully used by market gardeners in Michigan on cauliflower and cabbage.

THE FALSE CABBAGE APHIS

(*Rhopalosiphum pseudobrassicae*)

Until about 1914, the false cabbage aphis was confused with the common cabbage aphis, (*B. brassicae*). The two species are similar in appearance, and both habitually feed on plants belonging to the mustard family, including such plants as cabbage, radish, and turnips, and on a variety of weeds belonging to the same family. The bodies of both species are likewise coated with a waxy bloom. The false cabbage aphis is notably a pest of turnip and of radish, and our special interest in it is aroused by reason of the very great injury that it inflicts in fields of radish grown for seed.

Starting early in the spring with comparatively few individuals, its enormous fecundity enables it to produce whole armies of individuals during late summer and fall, which at times bring about the total destruction of fields of radishes grown for seed, sometimes causing losses which aggregate thousands of dollars in single fields.

When this insect occurs on cabbage, cauliflower, or similar plants, it is best controlled by using the same methods recommended for the control of the ordinary cabbage lice. (See page 14.) However, its presence in the tangled growth of a field of radishes, well along toward the time of harvesting the seed, demands something more effective. Under such conditions it is difficult to reach the undersides of all branches and leaves with a contact spray, and it is, therefore, advisable to depend on STRONG doses of some volatile dust, such as nicotine. Aim to reach as much of the plant surface as possible, at the same time depending on the volatile nicotine fumes to penetrate to all parts of the tangled growth and thus to kill the lice without direct contact. It is imperative that the nicotine, if in the form of a spray, be released in a volatile condition. To do this, add from 4 to 5 pounds of cheap soap to each 100 gallons of the mixture. Use 1 to 1½ pints of 40 per cent nicotine sulphate to 100 gallons of water, and reach into the growth with a spray rod so as to direct the spray upward. If a dust is employed, use at least a 3 per cent nicotine and hydrated lime dust, freshly mixed, and apply while still hot. Do the work in the absence of wind and when possible in the heat of the day, in order to give the nicotine an optimum chance to suffocate the pests. If cold dusts are employed, it may be necessary to use an even stronger mixture. In any case it is well to trail a long sheet of cheese-cloth behind the power duster, so that it floats over the tops of the

plants and tends for a short time to confine the fumes among the plants which have just received the dust.

CABBAGE-MAGGOT IN CABBAGE AND CAULIFLOWER

(*Hylemyia brassicae*)

Like the onion-maggot, the cabbage-maggot is the immature stage or larva of a small fly which resembles very closely the adult fly of the onion maggot. The cabbage-maggot feeds on plants belonging to the mustard family, including cabbage, turnip, rape, mustard, and a variety of weeds, including the wild mustards.

Fig. 9.—Adult flies of cabbage-maggot, greatly enlarged.

The eggs, which are laid on the stems of the plants at the soil level, produce maggots that work downward channeling and tunneling in the underground stems and roots. To reach and destroy these maggots, once they are underground, wet the soil about the stem and roots with a solution of corrosive sublimate (mercuric chloride) prepared by dissolving one ounce of the poison crystals in hot water and then diluting to eight gallons with cold water. Half a teacupful of the solution should be poured about the stem of each cabbage or cauliflower plant, either at the time of setting or within a day or two afterward. In case the plants are grown from seed sown directly in the field and then blocked out, the treatment must be made before the plants reach the size at which they are ordinarily planted. The treatment should be repeated twice at intervals of about a week. For making the application, use a wooden pail and a small enameled dipper, placing

about half a teacupful about each plant, as before stated. When the maggot occurs in radishes, the treatment is much the same, the solution being poured in a thin stream along the row, so that the soil about the plants is wetted. The treatment in this case also should be repeated several times at weekly intervals. If a little of the solution gets on the plants, they may be slightly burned, though such "burning" is not likely to cause much damage. The first application should be made when the plants show merely the first pair of leaves. No solution of greater strength than one ounce to eight gallons should be used, and very favorable results have followed the use of one ounce to ten gallons.

Corrosive Sublimate Is a Violent Poison, dangerous to all who handle it. It is the bichloride of mercury used as a disinfectant, and it possesses the property of combining with metals when in solution, quickly ruining the metals and itself breaking down as a result. It is, therefore imperative that all storage or dissolving of the poison be done in wooden, stone ware, or glass vessels, and that contact of the liquid with the metal of buckets or other metal implements or containers should be as brief as possible. All vessels containing the solution must be covered to prevent livestock, cats, dogs, poultry, etc., from drinking it. Furthermore, one must be careful about getting it on the hands and clothing, since some individuals are very susceptible to mercury poisoning. In making the application on radishes, a sprinkling-pot prepared by removing the "rose" or sprinkler and partly plugging the spout is effective. It is also important that the metal sprinkling-pot be coated inside throughout with wax, asphaltum, or some paint or water-proof material, to prevent contact between the solution and the metal of the sprinkler.

ANTIDOTE FOR CORROSIVE SUBLIMATE

Induce vomiting; give whites of eggs and milk. Send for physician.

TAR-PAPER DISKS FOR CABBAGE AND CAULIFLOWER

An older but, nevertheless, a dependable treatment for the maggots, either in cabbage or in cauliflower, lies in the use of tar-paper disks. The flies dislike these disks and seek other plants of the mustard family when they encounter them.

Secure a quantity of tarred building-paper and cut it into squares or circles from two to three inches across. Punch a round hole about one-fourth inch in size in the center, and then cut a slit from the hole to one side. A harness punch cuts a clean, round hole, and the writer uses one together with a pair of tinsmith snips to prepare the disks. In quantity, of course, it is best to buy them already prepared. Place the disk so that the stem of the cabbage plant comes up through the hole in the center, and press the disk down flat to the soil at the time of setting out the plants. The result is often 90 per cent or more of immune plants at a time when unprotected plants alongside are practically all lost.

CABBAGE FLEA-BEETLE

(*Phyllotreta vittata*)

Like all of the flea-beetles, the cabbage flea-beetle is small and inconspicuous, though very active, jumping long distances when disturbed. It is less than one-tenth of an inch in length and black in color, with a well-marked yellowish stripe on each wing-cover. The larva is long and slender, and mines in the leaves of young cabbage plants.

Remedy: The worst damage is inflicted by these little pests when the plants are young, and long before the heads are formed. At that time a spray of an arsenical or bordeaux mixture will serve to check them, the bordeaux acting as a repellant. After the heads appear, it is unsafe to use any of the arsenicals.

THE CABBAGE LOOPER

(*Autographa brassicae*)

Inconspicuous in its work, but, nevertheless, of some importance, is the cabbage-looper, so named because of the looping or measuring gait of the larvae. This pale-green, almost translucent larva reaches a size slightly larger than that of the common "cabbage worm." It is rather obscurely striped longitudinally. The larva walks with a looping gait, owing to the fact that there are no legs for the middle region of the body.

When full-grown, the larva spins a white, silken cocoon, sometimes under a leaf blade, often on some other object near at hand. After a time, the adult makes its way out of the cocoon. It is a winged moth or miller which spreads about one and one-half inches from tip to tip of the wings. It is brownish-gray in color, the front-wings being more or less transversely mottled, each front-wing bearing a small silver-white, well defined spot, the hind-wings being lighter in color and without mottlings.

The same remedies that apply to the common cabbage-worm (see page 19) will serve for the looper.

CABBAGE SNAKES

(*Mermis albicans*)

Alarming stories relative to the poisonous properties of "long, slender, hair-like 'snakes,'" which are found in the cabbage, are commonly circulated. These "fearful snakes" are the same creatures that are often found in watering-troughs and pools. They are known as "hair-snakes," believed by the uninformed to be animated horse-hairs. They really are parasites from the bodies of grasshoppers, crickets, etc., which pass part of their existence in the soil, the young gaining access to the bodies of grasshoppers or crickets early in their careers. (See page 3.) When a grasshopper is about to die from the drain put upon its strength by the parasite, the latter crawls out.

Some fall into the cabbages on which the hoppers happen to be feeding at the time when their strength fails. Such hair-snakes settle down into the cabbage head, finding a moist place wherein they manage to live for some time.

It is not at all likely that harm would result from eating a piece of hair-snake, but their presence in cooked food is naturally undesirable.

CABBAGE WORMS

(*Pieris rapae*)

White butterflies, the adults of the cabbage worm, are to be seen fluttering wherever there are plants of cabbage, cauliflower, rape, radish, turnip, mustard, or any member of the mustard family. There are three species found in Michigan; two native species, the northern white and the southern checkered white; and the imported white cabbage butterfly, which in numbers surpasses both of the other species.

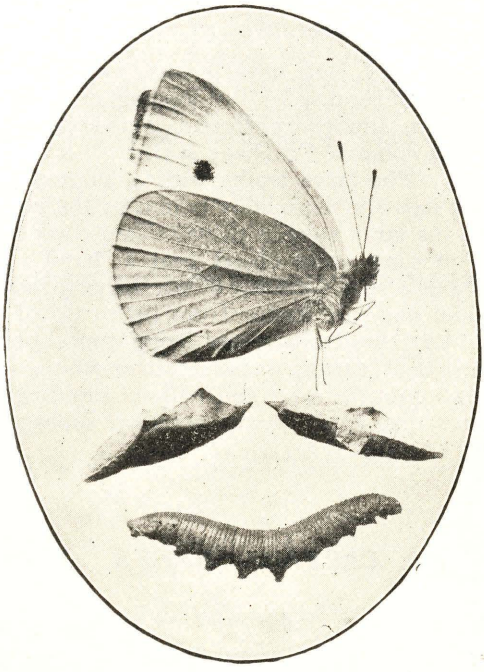

Fig. 10.—Imported cabbage-worm larva, pupae and adult, slightly enlarged.

The yellow butterfly of about the same size is not to be confused with the "whites," since its caterpillar feeds on clover and not on plants of the mustard family. One sees the white butterflies laying eggs on cabbage and its relatives, and soon afterward the well-known green or bluish-green larvae are to be found on the plants, where they are commonly called "cabbage-worms."

They eat holes in the plants, sometimes tunneling quite deeply into the heads, and changing to naked pupae, which are fastened by loops of silk to the undersides of leaves or on nearby objects. In a few days or weeks, these pupae, in turn, give rise to winged butterflies, except, of course, in the case of the over-wintering generation. Both adult butterflies and "worms" or larvae are to be found at most any time during the growing season.

The list of killing agents used against cabbage worms is a long one. In earlier times, soot, air-slaked lime, road-dust, cheap flour and many other dusts were used. Hot water had its day, and kerosene emulsion, to which has been added a little pyrethrum, is still used by some growers. The writer has, in the past, recommended several of the agents mentioned, but now we are recommending other remedies—not that either hot water or kerosene-emulsion will fail to kill, but because it is laborious to use hot water and dangerous to the plant, and because kerosene-emulsion is difficult to make and taints the cauliflower and cabbage if used late in the season.

Before the cabbage heads out very far, apply arsenate of lead or arsenate of calcium, either as a dust or spray. If arsenate of calcium is used as a spray, use one pound to 50 gallons of water. If arsenate of lead is used as a spray, use one and one-half pounds to 50 gallons of water. If, on the other hand, dusts are used, mix five pounds of arsenate of calcium thoroughly with 95 parts of hydrated lime; and if arsenate of lead is used, use 10 pounds of the arsenate of lead to 90 pounds of hydrated lime.

After the heads form well, use hellabore and hydrated lime, or hellebore and cheap flour—about one part of the hellebore to three or four of plaster, lime, or flour. The reason for the use of hellebore instead of arsenate of lead is merely that it is an organic poison whose effect is less permanent. The danger in eating the vegetable is thus greatly reduced, the poisonous principle of the hellebore breaking down on exposure to the weather.

THE PALE STRIPED FLEA-BEETLE

(Systena blanda)

Flee-beetles, as the name implies, have strongly developed jumping hind-legs, by means of which they are able to take long leaps after the manner of the common flea. They all belong to the family of leaf-beetles and feed on vegetation. The one in question, "the pale, striped flea-beetle," is very small, measuring about one-eighth of an inch in length, and is yellowish-brown in color. Down each wing-cover extends a yellow stripe. The prothorax is also yellow, the head brownish-red, the legs yellowish-red, and the under side of the body black.

While pre-eminently a pest of the sugar beet, in Michigan, this beetle makes its presence felt very forcibly on the garden beet, as well as on corn, beans, and potatoes. It is very fond of sorrel (ordinary red or horse-sorrel), pigweed or lamb's-quarter, rag-weed, and a great variety of cultivated plants and weeds.

The slender, thread-like larvae of this beetle are said by Chittenden* to feed on the roots of corn, lamb's-quarter, and probably also on the roots of Jimpson or Jamestown weed. They are white in color with a moderate number of hairs.

*Bulletin 23, U. S. Bureau of Entomology, Department of Agriculture.

Flea-beetles are pests during dry seasons, rarely doing serious injury during wet weather. The worst damage is done to beets while the beets are small, usually when they have about two leaves. Under such conditions, the beetles sometimes spoil quite large areas, usually in sandy regions. When the beets are larger, the insects eat out the soft tissue in patches, either on the upper or under surfaces of the leaves, after which the remainder of the patches dry up and fall out, leaving unsightly holes which increase in size as the leaf expands.

Remedy: Spray or dust with an arsenical, or, better still, spray with bordeaux mixture and an arsenical, put on at the ordinary strength,—arsenate of lead powder at the rate of one and one-half pounds to a barrel of water. Bordeaux, and arsenate of lime, one pound to 50 gallons, or paris-green, four ounces to 50 gallons, may be used instead of arsenate of lead,

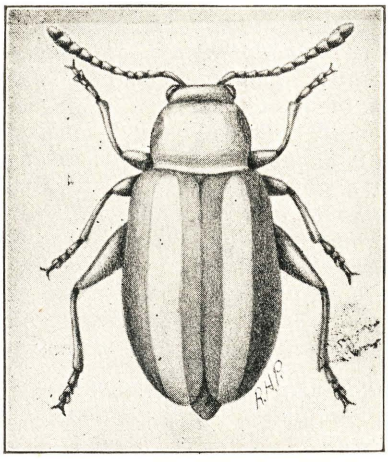

Fig. 11.—Pale striped flea-beetle, enlarged.

if preferred, at less cost and with even better results. A dust of arsenate of lime and hydrated lime should prove satisfactory, and in the garden will probably be the favorite treatment, because dusts are so easily applied, and the operation can be repeated from time to time without much preparation. Clean culture, including the burning of fallen leaves, and the destruction of all rag-weed, pig-weed, etc., will help to starve out this pest, in common with some other flea-beetles.

A method which has come into general practice in Michigan is to roll the field with roller or cultipacker while the beets are small and before blocking time. The rolling should be done during the heat of the day and not while the dew is on, because the plants are more brittle during early morning and more likely to be broken after they attain any size. Rolling should not be done after the plants get more than four leaves.

Hydrated lime applied as a dust, either with a duster or, if duster is not available, by the aid of a drill, acts as a very effective repellent to the adult beetles. Any method of application may be employed, so long as the dust is distributed evenly over the plants.

THE TRIANGLE FLEA-BEETLE

(*Disonycha triangularis*)

The triangle flea-beetle is so named because of the three dark, round spots placed in a triangular position on the orange prothorax. This beetle varies from about three-sixteenths to one-fourth of an inch in length. It is blue-black in color, with the exception of the orange prothorax before mentioned. It has the strong, jumping hind legs of its family. It works on the beet primarily and is controlled by the same measures that govern the pale, striped flea-beetle. In fact, it is usually found in company with the latter insect.

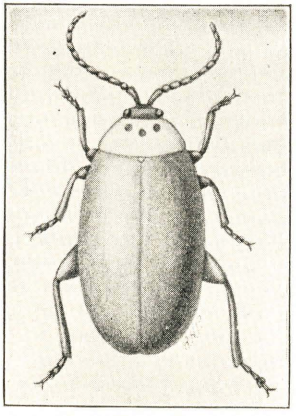

Fig. 12.—Triangle flea-beetle, enlarged.

THE GREEN PEA-LOUSE

(*Illinoia pisi*)

The Green pea-louse is an insect that is consistently increasing in importance in our northern states, and which is already the cause of severe losses to the pea canning industry and to growers of garden peas.

Like many other aphids, it feeds on a variety of plants, preferring alfalfa or red clover for winter-quarters and migrating to a variety of legumes or other plants for the summer. Each viviparous female is capable of giving birth to a large number of young, the record number being 147. The average number of young born to each viviparous female is, however, under 70, and the number of annual generations at our latitude about 10 or 12.

