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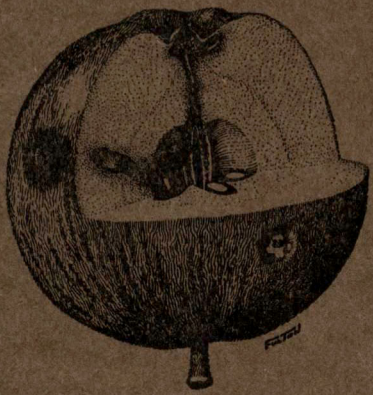
Oregon Agricultural College
Experiment Station
DEPARTMENT OF ENTOMOLOGY

Fruit Grower's Handbook of Apple and Pear Insects

Revised, 1922



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CORVALLIS, OREGON

This handbook is one of the results of the work of the Crop Pest Investigations provided for by Chapter 286, Session Laws of Oregon, 1919.

Oregon Agricultural College

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Department of Entomology

Fruit Grower's Handbook of Apple and Pear Insects

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Fruit Grower's Handbook of Apple and Pear Insects

FOREWORD

This circular is written for the use of the practical fruit grower. Our endeavor has been to deal with the essential facts that will assist the grower to recognize his insect enemies and intelligently combat them. Often the injury is typical and more conspicuous than the insect itself. When the grower has familiarized himself with the pest and its work he may discover that some insect formerly unnoticed is causing serious losses, and can govern his spray practices accordingly.

The keys to insect pests and the charts have been prepared with painstaking care. At first glance they appear complicated. They are inserted because it is believed they will prove of assistance in using this book to the best advantage. A few minutes spent in mastering the principle involved will reveal in them a mass of concentrated information.

For convenience, the insects and the types of injury they produce are divided into three main groups. A key is given at the head of each group. To facilitate identification, some of the insects are mentioned in two or more of

the keys. A further discussion of them will be found under the division to which they seem most naturally to belong. The three main groups are as follows:

*For the convenience of those who are unfamiliar with the workings of a "key" of this nature, it may be stated that the key is arranged in a series of "steps" or symbols of equal rank. In using the key, therefore, we proceed from one symbol to the next of equal rank, skipping all subheads, until we reach one fitting our specimen. We then drop to the subhead, or second-rank step and again follow steps of equal rank, etc.

For example, in Part III: We will suppose you have discovered the trunk and branches of a tree with "shot-holes" extending into the wood. Referring to the key—Symbol A. "Affecting the Roots"—No. Skip to next step of equal rank B. "Affecting trunk and branches" —Yes. Reading in succession, the succeeding subhead steps, 1, 2, 3, 4 do not fit, but 5—"Borers in wood" fits our case. Then, in succession, the sub-steps of equal rank, a and b do not fit, but c "Small shot holes scattered over bark—The Shot-hole Borer"—distinguishes our specimen.

PART. I. INSECTS AND THEIR WORK ON FRUIT

A. Pink worm feeding in flesh of fruit around core, with tunnel leading to surface.
Codling-moth. Page 7.

B. Long winding mine just under the skin.
Apple Miner. Page 18.

C. Cluster of small apples wrinkled around calyx end.
Rosy Apple-aphis. Page 23.

D. Flat scales fastened to skin of fruit, usually surrounded by a red discolored spot.
Scale Insects. Pages 52-54.

E. Funnel-shaped pits or dimples sometimes accompanied by small, irregular russeted area.
Plant Bugs. Page 17.

F. Holes or cavities in side of young or growing fruit.
1. Skin removed in irregular patches.
Syneta Leaf-beetle. Page 42.
2. Large deep cavities. May be caused by several insects.
Leaf-rollers. Page 13.
Fruit--worms. Page 16.
Bud-moth. Page 26.
Canker-worms. Page 41.
Tussock-moth. Page 37.

G. Holes in ripe or nearly mature fruit.
1. Shallow holes or irregular patches usually under a leaf fastened to surface.
Bud-moth. Page 26.
Leaf-roller. Page 13.
2. Small hole usually surrounded by small patches of mines near the surface. Codling-moth, second brood.

