

# The Agricultural Experiment Station

OF THE

Colorado Agricultural College.

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## Insects and Insecticides.

—BY—

C. P. GILLETTE

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# The Agricultural Experiment Station.

FORT COLLINS, COLORADO

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## INSECTS AND INSECTICIDES

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BY C. P. GILLETTE.

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The present bulletin is issued to supply the constant call for information in regard to the common insect pests and the remedies that are commonly used for their destruction or prevention. It is really Bulletin 71 revised and somewhat enlarged. The most important additions are the short articles upon two Currant and Gooseberry insects, the Currant and Gooseberry fruit maggot and the Currant and Gooseberry fruit worm. The most important omissions are in cuts of spraying apparatus.

No attempt has been made to include all of the insects injurious to fruits in the State, nor to give the methods of preparing all the insecticides of importance. The station will be glad to receive inquiries concerning any other insect pests that may be troublesome in any manner to residents of Colorado. Always send specimens of the insects and their injuries when possible and give as much information in regard to habits and injuries as you can. Fuller information in regard to any insect mentioned in this bulletin will also be given upon request.

In the second part of this bulletin the insecticides mentioned are numbered, so that in the first part, which treats of injurious insects, the remedies recommended in each case are referred to by number for the sake of brevity.

Many remedies that are rarely of importance and other supposed remedies that are of little or no use, are left out of this bulletin. The attempt is to give the more important remedies for use in this State.

# PART I.

## INSECTS INJURIOUS TO THE APPLE.

### ATTACKING THE FRUIT.

#### CODLING MOTH.

Flesh-colored larvæ eating into the fruit and causing wormy apples. The first brood of larvæ (worms) begin eating into the fruit when early apples are about an inch in diameter. This brood is not very numerous but it develops into a second brood that comes on late in the summer which is very much more numerous. The moth and its eggs are shown at Plate I., Figs. 3 and 4.

*Remedies*—The arsenical poisons are, by far, the best remedies we have for this insect. See remedies 3, 4, 5, 6, 7, 8.

The combination of Bordeaux mixture (8) with the arsenites is very popular farther east where fungus diseases are prevalent.

Make the first application as soon as the blossoms have faded and nearly all fallen. Continue the application till every calyx (blossom) is filled with the liquid. Repeat the application in one week. Or, if you were very thorough in the first treatment and if no blossoms have opened since, it will probably be better to follow the plan of Mr. Art. Roberts, of Paonia, and make the second application thirty days after the first, and then make a third application after another thirty days. Whether or not a large number of applications are needed will depend upon the number of wormy apples that appear during July and August. If heavy showers follow a treatment, it is usually well to repeat the application. This is not so necessary if arsenate of lead is used.

Upon the thoroughness of the first and second applications the success will chiefly depend. Just what degree of benefit may be expected from later applications has not been thoroughly determined. \*Professor Cordley, of Oregon, seems to have proven that late spraying is very important in that state.

Bandages (36) are also of considerable service if carefully attended to, and if the worms are very numerous. Lights to trap the moths are valueless. Screen cellar windows and doors where fruit is kept.

Plate 2, Fig. 1, shows blossoms from which the petals have fallen and also small apples with their blossoms (calyces) tightly closed so that little or no spray could be forced into them, all upon a single spur of a Duchess tree at one time. The blossoms at (a) are in just the right condition to receive and hold the poison. The two apples should have received the spray a full week earlier. In such a case two early sprays are needed.

#### HOWARD'S SCALE (*Aspidiotus Howardi*).

This scale is occasionally found upon apples in Colorado. It closely resembles the San Jose scale but seldom causes the red blotch where it rests upon the fruit. Fig. 6 of Plate I. shows this scale upon pear.

For remedies see San Jose scale on a following page.

\*Bull. 69; Or. Exp. Station.

**ATTACKING THE FOLIAGE.****LEAF-ROLLERS.**

The fruit tree leaf-roller (*Archips argyrospila*) is a green larva with a black head and measures about three-fourths of an inch in length when fully grown. The larvæ begin to hatch with the opening of the buds of the apple trees in the spring. They attack at once the tenderest leaves and fold them about themselves for protection. When abundant they may completely defoliate the trees. They disappear during June and do not appear again until the following spring. In the meantime the eggs may be found in little gray patches anywhere upon the bark of trunk or limbs. See Plate I., Fig. 5.

**Remedies.**—Crush as many as possible of the egg patches during winter and early spring. The best remedy is to spray thoroughly with one of the arsenites 3, 4, 5, 6, 8, as soon as the first leaves are out. Repeat in one week. Make a third application in another week or ten days if it seems necessary.

Protect the toads and insectivorous birds, as both feed freely upon the rollers. The blackbirds are especially destructive to them.

**FALL WEB WORM [(*Hyphantria cunea*)**

This insect is often mistaken for the next species. The webs.

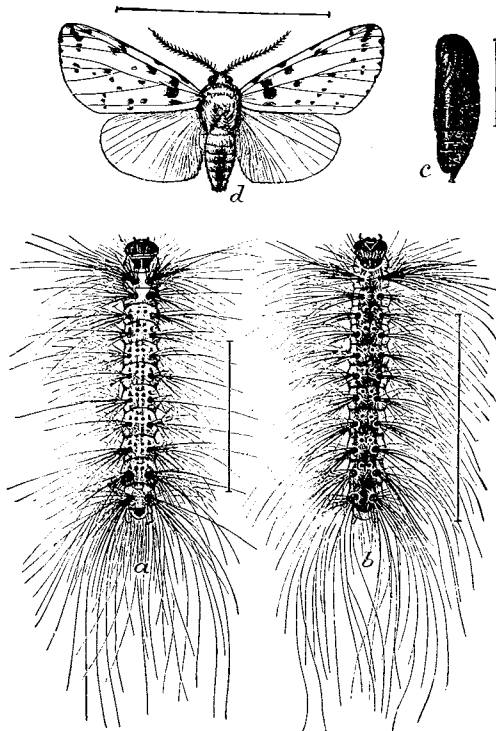


FIG. 1.—Fall Web-worm: a and b, caterpillars; c, chrysalis; d, moth.  
(Howard, Yearbook, U. S. Dept. of Agriculture, 1895.)

are larger and loose or open and the caterpillars stay in them to feed. When the leaves within the tent are devoured, the web is extended so as to take in more foliage. These tents also appear later in the season than those of the following species. They will seldom be noticed before the middle of July. The adult insect is a white moth, sometimes speckled with black. See Fig. 1.

*Remedies.*—The same as for the following species except that it is not practical to collect the eggs which are deposited upon the leaves.

#### TENT CATERPILLAR. (*Malacosoma fragilis*.)

This insect also hatches as soon as the leaf buds open, and builds small webs in the forks of the branches. A large number of caterpillars inhabit a web or tent, which is increased as necessity requires. See Plate I., Fig 1.

*Remedies.*—While the foliage is off, collect the large egg-clusters which are stuck to small limbs. They are covered with a dark, spongy material and are quite readily seen, appearing as galls or swellings of the limbs. If this remedy has been neglected, spray with the arsenical mixtures (3, 4, 5, 6, 8). While the tents are small they may be cut out and burned if on small limbs. If on large limbs they may be burned out with a torch.

#### APPLE FLEA-BEETLE. (*Haltica* sp.)

The apple flea-beetle is a small metallic-green insect, about an eighth of an inch in length, which jumps or drops from the foliage when disturbed. It is most abundant on young trees or nursery stock or sprouts.

*Remedies.*—Any of the arsenical mixtures (3 to 8) are effectual in destroying this insect or driving it from the foliage. It can usually be driven from the leaves by the application of dry substances, such as lime, ashes, plaster, etc., (30, 31).

#### BROWN MITE. (*Bryobia* sp.)

The brown or clover mite is extremely small and its presence is usually first detected by the faded, sickly appearance of the foliage. See Plate III., Fig. 1. The trees appear to need more water. The mites feed upon the leaves but deposit their red eggs upon trunk and limbs. When very abundant, these eggs color the bark red, which is most often noticed during winter.

*Remedies*—To destroy the eggs while the trees are dormant (during winter) use lime, salt and sulfur mixture (21); kerosene emulsion (14), quadruple strength; whale-oil soap (12), quadruple strength, or crude petroleum (16). To kill the mites during summer use kerosene emulsion or whale-oil soap of ordinary strengths. It is far better to treat the eggs.

#### APPLE PLANT LOUSE. (*Aphis pomi*.)

A green louse curling the leaves of apple trees, most abundant



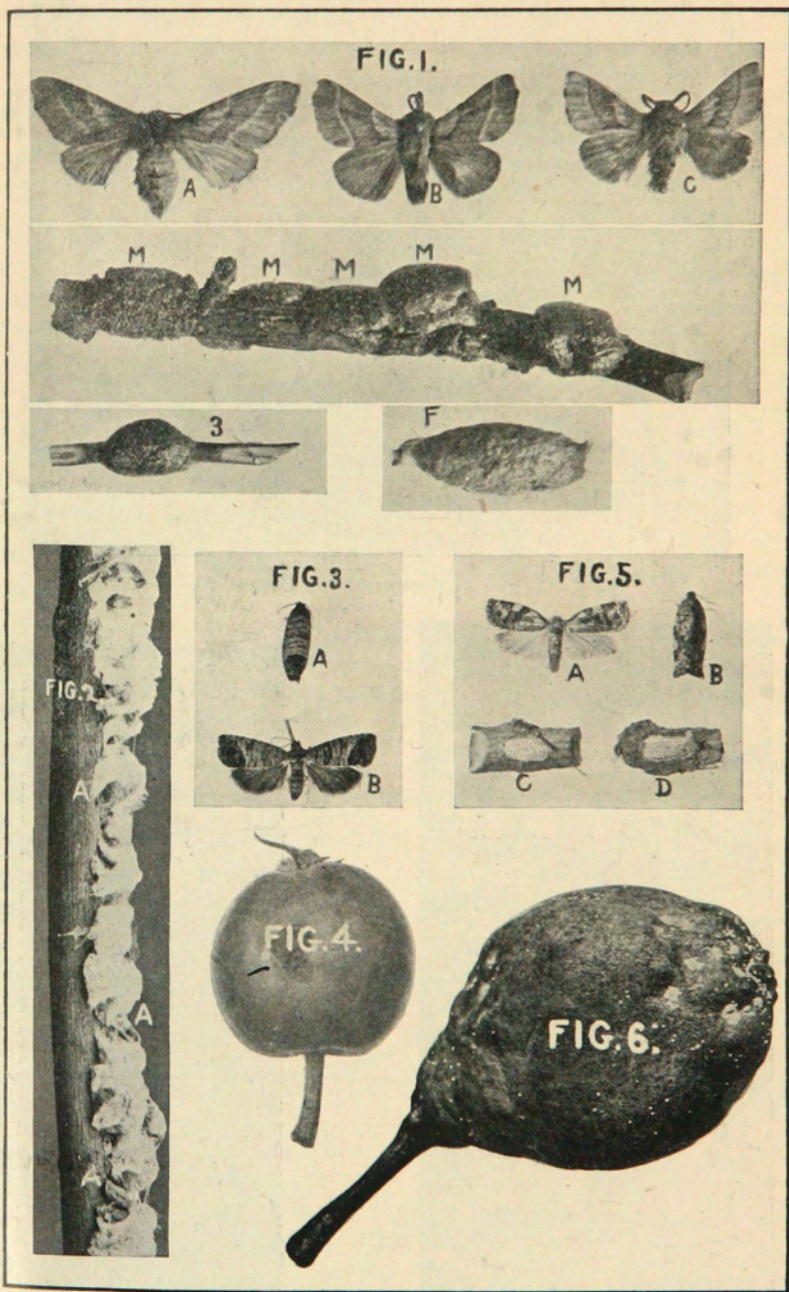


PLATE I.

