
The Agricultural Experiment Station

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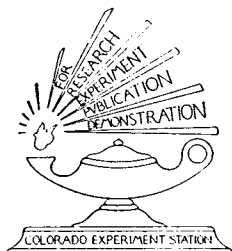
Colorado Agricultural College

INSECTS AND INSECTICIDES

Being a Revised Edition of Bulletin 114

—BY—

C. P. GILLETTE and GEO. M. LIST



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INSECTS AND INSECTICIDES

By C. P. GILLETTE and GEO. M. LIST

INTRODUCTION

The purpose of this bulletin is to furnish brief information regarding the insects that are most frequently found doing destructive work on small fruits, orchards, shade trees and shrubs of this State.

The aim has been to give a concise description of the insects and the treatments that have been found to be most successful in controlling them. The arrangement is not according to the scientific classification of the insects, but according to their host plants.

Part II, on "The Preparation and Use of Insecticides", has been made as brief as possible and only the formulae that are in accordance with the best practice are given. Throughout the first part, the insecticides are referred to by number, for sake of brevity.

If you are in doubt as to the pest that is annoying you, feel free to write the Experiment Station and send specimens for identification. Place the insects in a box, along with some of their food, and then write us what information you can as to their work and habits.

PART I.

INSECTS INJURIOUS TO TREES, SHRUBS AND SMALL FRUITS

APPLE AND PEAR FRUIT

CODLING MOTH.—This insect probably does more damage to the apples and pears of the State than all other insects combined. Most orchard men are very familiar with the flesh-colored larva that eats into the apple and causes the wormy fruit, but few are familiar with the moth that lays the egg from which this larva hatches. It is a small grayish-brown moth resembling the color of the apple bark and has a wing expansion of from one-half to three-fourths of an inch. It flies mostly in the twilight and is not attracted by light. It flies with a zig-zag motion and does not remain long on the wing.

The larvae pass the winter in tough silken cocoons under the rough bark, in crotches of the trees, in cellars and packing houses, in fruit boxes, and in rubbish on the ground. The moths begin to emerge as the blossoms fall from the trees, and soon begin to lay their eggs upon the upper surface of the leaves near the small fruit. Later in the season, when the fruit is larger and the fuzz has been rubbed off, many eggs are placed directly upon the fruit. Our records show that about 65 percent of the little larvae of the first brood, and 40 to 50 percent of the second, enter the calyx as soon as

they hatch from the eggs. The larvae feed in the fruit for about 21 days, then crawl down the tree to hide while they pupate and change to moths. There are two broods a year in Colorado. It takes about 50 days for one complete generation to develop from egg to egg or moth to moth. See Plate 1.

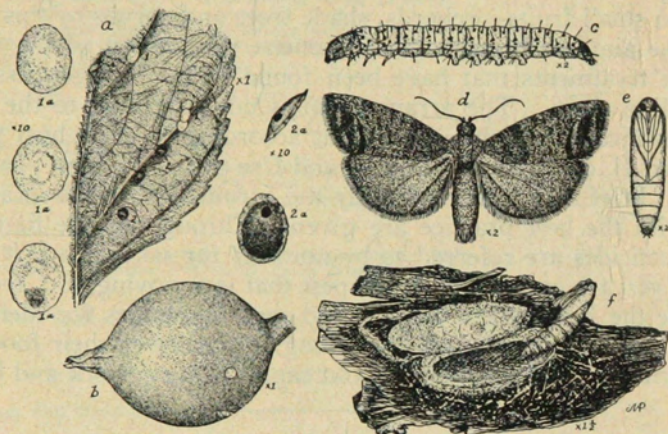


PLATE 1.—Codling Moth in its different stages: a, eggs upon a leaf; a 1, eggs natural size; 1 a, eggs much enlarged; upper 1 a, a newly laid egg; middle 1 a, the appearance of the egg after 4 or 5 days, showing the flesh-colored ring of the embryo, lower 1 a, showing the outline of the small larva, the dark spot being the head (an egg in this stage would hatch in a day or two); a 2, eggs parasitized by *Trichogramma minutus*, a very small 4-winged fly that deposits its eggs within those of the codling moth; 2 a, parasitized codling moth eggs much enlarged, showing holes made by the parasites as they leave the eggs; upper 2 a, side view of parasitized egg; b, egg natural size upon an apple; c, codling moth larva; d, codling moth; e, chrysalis or pupa; f, cocoon and chrysalis. Figures a1 and a2 and b, natural size; 1 a and 2 a, enlarged 10 times; c, d, and e, enlarged 2 times; f, enlarged $1\frac{1}{2}$ times. Original. Miriam A. Palmer, Delineator.

Remedies.—Remedies 2, 4, 5, and 29 are used against this pest. The arsenical poisons are most effective, and of these arsenate of lead is most generally used, in the proportion of 3 to 4 pounds of the paste to each 100 gallons of water. As a large percent of the little worms enter the calyx of the fruit, it will readily be seen that careful attention should be given toward destroying these. The sole purpose of the first spray is to get poison into the calyx cups that these little worms will be poisoned as they try to enter the apple. This spray should be applied just after the blossoms fall, and before the calyx lobes close. There are only a few days when the fruit is in the proper condition to receive this spray. Continue the application until every calyx is filled with the liquid. Large trees will require from 8 to 16 gallons for a thorough treatment. See Figs. 1 and 2.

Much has been written in regard to the so-called one-spray method of controlling the codling moth. It consists in putting on this first spray very thoroughly. This seems to be sufficient in some sections of the country, but in most parts of this State, where

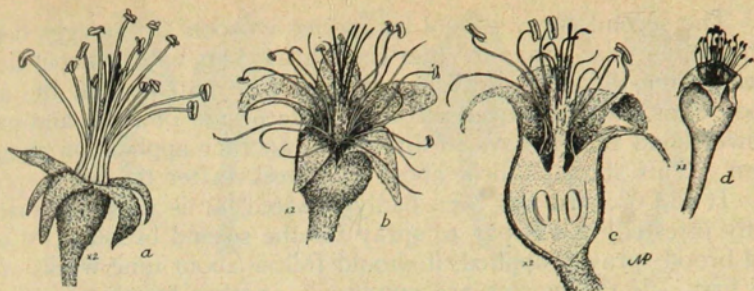


Fig. 1.—a, small apple from which the petals have just fallen. Effective spraying for the codling moth may be done in this stage, but it is not in as good condition for receiving the spray as b. b, small apple in the proper condition to receive the first spray for codling moth. The calyx-lobes have begun to close and form somewhat of a cup for holding the liquid and the stamens have begun to dry and will allow the liquid to enter the inner part of the calyx cup. c, cross section of b, showing the calyx cup, all parts of which must be covered with the spray to effectively poison the worms. d, pear in condition to receive the spray. Original. Miriam A. Palmer, Delineator.

the second brood is several times as large as the first, it will usually bring disappointing results. By this method, it is possible to poison the 65 percent that enters the calyx, but it gives little or no protection against the remaining 35 per cent that enter the side of the fruit.

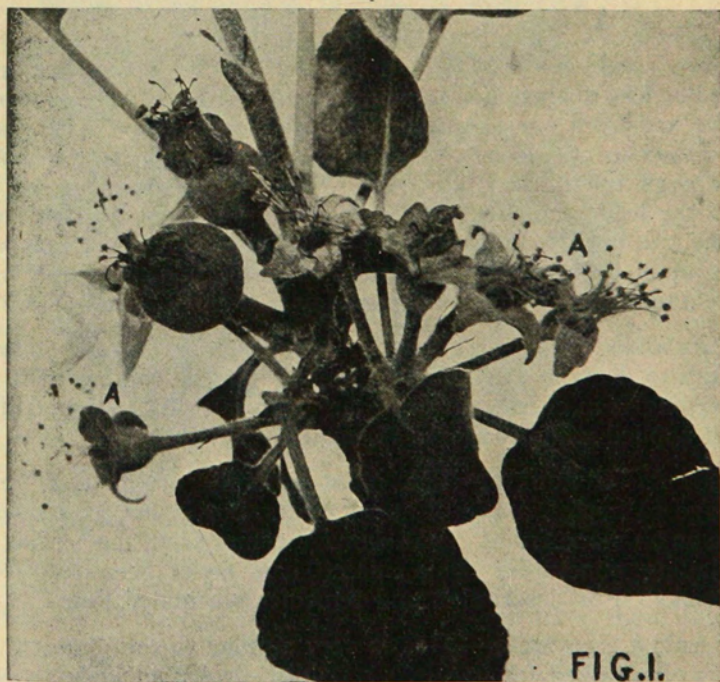


Fig. 2.—Blossoms from which the petals have fallen and which are still in good condition to receive the spray. The calyxes of the two larger ones have closed. It is too late to effectively apply the calyx spray to them.

The second spray should be applied as soon as the eggs begin to hatch, and the larvae to enter the fruit. This will be about three weeks after the first spray is applied. The hatching of the first brood eggs continues over a considerable period of time, and most growers find that it pays to direct still another application against them. This should follow about two weeks after the other spray.

If the orchard has been badly infested, or is near one that is badly infested, it will pay to spray for the second brood. If a second brood spray is applied, it should follow about nine weeks after the first. If the worms are numerous, another treatment may be made in two weeks. All sprays after the first are to cover the surface of the fruit with poison.

Remedy No. 29, that of using bands, is a great help in keeping this pest under control.

FRUIT-TREE LEAF ROLLER.—This pest often blemishes and even destroys much fruit early in the season. The little larvae begin to feed freely about the time the apples begin to form. Entire clusters of fruit may be destroyed then, or be so blemished that they will be of no value. See Plate 2.

For remedies, see under Foliage.

GREEN FRUIT WORM.—This is a large green caterpillar with a narrow, cream-colored stripe down the middle of the back, and a wide but less distinct line down each side. When fully grown, the larvae are from one to one and a half inches long. There is but one brood in a season. The moths appear in the spring and lay their eggs upon the fruit trees. The larvae hatch out and feed upon the leaves and fruit. The blemished fruit will often remain on the tree until picking time, but will show the scars. This worm feeds upon most of the tree fruits, but is most often found on the apple and pear. It feeds during May and early June.

Remedies.—The fruit worm very seldom gets numerous enough to demand attention. Spraying for the codling moth aids in keeping it in check. Any of the arsenicals will be found effective if applied while the larva is small.

PLUM CURCULIO.—The plum curculio often does serious damage to apples, and will attack pears, but is not as serious on these as on stone fruits. The damage comes from the feeding and egg-laying punctures. This insect has never been reported in Colorado. For description and remedies see under Plum.

APPLE CURCULIO.—This is very similar to the plum curculio and is often taken for it. It is a reddish brown snout-beetle about one-quarter inch in length with a snout or beak one-half as long as the body. It can be distinguished from the plum curculio because

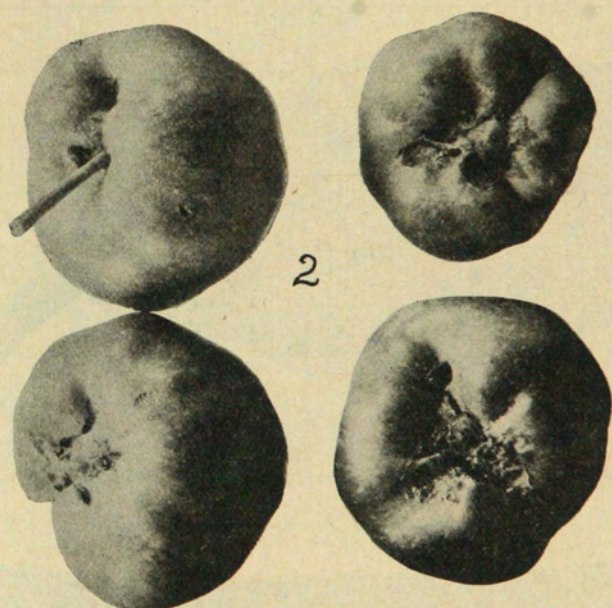


PLATE 2.

Fig. 1.—Apples picked on June 8, when they were from five-eighths to three-quarters of an inch in diameter, showing the characteristic injury from leaf-roller. Figure 2, apples picked from same orchard on August 9, when they were about two inches in diameter. Original in Circular 5, Office of state entomologist.

it is smaller and has two humps on each wing cover, while the plum curculio has only one. The beetles hibernate under grass, or any rubbish about the orchard, and appear on the trees about the time the petals fall, and begin to feed upon the young apples. The females begin laying eggs in the apples when the latter are about one-quarter inch in diameter. A puncture is made with the beak, the pulp eaten out and the egg deposited in the cavity. The food

punctures are similar to those made by the plum curculio. The cells about the punctures are destroyed, the growth stops and a deformed apple is the result. The female seals the egg punctures with excrement and does not cut a crescent-shaped mark about them, as does the plum curculio. There is but one brood a season.

Spraying with arsenicals will destroy a few of the curculios, but best results are obtained by destroying all hibernating places and cultivating the soil. They are always worse in thick, unpruned and uncultivated orchards.

SAN JOSE SCALE.—If an apple or pear tree is infested with this pest the fruit is very likely to show scarlet blotches about one-eighth of an inch in diameter, in the center of each of which will be found

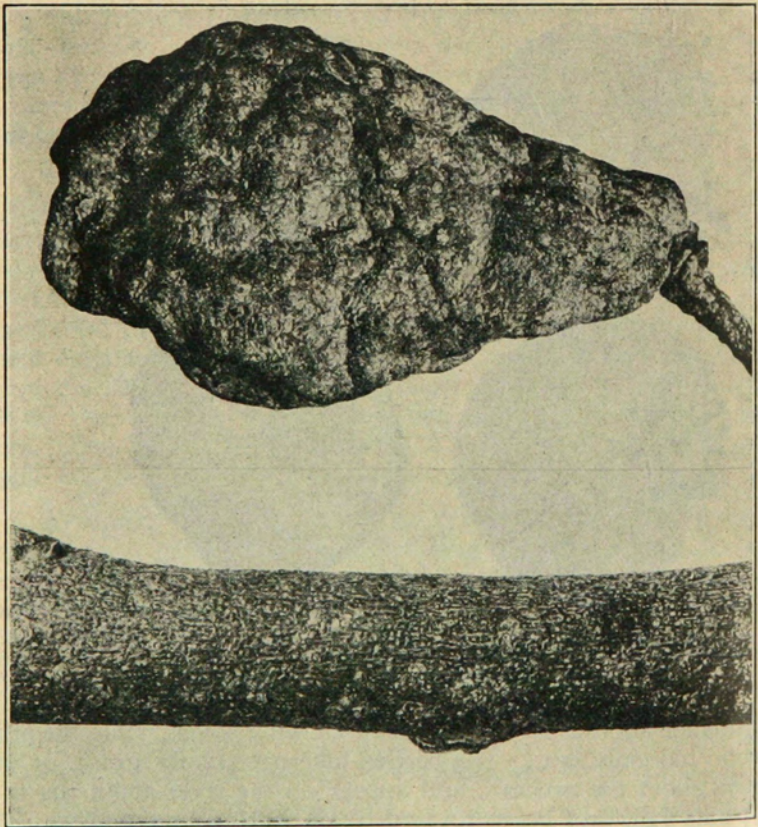


Fig. 3.—The San Jose scale on pear and willow. Note the roughened surface of the pear. Natural size. (After O. E. Essig, "Injurious and Beneficial Insects of Calif." Calif. State Com. of Hort.)

one of the scale insects. This is one of the best means of detecting an infestation in an orchard. On pears, it will make more or less of a depression, but without the scarlet color being so pronounced. For remedies see under Bark and Wood. See Figs. 3 and 4.

