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# INSECTS AND INSECTICIDES.

—BY—

C. P. GILLETTE.

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# CONTENTS.

## INSECTS.

### INTRODUCTORY NOTE.

#### INSECTS INJURIOUS TO THE APPLE:

##### Attacking the Fruit.

Codling Moth, *Carpocapsa pomonella* Linn.

##### Attacking the Foliage.

Leaf-roller, *Cacæcia argyrospila* Walk.

Tent Caterpillar, *Chisiocampa fragilis* Stretch.

Fall Web-worm, *Hyphantria cunea* Dru.

Apple Flea-beetle, *Haltica* sp.

Brown Mite, *Bryobia pratensis* Garm.

Apple Plant-louse, *Aphis mali* Fabr.

Scale Insects (mostly on bark).

Grasshoppers.

##### Attacking Trunk and Branches.

Borers, Flat-headed, *Chrysobothris femorata* Fabr.

Borers, Twig, *Amphicerus bicaudatus* Say.

Buffalo Tree-hoppers, *Ceresa* sp.

San Jose Scale, *Aspidiotus perniciosus* Comst.

Putnam's Scale, *Aspidiotus ancylus* Putnam.

Scurvy Bark-louse, *Chionaspis furfurus* Fitch.

Oyster-shell Bark-louse, *Mytilaspis pomorum* Bousche.

Woolly Plant-louse, *Schizoneura lanigera* Hausm.

##### Attacking the Roots.

Woolly Plant-louse, *Schizoneura lanigera* Hausm.

#### INSECTS ATTACKING THE PEAR:

##### Insects in General.

Pear-tree Slug *Eriocampa cerasi* Peck.

Pear Leaf-blister, *Phytoptus pyri*.

Howard's Scale, *Aspidiotus howardi* Cockerell.

#### INSECTS INJURIOUS TO THE PLUM:

##### Attacking the Fruit.

Plum Gouger, *Coccotorus prunicida* Walsh.

Plum Curculio, *Conotrachelus nenuphar* Herbst.

##### Attacking the Foliage.

Fruit-tree Leaf-roller, *Cacæcia argyrospila* Walk.

Slugs, *Eriocampa cerasi* Peck.

Brown Mite, *Bryobia pratensis* Garm.

Plant-lice, several species.

##### Attacking Trunk and Branches.

Peach Borer, *Sannina exitiosa* Say.

Flat-headed Borer, *Chrysobothris femorata* Fabr.

Scale Insects, several species.

#### INSECTS INJURIOUS TO THE CHERRY:

Several species referred to.

#### INSECTS INJURIOUS TO THE PEACH:

Peach Twig-borer, *Anarsia lineatella* Zell.

Peach Borer, *Sannina exitiosa* Say.

Plant-lice.

#### INSECTS INJURIOUS TO THE GRAPE:

Achemon Sphinx, *Philampelus achemon* Drury.

Eight-spotted Forester, *Alypia octomaculata* Fabr.

Stem Borer, *Amphicerus bicaudatus* Say.

Tree Crickets, *Ecanthus* sp.

Cottony Scale, *Pulvinaria innumerabilis* Rath.

Grape Flea-beetle, *Graptodera chalybea* Ill.

Grape Leaf-hoppers, *Typhlocyba* sp.

Grasshoppers.

## INSECTS INJURIOUS TO THE CURRANT :

Imported Currant-borer, *Sesia tipuliformis* Clerk.Currant Saw-fly, *Pristiphora grossulariae* Walsh.

## INSECTS INJURIOUS TO THE STRAWBERRY :

Strawberry Leaf-roller, *Phoxopterus fragariae* W. & R.Strawberry Crown-borer, *Tyloderma fragariae* Riley.

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**INSECTICIDES.**

## INSECTICIDES. (Preparation and Use).

## Substances that Kill by Being Eaten.

1. White Arsenic.
2. Arsenic Bran-mash.
3. Paris Green.
4. Scheele's Green (Green Arsenoid).
5. Arsenate of Lead.
6. Arsenite of Lime.
7. London Purple.
8. Bordeaux Mixture.
9. White Hellebore.
10. Borax.

## Substances that Kill by External Contact.

11. Soap.
12. Whale-oil Soap.
13. Fish-oil Soap.
14. Kerosene Emulsion.
15. Kerosene-milk Emulsion.
16. Kerosene and Crude Petroleum.
17. Gasoline.
18. Turpentine.
19. Lye and Washing Soda.
20. Lime.
21. Lime, Salt, and Sulphur Wash.
22. Resin Soap (Summer Wash).
23. Resin Soap (Winter Wash).
24. Pyrethrum or Buhach.
25. Tobacco.
26. Sulfur.
27. Hot Water.
28. Carbon Bisulfide—"Fuma."
29. Hydrocyanic Acid Gas.

## Substances that Repel.

30. Naphthaline, Gum-camphor and Moth-balls.
31. Tobacco.
32. Ashes.
33. Lime, Plaster, and Road Dust.

## Insect Traps.

34. Lights.
35. Sweetened Water, Cider, Vinegar, Etc.
36. Bandages.
37. Hopper-dozer or Hopper-pans.
38. Sticky Substances.

## THE APPLICATION OF INSECTICIDES:

In the Dry Way.

In the Wet Way.

Pumps.

How to Spray.

# INSECTS AND INSECTICIDES.

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C. P. GILLETTE.

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Bulletin 47, treating of "Colorado's Worst Insect Pests and Their Remedies," is out of print. As there is much demand for a bulletin of a general nature treating of the insects that are most injurious in Colorado, and the methods by which they may be destroyed or kept in check, the present publication has been prepared. In the first part of the bulletin, dealing with insects injurious to Colorado fruits, it has been the plan to treat the more common insects only, and to treat each as briefly as possible and still give the necessary information to enable the farmer or horticulturist to decide what insect is doing the injury in a particular case, and what remedies he should use. The object of the second part of the bulletin, treating of the "Preparation and Use of the More Important Insecticides," is well stated in the title. Many substances that are rarely used, and others which are of little or no value, are not mentioned.