FIG. 1—Western Tent-caterpillar: A, female moth; B, C, males. D, apple twig with egg masses (M). F, cocoon. 3, egg-mass of American Tent-caterpillar. Life size.  
 FIG. 2—Cottony Maple scale: A, scales mostly hidden by secretion. Life size.  
 FIG. 3—Codling moth: A, wings closed; B, open. Enlarged about 1/2.  
 FIG. 4—Apple showing white egg of Codling Moth (under letter F). Life size.  
 FIG. 5—Fruit tree leaf roller: A, moth, wings open; B, closed. C, D, egg patches, hatched. All life size.  
 FIG. 6—Pear with Howard's Scale. The young appear as minute white specks. Life

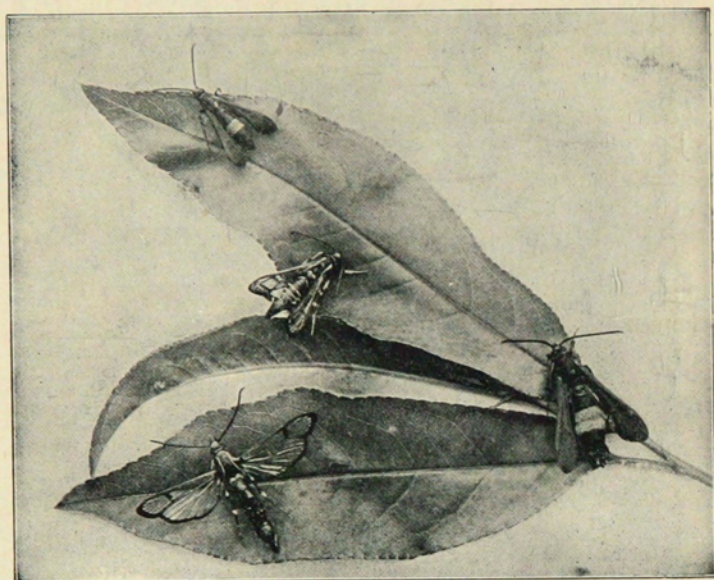


FIG. 1—Moths of Peach Borer.



FIG. 2—Peach tree bandaged with paper.

FIG. 3—Peach tree with wire screen.  
All after Slingerland, (Bull. 176, Cornell Expt. Station.)

late in the season, after the middle of July. See eggs on apple twig, Plate 3, Fig. 4. These are minute black objects.

*Remedies.*—For the destruction of the eggs, proceed as for the destruction of the eggs of the brown mite above. To destroy the lice, apply kerosene emulsion (14), or whale-oil soap (12), thoroughly and in a manner to bring the liquid in contact with the bodies of the lice.

### SCALE INSECTS.

For the treatment of scale insects it is advisable, in each case, to write to the Experiment Station for specific direction. Specimens of the scale should also be sent. Otherwise, use the treatment recommended for San Jose scale—on page 13.

### GRASSHOPPERS.

Several species. Those that fly from tree to tree can probably be managed best by means of arsenical sprays (3 to 8), when safe to use them.

Those that crawl up the trunks into the trees and jump to the ground when disturbed, can quite largely be kept out of the trees by the use of arsenic bran-mash (2) used freely about the border of

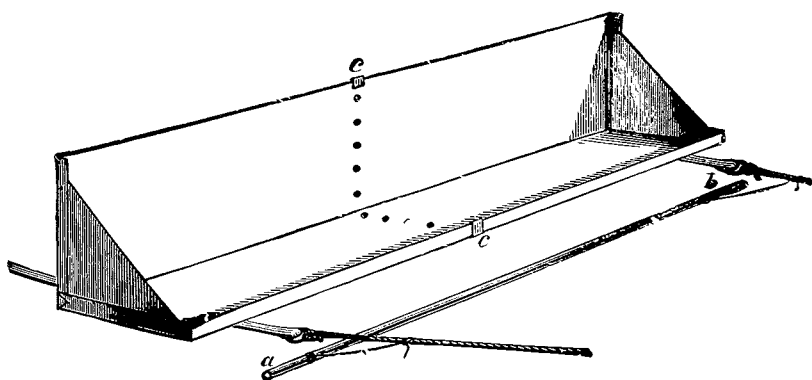


FIG. 2.—Hopper-dozer or Hopper-pan. (After Riley.)

the orchard, and by sticky bands (35) of Raupenleim, tree tangle-foot, printer's ink, or even cotton batting, about the trunks of the trees. If the sticky bands are used they should be spread upon strips of cardboard which have first been wrapped about the trunks.

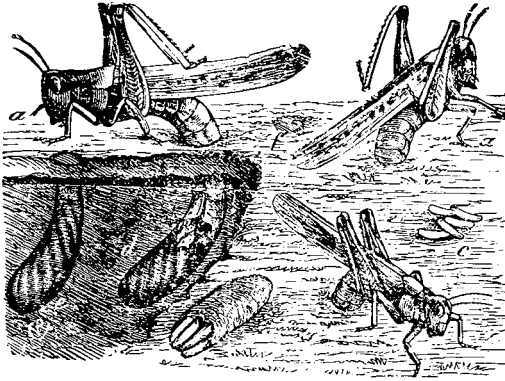


Fig. 3.—Rocky Mountain Locust, laying eggs in the ground; a, a, females with their abdomens in the ground; b, an egg-pod broken open; c, scattered eggs; d, egg-packet in the ground. (After Riley.)

Grasshoppers that injure orchards usually come from adjoining alfalfa or grassfields. In such cases the free use of the hopper pan (34) in the alfalfa or grass field is the best remedy. One of the hopper-pans is shown at Fig. 2. \*At Fig. 3 female grasshoppers are shown in the act of depositing eggs in the ground.

### ATTACKING TRUNK AND BRANCHES.

#### APPLE TWIG-BORER (*Amphicerus bicaudatus*)

A cylindrical, mahogany-colored beetle, about one-third of an inch long, boring holes in twigs of apple, pear, cherry and other trees and grapevines. See Fig. 4.

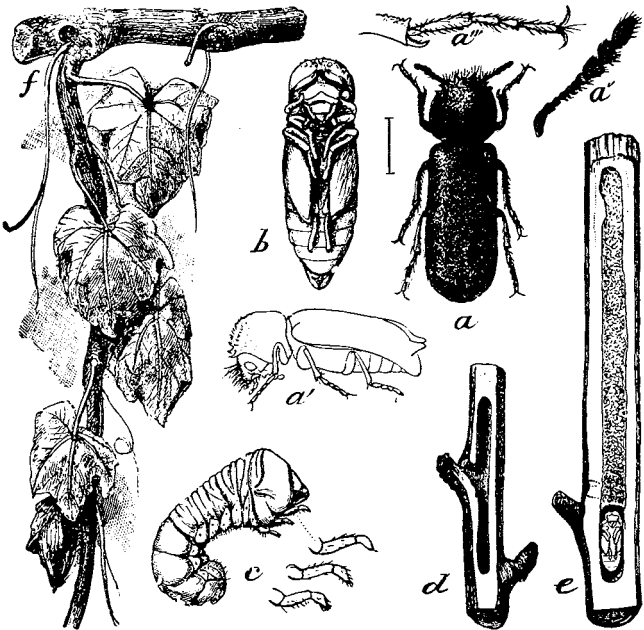


FIG. 4.—Apple Twig-borer; a, beetle dorsal view; a', beetle side view; b, pupa from beneath; c, grub, side view; d, apple twig showing burrow; e, burrow in tamerisk with pupa at bottom; f, stem of grape showing burrow. All enlarged except stems showing burrows. (Marlatt, Farmer's Bulletin 70, Div. Ent., U. S. Dept. of Agr.)

**Remedy.**—Cut out the infested stems and destroy the borers.

\*A very successful hopper pan made and used by Mr. P. K. Bliin at Rocky Ford is described and illustrated in bulletin 112 of this station.

## BORERS, FLAT-HEADED.

*(Chrysobothris femorata)*

A whitish grub boring beneath the bark of apple and other trees and peculiar in appearance in seeming to have a greatly enlarged flat head. Fig. 5.

*Remedies.*—Remove with a pocket knife whenever found. Protect the south side of the trunks of the trees from the sun's heat, either by shading or white-washing during late winter and spring.

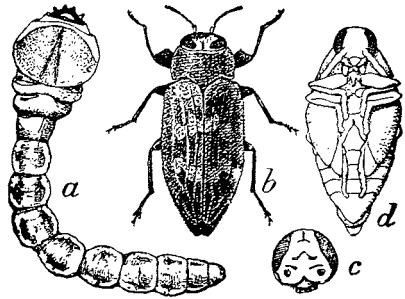


FIG. 5.—Flat-headed Apple-tree Borer; a flat-headed larvæ; b, the mature beetle; c, head of mature beetle; d, pupa. All twice natural size. (Chittenden, Circular 32, U. S. Dep. of Agr., Div. of Entomology.)

BUFFALO TREE-HOPPER. (*Ceresa* sp.)

Three-cornered, greenish to brownish insects, about a third of an inch in length. They jump when disturbed and puncture twigs of trees and stems of plants for the deposition of their eggs. From these punctures oval scars result. See Plate 3, Fig. 3.

*Remedies.*—Infested twigs may be pruned away and burned during winter or spring. Probably clean culture is the best prevention. Keep down all weeds and unnecessary vegetation in and about the orchard.

SAN JOSE SCALE. (*Aspidiotus perniciosus*.)

This insect is very easily overlooked and may be present in sufficient numbers to kill trees before its presence is discovered by the orchardist. They may infest trunk, twig, fruit, or foliage. The scale is nearly circular, about one-sixteenth of an inch in diameter, dark gray in color with a darker spot at the center. Anyone finding such scales upon any tree should send examples at once to the Experiment Station for examination, as there are several species closely resembling each other in outward appearance. As yet this scale is unknown in Colorado orchards. See Plate I., Fig. 6, which shows a closely related species on pear.

*Remedies.*—Spray with lime and sulfur mixture (21) while the trees are dormant. Or, spray with whale-oil soap (12) in the proportion of two pounds to a gallon of water, or with crude petroleum (16) during winter. If trees are very badly infested, it will often be best to cut and burn them.

PUTNAM'S SCALE. (*Aspidiotus ancyllus*.)

Very closely resembling the preceding species. Central spot on the scale reddish. Remedies the same.

HOWARD'S SCALE. (*Aspidiotus howardi*.)

This scale can hardly be distinguished, in external appearance, from the preceding species. It is the only scale that seems to be at all common in Colorado orchards. The central nipple is orange red and the scales are often quite light colored. Its presence should be promptly reported to the Experiment Station. Remedies the same as for San Jose scale above.