PUTNAM SCALE.—This is occasionally found on fruit. See under Bark and Wood.

HOWARD SCALE.—The Howard scale quite often attacks apples and pears. It is often difficult to distinguish this from the San Jose scale. The scarlet color on the fruit shows to some extent but is not as characteristic as with the San Jose scale. On pears, the depressions under the scales are usually well marked. See Plate 3. See Bark and Wood for remedies.

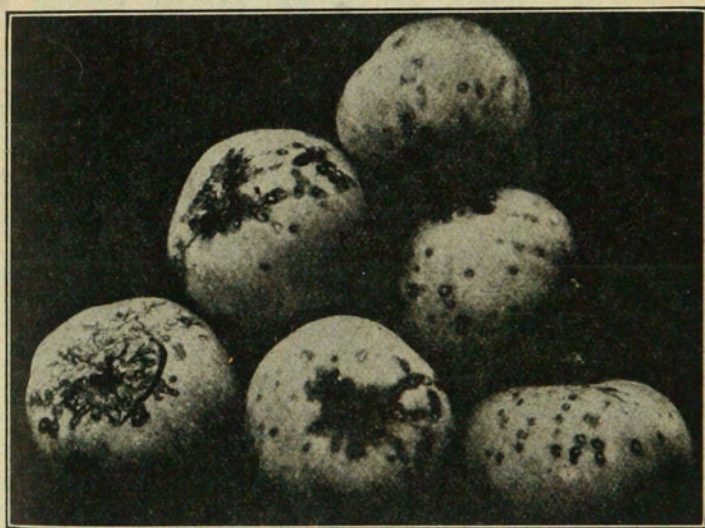


Fig. 4.—San Jose Scale on apples. Note the characteristic reddish blotches around the scales. Reduced (After Britton).

FOLIAGE

FRUIT-TREE LEAF-ROLLER.—This has been a serious pest in one or two sections of the State, where entire orchards have been largely defoliated. It feeds upon all of our fruit trees, with the exception of the peach, and upon many shade trees. It passes the winter in the egg stage. The eggs are deposited upon the twigs and the bark of the trees in masses varying from 25 to 100 or more. The female covers the eggs with an impervious gummy substance, which protects them and gives them a brown or grayish color. They begin to hatch as the buds begin to open and the little worms enter the buds and tie the leaves together with webs. As the leaves

grow they roll up, forming a nest in which the caterpillars feed. The larvæ eat fruit as well as leaves, if any should be enclosed within their nest. As the leaves get larger often a single leaf will be rolled to form a nest.

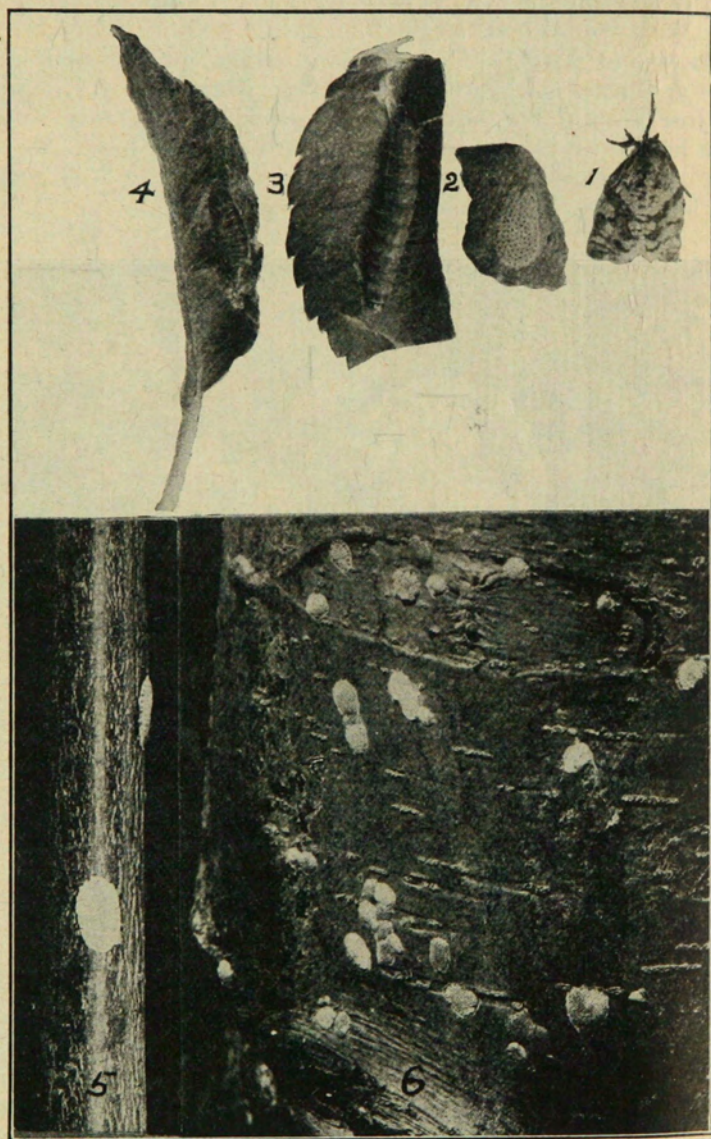


PLATE 4.—Fig. 1.—Adult leaf-roller moth; figure 2, hatched egg, mass on bark; figure 3, adult larva; figure 4, pupa; figure 5, light-colored egg masses on bark; figure 6, thirty-five hatched egg masses in a space of twelve square inches. (Original in Circular 5, Office of state entomologist.)

The larvæ feed for about four weeks. When mature they are light green in color, with brown or black head and legs, and they are very active if disturbed.

Pupation takes place within the nest, only a very delicate cocoon being made. The moths emerge in about ten to fourteen days and soon begin laying eggs. There is but one brood a year. See Plate 4.

Remedies.—Best results have been secured by a thorough application of miscible oil, one part in nineteen parts of water, made early in the spring before the eggs begin to hatch. Kerosene emulsion failed to give the same results.

Many of the young caterpillars can be killed by the use of arsenate of lead, 5 or 6 pounds of paste in 100 gallons of water. Make the first application just as the buds begin to burst, and the second just as the cluster buds begin to separate. The regular codling moth spray, just after the petals have fallen, should follow.

SAN JOSE SCALE.—See Bark and Wood.

PUTNAM SCALE.—See Bark and Wood.

TENT CATERPILLAR.—This insect passes the winter in the egg stage and hatches as the buds begin to open. The worms make nests in the forks of branches, in which they remain when not feeding. The eggs are placed in clusters of from 100 to 200 on the small branches and are covered with a cement-like substance. See Fig. 5.

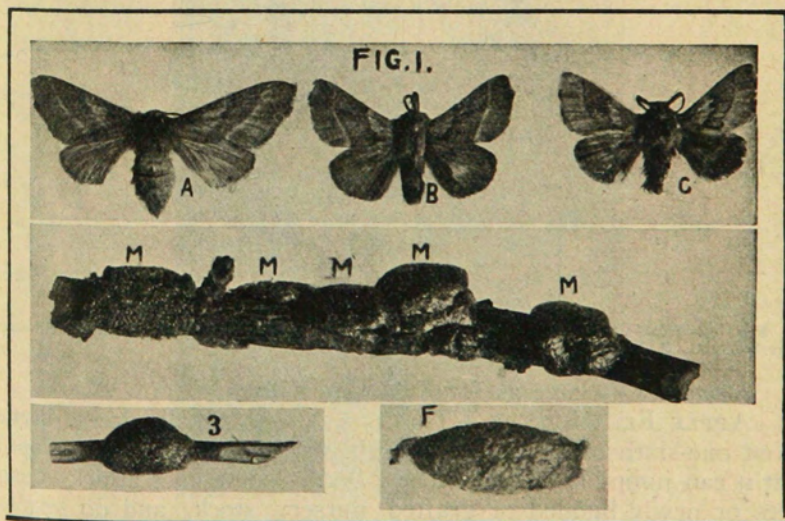


Fig. 5.—Western Tent Caterpillar; A, female moth; B, C, males; D, apple twig with egg masses (M). F, cocoon. 3, egg-mass of American Tent Caterpillar. Life size.

Remedies.—The worms are usually kept under control in orchards that are sprayed for the codling moth. Any of the arsenic-

als will destroy the small caterpillars. While pruning, many of the egg masses can be cut off and destroyed. The nests can be burned out with a torch.

FALL WEBWORM.—The webs do not appear until late in the summer. The insect hibernates in the pupa stage. The moths, which are white, emerge in the late spring and summer when they lay their eggs upon the leaves. The worms enclose within their loose web all the foliage upon which they feed, while the Tent Caterpillar spins a smaller nest to live in when not feeding. See Fig. 6.

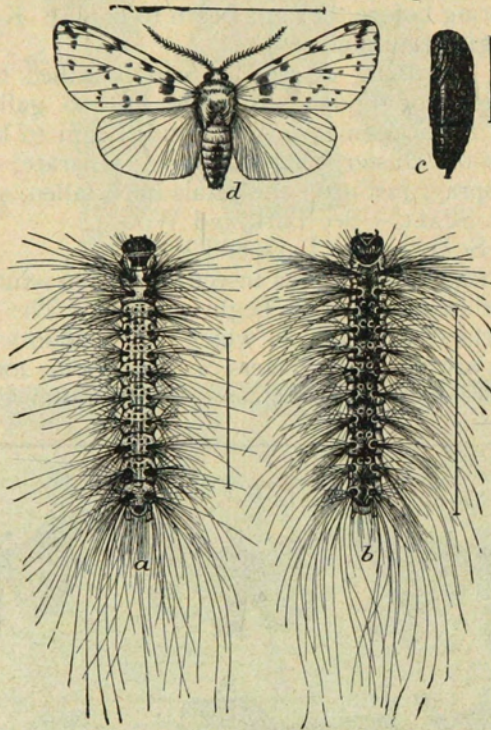


Fig. 6.—Fall Webworm; a and b, caterpillars; c, chrysalis; d, moth. (Howard, Year-book, U. S. Dept. of Agriculture, 1895.)

Remedies.—Same as for Tent Caterpillars.

APPLE FLEA-BEETLE.—This is a small metallic-green beetle about one-sixth of an inch in length, with hind legs so developed that it can jump like a flea. These beetles sometimes attack young trees or newly budded or grafted nursery stock, and do serious damage by eating holes in the leaves. Very little damage is ever done large trees.

Remedies.—Any of the arsenicals (2-4-5) are quite effective in destroying this pest. Any material that will form a dust over the

foliage has a tendency to keep these beetles from feeding. Nos. 6-7-15 and 27 may be used as repellants.

THE APPLE LEAF-HOPPER.—This is a small, active, greenish-yellow insect about one-sixth of an inch in length that feeds upon the leaves of apple and pear, and some other plants by sucking the juices and giving the leaves a mottled yellowish appearance, often causing them to fall prematurely. The young feed mostly on the under side of the leaves. They do not develop wings until their last moult, but are very active, running in all directions if disturbed. They winter over as eggs deposited in the bark of the small branches.

This insect as a rule does little damage, except occasionally to growing nursery stock, and sometimes it is abundant enough to damage the foliage and speck the fruit with excrement so that it is made unsightly and unsalable.

Remedies.—Must consist of contact sprays applied before the insects develop their wings. Spray from below to strike the hoppers on the under-side of the leaves. Use Nos. 8-9-10-11-12-18-19.

THE GREEN APPLE APHIS.—This is a small green louse that feeds on the under side of the leaves of apples and sometimes the pear and quince, sucking the plant juices and causing the leaves to curl. It is usually worse during the latter part of the season. It

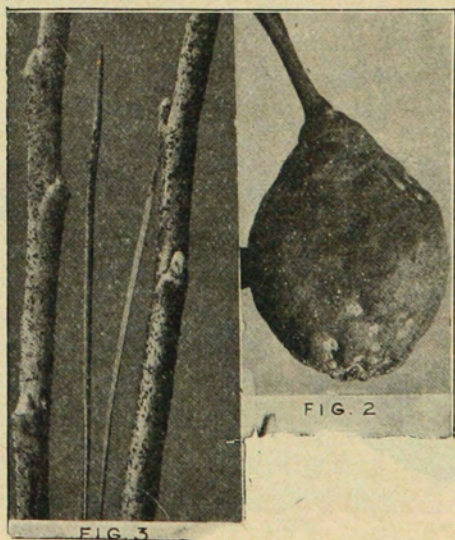


PLATE 3. Fig. 2.—Young Bartlett pear, life size, showing both young and adult of Howard scale. The young scales are white.

Fig. 3.—Two apple twigs showing eggs of the Green Apple Aphis; between these twigs two needles of pine showing eggs of another species of aphid that works upon the pine. (Original in Fourteenth Annual Report, Colorado Experiment Station.)

winters over in the egg stage. The eggs are small, black, shiny objects placed upon the small twigs of the trees. See Plate 3.

Remedies.—It is very difficult to destroy the eggs. The sprays usually recommended for this purpose cannot be depended upon. The best treatments consist in spraying with tobacco extract (19), kerosene emulsion (10), or soap (8), after the eggs have hatched, and before the leaves begin to curl.

ROSY APPLE APHIS.—This aphid or louse gets its name from its rosy or pinkish color. It is quite a serious pest to the apple in some sections, but has been found in Colorado in only two or three localities in sufficient numbers to do serious damage. The small, black, shiny eggs hatch in the spring about as the buds begin to open. The lice feed upon the leaves and twigs much as the Green Apple Aphid does, but they seem to have a poisoning effect on the twigs and fruit, leaving the twigs crooked and stunted and the fruit small and knotty. This pest remains on the apple and pear only a part of the season, leaving the latter part of June for another food plant. It returns in the fall to deposit its eggs upon the apple and pear. See Fig. 7.

Remedies.—Same as for Green Apple Aphid.



Fig. 7.—Apples disfigured by the attacks of the Rosy Apple Aphid when the fruit was young. These were picked at harvest time. Reduced one-half. (After O. E. Essig, Bul. "Injurious and Beneficial Insects of Calif." Calif. State Com. of Hort.)

GRASSHOPPERS.—Grasshoppers do serious damage to young orchards, especially when the orchards are sown to some crop that

will not permit of an annual cultivation to destroy the eggs, or when the orchard is adjoining an alfalfa or grass field. They can be held in check somewhat by the arsenical sprays (2-4-5). The best results in poisoning them are secured with poison bran-mash (3). A band of sticky material (31) about the trees will keep the wingless ones from climbing. See Fig. 8.