In the autumn, the lice are attracted to clover and alfalfa and possibly, in lesser numbers, to other legumes as well; and here a quantity of eggs are laid by oviparous females, after mating with males produced simultaneously. The eggs hatch out the following spring, producing viviparous females which multiply at the astounding rate just mentioned.

It is appalling to imagine just what would happen if all of these plant-

lice lived and reached maturity, the possible number being beyond our comprehension. However, there are a number of natural enemies which more or less completely keep the numbers down. These include syrphus-flies, lady-birds, a fungous disease, and several species of tiny, wasp-like parasitic creatures (*Lysiphlebus*) whose larvae develop inside the bodies of the aphids. These latter parasites are greatly influenced by weather conditions, warm, dry weather being favorable to the parasites, and cool weather being favorable to the plant-lice, merely because the parasites become inactive except in warm weather.

The character of the weather during the opening of spring exerts a very great influence on the magnitude of the pea-louse attack later in the season.

Fig. 13.—Pea-vines, showing effect of pea-aphis.

When spring begins to make itself felt, the eggs of the plant-lice on clover and alfalfa hatch out, producing viviparous females, which, if unhindered, soon begin to bear young. Multiplication is rapid, and if no parasites interfere, their numbers become noticeable in late May in Michigan.

If the season remains cool and the spring is "late," a great number of plant-lice are produced. If, on the other hand, the spring opens warm and fairly dry, then the parasites start work almost as soon as the plant-lice, and the plant-lice never have a chance to become plentiful.

The most practical artificial method of killing the pea-aphis at such a time is by the use of nicotine, and, in this particular case, the most effective and practical method of application would appear to be with a power duster. If a spray is used, the nozzles must be so arranged as to reach the undersides of the leaves, and this is almost impossible to accomplish without tearing the vines. The duster, on the other hand, directs a strong current of air downward at an angle with the ground, and this current which carries the dust, rebounds from the soil, flying upward and coating the under as well as the upper surfaces of the leaves. To confine the fumes of the free, volatile nicotine still more, it has been found practical to drag a long trailer of lightweight cloth over the dust nozzles, so arranged as to trail for a distance over the tops of the peas. This cloth trailer also serves to assist in preventing the drifting away of the dust, and its consequent loss. Because of the high cost of dusting with nicotine, and the fact that not all growers are provided with modern power dusters, many owners have not felt justified in dusting, except in instances where good, promising stands of peas were threatened with injury likely to amount to more than the cost of dusting.

The search for a more effective method of controlling the pea-louse is still going on. Fortunately, weather conditions are such in Michigan that only in occasional seasons do the aphids exact a severe toll.

THE ASPARAGUS BEETLE

(*Crioceris asparagi*)

The asparagus beetle, which was originally introduced from Europe, is a dainty little beetle, brightly colored and highly polished. It is about one-fourth of an inch in length, the wing-covers being reddish-yellow and cream colored, marked with black; and the thorax reddish-yellow with black dots. The larva is slimy olive-gray, with blackish head and legs. The elongate, black eggs, about one-tenth of an inch in length, stand on end on the young shoots of asparagus. They hatch in about eight days, and the young grubs or larvae excavate pits, which become discolored and impair the value of the stalks. In about two weeks, these larvae become full-grown and burrow into the ground to pupate, emerging as winged beetles after about eight days, the entire time required for the completion of the life cycle being about a month. Several generations are produced each year, and the winter is passed in the adult winged condition, under rubbish.

Remedy: Fields from which the shoots are being cut should never be treated with arsenical poison, because of the danger to human life. The practice of trapping the beetles on selected rows of shoots is one that has become nearly standard in commercial fields, having been practiced for

many years. Leave some young shoots for the beetles to lay their eggs upon, and cut and burn these shoots before they are a week old, in order to destroy the eggs. If patches or rows of such trap plants are systematically left over the patch, and if the shoots in these trap plots are carefully cut and burned just before the eggs hatch early in the season, there is usually little trouble as the season advances. As soon as the cutting season is over, the whole patch should be sprayed or dusted with an arsenical. All seedlings and feathery plants should be included in this general treatment. The development of nicotine dust has progressed to a point where we may expect with some confidence to see its use become practical in the control of this pest. A dust carrying two per cent of volatile nicotine, applied after cutting, should kill the insects on the youngest shoots with safety to the users. Late in the fall, all rubbish on and about the patch must be burned to kill the hibernating beetles. Fresh hydrated lime will kill the larvae, or slugs, if dusted on them, since the lime adheres to the sticky skins of the slugs.

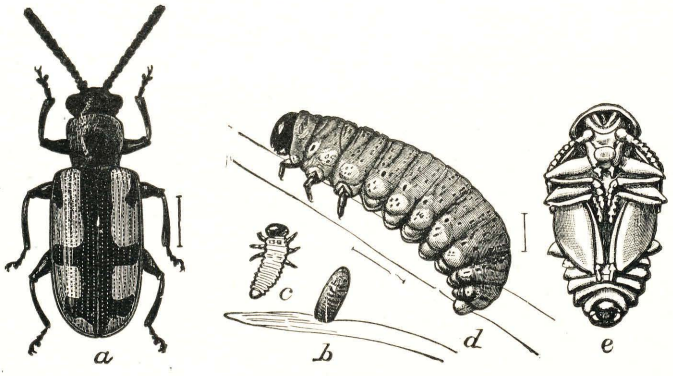

Fig. 14.—Asparagus beetle, enlarged. A, adult beetle; d, larva; c, young larva; b, eggs; e, pupa. (Chittenden, year book, Dept. Agr. for 1896.)

THE 12-SPOTTED ASPARAGUS-BEETLE

(*Crioceris duodecimpunctata*)

Often accompanying the common asparagus-beetle is to be found the 12-spotted asparagus beetle, a red-orange beetle a little larger than the common species and having, in general, similar habits. The 12-spotted beetle, late in the season, feeds inside the berries of the mature feathery plants and is, therefore, somewhat safe-guarded against sprays. However, the remedies suggested for the common asparagus-beetle are to be recommended for this species also.

THE GRAY FIELD SLUG

(*Limax agrestis*)

True slugs differ from land snails in that they lack shells. In Michigan there are four species of true slugs, which dwell out-of-doors. Two of them were introduced from Europe. Of these latter, the giant slug is to be found in some cellars and in root-cellars, as well as in a few greenhouses and forcing houses. It is, by no means, common here as yet.

The gray field slug, on the other hand, has managed to distribute itself pretty well over the state and to make itself felt wherever there are forcing houses, or where celery or lettuce, and, in some places, where potatoes are grown. This is especially true in damp locations.

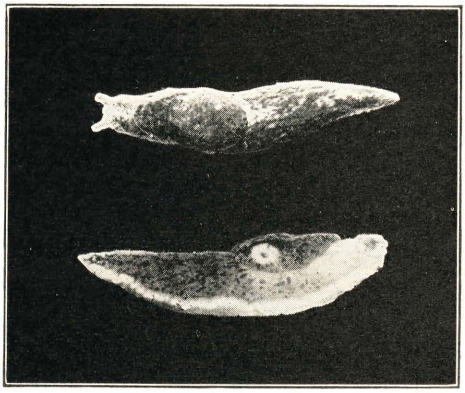

Fig. 15.—Gray field-slug, enlarged.

The slugs collect under boards or other shelter and attack the plants at night, scooping out cavities that often result in decay. In one case, they even burrowed down into the hills of potatoes and attacked the tubers underground.

Remedy: Kansas bait (See page 4) seems to be the most effective destroyer of slugs that has been proposed up to the present time. Sprinkle the poisoned bran about their haunts and about the plants to be protected.

A new formula for a bait which is said to have been used for snails (*Helix*) with great success in California calls for a mixture of arsenate of calcium, one part to sixteen parts of bran. The two are to be mixed dry and then moistened so that the bait will scatter nicely when tossed by hand. It should be applied in the evening, after a rain or after sprinkling. It is said to work best under moist conditions.

RHUBARB CURCULIO

(*Lixus concavus*)

The stems and large leaf-veins of rhubarb sometimes bear reddish-purple patches, more brilliantly colored than the natural purple and green of the stem. Such colored patches, if caused by the curculio, will show a wound usually near the center of the splash of color, and not infrequently a gummy exudate. On splitting the wound, it is sometimes possible to find an egg or a young grub buried beneath the surface. Such wounds are caused by a slender, black snout-beetle about half an inch long, the beetle being covered with a rusty powder easily wiped off.

Rhubarb stems mutilated in this way, either for the purposes of egg laying or by beetles which are merely feeding, are, of course, less valuable for table use, although the eggs and grubs are easily cut away. Eggs placed in rhubarb seldom if ever produce grubs which reach maturity, but eggs placed in dock do produce beetles. Furthermore, it is said that sunflower and thistle furnish suitable food for the normal development of the beetle. Aside from hand-picking, the destruction of these natural food-plants in the vicinity of rhubarb beds will help to keep the beetles in check.

THE COMMON STALK-BORER

(*Papaipema nitela*)

Perhaps no other insects are sent to this station for examination more often than the stalk-borers, and of all the stalk-borers one known as the common stalk-borer is ten-fold more common than all of the rest. As the name suggests, this little naked caterpillar tunnels in plants having pithy or hollow stems. Corn, dahlia, rag-weed, potato, tomato, rhubarb, aster, pig-weed, and a host of other plants are included in the weekly quota mailed in for examination. For the last two or three years, many of the samples have been supposed by the sender to be corn-borer, owing to the recent great interest in the latter comparatively new pest.

The common stalk-borer is a slender, naked, soft-skinned caterpillar which

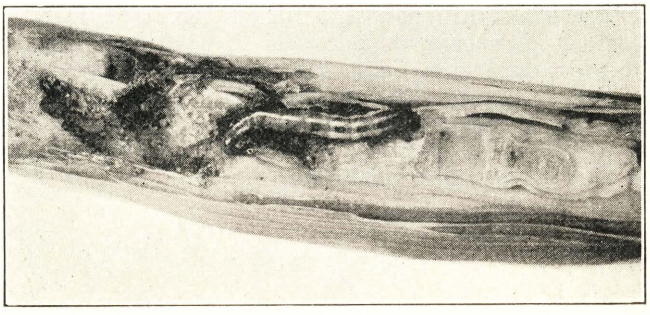

Fig. 16.—*Papaipema nebris* in corn-stalk, one of the borers easily mistaken for the European corn borer. Slightly enlarged.

sometimes attains a length of an inch and which is striped longitudinally with chocolate and cream-colored lines, except for the middle third, which is dark chocolate. This active, small larva pupates in its burrow and produces a winged moth late in the summer. The moth spreads about an inch and a quarter across its expanded olive wings. It is said to lay its eggs on ragweed and to pass the winter in the egg stage. In the spring the eggs hatch out and produce the larvae which are the cause of all the damage. There is but one annual generation.

Up to the present time, no adequate, satisfactory control measures have been discovered. The cutting and destruction by fire of all weeds, either late in the fall or early in the spring, would, undoubtedly, prove very much worth while, since it would do away with the over-wintering eggs. No other means of control suggests itself, except the destruction by hand of such larvae as can be found working in their burrows.

SQUASH BUG

(*Anasa tristis*)

Everyone knows the large, black stink-bug or squash-bug of the garden and field. Many have tried to kill it by sprays, dust-baths, and what not, but still the stink-bug flourishes. There seems to be no wash or powder that will kill the bug without, at the same time, killing the plants.

Fig. 17.
Squash Bug.

The eggs of these insects are red in color and quite large, and they are laid in patches on the leaves, for the most part on the underside. The young bugs that come from these eggs resemble the adults, except in their proportions and in size, although, of course, they lack the wings. The bugs not only attack the vines, piercing them with their long beaks, and extracting the sap, which alone is enough to seriously injure the plants, but, at the same time, they carry the germs of disease from one plant to another, thus inoculating healthy plants with the wilt, and possibly with other diseases.

Remedy: Plants grown under mosquito-netting escape the bugs, but such a measure is very expensive.

CLEAN CULTURE: In the autumn, after the crop is secured, the bugs continue to feed on the old vines for some time before the vines dry up and die. The writer has collected large numbers in such situations—young bugs, old bugs, and bugs half-grown. It is these young and vigorous bugs that hibernate and start new generations in the spring. The remedy is ob-

vious—destroy all old vines, such as squash, pumpkin, cucumber, and all vines of that family, just as soon as they have served their purpose. Either plow or burn, and do it THEN.

On cool nights, the bugs like to hide under shelters. Old shingles, placed on the ground near the vines, harbor dozens of the adults over night. Therefore, put out pieces of board and shingles and destroy the bugs early in the morning before they get to the vines. Jar the bugs off into pails of water having a little kerosene floating on the surface.

Calcium cyanide dust is said to be effective when used to kill the young bugs. This dust* is applied by means of an ordinary hand duster to the partially grown bugs on the ground under the plants, after they had been shaken or brushed off. Direct application of calcium cyanide dust to the leaves is to be avoided, because of the danger of "burning."

It is sometimes possible to effect partial control while the bugs are young by the use of nicotine and soap applied as a spray or by the use of a nicotine dust. The application should be applied to the base of the plant, to the bases of the leaves, or to the ground about the plant wherever the bugs are found to be hiding. Use one tablespoonful of 40 per cent nicotine sulphate to a quart of strong soap suds, if a spray is to be used. Cheap laundry soap which contains free alkali is preferable to soap of a better grade. The above proportions are intended for use with a hand atomizer. If a power sprayer is available, use 1 pint nicotine sulphate in 100 gallons of water with 4 pounds of cheap soap dissolved in the water.

Nicotine dust is best when freshly made and a 3 per cent strength is required.

Either treatment will probably have to be repeated from time to time.

THE SQUASH-VINE BORER

(*Melittia satyriniformis*)

The squash-vine borer would appear to be becoming more and more common in western Michigan. One finds the larvae or grubs tunnelling and feeding on the inner walls of either stems or the bases of the leaf stems, usually near the root, but occasionally at other points.

The larva is a naked white grub, which sometimes reaches the length of an inch, with a diameter of a quarter of an inch. This grub has a brown head with brown thoracic and anal shields. When full-grown, it burrows about two inches below the surface of the soil, where it spins its cocoon to remain during late summer and winter. There is believed to be but one generation in Michigan each year, and they are reported to infest both summer and winter squash as first choice, but also Cymlings, pumpkins, gourds, muskmelons, cucumbers, and wild balsam apples.

The tiny brownish eggs, which measure about 1/25 of an inch in length, are glued separately on the vine or leaf stems during late June or the first half of July. The larvae, which are at first tiny, bore their ways to the hollow stems and continue to feed there for about a month, after which they cut their ways out and bury themselves for pupation. The adult moth, which comes forth the following spring, has brownish front wings and almost

(*Cyanogas A. Dust) Jour. Econ. Ent. xx pp. 575-7.

transparent hind wings. It measures about 1½ inches across the expanded wings.

Remedy: Fairly good success in the control of this pest has been reported from the use of 3 pounds of arsenate of lead to 100 gallons of ordinary 4-4-50 Bordeaux mixture. This is applied from the time the eggs hatch, about the middle of June, until the latter part of July, success depending largely upon the care with which the treatment is carried out. Commercial growers, and sometimes those having small gardens, often practice covering the vine at various places along its length with a few hoefuls of soil at the joints. Most of these vines when covered with earth in this manner will strike root at the points covered, thus materially aiding the plant to withstand the strain put upon it by the mutilations occasioned by the borer.

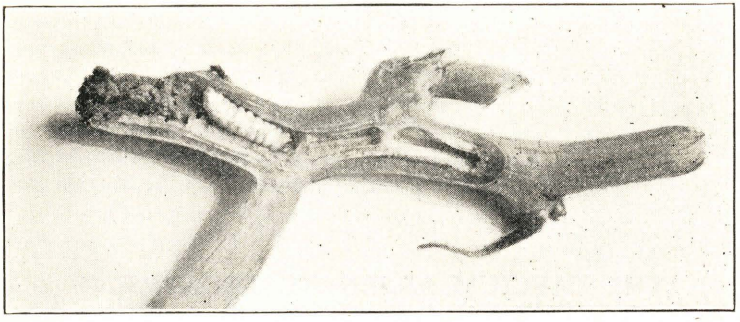

Fig. 18.—Squash-vine borer in tunnel in squash-vine.