H. Rough scars or scabs on surface of mature fruit.

1. Irregular russeted patches not in a depression.
   Syneta Leaf-beetle. Page 42.
2. General or mottled russeting of skin over a large area.
   Pear-thrips. Page 31.
3. Brown scars usually in a depression, and fruit more or less distorted. Due to early feeding of caterpillars.
   Leaf-roller. Page 13.
   Fruit-worms. Page 16.
   Bud-moth. Page 26.
   Tussock-moths. Page 37.
   Canker-worms. Page 41.

I. Plug of dried mud over calyx, concealing white grub.
   Solitary Wasp. Page 18.

CODLING-MOTH OR APPLE-WORM[1]

The Injury. Injury by codling-moth is too well known to require description. The tunnels through the flesh and core of the fruit, the pinkish white worm with a straw-brown head, the conspicuous emergence hole, and the tell-tale excrement about the entrance puncture are familiar to all growers of apple and pear.

It is estimated that the codling-moth costs the fruit growers of the United States $16,000,000 a year, one-fifth of this amount chargeable to cost of control. In Oregon the annual loss is about $660,000, the cost of control being an additional expense of nearly $240,000.

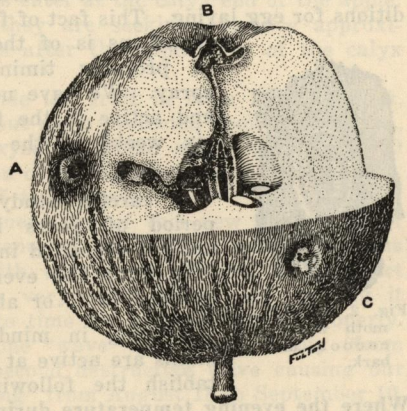


Fig. 1. Codling-moth. A. Exit hole. B. Entrance hole in calyx. C. Side entrance.

Seasonal History. Control to be successful must correlate with the seasonal activities of the insect. A careful study of the seasonal history of the codling-moth is, therefore, especially important.

Winter is passed as mature worms in cocoons under loose bits of scaley bark (Fig. 2), and in cracks and crevices on the trunk and main crotches. The cocoon is composed of silken threads, thin and tough, with bits of bark and dirt mixed in, making it inconspicuous. This cocoon is impervious to moisture and to reasonable changes

[1]Cydia pomonella.

in temperature, so that adverse weather conditions have little deleterious effect.

Worms change to chrysalids within the cocoon at about the "pink" stage of fruit blossom. Adults begin to emerge about the time the calyx spray is applied though the main brood is generally somewhat later. The moths are active just at twilight and are seldom observed in the field. They mate, and females then await favorable temperature conditions for egg laying. This fact of favorable temperature conditions is of the utmost importance in properly timing our "thirty-day" spray. We have noticed moths present and active in the field for a period of six weeks in the spring before eggs were laid.

Fig. 2. Codling-moth worm in cocoon under bark.

A careful study extending over a period of years indicates that eggs are not deposited in any numbers in the field until the evening temperature is 60 degrees F. or above.

Keeping in mind the fact that the moths are active at twilight we may establish the following conditional rule. **Where the evening temperature during May, at 8:00 p.m. is 60° or above, the first-generation codling-moths may be expected to deposit eggs.** Consequently, when this temperature of 60° at 8:00 p.m. is registered, it is the **proper time* to apply the "thirty-day" codling-moth spray.**

The eggs are small, flattened, translucent, like minute droplets of milk. They are placed on either surface of the leaf, on the bark of small terminal twigs and fruit

* The foregoing rule should be modified to this extent: Where evening temperatures reach 60° for only one or two nights, with a subsequent sudden drop to prevailing cooler temperatures, delay the spray application, awaiting more uniform evening temperature conditions of 60° or above.

spurs. Eggs hatch in 8 to 16 days. Young worms are white, with a black head disportionately large for the body. They may feed on the surface of leaves for a time, but soon seek out young fruits and tunnel their way inside. In the case of the apple, probably because of its downiness while small, from 30 to 85 percent of these first-generation worms enter at the calyx end of the apple. Note the fact that they are seeking entrance approximately 30 to 40 days after the application of the calyx spray.

Worms mature inside the fruit in from 3 to 5 weeks, leave fruit and seek out some protected spot, spin cocoon, and transform to chrysalis. Pupal stage lasts about 10 days. New generation of moths emerge and deposit eggs. These eggs hatch in 7 to 10 days.