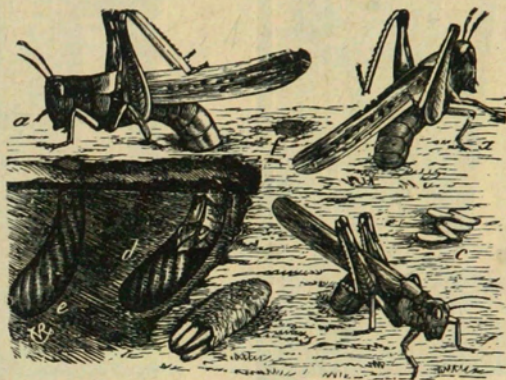


Fig. 8.—Rocky Mountain Locust, laying eggs in the ground; a, a, females with their abdomens in the ground; b, an egg-pod broken open; c, scattered eggs; d, egg-packet in the ground. (After Riley.)

The hoppers can be kept from migrating from alfalfa and grass fields by the free use of hopper-dozers or pans (30). See Plate 5.

BROWN MITE OR CLOVER MITE.—This is a very small brown or reddish mite. It feeds upon a large range of plants, including practically all of our fruits. It takes the name of Clover Mite from the clovers on which it is often very numerous. The dry climate of Colorado is very favorable to its increase. It feeds chiefly upon the leaves. Its presence is most easily detected by the faded, sickly appearance of the foliage of the trees. See Plate 6.

This pest winters over in both the egg and the adult stages, the small red eggs being placed upon the bark of the trunk and limbs and especially in the crotches of the smaller limbs. When very abundant the eggs color the bark red. Sometimes in the fall this mite becomes an annoyance by leaving the food plants and entering our dwellings. It does not bite people.

Remedies.—The use of lime and sulphur (16-17) early in the spring to destroy the eggs or the mites as they hatch is probably the best means of control. Kerosene emulsion (10) and soluble oil (12) are also quite effective at this time.

To kill the mites during the summer, use sulphur (20) at the rate of 1 pound to 3 gallons of water with a small amount of soap, about 2 pounds, to 100 gallons. Contact sprays (8-10-12-19) will destroy the mites, but a second application is required to kill

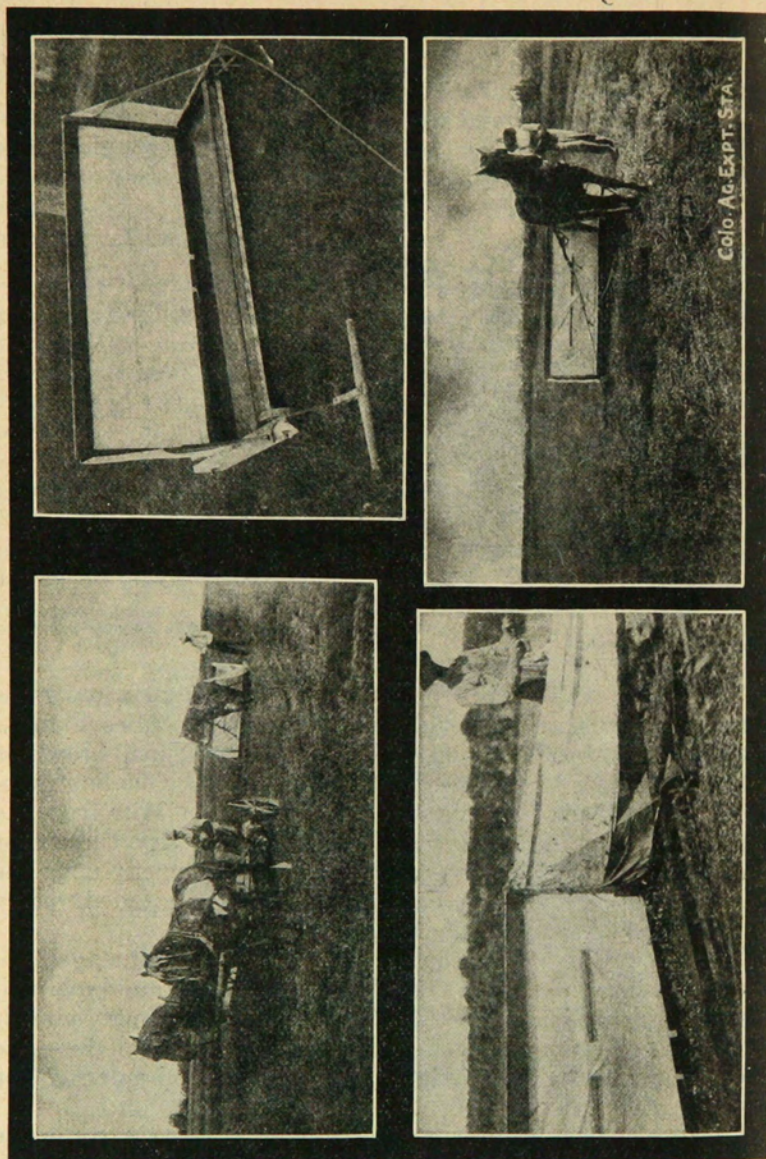
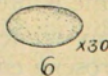
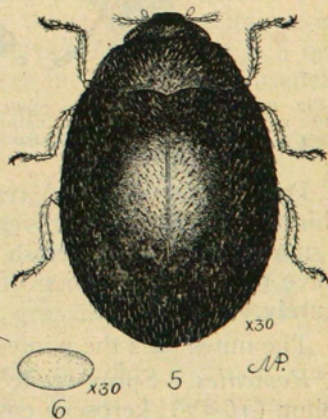
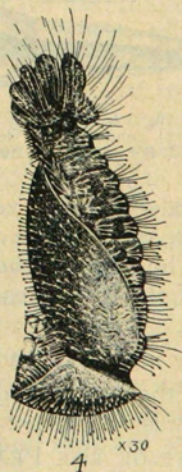
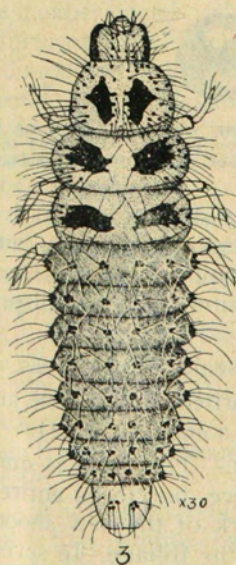
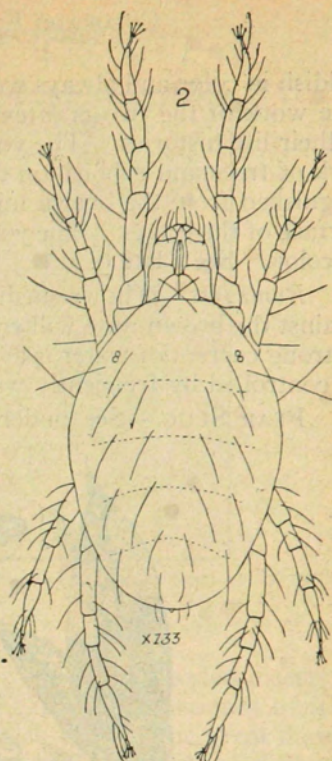
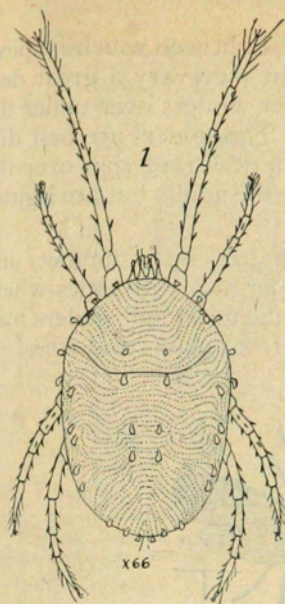


PLATE 5.—Home-made Hopper-dozer, after Blinn.
 Following the mower
 Near view, showing pan
 Manner of hitching horse
 Hopper-dozer

those that hatch from eggs. Sulphur usually remains on the tree long enough to destroy any that hatch from eggs after the treatment.

The spraying should be done from below, as the mites work largely on the under side of the leaves.

THE RED SPIDER.—The Red Spider is very similar to the brown mite, the adult being somewhat smaller and greenish or



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PLATE 6. Fig. 1.—Brown mite; 2, red spider; 3, 4, and 6, larva, pupa, adult and egg of (*Scymnus punctum*), a small lady-beetle that feeds upon the brown mite and red spider. Fig. 1 enlarged 66 times; 2 enlarged 133 times; 4, 5, and 6 enlarged 30 times. (Original in Bull. 152, Colo. Exp. Sta.)

reddish in color and always works under a slight web which it spins. The work of the two is often confused, but they vary a great deal in their life histories. The young red spider winters over under the bark of trees and rubbish on the ground. The spiders are best distinguished from the brown mites by the fine web they spin over the surface of the leaves. The young resemble the adults but are lighter in color. See Plate 6.

Remedies—The remedies recommended for summer use against the brown mite will control the spider also. In cities where a strong current of water is available, both the mites and spiders may be controlled by frequently washing them from plants and trees.

PEAR SLUG.—See under Cherry.

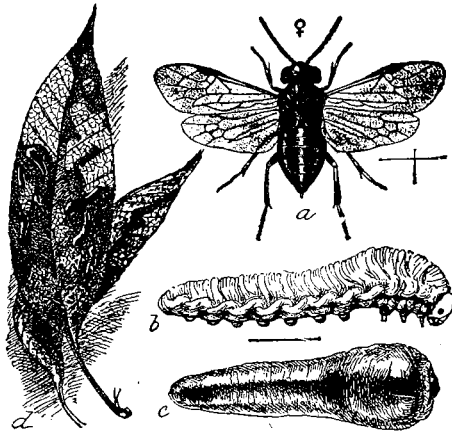


Fig. 9.—Pear-tree Slug; a, adult fly; b, larva or slug with slimy covering removed; c, same as preceding in natural condition; d, leaves showing slugs and their injuries. (Marlatt, Circular 26, Second Series, U. S. Dep. of Agr., Div. Entomology.)

PEAR LEAF-BLISTER MITE.—This is a very small mite that lives within the tissue of pear leaves, and in some cases apple leaves, causing small reddish or brownish blisters. When numerous, these may involve the greater portion of the leaves, causing them to fall prematurely.

The mites pass the winter under the bud scales on the trees.

Remedies.—Spray while the trees are dormant, with lime and sulphur (16-17), kerosene emulsion (10), or soluble oil (12).

VAGABOND OR RUST-MITE OF THE PEAR.—This mite is quite similar to the preceding in size and appearance, but feeds entirely upon the surface of the leaves and tender bark of the new shoots, causing a rusty appearance and a dwarfing of the foliage. In severe cases the leaves curl and the foliage seems scanty. See Fig. 10.

Remedies.—Same as for the preceding species.

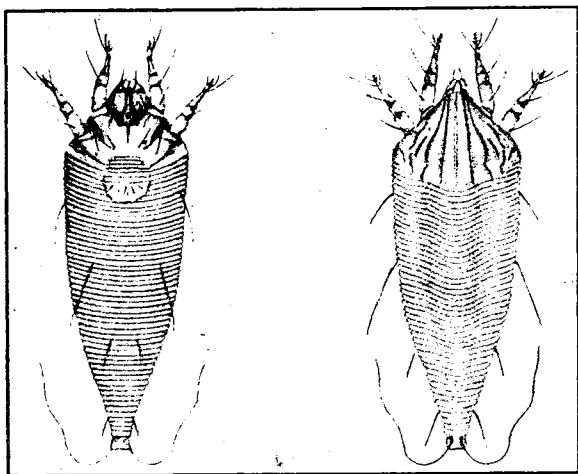


Fig. 10.—The Vagabond or Pear-leaf Rust Mite. Ventral and dorsal views. Greatly enlarged. (After Malepa from Parrott.)

BARK AND WOOD

SAN JOSE SCALE.—This is one of the most dreaded insects to all orchardists. It is responsible for the death of thousands of fruit trees in many sections of the country each year. The great danger comes from the rapidity with which it multiplies, and the difficulty the inexperienced orchardist has in locating the infestations. It may be present in sufficient numbers to kill the trees before its presence is discovered. It attacks practically all deciduous fruits and ornamental plants, infesting all parts of trees including trunk, branches, leaves and fruit, often getting so abundant on the branches as to encrust them with scales, giving them a gray, ashy, dead appearance. See Fig. 3.

The scale is a waxy secretion which, together with the old cast skins of the insect, acts as a protection to the soft yellow insect beneath it. The full-grown females are covered by a circular scale about one-sixteenth of an inch in diameter, with a central dark nipple. The scale of the male is smaller, gray in color, and oval, with the nipple nearer to one end.

The small, half-grown female scales are dark in color, almost black, and circular. This characteristic is used to distinguish this scale from the Putnam and Howard scales, and other closely related species.

When upon fruit the San Jose Scale makes a red or scarlet blotch that is quite characteristic. During fruit harvest is one of the best times to detect infestations. This same red discoloration is found within the outer bark surrounding the feeding place of the insect. See Figs. 3 and 4.

If trees are found to be infested, immediate action should be taken. Small trees may be killed in one or two seasons and older trees so weakened that they are of little value. This scale has been discovered in one fruit-growing section of Colorado, and may break out in others at any time. Anyone finding scale insects that he can not identify should send them to the Experiment Station for identification.

Remedies.—Spray with lime and sulphur mixture (16-17) while trees are dormant. The soluble or miscible oils (12) are also quite effective. It is usually best to cut and burn badly infested trees.

PUTNAM SCALE.—This very closely resembles the preceding species. Mature scales are slightly larger and lighter in color and the central spot on the scale is reddish and somewhat to one side of the center. Remedies the same as for the preceding.

HOWARD SCALE.—This scale is very difficult to distinguish, in external appearance, from the preceding species. It is about the same size and has a pale gray color, with a dark, orange-colored nipple somewhat to one side of the center.

This species is pretty generally scattered over the State. It does most damage to the pear, plum and prune, but also infests apple, peach, ash and maple. It causes a peculiar pitting of the surface of

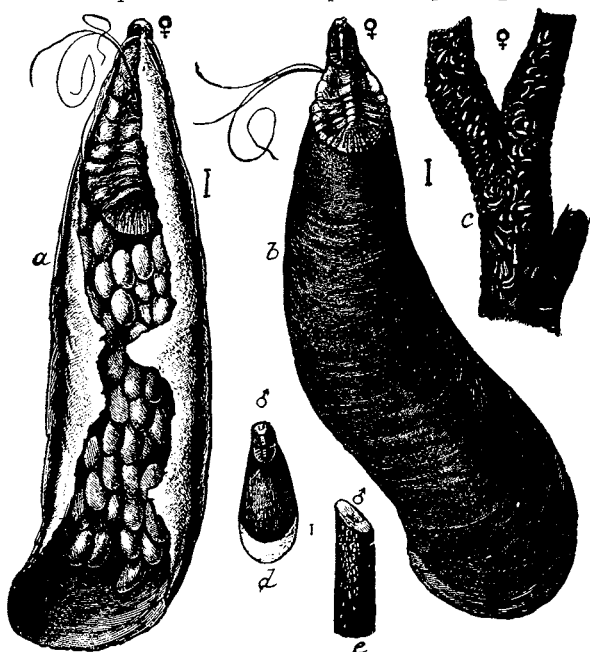


Fig. 11.—Oyster-Shell Bark louse: a, female scale from below, showing eggs, greatly enlarged; b, the same from above; c, female scale on twig, natural size; d, male scale, enlarged. (Howard, Yearbook, U. S. Dep. of Agr., 1894.)

pears. It also makes the scarlet blotches on fruit and bark somewhat similar to the San Jose scale, but does not increase as rapidly. See Plate 3.

