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**INSECT PESTS OF GROWING TOBACCO
IN CONNECTICUT**

DONALD S. LACROIX



Connecticut
Agricultural Experiment Station
New Haven

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INSECT PESTS OF GROWING TOBACCO IN CONNECTICUT

DONALD S. LACROIX

FOREWORD

For many years Connecticut tobacco growers have needed a concise, popular but accurate treatise on the insects that injure growing tobacco plants. Separate articles dealing with tobacco insects have appeared in the reports of this Station but some of them are now out of print. Moreover, it is a great convenience to have the information all together in one publication.

The author of this bulletin, Mr. Donald S. Lacroix, is a graduate of the Massachusetts State College, was formerly in the United States Bureau of Entomology and is now a teacher of biology in the High School at Amherst, Mass. For six consecutive summer seasons, Mr. Lacroix has been employed by this Station to investigate the insects injurious to growing tobacco in Connecticut. This bulletin was prepared by Mr. Lacroix and is largely the result of his investigations, supplemented, of course, by the work of others and the office records. It is believed that it will be a welcome addition to the literature on pest control and will prove a great help and convenience to the tobacco growers of Connecticut.

—W. E. Britton.

INSECTS are said to be man's chief competitors for existence on this planet. There are few places where they do not live. They are found injuring man's dwellings, foodstuffs, clothing, crops, and even his person.

Although tobacco products are used for the control of numerous pests, the tobacco plant itself is subject to depredation by many different kinds of insects. None of these is strictly dependent upon this one plant as a source of food. However, there are about 20 species that do enough harm to claim the attention of growers here. The rest are merely incidental or occasional feeders. The following text describes the most important insect pests of growing tobacco, the injuries they produce and any known methods of control.

Insects and Control

Insects are characterized as small animals having six legs in some period of their existence. Many of them go through four stages before their development is complete. The usual life cycle includes the egg, the larva, (caterpillar, maggot, "worm", grub), the pupa, and finally, the adult. In some forms of insect life the pupa stage is omitted.

From the standpoint of the economic entomologist, insects may be divided into two groups: (1) Those that chew the tissues and (2) those that pierce the plant and suck the sap. The members of the first group have biting mouth parts and injure foliage by actually cutting off small pieces of plant tissue and swallowing them. Obviously this class may be controlled by placing a stomach poison on the leaves so that it will be taken into the digestive system. It follows logically that insects of the second group must be held in check through some other kind of agency, since their food comes from within the plant. Hence the development of "contact" insecticides which kill by actual contact with the body.

Some General Considerations

A specific method of control, such as the use of barium fluosilicate dust for checking flea beetle injury, may be advocated for certain insects. In other cases no specific is known, but some pests in this class have been observed migrating to tobacco from weeds or other plants. Cleaning out host plants or destroying trash and places of shelter will materially reduce the number of insects of this type and too much cannot be said in favor of such general clean-up practices.

Another point worth some attention is that a regular dusting program on both shade-grown and sun-grown tobacco will control insect pests of many kinds, either through actual poisoning or through a repellent action, or both. Our observations covering the entire tobacco-growing area have indicated that wherever a dusting program is being carried out, leaf-eating insects are reduced in number. Clean culture and an intelligently conducted program combine to curb many harmful pests.

Most tobacco growers examine their plantations quite thoroughly at frequent intervals, a practice that should reveal any insect work in its early stages. This kind of careful observation is highly commended.

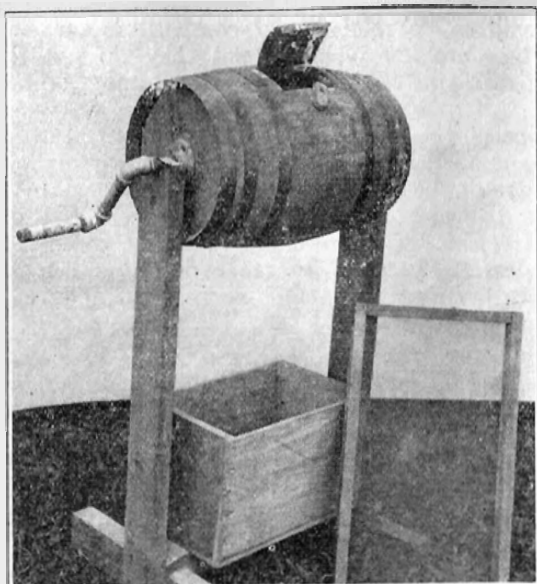


Figure 23. Barrel mixer for mixing dusts.

The plantation manager who carries out such a system is rarely caught unaware by pest invasions of various kinds. Naturally it requires rather careful scrutiny to notice the presence of some of the more obscure forms of insects, but the additional time required pays for itself.

If there is a question concerning insects at any time, specimens of the pests and of their work should be brought to the attention of members of the Experiment Station staff. This will aid the specialists in insect work to gather more accurate information on the species involved, and to offer helpful advice to the growers without loss of time.

Mixing and Applying Insecticides

Dusts: Dusts of several types have proven more satisfactory than sprays in controlling some tobacco pests because they are easier to apply and do not adhere long enough to leave a visible residue after the tobacco is cured. Spray machinery is awkward to handle in growing

tobacco, and sprays themselves tend to stick longer on the foliage, often remaining visible on the leaf throughout the curing processes.

One of the simplest and most efficient machines for mixing dusts is an ordinary keg, or small barrel, suspended horizontally between two uprights and turned by hand (Figure 23). By cutting a hole five or six inches square in the middle of the staves and attaching the cut-out piece by two straps or hinges, so that it acts as a cover, access to the inside is easily obtained.

The materials to be mixed are measured and poured into the barrel, along with 10 or 12 smooth stones (the size of a hen's egg). Next the cover is clamped shut, and the barrel and contents rotated slowly for about five minutes. The stones help to break up any lumps and also aid in mixing the materials. When this operation is completed, the cover is opened and the mixed dust poured out through a coarse sieve into a container below. The stones remain in the sieve.

It may seem difficult with the available dusting machinery to distribute properly the light dosages advocated. The natural tendency is to cover the tobacco foliage until the dust is seen plainly on the leaves. But this is a waste of material. Experience has shown that the dust gun should be opened just enough to produce a thin, fog-like cloud. When the operator walks along at a natural gait, no distinct whitening of the leaf surface should appear, but a close examination of a dusted leaf should show evenly deposited dust particles.

Poisoned Bran Bait: Small quantities of poisoned baits may be mixed in tubs using wooden paddles; but for large quantities, the materials may be dumped on a fairly tight floor, and mixed by shoveling over and over. It is best to mix the bran and the poison first in the dry condition and then to add a little water in which the molasses has been dissolved. Only enough water to moisten the mixture should be used. Never saturate the material or allow it to puddle. At the same time each flake of bran should be moist sufficiently to make some of the poison adhere to it.

Before broadcasting a poisoned bait, it is well to consider the habits of the insect for which it is to be used. As grasshoppers feed during the warmer parts of the day, morning will be the best time to apply the material. Most cutworms feed at night, hence poison for their control should be scattered during the late afternoon.

Calcium Cyanide: Granular calcium cyanide is recommended for wireworm control. When this material becomes damp, hydrocyanic acid, a violent poison, is released. Therefore it is imperative that all operations with calcium cyanide be conducted out of doors. To open a container of this material in confined quarters, and to breathe the fumes, will cause serious results. However, little or no trouble need be experienced if the cans are opened out of doors and care is taken not to breathe the escaping gas. All empty cans should be buried or carefully washed.

KEY TO INSECTS INJURIOUS TO TOBACCO*

The following classification of insect pests will help to identify those likely to be found on tobacco. By referring to this key, one can determine what insect he has found and can then turn to the pages where it is discussed.

* Modified from Anderson's "Key to Insect Injuries", *Tobacco Culture in Connecticut*, Conn. Agr. Exp. Sta., Bul. 364: 785-786, 1934.

I. INSECTS CAUSING INJURY TO PLANTS IN SEEDBEDS:

1. Very small seedlings in two- or four-leaf stage, defoliated. Tiny, purple, jumping insects, just visible to the naked eye.
Garden Springtail (p. 93)
2. Large holes eaten in the leaves, or whole seedlings devoured or cut off at soil surface. Large dark-colored worms which feed at night and curl up under the soil or at the sides of beds during the day.
Cutworms (p. 94)
3. Foliage of larger plants (middle to late May) with numerous "shot holes" eaten by small, black, active, jumping beetles, one-sixteenth of an inch long.
Potato Flea Beetle (p. 101)

II. INSECTS CAUSING INJURY TO YOUNG PLANTS IN THE FIELD:

1. Inside of root or base of stem tunneled out, causing plants to wilt and die, usually within a day or two after transplanting. Hard, yellowish-brown, shiny, slender worms, one-half to one inch long, in stalks or in soil near plants.
Wireworms (p. 104)
2. Injury similar to that mentioned above, but soft-bodied white maggots one-fourth of an inch long present.
Seed Corn Maggot (p. 107)
3. Young plants cut off at soil surface. Fat, dark-colored worms curled up in soil nearby.
Cutworms (p. 94)
4. Holes or notches eaten into sides of young stalks. Tough, leathery, gray maggots, about one inch long and with four protuberances on head.
Crane Fly Maggot (p. 109)
5. Injury similar to above mentioned, but with some tunneling of stalk and presence of a dirty yellow or brown active "worm", one-half inch long, accompanied by silken webbing.
Corn Root Webworm (p. 110)

III. INSECTS CAUSING INJURY TO LARGER, MORE MATURE PLANTS IN FIELD IN JULY OR AUGUST:

1. Growing point or buds attacked before leaves unfold
 - (a) Unfolding leaves distorted and curly but with no large holes. Brown mottled bug, one-fourth of an inch long, flying away when disturbed.
Tarnished Plant Bug (p. 111)
 - (b) Unfolding leaves ragged and misshapen with irregular, large holes. Small, rusty brown worms, when young; or green, slender worms with paler stripes lengthwise on sides, up to one and one-half inches long, when mature.
Tobacco Budworm (p. 112)
2. Mature leaves damaged
 - (a) Main veins silvery above and peppered with minute black specks. Brown, slender, sucking insects one twenty-fifth of an inch long.
Tobacco Thrips (p. 115)
 - (b) Numerous little "shot holes" eaten by small, black, active, jumping beetles, one-sixteenth of an inch long.
Potato Flea Beetle (p. 101)
 - (c) Large round holes between veins eaten by large, variously colored (never black) hoppers with prominent hind-legs.
Grasshoppers (p. 117)
 - (d) Holes much as above, or all of leaf tissue except larger veins eaten by dirty gray or brown, fat "worms".
Cutworms (p. 94)
 - (e) Large holes, or extensive areas without regard to veins, eaten away by large green caterpillars up to four inches long, with prominent horn-like appendage at posterior end.
Hornworms (p. 120)

- (f) One or two leaves well up on the stalks of Broadleaf or Havana Seed plants wilting. Large, dark brown, flat, shield-shaped bug hiding under leaves or piercing mid-rib of a leaf.
Spined Stink Bug (p. 124)
3. Inside of stalks tunneled out, causing plants to wilt. Single large, soft, grayish-brown caterpillar with stripes lengthwise on back and sides, one stripe extending across each side of head. Entrance hole lower in stalk.
Stalk Borer (p. 125)
4. Seed pods bored and entered by pale green, slender worms with lighter lengthwise stripes, up to one and one-half inches in length.
Tobacco Budworm (p. 112)

GARDEN SPRINGTAIL*

Appearance and habits: Injury from this insect is most noticeable in the seedbeds when the small tobacco plants are in the two- or four-leaf stage. While the damage to young plants may be limited to a few notches in the small leaves, often an infestation develops that causes complete defoliation in sections of the seedbed. When this occurs, the cotyledons (first leaves) are destroyed, leaving only the stems of the small plants standing.