The insecticides are numbered in the order in which they are taken up. They are also referred to by number in the first part of the bulletin, which makes it easy to refer to them. When more than one remedy is mentioned, they are given in the order of their preference.

# PART I.

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## 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 about seven weeks later 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 4, 3, 6, 8, 7, 5.

The combination of Bordeaux mixture (8) with the arsenites is very popular farther east where fungus diseases are prevalent. The writer believes there is no occasion as yet to use Bordeaux mixture upon apple trees in Colorado except for the purpose of causing the poison to adhere better to the foliage.

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. If heavy storms follow to wash out the poison, make a third application as soon as the storm is over. Upon the thoroughness of the first and second applications the success will chiefly depend. Just what degree of success 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. Lights to trap the moths are valueless. Screen cellar windows and doors where fruit is kept.

Plate II., 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.

### ATTACKING THE FOLIAGE.

#### LEAF-ROLLERS.

The fruit-tree leaf-roller (*Cacæcia argyrospila*) is a green larva with a black head and measuring 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

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

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 (4, 3, 6, 8, 5) 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 are larger and loose or open and the caterpillars stay in them to feed.

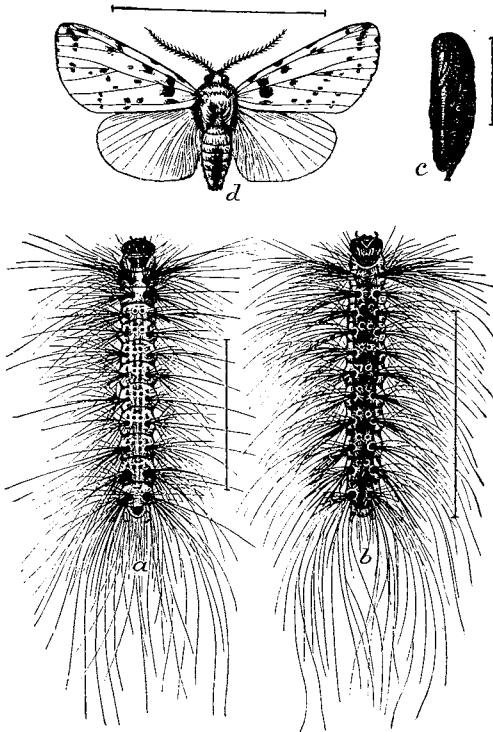


FIG. 1.—Fall Web-worm: *a* and *b*, caterpillars; *c*, chrysalis; *d*, moth.  
(Howard, Yearbook, U. S. Dep. of Agriculture, 1895.)

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. (*Clisiocampa 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 (4, 3, 6, 8, 5). 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. (32, 33).

BROWN MITE. (*Bryobia pratensis*.)

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 rust-colored 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 mali*.)

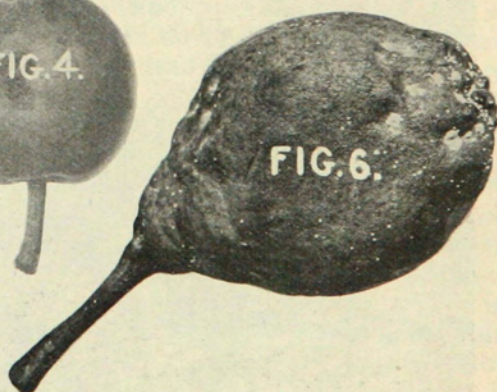
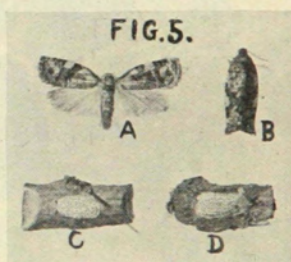
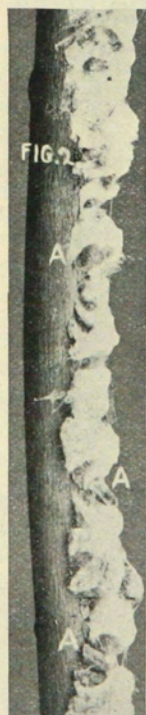
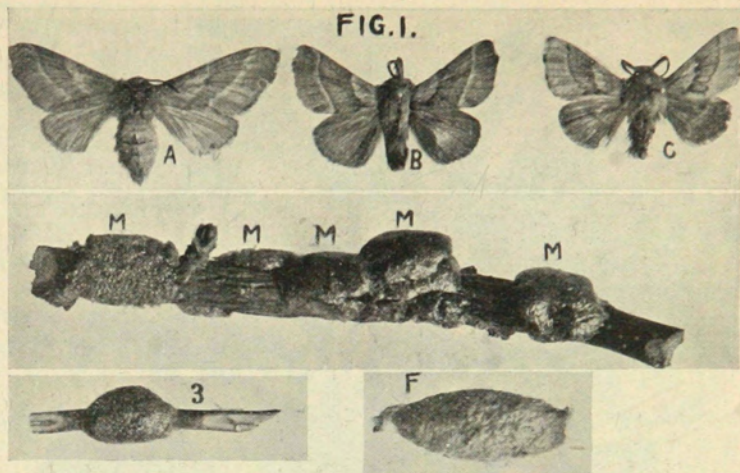
A green aphid curling the leaves of apple trees, most abundant late in the season, after the middle of July. See eggs on apple twig, Plate III., Fig. 4.

*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 directions. Specimens





# 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  $\frac{1}{4}$ .  
 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 size.  
 Figures from photos by the author.





PLATE 2.

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

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



of the scale should also be sent. Otherwise, use the treatment recommended for San Jose scale. See further on.