Remedies.—Same as for San Jose Scale.

OYSTER-SHELL SCALE OR BARK LOUSE.—This is an elongated oyster-shell-shaped scale of about the same color as the bark of the trees. It infests especially the lilac, and apple and pear trees. It passes the winter in the egg stage under the old scale. See Fig. 11.

Remedies.—Dormant sprays are ineffective. "Black leaf 40" (19), 1 part to 800 parts water, or kerosene emulsion (10) 8% kerosene, applied in the spring when eggs are hatching, will kill the young lice.

SCURVY SCALE.—This is a white scale insect. The female is about one-eighth of an inch long, flatter and more circular than the oyster-shell scale, and gives the bark a scurvy appearance. Male scales are much smaller and very slender. Like the oyster-shell scale, it passes the winter in the egg stage under the old scales. When eggs are crushed they are of a deep purple color.

Remedies.—Same as for Oyster-shell scale.

WOOLLY APHIS.—Small, reddish-brown lice attacking trunk and branches of the apple, especially on tender bark about wounds and on water-sprouts. They appear as bluish-white woolly patches which, when crushed, give a dark blood-red stain. The lice are covered with a woolly mass of white secretion. They suck sap from the bark and often cause an abnormal growth or swelling where they feed. See Fig. 12.

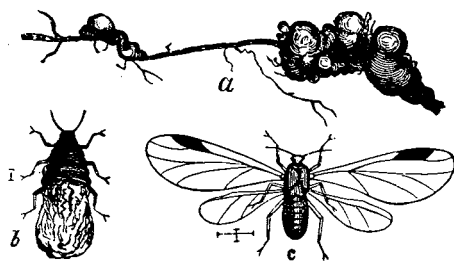


Fig. 12.—Woolly Aphis, root form: a, small root showing swellings caused by the lice; b, wingless louse showing woolly secretion; c, winged louse. (After Saunders.)

Remedies.—The white patches on the trunk and branches may be painted out with pure kerosene or crude petroleum (11), kerosene emulsion (10), or tobacco extract (19).

If the lice become abundant on branches and twigs, spray with "Black Leaf 40", 1 part to 800 parts water, with 3 pounds of soap to each 100 gallons to aid in penetrating the woolly secretion; or use kerosene emulsion (10) ordinary strength. Use a high pressure and coarse spray, in order to wet through the wool.

FLAT-HEADED BORER.—A light-yellow, legless grub that bores beneath the bark of apple and many of our shade and forest trees. The first body segments are flattened, making the larvæ appear to have an enlarged flat head. The adult is a dark brown, metallic-colored beetle about three-fifths of an inch long. This insect very seldom attacks any but weakened or injured trees. See Fig. 13.

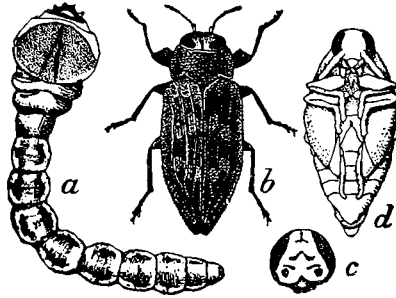


Fig. 13.—Flat-headed Apple-tree Borer: a, flat-headed larvæ; b, the mature beetle; c, head of mature beetle; d, pupa. All twice natural size. (Chittenden, Circular 32, U. S. Dep. of Agr., Div. of Entomology.)

Remedies.—Keep trees in thrifty condition. Protect from sun scald during winter and spring by shading or white-washing (15). Remove borers with pocket-knife when found.

GRASSHOPPERS.—Grasshoppers sometimes eat bark from trees in the nursery rows or in young orchards.

Remedies.—See under Foliage.

PEACH, PLUM, PRUNE, APRICOT AND CHERRY

FRUIT

TWIG-BORER OF PEACH.—The small brown larvæ of this insect winter over in silk-lined cavities made in the bark, especially in the crotches of small limbs. These are detected by a small mass of chewed bark which covers the burrows. Early in the spring the larvæ leave the burrows and eat into the buds and new shoots, causing them to wilt and die. The same larva may eat into several twigs, thus a few can do serious damage, especially to small trees. See Figs. 14 and 15.

Many of the second brood larvæ eat into the peaches, causing a gummy exudation and ruining them for the market. This is probably the worse insect pest of the peach in Colorado at the present time.

Remedies.—Lime and sulphur mixture (16-17) has been most generally used in this State. Spray just before the buds begin to open. At this time the larvæ begin to leave their winter quarters

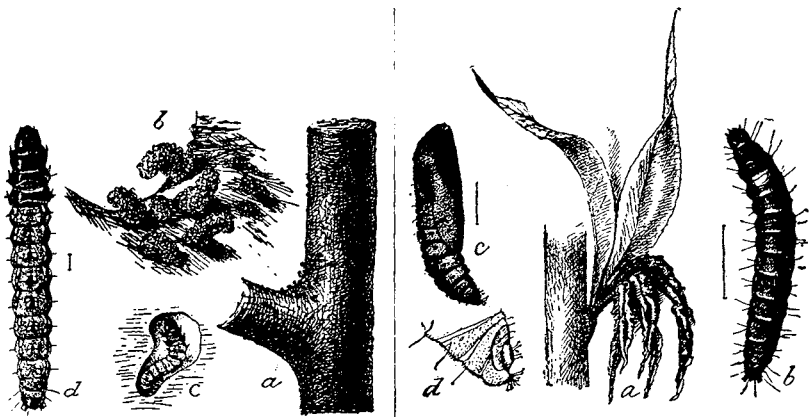


Fig. 14.—Peach Twig-borer; a, twig of peach showing little masses of chewed bark above the larval burrows; b, the same enlarged; c, larva in winter burrow, enlarged; d, hibernating larva greatly enlarged. (Marlatt, Bulletin 10, N. S., U. S. Dep. of Agr., Div. of Entomology.)

Fig. 15.—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.)

and are most easily killed. Winter applications are of very little value, in our experience.

Kerosene emulsion (10) and soluble oils (12) may be used, but are thought not to be quite as effective, and are more likely to cause injury.

If spraying for the twig-borers alone, arsenate of lead (4) used just after the buds open, gives good results. Many growers prefer this to the lime-sulphur treatment. Destroying infested fruit and twigs before the larvæ leave them aids in keeping this pest in check.

PLUM GOUGER.—This pest feeds upon plums, prunes and nectarines. It is a small gray snout beetle, a quarter of an inch in length, with ocher-yellow head and legs, wing covers smooth and without humps which are characteristic of many snout beetles. The beetles feed upon the fruit, making small punctures in the skin. Eggs are deposited in some of the punctures and the grub eats into the pit, destroying the seed. The larva pupates within the seed, the adult coming out about the time the fruit matures. The adults winter over in the soil. See Figs. 16 and 17.

This is probably the worst pest of the native or Americana plums in Colorado.

Remedies.—Jar the trees early in the morning and catch the beetles on sheets held beneath. Do this from the time the blossoms are out until no beetles are caught. Spray with arsenate of lead (4) soon after the blossoms fall, and again ten days later.

PLUM CURCULIO.—This beetle is very similar to the preceding one. It is brown to blackish in color, about one-fifth of an inch in

length, and with two prominent humps and several smaller ones on its back.

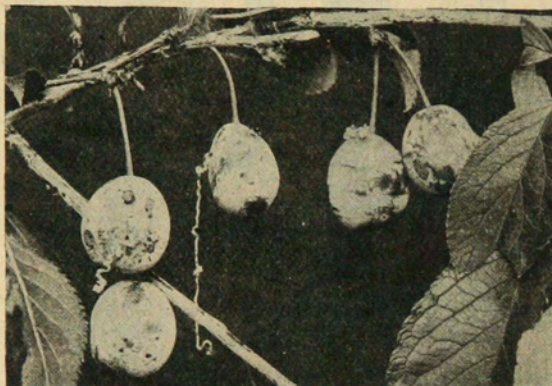


FIG. 16

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Fig. 16.—Plums, life-size, showing the punctures and gummy exudations caused by the Plum Gouger. The black specks on the plums represent the punctures which are made either for the purpose of taking food or for egg-laying. (Original in Fourteenth Annual Report Colo. Exp. Sta.)

There are two broods. It winters in the beetle stage in the soil, and in rubbish. The adult comes out in the spring and feeds upon the buds and foliage, and later upon the small fruit.

The food punctures in fruit are similar to those made by the preceding species, but the eggs are deposited in skin punctures that are distinctly crescent-shaped. The larvæ do not enter the pit, but

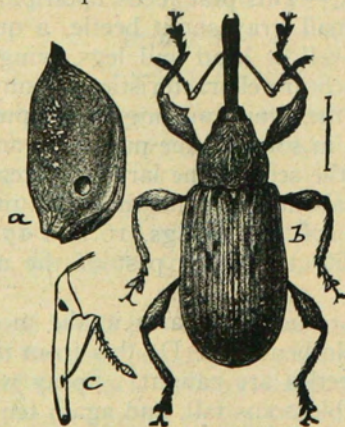


Fig. 17.—Plum Gouger: a, plum pit showing hole for exit of gouger; b, gouger; c, side view of head of gouger showing beak and antenna. (Riley & Howard, *Insect Life*, Vol. II., U. S. Dep. of Agr., Div. of Entomology.)

feed upon the flesh, causing the fruit to fall. The curculio infests plum, peach, cherry, apple, pear, wild plum, and hawthorn. It is to the cherry and plum what the codling-moth is to the apple.

This pest has never been reported in Colorado. Anyone finding what he thinks is its work should notify the Experiment Station.

Remedies.—Same as for preceding species. Spraying with arsenate of lead gives better results than with the Plum Gouger. Probably the best remedy consists in keeping the orchard free of rubbish and giving a fall cultivation to destroy the over-wintering beetles. The beetle thrives in over-grown, unpruned and neglected orchards. They are shy of the sun. Prune the trees and let the sun in.

GREEN PEACH APHIS (See Foliage).—This plant louse attacks the fruit of the peach and plum just after the flowers fall, causing many of the little fruits to drop.

TARNISH PLANT BUG.—For some time there has been considerable complaint of waxy peaches from peach growers of the State. The wax or gum forms in small beads or long strings on the fruit. When brushed off, very little, if any, blemish is left. This is often caused by the food punctures of the tarnish plant bug, a small, brownish, and very active plant bug about one-fifth of an inch in length. Early food punctures may cause deformed fruit.

The adults winter over among weeds and rubbish about the orchard, and breed principally on the weeds and undergrowth. Occasionally they deposit their long white eggs in the fruit.

The nymphs of young are wingless, attaining their wings at about one month of age.

Remedies.—This is a very difficult insect to control, owing to its wide range of food-plants, and the fact that much of the injury is done by the winged adults, which are very shy and active. Numbers 10 and 19 will be found to be of some value. Clean cultivation and the destruction of all hibernating places will also help much.

SCALE INSECTS.—Some of the scale insects, especially the San Jose and Howard scales, will attack the fruit. The Howard scale is quite bad on plums in some sections, spotting the fruit and making it unsalable. (See under Apple and Pear.)

FOLIAGE

GREEN PEACH APHIS.—A pale green or greenish yellow louse that hatches from the over-winter eggs early in the spring. It attacks the blossoms and small fruits, causing many to drop, and later attacks the leaves, which curl and turn yellow. About mid-

summer this louse leaves the peach and goes to a large variety of other plants. It returns to the peach in the fall to deposit the over-winter eggs upon the twigs. This louse also infests the plum.

Remedies.—Spray after the eggs hatch and before the lice get into the opening buds with "Black Leaf 40" (19), 1 part to 800 parts water; kerosene emulsion, 5 to 8 percent kerosene; or miscible oils. If the lice appear later, treat as in case of the Green Apple Aphis.

BLACK PEACH APHIS.—This louse, which is amber to black in color, attacks the peach only. It attacks the roots as well as parts above ground. It is on the twigs and foliage only until about mid-summer, but remains on the roots all the year.

Remedies.—For those above ground, treat the same as for Green Aphis on apple. For the root form, use the same treatment recommended for the root form of the Woolly Apple Aphis.

This has not been a serious pest in Colorado, only an occasional tree having been found infested.

GREEN PLUM AND PRUNE APHIS.—This is commonly known as the hop plant louse, the hop being the summer food-plant. It migrates to the plum and prune in the fall to deposit the over-winter eggs. Winged lice return to the hop early in the summer.

Remedies.—The same as given for the Green Peach Aphis.

CHERRY AND PEAR SLUG.—This is a dark-colored, slimy larva much resembling a small snail. The body is large in front and tapers behind. It feeds upon the upper surface of the leaves, often leaving only a skeleton to wither and die. The adult is a small, glossy, black, four-winged fly about one-fifth of an inch in length. This fly deposits her eggs in the tissue of the leaves just under the epidermis by means of a sawlike ovipositor, whence the common name of "saw-flies". There are two broods each year. This is a common pest on the cherry, pear, plum, quince and crabs. See Fig. 9.

Remedies.—White hellebore (7) 1 ounce to 3 gallons of water, arsenate of lead (4), "Black Leaf 40", 1 part to 800 or 1,000 parts of water; freshly slaked lime (27), or wood ashes (26) dusted upon the slimy larvae will kill many. A strong stream of water will wash them from the leaves.

FRUIT-TREE LEAF ROLLER.—This insect attacks the plum, prune and cherry quite severely, and the peach to some extent. (See under Apple.)

BROWN MITE AND RED SPIDER.—These are often quite bad on peaches and plums. For description and treatment, see under Apple and Pear.