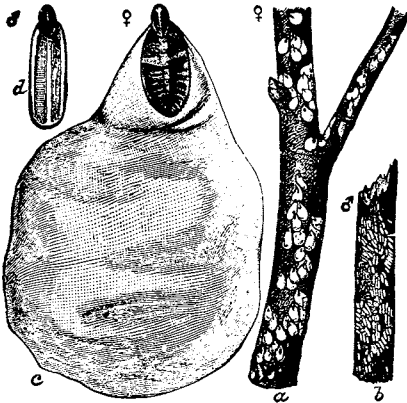


FIG. 6.—Scurvy Bark-louse; a, twig showing scales of female louse; b, twig showing scales of male louse; c, scale of female greatly enlarged; d, scale of male greatly enlarged. [Howard, Yearbook, U. S. Dep of Agr., 1894.]

## SCURVY BARK-LOUSE.

(*Chionaspis furfura*.)

Small white scales resembling scurf or dandruff on the trunk or branches. There are two sizes; the females are larger and oval, and the males are very small and slender. See Fig. 6.

Remedies the same as for the San Jose scale.

WOOLLY APHIS (*Schizoneura lanigera*.)

Small dark lice more or less densely covered with a white flocculent secretion. If the lice are crushed in the hand they leave a red stain. The lice attack chiefly tender bark about wounds or on tender growing shoots.

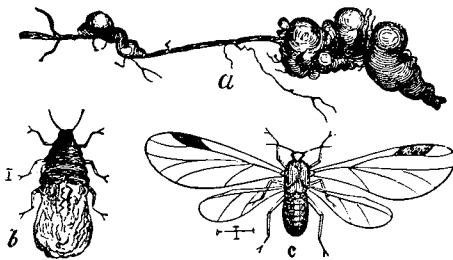


FIG. 7.—Woolly Aphis, root form: a, small root showing swellings caused by the lice; b, wingless louse showing woolly secretion; c, winged louse. (After Saunders.)

*Remedies.*—Early in the season, when the white patches begin to appear on trunk and branches, paint them over with pure kerosene (16), crude petroleum, or a very strong kerosene emulsion (14), or whale-oil soap (12) mixture. If the lice become abundant late in the season, apply kerosene emulsion or whale-oil soap in ordinary strength but with a great deal of force and a coarse spray in order to wet through the waxy secretion which covers them.

This insect also attacks the roots. See Fig. 7.

OYSTER-SHELL BARK-LOUSE. (*Lepidosaphes ulmi.*)

Scales of the same color as the bark of the tree, about one-eighth of an inch long, curved and small at one end. Very easily overlooked. See Fig 8.

Remedies the same as for the San Jose scale.

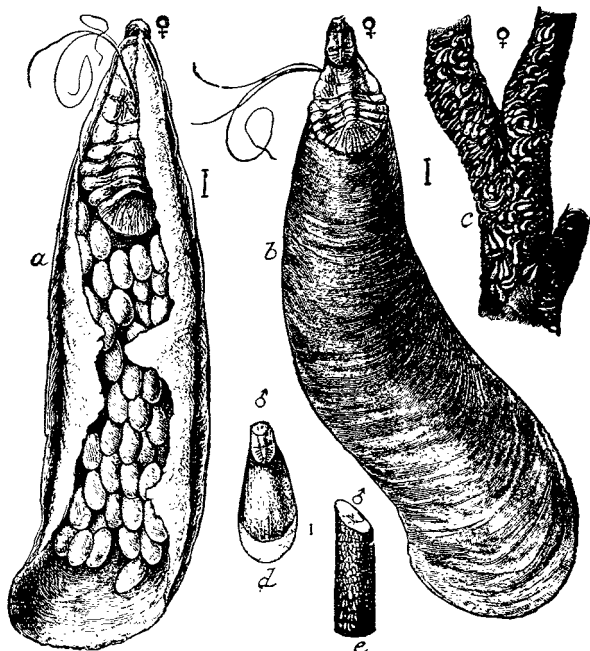


FIG. 8.—Oyster-shell Bark-louse: *a*, female scale from below, showing eggs, greatly enlarged; *b*, the same from above; *c*, female scale on twig, natural size; *d*, male scale enlarged. [Howard, Yearbook, U. S. Dep. of Agr., 1894.]

## ATTACKING THE ROOTS.

WOOLLY APHIS. (*Schizoneura lanigera.*)

This insect attacks the roots as well as the trunk and branches. It causes warty excrescences and often the destruction of the greater portion of the smaller roots. (Fig. 7). The description of the louse is the same as for the trunk form mentioned above.

*Remedies.*—Remove the earth about the crown for a distance of about two feet, put in four to six pounds of tobacco dust (or double this amount of stems) and cover again; then irrigate. If tobacco can not be procured, use kerosene emulsion (14) or whale-oil soap (12) of the ordinary strengths in its place, pouring in a liberal quantity.

## INSECTS ATTACKING THE PEAR.

Any of the insects mentioned above as attacking the apple may be found attacking the pear, except the woolly plant-louse, and the same remedies should be employed.

PEAR-TREE SLUG. (*Eriocampoides limacina*)

Slimy dark-colored larvæ with the head end much the larger, somewhat resembling snails, resting upon the upper surface of the leaves, which they skeletonize. See Fig. 9. Two broods each year.

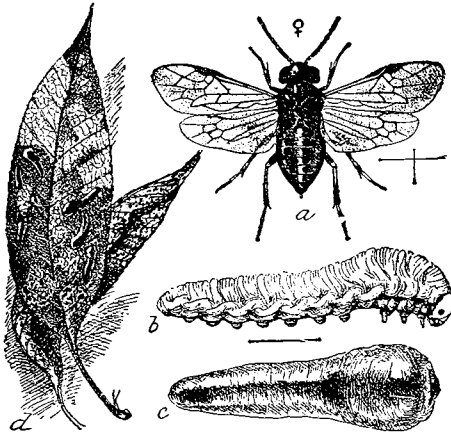


FIG. 9.—Pear-tree Slug: a, adult fly; b, larva or slug with slimy covering removed; c, same as preceding in natural condition; d, leaves showing slugs and their injuries. (Marlatt, Circular 26, Second Series, U. S. Dep. of Agr., Div. Entomology.)

**Remedies.**—Apply white heliobore (9) or any of the arsenical mixtures (3-8), by dusting or by spraying. Freshly slacked lime (20) or wood ashes (29) freely dusted upon the larvæ will kill most of them.

This is an easy insect to control and should not be allowed to continue its serious injuries to the pear, plum and cherry in this state as it has been doing the past few years.

PEAR LEAF BLISTER (*Phytoptus pyri*).

Small dark spots upon the leaves, sometimes very abundant and involving the greater portion of the surface. The diseased portion is thickened also and at first is green like the rest of the leaf. The leaves often fall prematurely.

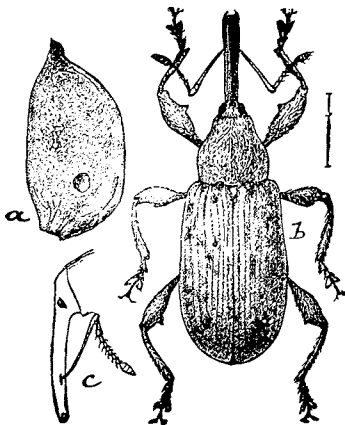


FIG. 10—Plum Gouger: a, plum pit showing hole for exit of gouger; b, gouger; c, side view of head of gouger showing beak and antenna. (Riley & Howard, Insect Life, Vol. II., U. S. Dep. of Agr., Div. of Entomology.)

**Remedies.**—Spray the trees while dormant with kerosene emulsion (14), treble strength; whale-oil soap (12), one pound to two gallons of water; or with lime and sulfur mixture. Gather and burn as many of the fallen leaves as possible.

## HOWARD'S SCALE.

(*Aspidiotus howardi*.)

This scale is too common in Colorado orchards. It is a close relative of the pernicious, or San Jose scale, but so far, has been most common upon plum and pear. Pears, or any fruit affected with scales, should be reported promptly to the Experiment Station. See Plate I., Fig. 6.

**Remedies.**—The same as for San Jose scale mentioned under apple insects.



**INSECTS INJURIOUS TO THE PLUM.****ATTACKING THE FRUIT.****PLUM GOUGER.** (*Coccotorus prunicida.*)

A small but rather robust snout-beetle about a quarter of an inch in length; color a leaden gray with head and thorax ochereous yellow; wing covers smooth without prominent humps on them. The beetle eats pin-holes in the growing plums in which it lays its eggs. The larva or grub eats into the pit and feeds upon the kernel, and later eats a hole out through both pit and flesh of the plum just before the plum matures (Fig. 10). The only insect in Colorado injuring the fruit of the plum to any extent.

*Remedies.*—Jar the trees early every morning, or in the evening, from the time the blossoms are out till very few beetles can be obtained, catching them on a sheet spread beneath. It only takes a very few beetles to do a great amount of harm, as I have found by actual count that a single female may lay as many as 450 eggs.\* Gathering and destroying all stung plums during the early part of July would nearly exterminate this insect. Spraying with an arsenical poison (3, 4, 5, 6, 7, 8) once, a few days before the trees blossom, and once or twice after, will give considerable protection. Use the poisons in two-thirds ordinary, or standard strengths. Arsenate of lead (5) is probably the safest to use on the foliage of the plum.

**PLUM CURCULIO.** (*Conotrachelus nenuphar.*)

This beetle is often confused with the preceding. As yet it has not been reported in Colorado. It is liable any year to appear in our orchards and all should be on the look out for it so as to do all possible to stamp it out or prevent its rapid spread. It is as destructive to the European varieties of plums as the codling moth is to apples. The beetle is brown to blackish in color, is about one-fifth of an inch long, and has two prominent humps and numerous smaller ones upon its wing covers. The beetle makes a crescent shaped cut in the flesh of the fruit where an egg is deposited and the grub does not enter the pit but feeds on the flesh outside of it, causing the fruit to fall.

*Remedies.*—Jarring and spraying as in case of the preceding species.

Should anyone find what he thinks to be the work of this insect in an orchard, it is hoped he will notify the Experiment Station at once.

**ATTACKING THE FOLIAGE.****FRUIT-TREE LEAF-ROLLER.** (*Archips argyrospila*)

See under apple insects. Use the poisons only two-thirds as

\*Insect Life, III., p. 227.

strong on the plum as on the apple. Arsenate of lead is least likely to injure the foliage.

#### SLUGS.

Skeletonizing the upper surface of the leaves. See pear-tree slug. Use the same remedies.

#### BROWN MITE

See under apple insects. Remedies the same.

#### PLANT LICE.

Two or three species attack the foliage of the plum badly in Colorado. Remedies the same as for apple plant-louse.

Other insects attacking apple foliage may be found on plum, where they are destroyed by the same treatment in either case.

### ATTACKING TRUNK AND BRANCHES.

#### THE PEACH BORER (*Sanninoidea exitiosa*.)

This insect often attacks the plum. For its treatment see peach enemies.

#### FLAT-HEADED BORER.

See under apple enemies.

#### SCALE INSECTS.

See under apple enemies. When scales are found it will be well to send specimens to the Experiment Station for identification and advice. Howards's scale and Putnam's scale both occur on plum in the State. They have been injuriously abundant in a few isolated cases only.

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### INSECTS INJURIOUS TO THE CHERRY.

The insects attacking the cherry in Colorado are the Fruit-tree Leaf-roller, Tent Caterpillar, Fall Web-worm, Brown Mite, Plant Lice, Scale Insects, Grasshoppers, Flat-headed Borer, Twig Borer, Buffalo Tree-hoppers and Pear Slug mentioned above.