FIGURE 24. Outline profile of the garden springtail. This insect is purple with pale yellow, irregular spots. Enlarged about 40 times.

The garden springtail (Figure 24) is about one millimeter (one twenty-fifth of an inch) long, in color dark purple spotted with yellow, and jumps like a flea so that it is difficult to catch. The body is globular with a rather large head and narrow neck. The insect jumps by means of a forked, tail-like appendage which it snaps against the surface from which it springs.

Another springtail (*Proisotoma minuta* Tully) is often found in the field very early in May, in such numbers as to fill furrows or depressions in the soil to a depth of an inch or more. Nothing is known about its life history in tobacco soils.

Food plants other than tobacco: The garden springtail feeds on young cabbage, turnip, cucumber, mushrooms and on many types of greenhouse seedlings, and has also been found in maple sap buckets feeding on the surface of the sap.

Control: Dusting or spraying with nicotine sulphate will control this insect. A heavy infestation at the Tobacco Substation was controlled by spraying the beds twice with nicotine sulphate diluted at the rate of one pint in 100 gallons of water. The spray was applied on bright days and the glass covers were kept on to confine the fumes.

* *Sminthurus horrens* Fitch.

CUTWORMS

There are 20 species of cutworms that feed on tobacco in various parts of the United States. In Connecticut there are probably half a dozen species which injure the crop, and of these the most important are discussed below. All exhibit the common tendency to cut various parts of the plant—some eating the stems of young plants at the soil surface, others cutting off leaves in seedbeds, and still others climbing up to devour the fully developed foliage. Cutworms are so much alike in many respects that it is often difficult to distinguish one species from another when they are taken in the field.

The Well-Marked or W-Marked Cutworm*

The larvae of this species have been found infesting very small plants in seedbeds early in May. Usually they crawl into the beds from adjacent territory where they have been spending the winter, and very systematically cut off and eat the small tobacco leaves. The cutworms go to work in a characteristic manner, eating all plants as they progress and leaving a clean sweep after them. It is not unusual to find that they enter the seedbed from one corner, spread out in their advance, and eat their way to the opposite ends of a series of beds.

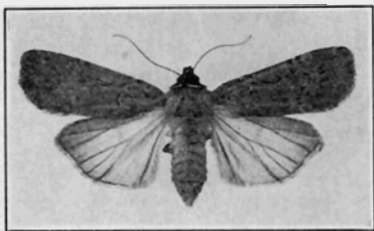


FIGURE 25. Moth of the W-marked cutworm, *Agrotis unicolor*, natural size.

The larvae are about one and one-half inches long, when mature, and in color may be dull brown, gray, or blackish, often tinged with green, and more or less marked longitudinally with dots and dashes. They winter over in this stage, coming out of their hiding places early in May, when they feed ravenously for a few days. Pupation takes place in the soil early in the second week in May and the adult moths emerge during the last week. It is rather difficult to describe the moth of this species (Figure 25) as many of the cutworm adults are so similar, but a comparison of the accompanying figures will serve better than a written description to differentiate the various kinds.

The female deposits her eggs the first part of June and from these hatch more larvae. Just how many broods occur here in one season is not certain, but it seems possible that two generations may exist.

Food plants other than tobacco: The larvae of the W-marked cutworm have been reported as feeding on a large number of plants including apple, bean, cabbage, celery, clover, grasses, lettuce, peach, plantain, and wheat.

* *Agrotis unicolor* Wik. (*Noctua clandestina* Harr.)

Distribution: This insect is found throughout Connecticut and occurs all over the northern half of the United States and in Canada. It is considered a northern species.

The Greasy Cutworm*

The greasy cutworm causes considerable damage because of its habit of wandering around and cutting off one plant after another. This species rarely occurs alone in large numbers.

Appearance and habits: The larva attacks tobacco in the field, usually soon after transplanting, and cuts the young plants off at the soil surface. It is not, however, the only species that causes this type of injury. It can be found near the ruined plants an inch or so under ground. It is a large, black worm, (Figure 26) more or less shiny and quite smooth, and it measures an inch and three-quarters to two inches in length when full grown.

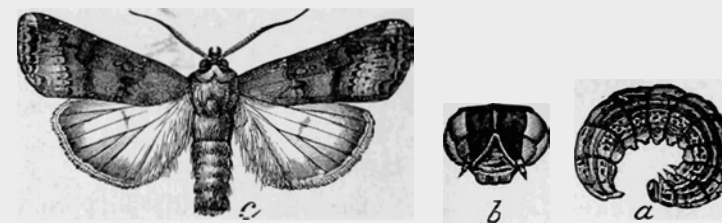


FIGURE 26. The greasy cutworm, *Agrotis ypsilon*: (a) larva, (b) front of head (c) adult. (After Howard, Bureau of Entomology, U. S. Department of Agriculture.)

Pupation takes place in the soil, and the pupa is so similar in appearance to other cutworm pupae that it is difficult to determine the species. The pupal stage ranges from ten days to two weeks.

“The adult moth (Figure 26) has a wing expanse of about two inches. The fore-wings are brown, sometimes light and sometimes nearly black, marked rather inconspicuously with fine, curved black lines. The apex of each wing is crossed by delicate, undulating, white lines, interspersed with dark and light spots, giving the entire end of the wing a paler color than the ground portion. The hind-wings are nearly white, shaded with brown along the veins and margins, and edged with a short white fringe.”**

Food plants other than tobacco: A long list of plants attacked by the greasy cutworm, according to the literature, includes asparagus, apple, bean, beet, cabbage, grass, clover, corn, grape, onion, orange seedlings, pepper, potato, squash, tomato, and many others.

Distribution: This cutworm has been reported as being world-wide in its occurrence and in the United States is especially destructive east of the Mississippi River.

* *Agrotis ypsilon* Rott.

** Britton, W. E., Sixth Rept. Conn. State Entomologist, 266, 1907.

The Spotted Cutworm*

The spotted cutworm is one that exhibits climbing tendencies. In late July it is frequently found in large numbers on well-grown tobacco, stripping the foliage down to the larger leaf veins and midribs (Figure 27). It will often cut into the stalks as well, even though they are an inch thick. Infestations of this pest usually develop quite suddenly, as the larvae migrate much in the fashion of armyworms.



FIGURE 27. The spotted cutworm fed on these tobacco leaves.

Appearance and habits: The mature larva of this cutworm (Figure 28) is about an inch and one-quarter long. It is dark in color and each side of the back has a row of wedge-shaped black marks that become more pronounced toward the posterior end. The under side is much paler in color than the back. All the worms found on tobacco have been nearly full grown, and their activities usually have been limited to a

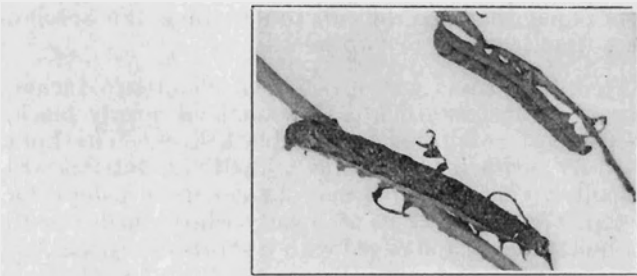


FIGURE 28. Larvae of spotted cutworm. Natural size.

few days. It is frequently characteristic of an infestation that the larvae begin to work on the outside rows of a field and slowly move towards the inner rows, eating most of the foliage as they proceed. Spotted cutworms may be observed climbing up the plants early in the morning and again in the early evening. As many as 45 worms work on a single, half-grown plant. During the heat of the day, many of them curl up under leaves that touch the ground, or burrow into the soil for protection.

* *Agrotis c-nigrum* Linn.

All infestations which have come to our attention in the past five years have been on Broadleaf tobacco. In several cases, the spotted cutworms appeared shortly after the cutting and removal of timothy hay in an adjoining field. In other instances, they migrated from alfalfa fields which were suffering from drought.

These sudden infestations usually appear during the latter part of July, and very soon the larvae leave the tobacco to pupate in the soil. Adults emerge throughout the latter half of August and deposit eggs for the next brood.

The adult (Figure 8) is similar to that of the greasy cutworm but has a black dash near the upper middle portion of each fore-wing. A light-colored, V-shaped notch is present in this black dash.

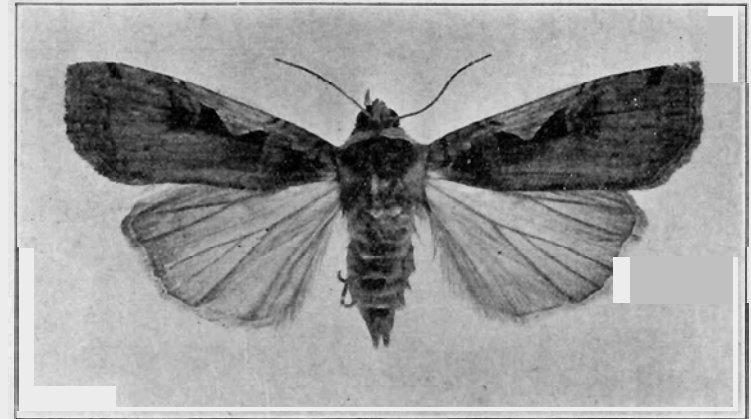


FIGURE 29. Adult of spotted cutworm, *Noctua c-nigrum* Linn., twice natural size.

Food plants other than tobacco: This insect also has a large list of host plants to its credit, including apple leaves, beet, cranberry leaves and blossoms, carrot, corn, currant, ferns, grasses, mangel, tomato, violet and wheat.

Distribution: The spotted cutworm has been found throughout the northern United States, Canada, Alaska, Europe, and Asia.

The Dark-Sided Cutworm*

This cutworm infests plants in both seedbeds and field and, like the spotted cutworm, often feeds on mature leaves.

Appearance and habits: The dark-sided cutworm makes its appearance in the tobacco seedbeds about the middle of May and starts eating crescent-shaped notches in the leaves of small plants (Figure 30). As the worms increase in size, they take larger portions of leaf and may devour all of the foliage by the time the plants are ready for transplanting. In the field, the insect feeds almost entirely on the lower leaves, and has not yet been observed cutting off an entire plant.

* *Euxoa messoria* Harr.

When fully grown, the dark-sided cutworm is an inch and one-quarter to an inch and one-half long, dark gray in color, with a paler stripe running the length of the back and another along each side. Black tubercles are scattered prominently in the pale side stripes (Figure 31). The worms reach this stage in late June and early July, when they go below the soil surface and form an earthen cell. They remain in a resting state for a week or two, pupate, and emerge as moths three weeks or a month later. The moth is dark gray in color, with several distinct, dark wavy transverse lines crossing each fore-wing. It has a wing expanse of about one and one-half inches (Figure 32).

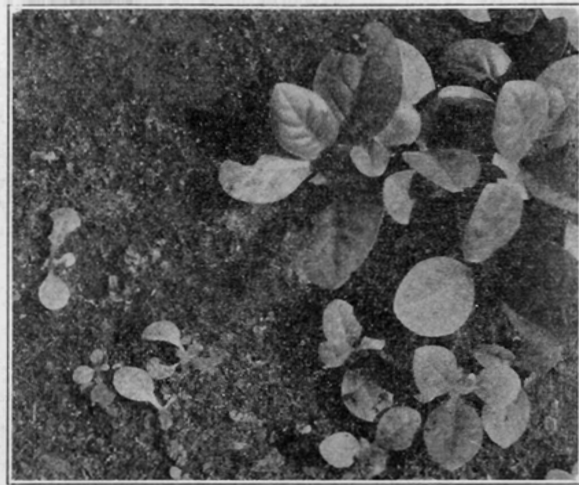


FIGURE 30. Tobacco in seedbed injured by feeding of dark-sided cutworm.