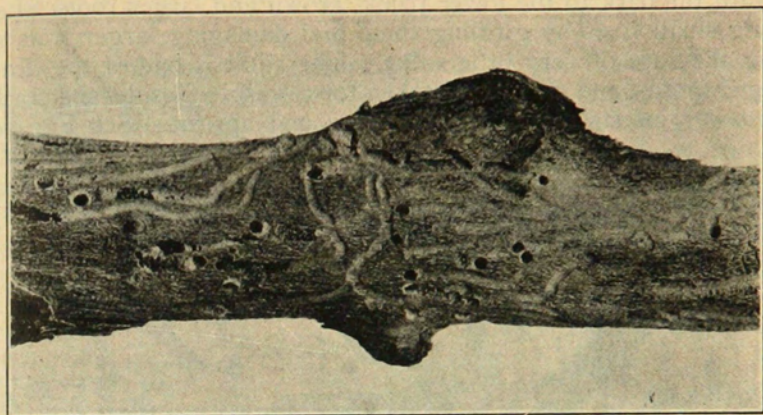


Fig. 18.—Small apricot limb with bark removed to show the galleries made by the larvae and adults, and holes made by the adults of the Shot-hole Borer or Fruit-tree Bark beetle. Enlarged twice. (After O. E. Essig, "Injurious and Beneficial Insects of California." Calif. State Com. of Hort.)

BARK AND WOOD

SHOT-HOLE BORER.—Quite often cherry, plum, prune, peach and sometimes pear and apple trees are found that have numerous small holes in the bark. These will be about the size of a hole made by small shot, or the size of a pin head. These holes are made by the Shot-hole Borer as the adult beetles leave the trees. If the bark is cut away, numerous channels running between the bark and sap wood will be found. These are made by the grubs of the small brown beetles. See Figs. 18 and 19.



Fig. 19.—Adult of the Shot-hole Borer or Fruit-tree Bark beetle. Enlarged five times. (After O. E. Essig, "Injurious and Beneficial Insects of Calif." Calif. State Com. of Hort.)

This borer very seldom attacks healthy, vigorous trees. It seeks those that have been weakened by disease or injury.

Remedies.—Keep trees in a healthy, vigorous condition. Destroy all infested trees by burning. Whitewash (15) will help to prevent sunscald and will, to some extent, keep beetles from laying eggs on the trees.

SCALE INSECTS.—See under Apple and Pear.

PEACH-TREE BORER.—A yellowish-white borer about one to one and one-quarter inches in length when full grown. It bores

beneath the bark to the lower trunk, crown and larger roots, often killing small trees by girdling them and damaging larger trees so much they are of very little value. The adult is one of the clear-winged moths, and may be mistaken for a wasp. Besides the peach, this borer infests plum, prune, cherry and apricot. See Fig. 20.

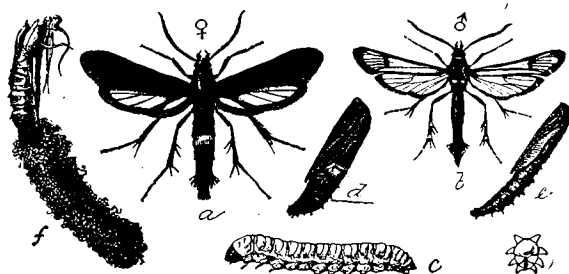


Fig. 20.—Peach-tree Borer: a, adult female; b, adult male; c, full-grown larva; d, female pupa; e, male pupa; f, pupa skin and cocoon. All about natural size. (Marlatt, Circular 17, Second Series, U. S. Dept. of Agriculture, Division of Entomology.)

Remedies.—Carefully inspect the trees every fall and spring and remove all borers with a knife. It may be necessary to remove some soil from about the crown to find all borers. Their presence is usually indicated by a gummy exudation upon the bark. A shield of paper about the trunk from June 1 to August 1, the egg-laying period, will aid in keeping the adults from laying eggs upon the bark. Asphaltum painted upon the trunks has been used in California for this purpose, with some success. See Fig. 21.

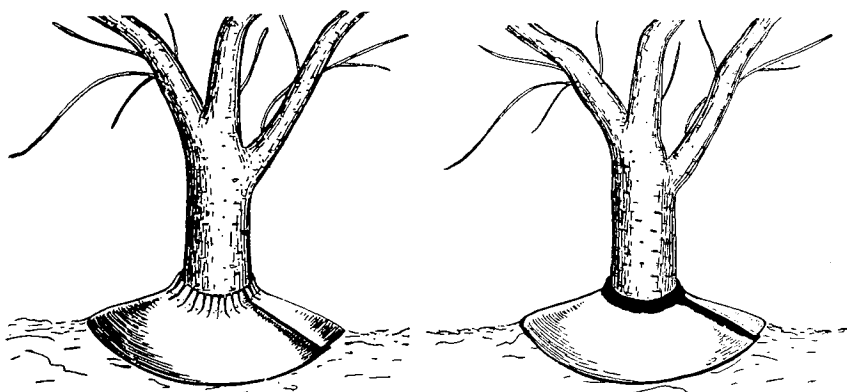


Fig. 21.—Showing a type of tree protector that gives results in controlling the Peach-tree Borer. No. 1 shows the protector in place but not sealed to the tree. The adult lays her eggs on the trunk of the tree, the small, newly hatched borers are unable to penetrate the dry tough bark of the tree trunk, so endeavor to crawl to the soil where the bark is moist and tender. The cone-shaped protector prevents them from reaching the base of the tree, and they soon perish. The protector must be closely sealed to the tree and all seams closed. (Loaned by the Scott Tree Protector Co., Baltimore, Md.)

CURRANT AND GOOSEBERRY

FRUIT

FRUIT WORM.—This is a flesh-colored worm about two-thirds of an inch in length when fully grown. It attacks both the gooseberry and currant in some parts of Colorado, and may destroy a considerable portion of the crop by eating large holes into the berries. It may enter a berry and eat out the interior and go on to another. Clusters of fruit and leaves are often loosely webbed together. The adult insect is a gray moth with rather long, narrow wings. See Fig. 22.

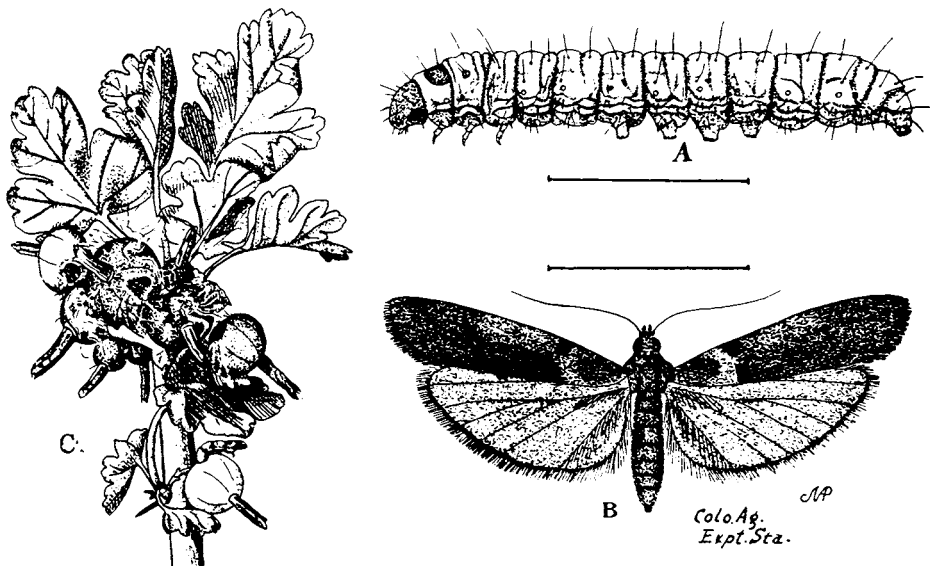


Fig. 22.—Currant and Gooseberry Fruit-worm; A, worm; B, moth; C, gooseberries webbed together. (Original in Bull. 114, Colo. Exp. Sta.)

Remedies.—Hand picking is probably the best remedy. Destroy all web clusters. This is practical only on a small scale. Poison sprays would kill many, but would make fruit unsafe for food. Thorough cultivation will destroy many of the over-wintering chrysalids.

FRUIT MAGGOT.—This is one of the most serious pests of the gooseberry and currant in Colorado. It is a small, white maggot which feeds within the fruit, causing it to turn red and drop. The adult is a two-winged fly about the size of an ordinary house fly, but yellowish-brown in color, with dusky bands across the wings. It comes out in the spring when the berries are about half grown and stings the fruit with its sharp ovipositor and deposits its eggs beneath the skin. In about three weeks the full grown maggot

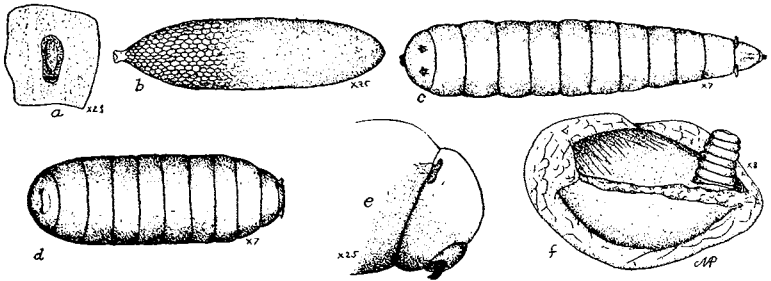


Fig. 23.—Currant and Gooseberry Fruit Maggot; a, egg puncture made in the berries by the adult flies; b, egg; c, larvae; d, pupa; e, head end of larva, showing sharp jaws beneath; f, larva entering a seed; a, enlarged $2\frac{1}{2}$ times; b, 35 times; c, d, 7 times; e, 25 times; f, 8 times. (Original, Miriam A. Palmer, Delineator.)

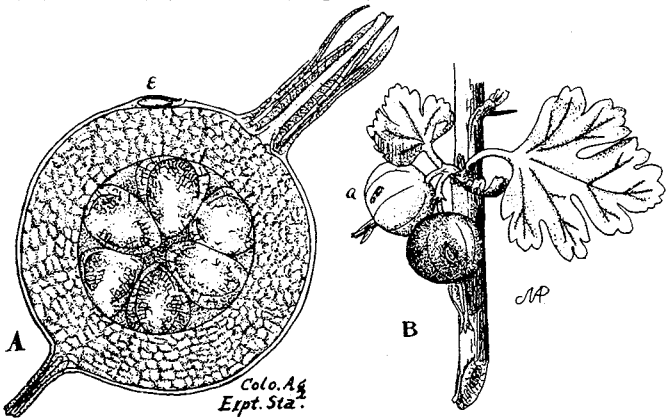


Fig. 24.—Currant and Gooseberry Fruit Maggot; A, section through a gooseberry, showing egg and puncture at e; B, two gooseberries on a stem, showing egg puncture, or sting, at a. (Original in Bull. 114, Colo. Exp. Sta.)

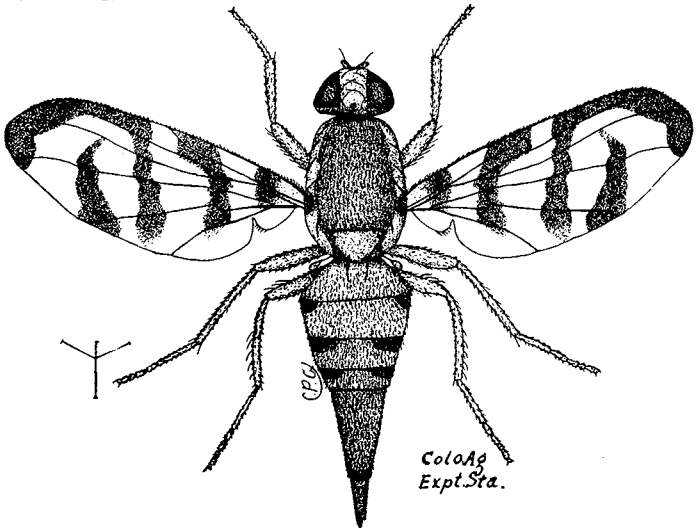


Fig. 25.—Adult of Currant and Gooseberry Fruit Maggot.

leaves the fruit and enters the ground, where it hibernates. There is only one generation a year. See Figs. 23, 24 and 25.

Remedies.—No practical method of control has been found. Collecting and destroying the infested berries will help, but is impractical, except on a small scale. Thorough cultivation to destroy the hibernating form will help. Chickens running among the bushes will destroy many.

FOLIAGE

NATIVE SAW FLY.—A light-green worm with a blackish head that feeds upon the leaves of currant and gooseberry bushes. The first brood appears in June and the second in August. The adult insect is a black, four-winged fly about the size of the house fly, that appears in the spring while the leaves are small and inserts the whitish eggs in the edge of the leaf between the two outer layers. The eggs form a blister-like elevation on the leaf.

Remedies.—Four pounds arsenate of lead (4) or 1 pound Paris green (2) in 100 gallons of water will be found effective. These should not be used before the fruit is picked. The following may be safely used on the fruit, and are quite effective: White hellebore, 1 ounce to 3 gallons of water, or, in the evening, thoroughly dust the leaves with the hellebore, or with pyrethrum.

IMPORTED OR EUROPEAN SAW FLY.—This pest has only recently been reported in Colorado. It is very similar to the preceding species, but is much more destructive. The larva can be distinguished from the native species by its dark head and numerous black specks on the body. The adult is somewhat larger than our native species. The small white eggs are placed in rows along the veins on the under side of the leaves.

Remedies.—Same as for the preceding species.

CURRANT PLANT LOUSE.—The eggs are small, shining black objects, and rather long in shape. They hatch, about as the buds begin to open, into a yellowish-green louse that feeds upon the opening buds and later upon the under side of the leaves. The numerous food punctures cause the leaves to curl and turn red and yellow in color. The lice remain on the currants all the season. Their favorite plant is the red currant, but they also attack the black currant and gooseberry.

Remedies.—Same as recommended for Green Apple Aphis. The leaves curl so tightly spraying must be done before they begin to curl, for best results.

BROWN MITE AND RED SPIDER.—These mites are often very abundant on currant and gooseberry. It is not uncommon to see bushes largely defoliated by them as early as July. See under Peach Foliage.

BARK AND WOOD

CURRENT BORER.—A yellowish-white larva, about one-half inch in length when mature, that tunnels into the canes, often killing them. It hibernates within the canes and comes out as a wasp-like moth in June. The moth very much resembles that of the Peach Borer, but is smaller. Infested canes can often be detected by the withered, yellowish appearance of the foliage or the small burrow made to the surface.

Remedies.—Cut out and burn all infested canes as soon as detected. Keep the old wood well trimmed out.

SCALE INSECTS.—The San Jose, Putnam, Oyster-shell, and several other species of scale insects may attack the currant and gooseberry.

STRAWBERRIES

LEAF ROLLER.—Small, greenish-brown caterpillar that webs the two halves of the leaves together and feeds within the roll, causing the leaves to wither and die. So much of the foliage may be destroyed that the fruit will not mature properly. See Figs. 26 and 27.

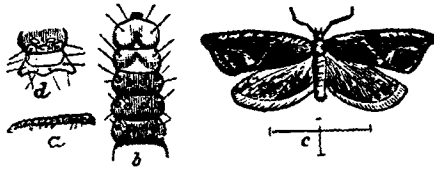


Fig. 26.—Strawberry Leaf-roller; a, larva, natural size; b, head end of larva enlarged; c, moth about twice natural size; d, tail end of larva enlarged. (After Saunders.)