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### INSECTS INJURIOUS TO THE PEACH.

#### PEACH TWIG-BORER. (*Anarsia lineatella*.)

This is the worst insect enemy of the peach in Colorado at the present time. As soon as the buds begin to open in the spring, a small brownish larva with a black head eats into the buds and



## PLATE 2.

FIG. 1—Blossoms from which the petals have fallen and still in good condition to receive the spray. Also apples with calyces closed.

FIG. 2—Spraying scene in orchard of Mr. Bergher, Palisade, Colo. Photos by the author.

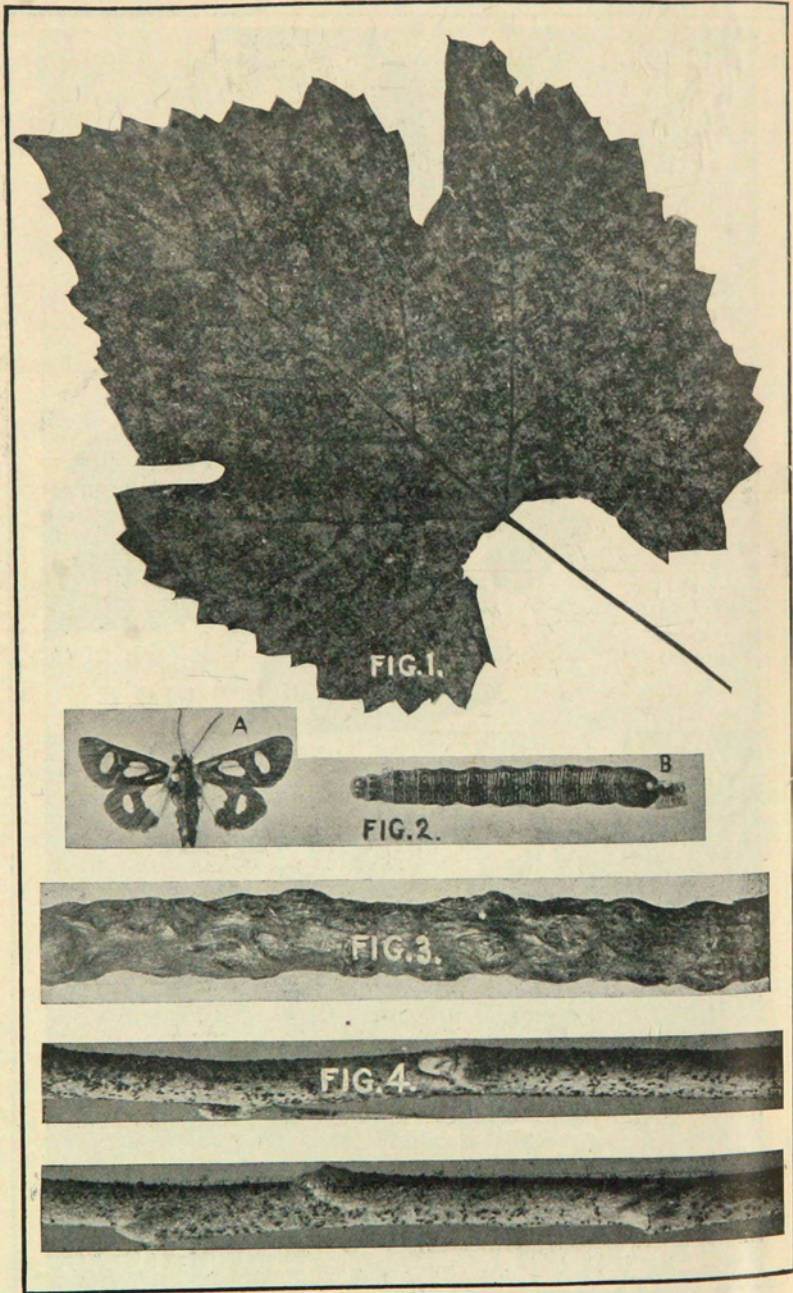


PLATE 3.

FIG. 1—Grape leaf showing bleached appearance due to grape-leaf hopper. (*Typhlocyba comes*.)  
 FIG. 2—Eight-spotted Forester (*Alypia 8-maculata*): A, moth; B, larva. Nearly life size.  
 FIG. 3—Apple twigs injured by Buffalo Tree-hopper (*Ceresa* sp.) Life size.  
 FIG. 4—Eggs of apple, plant-louse on apple twigs. Natural size. Photos by author.

destroys them. When the new shoots start, the borer eats into them causing them to wilt and die. Many of the second brood of this borer eat into the peaches, causing a gummy exudation and ruining them for market. The larvæ that appear in the spring spent their winter in little excavations which they made in the fall in the bark of the trees. See Figs. 11 and 12.

*Remedies.*—Early in the spring, just before the buds open, spray the trees with lime and sulfur wash (21). Whale-oil soap (12) in the proportion of a pound to two gallons of water. Fish-oil soap (13) diluted once with water, or kerosene emulsion, will doubtless do the work nearly or quite as well as the lime, sulfur and salt. Many of the larvæ may be caught under bandages (33) used as for the codling moth.

Mr. E. P. Taylor has had excellent success with arsenate of lead (5) at Palisade, Colo., this season.

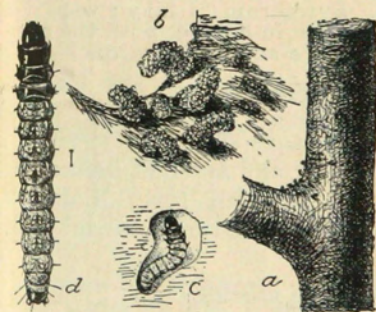


FIG. 11.—Peach Twig-borer: a, twig of peach showing little masses of chewed bark above the larval burrows; b, the same enlarged; c, larva in winter burrow, enlarged; d, hibernating larva greatly enlarged. (Marlatt, Bulletin 10, N. S., U. S. Dept. of Agr., Div. of Entomology.)



FIG. 12.—Peach Twig and Borer: a, young shoot wilting from attack of borer; b, adult larva enlarged; c, chrysalis enlarged; d, tail end of chrysalis showing hooks. (Marlatt, Bulletin 10, N. S., U. S. Dep. of Agr., Div. of Entomology.)

### THE PEACH BORER.

A yellowish white borer attaining the length of about one inch, boring beneath the bark of the lower trunk, crown and larger roots. See Plate 4.

*Remedies.*—Carefully inspect the trees every fall and spring, remove some of the earth next the crown, and search for and remove the borers with the aid of a pocket knife. Their presence is usually indicated by the exudation of a gummy material upon the bark. Shields of stout paper or wire screen placed about the trunks and left there from the 1st of June till the 1st of August will serve as a means of protection from egg-laying. The paper screen is the better. (See Plate 4, Figs. 2 and 3.)

### PLANT LICE.

The plant lice that attack the foliage of the peach may be

treated in the same way as the apple plant-louse mentioned above. The black peach aphid, which does its chief injury to the roots, should be handled in the same manner as the woolly aphid of the apple.

## INSECTS INJURIOUS TO THE GRAPE.

### THE ACHEMON SPHINX. (*Pholus achemon.*)

Hairless caterpillars devouring the leaves. When small, each caterpillar has a long dorsal spine on the last segment of the body. When nearly grown, the spine is represented by a shining black spot. These larvæ resemble the large tomato "worm."

*Remedies.*—Any of the arsenical poisons (3, 4, 5, 6, 7, 8) may be used as recommended for apple leaf-rollers. Pyrethrum (24) may also be used as powder or spray, but to kill, it must come in contact with the caterpillars. Hand picking is the best remedy in a small vineyard.

This insect is also bad on Virginia creeper.

### THE EIGHT-SPOTTED FORESTER. (*Alypia octomaculata.*)

A dark-colored caterpillar, about one and one-half inches long when fully grown. A close examination will reveal numerous small black and white cross lines and a few red ones to each body segment. See Plate 3, Fig. 2.

*Remedies.*—The same as for the preceding species.

This insect also infests the Virginia creeper.

### STEM BORER.

See apple twig-borer, which also attacks the grape.

### TREE CRICKETS. [*Ecanthus* sp.]

The female cricket punctures stems of grape and other plants and in each puncture deposits a long cylindrical egg. The punctures are usually in rows lengthwise of the stem and look like needle thrusts.

*Remedies.*—Cut out badly infested stems. Keep the vineyard clean of all weeds.

### COTTONY SCALE. [*Pulvinaria innumerabilis.*]

This scale, commonly found infesting soft maple, sometimes attacks grapevines. See Plate I, Fig. 2.

*Remedies.*—Kerosene emulsion made strong, so as to be one-fifth kerosene, thoroughly sprayed during the winter or early spring is very effective. When the little lice first hatch from the scales, about the last of June, the ordinary sprays of kerosene emulsion (14) or whale-oil soap (12) will destroy them. If the spraying is delayed till a heavy scale has formed over the lice, stronger applications will be required.

**GRAPE FLEA BEETLE.** (*Graptodera chalybæa*)

A small steel-blue beetle appearing early in the spring and again in midsummer and feeding upon the foliage. The beetles deposit eggs which soon hatch into small dark-colored larvæ which also eat holes in the leaves.

*Remedies*—Arsenical poisons (3-8) sprayed or dusted upon the foliage. If unsafe to use poisons, dust freely with Pyrethum (22).

**GRAPE-LEAF HOPPERS.** (*Typhlocyba* sp.)

Small jumping and flying insects, often called "grape thrips." The insects often fly out from the vine in great numbers when the latter is jarred and return quickly to the under side of the leaves. As a result of the punctures and the extraction of the sap, the leaves lose their dark green color and at first are minutely specked and freckled with white, as shown at Plate 3, Fig. I. Later the leaves shrivel and die. The red spiders, brown mites and thrips cause a similar appearance of the foliage they attack.

*Remedies*.—Spray forcibly with kerosene emulsion (14), kerosene and water (16), or whale-oil soap (12) very early in the morning while the insects are dormant and drop readily from the leaves. Burn dry leaves, dead grass and other rubbish in the vicinity of the vineyard during winter or early spring, on a cold day.

**GRASSHOPPERS.**

*Remedies*.—Use arsenical spray (3-8) where safe. If not safe to spray, use the arsenic-bran mash (2) freely about the borders of the vineyard and about the vines. Make free use of hopper-pans (34) in adjoining fields to reduce the number of hoppers before they reach the vineyard. Plow or thoroughly harrow the ditch banks and the borders of the field late in the fall to destroy as many of the eggs as possible.

**INSECTS INJURIOUS TO THE CURRANT.****IMPORTED CURRANT-BORER.** [*Sesia tipuliformis*.]

Yellowish white larvæ burrowing in stems, giving rise to wasp-like moths in June. The moths closely resemble those of the peach borer, shown at Plate 4, Fig. I.

*Remedies*.—Cut out the infested stems and burn them during winter or early spring. Also keep the old wood well trimmed out of the bushes, and always burn promptly the parts cut out.

**CURRANT SAW-FLY.** [*Pristiphora grossulariæ*.]

A green larva, about half an inch long when fully grown, feeding upon the leaves of currant and gooseberry bushes. Appearing late in June and again about the last of August. The adult insect is a black four-winged fly about the size of a house-

fly. The eggs are deposited, one in a place, under the epidermis of the leaves.