Food plants other than tobacco: Larvae of this cutworm have been reported as feeding on apple leaves, cabbage, corn, grape, onion, peach, pea, potato, radish, strawberry, sugar beet, sweet potato and turnip.



FIGURE 31.
Larva of dark-sided cutworm. Natural size.



FIGURE 32.
Adult of dark-sided cutworm. Natural size.

Distribution: The dark-sided cutworm has been found in northern South America and in all parts of North America.

The Variegated Cutworm*

While this is probably the most destructive of the cutworms and one that is found all over the world, it is no more injurious to tobacco grown in Connecticut than any of the other species mentioned here.

Appearance and habits: The variegated cutworm (Figure 33) ranges in color from a dark form, indistinctly marked with gray, to a dirty-gray form, faintly marked with slightly darker lines. Infestations are said to move like an invading army, climbing bushes and trees as well as smaller plants and consuming all tender parts. These cutworms feed during the day as well as at night.

The adult (Figure 34) has brownish fore-wings, more or less covered with black, and may or may not have transverse lines extending across them. It can be identified with certainty only by a specialist on moths.

Food plants other than tobacco: More than 70 different host plants are included in the records of the variegated cutworm, ranging from garden flowers and grasses to fruit and forest trees.

Distribution: This insect is found in all parts of the United States, in Mexico, southern Canada and Europe.

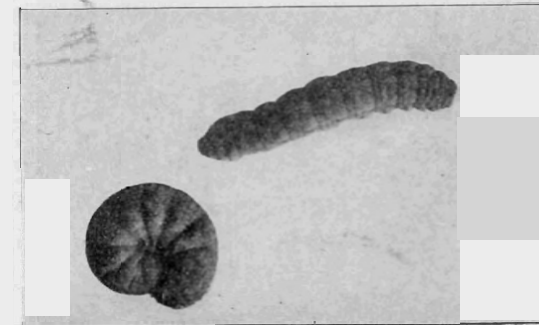


FIGURE 33. Variegated cutworm larvae. Natural size.

CONTROL OF CUTWORMS

The control of any of the species of cutworms described above is quite simple and relatively low in cost. One or two applications of a standard, poisoned bait usually suffice. The customary poisoned bran bait, recommended by the United States Department of Agriculture, is made up as follows:

Bran	100 pounds
Paris Green	2 pounds
Water	Enough to moisten

The formula which has been used successfully for many years at the Experiment Station and by many growers is:

Bran	100 pounds
Paris Green	3-5 pounds
Oranges or lemons	½ dozen
Cheap molasses	4 quarts
Water	About 15 gallons

The fruit juice and molasses are believed to make the bait more attractive to the worms.

* *Lycophotia saucia* Hbn.

The amount of water to be used must be determined by the condition of the mixture. As stated previously, the bran must be moistened enough to stick together in small lumps, so that it can be broadcast by hand, but not enough to puddle. The bran and Paris Green are first mixed thoroughly in a dry condition by shoveling them over on a floor or in a box just as one mixes fertilizers. The oranges or lemons are squeezed, cut into small pieces and mixed with molasses and water. After thorough stirring, the sweetened water is sprinkled over the bran and poison mixture while it is being shoveled over so that it will mix thoroughly.

Several days before setting the plants, this mixture is scattered broadcast over the field at the rate of 25 to 50 pounds dry weight to the acre. This should be done late in the afternoon or in the evening in order that it may be in a moist condition during the night when the worms are active.

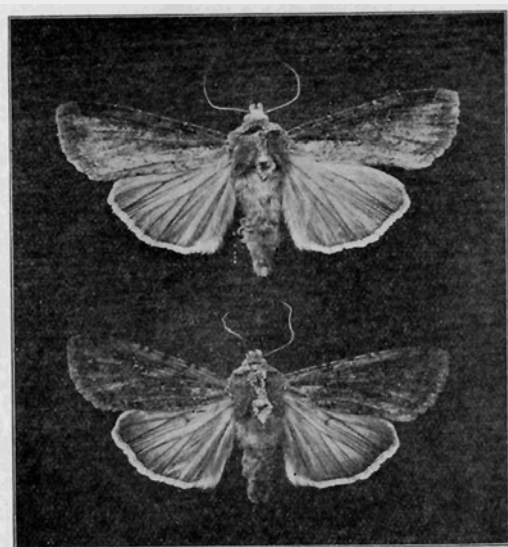


FIGURE 34. Adults of variegated cutworm.
Natural size.

The same mixture is used for late infestations, such as those of the spotted cutworm, but in this case the bait is spread carefully on the ground between the rows, or at the edge of the field. Care must be taken not to let it fall on the leaves because the Paris Green often burns them.

Seedbed infestations may also be treated with this bait. A dosage of 4 pounds (dry weight) of bait to 100 square yards of bed is sufficient. It may cause some burning of the leaves, but such injury is not serious at this stage of growth.

Since cutworms cause more or less trouble every year at setting time, the application of poisoned bait is a routine practice on most tobacco plantations each year before the worms appear. Although the broadcasting of the bait a day or more before setting would seem to be the most logical procedure, many growers, especially the shade growers, prefer to apply it directly afterward.

For application at time of setting or immediately afterward, the follow-

ing mixtures have been used successfully for years by good growers:

(1) Cottonseed meal	100 pounds
Paris Green	2 pounds
Molasses	2 quarts

Mix as described above and spread by hand directly over the row as soon as the plants are set, at the rate of about 75 pounds per acre. Advocates of this method hold that the cottonseed meal is not wasted, since it has a fertilizer value for the young plants.

(2) Fine hominy	100 pounds
Paris Green	1½ pounds

Mix thoroughly in a dry condition. Use no water or molasses. Apply beside the plants in the row (not on the leaves) by means of a tin can "shaker". The shaker is made by driving nail holes in the bottom of a two-quart can and fastening the can to the lower end of a stick about two feet long. One vigorous shake near each plant is sufficient. The mixture should be applied immediately after setting and if a later brood of worms emerges, the measure should be repeated.

3. Some growers prefer to use the same mixture as No. 2, but with less Paris Green, and to shake it directly on the plants. If this method is to be used, it is safer to substitute two to three pounds of lead arsenate for all or a part of the Paris Green.

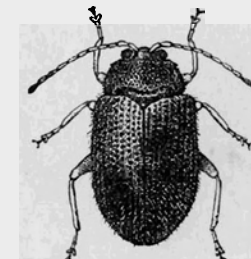


FIGURE 35. The potato flea beetle. (After Chittenden, Bureau of Entomology, U. S. Department of Agriculture.) Enlarged.

POTATO FLEA BEETLE*

The potato flea beetle is one of the most important tobacco pests in Connecticut. It is responsible for more injury to tobacco every year than any other insect with the possible exception of wireworms. It infests shade-grown and sun-grown tobacco alike and ruins leaves that otherwise would make excellent cigar wrappers and binders.

Appearance and habits: The adult beetles appear in the seedbeds about the middle of May, coming out of winter quarters to feed on the tender young tobacco plants. The adults (Figure 35) are small, black, shiny beetles about one-sixteenth of an inch long, oval in shape, and are capable of jumping out of sight very quickly. They feed on the under sides of the leaves, cutting out minute round "shot-holes" (Figure 36). This, of course, weakens the young plants. Shortly after the tobacco is transplanted into the field, the beetles seem to become less abundant. About the second week in July they appear in increasing numbers until about the twenty-fifth, after which they again decrease.

* *Epitrix cucumeris* Harris.

It is during the repopulation by this summer brood that the severest injury is experienced. At this time of year the flea beetle adults feed voraciously on both surfaces of leaves and materially reduce the value of the tobacco.

Thus far, no actual breeding of the insect has been found on tobacco plants or in tobacco soils. It is strongly suspected that the adult beetles migrate to tobacco from potato or tomato fields nearby.

Studies of the habits and activities of this species indicate that the females deposit their eggs in the soil from late June through early August, and that the eggs hatch in five to eight days (in rearing cages). Much difficulty was experienced in the laboratory in trying to rear larvae under artificial conditions, but the information available indicates that larval life is most variable. The fact that no larvae have been found in tobacco soils, but have been observed in large numbers in adjacent potato fields, substantiates the belief that the insects migrate to the tobacco.

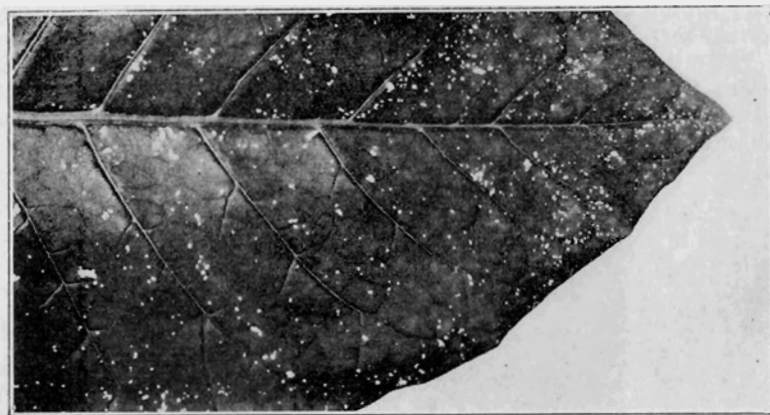


FIGURE 36. Potato flea beetle injury on tobacco leaf.

Pupation takes place in the soil. The pupa is white and is not protected by any cocoon or pupa case; it is approximately one-sixteenth of an inch long and matures in about seven days. Upon emergence the adults are light brown, but eventually the color deepens and becomes black. Because of the fact that there seems to be more or less egg deposition throughout late June, July, and early August, it is difficult to say whether there are several generations or a single continuous brood in a season. Judging from population counts made on tobacco at the Windsor Station over a period of years, there is one peak of emergence early in June, and another peak (decidedly higher) in mid-July, followed by a gradual decrease until harvesting time. This suggests the possibility of one continuous brood, with the overwintering of the adults which appear in late summer.

Another species, the tobacco flea beetle¹, is a serious pest of tobacco in the South, but has been taken in Connecticut only once and thus appears to be of no importance here.

¹ *Epitrix parvula* Fabr.

Food plants other than tobacco: The potato flea beetle eats the foliage of potato, tomato, egg plant, melon, cucumber, turnip, cabbage, some weeds, and garden flowers.

Distribution: This insect is found in all parts of the United States and in Canada. In Connecticut it feeds on shade-grown, Havana seed and Broadleaf tobaccos. In the past it was not a serious pest on Broadleaf, but it has become more and more injurious to this type in East and South Windsor and Ellington since the potato acreage has been increased.

Control: Seedbed infestations of the potato flea beetle are reduced greatly by the application of ordinary 4-4-50 Bordeaux mixture. This treatment seems to act as a repellent more than as a poison, as the beetles will not feed on foliage that is thoroughly covered with the mixture. The dusts recommended below may also be used.



FIGURE 37. Dusting tobacco for control of potato flea beetles.

The most efficient treatment for the insect in the field is the application of **barium fluosilicate dust**. After several years of experimenting, and also of actual use on a commercial scale, it has been proved that this material applied at the rate of four to six pounds to the acre on half-grown plants will reduce the beetle population markedly. On larger plants, and where very heavy infestations develop, doses up to ten pounds to the acre may be advisable. In order to facilitate the distribution of this material it may be mixed with finely pulverized tobacco dust at the rate of one part (by volume) of barium fluosilicate with five parts of the tobacco dust. The brown color of the resulting mixture does not leave a visible residue on the foliage.