### 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 be quite largely kept out of the trees by arsenic bran-mash (2) used freely about the border of the

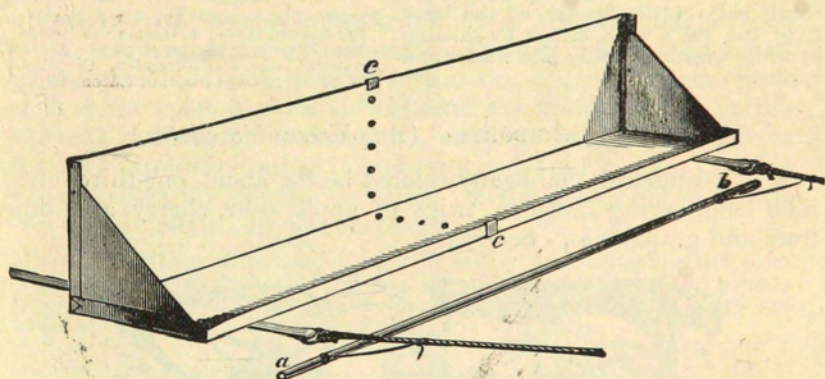


FIG. 2.—Hopper-dozer or Hopper-pan. (After Riley.)

orchard, and by sticky bands (38) of Raupenleim or printer's ink, or even cotton batting, about the trunks of the trees. If the Raupenleim or printer's ink is used, it should be spread upon a strip of cardboard which has first been wrapped about the trunk.

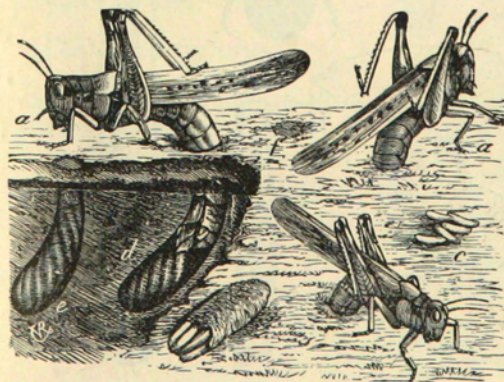


FIG. 3.—Rocky Mountain Locust, laying eggs in the ground: *a, a*, females with their abdomens in the ground; *b*, an egg-pod broken open; *c*, scattered eggs; *d*, egg-packet in the ground. (After Riley.)

Grasshoppers that injure orchards usually come from adjoining alfalfa or grass fields. In such cases the free use of the hopper-pan (37) 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.

### 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. 4.

**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.

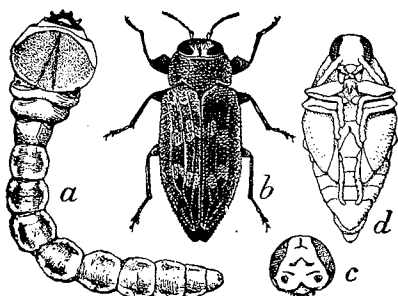


FIG. 4.—Flat-headed Apple-tree Borer: *a*, flat-headed larva; *b*, the mature beetle; *c*, head of mature beetle; *d*, pupa. All twice natural size. (Chittenden, Circular 32, U. S. Dep. of Agr., Div. of Entomology.)

### 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. 5.

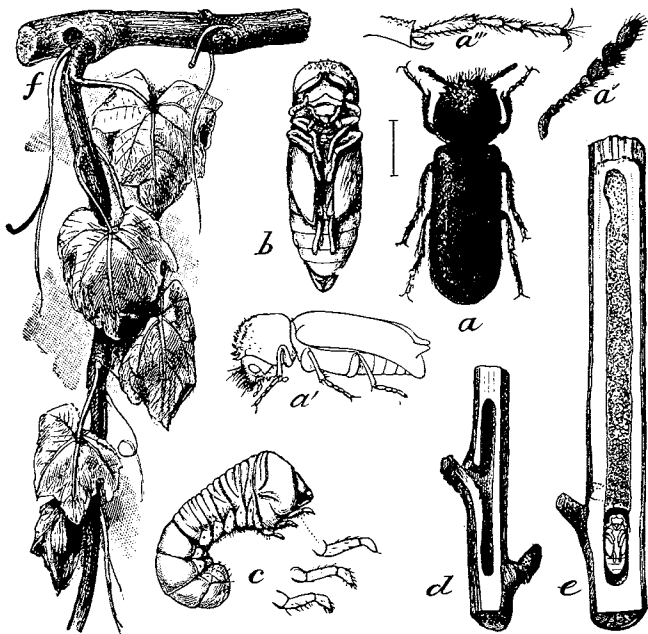


FIG. 5.—Apple Twig-borer: *a*, beetle dorsal view; *a'*, beetle side view; *b*, pupa from beneath; *c*, grub, side view; *d*, apple twig showing burrow; *e*, burrow in tamarisk with pupa at bottom; *f*, stem of grape showing burrow. All enlarged except stems showing burrows. (Marlatt, Farmer's Bulletin 70, Div. Ent., U. S. Dep. of Agr.)

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

BUFFALO TREE-HOPPERS. (*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 III., Fig. 3.

*Remedies.*—Infested twigs may be pruned away and burned. Probably clean culture is the best remedy. 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 rust-red 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, sulfur, and salt 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 ancylus*.)

Very closely resembling the preceding species. Remedies the same.

## SCURVY BARK-LOUSE.

(*Chionaspis furfurus*.)

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 same as for the San Jose scale.

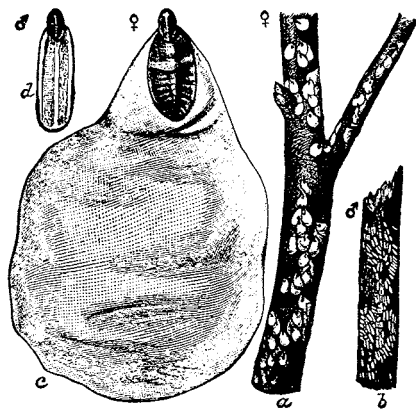


FIG. 6.—Scurvy Bark-louse: *a*, twig showing scales of female louse; *b*, twig showing scales of male louse; *c*, scale of female greatly enlarged; *d*, scale of male greatly enlarged. [Howard, Yearbook, U. S. Dep. of Agr., 1894.]