*Remedies.*—The best remedy for this pest is white hellebore (9) dusted lightly over the foliage in the evening. If this is carefully done, nearly every larva can be found dead under the bushes next morning. Arsenical sprays (3-8) may be used either dry or in water, as for other leaf-eating insects. These poisons should not be used before the currants are picked. Pyrethrum (22) may be safely used at any time.

### THE CURRANT AND GOOSEBERRY FRUIT MAGGOT

(*Epochra canadensis*).

A two-winged fly about the size of an ordinary house fly, but yellowish brown in color and with dusky bands across the wings, appears among the bushes when the berries are about half grown and "stings" the fruit with its sharp ovipositor. In each puncture an egg is deposited just beneath the skin as shown at *e*, and the punctured spot turns dark as shown at *a*, Fig. 14.

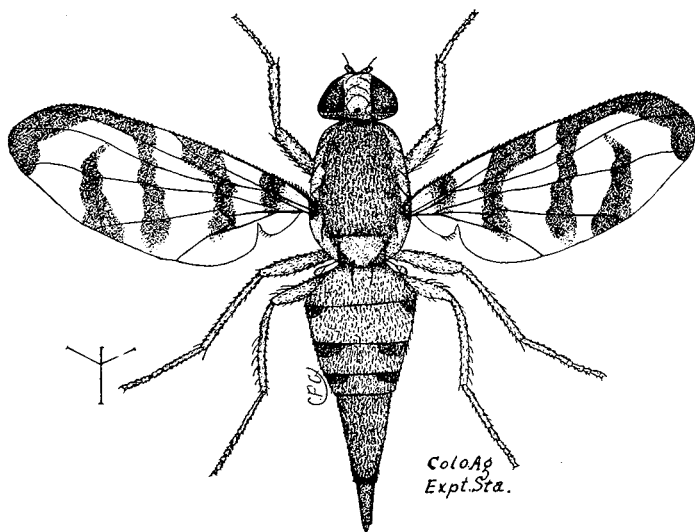


FIG 13.—Adult of Curran and Gooseberry Fruit-maggot.

The eggs soon hatch into little white maggots that eat into the seeds and cause the berries or currants to turn red and drop. When fully grown, the maggot leaves the fruit and works its way beneath the surface of the ground where it stays until the next summer when it comes forth again as a fly to lay eggs upon the next crop of gooseberries and currants.

*Remedies.*—Insecticides are useless here. If the stung fruit could be gathered and destroyed every day or two, there would be fewer flies



another year. If the surface of the ground is well turned under during the fall or early spring, many of the insects would be prevented from emerging. Thorough cultivation close to the plants throughout the season would do much to keep this insect in check.

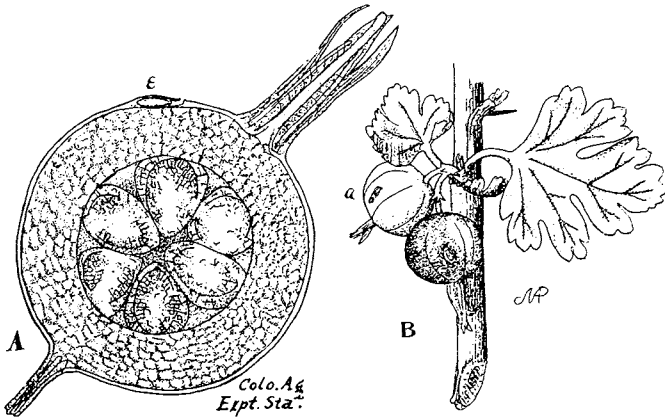


FIG. 14.—Currant and Gooseberry Fruit-maggot: A, section through a gooseberry showing egg and puncture at *e*; B, two gooseberries on a stem showing egg puncture, or sting, at *a*. Original. Drawings by Miss M. A. Palmer.

This is probably our worst currant and gooseberry pest in Colorado, and as it also attacks the wild currants and gooseberries it is likely always to be rather common in the mountainous districts.

### THE CURRANT AND GOOSEBERRY FRUIT WORM

(*Zophodia bella* Hulst.)

A flesh-colored worm, looking very much like the apple worm and about two-thirds of an inch in length when fully grown also attacks the gooseberries and currants in Colorado and often destroys a very large proportion of the fruit. Leaves and fruit are loosely webbed together by the worm which feeds upon the berries. It eats a hole large enough to enter and after devouring the whole interior of one berry it goes to another. The adult insect is a gray moth with rather long narrow wings. The insect and its injuries are shown in Fig. 15.

*Remedies.*—Poisonous sprays would doubtless kill many of these worms but they would render the currants and gooseberries unsafe to be used as food. If one has a few bushes only for home use, the worms could be nearly all destroyed by pinching the web clusters of fruit between the thumb and finger every day or two until no more appeared. Thorough cultivation would also destroy a large proportion of the chrysalids that spend the winter near the surface of the ground about the bushes.

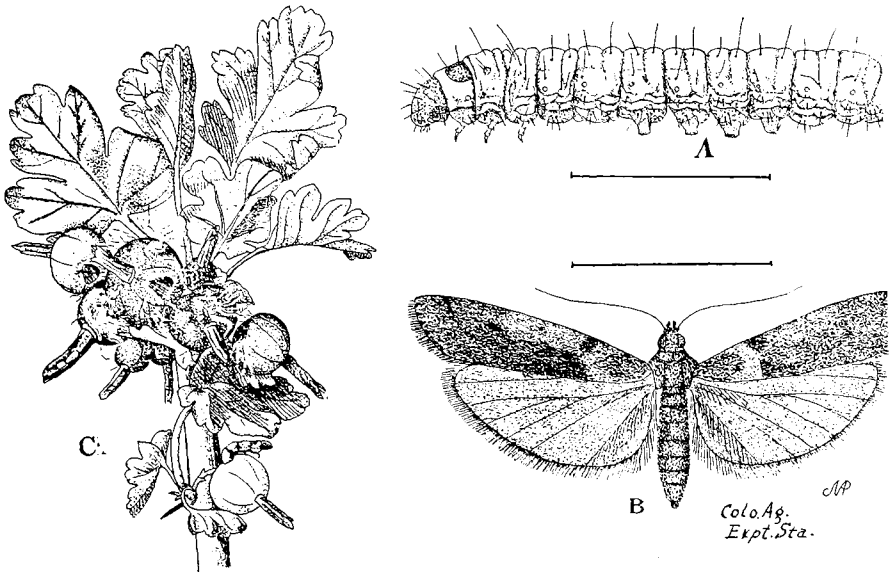


FIG 15.—Currant and Gooseberry Fruit-worm: A, worm; B, moth; C, gooseberries webbed together. Original. Drawings by Miss M. A. Palmer.

## INSECTS INJURIOUS TO THE STRAWBERRY.

### STRAWBERRY LEAF-ROLLER. [*Ancylis comptana*.]

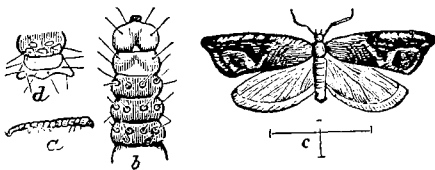


FIG 16.—Strawberry Leaf-roller: a, larva, natural size; b, head end of larva enlarged; c, moth about twice natural size; d, tail end of larva enlarged. (After Saunders.)

Small brownish or greenish larva attaining a length of nearly half an inch and having the habit of folding the leaves of the strawberry. In these folds the larva lives and feeds and finally changes to a small rust-colored moth with white marking on the wings. See Figs. 16, 17.

**Remedies.**—When the fruit has been gathered, scatter straw over the vines and burn it. Arsenical sprays (3-8) may be used, but the worms are so protected in the folded leaves that it is difficult to get a poisonous dose to them. The vines will put up a good growth of tops after the burning, if it is not done too late.

## STRAWBERRY CROWN BORER.

[*Tyloderma fragariae*.]

A small yellowish white grub boring into the crown of the plant during summer.

*Remedies.*—Burning as for the preceding species will destroy a large proportion of the borers. Do not allow the plants to become very old, but plow each year or once in two years as soon as the berries are picked, and start a new bed at some distance from the old one. Poisons are of doubtful value.

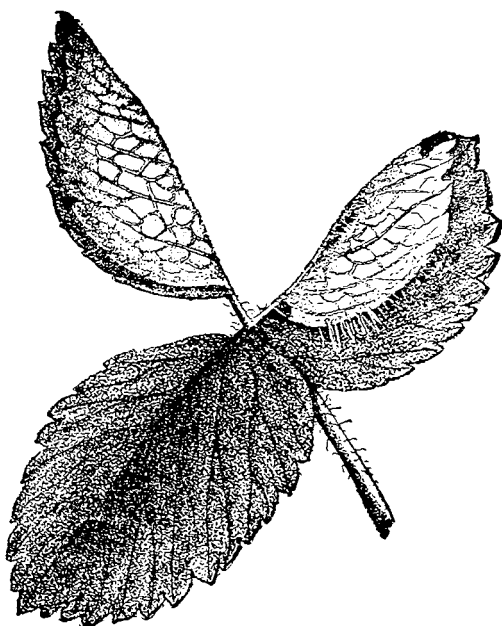


FIG. 17.—Strawberry leaves showing their appearance after being folded. (After Weed.)

## PART II.

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### INSECTICIDES.

#### THEIR PREPARATION AND USE.

In order to be able to apply insecticides intelligently and with success, it is important to understand something of the habits of the particular insects to be destroyed and also of the nature of the remedies to be used. Many insects, like grasshoppers and the potato beetle, devour the surface tissue of plants, while others, like plantlice, squash-bugs, and scale insects insert sharp tubular beaks into the tissues of plants and suck the sap from beneath the surface. Insects of the first class may nearly always be destroyed by means of food-poisons, such as arsenic, Paris green, hellebore, etc., while those of the latter class are unaffected by food poisons and have to be killed by substances that come in contact with the surface of their bodies, or in some other manner. It is not necessary to be a skilled entomologist in order to determine which class of insects is doing injury to the plants in question. If the leaves are ragged or eaten full of holes, it is practically certain that the injury is being done by an insect with biting-mouth parts. If the leaves simply wilt and dry up without having the tissue eaten away, the insect doing the injury is of the second type mentioned. The most common remedies for this class of insects are kerosene emulsion, whale-oil soap, crude petroleum, and lime salt and sulfur washes.

In many cases it is impossible to get an insecticide upon the insect that it is desired to kill, or upon its food, and then other means have to be used to prevent the injuries. Borers, underground feeders upon roots, and weevils living in seeds, are examples of such insects.

In the pages that follow I shall not attempt to treat of all the methods used to destroy insects or avoid their injuries, but the more important ones only.

#### SUBSTANCES THAT KILL BY BEING EATEN.

Nearly all the food-poisons have for their active principle arsenious acid, or white arsenic ( $As_2O_3$ ). White hellebore and borax, are about the only exceptions.

##### 1. WHITE ARSENIC.

While this is the cheapest of the arsenical poisons, it is used but little, except for the purpose of making arsenical compounds

with other substances. Because some states have passed laws requiring a high percentage of arsenic in Paris green, arsenic has been used as an adulterant of this poison, and thereby working an injury to the purchaser if not a benefit to the manufacturer of it, because arsenic is much cheaper than Paris green; and when it is mixed with the latter, it greatly increases its liability to burn foliage. The reason that white arsenic burns foliage badly is it dissolves in water and, when in solution, it penetrates the leaves and kills the living tissue. Arsenical mixtures must *never be in solution, but only in suspension*, in the water that is used to distribute them upon foliage.

