CIRCULAR NO. 63, SECOND EDITION.

United States Department of Agriculture,
BUREAU OF ENTOMOLOGY,
L. O. HOWARD, Entomologist.

ROOT-MAGGOTS AND HOW TO CONTROL THEM.

By F. H. CHITTENDEN,
In Charge of Breeding Experiments.

The roots of vegetable crop plants of many kinds are subject to the destructive influence of maggots which injure them severely during certain seasons. Several forms of injurious root-maggots are recognized, but of these there are three species which are much more destructive than the others. The most important are the cabbage maggot and the imported onion maggot, the former a specific enemy of cabbage and

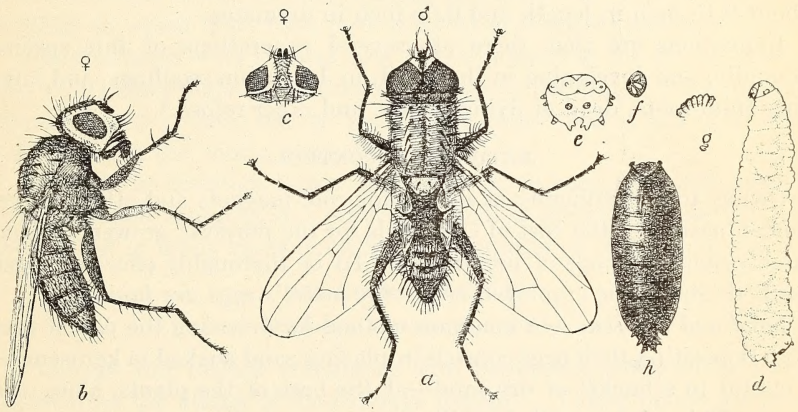

FIG. 1.—Seed-corn maggot (*Pegomya fusciceps*): *a*, male fly, dorsal view; *b*, female, lateral view; *c*, head of female from above; *d*, larva, from side; *e*, anal segment of larva; *f*, anal spiracles; *g*, cephalic spiracles; *h*, puparium—all much enlarged (author's illustration).

other cole crops, the latter of the onion. A third species, the seed-corn maggot, attacks the sprouting seeds of both onion and cole crops and of a considerable variety of other plants, afterwards working into the roots and stalks beneath the earth's surface. As the last-mentioned insect is nearly omnipresent and omnivorous, it will receive first consideration.

These species all belong to the genus Pegomya (Phorbia) of the dipterous family Anthomyiidæ.

THE SEED-CORN MAGGOT.

(*Pegomya fusciceps* Zett.)

Vegetable growers frequently find that planted seed fails to develop, and, on looking for the cause, discover a small white maggot which, from early-observed occurrence on seed corn, has been termed the seed-corn maggot. In more recent years it has often been associated with injury to beans, whence another name, "bean fly." Many other vegetables

are subject to damage, cabbage, turnip, radish, peas, onions, beets, and seed potatoes being often much affected. This insect, which is generally distributed in the United States, is shown in its different stages in figure 1. It resembles the common house fly. The particularly distinguishing characteristic of the fly is a row of short bristly hairs of nearly equal length on the inside of the posterior tibiæ or shanks of the male (fig. 1, *a*). The length of the wing is about one-fifth and of the body about one-sixth of an inch. There is little doubt that the insect is of European origin and that it is increasing in destructiveness in this country.[1]

In its earlier stages, also, the seed-corn maggot resembles the house fly. The maggot is footless and cylindrical, presenting in profile the appearance represented at *d*. It measures about one-fourth inch in length and about 0.04 inch in width. The color varies from nearly white to pale yellowish.[2] The maggot transforms into a puparium (*h*), barrel-shaped, of elliptical outline, and pale brown in color, measuring about 0.15 inch in length and 0.05 inch in diameter.

Indications are that there are several generations of this species annually, one developing in the North in June from seedlings, and later ones from roots, dead or dying plants, and other refuse.[3]

METHODS OF CONTROL.