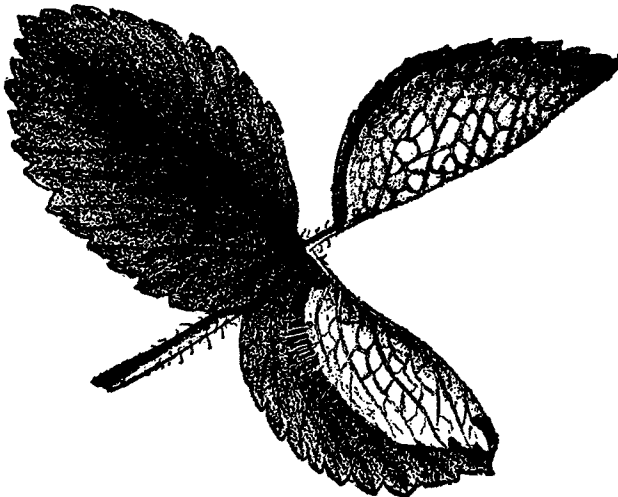


Fig. 27.—Strawberry leaves, showing their appearance after being folded. (After Weed.)

The adult insect is a small, dark-brown or rust-colored moth with white markings on the wings; about one-half inch across expanded wings. It also attacks the raspberry and blackberry.

Remedies.—New Jersey Experiment Station, Bulletin 225, reports success with arsenate of lead (4), 5 pounds to 100 gallons of water, applied before the leaves are rolled, or about one week after the moths appear in the spring. After the fruit is gathered, scatter straw over the plants and burn.

STRAWBERRY CROWN BORER.—This is a yellowish-white grub that eats into the crowns of the plants. It is the larva of one of the snout beetles.

Remedies.—Do not allow beds to get too old. If badly infested, gather only one crop before renewing. Place the new beds some distance from old ones. Burning over, as recommended for preceding species, is of some value.

RED SPIDER.—Often attacks strawberries. For remedies see under Apple, Peach and Pear.

RASPBERRY AND DEWBERRY.

RASPBERRY SAW FLY.—A light-green larva about three-fourths of an inch long when fully developed, that eats irregular holes in the leaves. The small, white eggs are deposited within the tissue of the leaves by a fly resembling the Cherry Saw Fly.

Remedies.—Same as for Saw Flies on currants and gooseberries.

CANE BORER.—Small, cylindrical borer that eats into the new shoots during early summer, causing them to wither. It remains in the canes during second season, eating downward through the pith, often killing the cane before the fruit matures.

Remedies.—Cut off all affected canes and burn while the borers are still in them.

RED SPIDER AND BROWN MITE.—Often attack the raspberries and dewberries. For remedies see under Apple, Pear and Peach.

GRAPE

LEAF-HOPPER.—Closely related and very similar to the Leaf-Hopper of the apple and pear. For description and remedies see under Apple and Pear Foliage. See Fig. 28.

EIGHT-SPOTTED FORESTER.—A caterpillar about one and one-half inches long when mature, dark-colored, with numerous small, black and white cross lines on each body segment. The adult is a dark-colored moth with eight light spots on the wings. See Fig. 29.

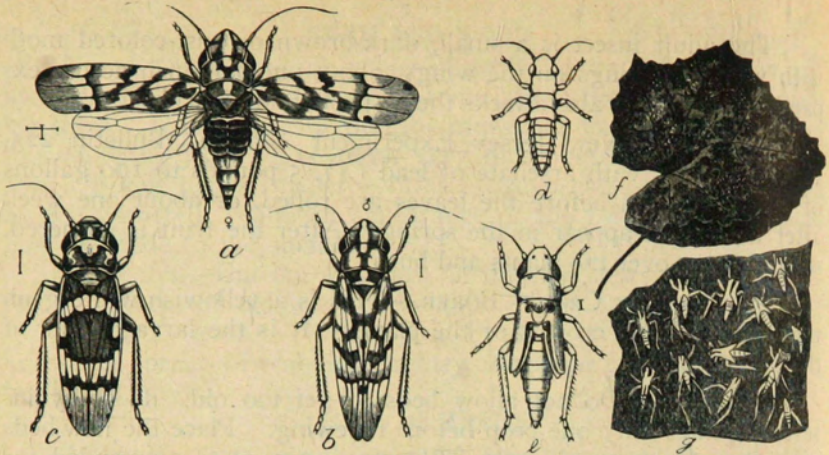


Fig. 28.—Grape Leaf-hopper; a, adult female; b, adult male; c, another form of the species, showing variation in markings; d, newly-hatched nymph; e, last stage nymph; f, appearance of injured leaf; g, cast pupa skins. a-e, much enlarged; g, less enlarged; f, reduced. (After Marlatt, U. S. Dept. of Agr. Div. of Entomology.)

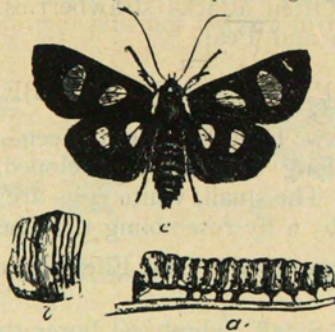


Fig. 29.—Eight-spotted Forester; a, larvae; b, one segment of body of larva enlarged; c, moth. Natural size, except b.

Remedies.—The arsenicals (2-4-5) will be found effective. In small vineyards hand picking might be found practical.

This insect also attacks the Virginia Creeper.

COTTONY SCALE.—See under Maple.

SHADE TREE PESTS

COTTONY MAPLE SCALE.—This insect winters over as partly grown, brown scales on the smaller limbs and twigs. With the coming of spring, the insect grows and throws out a white, cottony secretion from the posterior end of the scale. During June, a mass of small, creamy-white eggs are deposited in the cotton under the old scale. At this time the scales are very conspicuous. The eggs hatch during the last of June and early July and the young lice locate on the under side of the leaves. This is a common pest of the maple, and also infests black locust, elm, and many other trees and shrubs. See Fig. 30.

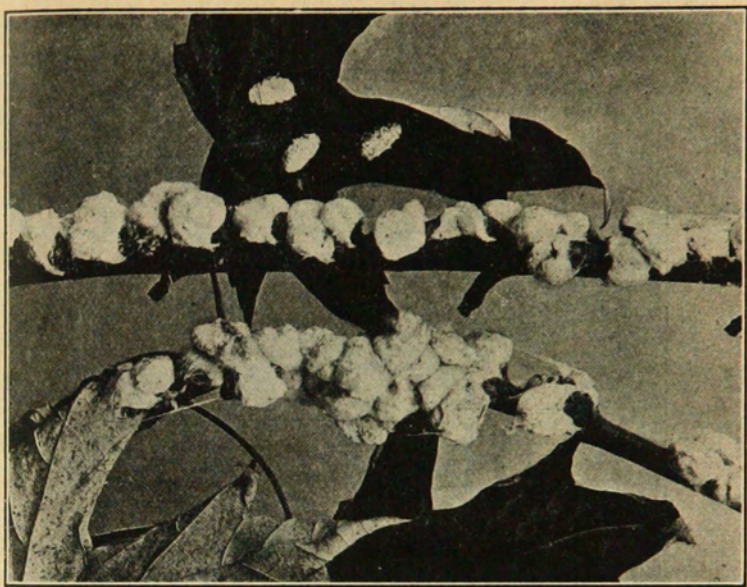


Fig. 30.—The Cottony Maple Scale. Mature females on maple twigs. Larvae of one of the lady-bird beetles, *Hyperaspis signata* Oliv. on leaf at the left. These lady-bird beetles feed on scale insects. Natural size. (After O. E. Essig, "Injurious and Beneficial Insects of Calif." Calif. State Com. of Hort.)

Remedies.—Kerosene emulsion (10), 15% kerosene, used during the dormant season, will be found fairly effective.

Tobacco extract (10) or kerosene emulsion (10), that is, 7% kerosene, will destroy the young insects, but it is difficult to strike all of them on the under side of the leaves. If a strong current of water can be used, many of the young insects can be washed to the ground, where they will perish.

ELM SCALE.—The young lice hatch in June or early July and feed upon the leaves until fall, when they return to the bark, insert their beaks and hibernate during winter. In the spring the eggs are deposited under the body and a partial scale formed over the females. The presence of the insects is best indicated by the partial scale which consists of a white, waxy ring secreted about the insect. Infests elms only. See Fig. 31.

Remedies.—In Nevada, where this has been quite a serious pest, best results have been obtained by using soluble oils (12), 1 part to 15 parts water, during the dormant season. For summer treatment use kerosene emulsion (10) or tobacco (19), as recommended for the maple scale.

OYSTER-SHELL SCALE.—In some sections of the State this scale is quite bad on the ash and lilac. For description and remedies, see under Apple and Pear, Bark and Wood.

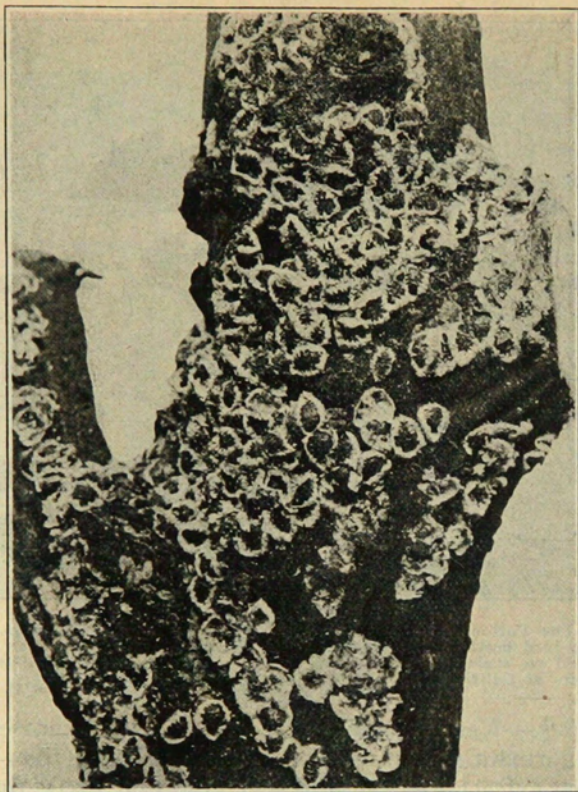


Fig. 31.—The European Elm Scale on the American elm. Adult females as they appear in June. Natural size (After O. E. Essig, "Injurious and Beneficial Insects of Calif." Calif. State Com. of Hort.)

LOCUST BORER.—A white grub about three-fourths of an inch in length when fully grown, that feeds within the trunk and limbs of the black locust, destroying many trees. Small, white eggs are deposited in crevices of the bark during the early fall by the adult insect, which is a wasp-like beetle about three-fourths of an inch in length. These hatch the same fall and the little borers eat into the bark, where they live over winter. They mature the following July and the beetles come out during late summer and early fall. The presence of the borers can be detected by the borings that are forced out of the burrows.



Fig. 32.—Larva of Cottonwood Borer.

Remedies.—Spraying is ineffective. Destroy all badly infested trees by burning. Many of the grubs can be killed and the life of valuable shade trees prolonged by squirting a small amount of carbon bisulphide into the burrows and plugging them with mud. This will necessitate going over the trees several times during early summer.

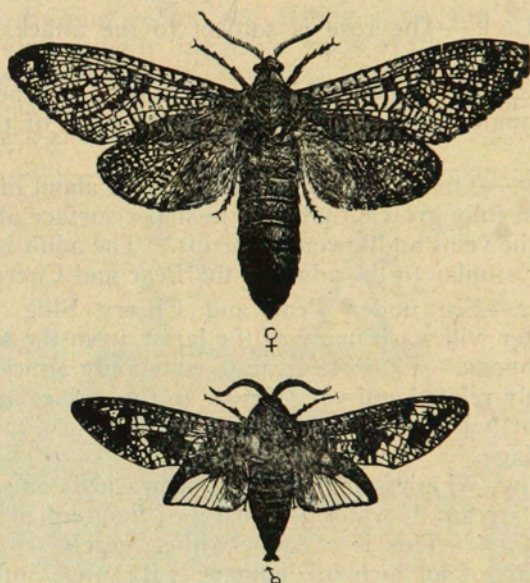


Fig. 33.—Cottonwood Borer, showing male and female moths. The female is larger.

COTTONWOOD BORER.—A large, reddish caterpillar, head shining black, body somewhat flattened, and when mature about three inches long; bores large holes or galleries in the trunks of the cottonwoods and poplars. It transforms to a large thick-bodied moth in June and July. See Figs. 32 and 33.

Remedies.—This borer does not bring its borings out to the surface, so it can be detected only by the discoloration of the bark, due to sap leakage. The borers sometimes can be dug out with a stiff wire, or the channels opened and carbon bisulphide injected. (See under Locust Borer.)

BOXELDER LEAF-ROLLER.—This is very similar in appearance and habits to the Fruit Tree Leaf-Roller. It seems to attack boxelder exclusively in Colorado.

Remedies.—See under Fruit Tree Leaf-Roller.

PLANT LICE ON ASH, ELM, WILLOW, BOXELDER, LOCUST, ETC.
—Most all of our shade trees and shrubs are subject to the attacks

of one or more species of plant lice. These vary somewhat in appearance and habits, but are all subject to the same treatment. Use contact sprays, as kerosene emulsion (10), tobacco (19), or soap (8).

ORNAMENTAL PLANTS

ROSE

PLANT LICE.—The rose is subject to the attacks of several species of plant lice.

Remedies.—Use contact sprays (10), (19), (8), being careful to spray the under side of the leaves, where most of the lice will be found.

SAW FLY.—This is a greenish-yellow larva about one-half inch in length when fully grown, that eats the upper surface of the leaves, leaving only the veins and lower epidermis. The adult is one of the saw flies very similar to the adult of the Pear and Cherry Slug.

Remedies.—See under Pear and Cherry Slug. A strong stream of water will wash many of the larvæ from the leaves.

LEAF-HOPPER.—The rose is quite commonly attacked by leaf-hoppers, closely related and very similar to the species attacking the apple and pear. For description and remedies, see under Apple and Pear Foliage.

The young, wingless hoppers can be washed off the foliage with a strong stream of water and many of them killed.

ROSE SCALE.—This is a snow-white, nearly circular scale about one-tenth of an inch in diameter. It often infests blackberries, raspberries, and dewberries, as well as roses. See Fig. 34.

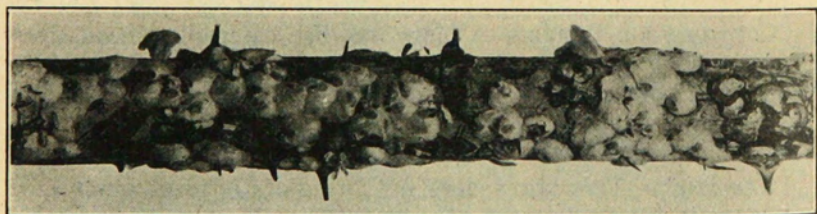


Fig. 34.—The Rose Scale on wild blackberry. Only slightly enlarged. (After O. E. Essig. "Injurious and Beneficial Insects of California." Calif. State Com. of Hort.)