### 2. ARSENIC BRAN-MASH.

Prepared by mixing one pound of arsenic and 20 to 50 pounds of bran together with just water enough to thoroughly moisten the mass. Some prefer to add a pound of sugar to the above in order to cause the particles of bran to adhere to each other, so that it may be distributed in little balls pressed together with the hands or with a paddle. This poisoned bran is used for the destruction of grasshoppers in orchards and vineyards where it is not possible to use a hopper-pan. Many prefer to sow the moistened bran and arsenic broadcast where the grasshoppers are numerous. Paris green may be substituted for the arsenic.

### 3. PARIS GREEN.

<sup>18</sup>This poison in a pure state is said to be composed of three substances—arsenious acid, acetic acid, and copper oxide—united in a chemical combination. The percentage of arsenic may vary considerably, as these substances do not always combine in exactly the same proportions. The range is nearly always between 55 and 60 per cent. arsenic, with an average of about 58 per cent. \*Mr. J. K. Haywood, one of the chemists in the Department of Agriculture at Washington, D. C., says that the chemical composition of Paris green should be:

	<i>Per cent.</i>
Arsenious acid .....	58.65
Copper oxide .....	31.29
Acetic acid .....	10.06

Pure Paris green is one of the very best of the arsenical compounds for the destruction of insects, but this poison is often found greatly adulterated upon the market. If adulteration is suspected, or if the poison is being purchased in any considerable quantity, it is advisable to test its purity in some way. Pure Paris

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\*Farmer's Bull. No. 146, U. S. Dept. of Agr.

green is entirely soluble in ammonia, giving a clear blue liquid. If any particles can be seen floating through the liquid, or settling to the bottom, the article is not pure. If the ammonia dissolves all there can be little doubt that it is pure. This is a test that anyone can make. The particles of Paris green are entirely bright green in color and globular in form, and the presence of an adulterant can be most easily detected under a microscope of moderate power. Prof. Woodworth of the University of California explains another method by which impurities can usually be detected in Paris green. It is by placing a small amount of the poison on a clean piece of glass and then slanting the glass and jarring it so as to cause the powder to slide to the lower side. If this is done carefully the adulterants, which are not green in color, will fall behind and can be detected with the unaided eye.

Where there are several persons in the same neighborhood wanting this poison, it is best for all to order together and then send a sample to a chemist for analysis. If a good number unite in this way the Station chemist, most likely, would be willing to make the test free.

*Application of Paris Green to Plants.*—This poison is usually applied in a watery spray, and the most common strength is:

Paris green .....	1 pound
Water .....	160 gallons
Lump lime (freshly slacked) .....	2 pounds

On very sensitive foliage, like that of the peach, apricot, nectarine and bean, it would be safer to use 200 gallons of water to a pound of poison. A pound to 100 gallons is quite safe for applications upon apple, cherry, cabbage, beets, potatoes and most other trees and plants in the dry atmosphere of Colorado. The poison always should be placed in a small quantity of water first and thoroughly stirred in and then poured into the full amount of water to be used.

The chief objection to the use of pure Paris green as an insecticide is its high specific gravity, which causes it to settle rapidly in water. Pumps used to apply this poison always should have some means of keeping the water well stirred.

*Dry applications* may be made in various ways. Sometimes the poison is used pure, in which case the lightest possible dusting is made over the plants. It is usually better to dilute the poison with about twenty times its own weight of flour, plaster or lime when a more liberal dusting may be made. This method is more

economical of the poison and enables one better to tell when all parts of the plant have been treated. A good proportion is:

Paris green .....	1 pound
Common flour.....	25 pounds

The advantages of flour over lime or plaster are, it helps better to stick the poison to the leaves and is not distasteful to insects. Particles of poison imbedded in a mass of plaster or lime would probably be avoided by most insects. Filling the blossom ends of apples with lime mixed with poison may drive the worms to eat their way into the apples where they will escape the poison entirely.

The methods of applying dry poisons are chiefly two. If low plants, like cabbages and tomatoes, are to be treated, and the area to be covered is not too great, a very satisfactory method is to make a small sack—about ten inches long by five inches in diameter—of strong cheesecloth or other light muslin, fill half full with the mixture of poison and flour and then shake or jolt the sack over the plants.

Where large areas are to be treated, or where it is necessary to make the application to trees or high bushes, some kind of dust gun or bellows is an advantage. Powder guns of different kinds are upon the market and some of them are being extensively advertised at this time. These instruments have a place to fill, but I do not believe they can take the place of the watery spray for large trees, and particularly for the application of poisons for the destruction of the codling moth.

#### 4. SCHEEL'S GREEN (GREEN ARSENOID).

Scheele's green, also sold as "green arsenoid," differs very little from Paris green in chemical composition, except in lacking the acetic acid. It is considered as effectual as an insect destroyer, and has a great advantage over Paris green in being much more finely divided, so that it remains in suspension in water for a much longer time. It is also cheaper in price. Dr. Marlatt, of the Division of Entomology, says it should replace Paris green as an insecticide.

Apply either wet or dry, as recommended for Paris green.

#### 5. ARSENATE OF LEAD.

This compound contains only about 20 to 25 per cent. of arsenic acid, but has some important advantages over the other arsenical compounds. It is so completely insoluble in water that it may be used in almost any strength without injuring foliage and consequently is least likely to injure plants that are most sensitive to arsenical poisons. When suspended in water this poison is so finely

divided that it settles slowly, and consequently can be more evenly distributed than most arsenical mixtures. Its third point of superiority is in its adhesive qualities when applied to foliage. Applications made to foliage in the latter part of May at this Station could plainly be seen upon the leaves the first of September. The disadvantage of the poison is its not being quite so quick to kill the insects that eat it as are the other arsenites, consequently it is necessary to use it in stronger mixtures.

To prepare arsenate of lead, dissolve in water arsenate of soda and acetate of lead (white sugar of lead) in the portion of three pounds of the former to seven pounds of the latter. Then use not less than five or six pounds of the combined chemicals to each hundred gallons of water. Three or four times this strength will do no harm to foliage. If the poison is purchased ready made, use:

Arsenate of lead .....	4 to 6 pounds
Water ... ..	100 gallons

#### 6. ARSENITE OF LIME.

White arsenic and lime may be made to combine, forming an arsenite of lime that is practically insoluble in water. The poison may be prepared in either of two ways. What is known as the Kedzie formula is as follows:

“Boil two pounds of white arsenic and eight pounds of salsoda for fifteen minutes in two gallons of water. Put into a jug and label ‘poison’ and lock it up. When ready to spray, slack two pounds of lime and stir it into forty gallons of water, adding a pint of the mixture from the jug.

The other method is to boil together arsenic, lime and water for a full half hour in the following proportions:

White arsenic .....	1 pound
Lump lime .....	4 pounds
Water .....	4 gallons

Then dilute to 200 gallons of water before applying to foliage.

These preparations have become very popular in the past few years and deservedly so. White arsenic is cheap and consequently is in very little danger of adulteration, so that one is almost certain of the strength of his mixture when using this poison. Care must be taken, however, to *use fresh unslacked lime of good quality.*

Before being diluted for use, the mixture should be passed through a coarse cloth or sieve, to take out the lumps that would otherwise clog the spraying nozzle.



## 7. LONDON PURPLE.

London purple is a by-product in the manufacture of aniline dyes and has for its active principle arsenite of lime. It also contains some free arsenic, lime, coloring matter and other impurities. The amount of arsenic present is subject to considerable variation, but will usually range between 40 and 55 per cent. As there is often considerable soluble arsenic present, it is always best to use a pound or two of freshly slacked lime with every pound of the poison if used in water.

This poison is finely divided and remains in suspension in water much longer than Paris green does and it usually sells at about two thirds the price of that poison. It seems to be going into disfavor because of its variable composition and the danger of its burning foliage. It is also considered somewhat less effectual in killing insects than is Paris green or Scheele's green. It should compare favorably, however, with the prepared arsenite of lime in its power to kill insects, and there is little danger that it will be adulterated, as it is a waste product.

Apply either wet or dry in the manner and in the same proportions as are previously recommended for Paris green; being sure to add a pound or two of freshly slaked lime for each pound of poison if used as a spray.

## 8. BORDEAUX MIXTURE AND THE ARSENITES.

Bordeaux mixture is a fungicide and is the substance most often used for the destruction of fungous diseases that attack the surface of the plants. It has been found to be of value for use against flea-beetles, and the writer also demonstrated its value a number of years ago as a medium in which to spray Paris green or London purple. These poisons can be used very strong in this mixture without injury to foliage and they do not in the least lessen its effect as a fungicide. Such a mixture will destroy both insects and fungi with one application.

Bordeaux mixture may be prepared as follows: Take of

Copper sulfate.....	4 pounds.
Quicklime .....	4 pounds.
Water.....	45 gallons.

Dissolve the copper sulfate in a gallon of hot water, slake the lime in another gallon of water, and then add the milk of lime slowly to the copper sulfate solution while the latter is being constantly stirred. Then add 43 gallons of water.

If insects are to be killed at the same time, add to the above quantity of Bordeaux mixture one-third pound of London purple, Paris green or Scheele's green, or two pounds of arsenate of lead.

## 9. WHITE HELLEBORE.

Hellebore, as obtained from drug stores, is a light, yellowish-brown powder. It is a vegetable poison and is obtained by pulverizing the roots of an European plant *Veratrum album*. It is not as poisonous as the arsenites and consequently it is not as effective in the destruction of most insects, but it has its special uses. Slugs, which are the young of saw-flies, are particularly susceptible to its effects. The poisonous property is an alkaloid and it loses its virtue after being exposed to the air for a few days. For this reason it can not be used where it is likely to remain long before being eaten, and it must be kept in tight receptacles and must not be kept too long before using. It is often useful for the destruction of insects upon plants containing fruit that will soon be used for food.

Dry applications are easily made upon low plants by making a small cheesecloth sack, through which the dust may be sifted lightly over the foliage. The best time to apply is in the evening

In the wet way use:

White hellebore.....	1 ounce.
Water.....	3 gallons.

Apply as a spray in the evening.

## 10. BORAX.

Used chiefly for the destruction of cockroaches. Spread the powdered borax upon bread, sweet potato or banana peelings, or mix with sweetened chocolate, and place the bait where the cockroaches can get at it.

**SUBSTANCES THAT KILL BY EXTERNAL CONTACT.**

Substances in this group are chiefly used against insects that take liquid food from beneath the surface of the plant by means of a tubular rostrum or beak, but they may be used against many other soft-bodied insects with success. Insects having a hard outer crust to their bodies resist these substances and are not easily killed by them. If insects are covered with a powdery or cottony material, the insecticide will have to be applied with considerable force to cause it to penetrate to the body. Applications must always be thorough, because only those insects will be killed that have the substances thrown upon them.

## 11. SOAP.

The ordinary soft soaps and laundry soaps have long been used for the purpose of killing vermin on plants and animals, and

they have considerable insecticidal value, particularly for the destruction of very tender insects, like plant lice. The soaps that are specially useful for the destruction of insects, are sold as whale-oil soap, fish-oil soap, or tree-soaps. Whatever the name, the oil is usually fish-oil.