OYSTER-SHELL BARK-LOUSE. (*Mytilaspis pomorum*.)

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. 7.

Remedies the same as for the San Jose scale.

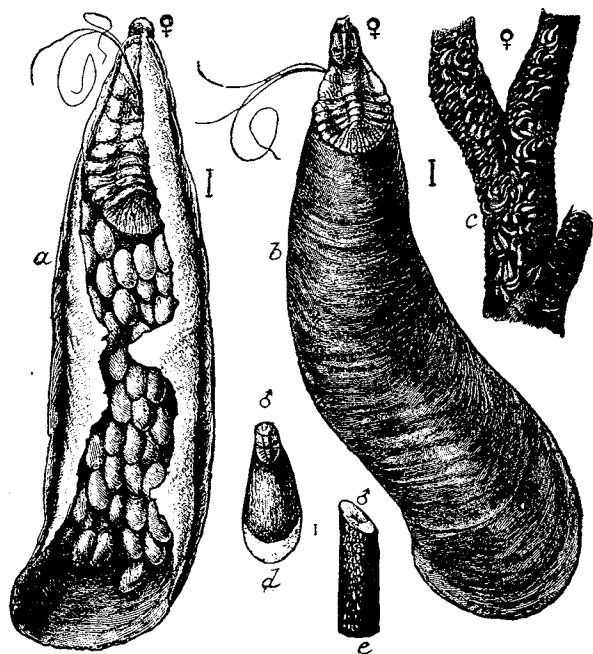


FIG. 7.—Oyster-shell Bark-louse: *a*, female scale from below, showing eggs greatly enlarged; *b*, the same from above; *c*, female scale on twig, natural size; *d*, male scale enlarged. [Howard, Yearbook, U. S. Dep. of Agr., 1894.]

#### WOOLLY PLANT-LOUSE. (*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.

*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 strengths 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. 8.

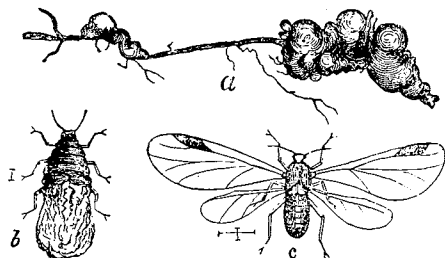


FIG. 8.—Woolly Aphis, root form: *a*, small root showing swellings caused by the lice; *b*, wingless louse showing woolly secretion; *c*, winged louse. (After Saunders.)

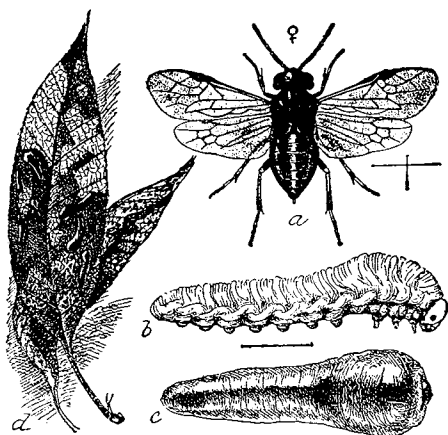
**ATTACKING THE ROOTS.**WOOLLY PLANT-LOUSE. (*Schizoneura lanigera*.)

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. 8). 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. (*Eriocampa cerasi*.)

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.

*Remedies.*—Apply white hellebore, or any of the arsenical mixtures (3-8), by dusting or by spraying. Freshly slaked lime (20) or wood ashes (32) freely dusted upon the larvæ will kill many of them.

This is an easy insect to control and should not be allowed to continue the serious injuries to the pear, plum and cherry in this State that 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. 9.—Pear-tree Slug: a, adult fly; b, larva or slug with the 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.*—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, salt and sulfur mixture. Gather and burn as many of the fallen leaves as possible.

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

Was found attacking pears badly in an orchard near Delta, Colo., last summer. This is a close relative of the pernicious, or San Jose scale, but, so far, has been known only 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.

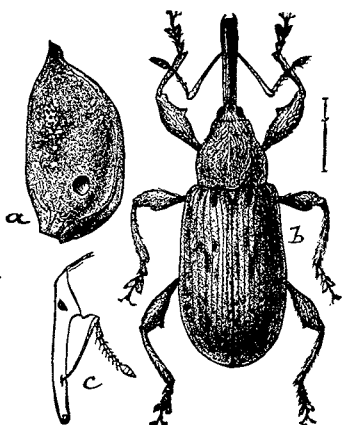


FIG. 10.—Plum Gouger: *a*, plum pit showing hole for exit of gouger; *b*, gouger; *c*, side view of head of gouger showing beak and antenna. (Riley & Howard, *Insect Life*, Vol. II., U. S. Dep. of Agr., Div. of Entomology.)

## 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 ochreous 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 flesh on the kernel and later eats a hole out through both pit and flesh of plum just before the plum matures (Fig. 10). Attacks the red, or Americana varieties only. 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 (4, 3, 6, 7, 5, 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

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



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 to the European varieties of plums what the codling moth is to the apples, only worse. 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 his orchard, it is hoped he will notify the Experiment Station at once.

### ATTACKING THE FOLIAGE.

FRUIT-TREE LEAF-ROLLER. (*Cacæcia argyrospila*)

See under apple insects. Use the poisons only two-thirds as strong on the plum as on the apple. Arsenate of lead is probably 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. (*Sannina 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. Howard's scale and Putnam's scale both occur on plum in the State. They have been injuriously abundant in a few isolated cases only.

## 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.

## INSECTS INJURIOUS TO THE PEACH.

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

This is the worst peach enemy 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 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, salt 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, 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 (36) used as for the codling moth.