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

Sand and kerosene.—A common method for deterring the parent flies from depositing their eggs consists in placing sand soaked in kerosene—a cupful to a bucket of dry sand—at the base of the plants, along the rows. This mixture will also kill young maggots that might attempt to work through it.

Carbolic-acid emulsion.—For all three forms of root-maggots which we are considering, a carbolized form of kerosene emulsion is effective. This is prepared by adding to 1 pound of soap boiled in 1 gallon of water, one-half gallon of crude carbolic acid, and diluting the whole with from 35 to 50 parts of water.[4] This mixture is applied about the stalks of the plants affected. It is best to use it a day or two after the plants are up, or are transplanted, and repeat every week or ten days until about the third week in May, in the North. Farther south these applications must be made earlier in the season.

---

[1] A more extended notice is furnished in Bul. 33, n. s., Div. Ent., pp. 84–92.

[2] In all material examined there are only 6 or 7 cephalic spiracles (fig. 1, *g*), whereas in the other root-maggots here considered there are 11 or more.

[3] There is evidence that another maggot has been confused with this species.

[4] The mixture is effected according to directions furnished in Farmers' Bulletin 127, p. 22 (1903 ed.), which will be furnished on application.

The use of mineral fertilizers.—Mineral fertilizers are useful as deterrents, particularly when employed just before or after a shower has thoroughly wet the ground. The principal fertilizers for this purpose are kainit, nitrate of soda, and sulphate or chlorid of potash. They may be used as top dressings before planting; or, if not employed until afterwards, they should be applied as nearly as possible to the roots, the earth being turned away from the plants for this purpose. These fertilizers possess the advantage of acting also as a stimulant to plant growth, thereby facilitating recuperation from root-maggot attack.[1]

Danger from use of organic fertilizers.—Stable manure and organic fertilizers are apt to induce infestation, since the species under consideration is well known to develop in excrement and other decomposing material. Numerous instances of this have come to the writer's knowledge during recent years. It is advisable, therefore, to avoid the use of manure, rotted leaves, or other organic fertilizers, and to avoid planting in fields in which there have been infested or diseased plants.

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

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

THE CABBAGE MAGGOT.

(*Pegomya brassicæ* Bouché.)

Cabbage and related cruciferous crop plants frequently suffer severe injury from the attack of the cabbage maggot. Young plants are most seriously affected, the maggots eroding the outer surface and boring into the interior of the roots, devouring the tender rootlets and frequently penetrating into the lower portion of the stalk.

This insect, known also as the radish maggot, is an imported pest, and was first noticed ruining cabbage, cauliflower, and similar plants in New York State about half a century ago. It does most serious injury throughout the northern tier of States and Canada, attacking all forms of crucifers, whether wild or cultivated. In that region it is the cause of more or less loss to these crops year after year, but as with other destructive insects, it is much more abundant in some seasons than in others. Since 1902 it has not only been exceedingly destructive, but

[1] It is frequently necessary to use these fertilizers in large quantities. In cabbage fields a fertilizer of the proper composition is applied before planting at the rate of 1,000 to 1,500 pounds to an acre. After the plants have started growth, a top dressing of 100 pounds of nitrate of soda and 200 pounds superphosphate is added. When the heads are beginning to develop, a third application of about 200 pounds of nitrate of soda to the acre is often desirable. For details consult Voorhees's "Fertilizers."

has increased in injuriousness from year to year. Frequently entire crops over considerable areas are completely destroyed.

Two or three generations of this maggot are indicated in the Northern States, and perhaps four or five in the South.

METHODS OF CONTROL.

Since this species also is a root-feeder, the remedies prescribed for the seed-corn maggot are applicable. In addition there are certain preventive and other measures for its destruction that have been found successful, their use being justified by the great value of cabbage plants.

Carbolic-acid emulsion, prepared as prescribed on page 2, and diluted about 35 times, is particularly applicable when this maggot occurs on radish and other plants than cabbage and cauliflower.