Any good hand duster (Figure 37) that is not too inconvenient to operate and that can be regulated easily, is suitable for applying the material. Dusting may be done at any hour of the day, as the sticky hairs on tobacco foliage serve very nicely to hold the dust particles. However, it is obviously a waste of material to dust in a strong wind. Therefore early morning and late afternoon and evening will probably prove to be the best times.

Rotenone and pyrethrum dusts, applied as above and at the rate of ten or twelve pounds to the acre, are quite effective in stopping an infestation quickly. Unfortunately these two materials lose their insecticidal value on exposure to air, so that their effectiveness diminishes and at the end of a few days their killing power disappears. The active ingredients in barium fluosilicate do not lose their efficiency, however, and are active for ten days or so if there are no rain storms. This material is slower in its killing action, but it keeps the beetle population down to a low figure for an extended period of time.



FIGURE 37. Wireworm injury to young tobacco plants.

WIREWORMS

Wireworms of various species cause a tremendous amount of damage to crops in general. Tobacco growers have known them for a long time, and their numbers seem to increase from year to year. Along with flea beetles, they are the most injurious of our tobacco pests. At least five species of wireworms are known to injure or destroy newly transplanted tobacco: *Pheletes ectypus* Say. (the eastern field wireworm), *Limonius plebejus* Say., *Melanotus cribulosus* LeC., *Melanotus* sp., and *Asaphes* sp. All occur in Connecticut but the first two are the most numerous.

Appearance and habits: Starting within twenty-four hours after tobacco has been set in the field, these pests do most of their work within

two or three weeks. In newly transplanted tobacco it will be found that many of the plants are dying or wilting rapidly over a considerable area, sometimes a square rod, and again an acre or so. When the plants are dug up and the stems split open, one or more hard, shiny yellow larvae are seen. Further examination of the soil immediately around the place where the plant was set will often bring to light more of these "worms". They are from three-eighths to five-eighths of an inch long, are rather slow moving and have a very hard covering. Typical injury is shown in Figure 38.

As has been suggested above, wireworms may tunnel young plants for a few days and then apparently disappear, or they may feed for several weeks, necessitating two or three transplantings. Formerly it was thought that when they disappeared, they would do no further damage that season, but investigations during the past five years indicate that they chew the fine roots of the tobacco more or less throughout the summer. This continued feeding saps the strength of the plants in proportion to the abundance and activities of the worms.

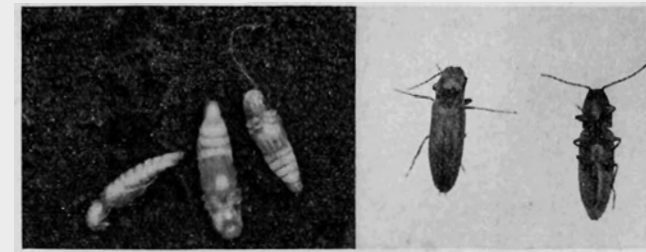


FIGURE 39. Wireworm pupae and adults. Twice natural size.

When the larvae of the eastern field wireworm are fully grown, they pupate in the soil at depths varying from six to twelve inches below the surface. Pupation occurs during the last week in July and the first in August. At this stage, the insect is creamy-white in color, about half an inch long, unprotected by any cocoon, and is very soft and delicate. The general outline is similar to that of the adult beetle (Figure 39).

The change from the pupa stage to the adult takes place under the soil in late August and early September. The adult beetles remain underground until the following spring, when they crawl to the surface on the first warm days in May.

These beetles are about one-half inch long, with a hard covering of a brownish color, rather elongated in shape, and tapering towards the posterior end of the body. The undersides of the bodies are covered with dense hairs, giving a silver or bronze appearance to the lower parts. A joint between the wing covers and the front end of the body is quite flexible, so that when the beetles are placed on their backs, they give a snap, and flip the middle of the body against the ground, thus catapulting themselves into the air. In this manner they regain their footing. Because of the peculiar habit of righting themselves, they have been called click beetles, snapping beetles, and skip-jacks.

During the last week in May, these adults may be seen in large numbers crawling over the cloth of tobacco shade tents. Both males and females

have been collected but the males outnumber the females greatly. None has been taken in the field after the first week in June.

Eggs are laid in fairly moist soil and hatch in about two weeks. The young larvae feed on small rootlets, and live for at least three years before reaching maturity.

Wireworms are found on both shade-grown and sun-grown varieties of tobacco. Most of the observations made recently have been conducted on shade-grown types, however, and it has been found over a period of years that two-thirds of the larvae are directly beneath the tobacco rows.

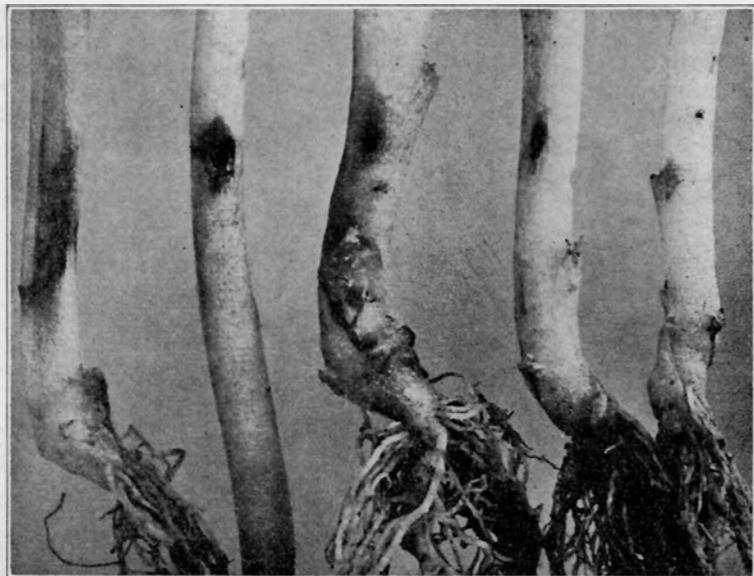


FIGURE 40. Work of the seed corn maggot on young tobacco plants. Slightly enlarged.

Also, field counts have indicated that about one-third of the total wireworm population is in the first six inches of soil, and the remaining two-thirds from six to twelve inches below the soil surface. In late May or early June the majority of the larvae are near the surface.

Food plants other than tobacco: Wireworms attack grasses of all kinds, corn, wheat, beans, potato, beets, and many other plants.

Distribution: Species are found throughout most of the world.

Control: The most satisfactory way to kill wireworms is to apply calcium cyanide in the soil, around the young tobacco plants, when most of the larvae are near the surface. This can be done most conveniently by drilling the granular calcium cyanide into the ground with a corn planter to a depth of three or four inches. While this treatment will kill the worms, it is costly. Quantities of at least 100 pounds to the acre must be used to get 75 to 80 per cent control.

Various baits, repellents, poisons and other concoctions have been used in attempts to control the worms without destroying the plants, but none of the results have been encouraging. Numerous investigations the country over have led to the use of a trap crop, followed by an application

of cyanide, as the one successful method. Some have advocated planting corn or wheat before the tobacco is set, and treating the bait crop after the wireworms have congregated along its rows. All this involves the cost of seed and labor. It seems more feasible to use tobacco plants (of which the grower usually has an abundance), as a bait crop; drill the cyanide—thus killing the worms along with the plants—and after a period of five or six days, reset.

Observations on cyanide treatment of tobacco soils infested with wireworms have conclusively shown a kill of from 75 to 85 per cent, and fields thus treated have not been reinfested over a period of six or seven years.

Delayed setting of tobacco is another method of avoiding wireworm injury. The larvae are more active in early June, hence plants set in the field during the middle of the month usually escape damage.

SEED CORN MAGGOT*

The seed corn maggot is one of those pests that is found at indefinite intervals, appearing with no warning and disappearing just as suddenly. At times it causes complete destruction of young plants on considerable acreage, requiring a replanting of the infested territory.



FIGURE 41. Adult and pupae of the seed corn maggot. Enlarged.

Appearance and habits: Injury by the seed corn maggot appears within a few days after the plants are set in the field and at first has all the earmarks of wireworm work. A close examination of the infested plants will disclose the presence of small, dirty white maggots about one-fourth of an inch long, broad at the posterior end and tapering to a pointed head. Several may be found working in the stalk of a single young plant. The entrance hole is just below the soil surface and is so inconspicuous that it may not be seen at first (Figure 40). From this point the burrow is enlarged and extends upward and downward for half an inch or more.

After spending two or three days in the plants, the maggots move into the soil and within a week change to the pupal state: a brown, oval puparium, (Figure 20) one-sixth to one-fifth of an inch long. From ten days to two weeks is sufficient to complete pupal development, when small, two-winged flies emerge. (Figure 41) These adults are greenish

* *Hylemyia ciliarura* Rond.

gray in color, one-fifth of an inch long, have black antennae, and are covered sparsely with black bristles. The life cycle is of such short duration that it is possible to find three broods annually in this latitude.

Food plants other than tobacco: The seed corn maggot has been reported as feeding on cabbage, corn, onion, strawberry, peach seedlings, beans, peas, beets, turnips, seed potatoes, and crimson clover. It is a well known fact that the maggots live also in decaying organic matter, such as rotting clover stems and alfalfa sod, and they have been reported as breeding in manure, although there is some evidence to disprove this.

Distribution: This species is found in all sections of Connecticut. Probably it came from Europe, and occurs throughout the United States, Canada and Hawaii.

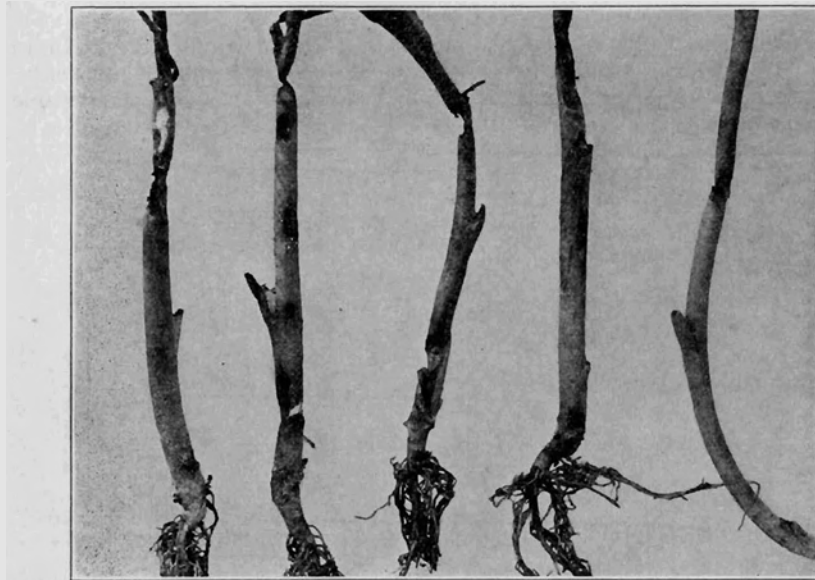


FIGURE 42. Crane fly maggot injury to small tobacco plants.

Control: The insect appears so suddenly, does its work with such swift destructiveness and vanishes so quickly that there has been no opportunity here for chemical control experiments on tobacco. Crop rotation has been suggested, but this method is not practical in our tobacco areas. As long as infestations remain so sporadic and infrequent, resetting with fresh plants as soon as the maggots disappear seems to be the cheapest, safest and most logical procedure. This method has been employed in all serious cases that have come to our attention within the past ten years. It causes a few days delay in getting the crop started, and some expense, but good stands have been obtained by resetting and there is no resultant injury to the final product.

CRANE FLY MAGGOT*

The crane fly maggot is an insect found attacking tobacco occasionally, and so may be listed as a spasmodic pest of this crop.