#### 12. WHALE-OIL OR TREE-SOAP.

For ordinary plant lice one pound of the soap to eight or ten gallons of water is sufficient if the application is thorough. Double this strength will not injure most plants and is often required to destroy more resistant insects. For scale lice, like the San Jose scale for example, it is used as strong as a pound, or even two pounds, to a gallon of water. These strongest applications can only be used in the winter or early spring when the trees are dormant. The soap is more effectual if applied when quite hot.

#### 13. FISH-OIL SOAP (HOME-MADE).

Lodeman in his "Spraying of Plants" gives the following formula for the preparation of fish-oil soap:

Potash lye.....	1 pound
Fish-oil.....	3 pints
Soft water.....	3 gallons

Dissolve the lye in boiling water and then add the oil and boil for two hours longer. When using dissolve a pound of this soap in from six to ten gallons of water. Use for the same purposes as whale-oil soap, and in the same strengths.

#### 14 KEROSENE EMULSION.

This preparation is probably the best general purpose insecticide for the destruction of insects by external contact. The materials composing it are always at hand and it is not difficult to prepare after one has had a little experience. Soft water should be used, if possible. If hard water is used it may be necessary to "break" it first by adding washing soda or potash lye.

To make the emulsion use the ingredients in the following proportions:

Soap.....	1 pound
Kerosene.....	2 gallons
Water.....	27 gallons

Prepare by dissolving the soap in a gallon of water, then, while the soapy water is boiling hot, remove from the fire and immediately add two gallons of kerosene and agitate briskly for a few minutes. If a large amount is being made, use a force pump and forcibly pump the mixture back into the receptacle that con-

tains it until all is a frothy, creamy mass. If such a mixture is not obtained in a very few minutes, put the whole over the fire again until it boils and then repeat the pumping, and the emulsion will almost surely form. When put back for reheating, *watch every moment to see that it does not boil over and take fire.* This work should be done out of doors. After the emulsion is made, add the remaining 27 gallons of water and all is ready for use.

Small quantities may be emulsified with a rotary egg-beater.

Whale-oil soap, or any cheap soap, may be used.

Clean dishes and clean water should be used. Every particle of dirt in the emulsion serves as a center of attraction about which the oil droplets will collect and then rise to the top to form a film of oil on the surface.

The strength above given is suitable for most insects. Most plant lice may be killed with an emulsion of half the above strength.

#### 15. KEROSENE-MILK EMULSION.

Kerosene will emulsify with milk, also, and when small quantities are wanted it is often less trouble to use the milk than to prepare the soapy water. These proportions are:

Milk (sour).....	1 gallon
Kerosene.....	2 gallons

Dilute with water as in the preceding formula. If sweet milk is used, add a little vinegar. Otherwise it may be impossible to form a stable emulsion.

#### 16. KEROSENE AND CRUDE PETROLEUM.

These oils are used pure, and also diluted with water, for the destruction of scale and other insects. Experiments in the Eastern States seem to indicate that the safest time to apply is early in the spring, just before the buds swell, and on a bright, windy day when the oil will evaporate rapidly. It seems that when applied in moderation, in the proportion of 40 parts of the oil to 60 of water, these substances will seldom injure apple, cherry or pear trees, but can hardly be applied to tenderer trees, such as peach and plum, without further dilution.

When diluted with water in the form of a spray they may be used upon foliage of most plants, without injury, in the proportion of one of the oil to five or six of water. Most plant lice are killed in mixtures as weak as one of oil to fifteen or twenty of water.

Pumps are now made for the purpose of mixing the oil and water in the form of a spray, and so do away with the need of preparing an emulsion. The one who has the insecticides to apply

must decide whether or not he will go to the extra trouble of making the emulsion or whether he will go to the extra expense of purchasing a special and somewhat more costly pump that may not work very satisfactorily at all times.

#### 17. GASOLINE.

This oil is also destructive to insect life. Its chief use is for the destruction of bed-bugs. It is applied pure by means of an oil-can or hand atomizer. To be effectual the bugs must be thoroughly treated with it. As it is inflammable, care must be taken not to bring fire near until the apartments where it is used are well aired.

#### 18. TURPENTINE.

Turpentine is used for the same purposes as gasoline and the same precaution applies.

#### 19. LYE AND WASHING SODA.

These substances are in considerable popular favor for the destruction of insects, but the writer's experience with them has not been encouraging. In the proportion of a pound to three gallons of water they may be used upon the trunks of trees and will kill soft-bodied insects that might be wet by them. To be used upon foliage they should be diluted to a pound to forty gallons of water, and in this strength they will hardly destroy the tenderest of insects. Kerosene emulsion or whale-oil soap are much more effectual insecticides.

#### 20. LIME.

Lime, either wet or dry, may be used freely upon foliage without fear of injury. It is of very little value as an insecticide. When freshly slaked and freely dusted upon the slugs that infest pear, cherry and plum trees, it causes them to drop off and most of these perish. Experiments at this Station have not been wholly successful in killing slugs this way. As a coating upon the bodies of fruit trees it undoubtedly does much to prevent sun-scald late in winter and early in spring. The addition of a liberal amount of skim-milk or salt, or both, to the preparation will greatly increase its adhesive qualities. The following formula is printed in the 1899 report of the Canada Experimental Farm:

Skim-milk .....	6 gallons.
Water .....	30 gallons.
Lime .....	60 pounds.
Salt .....	10 pounds.

#### 21. LIME, SALT AND SULFUR WASH.

This wash, when properly made, is one of the most effectual

applications for the destruction of scale insects and eggs of the brown mite, particularly in dry climates, like that of Colorado. It should be used only in the winter or spring, while the trees are dormant. The ingredients may be in the following proportions:

Lump lime (good).....	20 pounds.
Sulfur.....	15 pounds.
Salt.....	10 pounds.
Water.....	50 gallons.

Slake the lime, preferably with hot water, in an iron kettle or a barrel, and while slaking, slowly add the sulfur and stir it in. Then boil over a good fire or by means of a jet of steam in about one half the required amount of water (25 gallons) for an hour or two, or until a dark red color is obtained. Then add the salt and boil for 15 minutes longer, strain, dilute to 50 gallons and apply while hot. Many are leaving out the salt and they seem to have just as good results.

## 22. PYRETHRUM, BUHACH, OR PERSIAN INSECT POWDER.

This substance is a vegetable powder and is obtained by pulverizing the dried blossoms of plants of the genus *Pyrethrum*. It may be obtained at almost any drug store, and is peculiar in its power to kill insects while it is not poisonous to the higher animals. It may be used either wet or dry. If applied in water, use in the proportion of:

Pyrethrum.....	1 ounce.
Water.....	3 gallons.

If applied dry, use pure and make a very light application, or dilute with flour and apply more freely.

If thoroughly disseminated in the air of a room it will soon bring to the floor all the flies and mosquitoes therein. A good way to rid a room of flies is to make a thorough dusting of the powder through the room and then close the room tightly for the night. Then in the morning sweep up the flies and burn them. If they are not destroyed in this way after being stupefied, many will finally overcome the action of the powder and live.

## 23. TOBACCO.

Tobacco has long been used in one way or another for the destruction of insects. Its chief use seems to be for the destruction of lice. When slowly burnt the smoke may be utilized for the destruction of lice on plants in greenhouses or window gardens. In the form of a fine dust it is often effectual in ridding plants of flea-beetles, and in the form of dust or stems is probably the best remedy we have for woolly aphid on the roots of apple trees.

A decoction made by boiling tobacco dust or stems in water in

the proportion of a pound to three or four gallons, is destructive to plant lice (*Aphidæ*) and to lice upon cattle. Tobacco, very finely powdered, in the form of snuff, may also be used dry against the same insects. It is best to first spray the insects with water.

#### 24. SULFUR.

Everyone knows of the use of sulfur fumes for the destruction of animal life. Sulfur is specially destructive to "red spiders" and "brown mites," and may be applied as flowers of sulfur, dry, through a blow-gun of some sort, or mixed in soapy water or soap solutions in the proportion of an ounce to a gallon of the liquid and applied as a spray. The liquid must be kept thoroughly stirred, as the sulfur settles quickly.

#### 25. HOT WATER.

Water heated to 130 to 140 degrees Far. kills very quickly any insect that is put into it, but is harmless to plants unless they are kept submerged for a long time. Lice, especially those on roots, may often be killed conveniently with hot water.

### SUBSTANCES THAT KILL BY BEING INHALED.

There are two insecticides of this sort that are of special importance. As both are destructive to vegetable life also, care must be had in their use that they are not applied in strengths that will destroy the plants. It is important that tents, rooms, or other receptacles in which objects are placed for fumigation, be as nearly air tight as possible.

#### 26. CARBON BISULFIDE; "FUMA."

This is a clear, extremely volatile liquid with a very disagreeable odor unless obtained pure, when it is much more expensive. The fumes are heavier than air, so that it is always best to expose the liquid in the upper part of a building, or other receptacle containing objects to be treated. The fumes are explosive also when mixed with air, so that *great care must be taken not to bring fire near them.*

For the purpose of fumigating a building or other inclosed space containing growing plants, not over one pint of the liquid to 1,000 cubic feet of space should be used. For the destruction of insects in seeds, carpets or clothing it may be used much stronger.

To destroy ant hills, thrust a sharp stick down into the hill to a depth of eight or ten inches and then remove it and pour in two or three ounces of the carbon bisulfide; fill the hole with earth by stamping on it, and then throw over the hill a wet blanket to

hold down the fumes. Allow the blanket to remain for a half hour at least, and the ants will be dead. If the hill is a very large one it would be well to make two or three holes for the carbon bisulfide.

To kill prairie dogs, pour three or four ounces of the liquid on a ball of cotton and roll the latter down the prairie dog hole and quickly fill the mouth of the hole with dirt. Dry horse droppings or pieces of gunny sacking may be used in place of the cotton.

For the destruction of the woolly-louse of the apple, thrust a crow-bar or other sharp instrument into the ground to the depth of one foot or a little more, and at a distance of two feet from the crown of the tree and upon three sides of the tree. In each of these holes pour one ounce of the carbon bisulfide and close the holes quickly with damp earth. This is a cheap and effectual remedy and, if care is taken to have the holes made two feet from the tree and to have only about an ounce of the liquid put in a hole, there will be little or no danger of killing the trees.

This substance is expensive when purchased in small quantities at a drug store. It may be obtained quite cheaply if purchased in 50-pound lots, from Mr. Edward R. Taylor, Cleveland, Ohio. Write for prices.

#### 27. HYDROCYANIC ACID GAS.

This gas has come into very general use, particularly in the orange growing sections of the country, for the destruction of scale insects. It may also be used for the destruction of insects in mills and in dwellings and in closed receptacles generally. Some of the best nursery men have adopted the excellent plan of fumigating all their nursery stock with hydrocyanic acid gas before shipping to their customers. This should always be done.

The chemicals of which this gas is made are cheap and are used in the following proportions:

Potassium cyanide (of 98 per cent. purity) . . . . .	1 ounce.
Commercial sulfuric acid . . . . .	1 ounce.
Water . . . . .	3 ounces.

The above quantities are sufficient for a space of 100 cubic feet for the fumigation of dormant trees and plants (nursery stock). It may be used in the same strength, or even stronger, for the fumigation of mills, houses, clothing and the like.