Remedies.—Spray during dormant season with No. 8, 16 or 17. The soap should be used 1 pound to 1 gallon of water.

VIRGINIA CREEPER

EIGHT-SPOTTED FORESTER.—See under Grape.

THE ACHEMON SPHINX.—A hairless caterpillar that feeds upon the foliage. It resembles the large tomato "worm". When

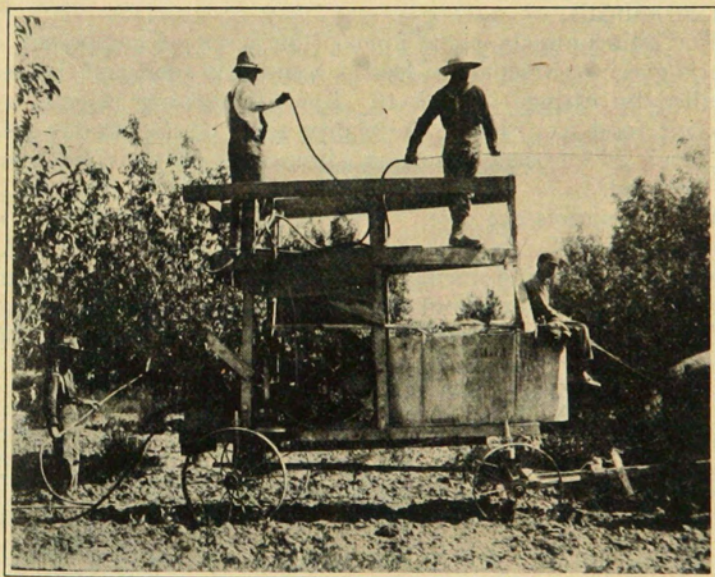
small it has a long spine on the last body segment. When nearly full grown the spine is represented by a shining black spot.

Remedies.—Hand picking will usually keep the insect in control. The arsenicals, 2, 4 and 5, are quite effective.

SWEET PEAS

RED SPIDER.—Many growers of this common flower find the lower leaves turning yellow and falling, and the vines stopping growth. This is usually due to the work of the Red Spider.

For description and remedies, see under Peach Foliage. Frequent drenching with the garden hose will do much to keep the spider in check and prevent its injuries.



Spraying from a home-made tower.

PART II.

INSECTICIDES--THEIR PREPARATION AND USE

There are two general classes of insecticides: Those used against insects which have jaws and bite off and eat parts of the leaves, fruit or whatever they feed upon, and those used against sucking insects that have mouth parts in the form of a beak or slender tube through which they draw the juices of plants or the blood of animals.

For biting insects, some form of an arsenical compound, such as Paris green or arsenate of lead is commonly used and the insects are killed by eating the poison. For the sucking insects, which take their food from inside the plants, some of the contact insecticides, such as kerosene emulsion, lime and sulphur, or tobacco, must be used.

Contact sprays are often very effective in destroying the eggs of insects, especially those that winter over in the egg stage, as this will permit of spraying during the dormant season, when a stronger solution can be used without injury to the plants.

Insecticides are generally used in one of three forms—liquid spray, powder, and fumes or vapor.

SUBSTANCES THAT KILL BY BEING EATEN

Arsenic in some of its compounds is the cheapest and most efficient poison used. As a very small amount of soluble arsenic is injurious to vegetation, only the insoluble compounds can be used.

I. WHITE ARSENIC

Pure white arsenic, arsenic trioxid (As_2O_3), which comes in the form of a white powder, is the cheapest form in which arsenic can be obtained, but since in this form it is soluble in water, it can not be used as an insecticide where it is applied directly to vegetation

2. PARIS GREEN

This is an arsenite of copper. It contains about 58% of arsenic (As_2O_3). The National Insecticide Law requires that it contain at least 50% of arsenic trioxid.

For many years this was a standard arsenical insecticide for orchard use, but owing to the danger of injury to foliage, from some soluble arsenic present, it has been largely replaced by less soluble arsenical compounds.

Paris green is often used in the dry form for dusting on plants. In this case it is better to dilute with some other material, such as flour, slaked lime, or plaster.

A good proportion is:

Paris green	1 pound
Common flour, lime or plaster.....	25 pounds

The flour will prove better than the other materials, as it will not be distasteful to insects and will adhere better to foliage.

When the Paris green is applied in a watery spray, the most common strength is:

Paris green	1 pound
Water	160 gallons
Lump lime	2 pounds

For stone fruits it is safe to use 200 gallons of water. Make the Paris green into a paste, then slake the lime in a small amount of water and add to the Paris green. Dilute until it can be strained into spray tank. Keep the liquid thoroughly stirred during application, as the Paris green settles out very quickly.

3. POISON BRAN MASH

The following poison bran mashes have been found quite effective in destroying grasshoppers in orchards and vineyards, and army worms and cutworms when abundant:

White arsenic or Paris green.....	1 pound
Bran	20 pounds
Syrup	2 quarts

This formula has been used for a number of years, but Professor George A. Dean of Kansas has developed the following formula that is highly recommended:

Paris green	3 pounds
Bran	50 pounds
Syrup (cheap)	4 quarts
Water	5 gallons
Lemons	10

Mix the Paris green and bran together while dry; dissolve the syrup in the water; squeeze the lemons into this and finely chop the peel and pulp and add them also; pour this mixture into the bran and Paris green, and stir so as to dampen the mash thoroughly. The lemons may be prepared by putting them through a meat grinder. Distribute the mixture broadcast in as fine particles as possible where the grasshoppers are most abundant. The application should be made towards evening or early (between 4 and 7 o'clock) in the morning. From 3 to 5 pounds of dry bran is usually sufficient for an acre of land. Never distribute in little piles. For army worms, distribute more freely just ahead of the line of march.

4. ARSENATE OF LEAD

Arsenate of lead (paste).....	3 to 6 pounds
Water	100 gallons

It is better to purchase arsenate of lead than to attempt to make it. This is the standard spray for codling moth and other biting insects. It has replaced the other arsenicals in practically all cases.

This poison is so completely insoluble in water that it can be used in most any strength without injury to foliage or fruit. The fineness of the particles causes it to settle very slowly, and consequently it can be more evenly distributed than most arsenical compounds. In adhesiveness it is superior to other arsenicals, but has the fault of not killing as quickly as Paris green.

Arsenate of lead is sold both in the form of a paste and as a powder. Under the national insecticide law, the paste must not contain more than 50% water and must contain arsenic equivalent to 12½% arsenic trioxid (As_2O_3). The water soluble arsenic must not exceed the equivalent of three-fourths of one percent of arsenic.

The paste has been more generally used than the powder, but if the powder is fine enough to remain in suspension when mixed with water, the results will be as good. One pound of powdered arsenate of lead is equivalent to two pounds of the paste form.

In preparing both the paste and powder forms for the spray tank, mix them first into a very thin paste. Never throw them as a mass into the spray tank.

5. ZINC ARSENIC

This is an arsenical compound that is comparatively new as an insecticide. It is being quite extensively used on the Pacific coast as a substitute for arsenate of lead. This is a light, fluffy powder containing arsenic equivalent to 40 percent arsenic trioxid. It goes into suspension in water very readily and remains in suspension better than arsenate of lead or Paris green. In 1912, severe burning resulted in many apple orchards on the Western Slope, where it was being tried out by the growers. One pound is equivalent to three pounds of arsenate of lead.

6. BORDEAUX MIXTURE AND THE ARSENITES

Bordeaux mixture has been a standard fungicide for many years, and besides the fungicidal properties, it acts as a repellent to certain insects, especially the flea-beetles. It has also been demonstrated that it has the effect of lessening the burning effect of Paris green, arsenite of zinc and other arsenicals, without injuring

their poisoning qualities. Such a mixture will destroy both insects and fungi at one application.

A standard formula for Bordeaux mixture is:

Bluestone (copper sulphate).....	4 pounds
Lime (unslacked)	5 pounds
Water	5 gallons

Dissolve the bluestone by suspending it in a sack in water, then dilute to 25 gallons. Slack the lime into an even creamy paste and then pour it into the bluestone solution slowly and dilute to 50 gallons. Never add the concentrated lime solution to the bluestone solution until the latter has been diluted.

If poisons are to be used with the Bordeaux, use them according to the proportion given for the different poisons, considering the Bordeaux as water.

7. WHITE HELLEBORE

Hellebore is a yellowish-white powder made from the roots of a plant (*Veratrum album*) belonging to the lily family. It, being a vegetable poison, is not injurious to foliage. It is very effective against certain insects, especially the slugs which are the larvae of saw flies.

When exposed to the air, hellebore loses its strength, so a fresh article should always be demanded. Due to this fact, it is considered safe to use it on ripening fruit. It is often used on the cherry to control the cherry slug up to picking time. It is applied both dry and in water. When applied dry, it may be used without dilution.

When applied in water use:

White hellebore	1 ounce
Water	3 gallons

SUBSTANCES THAT KILL BY EXTERNAL CONTACT

Contact insecticides are especially effective against soft-bodied insects.

Contact sprays have been developed, primarily, to use against sucking insects, but many of the chewing insects may be destroyed by them. To get results, thoro spraying must be done, as only those insects that have the material thrown directly upon them will be killed.

8. SOAP

Soap solutions are often used as contact insecticides against plant lice. Quite often, if one has only a few small trees or bushes in the garden, they may be treated with a solution of ordinary laundry soap, one pound to six gallons of water.

The whale oil or fish oil soaps are more effective. Use one pound to six to ten gallons of water.

9. FISH OIL SOAP (HOME MADE)

Slingerland and Crosby in their "Manual of Fruit Insects" give the following formula for the preparation of fish oil soap:

Caustic Soda	6 pounds
Water	$\frac{1}{2}$ gallon
Fish oil	22 pounds

"Completely dissolve the caustic soda in the water, and then add the fish-oil very gradually under constant and vigorous stirring. The combination occurs readily at ordinary summer temperatures and boiling is not necessary. Stir briskly for about twenty minutes after the last of the oil has been added."

Use:	
Soap	1 pound
Water	6 to 10 gallons

10. KEROSENE EMULSION

Soap (whale-oil or common soap)	$\frac{1}{2}$ pound
Water	1 gallon
Kerosene	2 gallons

Dissolve the soap in the water by boiling. Remove from the fire, and while still hot mix with the kerosene. Agitate vigorously by driving it thru a spray pump until the oil is well emulsified and a uniform cream-colored mixture is produced. Small amounts may be emulsified by stirring vigorously, or by using a rotary egg-beater.

Dilute this stock solution by using 1 part to 10 or 12 parts water for a summer spray. For use on dormant trees, use 1 gallon of the stock solution to 5 to 7 gallons of water.

The strength of an oil emulsion depends upon the percent of oil it carries. The strength of the emulsion to use is often indicated by this percentage.

To obtain the amount of dilution to secure a certain percent, divide the percent of kerosene in the stock solution by the percent desired in the diluted emulsion and the result will be the amount to which one gallon should be diluted. As one gallon of the stock solution made according to the above formula will carry 66 2-3 percent of kerosene, to obtain the amount to which it should be diluted to get a 12 $\frac{1}{2}$ percent emulsion, divide 66 2-3 by 12 $\frac{1}{2}$, which gives 5 1-3. One gallon diluted to make 5 1-3 gallons will give a 12 $\frac{1}{2}$ percent emulsion.

Summer sprays should carry from 5 to 7 percent kerosene, and sprays for dormant trees from 10 to 15 percent.

11. KEROSENE AND CRUDE PETROLEUM

These oils are sometimes used pure as insecticides. Some years ago they were used quite extensively in parts of the East in special spraying machinery that diluted them with water as they were being applied to the trees. Other sprays equally effective and

much safer to use on trees have taken their places. Many growers use them in painting or swabbing the clusters of woolly aphid that gather about wounds on apple trees.

12. SOLUBLE OR MISCIBLE OILS

There are several concentrated oil emulsions on the market known as soluble or miscible oils. These are used almost entirely as dormant sprays against the scale insects and certain other insects that winter over in the egg stage on the trees. They are subject to the same criticism as all other oil sprays, that of being more or less injurious to trees under certain conditions. To lessen the danger of injury, they should be applied only while the trees are dry and the temperature fairly high, at least several degrees above freezing. In their work in the Eastern states, they have found the danger of injury less if applied after the sap begins to flow, and just before the buds open.

Only "soft" water should be used in any of the oil sprays, as a very small amount of alkali will tend to break down the emulsion and give free oil.

13. GASOLINE

Gasoline is sometimes used as an insecticide. Its chief use is against bed-bugs. It is destructive to both the adults and eggs. It is applied pure by means of an oil can or hand atomizer. Keep all fire away until the building has been well aired.

14. TURPENTINE

Turpentine is used the same as gasoline, and the same precautions apply. It is more deadly to bed-bugs.

15. LIME

Lime, either wet or dry, is of very little value as an insecticide. It is sometimes used to dust trees that are infested with the cherry and pear slug, it causes slugs to drop off and most of them perish. Any other fine dust will have the same effect.

Whitewash on trees destroys very few insects but often prevents sun scalding. A good wash for this purpose is made in the following proportions:

Lime (lump)	30 pounds
Tallow	4 pounds
Salt	5 pounds
Water to make it flow well.	

The Government recommends the following formula:

Lime (unslaked)	40 pounds
Salt	15 pounds
Rice flour	3 pounds
Spanish whiting	$\frac{1}{2}$ pound
Glue	1 pound
Water	5 gallons

Slake the lime and strain. Boil the rice and dissolve the salt and glue in warm water. Add the materials to the slaked lime in

the following order, stirring well all the time: Salt, boiled rice, Spanish whiting, glue and water. Let stand for a few days before using, then apply hot.

16. LIME-SULPHUR WASH

This is the safest and most effective spray that can be used against the San Jose and other kindred scale insects.

The old formula that is still quite generally used is:

Lump lime	20 pounds
Sulphur	15 pounds
Water	50 gallons

The lime is slaked with hot water in the kettle or cooking vessel, the sulphur is then stirred in and about one-half of the water added, then cooked from 50 to 60 minutes, or until the liquid becomes of a dark red color, when it is ready to dilute to 50 gallons and use. Best results are obtained when it is applied while hot.

17. HOME-MADE CONCENTRATED SULPHUR

Fruit growers who have considerable lime-sulphur spraying to do can make their own concentrated solution. This can be made and stored in tight barrels for future use, and if properly made and diluted according to the amount of sulphur it carries, it is just as effective as the commercial preparations.

With the present prices of the commercial products the grower will find the home-made solution much cheaper, except for the original outlay for a cooking plant and storage barrels.

In making this mixture the same methods are used as given above for making the dilute solution, but the following formula is used:

Lump lime (pure)	40 pounds
Sulphur	80 pounds
Water	50 gallons

Use only the best grade of pure lump lime. In boiling, never allow the water to get below 50 gallons, as this amount is required to carry the sulphur in solution. A mark showing the 50-gallon line should be made on the kettle or on the stirring paddle. If the mixture is to be stored for future use, strain into an air-tight container and keep where it will be above the freezing point.