It is obvious that a thorough cultivation of the soil after an infested crop has been harvested will destroy a large proportion of the pupae that are located an inch or two beneath the surface of the soil. It is also obvious that a thorough clean-up involving the destruction of all crop remnants immediately after the first killing frost or after the crop has been harvested, will help to reduce the number of borers that would otherwise survive and attack the vines the following year.

THE STRIPED CUCUMBER-BEETLE

(*Diabrotica vittata*)

The striped cucumber-beetle is a small, black and yellow striped beetle that feeds on the leaves of cucumber, cantaloupe, and other vines of like nature, attacking them as they come up and continuing to feed on them for weeks.

Not only do the beetles feed on the plants, but they also lay their eggs on the stems, and the grubs from these eggs burrow in the stems and roots. Furthermore, it is now known that the adults are largely responsible for the spread of wilt disease, a serious disease which destroys vines of cucumber,

squash, cantaloupe, and their allies. The ravages of these little beetles, which often appear in swarms, and the annoyance resultant upon their depredations in the garden, have led to the adoption of many remedies,—among them, a dusting with hydrated lime to which has been added a little turpentine, nicotine dust, air-slaked lime and sulphur; and a host of other forms of dust, all of which are more or less helpful.

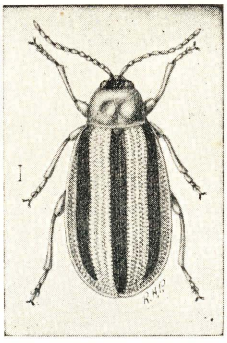

Fig. 19.—The striped cucumber-beetle, greatly enlarged.

THE CALCIUM ARSENATE TREATMENT

The most effective and likewise one of the cheapest of all remedies known to the writer is made by thoroughly mixing five parts by weight of calcium arsenate with 95 parts of agricultural gypsum, and applying this through a shaker—using either a gallon bucket with a few small holes punched through the bottom, or a small sack of coarse cloth. Gypsum is too dense, or heavy, to pass effectively through a duster, but it may be applied very rapidly through a shaker; and the beetles feed freely on gypsum dust, while they seek to avoid a dust containing lime, no doubt because of the disagreeable taste of the latter. A superior grade of twice ground gypsum, prepared expressly for dusting purposes, is now on the market. To mix thoroughly either type of gypsum with poison, in the absence of a mill, either place the powder in an old rotary churn with a few large pebbles and turn for an hour or so, or else sift repeatedly through a coarse sieve.

Apply as soon as the beetles appear and continue dusting until the plants are well grown.

MELON LOUSE

(*Aphis gossypii*)

Everyone who grows cucumbers, squash, or melons in Michigan, may expect sooner or later, an attack by the melon louse or cucumber louse. In the South, this same insect is known as the cotton louse, and still farther south one finds it working havoc on citrus trees. It is generally known that many of our aphid enemies, divide the time between two classes of plants, the

winter being passed in the egg stage, usually on a woody perennial, and the summer on one or more sappy annual plants. Usually, the summer forms reach maturity early, and consist altogether of females which bear their young alive, and which multiply very rapidly. Such an insect is the melon aphis.

It was recently discovered by Dr. Edith Patch, Entomologist of the Maine State Experiment Station, that this aphid, at least in the North, passes the winter in the egg stage on "live-forever" or orpine (*Sedum purpureum*) the eggs being laid by wingless forms—the offspring of winged lice—which fly back to the "live-forever" in late summer and early fall. From the "live-forever," winged individuals migrate back to the melon and cucumber fields the following summer, feeding on a wide variety of other plants in the absence of cucurbitaceous plants (members of the gourd family) which are preferred by the melon louse.

It would appear that the presence of "live-forever," either growing wild or in flower beds, cemetery lots, or in fact, anywhere, constitutes a liability and a menace in districts where cucumbers, squash, or muskmelons are grown, especially where they are grown in commercial quantities.

Under existing conditions, we must expect to have to deal with the pest direct; that is, on the vines, and in Michigan where quanities of cucumbers are grown for pickling the necessity for drastic action and effective control measures is at once apparent.

The best method of control at command consists in a thorough spraying or dusting with nicotine, using one pint of 40 per cent nicotine sulphate to 100 gallons of water, with four pounds of common laundry soap; or, in case it is desirable to apply the nicotine with bordeaux, omit the soap. The spray should be directed upward from beneath in order to reach the aphids on the under sides of the leaves, or, in case nicotine dust is used, one finds it much easier to reach the under sides of the leaves effectively, and one obtains a much better "kill" if the dust is applied liberally and forcibly. A power duster possesses advantages over a smaller hand duster.

The cucumber louse usually starts working in a field in a more or less restricted area, and then spreads over the entire field. Under such conditions, one can sometimes clean up an infestation by very thorough dusting or spraying in the patches first attacked; at least, one can often slow up the spread of the aphids by the use of a hand rig, when the attack first starts in one or more small areas, and before the field is completely infested.

THE POTATO APHID

(*Illinoia solanifolii*)

Among the plant lice found on potatoes, the true potato aphid stands out preeminently as affecting the crop. The females sometimes reach one-sixth of an inch in size, and in color they vary from green to pink. Both winged and wingless individuals occur on potatoes.

In the autumn, winged forms of the potato-louse fly to rose bushes, usually wild roses, and fasten their dark, glistening eggs to the bushes. From such eggs are hatched a multitude of aphids in the spring; so that the potato lice that one finds on the potato plant and its allies come from the over-wintering eggs found on roses. No more eggs are produced until the fol-

lowing autumn, at which time many lice fly back to the rose plants for the purpose of depositing eggs. On the potato, the lice bring forth their young alive, generation after generation, at short intervals; so that if cool weather prevails with plenty of moisture, the attack is likely to develop into very serious proportions.

The direct effect of an attack of the potato aphis is serious. When hordes of the tiny creatures suck the juice of the potato plants and concentrate on the new growth, a marked loss of vigor in the plant is sure to result, if, indeed, the plants are not killed outright. Aside from this injury, the potato louse is capable of transferring the virus of disease from a sick plant to a healthy one, the mosaic in particular being transported by aphids. It is not inconceivable that in the years to come we shall arrive at the conclusion that the extra labor made necessary, and the loss entailed by the potato aphis and mosaic will make it worth our while to eradicate the wild rose, at least in districts where seed potatoes are commercially grown. Such a course would, undoubtedly, relieve the grower of much labor and expense, besides reducing to a minimum the losses now endured. In the meantime, use 40 per cent nicotine sulphate, at the rate of one pint to 100 gallons of bordeaux; or use one of the other similar sprays with bordeaux, applying thoroughly so as to hit each louse; or else use 2-3 per cent nicotine dust whenever the lice appear in large numbers. The only reason that a contact spray, such as nicotine, is not recommended as a regular routine treatment, is because of its high cost. Bordeaux alone is less efficient; but it is valuable as a fungicide and pays for itself as well in giving a partial control of the aphis.

POTATO LEAFHOPPER

(*Empoasca fabae*)

Potato leafhoppers are small, slender, green creatures, about one-eighth of an inch in length, which jump freely when disturbed, and which feed on the foliage of potato and a variety of other plants. These tiny insects collect in potato fields during hot, dry seasons and produce tip-blight or hopper-burn.

The life history of the potato leafhopper is still something of a mystery. It is reasonable to believe that it passes the winter under fallen leaves and rubbish, since some of its near relatives do so. It is now known to feed on a variety of plants other than potato, including egg-plant, rhubarb, dock, bean, clover, alfalfa, and apple, seeming to prefer bush-bean during the early part of the season, and migrating to the potato after the season becomes warm.*

Hopper-burn of potatoes appears as brown, and later as blackened areas at the tips and borders of the leaves, which finally curl up and die, interfering seriously with the crop of tubers.

In the early part of the season, when the hoppers first appear in the fields and before they acquire wings, it is possible to kill them by a spray of nicotine-sulphate, using one pint of the 40 per cent nicotine-sulphate to 100 gallons of standard bordeaux-mixture. Any spray for potato leaf-hopper should be applied so that both the upper and under surfaces of the leaves

*Prof. D. M. DeLong, Columbus, Ohio, Journal of Economic Entomology, Vol. 21, No. 1, February, 1928.

will be hit and thoroughly moistened. However, the expense of spraying repeatedly with nicotine is high, and it therefore seems advisable to depend, instead, on discouraging the leaf-hoppers by spraying the foliage with bordeaux-mixture. The regular 4-4-50 bordeaux-mixture, or better still, the 5-7½-50 mixture, acts quite efficiently as a repellent for leafhoppers, and ordinarily it is possible to keep them sufficiently in check with one of these to raise a profitable crop. In any case, it is necessary that the spray be generously applied, both on the upper and lower surfaces of the leaves; and in an ordinary season the spray must be repeated from time to time. The experience of the past few years has demonstrated conclusively that plants

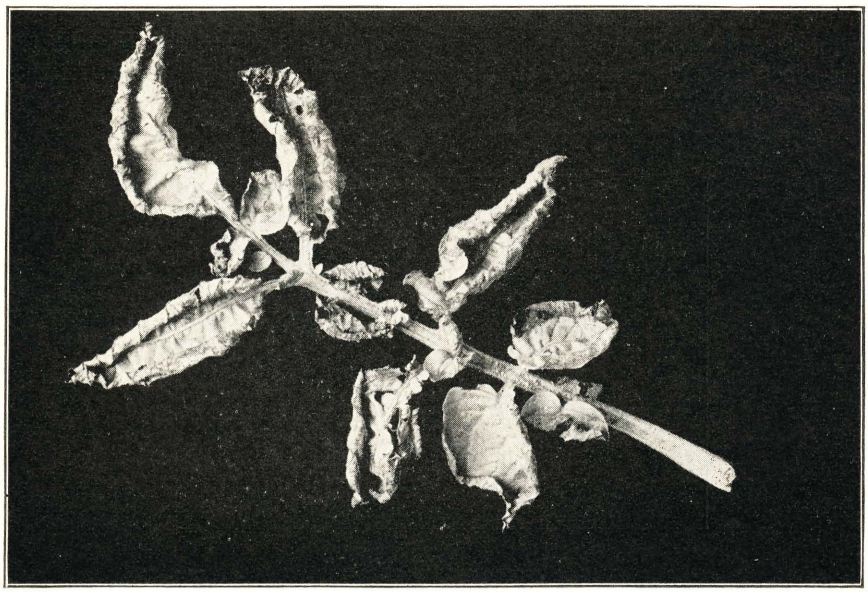

Fig. 20.—Potato leaf, showing hopper-burn.

so sprayed are greatly benefited and come through in much better condition than those unsprayed.

Many different kinds of leafhoppers pass the winter in rubbish, and while there is some doubt at present as to the exact habit of this particular pest, nevertheless, it is advisable to rake up and destroy by fire as much of the rubbish in fence corners, and wherever fallen leaves accumulate, as possible. This should be done late in the fall, after the insects have retired and hidden away for the winter, and while it is cold enough to discourage them from flying away during the raking up process.

The formula for making standard bordeaux-mixture is given on page 72 in this bulletin.

THE POTATO-BEETLE

(*Leptinotarsa decemlineata*)

The common potato-beetle is a native of the Northwest, where it has ranged since early times on wild plants belonging to the potato family. Late in the nineteenth century, this potato pest worked its way across the continent, and, finding an abundance of potato fields in the East, it created such a disturbance in farming communities that the necessity of devising new and effective methods of poisoning insects at once became apparent. Born of this necessity, there arose a variety of poisons, more or less effective, from which one finally stood out as superior to all the rest. Paris-green gradually came to be regarded as first choice, and up to the present time paris-green is still freely used for dusting and spraying potatoes, though arsenate of calcium is now conceded to be superior.

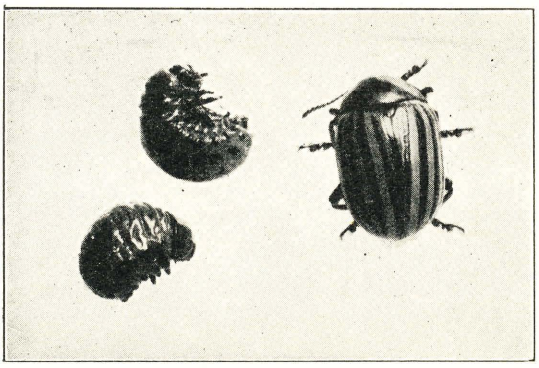

Fig. 21.—Potato-beetle; adult beetle and larva, enlarged.

The oval, highly arched beetle with its wing-covers decorated by 10 alternate, yellow and black lines, is commonly known. Two generations develop each year, and from the eggs laid by these beetles come the equally familiar red slugs. Both the adult striped beetles and the slugs devour potato plants. During the winter, the adults hibernate underground, or, less often, underneath fallen leaves and rubbish. They come out in the spring, and, after feeding for a little, they lay their orange-colored eggs on end in groups, usually on potato plants. The larvae or slugs burrow underground when full grown, and those hatched early in the season mature in time to become the parents of a second generation in late summer.

Control

A spray or dust of an arsenical will easily control potato-beetles. Such a spray or dust is applied to the potato plants and freely eaten by both larvae and adults. There remains, however, some choice as to which arsenical to use. The poison is practically always applied in standard 4-4-50 bordeaux, or something that takes its place, if a dust is used. If a spray is

to be used, the first choice would be arsenate of calcium, using one pound to 50 gallons of bordeaux mixture. The next choice would be paris-green at one-half that strength, and last of all would be arsenate of lead used twice as strong.

If a dust of arsenate of lime is selected, use 5 per cent of the powder, or, as second choice, use 10 per cent of arsenate of lead. Paris-green is coarser than any of the other commonly used poisons, and hence does not stick quite so well. Calcium arsenate costs least of all, sticks as well as any, is lightest of all in weight, and a pound goes further than any of the rest, except paris-green. See section on calcium arsenate on page 73.

BEAN MAGGOT

(*Hylemyia cilicrura*)

Closely related to the cabbage-maggot and to the onion-maggot, is the bean-maggot, sometimes known as the seed-corn maggot. In appearance, all three species resemble one another very closely, but, in habit, differences exist that call for entirely different control measures.

In Michigan the great majority of the bean-maggots pass the winter in the maggot stage in the roots of clovers and in fresh manure. At any rate, they are to be found in clover roots at the time when beans are planted, and, quite naturally, when beans are put on recently plowed, infested clover sod, the maggots simply move over from the dying clover roots to the fresh sprouting corn and bean plants. The writer has seen bean plants (deeply planted) fairly riddled by the maggots, even before they appeared above the surface of the soil.

Fig. 22.—Very young bean plants attacked by bean maggots.

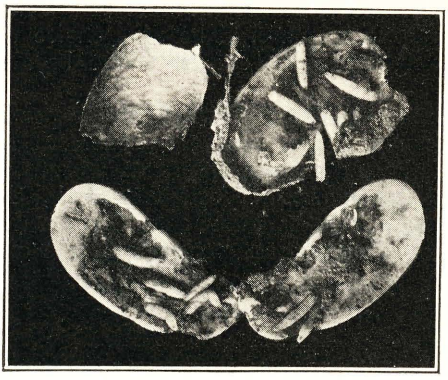

Fig. 23.—Work of Bean Maggot in sprouting beans, taken from infested field, enlarged.

Conditions favorable to the bean-maggot, from the maggot's standpoint, are late spring plowing (so that the larvae do not have time to pupate before the beans sprout), fresh manure, clover straw on or in the soil, and deep seeding.

Therefore, it is recommended that bean land be plowed in the fall or EARLY spring, that it be fertilized with ROTTED manure, and that the seeding average little more than one-half inch deep, in order that the beans may be enabled to appear above the ground before the tiny bud, which is to be found between cotyledons, is eaten off. Alfalfa roots are fleshy and serve to nourish the maggots much longer than do roots of June clover or of any of the other clovers. Therefore, if alfalfa land is to be used, plow it in the fall. Canada thistles seem to serve the same purpose, and, for this reason, it seems advisable to plow land infested with thistles in the fall.

The later generations of maggots seldom if ever do much damage to beans; since the bean-roots are less succulent by the time the maggots appear.