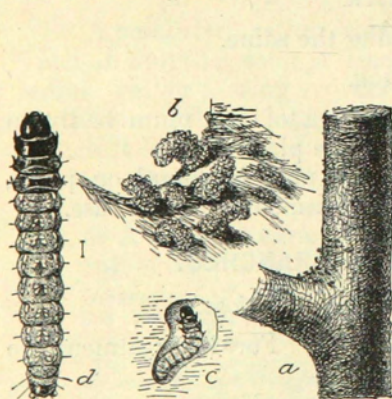


FIG. 11.—Peach Twig-borer: a, twig of peach showing little masses of chewed bark above the larval burrows; b, the same enlarged; c, larva in winter burrow, enlarged; d, hibernating larva greatly enlarged. (Marlatt, Bulletin 10, N. S., U. S. Dep. of Agr., Div. of Entomology.)

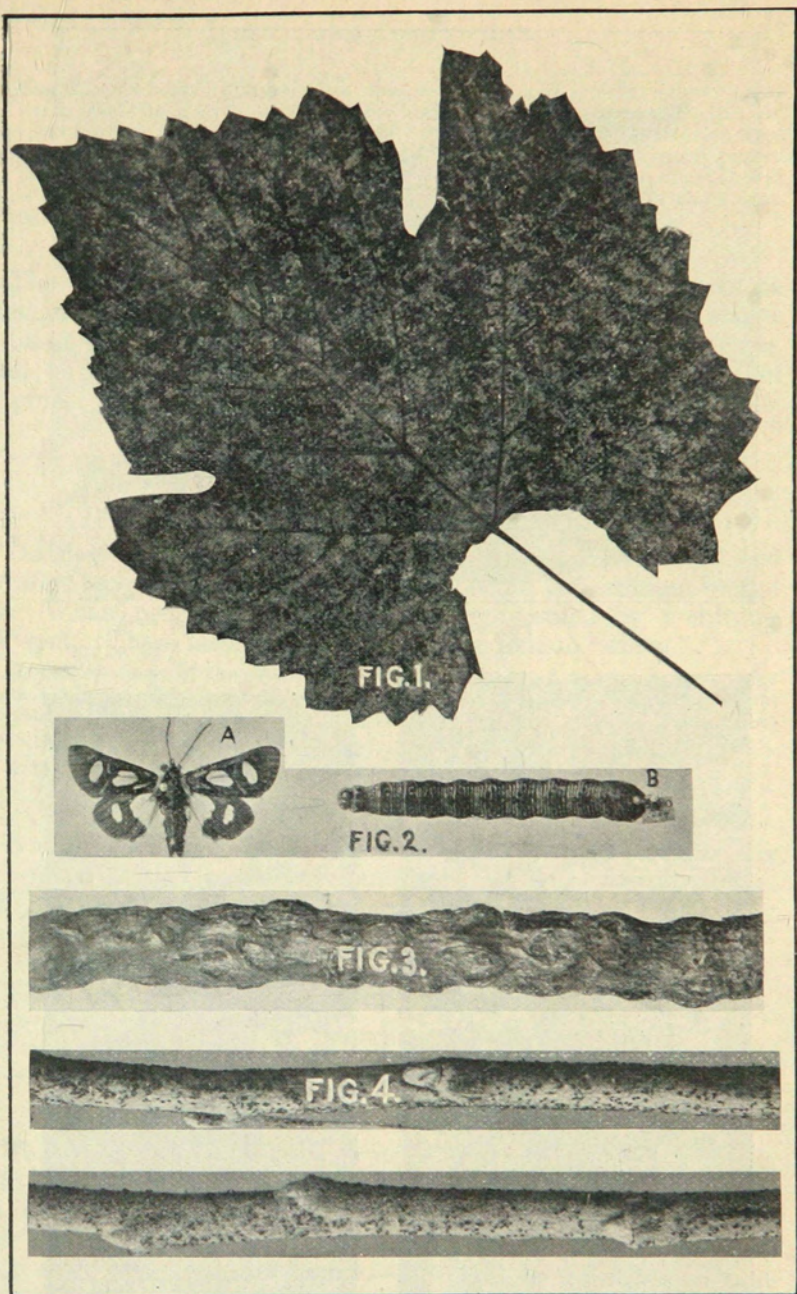


FIG. 12.—Peach Twig and Borer: a, young shoot wilting from attack of borer; b, adult larva enlarged; c, chrysalis enlarged; d, tail end of chrysalis showing hooks. (Marlatt, Bulletin 10, N. S., U. S. Dep. of Agr., Div. of Entomology.)

### THE PEACH BORER.

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





### PLATE 3.

FIG. 1—Grape leaf showing bleached appearance due to grape-leaf hopper (*Typhlocyba*).

FIG. 2—Eight-spotted Forester (*Alypia 8-maculata*): A, moth; B, larva. Nearly life size.

FIG. 3—Apple twigs injured by Tree-hopper (*Ceresa* sp.). Life size. Photos by author



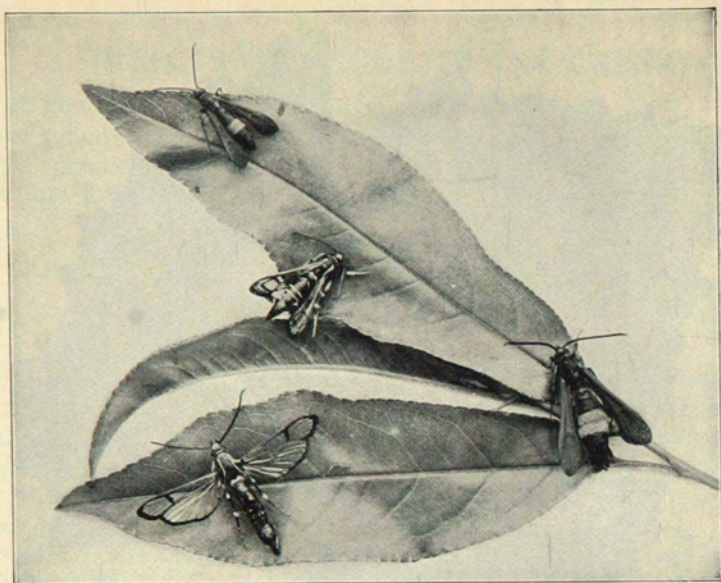


FIG. 1—Moths of Peach Borer.