Appearance and habits: Injury appears in the field soon after tobacco has been transplanted (Figure 42). The larva eats notches or holes in the side of the stem so that the plant breaks off and dies. This type of injury is quite distinct from that by the seed corn maggot in that there is little or no tunneling in the stems. Most of the injury is done from the outside.

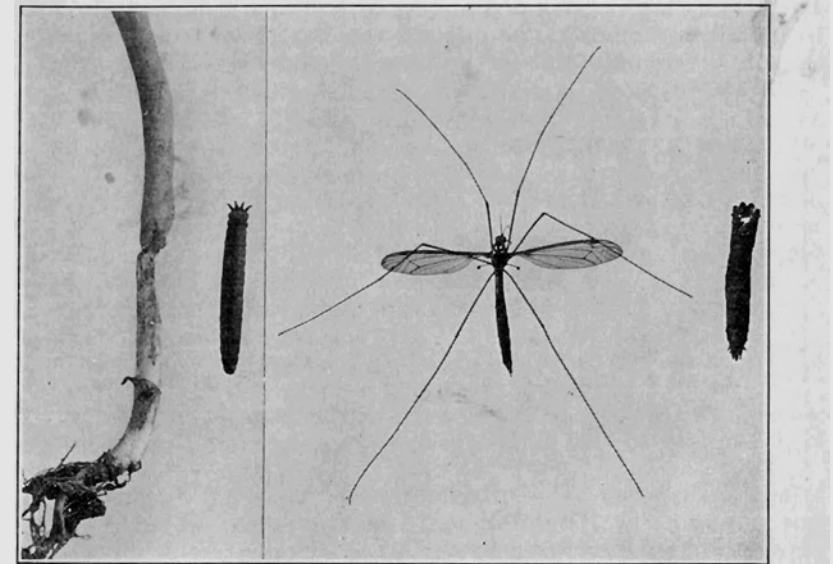


FIGURE 43. Injured tobacco plant, larva, adult, and pupa skin of Crane Fly Maggot. Natural size.

"The maggot (known also as the 'leather jacket') is tough and leathery in texture, gray in color, about an inch in length, with four curious protuberances at the head"¹. After the pupal stage it emerges as a long-legged fly, known as a crane fly (Figure 43). The accompanying illustration shows the general characteristics of this insect better than a written description.

Food plants other than tobacco: This crane fly maggot has been reported as feeding on wheat, and has also been taken under leaf mold.

Distribution: It occurs throughout the United States.

Control: No method of control is known.

* *Nephrotoma ferruginea* Fabr.

⁽¹⁾ Britton, W. E. and Anderson, P. J. Conn. Agr. Exp. Sta., Report of Tobacco Station at Windsor, 1925. Bul. 6: 88-90, 1926.

CORN ROOT WEBWORM (STALK GIRDLER)*

The corn root webworm is not a common pest of tobacco in Connecticut, and when an infestation develops, the injury first looks like the work of wireworms. This insect belongs to a large group of stem girdlers that ordinarily feed on grass, weeds, and sod-producing plants. Thus it may occur on land that has been used for hay, corn, or other forage crops, or that has been lying idle.

Appearance and habits: As has been mentioned, young tobacco plants infested with larvae of this insect appear to be suffering from wireworm injury. The stalks of the newly transplanted tobacco are girdled just below the soil surface (Figure 44) prior to the larva's penetration to the inside. Here will be found a small but very active "worm" (Figure 45) dirty yellow in color and about one-half inch long, and also a web of tough silken strands. The extreme rapidity of movement and the web serve to differentiate this species from the slow-moving wireworm.



FIGURE 44. This young tobacco plant has been injured by the corn root webworm.



FIGURE 45.
Corn root webworm larvae.
Slightly enlarged.

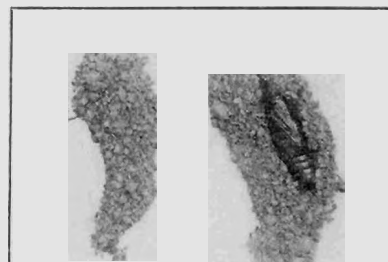


FIGURE 46. Cocoons of corn root webworm. The one on the right is cut open. Slightly enlarged.

The larva reaches maturity late in June, leaves the plants, and proceeds to make a cocoon in the soil. This protective covering is constructed from masses of silk and entangled particles of soil (Figure 46), forming a pear-shaped cell from one-half to three-fourths of an inch long, and three-eighths to one-half inch wide, at the widest part. These cells are found anywhere from one to three inches underground, and inside of them the pupa remains for a period of ten days to two weeks.

About the middle of July, the adult moths emerge from the cocoons. When disturbed, they dart around in a zig-zag flight, usually coming to

* *Crambus caliginosellus* Clem.

rest under a clod or on the underside of a leaf. The moth is about one-half inch long, very narrow, and with light brown wings having lighter colored stripes.

The eggs of the corn root webworm are apparently deposited in haphazard fashion, on plants or on the soil. They are not glued to any surface as are many insect eggs, but roll around loosely. Each egg is at first creamy white, later turning pink and eventually deepening in color to a reddish orange. It is oval and fluted, with longitudinal ridges. Eggs obtained in rearing the insect at Windsor did not hatch, but according to the literature, the egg stage lasts from five to nine days. Only one generation of the insect occurs on tobacco in Virginia, and the same is probably true in Connecticut.

Food plants other than tobacco: Corn, plantain, (*Plantago major* and *P. lanceolata*), aster, wild carrot, grass and daisy are listed among the host plants of this insect.

Distribution: Only one infestation on tobacco land in this State has come to our attention in recent years. It may be that there were other outbreaks that were mistaken for wireworm trouble. The insect occurs throughout the eastern United States and causes much damage to tobacco in the Virginia section.

Control: The various attempts made to control the insect in the southern tobacco districts seem to resolve themselves into a matter of clean culture or crop rotation. If weeds are kept out of the field and some vegetable crop is planted on new land before using it for tobacco, it seems probable that no webworm infestation will develop.

TARNISHED PLANT BUG*

The tarnished plant bug is another insect that occurs over a wide range, causing trouble in some years and appearing only in small numbers in others.

Appearance and habits: This bug (Figure 47) is about one-quarter of an inch long and less than half as wide, flattened, oval in outline, and of a general brown color, mottled with irregular areas of white, yellow, brown and black. On either side of the upper surface of the body, there is a transparent, yellow, triangular area ending in a black spot.

The insect passes the winter in the adult stage in protected places: in old weed masses, under bark of trees and stumps, under stones and the like. When warm weather comes, the adults emerge from winter quarters and feed on a large variety of plants by piercing the leaves, buds, or stems, and sucking the juices.

On tobacco, they usually appear throughout late July and August, feeding at the growing point. Apparently they introduce some poisonous substance into the plant tissue that causes a very irregular unfolding of the new foliage. As a result, the leaves are malformed and useless as cigar wrappers.

The females place their eggs in leaf veins, buds and flowers of various plants. From these hatch small green bugs, called nymphs, which mature in three or four weeks. Hence it is probable that several generations have time to develop in a season.

No eggs of the tarnished plant bug have been found on tobacco in

* *Lygus pratensis* Linn

the field, and adults caged on tobacco plants died without depositing any. It is thought that the insects migrate to tobacco from surrounding territory.

Food plants other than tobacco: The tarnished plant bug has been reported feeding on more than 50 different kinds of plants including apple, beet, celery, bean, potato, cotton, cucumber, pear, peach, and garden flowers of various kinds.

Distribution: The insect is found throughout Europe and the Americas.

Control: No effective control is known. Spraying or dusting with contact insecticides is not practicable because the insects fly away at the approach of any disturbance. Stomach poisons are of no avail as the pest does not chew plant tissue. Clean culture and destruction of weeds and hibernating quarters will undoubtedly aid in its control.

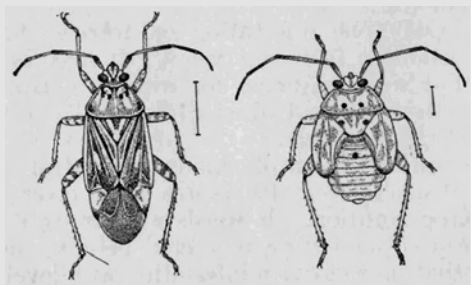


FIGURE 47. The tarnished plant bug: adult at left; last stage of nymph at right. Enlarged about four times. (After Chittenden, Bulletin 43, Bureau of Entomology, U. S. Department of Agriculture.)

TOBACCO BUDWORM*

While this insect is not yet of major importance to Connecticut tobacco growers, at times it causes some anxiety, and in the southern tobacco growing areas it is responsible for severe injury. Its range in this State is becoming more extensive. Specimens have been taken in new localities every season for the past five years.

Appearance and habits: The first signs of the activities of the budworm are found early in July when the plants are partly grown. At this stage the young larvae feed on the growing tip (bud), eating irregular holes in the immature leaves (Figure 48). As the leaves unfold, the holes enlarge and cause a distortion of the growing tissue. Meanwhile the larvae become larger and may move out to the young leaves to continue their feeding. Individuals seem to prefer to remain on one plant, there being little or no migration, and usually only a single larva is found on a plant.

During the early feeding period, the young caterpillars are about one-fourth of an inch long, brown in color, and not unlike a small piece of rusty iron wire in appearance. When disturbed, they may wriggle away and drop to the lower parts of the plant on a fine silken thread.

As development continues, the rusty color gives way to a pale green shade, and black tubercles, each bearing a single hair, appear on each

* *Heliothis (Chloridea) virescens* Fabr.

segment of the larvae. When two-thirds grown, (Figure 49) the caterpillar is green, with lighter stripes running the length of the body on each side. Full growth is attained by mid-July when there may be considerable variation in color. At this time the larvae leave the plants, burrow into the soil and go into a resting state for three or four days after which they pupate. The pupa, (Figure 50) at first green and later a deep brown, is spindle-shaped and about one-half inch long. After approximately ten days the adult moth emerges.



FIGURE 48. This tobacco plant was injured by the tobacco budworm.

The moth is velvety, and light green in color, with four paler stripes running obliquely across each wing (Figure 50). The wing-spread is from one to one and one-quarter inches. Eggs are deposited singly on the undersides of leaves and hatch in about five days in hot weather. From these develop the second brood of worms, that first feed on suckers and later climb to the seed pods. Boring into these, they devour the contents. The second brood of larvae mature by the end of August, pupate early in September, and the adults emerge late in September and early in October. Just how they overwinter in Connecticut has not been determined.

Food plants other than tobacco: The tobacco budworm has been reported as feeding on tomatoes, potatoes, sweet peas, cotton, cultivated geranium, ageratum, and other plants.

Distribution: In Connecticut, larvae have been taken in Avon, Windsor, Granby, East Granby, East Hartford, West Suffield, and Pogoquock.

The insect seems to be well distributed throughout the eastern half of the United States. In general it is more abundant in the South, but is said to be rare in Kentucky and Tennessee.

Control: The most efficient means of combating the budworm is to sprinkle poisoned cornmeal in the growing tip of each plant. Of the many baits tried, this seems to be the most attractive. It is made by thoroughly mixing one pound of lead arsenate with 75 pounds of cornmeal, or 6 heaping teaspoonfuls of lead arsenate to one peck of cornmeal, and is sprinkled lightly into the growing tip. Pyrethrum dusts and sprays have not proved effective as control measures.