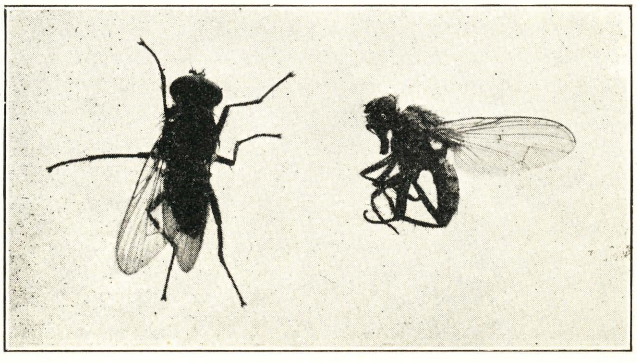

Fig. 24.—Adult of bean-maggot, enlarged about four times.

CARROT RUST-FLY

(*Psila rosae*)

The carrot rust-fly is a small, greenish fly, sparsely covered with short, yellowish hairs, and is of European origin. It was first discovered in Canada in 1885, and is a serious pest of carrot, parsnip, and celery, being also found on parsley and wild carrot. It is recorded as well on potato,

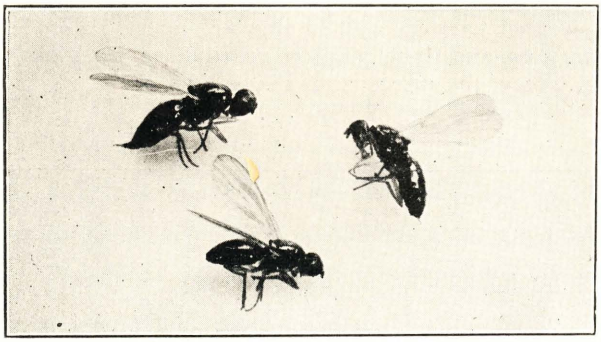

Fig. 25.—Adult of carrot rust-fly, enlarged about three times.

turnip, and rape. It is now known to be present in a number of the north-eastern and north central states, including New York and parts, at least, of New England. It is also reported from Oregon. The injury is done in the larval stage by a small, slender, yellowish-brown maggot, measuring about one-third inch in length.

This tiny maggot is hatched from an egg laid in a crevice in the soil or on the crown of the plant itself. The maggot works downward and eats most of the small roots before finally attacking the tap root. In the case

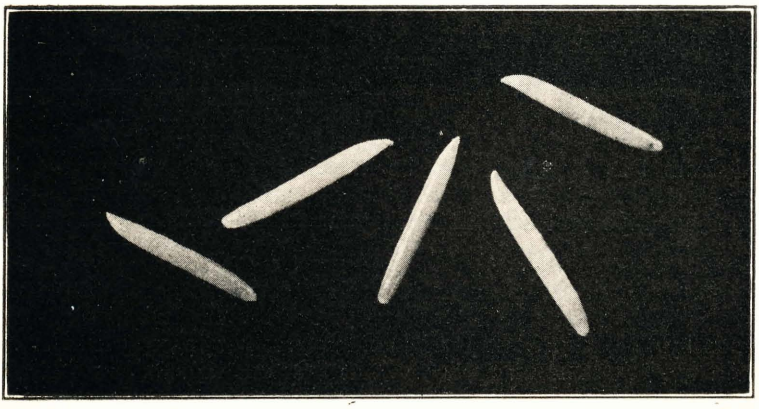

Fig. 26.—Maggots of carrot rust-fly, enlarged about three times.

of plants having fleshy tap roots, one finds such roots tunneled, and rendered unfit for food while, in many cases, the exterior of the root appears uninjured.

The insect passes the winter in the pupal stage, buried in the soil to a depth not to exceed six inches. The emergence of adults commences late in May and continues until early in July. Most of the flies, however, appear in early June, the females laying eggs shortly after they emerge. The larvae feed for a period of from one to two months, most of them, however, entering the soil for pupation by the middle of July.

There are two well-marked generations, the second generation appearing in early August and continuing to produce adults until early in September. It often happens that parsnips and carrots are placed in storage while they still contain maggots, and these maggots continue to work in the roots while in storage. In celery, the insect is said to eat off the roots, thus killing the plant.

Fig. 27.—Work of carrot rust-fly in carrots.

This important pest of carrots and celery was discovered in Michigan for the first time at Sault Ste. Marie in June, 1914. Its work there seems to have been confined to a small area, and nothing more was heard of the insect until December, 1929, at which time specimens were sent in from Alpena, and several acres of carrots were reported as seriously injured. During December, 1930, another report, accompanied by specimens was received from Petoskey. It is to be hoped that carrots from the infested regions will not be allowed to reach districts where celery is grown, as celery constitutes an important crop in Michigan.

Remedy: The destruction of wild carrots along roadsides and in fields not under cultivation suggests itself at once as a restrictive measure very much worth while. In New York, it has been found possible to dodge the broods by planting about June 1 and harvesting in early September. It has been stated that the maggots work at first on the small roots before attacking the main roots. This makes it possible to leave the carrots in somewhat longer than if the attack were made immediately on the tap root.

In case of small acreages, the treatment with 2 per cent Bordeaux oil emulsion, using several applications at intervals of one week, is said to give some measure of protection. This treatment is identical with the treatment recommended for the control of the onion maggot and consists of wetting the soil about the roots with the oil emulsion.

Deep, fall plowing after the crop is harvested undoubtedly will dispose of many of the larvae and pupae in the soil. Destruction of all roots found to be infested in storage will undoubtedly take care of many more. It is to be regretted that, up to the present time, no satisfactory and practical control for the pest when working in celery or in carrots has been developed, other than that mentioned. Until such control measures are discovered, it is advisable to grow susceptible crops in districts where the maggots exist, under the most rigid, sanitary conditions.

THE BEAN WEEVIL

(*Mylabris obtectus*)

The beetle lives over the winter in stored beans, and sometimes in peas. It flies to the young bean plants (unless we carelessly sow infested beans, when it does not even have to fly) and feeds on the young plants until the

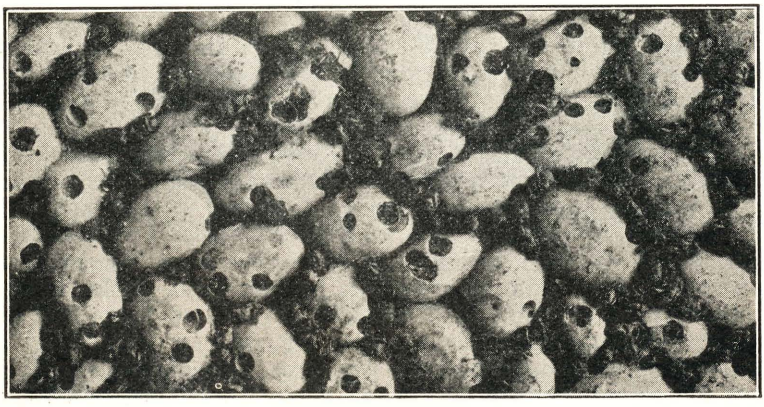

Fig. 28.—Beans infested with bean-weevil, slightly enlarged.

pods are formed. At this time, eggs are laid inside the pod, the beetle boring a hole right through the pod. Soon the grubs from the eggs enter the young seeds, feeding therein and remaining there until the beans are harvested. In due time the grubs change to beetles and bore their way out, sometimes several from one bean. If the weather is warm, or if the beans are stored in a warm place, the new crop of beetles soon lays eggs and fresh seeds are attacked, the process going on until nothing remains but a worthless, evil-smelling powder. Clean beans stored near infested ones are practically sure to become infested, since the pests work in stored seeds just as well as in the field.

Treatment: Perhaps some beans will escape treatment, but our SEED BEANS should always be free from weevils. In order to make sure, all seed beans that contain weevils should be fumigated.

The treatment can be made at little cost. Carbon disulphide (bi-sulphide of carbon) kills the weevil very efficiently. The makers furnish it in 50 pound drums, or it can be bought in small quanities from retailers. Use about one pound for 50 bushels, in a tight bin. (For directions for fumigating see page 73.)

THE PEA WEEVIL

(*Mylabris pisorum*)

The pea-weevil works much like the bean-weevil, but it does not work in dry peas. It confines its work to growing peas attacking them in the field. One beetle only develops in a pea. The bean-weevil is smaller and works both in peas and in beans. Often several of the bean-weevils develop in one seed. The treatment for the pea-weevil is the same as that for the bean-weevil.

THE MEXICAN BEAN BEETLE

(*Epilachna corrupta*)

The Mexican bean-beetle, which has newly arrived in Michigan, attacks all sorts of cultivated bean plants and if left unchecked is likely to prove a very serious enemy of string-beans, snap-beans, common white beans, and limas.

The beetle belongs to the group of ladybirds. It is larger than the commoner ladybirds with which everyone is familiar, being about a quarter of an inch in length,—sometimes even more. It is oval in form and its highly arched, yellowish, or orange-brown wing covers are each ornamented with eight irregular black spots, arranged in three rows across the back, making 16 spots in all. The larva, or immature, feeding form, attains a length of about one-third of an inch. It is elongate, elliptical in form, and its back is decorated with branching spines. (See Fig. 30.)

Like so many of our most destructive pests, the adults pass the winter sheltered under dead plants or hidden in all sorts of trash and rubbish, notably in wood-land or other places in the vicinity of bean fields. The beetles are strong fliers and drift on the wind for miles.

They commence to leave their winter quarters early in the spring, in time to feed on the young bean plants, and to lay their eggs in loose clusters on the under surfaces of the bean leaves, sometimes as many as 50 being found in a cluster. Other individuals delay their operations for a month or more, so that the egg laying occupies quite an extended period, beginning when the bean plants first appear above ground and continuing for several weeks.

While the beetle prefers the common bean, along with lima and string beans, it does not confine itself to these plants.* It can maintain itself on

*Farmers Bulletin No. 1407, Bureau of Entomology, U. S. D. A., by Dr. Neale F. Howard.

beggar weed or beggar tick, on cow-peas, and on soy-bean. It also feeds on other beans, and not so freely on alfalfa and sweet clover. In some cases the larvae have been found feeding on velvet bean, crimson clover, corn, grasses, potatoes, squash, and other plants and weeds. Michigan may expect to be obliged to endure two generations and perhaps a small third generation.

Both the larvae and adults feed on the under surfaces of the leaves, skeletonizing them and producing a new crop of adults early in August. By the middle of August, there appears a second generation of larvae which pupate and become adults in time to hide themselves in trash and rubbish for the winter. Besides this, there may be a late third generation of comparatively small importance.

Fig. 29.—Work of larvae on underside of bean-leaf, with pupae, slightly enlarged.

Control Measures

The habit of the Mexican bean-beetle of hibernating in debris and rubbish at once brings to mind the value of raking and burning all trash, both in the vicinity of bean fields and elsewhere where the beetles are found to be congregating. This may be in the vicinity of wood-lots, along ditch banks, along fences, wherever fallen leaves have drifted into scrub ground or brush, or in other places where a search shows the beetle to be hiberating. All fields of string beans or any fields where the beans are picked in the pod should be plowed as soon as the crop is over. The importance of care in preparing the seed-bed cannot be over-estimated. Thrifty plants growing in fertile soil will withstand the hazard of an attack far better than less vigorous plants.

Sprays and Dusts

A spray or dust, to be effective, must be so applied that it will coat the under surfaces of the leaves. Both the beetles and the larvae feed on the soft, under surfaces of the leaves, and no spray applied to the upper surface

will prove effective. Furthermore, the bean is very sensitive to arsenical poisons. Results from experiments in other states lead to quite a diversity of opinion as to the choice of the best poison to use, as to the dose which will kill the insects and which will do the least injury to the sensitive plants, and as to the most practical and least expensive method of application to obtain maximum results for the least cost. In making this preliminary selection of spray materials and methods of application, we are forced to depend on the experience of other workers who have had an opportunity to carry on operations on a commercial scale.

It happens that a multitude of attempts have been made to gain control by means of a variety of sprays and dusts, and of all of these it would seem that lead arsenate, paris-green, and zinc arsenite should be excluded from the list of killing agents to be used on beans, at least until or unless further trials prove that they are safer to use than is now believed. Of the remainder, the most promising appears to be magnesium arsenate, applied as a spray at the rate of one pound to 50 gallons of water.

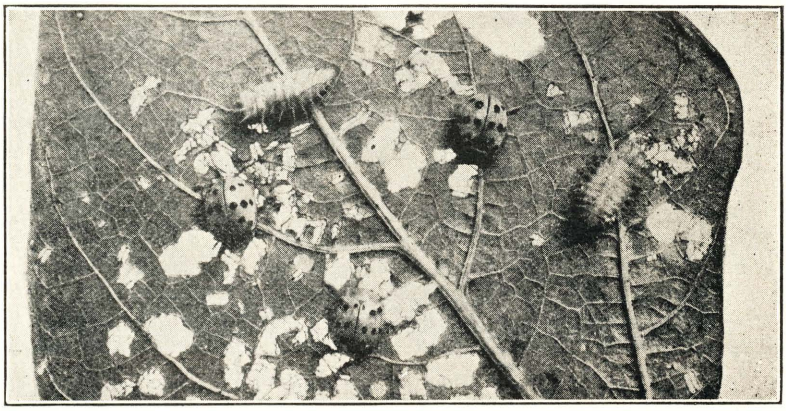

Fig. 30.—Larvae and adults of Mexican bean-beetle, with their work. Natural size (from Bureau of Entomology, U. S. D. A.).

This selection is subject to change as time goes on, for other treatments of greater value may be developed. However, at the present time the writer can suggest nothing better, after consulting a multitude of published reports and after corresponding freely with entomologists working in infested areas. The recommendation here given is that favored by Dr. Neale F. Howard, Associate Entomologist in charge of Mexican Bean Beetle Investigations of the National Bureau of Entomology.

Warning

All string and snap beans which have received a poisonous spray must, of course, be scrubbed before being used, and no bean hay or bean pods can be used for feed or placed in the silo after having been sprayed or dusted.

Do not use arsenate of lead, arsenite of zinc, or paris-green on bean plants.

DIMPLE BLEMISH OF BEANS

Fig. 31 shows a very common blemish found in white beans, a blemish whose cause was until quite recently a mystery. Beans are occasionally found with depressed areas, sometimes with a puncture at the bottom of the depression, and sometimes with the surrounding skin torn and burst. The injured area is usually discolored and the bean so blemished as to be unattractive.

In 1918 and 1919, Dr. I. M. Hawley, of Cornell University confined several species of suspected "bugs" or Hemiptera in cages with growing beans and produced blemishes in no way differing from those under discussion. He found that *Adelphocorus rapidus* produced the typical lesions

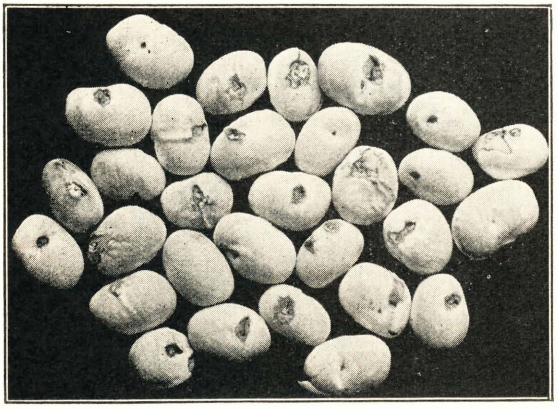

Fig. 31.—Dimpled beans.

and blemishes. The injury is perpetrated while the pods are still green but not full-grown. These bugs belong to the family *Miridae* and are most plentiful in places where lamb's-quarter and rag-weed are allowed to grow. It would seem, therefore, that the destruction of these two weeds would aid in avoiding the pest.

MINT FLEA-BEETLE

(*Longitarsus waterhousei*)

Aside from the attacks of cut-worms, grasshoppers, and a small jumping beetle, known as the mint flea-beetle, neither the peppermint nor the spearmint crops are frequently called upon to endure attacks by insect enemies.

The last named insect is tiny, about one-twelfth of an inch long, and in color a pale brown. As the name suggests, the beetle is provided with strong hind-legs, fitted for pumping. This jumping habit has become so fixed as the habitual method of locomotion that the male beetles have lost the power of flight, the membranous wings being entirely lacking. The

larger females still possess wings but seldom if ever use them, prefering to jump or crawl, as do the more active males.