FIG. 2—Peach tree bandaged with paper.



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

*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 May till the 10th of July will serve as a means of protection from egg-laying. The paper screen is the better. (See Plate IV., 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 louse of the apple.

## INSECTS INJURIOUS TO THE GRAPE.

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

Hairless caterpillars devouring the leaves. When small, the caterpillars have each 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 may be used as recommended for apple leaf-rollers. Pyrethrum (24) may also be used as a 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 III., Fig. 2.

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

This insect also infests the Virginia creeper.

#### 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.*—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 Pyrethrum (24).

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 III., 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 (37) 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 IV., Fig. 1.

*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.

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 (24) may be safely used at any time.

## INSECTS INJURIOUS TO THE STRAWBERRY.

### STRAWBERRY LEAF-ROLLER. [*Phoxopteris fragariæ*.]

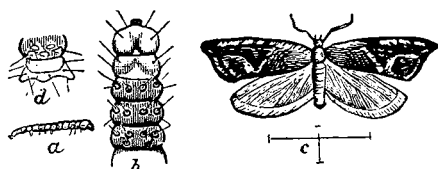


FIG. 13.—Strawberry Leaf-roller: *a*, larva, natural size; *b*, head end of larva enlarged; *c*, moth about twice natural size; *d*, tail end of larva enlarged. (After Saunders.)

Small brownish or greenish larvæ 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 markings on the wings. See Figs. 13, 14.

**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 fragariæ*.]

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 frequently as soon as the berries are picked and start a new bed at some distance from the old one. Poisons are of doubtful value.

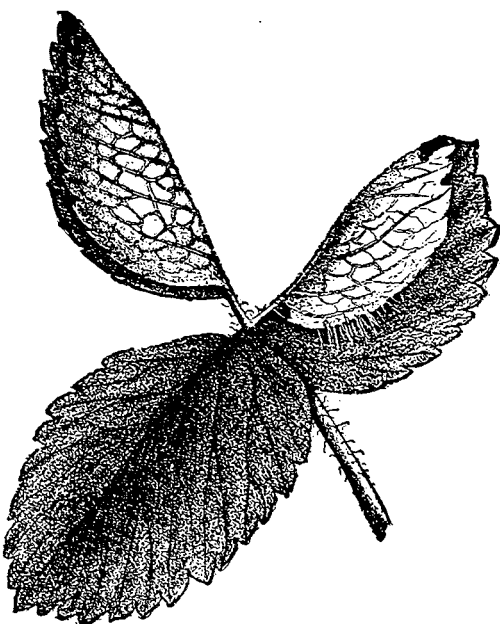


FIG. 14.—Strawberry leaves showing their appearance after being folded by the roller. (After Weed.)

## 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 plant-lice, 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 are 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-sulfur and salt 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 weevil 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, such as lime, copper and lead. Because some States have passed laws requiring a high percentage of arsenic in Paris green, arsenic has been used as an adulterant of Paris green 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 six to ten 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.

## 3. PARIS GREEN.

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, and the reports of many analyses in different States do not indicate that 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.*—The arsenical mixtures are usually applied in a watery spray, and the most common strength is:

Paris green .....	1 pound
Water .....	160 gallons
Lump lime (freshly slaked) .....	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 the 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 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 .....	20 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 will drive the worms to eat their way into the apple, where they will probably 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 an important place to fill, but I doubt very much if 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 25 per cent. of arsenic acid, but has some 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 takes the form of a flocculent precipitate that remains suspended a long time without settling, 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 in its not being as destructive to 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 proportion of three pounds of the former to seven pounds of the latter. Then use not less than two or three pounds of the combined chemicals to each hundred gallons of water. Three or four times this strength will do no harm to foliage.

#### 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 sal-soda for fifteen minutes in two gallons of water. Put into a jug and label '*poison*,' and lock it up. When ready to spray, slake 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 .....	2 pounds
Water .....	3 gallons

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

These preparations have become very popular in the past two 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, unslaked 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 slaked 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 does Paris green, 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 fungi that attack the surface of 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.

#### 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 a European plant, *Veratrum album*. It is not as poisonous as the arsenites and consequently 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. There are two kinds of soap that are specially useful for the destruction of insects, and these are whale-oil soap and fish-oil soap.

#### 12. WHALE-OIL 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.

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. Before 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 very 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 contains 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 laundry 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. The 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 farther 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 to fifteen or twenty.

Pumps are now made for the purpose of mixing the oil and water in the form of a spray, and so doing 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.

#### 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 only 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 is said to be very effectual in destroying them. Experiments at this Station have not succeeded very well 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 are used in the following proportions:

Lump lime .....	30 pounds
Sulfur .....	20 pounds
Salt .....	15 pounds
Water .....	60 gallons

Put all together in a barrel or other receptacle and boil for four or five hours. If a wooden receptacle is used, steam boil. Strain through a coarse cloth to take out coarse lumps, and apply as a spray while hot.

## 22. RESIN SOAP (SUMMER WASH).

A resin soap for summer use may be prepared in the following proportions:

Resin .....	2 pounds
Caustic soda .....	1 pound
Tallow .....	1 pound

Dissolve the soda in one and one-half gallons of water; then add the resin and tallow and dissolve them also by applying a moderate degree of heat, adding water enough to make three gallons. Before using, dilute one part of the soap with sixteen parts of water.

Used for the same insects as are whale-oil soap and kerosene emulsion.

## 23. RESIN SOAP (WINTER WASH).

*Resin .....	30	pounds
Caustic Soda (70 per cent.) .....	9	pounds
Fish-oil .....	4½	pints
Water .....	100	gallons

Place the first three ingredients in an iron kettle and cover with five or six inches of water. Boil for an hour or two until the liquid has a dark brown color, after which the remainder of the water may be added.