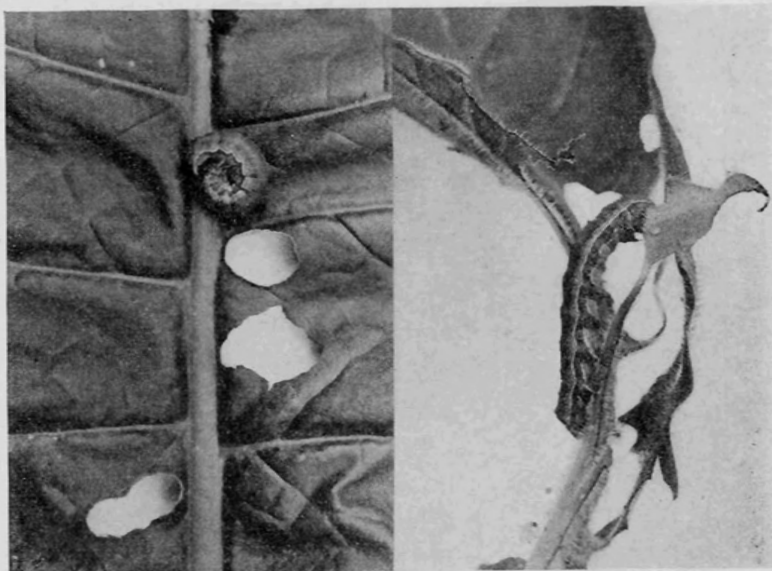


FIGURE 49. Tobacco budworm larvae and their injury to tobacco foliage. Natural size.



FIGURE 50. Pupa (left) and adult moth (right) of tobacco budworm. Twice natural size.

TOBACCO THRIPS*

The tobacco thrips is most injurious to tobacco in dry seasons, since it appears only in small numbers during years of normal or excessive rainfall. All types of tobacco are affected.

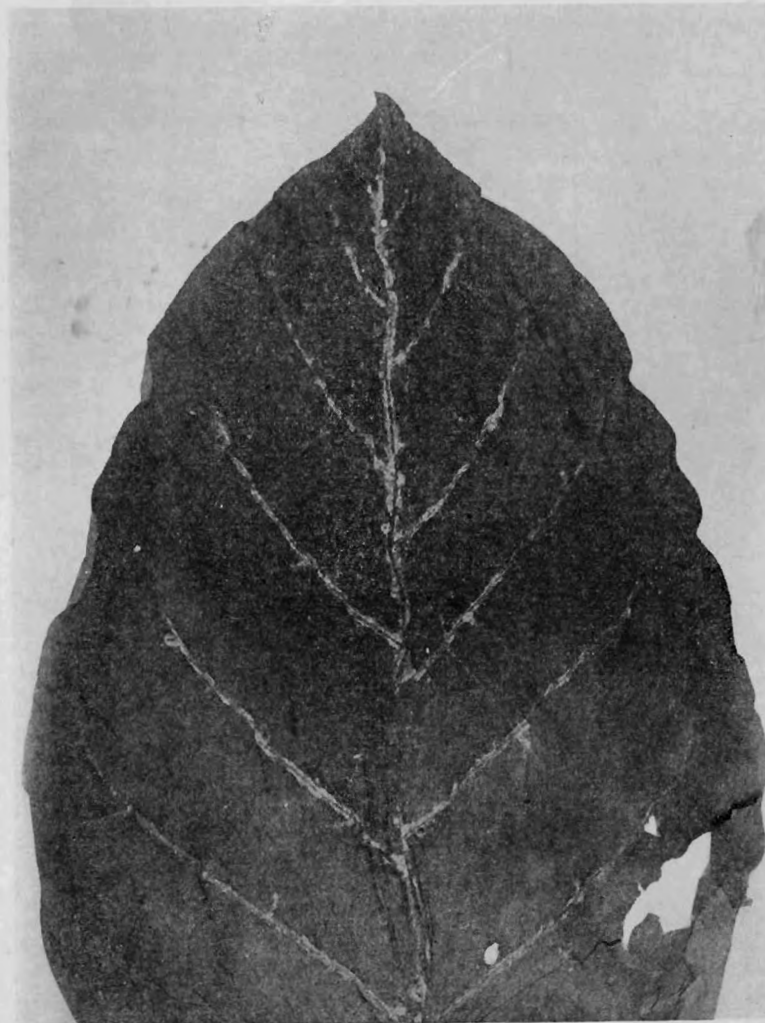


FIGURE 51. Thrips injury on a cured tobacco leaf.

Appearance and habits: The first signs of the presence of the insect are silvery outlines (Figure 51) traced around and parallel to the midrib and veins of the lower leaves. If an infested leaf is examined with some care, one finds minute insects, about one twenty-fifth of an inch long,

* *Frankliniella fusca* Hinds.

dark brown or black in color, and very narrow in comparison to their length (Figure 52). They crawl along beside the midrib and larger veins. Severe infestations may cause the tobacco foliage to turn yellow. The injury is more pronounced when the leaves are cured, for then the silvery effect contrasts strongly with the brown, dry tissue, a condition known in the trade as "white vein".

Frequently it is possible to find the young stages of thrips, yellow in color, on the undersides of infested leaves. These hatch from eggs



FIGURE 52. Photomicrograph of a tobacco thrips enlarged about 60 times.

deposited in the tissues of the underside of the leaf, and reach maturity in about 10 days. The life cycle is so short that it is possible for several generations to develop in a season.

Adult thrips winter over in the shelter of many plant stems, particularly those of grasses and weeds.

The injury results from the peculiar method of feeding which is typical of insects of this type. The mouth parts are so constructed that the thrips must first lacerate the leaf surface and then suck the juices which exude.

Food plants other than tobacco: The tobacco thrips has been reported as feeding on cotton, dewberry, shepherd's purse, oats, wheat and cocklebur.

Distribution: The insect is found throughout the United States, east of the Rocky Mountains.

Control: Many types of insecticides have been tried for the control of thrips. Thus far, dusts of various kinds have been less efficient than sprays, when used on tobacco. Of the latter, "Cubor"*, diluted with water at the rate of one part to 200, or Nicotine Sulphate, diluted with water at the rate of one to 400, with the addition of "Penetrol" as a spreader, have given a fair degree of control. "Ku-Ba-Tox"* and water, one to 400, also proved efficient.

By cleaning up weedy borders and burning piles of trash near tobacco fields, many of the over-wintering shelters can readily be destroyed.

GRASSHOPPERS

Grasshoppers are well known to everyone as they are found throughout the summer along roadsides, in fields, and in gardens. They feed on grasses and vegetation in general, and the amount of injury they cause varies with their abundance. At least three species are of economic importance in Connecticut tobacco culture, and there are many others found occasionally on tobacco plantations.

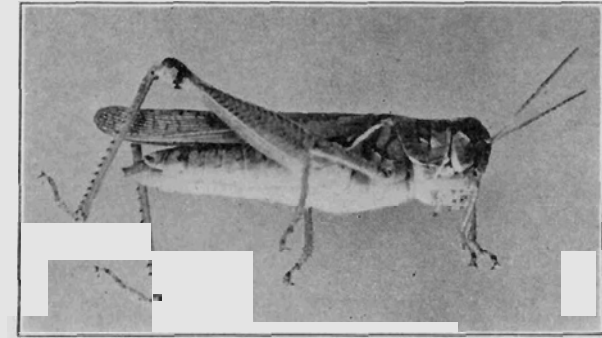


FIGURE 53. Red-legged grasshopper, twice natural size.

The Red-legged Grasshopper**

Appearance and habits: The red-legged grasshopper, so called because of the red tibia of each hind leg, is perhaps the most abundant of the grasshoppers found on tobacco (Figure 53). This insect, when mature, is about one inch or an inch and one-quarter long, brownish in color, with the red tibiae mentioned above, and is very active.

Injury from grasshopper feeding usually appears first on the outside rows or at the ends of the rows of tobacco, because the insects migrate from surrounding fields. Holes of varying sizes are made in the leaves,

* "Cubor" and "Ku-ba-tox" contain rotenone as the principal toxic constituent.

** *Melanoplus femur-rubrum* DeG.

(Figure 54) just as though hail had punctured them, but the leaf tissues are eaten out entirely, leaving no lip or flap of the tissue which is so characteristic of hail injury. When disturbed, the grasshoppers jump rapidly out of range. In due course of time they spread towards the middle of the field, so that their injury becomes quite general unless they are poisoned.

There is only one generation annually. The females deposit eggs in the ground in late summer, and the eggs hatch the following spring.

Food plants other than tobacco: The red-legged grasshopper is another of those insects found on a large variety of plants including alfalfa, grasses of many kinds, vegetables and flowers.

Distribution: It is found in all parts of North America.

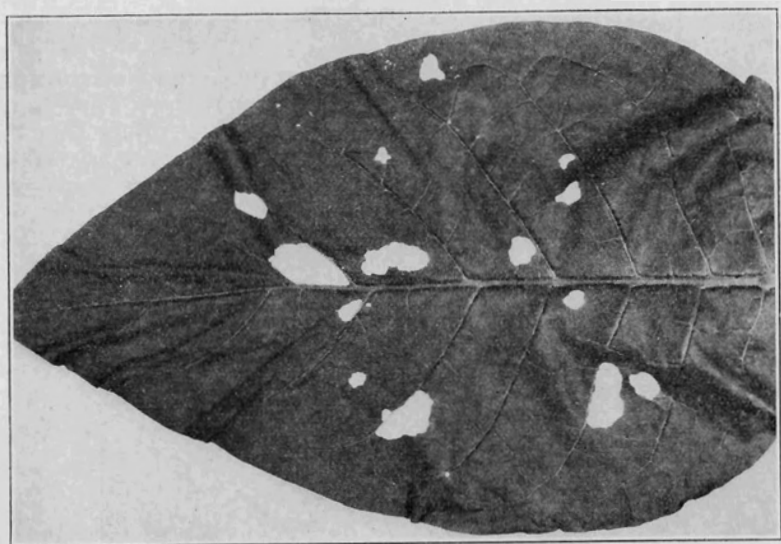


FIGURE 54. Grasshopper injury to tobacco leaf.

The Carolina Grasshopper*

Appearance and habits: This species is the largest of our grasshoppers feeding on tobacco. The adult insect (Figure 55) is about an inch and one-half long, and is of a salt-and-pepper color but varies with the color of the soil upon which it is found. Its black hind-wings have yellow margins that are very distinctive in flight, and this insect flies, rather than jumps, on being disturbed.

The injury caused by the Carolina grasshopper is like that of the red-legged species, with which it is found in smaller numbers, and its life history is also similar. The period from the hatching of the eggs to full growth is from 70 to 90 days.

Food plant other than tobacco: Corn, wheat, alfalfa, soybean, and grasses are infested by this insect.

* *Dissosteira carolina* Linn.

Distribution: The pest is found all over the United States, occurring in larger numbers in the South.

The Lesser Migratory Locust*

Appearance and habits: The lesser migratory locust closely resembles the red-legged grasshopper. Its points of difference are that its wings extend about one-third of their length beyond the tip of the abdomen, and in that its dark colors are more deep and livid while the lighter parts are paler yellow, thus contrasting more strongly than those of the red-legged species.

This locust lives on alfalfa, clover, and other similar plants. If tobacco is planted on land formerly used for these crops, the over-wintering eggs will give rise to a rather serious infestation throughout the tobacco.

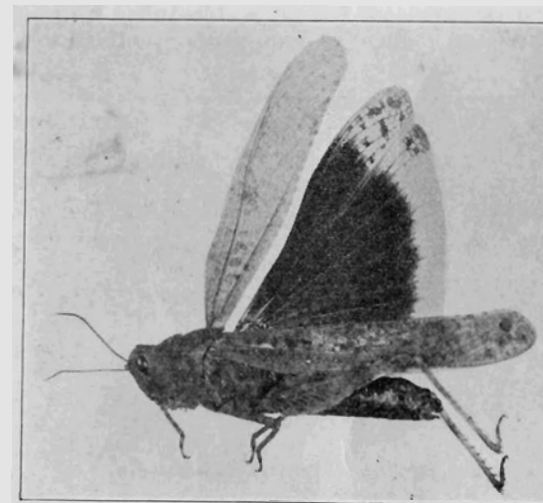


FIGURE 55. The Carolina grasshopper. Slightly enlarged.