The time of the emergence of this new generation of moths and the occurrence of the summer brood of worms will vary greatly with the season. Often, and in fact usually, the brood is very much drawn out, making it particularly difficult to time the summer sprays properly. Often there will be one "wave" of worms in July (from 1st to 20th) and a second destructive wave causing our costly "September sting" from August 18 to September 10.

Only breeding-cage records will determine these points and, because of the pressure of other duties, growers are at a disadvantage in attempting to get the facts. Advice on summer sprays should therefore be obtained, if possible, from reliable sources: your county agent, fruit inspector, the Experiment Station, or trained experts. In the absence of this source of information for your locality, **keep the fruit covered with a protective poison spray.**

Control

Some knowledge of the seasonal history (see above), a reasonably efficient outfit in good working order, and a willingness to observe care and take time to be thorough in the application of the spray are factors essential to successful control.

Lead arsenate is the standard poison material. Four applications of poison are generally necessary; in the exceptional season or locality it may require three to five. The powdered arsenate is usually the preferable form. The standard dilution is 3 pounds to 200 gallons of spray solution. Increasing the dosage to 5 to 200 in the late August spray is frequently practiced.

Applying codling-moth sprays by rote or by the calendar is not in keeping with our present knowledge of this pest. There are variations of from 3 to 6 weeks in worm activity in succeeding seasons. The following discussion is important.

The "Calyx spray" is the first application and is applied just as the last petals are falling and before the calyx lobes on the center blossom of the cluster close. Where large areas are to be covered or where the blooming period of the varieties in a block varies somewhat, it is often necessary to begin spraying when two-thirds of the petals have fallen in order to complete the operation before the lobes close. Pay particular attention to the blossom clusters. Use a misty spray and aim the solution into the calyx cup. From 30 percent to 85 percent of the early generation of worms will seek entrance to the apple at this point. **In most varieties of the pear the calyx lobes do not close,** therefore **this first application is not generally necessary for pears.**

The "4-to-5 weeks" spray. The second application of spray for the codling-moth is termed, arbitrarily, the 4-to-5 weeks spray. The actual time of its application will vary with the locality and the season and, for maximum efficiency, is absolutely dependent on the time of egg deposition by the first generation of the codling-moth. A glance at the life-history establishes the rule. The moths emerge a few days after the calyx spray. They do not oviposit until the evening temperature at 8:00 p.m.

is 60°. Therefore, procure a standard tested thermometer and make daily readings at 8:00 p.m. **When the evening temperature** at 8:00 p.m. is 60° or above, **apply the second** codling-moth spray. Use a misty spray and plan to cover the fruit.

The July Spray. This third application for the codling-moth is for the control of the second generation of worms. The time of application will again vary with the locality and season and can be determined accurately only by breeding-cage observations. By the use of breeding cages one may make daily observations and as soon **as moths of the new generation are observed** apply the third codling-moth spray.

Fig. 3. Aphis apples.

The August Spray. This is probably the most important spray of all, certainly the most difficult to time properly. The emergence of the summer generation is usually very much drawn out, moths continuing to appear and deposit eggs until late August or early September. Often there is a heavy late emergence, giving rise to a very costly attack on the nearly mature fruit. In fruit districts of Western Oregon, this late injury has become so general and so serious that the August spray is regularly applied and considered good insurance. The time of its application varies from August 15 to September 10. We suggest increasing dosage by one-half for this spray. Get in touch with your fruit inspector or county agent for advice on timing

this spray. In the absence of this advice the rule would be to "keep the fruit covered with arsenate."

The addition of spreaders to the poison spray solution to increase its effectiveness and materials for use as spreaders are discussed on page 71. See Oregon Agricultural College Station Bulletin 169, Insecticide Investigations, pages 18-41, for detailed discussion and recommendations on spray practices.

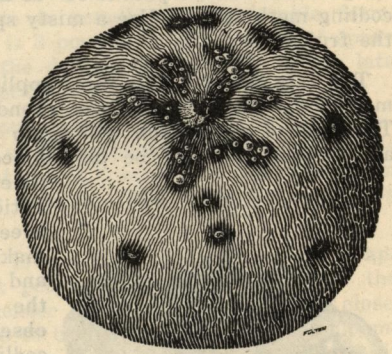


Fig. 4. San Jose scale.