The eggs of the mint flea-beetle are laid in the soil, during late summer and autumn. Here they remain until the following May, when they hatch out into slender larvae each about a fifth of an inch in length and white, with a shining pale-brown head. These larvae feed on the rootlets and tunnel in the roots and underground stems, sometimes working up above the ground level for an inch or more. Peppermint plants take on a deep purple

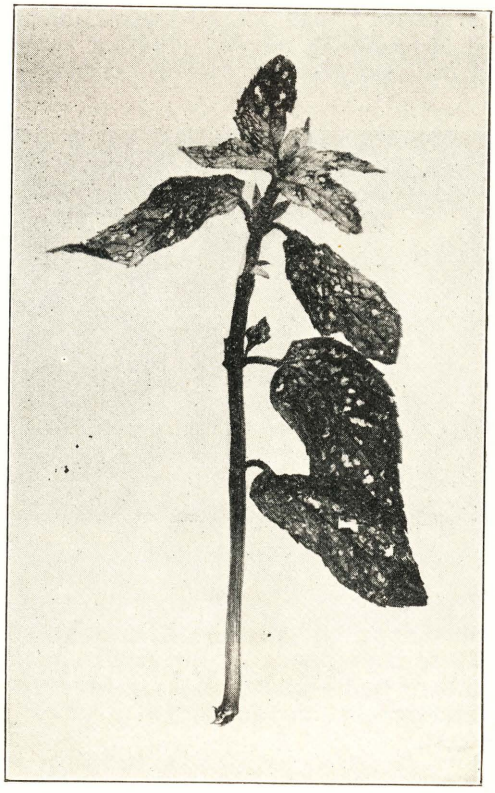

Fig. 32.—Injury to mint leaves by adults of mint flea-beetles, about natural size.

color, and the destruction of much of the root system of the plant loosens its hold on the soil, so that the plants are easily pulled up.

The larvae feed for about a month and then change to pupae, which in turn produce the winged beetles. Fortunately, there is but one generation each year.

Early in August, the beetles crawl and jump to new fields, gradually working their way into the fields and continuing to advance until late fall. During their lives, the adult beetles feed freely on the leaves of the plants, resulting in serious injury to the crop.

Control

Plant mint on land that has not grown mint for at least two seasons,—not even volunteer mint on the ditch banks, or on ground that has been clean-cultivated or summer-fallowed, the roots should be dug from fields having as light an infestation as possible, and preferably from those well-dusted the previous year. Before the transplants are removed from the fields, they should be thoroughly shaken, in order to loosen and disengage the dirt and eggs before they are carried to the new fields.

Dusting: Aside from cultural practices, the most important control measure used against the mint flea beetle is dusting. Most of our information concerning the selection of dusts has come through the efforts of Mr. E. L. Woodhams and Mr. Richard F. Stroud, of the A. M. Todd Company, at Mentha, Michigan, where large acreages of peppermint are grown. In a recent letter from Mr. Stroud, he states that, of all dusts thus far tested for the early applications on standing mint, the first choice is 95 per cent

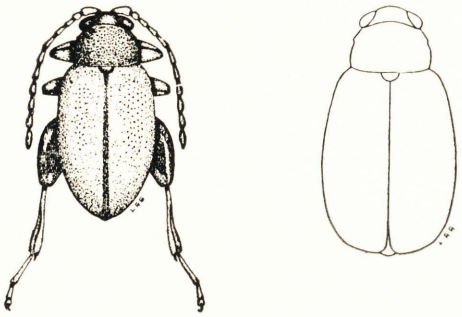

Fig. 33.—Adult male (left) and female (right) of mint flea-beetles, greatly enlarged.

calcium arsenate with 5 per cent Bentonite. It should be applied between the 15th and 25th of July at the latitude of Mentha. This dusting is sometimes repeated if the necessity arises. After the cutting of the mint, the fields should be dusted immediately, before the females migrate, and that means *just as soon* as the field has been cut, with a dust consisting of common flour with 8 per cent of the finest dusting paris-green. This is applied to the stubble to kill the females that would otherwise migrate to other fields. Hay from mint so dusted should not be used either for bedding or for fodder.

CLOVER SEED-MIDGE

(*Dasyneura leguminicola*)

As the name implies, the clover seed-midge is a two-winged fly, the larva of which injures the seed. It works on red, mammoth, white, and alsike clovers. The injury is confined to the seed alone, but formerly, when the first crop of clover was cut after the heads turned brown, the loss of seed was sometimes very severe.

There are two generations each year, their occurrence being so timed that the adult female flies in time to lay eggs in the buds of June clover, just before blooming time,—and again the next generation of flies appears just in time to oviposit on the second crop of ovules; that is, of the crop that is designed for seed. This rule holds WHEN THE FIRST CROP IS CUT AFTER THE BLOSSOMS TURN BROWN. Necessarily, the time of cutting the first crop determines the time of bloom of the second crop.

The eggs of the clover seed-midge are laid in the florets of the heads, usually before they open, and the pink maggot works downward to the ovule, which is, at that time, soft and succulent. The destruction of the ovule, of course, means no seed in that particular floret. The larvae normally descend into the soil for a short distance, and some of them are said to spin cocoons of a very frail and flimsy nature. At any rate, pupation normally occurs under ground, and the adult, winged flies come out and lay their eggs just before the head bursts into bloom.

Now, it is clearly apparent that we may hasten the development of the second crop of clover heads by cutting the first crop early, and since the hastening of the second crop results in also developing the ovules into hardening seeds ahead of time, it makes it possible to get the seed crop so far along by the time the second generation of midges appears that the ovules are unsuitable for food.

The proper time to cut is during full bloom, and June clover cut at that time is pretty sure to be safe. Other insects may attack the clover seeds and lead to confusion. The pest which is most likely to be mistaken for the midge is the crimson-clover seed Chalcid (*Bruchophagus funebris*). Any time that early cutting does not protect the seed crop, the writer would like to see samples of the heads or seeds, the latter with the hulls still present; since it requires a certain familiarity with the pests to distinguish them, and since the same remedies do not apply to both of these pests.

ALFALFA EEL-WORM

(*Tylenchus dipsaci*)

A new disease of alfalfa, only recently recognized in the United States, is sometimes called the alfalfa-stem nematode, and sometimes the alfalfa eel-worm. It gives rise to root-rot, or stem-rot, as it is sometimes called.

Michigan is apparently able to supply good conditions for the establishment of this new pest, although no cases have been as yet found here. A short discussion is included in this bulletin for the reason that it is likely soon to be with us.

While it is essentially a disease of the crown, the stems become brown and brittle, and buds and sprouts become swollen and pale in color. After a time, when the plant becomes badly infested, rotting of stems and crown occurs, this rotting being likely to continue down into the roots.

The cause of this trouble is an eel-worm, a slender transparent worm about one-twentieth of an inch long. It penetrates the stems of alfalfa and then lays its eggs, about 200 of them. The ensuing myriads of eel-worms that finally appear destroy the plant. Individuals are carried easily by irrigation water, or in dried hay, since the worms stand ordinary drying for a long period; or they may be carried casually on the feet of animals or of men, or on implements. They may possibly be blown by the wind.

It would appear that infested land plowed and kept free from alfalfa for three years becomes quite free from the worms. It is pointed out in Circular 297, of the Bureau of Plant Industry, U. S. Department of Agriculture, that they may easily be carried in soil adhering to farm implements. It is recommended, therefore, that utensils used on land infested with the worms be treated with something to kill any adhering worms, at least until the land has been free from alfalfa for three years. A blow torch or scalding water can be used for this purpose.

Furthermore, we are not at all certain that several other crops, including red, white, and alsike clovers, buckwheat, rye, English pea, turnip, potatoes, and some weeds are safe, since the worms will attack them and may be capable of maintaining themselves on these crops.

For further information see U. S. Department of Agriculture Circular 297, above cited.

Any suspected material should be carefully sealed up in a tight container and sent to the entomologist.

ALFALFA AND CLOVER SNOUT-BEETLES

Now that alfalfa has become of wide-spread importance, we are forced to consider an array of snout-beetles which find alfalfa attractive. Of these, three species are present in appreciable numbers in Michigan. One of these, the clover root-curculio, (*Sitones hispidulus*), is an introduced species. It

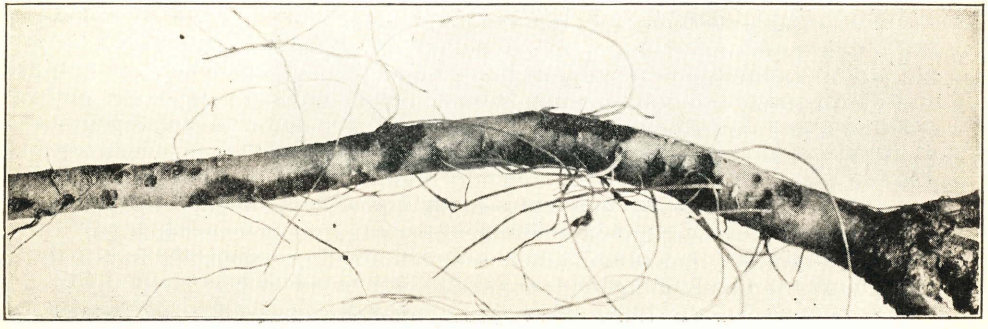

Fig. 34.—Work of clover-root curculio on alfalfa root.

winters as an adult under rubbish, the adult beetle being about one-eighth of an inch long and feeding on the leaves. The larvae feed on the roots, eating cavities in the large roots and devouring the finer roots entire.

The clover sitones (*Sitones flavescens*) is about one-fourth of an inch long, and dark brown in color. It eats U-shaped cavities from the sides of the leaves of clover and alfalfa, the larvae feeding on the crown and roots. It is probably also an introduced species.

The third species, the clover leaf-weevil (*Hypera punctata*), which originally came from Europe, has been in Michigan for many years. It is much larger than the other two species, being almost one-third of an inch long. It is heavy bodied and brownish in color, striped longitudinally with grey.

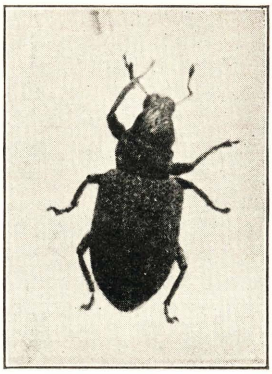

Fig. 35.—Clover-root curculio, enlarged.

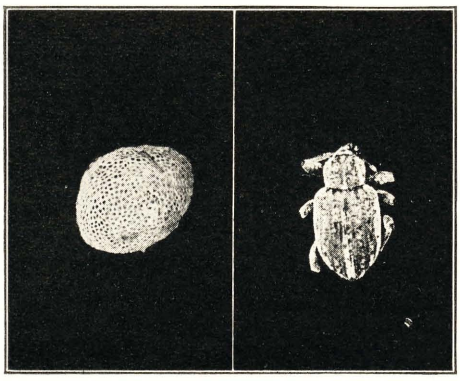

Fig. 36.—Clover leaf-beetle, cocoon and adult beetle.

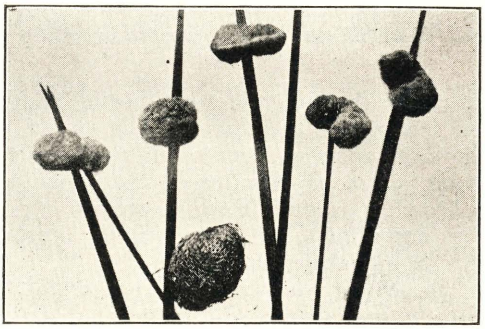

Fig. 37.—Mummified bodies of clover leaf-beetles, killed by fungus disease.

The larvae feed during the night on the leaves, and if not attacked by a fungus disease would, no doubt, prove destructive. However, there is a fungus disease that usually attacks them as soon as they become very plentiful, impelling the larvae to climb up to the tips of grass leaves, where they die. (See Fig. 37.) These larvae, killed by the fungus disease, are poisonous if sufficient quanities are eaten by stock.

None of these three snout-beetles have called for very active control measures in Michigan thus far, the last named one usually being naturally controlled by its fungus disease.

ALFALA-WEEVIL

(*Phytonomus posticus*)

Another species of alfalfa-weevil (*Phytonomus posticus*) is established in parts of Utah, Idaho, Oregon, Nevada, California, Wyoming, and Colorado. Originally it came from the eastern continents, being found in Europe, Asia and northern Africa. It appeared in the U. S. in 1904, being found first in Utah. The beetles are from one-eighth to three-sixteenths of an inch long, and are dark brown, with short, black and grey hairs which give the insects a mottled appearance. They hiberate on alfalfa plants or under rubbish.

When excessively plentiful, the beetles will work also on garden truck. The greatest damage is done by the larvae, which feed on the leaves. They do not often destroy a stand, but reappear year after year, devouring the foliage during the first half of the season, there being but one brood each year.

As they pass the winter in hiberation, the destruction of their winter quarters under rubbish will help materially in their control. There has been developed a promising means of control by spraying or dusting with an arsenical just at the time when the young larvae become numerous, about two weeks before the normal time for cutting the first crop. Full directions for the application of this spray may be found in Farmers' Bulletin 1185, Bureau of Entomology, U. S. Dept. of Agr., December, 1920.

It is to be remembered that thus far the real alfalfa weevil is confined to a few of the western states and that it has not as yet reached the central states. It is well to be on the lookout, but it will probably be many years before it becomes a serious problem in Michigan.

EUROPEAN CORN-BORER

(*Pyrausta nubilalis*)

The European corn-borer is one of the most undesirable alien insects that has ever come to this country. It is a first-class destroyer of corn. Sorghum, broom-corn, and a number of vegetables having fleshy stalks, such as celery, bean, rhubarb, and many others, are attacked by the two-brooded eastern corn-borer. Worst of all, it will feed, when forced to do so, on a long list of less important crops and on many weeds, notably on the smartweeds (*Polyganum*). The two-brooded form was first noticed in this coun-

try in 1917, when it appeared in the vicinity of Boston, since which time it has spread over parts of New England. In the vicinity of the Great Lakes, both in the United States and in Canada, a single-brooded type is well established. The insect is so well established at this time that we must forego all hope of ever exterminating it. It confines its activities chiefly to corn, but in Ontario, where it occurs in large numbers, it attacks also Canada thistle, dock, smartweed, etc.

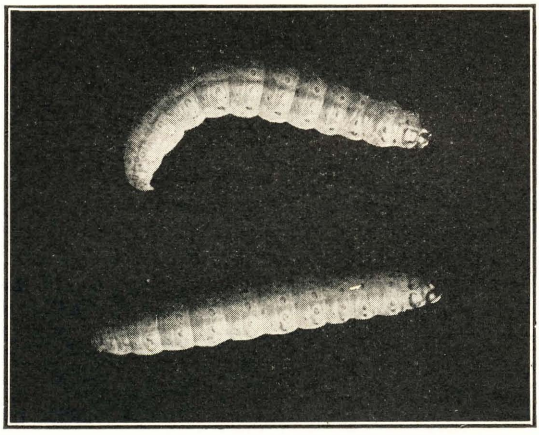

Fig. 38.—Larvae or "worms" of corn-borer, enlarged twice.

When working in corn, the larvae tunnel through the stalks and the ears, not refusing, however, to bore into roots, tassels, and leaf-ribs. The presence of the pest is often revealed by the breaking over of the tassel, which has been weakened by the tunneling of larvae. Other larvae bore into the growing ears, and all parts of grain and cob are utilized for food.

Similarly, other plants are pierced by tunnels, and such plants are always likely to serve as distributors of individuals to new localities when carried from place to place. Thus, the carrying of cut-flowers, such as asters,

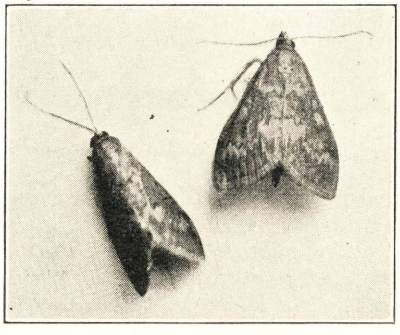

Fig. 39.—Adult moths of European corn-borer, slightly enlarged.

chrysanthemums, and gladiolus, or of such plants as chard, celery, beets, spinach, or a host of similar plants, is to be discouraged when they are to be taken from an infested district to one in which the pest is not already established. The injury inflicted to corn may run from a slight one to a total loss.

The corn-borer passes the winter as a full grown larva or "worm" about an inch long, in a tunnel burrowed in the plant on which it is working. Here it rests until about the middle or last of May, when an exit hole is prepared, after which a flimsy cocoon is spun in which the change to a pupa takes place. During June, the adult moth emerges from the cocoon,—a moth capable of flying to a distance of many miles. Eggs are placed in groups of 15 or 20 on the under sides of the leaves or stems of the plants, some females producing over 1,000 eggs each. From these eggs come the larvae, which tunnel through the plants during the summer and autumn.