The life history and seasonal habits are similar to those mentioned under the discussion of the red-legged grasshopper.

Food plants other than tobacco: The lesser migratory locust has been reported as feeding on asparagus, bean, buckwheat, alfalfa, clover, rye, oats, corn, watermelon, wheat, etc.

Distribution: It occurs throughout the United States, Mexico and Canada.

Other Species Closely Related to Grasshoppers

There are at least two species of green Katydid which are often found feeding on tobacco in small numbers. These are the Curved-tail Katydid(†) and a similar species, *Scudderia pistillata* Bruner, two insects with

* *Melanoplus mexicanus mexicanus* Saussure, (*M. allantis* Riley).
 (†) *Scudderia curvicauda* DeGeer.

"feelers", or antennae, which are longer than the bodies. (Antennae of other grasshoppers are shorter than the body.) Also the katydids are grass-green in color.

Tree crickets (*Oecanthus* sp.) are often found in small numbers on tobacco in August. These are delicate insects about an inch long, with pale green wings and dusky bodies and legs.

Control of Grasshoppers

Grasshopper infestations can be prevented or greatly reduced through the application of poisoned-bran bait, such as that suggested for cutworm control on page 99. The addition of chopped oranges or lemons and molasses is said to make the mixture more attractive. The scattering of poisoned bait around the edges of tobacco fields and out into surrounding grass or weeds affords considerable protection. If an infestation has already developed on tobacco, the same treatment throughout the infested territory will soon reduce the grasshopper population.

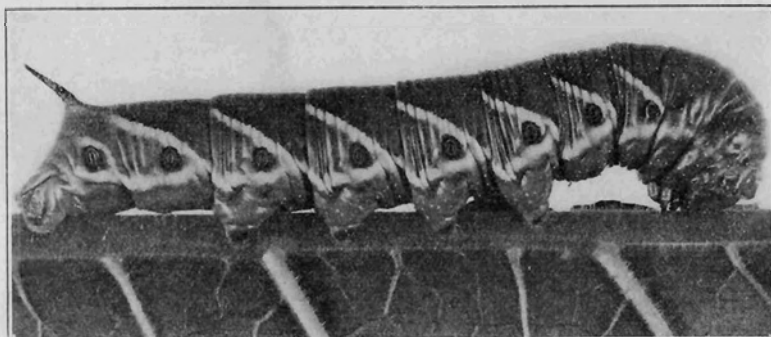


FIGURE 56. Larva of northern or tobacco hornworm, nearly one and one-half times natural size.

Other poisoned baits, using salt as the attracting agent, have proved quite efficient in tobacco-growing areas outside of New England. The following formula is used in Wisconsin:

Sawdust	100 pounds
Sodium arsenite	1 quart
Molasses	1 gallon
Salt	5 pounds
Water	7-10 gallons

Either material should be scattered over the ground lightly in the morning, as grasshoppers feed during the day.

HORNWORMS

Early in the history of tobacco culture in Connecticut, hornworms (also called green worms, tobacco or tomato worms) were reported as causing more injury to growing plants than any other pest. They still are a serious pest of outdoor tobacco, but have not been so prevalent in

the last five or six years. There are two species: The northern or tobacco hornworm¹ and the southern or tomato hornworm². The former is more abundant here than the latter.

Appearance and habits: The larvae, or "worms", of these species are seen more often than the adult moths and can be distinguished by the fact that the northern hornworm has a black horn on the posterior extremity, and the southern species has a red horn. Also the northern worm (Figure 56) has eight oblique greenish-white stripes on the sides, each joining a similar horizontal one at its lower end, forming a series of whitish "V's". The southern worm (Figure 57) has seven oblique bands which do not turn backward to form the V-shaped marking.



FIGURE 57. Larva of southern or tomato hornworm. Natural size.

The young worms become evident early in July and feed for three or four weeks before reaching maturity. At that time they are about four inches long. In the early stages they eat many small holes in the tobacco leaves, but their appetites increase as the larvae develop, and just before maturity they may strip the plant of everything but coarse leaf veins and midribs. Their presence is also indicated by large droppings of excrement on the plants or on the ground.

Early in August the mature larvae leave the plants and burrow into the soil. There they rest for several days and then change into the pupal

¹ *Phlegonthius quinquemaculata* Haw.
² *P. sexta* Johan.

stage. The pupae are naked, polished dark mahogany brown, spindle-shaped, about two and one-half inches long and with a curved tongue-case on one side, often called a "jug handle" (Figure 58). The tongue-case of the tobacco species is longer than the one on the pupa of the tomato species. The winter is spent in the pupal stage.

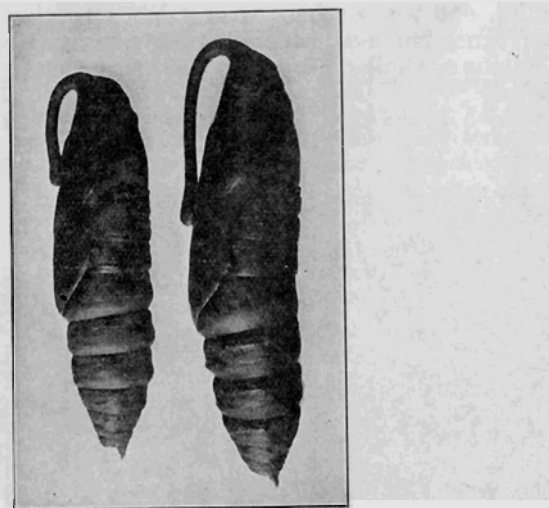


FIGURE 58. Pupae of both species of hornworms. The larger is the northern species. Natural size.

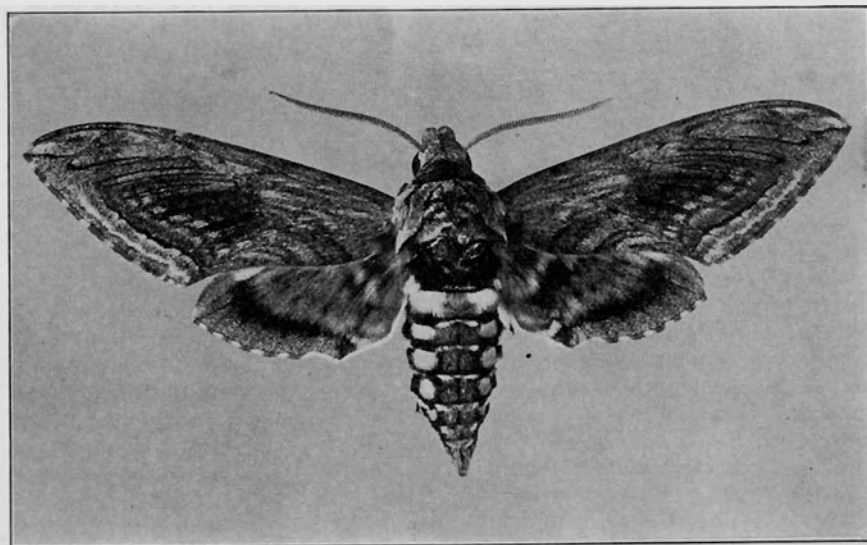


FIGURE 59. Moth of the northern tobacco hornworm. Natural size.

Adult moths (known as sphinx or humming-bird moths) emerge in June and are large, brownish gray insects with a wing expanse of four or five inches, and with long, pointed, heavy bodies. The northern species has fore-wings marked with delicate lines paralleling the margins (Figure 59). The southern has a more mottled appearance, with a small white spot in the middle of each fore-wing (Figure 60). Also the northern species has five pairs of orange spots on the sides of the body, while the southern has six pairs.

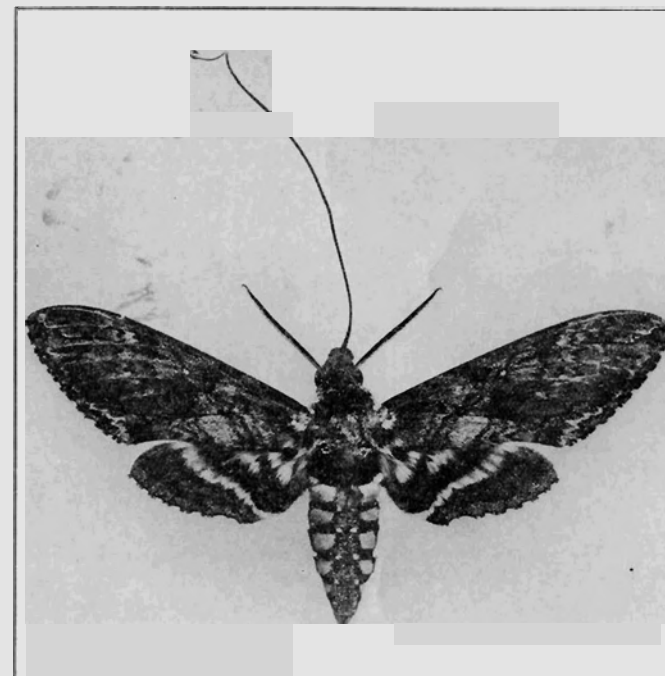


FIGURE 60. Moth of the southern or tomato hornworm with tongue extended. Slightly reduced in size.

The females deposit spherical, greenish-yellow eggs on the undersides of leaves, usually singly. Because the moths fly at dusk, they are not often observed. The eggs hatch in three or four days and the young larvae start feeding immediately. One generation is produced yearly and sometimes a partial second brood has been noted.

Food plants other than tobacco: These insects have been found on tomato, eggplant, pepper, and potato, and the adults sip nectar from flowers of Jimson weed, petunia and other deep-throated flowers.

Distribution: Both species are found in Connecticut, but the northern species is more abundant around Windsor and Hartford, and the southern is more abundant in the southern parts of the State. The former occurs from our southernmost states into Canada; and the latter ranges from the northern states southward into South America.

Control: When the infestation is not heavy, hand picking usually suffices to hold the worms in check. More serious infestations can be prevented by dusting the plants with arsenate of lead or barium fluosilicate. In any case the material should be applied as soon as the young larvae appear, as experiments have shown that they are more easily killed by poison in the early stages of development than when almost fully grown. Applications of these dusts at a rate of six pounds to the acre in early July and again in mid-July will prevent serious trouble.

Natural enemies of the hornworms may help in a small way to reduce the numbers of these pests. One parasite common in Connecticut is *Apanteles congregatus* Say, whose larvae feed on the internal parts of the hornworm larva and bore their way to the outside of the host. Here they attach themselves and spin small white cocoons that cling tenaciously to the hornworms' skin. From a dozen to several dozen of these white cocoons may be found on one hornworm and are often mistaken for eggs.

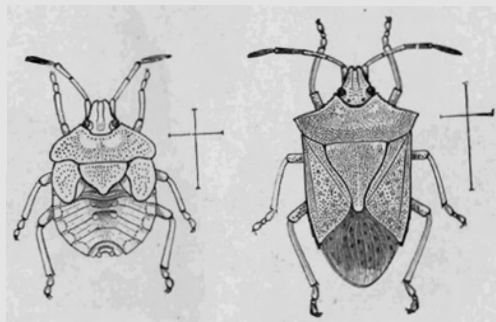


FIGURE 61. The spined stink bug. (After Howard, Bureau of Entomology, U. S. Department of Agriculture.)