Other formulæ for the preparation of resin soaps have been given, but as they are not much used, I will not take space to give them here.

## 24. PYRETHRUM, OR BUHACH.

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 the application and 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.

## 25. 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 animal and plant 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 aphis on the roots of apple trees.

A decoction made by boiling tobacco stems in an amount of water sufficient to cover them is destructive to plant lice (*Aphididæ*) and to lice upon cattle. Tobacco, very finely powdered, in the form of

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\*This formula and directions are copied from "*The Spraying of Plants*," by Lodeman.

snuff, may also be used dry against the same insects. It is best to first spray the insects with water.

#### 26. 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 water or soap solutions in the proportion of an ounce to a gallon of the liquid and applied as a spray.

#### 27. HOT WATER.

Water heated to 125 to 135 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.

#### 28. CARBON BISULFIDE; "FUMA."

This is a clear, extremely volatile liquid with a very disagreeable odor. 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.

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 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 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.

#### 29. 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 plan of fumigating all their nursery stock with hydrocyanic acid gas before shipping to their customers.

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 that 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. Figs. 16 and 17 are from this book.

### **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.

#### **30. 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.

#### **31. 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.

#### **32. 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 distasteful, so the insects are driven to other plants.

#### **33. 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.

### **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.

## 34. 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 and the corn or boll-worm.

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 considerable importance as a means of lessening the injury to crops by the destruction of insects.

## 35. 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 overestimated by those who use them.

## 36. 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 be not 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 25th of June in the northern parts.

Heavy paper may be used in place of the cloths.

The peach twig-borer can also be taken under these bands.

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

### 37. 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 fields by two men or two horses. In the bottom of the pan is placed a small amount of water with kerosene on top of 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.

### 38. STICKY SUBSTANCES.

Bandages of sticky substances, such as printer's ink, "Dendroline," or "Raupenleim," 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.

### IN THE DRY WAY.

The upper surface of the leaves of all low plants can be easily treated with a dry insecticide by dusting it upon them through a cheesecloth, or other thin muslin sack, held in the hand. There are also various appliances upon the market for the distribution of powders. One of these that is very convenient for filling the air of a room with dust to kill flies, or for the application of powders to low herbage, is shown in Fig. 15. It can be had of Thomas Woodason, 451 East Cambria Street, Philadelphia, Pa.

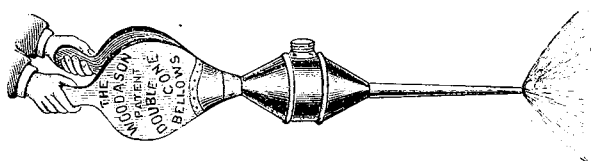


FIG. 15.—Dust-sprayer.

The Hillis Dust Sprayer Co., St. Louis, Mo., manufacture a

"dust-sprayer" large enough to distribute dry insecticides through trees of the size of an ordinary apple tree.

#### IN THE WET WAY.

There are so many manufacturers of spray pumps and nozzles of all descriptions that it is impossible to point out any make as being the best. The illustrations here given are for the purpose of giving the reader an idea of the kind of a pump that will be needed for his work. Each must be his own judge as to the quality and price of the pumps offered him.

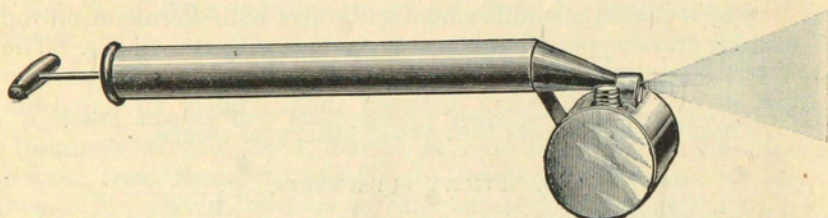


FIG. 16.—"Faultless" Hand Atomizer.

Fig. 16 is an illustration of the "Faultless Sprayer, manufactured by F. E. Myers & Bro., Ashland, Ohio. It is inexpensive and will answer well where only a few small plants are to be treated.

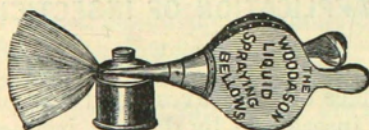


FIG. 17.—Bellows Atomizer.

Fig. 17 shows a form of atomizer, having a similar use, also sold by Woodason, of Philadelphia.

#### 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 the same help, but with a greater expenditure



of energy. 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. Fig. 18 illustrates a form of bucket pump manufactured by The Deming Company, Salem, Ohio. 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 vegetables, shrubbery and all low plants, but should not be purchased for orchard work if one has more



FIG. 18.—Bucket Pump.



FIG. 19.—Leggett's Air-pressure Pump.

than a very few trees to treat. In the small sprayer shown at Figure 19 the liquid is forced up by means of air pressure. Such a pump is often convenient when a person is compelled to do his spraying alone. This sprayer also has an oil attachment, so that water and kerosene may be applied mixed without the trouble of making an emulsion. This pump is manufactured by Leggett & Brother, New York City.

Fig. 20 shows a form of air-pressure sprayer sold by the North Jersey Nurseries, Springfield, N. J.

Many prefer some form of the knapsack sprayer for the treatment of low plants. At Fig. 21 is shown one of these sprayers as sold by William Stahl, Quincy, Ill. Knapsack sprayers are also

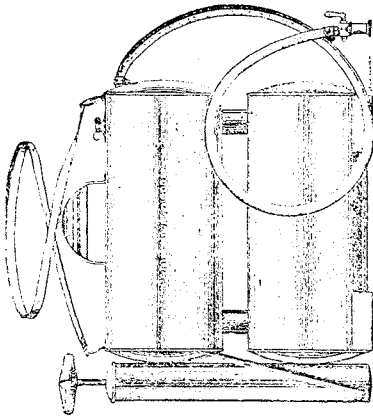


FIG. 20.—Another form of Air-pressure Pump.