Home-made concentrates are apt to vary more in strength or density than the commercial brands. For this reason, each cooking should be tested and diluted according to the amount of sulphur in solution. This test is made by the Baume hydrometer, an instrument made for testing the density of liquids.

The hydrometers are manufactured by the Bausch & Lomb Optical Company, Rochester, N. Y.

The following table, taken from Bulletin 330, New York Agricultural Experiment Station, will be found useful in making dilutions from the hydrometer readings.

Reading on Degree	Hydrometer, Baume.	Specific gravity.	With each gallon of concentrate use for San Jose Scale.
35	1.3181	9 gallons water
34	1.3063	8½ gallons water
33	1.2946	8 gallons water
32	1.2831	7¾ gallons water
31	1.2719	7½ gallons water
30	1.2608	7 gallons water
29	1.2500	6¾ gallons water
28	1.2393	6½ gallons water
27	1.2288	6 gallons water
26	1.2184	5¾ gallons water
25	1.2083	5½ gallons water
24	1.1983	5¼ gallons water
23	1.1885	4¾ gallons water
22	1.1788	4½ gallons water
21	1.1693	4¼ gallons water
20	1.1600	4 gallons water
19	1.1507	3 2-3 gallons water
18	1.1417	3 1-3 gallons water
17	1.1328	3 gallons water
16	1.1240	2 4-5 gallons water
15	1.1153	2½ gallons water

18. TOBACCO

Tobacco in one form or another has come to be one of the most generally used and the most effective insecticides. In the shape of a fine powder it is sometimes used against flea-beetles; the dust made from the stems is one of the best remedies we have for woolly aphid on the roots of the apple trees.

19. TOBACCO EXTRACTS

There are several commercial tobacco preparations on the market. Those most generally used are "Black Leaf 40" and "Nicofume". These both contain about 40 percent nicotine, which is the poisonous principle in tobacco. This is one of the most deadly poisons known. It is soluble in water and entirely volatile when pure. In "Black Leaf 40", the nicotine has been treated to form a sulphate which is non-volatile. "Black Leaf 40" is used in strengths varying from 1 part to 800 parts of water to 1 part to 1,200 parts. Three pounds of soap added to each 100 gallons will make it spread and stick better. When used against the woolly aphid, the soap will aid the mixture to penetrate the woolly covering of the lice.

"Black Leaf 40" can be combined with arsenate of lead and lime-sulphur sprays, but should not be used with arsenite of zinc.

"Nicofume" is used almost entirely for greenhouse insects. The nicotine being volatile, it will not stay on the plants long. Its principal use is to soak material from which a smudge is made. The nicotine is driven off and destroys the insects.

Tobacco decoction is sometimes made by steeping 1 pound of tobacco in 4 or 5 gallons of water. Do not boil, as this will volatilize the nicotine.

20. SULPHUR

Flowers of sulphur has been found to be very destructive to the mites and red spider. It can be dusted on the plants in the dry form or may be mixed with water, 1 pound to 3 gallons, and used as a spray. First stir the flowers of sulphur into a small quantity of soapy water and then dilute to the desired proportion. The mixture must be stirred vigorously, as the sulphur settles very quickly.

21. HOT WATER

Hot water may be employed to kill insects and eggs upon dormant nursery stock. Temperatures from 135 to 145 degrees for 10 seconds are usually harmless to dormant plants, and will kill all aphid eggs.

In some tests made at the college, those trees submerged for 10 seconds in water of 145 degrees were slightly injured, but 5 seconds in this temperature killed plant lice eggs, and showed no injury to the stock. One hundred thirty degrees was not very effective on some eggs treated. Probably the safest and most effective temperature is 135 to 140 degrees, with 10 seconds submergence.

SUBSTANCES THAT KILL BY BEING INHALED

22. CARBON BISULPHIDE

This is a colorless liquid with a very disagreeable odor. It is very volatile and the fumes are poisonous to both plant and animal life. Its chief use as an insecticide is against household and granary pests, borers and under-ground insects. For household and granary pests, use 1 pint to each 1,000 cubic feet of space or for each 100 bushels of grain. Place in shallow vessels so it will evaporate quickly. Keep building closed for 24 to 36 hours.

For borers by means of an oil can, squirt a few drops of carbon bisulphide into openings made by the borer, then plug with mud. Ants can be destroyed by punching a hole or two in their nests and pouring in 1 or 2 ounces of the liquid, after which the hole should be closed, and a wet blanket thrown over the hill. It is sometimes used against the woolly aphid on apple roots by making several holes 6 to 12 inches deep and about a yard apart about the tree and pouring 1 or 2 ounces of the liquid into each hole. Close the holes immediately.

Caution: Keep all fire away while using this material, as the gas is very explosive when mixed with air.

23. HYDROCYANIC ACID GAS

This is the standard fumigant for most horticultural purposes, and is often used to destroy insects in dwellings and mills. Many

states require all nursery stock sold within the state to be fumigated with this gas.

The following formula has been adopted in most states as the standard for fumigating nursery stock :

Potassium cyanide (of 98 percent purity).....	1 ounce
Commercial Sulphuric acid	2 ounces
Water	4 ounces

The above quantities are sufficient for 100 cubic feet of space. Submit the nursery stock to the fumigation for from 40 to 60 minutes. For fumigating dwellings, mills, clothing, and the like, it may be used even stronger, and should run several hours.

This gas is sometimes used in fumigating greenhouses, but as there is great danger of it injuring the tender plants, it should be used only by those of experience. For this purpose, the quantities given in the above formula are used to each 1,000 cubic feet of space. Fumigate only at night, and while plants are dry, as sunlight and moisture make the gas more injurious to vegetation. Leave the house closed for 5 or 6 hours before airing, and air well before entering. In mixing the materials, use only an earthen or wooden vessel, and add the materials in the following order :

First, put in the water, then add the acid slowly. Put the required amount of cyanide in a thin paper bag, and when all is ready, drop it into the liquid and leave the room as quickly as possible. The gas is very poisonous and almost odorless. One breath of it when strong may mean death. Never enter the fumigation room until it has been aired 30 minutes.

All buildings should be made as tight as possible before fumigation starts. Nursery stock may be fumigated in a tight box or a house prepared especially for this work. Such a house should be built with two thicknesses of matched boards, with building paper between. Ventilators should be provided and doors made tight-fitting.

Handle the potassium cyanide with great care, remembering it is a deadly poison.

REPELLANTS

24. NAPHTHALENE FLAKES, GUM-CAMPHOR, AND MOTH BALLS

These are used as repellants against fleas, clothes moths, museum pests, chiggers, etc. Scatter the repellants about the infested materials. They are often used in insect boxes and packed in with furs, feathers, and woollen goods to keep out insects that feed upon these animal products. They are not used to kill insects.

25. COMMERCIAL REPELLANTS

There are several commercial repellants upon the market that are of some value in protecting stock from flies. These can be secured at most any drug store.

26. ASHES

Wood ashes, dusted upon plants while they are moist, has the tendency to keep certain insects away, especially flea-beetles and cucumber beetles. It does not kill the insects, but makes their food distasteful.

27. LIME, PLASTER AND ROAD DUST

These are used like ashes as repellants against flea-beetles and cucumber beetles, but are of little or no use in destroying insects, except, possibly, the pear and cherry slugs.

INSECT TRAPS

28. LIGHTS

Many night-flying insects are attracted by lights. The lights are placed over a vessel containing water with kerosene over the surface. The insects fly against the lights and fall into the kerosene and water. Many beneficial insects are also destroyed in this way, so it is doubtful if it is very practical except in rare cases. Not all night-flying insects are attracted by lights. Such an insect is the codling moth. Some of those that can be caught in this way are the adults of the army-worm, cut-worms, corn, or boll-worms, and the beet web-worm.

29. BANDAGES

Burlap or other heavy cloth bands placed about the trunks of apple trees are very useful in capturing the larvae of the codling moth, as they leave the fruit and search protected places to spin their cocoons. If the loose bark is scraped from the trees, 50 to 60 percent of the larvae leaving the fruit can be caught. This is a very important help in cleaning up a badly infested orchard.

The bands should be of three thicknesses of cloth. Wrap the band loosely about the trunk, lap the ends, and fasten with a tack. They should be placed on the trees by the 15th of June. Remove them every ten days until the 20th of August, and kill all larvae, then remove when convenient after picking time.

30. HOPPER-DOZERS OR HOPPER-PANS

The hopper-dozers are useful in catching the jumping insects, especially grasshoppers. They consist of a large pan carrying water with kerosene on it, so arranged that it can be drawn across the field by a horse. The back of the pan should be extended until it is four feet high. The insects jump against this and fall into the water and oil.

31. STICKY MATERIAL

Bandages of sticky material are often placed around the trunks of trees to keep insects from climbing to the branches. The most common of these is "Tree Tanglefoot", manufactured by O. & W. Thum Co., Grand Rapids, Michigan. Printer's ink or any other sticky material may be used. Where any oily substance is used, it should be put on a heavy paper bandage so as not to come in contact with the bark of the trees.

THE APPLICATION OF INSECTICIDES

THE PUMPS

Much of one's success in controlling any of the insects will depend upon the efficiency of his spraying machinery. The spraying must be thoroly done, and at the right time, to bring results. All pumps and supplies should be on hand and in good condition before it is time to start the work. The insects will not wait upon the tardy fruit grower.

Do not make the mistake of getting too small a pump. Small hand pumps have their place in spraying shrubbery and garden vegetables, but should not be purchased for orchard work. The larger hand pumps fitted to a barrel will do fairly good work in an orchard of medium to small trees, but in a commercial orchard the labor of pumping is too great, and is almost sure to result in a poor job being done. In such orchards, gasoline power outfits are most useful. They will carry a higher, more uniform pressure and do the work more cheaply. It is a matter of economy to use tanks that will hold 200 or 250 gallons.

All pumps should be fitted with brass valves, as the materials used will corrode valves made of other metals and harden and decompose leather valves. It is important to have the barrel or tank fitted with an agitator that will keep the liquid well stirred so the materials in suspension will not settle. The hose to which the nozzles are attached should be light as possible, yet strong enough to stand the high pressure.

APPLICATION OF DRY INSECTICIDES

There are various dust sprayers, both large and small, upon the markets. They are planned to distribute the dry insecticides upon the plants. The worst objection to these, especially the smaller ones, is that they do not feed regularly, hence do not give a uniform flow of powder.

Small trees and low plants can be treated by dusting the powder through a cheese cloth bag, but it will reach the upper surface of the leaves only. It is best to apply the dust early in the morning, or in the evening, when there is sufficient moisture to cause it to stick where it falls.

HOW TO SPRAY

Lack of thoroughness in spraying causes more failures than any other one cause. If insects are to be killed by poisoning, it is important to cover all their food with the poison; if they are to be killed with a contact spray, it must hit the insect. The first requisite is a man to hold the nozzle who knows what thorough spraying is and is not afraid to do it. The second is a pump that will give plenty of pressure, and the third is a nozzle that will break the liquid into fine particles. The liquid should be strained into the barrel or tank, so there will be no solid particles large enough to clog the nozzle.

With the poison insecticides, the best results follow when the leaf is covered most completely and uniformly with the spray mixture. This is best done by making a spray fine enough so that it will fall on the leaf in mist-like particles and dry there. The aim should be to cover every leaf in this way. In order to do this, it will be necessary to spray the tree from all sides and angles. Do not make the mistake of having the spray so fine it will not carry into the tree enough to reach the inner limbs.

In applying the contact insecticides, the spray should be coarse enough to wet the insects when it strikes them and to penetrate the woolly covering that some insects have.

In applying the first spray for the Codling Moth, when the object is to fill the calyx cups of the little apples with the liquid, the best results are obtained with a medium coarse spray that will thoroughly wet all parts of the blossom end of the fruit. By this is not meant a spray made up of coarse drops, but one that is broken into fine particles, but still with body enough to carry 8 or 10 feet from the nozzle without going into a mist or fog.

It is important to have the nozzle on an 8 foot rod, at least, and at an angle of about 30 degrees. This will permit one to reach the higher parts of a tree and spray them from different angles. When spraying large trees, the work is greatly facilitated by having a tower arranged on the machine so that one man can spray from an elevated position. This is especially important in putting on the first Codling Moth spray. At this time a large percent of the little apples are directed upward and the spray can be thrown directly into the calyx cups.

NOZZLES TO USE

There are two types of nozzles that are used extensively, the Bordeaux type that throws a flat spray, the fineness and volume of the spray being regulated by the size of the stream that is thrown against a flat face of the nozzle; and the Vermorel or whirl-nool type that throws a cone-shaped spray which may be graded from coarse to fine, depending upon the pressure and the size of the aper-

ture in the plate. The latter have been greatly improved by giving them a center drive that produces a solid cone of spray, instead of the hollow cone. With the solid cone there is less likelihood of missing parts of the plants, and the wind does not catch the spray as badly. Good work can be done with both types of nozzles.

STATION BULLETINS

All available bulletins will be sent free on request to residents of this State.

The following are bulletins that are available at the present time:

No.	Title
135.	A Few Orchard Plant Lice.
150.	Measurement and Division of Water.
157.	Arsenical Poisoning of Fruit Trees.
168.	Deterioration of Manures Under Semi-Arid Conditions.
169.	Some Insect Mites Attacking the Peach in Colorado.
170.	Thinning the Winesap.
172.	Garden Notes.
173.	Notes on a Dry Land Orchard.
176.	Productiveness and Degeneracy of the Irish Potato.
177.	Hold-over Blight in Pears.
182.	Colorado Climatology.
183.	Deterioration in Quality of Sugar Beets.
186.	Fixation of Nitrogen in Colorado Soils.
187.	Feeding Experiment with Lambs.
188.	Ration Experiments with Swine.
189.	Cost of Beef Production on Enclosed Range.
190.	Variation Studies in Brome Grass.
192.	Home-made Cider Vinegar.
193.	Nitrifying Efficiency in Colorado Soils.
194.	Frictional Resistance in Artificial Waterways.
195.	Small Fruits for Colorado.
196.	Some Soil Changes Produced by Micro-organisms.
198.	Onion in Colorado.
199.	Vegetable Growing in Colorado. Common Insects of the Garden
200.	Silos and Silage.
201.	Mushrooms.
203.	Farm Costs on the Colorado Agricultural College Farm.
205.	Yellow-berry in Wheat.
206.	Spur Blight of the Red Raspberry.
207.	Some Miners' Inch Measuring Devices.
208.	A Study of Colorado Wheat.
209.	Irrigated Agriculture in the San Luis Valley.
210.	Insects and Insecticides.
211.	Colorado Plants Injurious to Livestock.
212.	Fungous Diseases of Colorado Crop Plants.
213.	Poultry Raising in Colorado.
214.	Forage Crops for Colorado Plains.
216.	Studies of Health In Potatoes.