THE SPINED STINK BUG*

Appearance and habits: Often during the middle of the day, when the heat of the sun is beginning to wilt the lower leaves of the tobacco plant, an occasional leaf higher up on the stalk will be found badly wilted. A careful search on or near the affected leaf will disclose the presence of a stout, shield-shaped bug (Figure 61) about half an inch long, reddish or yellowish gray in color, which has prominent "shoulders" in front. This is the spined stink bug, and it feeds by piercing the leaf stem near its juncture with the stalk. In the course of the feeding, certain poisonous juices are said to be injected into the stem, causing the leaf to wilt. However, it returns to normal shape within a day or two so that no permanent injury results.

Food plants other than tobacco: This insect has been reported as feeding on white pine, raspberry, melon, tomato, peach and strawberry, and has been taken from hibernation in an old nest of the red-eyed vireo in New York State. It is said to be predaceous on other insects.

* *Euschistus variolarius* Beauv.

Distribution: The spined stink bug is found in all parts of the United States and in Canada. It is reported as being especially abundant in the northern states.

Control: The most effective method of control is hand picking.

COMMON STALK BORER*

The common stalk borer is found on some tobacco plantations every season, but usually occurs in such small numbers that its injury is normally of no great importance.

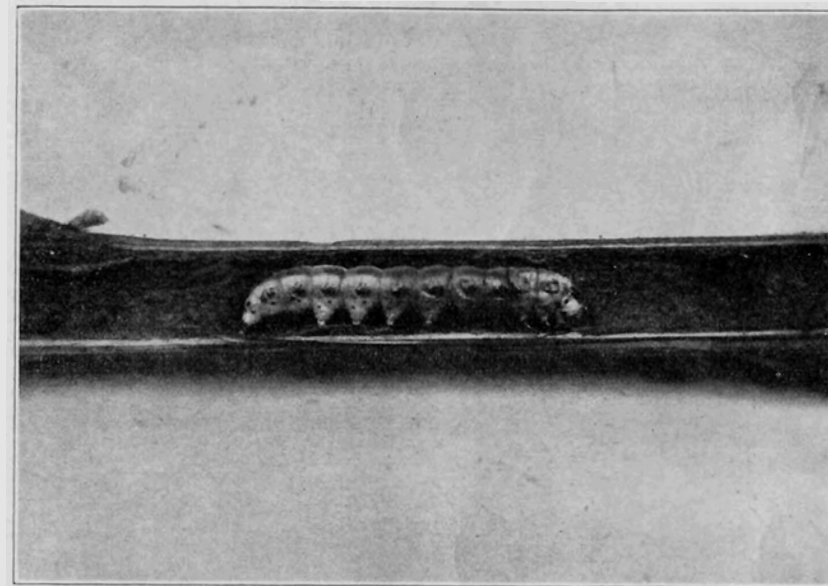


FIGURE 62. The common stalk borer in tunnel. Slightly enlarged.

Appearance and habits: When tobacco plants are found to be wilting suddenly in early July, a careful examination will often reveal the presence of a brown-striped worm, tunneling inside the pith (Figure 62). This worm has a dark girdle near the middle of the body, and a lateral black stripe extending from the side of the head to the posterior part. Further observation will disclose an entrance hole bored into the lower part of the stalk, usually just beneath the place of attachment of a leaf (Figure 63). Another characteristic of the work of this larva is that it attacks plants in the outside rows and is rarely found near the center of a field. Then too, the stalk borer is of a restless temperament, never seeming to be satisfied with its host. One individual may bore into several plants. These habits suggest that it migrates into tobacco fields from weedy borders.

The larva reaches full growth by the end of July, pupates within its host plant, and emerges as an adult moth in September. The moth has

* *Papaipema nitea* Guenée

a wing expanse of about one and one-fourth inches, is purplish gray in color, with a faint cross band of lighter color near the wing margins (Figure 64).

Eggs are deposited on weed stalks, and so far as is known, the winter is passed in this stage. There is a single generation each year.

Food plants other than tobacco: The common stalk borer infests a large number of plants including corn, beans, potato, eggplant, tomato, rhubarb, spinach, dahlia, aster, chrysanthemum, gladiolus, lily, hollyhock, peony, sunflower, giant ragweed and many other common vegetables and larger weeds.



FIGURE 63. Tobacco stem showing the entrance hole made by the stalk borer.

Distribution: The insect has been taken in corn from practically every county in Connecticut, and has been reported in tobacco from all parts of the tobacco-growing areas in the Connecticut Valley. It has been found in every state east of the Rocky Mountains.

Control: Destruction of the infested plants will prevent further work of the pest. As it is not found in large numbers, this method of control is as good as any. Clean out all weeds along the edges of shade tobacco fields to prevent further breeding.



FIGURE 64. The adult moth of common stalk borer.
Natural size.

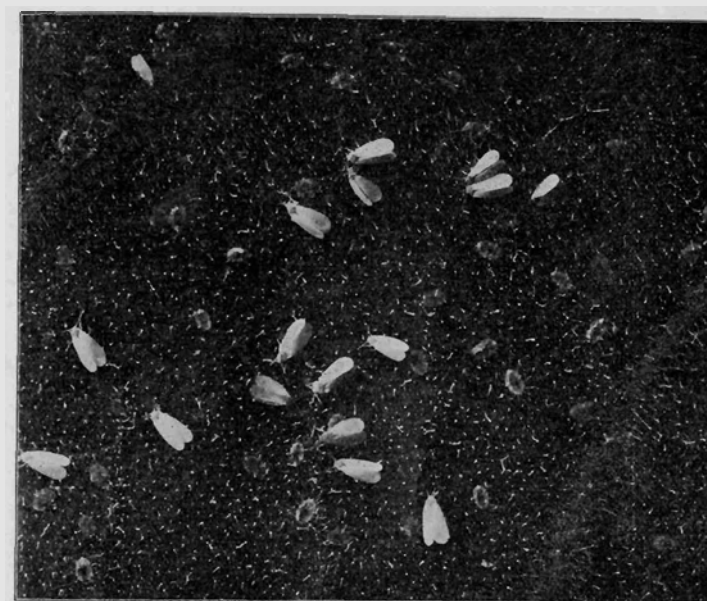


FIGURE 65. Greenhouse whitefly on tobacco. Enlarged three times natural size.

OTHER INSECTS OCCASIONALLY FOUND FEEDING ON TOBACCO

The pests heretofore discussed are by no means the only ones which feed on the tobacco plant. There are many others found here and there in small numbers. Several species of plant lice, or aphids, have been taken on the under-surface of tobacco leaves from time to time. These are small, soft-bodied, slow-moving insects, which pierce the leaf tissue and suck plant juices. They have never been observed in numbers large enough to cause any injury to tobacco in Connecticut. The species taken are the bean aphid¹, the potato aphid², and the green peach aphid³.

¹ *Aphis rumicis* L.
² *Illinoia solanifolii* Ashm.
³ *Myzus persicae* Sulz.

The greenhouse whitefly⁴ has been found on tobacco grown in the greenhouse at the Experiment Station in Windsor and on some grown outside at the Experiment Station in New Haven. The adult of this insect looks very much like a minute white moth (Figure 65). The younger stages are pale yellow in color. Both are often found in large numbers on the underside of leaves in the greenhouse. Fumigation of an infested greenhouse will control whitefly.

The spotted cucumber beetle⁵ is found on tobacco in small numbers every season, and eats small holes in the leaves. This insect is a yellowish green beetle about one-quarter of an inch long, with twelve black spots on the wing covers, and a black head (Figure 66).



FIGURE 66. Twelve-spotted cucumber beetle. Enlarged four times.

⁴ *Trialeurodes vaporariorum* Westwood.

⁵ *Diabrotica 12-punctata* Fabr

SEASONAL CHRONOLOGY OF THE MORE IMPORTANT TOBACCO INSECTS
IN CONNECTICUT

Time of year	Insect	Control
IN SEEDBEDS		
Late in April and early in May	Garden Springtail	Nicotine sulphate
Early in May to late in July	Cutworms	Poisoned bran bait
Early in May to late in July	Flea Beetles	Barium fluosilicate or pyrethrum or rotenone dusts or Bordeaux mixture
IN FIELD		
Late in May or early in June	Wireworms	Cyanide or delayed setting
Late in May or early in June	Seed Corn Maggot	No control known
Late in May or early in June	Crane Fly Maggot	No control known
Throughout June	Cutworms	Poisoned bran bait
Throughout June	Flea Beetles	Barium fluosilicate or pyrethrum or rotenone dusts
Late in June and throughout July	Thrips	Nicotine sulphate or rotenone or pyre- thrum sprays
Early in July to mid-July	Budworm	Poisoned corn meal bait
Early in July to mid-July	Stalk Borer	Cut out infested plants
Throughout July	Flea Beetles	Barium fluosilicate, pyrethrum or rote- none dusts
Throughout July	Tarnished Plant Bug	Clean up weeds and trash
Throughout July	Grasshoppers	Poisoned bran bait
Throughout July	Hornworms	Hand picking or ar- senate of lead or barium fluosilic- ate
Middle of July	Cutworms	Poisoned bran bait
From early to mid-August	Flea Beetles	Barium fluosilicate, pyrethrum or rote- none dusts
From early to mid-August	Grasshoppers	Poisoned bran bait

LITERATURE ON TOBACCO INSECTS

- Anderson, P. J. Tobacco Culture in Connecticut. Conn. Agr. Expt. Sta. Bul. 364: 785-797. 1934.
- Britton, W. E. Insect enemies of the tobacco crop in Connecticut. Conn. Agr. Expt. Sta. Rpt. 30 (1906): 263-279. 1907.
- _____ Injury to young tobacco plants by the seed corn maggot. Conn. Agr. Expt. Sta. Bul. 234: 101. 1922.
- _____ Tobacco injured by Tipulid larvae. Conn. Agr. Expt. Sta. Bul. 275: 325. 1926.
- _____ and P. J. Anderson. Tobacco insects observed in Connecticut in 1925. Conn. Agr. Expt. Sta. Tob. Subst. 6: 74-93. 1926.
- Crumb, S. E. Tobacco cutworms. U. S. Dept. of Agr., Tech. Bul. 88: 1-179. 1929.
- Hooker, W. E. The tobacco thrips, a new and destructive enemy of shade-grown tobacco. U. S. Dept. of Agr., Bur. Ent. Bul. 65: 1-24. 1907.
- Howard, L. O. The principal insects affecting the tobacco plant. U. S. Dept. of Agr. Farmers' Bul. 120: 1-32. 1900.
- Lacroix, D. S. Tobacco insect studies in 1930. Tobacco Substation at Windsor, Report for 1930. Conn. Agr. Expt. Sta. Bul. 326: 419-431. 1931.
- _____ Tobacco insects in 1931. Tobacco Substation at Windsor, Report for 1931. Conn. Agr. Expt. Sta. Bul. 335: 261-268. 1932.
- _____ Tobacco insects in 1932. Tobacco Substation at Windsor, Report for 1932. Conn. Agr. Expt. Sta. Bul. 350: 488-499. 1933.
- _____ Tobacco insects in 1933. Tobacco Substation at Windsor, Report for 1933. Conn. Agr. Expt. Sta. Bul. 359: 377-382. 1934.
- _____ Tobacco insects in 1934. Tobacco Substation at Windsor, Report for 1934. Conn. Agr. Expt. Sta. Bul. 367: 135-143. 1935.
- Metcalf, C. L. and W. P. Flint. Destructive and Useful Insects. McGraw-Hill Book Co. 1928.
- Morgan, A. C. The tobacco budworm and its control in the Georgia and Florida tobacco growing region. U. S. Dept. of Agr., Farmers' Bul. 1531: 1-9. 1927.
- Runner, G. A. The so-called tobacco "wireworm" in Virginia. U. S. Dept. of Agr. Bul. 78: 1-30. 1914.

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