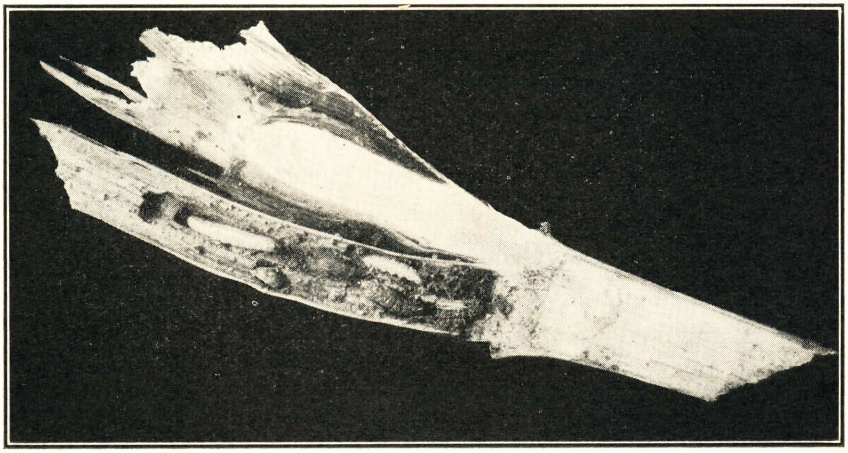

Fig. 40.—Corn-borers tunneling in stalk.

The most important control measures developed, up to the present time, consist in the disposal of crop remnants, most important of which are cornstalks, in such a way that they cannot harbor the larvae nor serve as retreats during the period preceding pupation. The ensiling of corn plants disposes of the contained larvae perfectly, and the shredding of the stalks kills almost all of them. The complete burial by plowing of all stalks, stubble, and bits of the corn plant, in such a manner as to leave the surface of the ground entirely bare, is probably the most important measure yet developed. Such measures, to be successful, must be taken before the adults emerge and should be taken before the larvae spin their cocoons in the spring. Certain other practices, such as the burning of stalks and the beating of stubble, find favor under special conditions.

The maintenance of an effective quarantine aimed toward preventing the spread of the pest to hitherto uninfested districts has proved of value.

For further information relative to habits, control, and cleanup regulations, consult the following bulletins, which are easily obtainable:

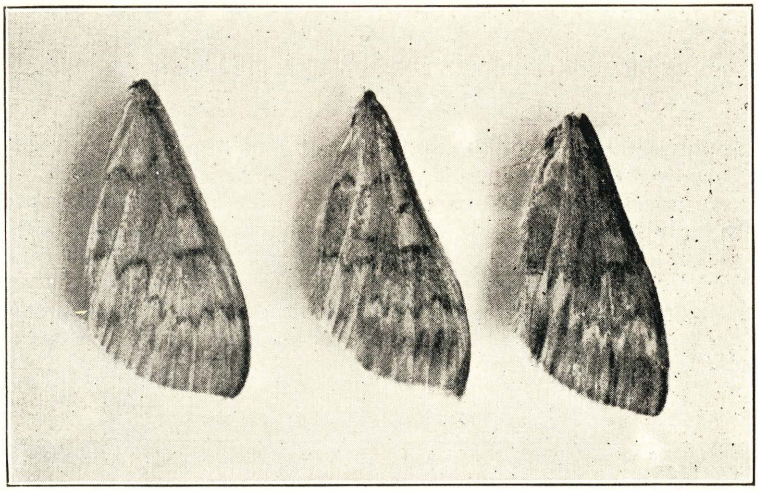

Fig. 41.—Front-wings of European corn-borer, enlarged.

Farmers' Bulletin No. 1294, U. S. Dept. of Agriculture. The European Corn-borer and its Control.
Farmers' Bulletin No. 1548, U. S. Dept. of Agriculture. The European Corn-borer, Its Present Status and Methods of Control.
Bulletin No. 44, Bureau of Agricultural Industry, Mich. Dept. of Agriculture. European Corn-borer Control in Michigan.
Extension Bulletin No. 59, Extension Div., Mich. State College Methods of Control of European Corn-borer.
Extension Bulletin No. 55, Extension Div., Michigan State College. Plowing for European Corn-borer Control.
Circular Bulletin No. 70, Experiment Station, Michigan State College. The Present Status of European Corn-borer in Michigan.

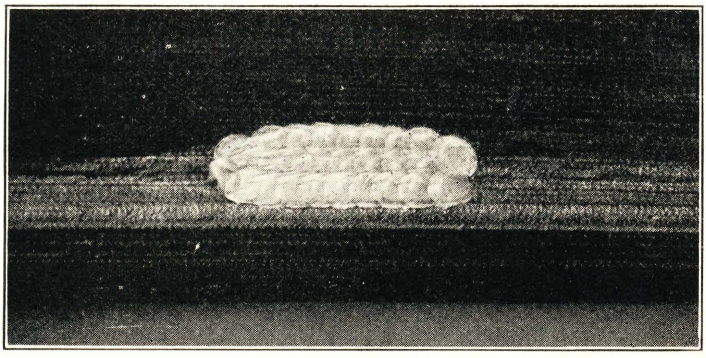

Fig. 42.—Egg-cluster on corn-leaf, greatly enlarged.

CORN EAR-WORM

(*Heliothis obsoleta*)

The corn ear-worm is by no means a new pest in the United States. Working in corn as a principal host-plant in the North, it is well known and regarded as a troublesome enemy to this important crop. When the European corn-borer made its appearance, the two were and still are too often regarded as identical in the minds of the uninitiated.

It is practically useless to try to forecast years in which the corn ear-worm will be abundant in the North. In some seasons, one finds 75 per cent or more of the sweet-corn invaded by the striped larvae or "worms,"

Fig. 43.—Work of corn ear-worm in corn.

working on the kernels when they are "in the milk," or later until they become hard. The entrance is almost always made at the tip of the ear, but when the husk is removed the larvae may be found almost anywhere. Usually, only one larva is found, due to a well-known cannibalistic habit.

An ear of sweet-corn is practically ruined by a single larva, since the space left by the destruction of the kernels is almost sure to become the medium for fungus growth, one species of which produces a dark stain, ruining the ear for table purposes. Furthermore, at least some of these fungus growths may prove poisonous if eaten by livestock.

Field-corn is also attacked, and likewise pop-corn, but in the case of field-corn the uneaten kernels mature, and, when shelled off and cleaned, they are

practically undamaged. The corn-ear worm is found all over the United States and southern Canada, and its range extends to a good part of South America. It is found as well in all the continents of the world. In our southern states it is known as the "cotton-boll worm." It is, also, a serious enemy of tomatoes, and of less importance, of a long list of other vegetables. In the South, there are several generations each year, fewer generations appearing as we progress northward. Each female is said to be capable of laying several hundred eggs, even up to 2,500. When corn is attacked, the

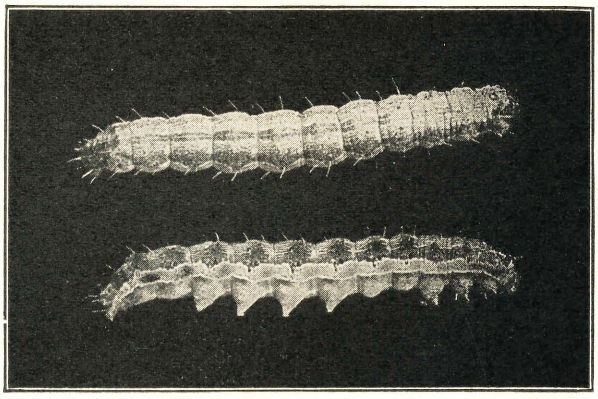

Fig. 44.—Corn ear-worms.

eggs are likely to be laid on the fresh silk, the newly hatched larvae eating their way down to the kernels. When full-grown, the larva leaves the ear and buries itself underground, where it changes to a pupa in an earthen cell. Later the pupa produces a clay-colored moth.

The number of infested ears of corn may be greatly lessened by dusting the silk, just after it is pushed out, with powdered arsenate of lead and hydrated lime or sulphur, mixed about half and half. The dusting may be accomplished with a hand duster, and the application should be repeated once or twice before the corn in ready for market. Such a dusting would seem to be warranted in fields of sweet-corn and in fields of pedigreed field-

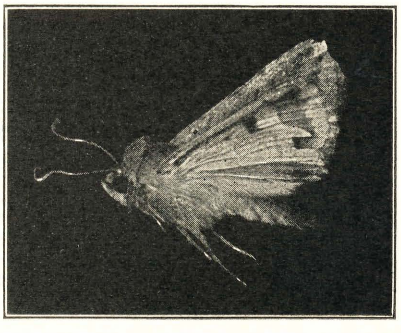

Fig. 45.—Adult moth of corn-ear worm.

corn—in fact, wherever the value of the crop will pay for the treatment. It may be regarded somewhat in the light of insurance, and, while protection of the crop is not likely to be complete, the number of perfect ears is certain to be greatly increased.

NORTHERN GRAIN APHIS

(*Siphonophora avenae*)

Several species of plant-lice infest grains in Michigan. However, two species stand out from all the rest in importance as measured by their potentialities for harm. Of those two species, the one best known in Michigan is the oats aphis or northern grain aphis, known to apple growers as the bud-louse of apple. This insect, which came to this country from Europe, passes the winter on apple twigs as a shiny black egg, from which there develops a line of plant-lice which migrate to grasses and grains, if the weather is favorable, about the time that apples bloom. The sudden appearance of these plant-lice and their rapid increase during cool and moist weather, is sure to alarm the owner of the field. Sometimes the lice become so numerous that the grain plant is fairly covered with females, which bring forth their young alive so freely that the heads of grain are often packed with the lice, some of which are provided with wings to facilitate the spread to other plants and thus to forestall over-crowding.

Under cool, moist conditions, the outlook frequently becomes sufficiently alarming, but, fortunately, the northern grain-louse is usually held in check by tiny winged parasites, even smaller than the lice themselves. These small, wasp-like insects belong to the two genera, *Lysiphlebus* and *Aphidius*. They remain sluggish during cool weather, but become active when the weather turns hot and dry, flying about searching out and busily laying their eggs inside the bodies of the lice. This is accomplished by the aid of a sharp, needle-like ovipositor, by means of which the egg is thrust through the skin into the body cavity of the living louse. During a hot, dry period, the multiplication of the parasites is more rapid than that of the lice, so that, to the knowledge of the writer up to the present time, no attack has been of sufficient gravity to cause the failure of the grain crop in Michigan. Undoubtedly, the loss of sap removed from the plants by the feeding of the lice must cause some loss, but in the absence of effective control measures, we must, indeed, feel very grateful that it is no worse.

These tiny parasites are aided by ladybirds and the larvae of Syrphus flies, which devour the lice with great rapidity when they occur in large numbers.

THE SPRING GRAIN-APHIS OR SO-CALLED "GREEN-BUG"

(*Toxoptera graminum*)

Much that has been stated above about the northern grain aphis applies to its more dangerous relative, the spring grain-aphis. Both are present in Michigan. Both are importations from Europe, and both feed during the summer on grasses and grains, becoming epidemic during seasons that start in with cold, wet, backward springs, the spring grain-aphis reaching the height of its destructiveness when warm, dry weather is delayed until abnormally late in the summer.

Plants attacked by the spring grain-aphis suffer far more than those attacked by the common grain-aphis.

Plants badly attacked turn yellow and many die. The pest is, apparently, a newcomer to Michigan, the first actual damage reported having occurred during 1926, when a few fields in the Upper Peninsula and one or two in the northern part of the Lower Peninsula were injured.

The black eggs of the spring grain-aphis are said to be placed on blue grass. Hatching begins in March, and during the summer 12 or more generations are produced.

Like the common grain-aphis, the spring grain-aphis is normally kept in check by its parasitic and predatory natural enemies, appearing in epidemics only when favored by cold, wet weather early in the season.

SOD WEB-WORM

Also Called Root Web-worm and Corn Web-worm

The larvae of several species of *Crambus* are to be found working on the roots of grasses, and also on corn. These small, slender "worms," or almost naked caterpillars, spin tubes of silk underground wherever they happen to be feeding, and their work, in the aggregate, accounts for enormous losses.

When the attack occurs in meadows or in pastures, which are favorite feeding grounds for sod web-worms, the loss is spread out rather evenly and is often overlooked, but when young corn is attacked, the loss may be complete. There are two generations of the species under consideration, and it is usually sufficient to find the roots of corn or of grasses webbed with loosely constructed silken tubes to know the cause.

The only practical remedy is to plow, early in September, all grass sod intended for corn the following year. Furthermore, it shows good judgment to avoid planting corn after old pastures are plowed, if an examination shows the webs to be present about the roots of the grass.

WHITE GRUBS or JUNE-BEETLES

(*Phyllophaga*)

The common June beetle, June-bug, or May beetle is familiar to all. This large, clumsy, dark-brown beetle is to be observed, usually every third year, flying at dusk about shade-trees, notably oak trees. It is the common large beetle that bumps into illuminated windows, buzzing and scrambling about and creating a disturbance. The larva of this creature lives underground and feeds on the roots of grasses, strawberries, corn, beans, and other plants, often burrowing in the tubers of potatoes, in which stage it is known as the white-grub. Like all beetles, it passes through four stages, starting with the egg which is laid underground by the adult June-beetle. From this egg, the white-grub hatches, and the grub, after attaining its full size, changes to a pupa, still underground; while this in turn produces a winged June-beetle, in the case of most of our common injurious species, during the spring of the third year from the time that the egg was laid. To go back to the tiny larva just hatched from the egg, its small size during the summer of its birth prevents it from destroying very much vegetation in the form of roots.

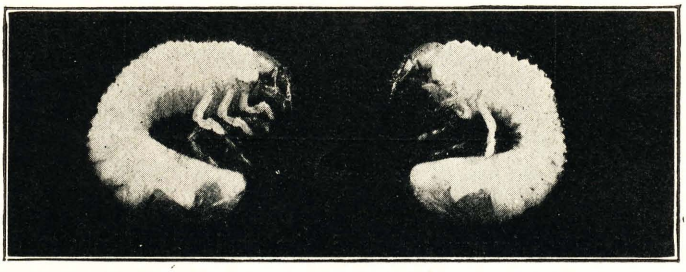

Fig. 46.—White grubs, of larvae of June beetles.

When fall comes, the grub goes down below the plow-line and passes the winter. In the spring (just about a year after the egg is laid) the grub comes up to feed on the roots of plants. This is the year that the grub gets is growth, and the injury to vegetation may be very serious, indeed, at this time.

Late in the fall, the grub descends once more to a deep level and comes up again just about two years after the egg is laid. The season of feeding is a short one in this case. By early July the grub has once more dug down and built a cell in which it changes to a pupa and later to the "hard shell" beetle (the adult), ready to come up in April and May of the third year, to fly, to feed on the leaves of trees, and to lay the eggs for the next generation. Therefore, in any one brood of June-beetles there is a flight of adult beetles and the laying of eggs one year, an attack on the roots of vegetation the year following, and a short period of feeding, which may pass unnoticed, in the third year. To complete our data for planning to avoid loss by this pest, we know that the eggs are laid by choice in grass-sod or strawberry beds, or in some field covered with vegetation. Clover seems to be less frequently chosen for this purpose. It is, therefore, unsafe to put corn,

beans, potatoes, strawberries, hops, or young nursery stock in land that was in timothy or other grass or in strawberries the previous year, if that happened to be a June-beetle year. We are frequently asked what we can grow in such a case, and our answer is that small grains suffer less loss than cultivated crops.

Trees on which the beetles are feeding may be sprayed with an arsenical, or the beetles may be shaken off the trees onto sheets spread on the ground, and much good is sure to result the following year, as measured by a decrease in the number of grubs.

Deep plowing during mid-summer of the second year after the eggs are laid is said to be effective, the object being to break up the cells in which the grubs are changing to pupae—and later to adults. Since the cells are not so deeply placed at this period as are the two other wintering cells, disking and breaking up of the soil is advocated at this time. The plowing should be done about the middle of July. In the case of golf-links and extensive

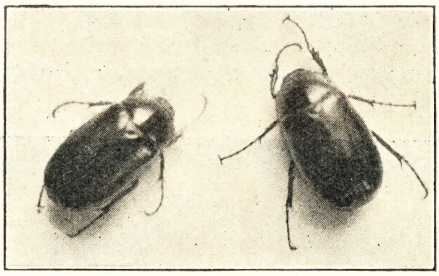

Fig 47.—June-beetles (*Phyllophaga fusca*).

lawns where the land is never plowed, the grubs are likely to congregate, attracted by the broad expanse of grass sod; and in such places, many grubs are dug out and eaten by birds and skunks. In the latter case, the presence of the grubs is often to be preferred to the pits that are left in the greens.