Hand picking, although laborious, has the merit of being effective, and is practiced with considerable success by extensive cabbage growers, although not practicable on radish and similar crops. It consists in pulling up the young cabbage or cauliflower plants, examining the roots for eggs and maggots, and either destroying the eggs and maggots by crushing with the hand or by washing the roots in a strong solution of soap and then replanting. In most cases the plants show no ill effects from this treatment after two or three weeks have elapsed. By looking closely, the minute white eggs may be seen about the stalks of young cabbages, and if the earth be raked away so as to expose the eggs to the sun these will dry up, thus preventing the maggots from hatching. Afterwards the plants should be hilled.

Methods of cultivation.—Experience shows that comparatively little is to be expected from various farming methods which are sometimes perfect safegards against other insects. Whatever might be advised and found successful on one farm might, for one or more reasons, be found ineffective on another.

By keeping the soil well hilled around the plants the cabbage develops more roots, thus affording more food for the maggots and still leaving enough roots to strengthen the plant itself.

Crop rotation should be followed with any plants other than crucifers or onions. With these latter it is inadvisable, as the same atmospheric or other conditions which induce injury by the cabbage maggot seem to operate in increasing the numbers of the onion pest, which has a similar distribution.

Fall plowing is advisable.

Crop remnants of all crucifers, and particularly cabbage stumps, should be removed and destroyed, especially early in the season. Late in the fall a less number of maggots would be destroyed in this way, but it is always a desirable method for the protection of the crop against other pests which harbor in the old stalks or feed on the new leaves in early winter, to appear the next spring.

Gas lime, applied about each plant, has often been advised as a remedy, but those who have tried it are almost equally divided as to its efficacy. It is well worth further experiment where the gas lime can be obtained fresh without difficulty. It may frequently be had for the cost of carting.

The bisulphid of carbon treatment.—In case tarred paper cards, which will presently be described, or other preventive methods here given, are not employed, and the insects occur in great numbers at the roots of cabbage, bisulphid of carbon may be used. It should be applied below the root system with a special injector or syringe,[1] taking care that the application is not made directly to the plants, as it is very likely to kill them. A hole is made a little distance (3 or 4 inches) from the plant, and the injector inserted at an angle, as shown in fig. 2. After injecting the liquid the instrument should be withdrawn and the hole closed by packing it down with the foot. From a teaspoonful to a tablespoonful to each young plant, and a single application, is generally sufficient.

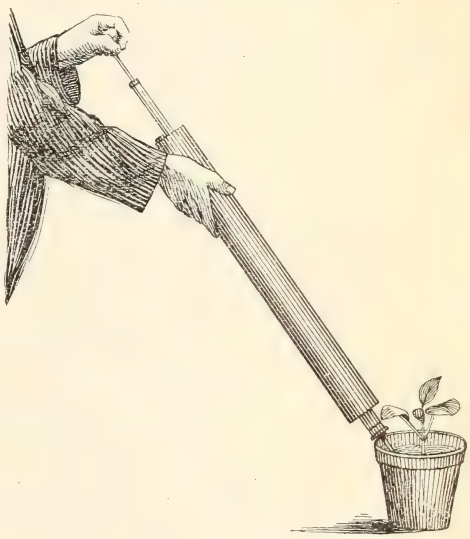

Fig. 2.—Bisulphid of carbon injector in use.

Tarred paper cards.—The use of disks or pads of tarred paper for the protection of cabbage against the oviposition of the fly was perfected in 1889 by Mr. W. H. Goff, who describes his cards and the manner of cutting them as follows:

The cards are cut in a hexagonal form (fig. 3), in order to better economize the material, and a thinner grade of tarred paper than the ordinary roofing felt is used, as it is not only cheaper, but being more flexible, the cards made from it are more readily placed about the plant without being torn.

The blade of the tool, which should be made by an expert blacksmith, is formed from a band of steel, bent in the form of a half hexagon, and then taking an acute angle, reaches nearly to the center, as shown in fig. 5. The part making the star-shaped cut is formed from a separate piece of steel, so attached to the handle as to make a close joint with the blade. The latter is beveled from the outside all around, so that by removing the part making the star-shaped cut the edge may be ground on a grindstone. It is important that the angles in the blade be made perfect, and that its outline represent an exact half hexagon.