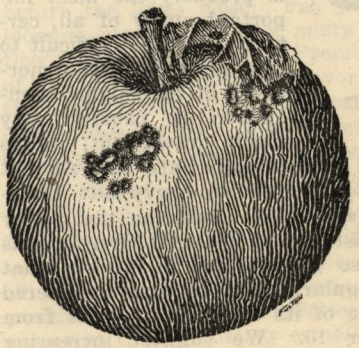


Fig. 5. Bud-moth injury.

Breeding Cages

Breeding cages for studying the generations and emergence of the codling-moth may be easily constructed and are very essential for proper control work. A little patience and as much observation as one would ordinarily bestow on the weather is sufficient to obtain the essential knowledge on the emergence of the adult moths. A fair-sized wooden box, the top covered with screen, a frame cage with a hinge door covered with screen, or any similar arrangement is sufficient.

Banding the trunks of the trees with a strip of burlap is an old and very effective system. By a glance at the inside of this band one may keep a check on the generations and incidentally kill many forms before they emerge.

The Codling-moth Trap. A slight improvement on the burlap band makes a natural trap and also furnishes a simple and easily accessible breeding cage for observation on emergence. Fold the burlap band two or three times to a width of two or three inches. Over this burlap band spread a strip of ordinary wire screen running twelve meshes to the inch. The screen strip should be six to eight inches wide and long enough to encircle the tree and lap slightly. Bend over the edges of the wire about one inch on each edge to form an elastic cushion and hold the wire snugly about the tree and up from the burlap band. Tack the upper edge in place, making it snug and form fitting. Fold the wire over the burlap band and fasten below. It is preferable to scrape all loose bark away from the tree before attaching the band. The worms may easily crawl through the openings in the screen and pupate under the burlap band. The adult moths on emerging, however, find it impossible to escape, provided the screen is carefully adjusted. One may observe them inside this screen and thus obtain valuable data on emergence. The moths are trapped and cannot seek the leaves for laying their eggs.

LEAF-ROLLERS[2]

The Injury. The work of leaf-rollers on fruit is practically identical to that of the fruit worms. Irregular cavities are chewed in the side of the young apple. A large percentage of the early injured fruit drops and that

[2]Archips argyrospila.

which remains to maturity bears sunken scars of roughened, brownish skin (Fig. 8), usually with scattered, dark corky scales adhering.

Leaf-rollers destroy many blossoms or injure them so they will not set. In summer the injury from defoliation

Fig. 6. Leaf-rollers.

may become serious although difficult to measure. Trees badly infested have a brownish appearance due to the large amount of partly devoured leaves.

Second brood larvae of one species occasionally feed on nearly mature fruit, eating shallow cavities under the protection of a leaf webbed to the apple. (Fig. 9, A). This injury does not give rise to a scar, but the exposed flesh dries with a brown hardened surface.

Seasonal History. Of the two species of leaf-rollers the Fruit Tree leaf-roller is most numerous and destructive.

It passes the winter as brown oval masses of eggs (Fig. 7) attached to the bark. Larvae hatch out in early spring and feed on young leaves and blossoms. There is but one brood a year. Moths appear in midsummer and deposit eggs. The Oblique Banded leaf-roller is often present on the same trees and has a second brood late in the summer.

Fig. 7. Leaf-roller eggs.

Control

On account of its habit of living in tightly curled leaves, this insect cannot be effectively controlled by arsenical sprays. The best remedy known is a spray of miscible oil (8 to 100) applied as the buds open in spring. A period of fair weather for several days after spraying is very important for good control. No serious injury will follow an application on fruit buds that show much green at the tip, if it is necessary to delay spraying that long in order to find a period of settled weather. A thorough coating is essential and all parts of the tree including the main branches and trunk should be covered.

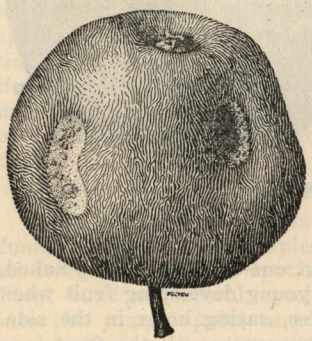


Fig. 8. Fruit-worm injury.