The tent, building or receptacle in which the fumigation is to take place, should be as tight as possible. The less wind there is the better, if the fumigating room is not very tight.

The gas should be generated in an earthen jar, or wooden bucket or tub. *The chemicals must be added in the following order:* First put in the water; then add the acid; and, after the



water and acid have mixed, add the potassium cyanide. A good way to add the poison is to have it tied in a paper sack and placed upon a piece of board over the dish containing the acid and water, with a string attached to the sack and passing to the outside. Then, when everything has been made tight, a pull on the string will precipitate the sack of cyanide in the acid and a rapid escape of the poisonous fumes (HCN) will immediately take place, causing violent bubbling of the liquid. Filling ones lungs with these fumes would cause almost instant death, so great care must be taken not to breathe them. Fumigating rooms must be arranged so that doors or windows of some sort can be raised from the outside quickly. Then a thorough airing must take place before anyone enters.

It would require considerable space to give full directions for the fumigation of orchard trees, and, as there is little likelihood that such fumigation will be called for in Colorado for some time to come, I shall not take space to describe the process here. Those specially interested can obtain bulletins giving full directions from the Department of Agriculture, Division of Entomology, Washington, D. C. Full directions can also be obtained in a book entitled "Fumigation Methods," by W. G. Johnson, and published by Orange Judd Co., New York.

### **SUBSTANCES THAT REPEL.**

There are a number of substances that are more or less useful for the purpose of driving insects away from places where they would do harm if unmolested. I give below a few of the most important.

#### 28. NAPHTHALINE, GUM-CAMPHOR, AND MOTH BALLS.

Naphthaline crystals are much used in insect boxes and in boxes or trunks where furs, feathers or woolen goods are kept, for the purpose of keeping out insects that feed on these animal products. It is probably the best single chemical that can be used for this purpose. Gum-camphor is also much used for the same purpose and moth-balls are a combination of these two volatile substances. These materials cannot be used to kill insects, but only to repel them.

#### 29. TOBACCO.

Tobacco, in the form of dust, or otherwise, is often used for the same purpose as the preceding, but to be effectual must be used quite freely.

#### 30. ASHES.

Ashes, particularly from wood, are frequently used to dust

upon plants after a rain or while the dew is on and often result in the insects disappearing. Particularly is this true in case of flea-beetles and the cucumber beetle when feeding upon leaves. Ashes do not kill the insects, but they make the food distateful, so the insects are driven to other plants.

### 31. LIME, PLASTER, AND ROAD DUST.

These substances are also used like ashes as repellents, but are of little or no use for the destruction of insects, except, possibly, the pear and cherry tree slugs.

## INSECT TRAPS.

There are many methods of trapping and destroying insects. One of the most common is the use of bright lights exposed at night.

### 32. LIGHTS.

The usual plan is to place a light over a dish of some sort that contains water with coal oil on top of it. Many night-flying insects are attracted by lights and may be destroyed by devices of this kind, but there are also many insects that fly at night that are not attracted by lights. Such an insect is the codling moth, though light traps are often recommended for its destruction. Among those insects that are readily attracted by lights might be mentioned the adults of the army worm, of the various cut-worms, the garden web-worms, the corn or boll-worm, and the beet-worms.

It is not infrequently the case that more of the beneficial insects are destroyed than of destructive species, and it is quite doubtful if lights are often of any great importance as a means of lessening the injury to crops by the destruction of insects.

### 33. SWEETENED WATER, CIDER, VINEGAR, ETC.

Some insects are attracted in considerable numbers to such substances as the above, but it is very seldom that the benefit derived from them will pay for the trouble and expense of using them. Mr. David Brothers, of Edgewater, Colo., reported excellent success capturing moths of the fruit-tree leaf-roller with weakened vinegar in pans in the orchard, and the codling moth is attracted to some extent to a mixture of molasses and vinegar placed in apple trees. The advantage of such baits for the capture of insects is usually greatly overstimated by those who use them.

### 34. BANDAGES.

Heavy cloth or paper bands placed about the trunks of apple trees are quite useful for the capture of the larvæ of the codling

moth that are leaving the apples and going in search of a suitable place to spin their cocoons. Burlap bands are cheap and seem to be as good as any. The writer took 1,481 codling moth larvæ under a single burlap band one season. Old gunny sacks cut into strips serve as well as anything. The band should not be less than four inches wide and should be composed of three thicknesses of the cloth.

The bands should be wrapped loosely about the trunks, the ends overlapped and held in place by a single carpet tack pushed in with the thumb.

If used against the codling moth they should be removed once in a week or ten days for the purpose of killing all the worms and then replaced.

The bands should be placed on the trees about the 10th of June in the warmer parts of the State, and about the 20th of June in the northern parts.

Bands of paper or wire screen are sometimes wrapped about the entire trunk to prevent the entrance of borers, as shown in Plate 4 Figs. 2 and 3.

### 35. HOPPER-DOZERS OR HOPPER-PANS.

For the purpose of catching jumping insects, especially grasshoppers, the hopper-dozer or hopper-pan is most useful. There are different methods of constructing these pans. A form used by Dr. Riley and illustrated by him many years ago is shown at Fig. 2. The pan in the illustration is entirely of sheet-iron, and is drawn across the field by two men or two horses. In the bottom of the pan is placed a small amount of water with kerosene on it. All grasshoppers that come in contact with the oil die. The back of the pan may be extended by means of stakes at the corners and a strip of cloth hung between them. Such an extension catches many grasshoppers that would otherwise escape. A modification of this pan is shown in bulletin No. 112, of this station by Mr. P. K. Blinn.

### 36. STICKY SUBSTANCES.

Bandages of sticky substances, such as printer's ink, "Dendroline," "Raupenleim," "Tree Tangle-Foot" or even cotton batting, are sometimes used to prevent insects from climbing trees. Where oily substances are used it is safer to put them on a bandage of stout paper, which is then wrapped about the trunk of the tree.

## THE APPLICATION OF INSECTICIDES.

I think it best not to attempt to show types of apparatus for

the application of insecticides in this bulletin. There are so many manufacturers of spraying machinery now that it would be impossible to show pumps and other appliances made by more than a few of them. At the close of this article is a list of some of the more prominent dealers in spraying machinery. One who contemplates purchasing spraying apparatus should write to a few of these firms for catalogues, and then select what seems to be the pump or other machine that is best suited to his needs. Advertisements of other dealers in spraying machinery may be found in papers and magazines devoted to agricultural and horticultural pursuits.

### **APPLICATION OF DRY INSECTICIDES.**

The upper surface of the leaves of all low plants can be easily treated with a dry insecticide by dusting it through a cheesecloth, or other thin muslin bag held in the hand. There are also various dust sprayers of large and small sizes upon the market.

By whatever means the dust is distributed it is best applied in the evening or early morning when foliage is slightly moistened with dew, or after a shower.

### **APPLICATION OF WET INSECTICIDES.**

#### **THE PUMPS.**

Pumps with metal valves should be obtained for the application of insecticides or fungicides in liquid form, as the materials used harden or decompose leather valves so that they last but a short time. If the pump is to be used with a tank or barrel it is also important to have some kind of attachment that will keep the liquid agitated so the materials in suspension will not settle. A common error is to purchase a pump of too small capacity, because it is cheaper. A smaller, cheaper pump usually means less accomplished in a day with same help and a poorer job, with a greater expenditure of labor. And then, it is often important to complete the spraying in as short a time as possible after it is begun. To do this, a pump of large capacity with two or more leads of hose is necessary. The hose to which the nozzles are attached should be as light as possible and still have the requisite strength—a hose of good quality with heavy wall, but small caliber. Bucket pumps are sold by different dealers at prices ranging between about \$2.00 and \$8.00 in price. They are suitable for use among garden vegetables, shrubbery and all low plants, but should not be purchased for orchard work if one has more than a very few trees to treat.

If one has light spraying to do and is without help, the compressed air sprayers are very convenient. Large compressed air sprayers that derive their power from gearing attached to the

wagon wheel are specially adapted to the treatment of low plants, but I very much doubt if any spraying machines of this class upon the market are well adapted to the spraying of large orchard trees where the wagon must stand still a large proportion of the time while the spraying is going on.

Where large orchards are to be sprayed it is a matter of necessity and economy to use tanks that will hold 200 and 300 gallons, and pumps of large capacity. In such orchards gasoline power sprayers are most useful.

### HOW TO SPRAY.

The first requisite for a good job of spraying is a pump that will give plenty of pressure in the hose. Then, if one has a good spraying nozzle and a liquid that is free from solid particles of a size to clog the sprayer, there will be no difficulty in getting a good spray. Barrels and tanks should always be filled through a strainer to avoid loss of time and annoyance through the clogging of nozzles.

A very fine spray is most economical of material and, for an even and thorough distribution, is best, and is specially useful for the destruction of caterpillars, slugs and other insects that devour the foliage of plants. In case of the first spraying for the codling moth, however, I am still constrained to recommend as I have done for years, that the spray be a medium coarse one. By this I do not mean that the spray should be composed largely of large drops produced by the breaking up of a solid stream thrown forcibly into the air, and it should not be a fine mist or fog. A rather coarse Vermorel, or a good Bordeaux nozzle with a pressure of 100 or 125 pounds, will furnish such a spray as I refer to. When spraying is being done to destroy leaf-eating insects, care should be taken not to spray too long in one place, as this will result in the little drops that collect upon the leaves uniting and running off, carrying the poison with them. Here again this rule does not apply to the first treatment for the codling moth. In that application there should be but one end in view, and that to fill every blossom or calyx cup with the spray.

### NOZZLES TO USE.

There are two types of nozzles that are used almost exclusively for the distribution of liquids. Perhaps the most popular among these are the Bordeaux and Seneca nozzles which throw a flat spray or a solid stream, and the Vermorel nozzles which throw a cone shaped spray which may be graded from medium coarse to extremely fine depending upon the pressure and the tip that is used upon the nozzle. It is a big advantage in noz-

zles of this class to have them joined to the connecting rod so they may be turned at any angle to the rod that is desired.

Any of these nozzles may be used singly or in batteries of two to four.

### SOME LEADING MANUFACTURERS OF SPRAYING MACHINERY.

The Gould Manufacturing Co., Seneca Falls, N. Y.  
 The Deming Co., Salem, Ohio.  
 The C. E. Brown Co., 47 Jay Street, Rochester, N. Y.  
 The Friend Manufacturing Co., Gasport, N. Y.  
 The Hook-Hardie Co., Hudson, Mich.  
 Dayton Supply Co., Dayton, Ohio.  
 F. E. Meyers & Bro., Ashland, Ohio.  
 Bean Spray Pump Co., San Jose, California.  
 Spramotor Co., 107-109 Erie Street, Buffalo, N. Y.  
 Wallace Machinery Co., Champaign, Ill.  
 Morrill & Morley, Benton Harbor, Mich.  
 William Stahl, Quincy, Ill.  
 Fairbanks, Morse & Co., Denver, Colo.  
 Webber Engine Co.,  
 Dean Power Pump Co., Holyoke, Mass.  
 Field Force-Pump Co., Elmira, N. Y.  
 International Harvester Co., Denver, Colo.



Spray tank and hand pump used with excellent results by Senator J. W. Crowley, in his large orchards at Rocky Ford, Colorado.