[1] What is known as the McGowen injector, formerly manufactured at Ithaca, N. Y., but no longer for sale, has proved most successful.

To use the tool, place the tarred paper on the end of a section of a log or piece of timber and first cut the lower edge into notches, as indicated in fig. 4, using only one angle of the tool. Then commence at the left side, and place the blade as indicated by the dotted lines, and strike at the end of the handle with a light mallet, and a complete card is made. Continue in this manner across the paper. The first cut of every alternate course will make an imperfect card, and the last cut in any course may be imperfect, but the other cuts will make perfect cards if the tool is correctly made and properly used.

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

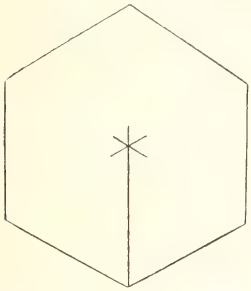

FIG. 3.—Tarred paper card in outline, one-half size (after Goff).

A Wisconsin grower protected 7,000 plants and secured a splendid crop, while unprotected plants nearby would have been a complete failure if the maggots had not been picked off by hand. Others have reported similar success. One reported having lost only 25 plants out of 10,000 to 15,000 that he protected with the cards, where ordinarily he would have lost from 75 to 90 per cent of the crop.

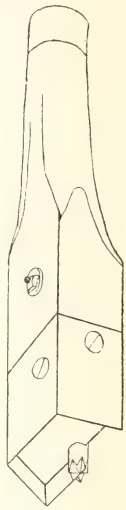

FIG. 5.—Tool for cutting cards, about one-fourth size (after Goff).

The tarred cards are applicable to cabbage and cauliflower only, but it is claimed by those who have employed them that they are cheaper, more practicable, and more efficient than anything else yet devised for preventing the ravages of the cabbage maggot. Success in using them is dependent upon their being properly applied, *to fit tightly*, so that the fly is unable to obtain access to the stem for the deposition of her eggs. Cards must be renewed and their use continued for each maggot year to be effective.[1]

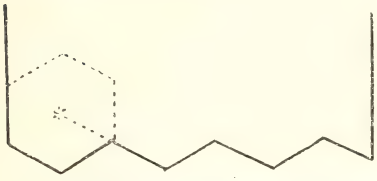

FIG. 4.—Showing how tool is used, dotted line indicating position of edge of tool (after Goff).

THE IMPORTED ONION MAGGOT.

(*Pegomya cepetorum* Meade.)[2]

The name "imported onion maggot" is used for this insect because there are other onion-feeding maggots in addition to the seed-corn

[1] A Wisconsin firm has used as many as 20,000 of these cards a year, and estimates the cost of material and labor at about $1 for the protection of 1,000 plants. This shows its practicability on a large scale.

[2] This species is commonly referred to in literature as *Anthomyia* and *Phorbia ceparum* Bouché. According to Mr. Coquillett, it is difficult to decide, from the description of the adults, whether or not Bouché's and Meade's species are identical.

maggot. Its injury, which constitutes the most important drawback to the culture of onions, is accomplished by the consumption of the bulb, inducing subsequent decay of the affected portions and their very frequent destruction.

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

As in the case of the cabbage maggot, two or three generations are evidently the rule in the North.

REMEDIES.

The methods of control prescribed for the seed-corn maggot are frequently about all that are necessary for this species. In case of severe infestation the bisulphid of carbon treatment, discussed on page 5, as also other remedies advised for the cabbage maggot, are useful, with the exception of the tarred cards, which can not be conveniently nor economically used on onion. The flies are probably attracted to old onion beds and to crop remnants; hence clean field methods are advisable.

NOTE.—This circular has been prepared to facilitate correspondence, due to the fact that the three root-maggots mentioned herein have been extremely injurious during recent years. A monographic account, which has been of service in the preparation of this circular, was published in 1894 by Prof. M. V. Slingerland (Bul. 78, Cornell Univ. Agl. Exp. Sta., pp. 481–577). It is now out of print.

Approved:

JAMES WILSON,
Secretary.

WASHINGTON, D. C., *February 12, 1906.*

O