From the foregoing it will be seen that in the case of any one brood of white-grubs we may expect an attack every third year, and it will also be apparent that there is nothing to prevent two or more broods occupying any given area simultaneously, so that in such areas white-grub attacks are to be expected two out of every three years.

Two broods now exist in Michigan,—brood A occupying districts which include the Thumb and adjacent areas, and a large district including much of southwestern Michigan. This area is due to suffer from white grubs in 1933.

Brood C is due to appear in destructive numbers over a smaller area in southern Michigan and in the extreme southeastern parts during 1932.

For a more complete discussion of white-grubs, see Circular Bulletin No. 132 of this station.

WIRE-WORM

(*Agriotes mancus*)

Wet ground, and especially wet, mucky ground is likely to be inhabited by slender, hard-bodied larvae which are usually smoothly polished and yellow. These larvae tunnel into potatoes, young corn, and other crops, their presence often seriously interfering with the raising of crops in such soil.

The particular wire-worm most common in Michigan, the one which causes more trouble than all the other species combined, has sometimes been called the wheat wire-worm, although its operations are by no means confined to grains. It is one of the "click-beetles" or "skip-jacks,"—beetles that have the power to throw themselves into the air when placed on their backs on a flat surface.

Fig. 48.—Wire-worms, larvae of snapping-beetles.

The larva requires three years for the completion of its growth, and at the end of that period it changes into a pupa in a little cell in the soil, coming out the following season as an adult snapping-bug or snapping-beetle.

Grass sod is preferred by the beetle to everything else for egg-laying purposes, and, for this reason, grass sod should be avoided for a period of years on soils where wire-worms accumulate. It happens, furthermore, that the beetles seem to avoid to a marked degree, fields in either clover or buckwheat when the time comes to deposit their eggs. For this reason, it is good practice to get land infested by wire-worms into clover or into buckwheat as much of the time as possible, avoiding grass at all times. Wire-worm infested soil is usually somewhat acid in reaction, and it may be necessary to use lime in order to bring the soil into good condition for either clover or buckwheat, or to use hardwood ashes for the same purpose, as our ancestors did. At any rate, it usually takes a number of years to

starve wire-worms out of a field, because of the slow development of the individuals.

Fall plowing breaks up some of the cells in which the larvae and pupae pass the winter and is, therefore, an aid, although not a very effective one, in clearing the land of the pest.

There are a number of wire-worms which are serious enemies to agriculture and which are not to be controlled in the manner just described, but these wire-worms are more or less negligible in Michigan, because they seldom become serious menaces in the state.

THE ARMY WORM

(*Cirphis unipuncta*)

The army worm is a cut-worm which at intervals appears in unusual numbers.

This creature has all the habits of other cut-worms. It works at night and on overcast days. It cuts its food and wilts it. It passes through the four stages common to insects of its order: egg, larva or "worm," pupa, and winged moth.

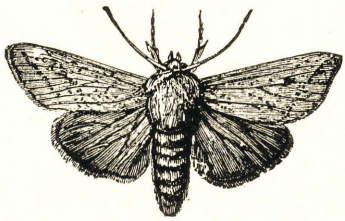

Fig. 49.—Army-worm adult moth
(After Riley).

However, its powers of reproduction are very great, and, consequently, when favorable conditions arrive it has a way of appearing in enormous numbers, sometimes sufficient to destroy completely the crops in which it happens to be at work. The army worm is always to be found in Michigan to a greater or less degree. It produces three generations a year; one in early spring, one in mid-summer, and one in the autumn. Occasionally, the spring generation is well represented, and once in a while mild attacks occur in September, but usually serious attacks occur in July or August if they develop at all.

A low-lying oats field is ideal for rapid development of the army worm. Here the drive is likely to take its start. The young larvae work at night, cutting off leaf after leaf until there remains only the naked straw and the head. Meantime, the larva is growing and the food supply is getting dryer and less plentiful. The heads are attacked, and, true to its habit of cutting off its food, the heads are lopped off and fall to the ground. Now comes the march to new fields, and, because of the orderly drive in which practically all individuals start and continue in one general direction, the name "army worm" is suggested. The individuals do not scatter radially, but they march,

frequently covering the ground. New fields are invaded and occupied,—most often fields of corn, where the larvae complete their growth and change to pupae, each in its earthen cell. Later, the pupa changes to a winged moth, which flies and provides for the next generation.

During the long intervals between outbreaks, the army-worms are kept in check by natural enemies, the most important of which are Tachina-flies and Hymenopterous parasites, both internal parasites which lay their eggs on or in the bodies of the larvae. The parasites are influenced greatly by temperature conditions, and so, as in the case of cut-worms, an attack is most likely to occur after a cold, wet, late spring.

When a farm or a field is found to be infested, there is usually no hope of saving the occupied fields or portions of fields. It becomes imperative at once to take measures to prevent the spread of an army to uninvaded areas.

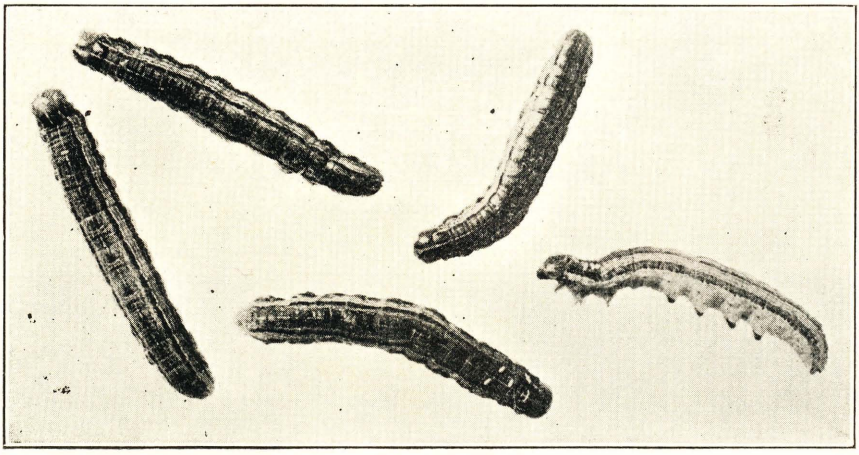

Fig. 50.—Army-worms, slightly enlarged.

To do this, place barriers in the line of march. Usually, three deep, clean-cut furrows placed parallel; 10 or 12 feet apart, will stop them. Turn the furrows toward the advancing worms, and, when each fills up, turn it under, leaving a fresh furrow, burying the "worms" already in the furrow, and making ready a new one at the same time.

When the soil is sandy, mucky, or otherwise difficult to make stand in a clean-cut furrow, or when there is no room for a series of furrows, make one good, deep furrow and drag a small log back and forth through the furrow, crushing the larvae as fast as they collect. Army-worms are poor climbers, and are easy to confine in a furrow.

The same baits as used against other cut-worms may be used to advantage in gardens or lawns and in places where some of the larvae get by the barriers. (See page 10.)

THE FALL ARMY-WORM

(*Laphygma frugiperda*)

Once in a number of years, ears of corn are found late in the season with a number of larvae present,—larvae which resemble those of the ear-worm very closely. Usually, such larvae belong to another species of moth, the "Fall Army Worm" (*Laphygma frugiperda*), which also attacks all sorts of crops besides corn. In Michigan, beans are likely to be eaten. Fig. 53

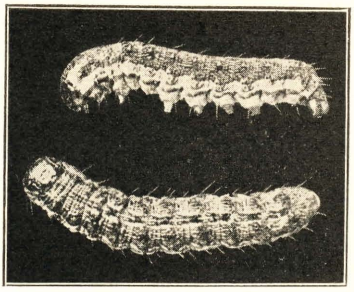

Fig. 51.—Fall army-worm.

Fig. 52.—Work of fall army-worm in beans.

Fig. 53.—Work of fall army-worm in beans.

shows some white beans, or rather the shells left after the contents have been scooped out by the fall army-worm. Attacks by the fall army-worm come at long intervals in Michigan, and the best control seems to be the use of poisoned-bran bait. (See page 10) a control which, at the very best, is unsatisfactory.

THE CHINCH-BUG

(*Blissus leucopterus*)

Severe losses are caused in the southern tier of Michigan counties, from time to time, by attacks of chinch-bugs. These bugs, which are less than a quarter of an inch long, occur in enormous swarms, sucking the sap from small grains, corn, and related plants.

While permanent control of the pest can be brought about only by the destruction of the hiberating adults in their winter quarters, the farmer can usually escape with a comparatively small loss if he takes steps to stop the bugs in their advance upon his fields.

The adult chinch-bugs pass the winter in clumps of grass, under fallen leaves and rubbish, and wherever protection from the weather may be had. In the spring, they fly to fields of wheat, where eggs are laid. The young bugs, when hatched, suck the sap from the young wheat plants, causing serious losses in the wheat itself. After the wheat begins to ripen, the bugs start out on foot to reach corn fields, often almost covering the ground, so great are their numbers. They finally climb up into the corn, attacking the fresh, green corn plants as they come to them and quickly destroying them. The bugs then work even more deeply into the fields, until there is no hope

for the crop. Here a new generation of bugs is produced, the adults of which pass the winter in grass and rubbish, as did the first ones noted.

The greatest damage in Michigan is done when the bugs attack corn. If the owner can stop the progress of the bugs before the corn crop is attacked, or at least before they get beyond the first few rows, he can usually avoid serious damage. Only a few of the bugs of the summer generation fly, the swarms traveling on foot to invade the corn, and, therefore, a barrier placed between the grain fields and the growing corn serves to protect the corn for the time being.

Various types of barriers are used in chinch-bug infested regions, but the one most successful under Michigan conditions seems to be the one used extensively during the invasion of 1922, and described as follows:

First—Drag a weighted plank, 10 or 12 inches in width, lengthwise across the line of advance. This forms a smooth path on which to lay tar. If the chinch-bugs have advanced into the corn, it is well to lay out the path a few rows ahead of the line of infestation.

Second—In the center of the path dig a series of post-holes 12 inches deep and 20 to 30 feet apart. Be sure to bevel the rims of the holes.

Third—Lay down a line of tar about an inch in width on the side of the path farthest from the advancing bugs, being sure that it touches the rim of each hole. As the bugs advance to the tar line they will not cross, but will travel along parallel to it in an effort to find a place to pass over. As they reach the holes, they pass over the rims and fall to the bottom.

Fourth—In the bottom of each hole place about two inches of hydrated lime, and dust it around the sides about half way up. The insects, falling in the lime, cover themselves with the dust and soon suffocate. Visit the holes once a day and stir the lime. When the insects are numerous, one should clean out the holes and renew the lime every three or four days or oftener, as the case may demand.

Dust Mulch Control of Chinch-bug

The dust mulch barrier is a complete barrier to the migrating chinch-bug where the soil is dry and sandy. If there is any great amount of clay with the sand, the soil forms clods and will not become fine enough to be of use.

Select the location where you are to construct the mulch barrier, figuring on a path six or seven feet in width.

When the time of migration approaches, plow a deep furrow down the center of the path, throwing the earth toward the insects. Plow back in the same furrow, throwing the earth away from the insects. Procure a log about 12 or 16 inches in diameter and about five or six feet long. Hook a team to the log and drag it back and fourth in the furrow. This rubs up the lumps and keeps the sand loose and soft. The bugs will fall into the trench but cannot crawl out.

Where the soil is well dried out and easy to keep pulverized, it will require dragging only about twice daily. This daily dragging will kill any bugs in the trench.

Destruction of the hibernating adults in their winter quarters can be accomplished most easily by fire. The bugs hide away in grass tussocks, under fallen leaves, in brush piles, under shocks of corn, and, in fact, in any place where shelter from too sudden freezing and thawing may be had. It is not really the low temperature that kills them, but alternate freezing and thawing, together with the moist conditions. Moisture during the summer is very unfavorable to the creatures.

HESSIAN-FLY

(*Phytophaga destructor*)

The Hessian-fly attacks wheat primarily, but it works also in winter-barley, rye, and some grasses.

It causes straw to lodge just before harvest, and also causes heads to fill poorly. It kills some plants in autumn and winter.

Life History: There may be many generations, but two of them are of more importance than the others to wheat growers. The fly passes the winter as a larva inside its puparium (flax-seed), which is tucked in between the leaf-sheaths just above the root. In spring the larvae, pupate and finally produce adults, which lay reddish eggs on the leaves of the developing wheat plants. Maggots from these eggs work down inside the leaf-sheaths, usually above the bottom node, and there scrape the plant tissue and feed on the juice and scrapings, causing a weakening of the straw and interfering with the development of the head. If several maggots are packed closely together, their puparia (flaxseeds) may so deform the straw as to cause the plant to lodge when the filling head becomes heavy just before harvest.

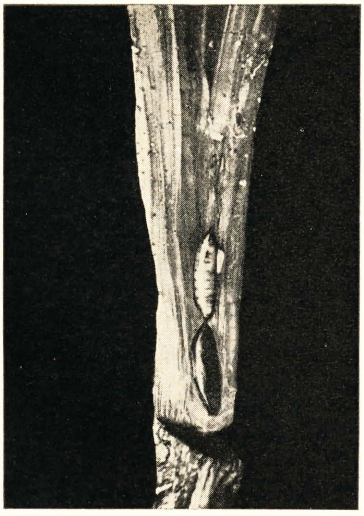

Fig. 54.—Hessian-fly. Flax-seeds in young wheat, enlarged.

During summer, a varying number of generations is produced, so that there may be an abundance of adult winged female flies during the autumn, ready to lay eggs on the leaves of the young plants. It is the crop of larvae from this crop of eggs that passes the winter in the winter puparia. This pest is at times kept under control by parasites, while at other times the parasites fail to control it. The fly thrives at a temperature lower than that required by the parasites, and so a cold, wet spring gives the fly a partial

immunity from its natural enemy, resulting in a "bad fly year" if the pests were at all plentiful to begin with.

Control: There comes a time each year, usually in September, after which no eggs are laid. If we can so time our seeding that the plants will not be in suitable condition for receiving the eggs until after the flies are through, we escape the fly altogether. This critical time is called the "fly-free date," and varies with each season. It is, however, possible to compute the relative time between different parts of the State and to base the time for sowing on the average time observed during a period of 25 years over the entire United States. This study is based on an investigation made by Dr. A. D. Hopkins, of the U. S. Bureau of Entomology.

The Department of Entomology of the Michigan State College is glad to compute the date on request for any locality in the State. It is an approximate average date, corrected to the best of our ability for latitude, longitude, altitude, character of soil, and the influence of large bodies of water.