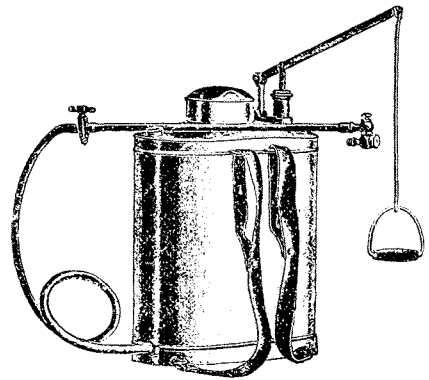


FIG. 21.—Knapsack Sprayer.

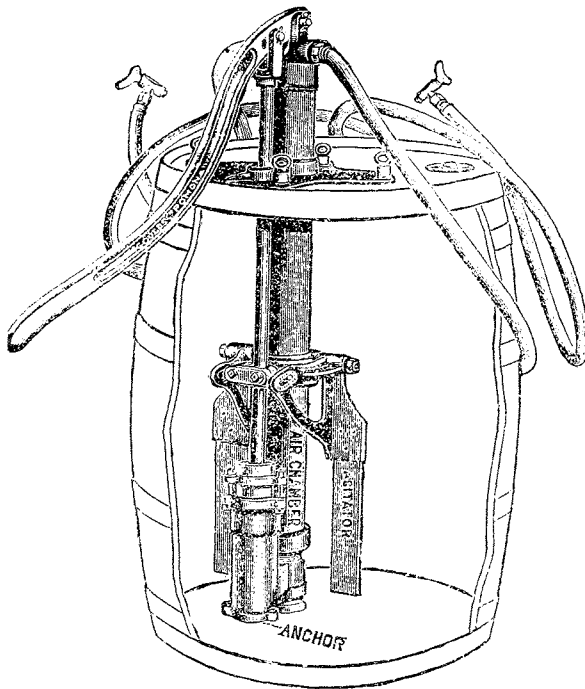


FIG. 22.—Barrel Pump.

made with an oil tank attached so as to spray kerosene, or petro-

leum, in a mechanical mixture along with water, so as to do away with the need of making an emulsion.

For the treatment of small orchards a barrel pump is generally used. One of the best of these is Gould's "Pomona" spray pump shown in Fig. 22. The pump carries two leads of hose and has a patent agitating arrangement within the barrel. It is sold by The Gould Manufacturing Co., Seneca Falls, N. Y.

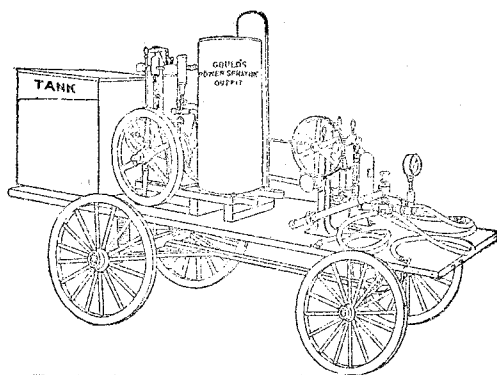


FIG. 23.—Power Pump. Run by Gasoline Engine.

Where a large amount of orchard spraying is to be done larger pumps and tanks should be used. Fig. 23 shows a gasoline power sprayer attached to a large wagon tank. Such sprayers will easily run four leads of hose and keep up a high pressure. Without a good pressure it is impossible to throw a fine and forcible spray. The power sprayer here shown is also manufactured by The Gould Manufacturing Co. There are many other companies manufacturing spraying apparatus. Their advertisements will be found in agricultural papers. If anyone is thinking of purchasing an expensive spraying outfit he should obtain catalogues and prices from several manufacturers or dealers and then purchase where he thinks he can do best.

### 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. A very fine spray is most economical of material and, for an even and thorough distribution, is best. Care should be taken, also, not to continue the spraying until the little drops that collect on the foliage unite and run off, carrying the poison with them. In some cases, however, as when spraying the first and second times for the codling moth, the writer prefers a rather coarse spray and to continue until the calyces of the forming fruits have all been thoroughly drenched without regard as to how much the liquid is dripping from the foliage. The medium coarse spray is preferred for this work, because the larger drops carry better into blossoms, or calyces, of the apples.

The "Seneca" nozzle sold by the Gould Manufacturing Co. and shown at Fig. 24 throws a good coarse spray. The "Borde

nozzle shown at Fig. 25 and sold by The Deming Co. is one of the

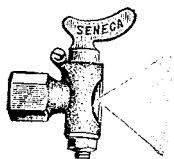


FIG. 24.—Seneca Nozzle.

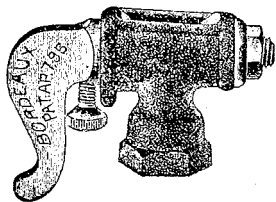


FIG. 25.—Bordeaux Nozzle.

best nozzles for either coarse or medium fine spray. For a very fine, misty spray I know no nozzle that equals the "Vermorel." This nozzle is mounted singly, as shown in Fig. 26, or in batteries of two, three or four nozzles combined. A battery of two nozzles is shown at Fig. 27. Figs. 26 and 27 are from the catalogue issued by the Gould Manufacturing Co.

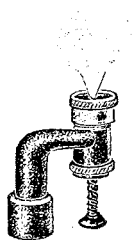


FIG. 26.—Single Vermorel Nozzle.

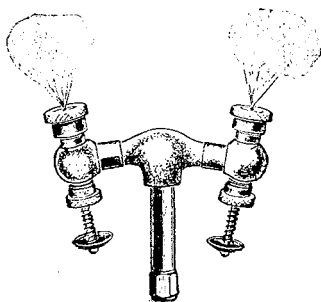


FIG. 27.—A Battery of two Vermorel Nozzles.

For farther information in regard to insects or insecticides address the Experiment Station. When making inquiries concerning insects, send samples of the insects and their injuries whenever possible.