The computed dates for the sowing of fall wheat for Michigan by counties are as follows:

County	Altitude above sea level, feet	Dates of seeding as computed
Alcona	600	Sept. 10-20
	1,000	Sept. 6-16
Allegan	600	Sept. 20-30
	800	Sept. 18-28
Alpena	600	Sept. 9-19
	800	Sept. 7-17
Antrim	600	Sept. 10-20
	1,200	Sept. 4-14
Arenac	600	Sept. 13-23
	800	Sept. 11-21
Barry	800	Sept. 18-28
	1,000	Sept. 16-26
Bay	600	Sept. 14-24
	700	Sept. 13-23
Benzie	600	Sept. 16-26
	800	Sept. 14-24
Berrien	600	Sept. 23-Oct. 2
	800	Sept. 21-Oct. 1
Branch	900	Sept. 19-29
	1,000	Sept. 18-28
Calhoun	800	Sept. 19-29
	1,000	Sept. 17-27
Cass	700	Sept. 22-Oct. 2
	1,000	Sept. 19-29
Charlevoix	800	Sept. 7-17
	1,200	Sept. 3-13
Cheboygan	600	Sept. 8-18
	1,000	Sept. 4-14
Clare	800	Sept. 12-22
	1,200	Sept. 8-18
Clinton	700	Sept. 17-27
	800	Sept. 16-26
Crawford	1,100	Sept. 6-16
	1,200	Sept. 5-15
Eaton	800	Sept. 17-27
	900	Sept. 16-26
Emmet	600	Sept. 8-18
	1,000	Sept. 4-14
Genesee	600	Sept. 17-27
	800	Sept. 15-25
Gladwin	700	Sept. 12-22
	1,000	Sept. 9-19
Grand Traverse	600	Sept. 12-22
	1,000	Sept. 8-18
Gratiot	700	Sept. 15-25
	800	Sept. 14-24
Hillsdale	900	Sept. 19-29
	1,200	Sept. 16-26
Huron	600	Sept. 13-23
	800	Sept. 11-21
Ingham	800	Sept. 17-27
	900	Sept. 16-26
Ionia	800	Sept. 16-26
	900	Sept. 15-25

County	Altitude above sea level, feet	Dates of seeding as computed
Iosco	600	Sept. 11-21
	1,000	Sept. 7-17
Isabella	700	Sept. 14-24
	1,000	Sept. 11-21
Jackson	1,000	Sept. 16-26
Kalamazoo	700	Sept. 20-30
	1,000	Sept. 17-27
Kalkaska	600	Sept. 11-21
	1,200	Sept. 5-15
Kent	600	Sept. 18-28
	800	Sept. 16-26
Lake	800	Sept. 13-23
	1,200	Sept. 9-19
Lapeer	700	Sept. 15-25
	800	Sept. 14-24
Leelanau	600	Sept. 11-21
	900	Sept. 8-18
Lenawee	700	Sept. 21-Oct. 1
	1,000	Sept. 18 28
Livingston	900	Sept. 16-26
	1,000	Sept. 15-25
Macomb	600	Sept. 18-28
	1,000	Sept. 14-24
Manistee	600	Sept. 13-23
	1,000	Sept. 9-19
Mason	600	Sept. 15-25
	800	Sept. 12-23
Mecosta	900	Sept. 12-22
	1,000	Sept. 11-21
Midland	600	Sept. 15-25
	700	Sept. 14-24
Missaukee	1,000	Sept. 9-19
	1,400	Sept. 5-15
Monroe	600	Sept. 21-Oct. 1
	700	Sept. 20-30
Montcalm	800	Sept. 15-25
	900	Sept. 14-24
Montmorency	800	Sept. 7-17
	1,200	Sept. 3-13
Muskegon	600	Sept. 18-28
	800	Sept. 16-26
Newaygo	700	Sept. 15-25
	1,200	Sept. 10-20
Oakland	800	Sept. 16 26
	1,200	Sept. 12-22
Oceana	600	Sept. 16-26
	800	Sept. 14-24
Ogemaw	800	Sept. 10-20
	1,200	Sept. 6-16
Osceola	1,000	Sept. 10-20
	1,600	Sept. 4-14
Oscoda	1,000	Sept. 7-17
	1,200	Sept. 5-15

County	Altitude above sea level, feet	Dates of seeding as computed
Otsego	1,000	Sept. 6-16
	1,400	Sept. 2-12
Ottawa	600	Sept. 19-29
	800	Sept. 17-27
Presque Isle	600	Sept. 8-18
	800	Sept. 6-16
Roscommon	1,100	Sept. 7-17
	1,200	Sept. 6-16
Saginaw	600	Sept. 16-26
	700	Sept. 15-25
Sanilac	600	Sept. 15-25
	1,000	Sept. 11-21
St. Clair	600	Sept. 16-26
	800	Sept. 14-24
St. Joseph	600	Sept. 23-Oct. 2
	800	Sept. 21-Oct. 1
Shiawassee	700	Sept. 16-26
	800	Sept. 15-25
Tuscola	600	Sept. 15-25
	800	Sept. 13-23
Van Buren	600	Sept. 22-Oct. 1
	800	Sept. 20-30
Washtenaw	800	Sept. 18-28
	1,000	Sept. 16-26
Wayne	600	Sept. 20-30
	800	Sept. 18-28
Wexford	1,000	Sept. 9-19
	1,400	Sept. 5-15

JOINT-WORMS OF WHEAT

(*Harmolita tritici*)

The joint-worms belong to a group of small, wasp-like insects, the larvae of which work in the walls or leaf-sheaths of straws, grasses, and grains. They all resemble one another more or less and are classed together in the genus *Harmolita*. Two of these species are at times serious pests of grains in the eastern part of the United States, while other species attack grains and grasses elsewhere.

Of our two species, the common wheat joint-worm is the most common, and at long intervals we may expect attacks by this insect.

While the work of the wheat joint-worm differs very greatly from that of the Hessian-fly, the two are often confused and not differentiated in the minds of growers. The Hessian-fly works between the true straw and the leaf-sheath, while the joint-worm works in the wall of the straw (not in the bore). There is only one generation annually, and the egg is laid in the spring just after the wheat has begun to lengthen out, but before the straw becomes at all hardened. The grubs, which are very small, produce thickenings in the wall of the straw, which finally becomes woody so that short

lengths of the straw become distorted and brittle, with the grubs lying embedded in small cavities distributed therein. When threshing time comes, these short lengths of woody straw break out and come out with the grain, to be separated from the grain by the sieves. Such a woody section, if whittled, will reveal the larvae or pupae lying singly in small cells or cavities, waiting for spring, at which time the pupae will change to tiny, waspish, active insects ready to place the eggs for the next generation.

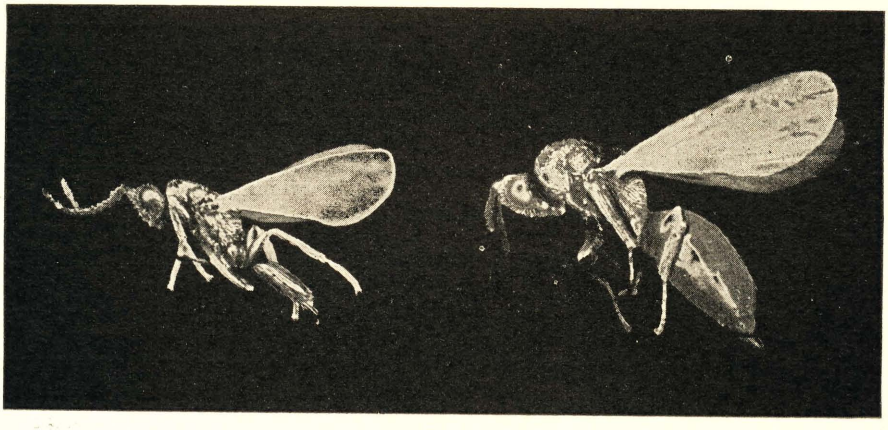

Fig. 55.—Wheat joint-worms.—Male at left, female at right, enlarged.

The effect of these attacks is to hinder the flow of sap to the growing berries and to produce small and often distorted grains. Oftentimes, the straw will be found to be bent at a sharp angle and to lodge so that it will be missed by the reaper, the loss varying from a slight one to almost a total loss.

Fortunately, the grubs that go with the straw through the separator are for the most part killed by the cylinders. A few may escape, but only a few. The mass of the individuals that survive the winter do so in the stubble, and because of our practice of starting clover in wheat fields it is not desirable to plow the stubble or to burn it. Therefore, it is recommended that the grain be cut fairly high, and then, after time is allowed for the rotting of

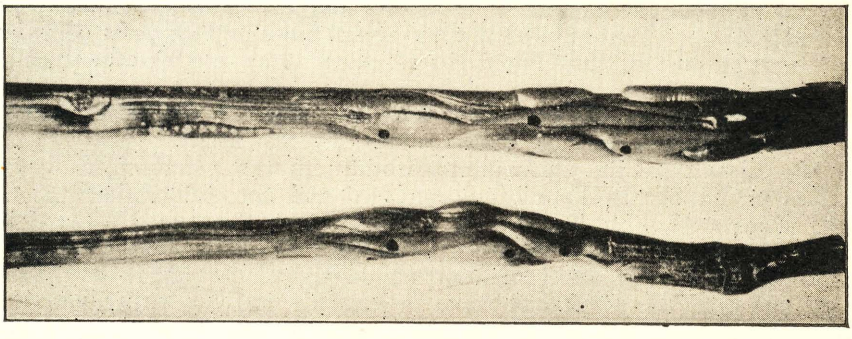

Fig. 56.—Swellings made by wheat joint-worms in straw, enlarged.

the roots, rake the standing short lengths of straw constituting the stubble with a side-delivery rake, and burn the rakings. New fields should be planted at some distance from infested stubble, even though, as is well known, the winged insects fly quite freely to a distance of half a mile or more.

There are seldom two years of severe loss in succession, since thus far the parasites, which are usually plentiful, always seem to dispose of the joint-worms before it is too late. We may lose heavily for one year, but if the methods above presented are employed, the parasites are almost certain to help sufficiently to prevent great loss the following year. The worst feature about a joint-worm attack is the fact that it is usually attributed to the Hessian fly, and, consequently, the methods usually used for the control of the Hessian fly are discredited.

WHEAT-SHEATH JOINT-WORM

(*Harmolita vaginicola*)

This species has been recorded less frequently than the common wheat joint-worm, although, undoubtedly, the work of the two species has often been confused. In the case of the sheath joint-worm, the seat of the injury is confined to the leaf-sheaths, which become swollen and crinkled, causing a sharp bend in the stem. The entire plant suffers more severely from its

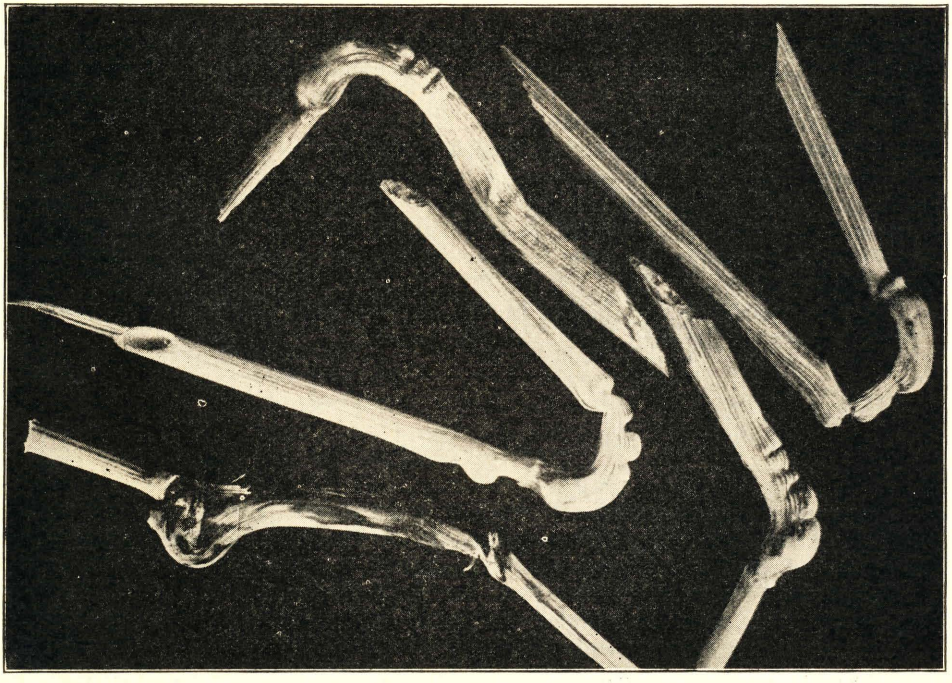

Fig. 57.—Work of the less common but more destructive joint-worm (Harmolita vaginicola), also known as the wheat-sheath joint-worm.

attacks than in the case of the commoner species. Often the plants attacked never reach more than half size, or even less, and the head may be shortened, so that only a few kernels may be produced, and even these may be almost entirely aborted.

Parasites usually keep the wheat-sheath joint-worm in subjection. No better methods of helping out nature are at present known, other than those recommended for the common joint-worm.

COMMONLY USED INSECTICIDES

BORDEAUX MIXTURE, 4-4-50

(Adapted from the "Spray Practice Outline," Michigan Special Bulletin 93.)

Dissolve four pounds of copper-sulphate (blue vitrol, bluestone) in two gallons of hot water, then dilute with water to make 25 gallons or one-half barrel. Do not use an iron or tin vessel for this purpose, as the copper sulphate would destroy it, and, besides this, the iron would spoil the bordeaux. A wooden pail serves very well for this purpose. Slake four pounds of lump lime or unslaked lime into a thin paste, and add water to make 25 gallons. Pour the slaked lime and the solution of copper-sulphate together into a third barrel, and the bordeaux is made. It should, however, be strained through a brass wire strainer as it is run into the spraying tank.

For potato leaf-hopper, use five pounds of copper-sulphate, and seven and one-half pounds of lump lime instead of the four pounds of each recommended for the standard mixture.

A larger or smaller amount of the bordeaux can be prepared equally well by maintaining the same proportions. Do not mix the chemicals and then dilute, and do not pour either the copper-sulphate into the lime or the lime in to the copper-sulphate; but pour them together into a third container, or dip out alternately from the copper-sulphate barrel and from the lime into the mixing barrel.

In case unslaked lime is not to be had, one can use six pounds of hydrated lime in place of the four pounds of the former.

PARIS GREEN

Paris-green (aceto-arsenite of copper) is a stomach poison, formerly used almost exclusively against chewing insects. It has been replaced largely by arsenate of lead in orchard work, because it cannot be mixed with lime sulphur and because it is less safe to the plants under all conditions. Paris-green occurs as rounded nodules and is not in the form of a fine powder. These nodules are heavy and are easily washed off by rains. Furthermore, they drop off the plants when spraying is continued to the point of dripping.

A spraying of Paris-green should be put on in a fine, fog-like form, and the spraying should be stopped short of the dripping point. On potatoes,

eight ounces to 50 gallons of water or of bordeaux is used, but one must be careful to stop spraying before the plants drip, or many of the large, heavy particles of poison will drop off.

An effective method is to mix four ounces of the poison in a half pound of freshly slaked hot lime, later stirring the mixture into the water or the bordeaux. Much of the dissatisfaction which follows the use of Paris-green is due to the use of a coarse spray which causes dripping, and the consequent loss of the poison. More than the ordinary agitation is required to keep this poison in suspension.

ARSENATE OF LIME

Calcium arsenate or arsenate of lime is a white powder somewhat resembling arsenate of lead, but costing less and having about twice the killing power per pound of the lead compound. In other words, in places where it is safe to use it at all, a pound costs less and goes about twice as far. It is not recommended for general use on fruit-trees, because it often "burns" the foliage several days after the application, but cucumbers, potatoes, beans, cotton, and some other plants appear to tolerate the calcium compound even better than arsenate of lead.

The arsenate of lime stays in suspension well and sticks well. It is light enough to work satisfactorily in dusts, and is to be recommended universally for certain purposes.

Most manufacturers of lead arsenate will supply arsenate of lime as well, and the experience of a single season will convince any potato-grower or cucumber-grower of the advantages that lie in the use of the calcium arsenate.

CARBON DISULPHIDE FUMIGATION FOR INSECTS IN STORED GRAINS AND SEEDS

All fumigants for insects work best during warm weather. A temperature of 70 degrees Fahrenheit is desirable, but not necessary. Fumigation should be postponed when the temperature falls below 50 degrees. Furthermore, seeds and grains must be DRY if the operation is to be successful; that is, if the insects are to be killed without injuring the viability of the seeds.

First, make sure that the bins or barrels are tight. If they are not tight, spread or tack several thicknesses of newspaper over the inner surfaces, overlapping so as to close all crevices.

Measure the inside of the bin, counting in the air space above the grain, and allow one pound (avoirdupois) for 100 cubic feet of space. If it becomes necessary to fumigate at a temperature lower than that stated, then the dose must be increased. Moist seeds absorb the gas, and the danger of injuring their germinative power increases with their moisture content.

After the bins are made tight, arrange for covering the top. If wooden covers are lacking, it is possible to place sticks across the top of the bin, and then, by placing newspapers between blankets, to arrange a satisfactory cover which will confine the gas quite effectively. When all is ready place some old pans on top of the grain or seeds, pour in the liquid, and close

everything tightly. Leave for 36 or 48 hours, and then open and air thoroughly, shoveling over the grain so as to let the gas at the bottom escape.

Warning: Do the work in the day time and keep all fire away, since CARBON DISULPHIDE GAS IS EXTREMELY EXPLOSIVE, IF IGNITED. IT IS ALSO POISONOUS, IF BREATHED. It kills humans just as readily as it kills insects. Furthermore, the insurance in some insurance companies lapses during the operation.

Carbon disulphide can be used to advantage, also, for killing woodchucks, gophers, and other pests whenever it can be poured into burrows.

Carbon disulphide is an evil-smelling liquid which quickly changes to a gas when poured out at ordinary temperatures. The gas is heavier than air, and settles down through the seeds, penetrating to all air spaces and crevices. It will not kill many eggs, and, therefore, the fumigation may have to be repeated.

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