FRUIT-WORMS

The Injury. The full extent of injury by fruit-worms is seldom realized by the grower. The apparent injury is observed at picking time when the scar appears as a russeted area (Fig. 8), usually situated in a depression and the fruit somewhat distorted. A type of injury that frequently escapes observation is the serious attack on very small fruit. The fruit drops previous to thinning and is unnoticed. Limited observations indicate that from 12 to 40 percent of the fruit drops, and from 6 to 20 percent of the mature fruit shows the typical scars. Probably about the same amount of fruit is injured on both apple and pear, but due to the lighter set of fruit on pear the percentage of injury is higher here and the effects more apparent.

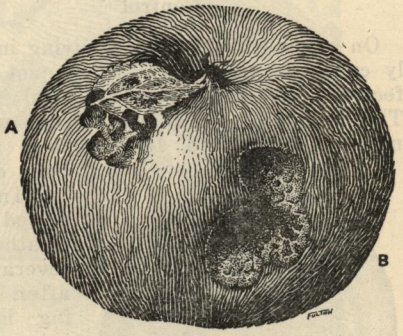


Fig. 9. Caterpillar injury. A. Late injury, B. Midsummer injury.

The fruit-worms, when about one-third-grown, as naked, green caterpillars, attack the young developing fruit when it is about the size of marbles, eating holes in the side. One worm will ordinarily injure one or all the fruit in a number of clusters.

Seasonal History. Most of these insects pass the winter as adult moths concealed in protected areas, fence rows, etc., adjacent to the orchard. The moths are active in spring about the time of the delayed dormant spray. They

deposit eggs singly at base of spurs. Larvae hatch when blossoms are in "early pink." Larvae feed for about two weeks on leaves, attacking blossoms to some extent. When feeding on the leaf they cover considerable surface area in obtaining relatively small amounts of food. When the fruit sets and for three to four weeks thereafter the worms attack the developing fruit. Ordinarily but a single meal is obtained from each fruit, so one worm may injure a great number of fruits.

The worms mature in June and early July, drop to the ground, and pupate in the soil at a depth of about 4 inches. The adults emerge in October and so pass the winter.

Control

Taking advantage of the fact that during their early existence the worms feed on the foliage, tending at this time to feed over considerable surface area, it is advised to use lead arsenate in combination with the blossom-pink application for scab at the rate of 2-100. Later applications are of little practical value. This spray is particularly advisable on pears, but our 1919 observations indicate that in well-sprayed apple orchards also, the percentage of fruit-worm injury is much higher than is that of codling-moth.

PLANT BUGS[3]

The Injury. Mature fruits of apple and pear found with funnel-shaped pits or dimples in the surface. Often with an irregular russeted spot at bottom of the depression. Plant bugs of several species insert their sucking beak into the young apples and pears and feed, causing the above effect on the mature fruit.

Seasonal History. Pass the winter as eggs in bark. Young bugs hatch in spring and feed on tender leaves and fruit. Adults appear in midsummer.

[3]Miridae.

Control

For most species, where this type of injury becomes serious, nicotine sulfate added to the blossom-pink and calyx sprays gives control if thoroughly applied.

APPLE MINER[4]

The Injury. Occasionally an apple is found with winding mines extending rather aimlessly over the surface. These mines are made by very small wedge-shaped, flattened larvae working just below the outer skin of the apple.

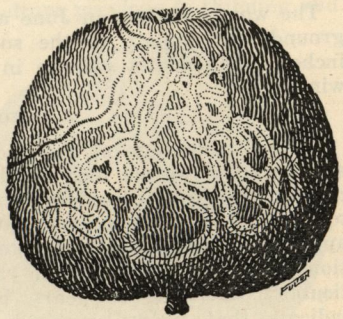


Fig. 10. Apple miner.

History and Control

Not well known. The adult is a very minute moth. Similar mines of a similar larva are common on canes of berry fruits and rose. On apple, this pest is sufficiently rare to be a curiosity and of no economic importance.

SOLITARY WASP

The Injury. Occasionally mature apples and pears are found with a smooth, compact plug of dried mud in calyx end. Opening this plug reveals a small white maggot.

History and Control. This is the work of a solitary wasp similar to the mud dauber. Fruit in no way injured. Condition sufficiently rare to be a curiosity and of no economic importance.

[4]Marmara sp.

PART II. INSECTS AFFECTING THE BUDS AND LEAVES

A. Feeding on buds.

1. Small caterpillars in opening buds.
   a. Chocolate-colored worms; tunnel into base of buds or web small leaves and blossom buds together and feed between them.
      Bud-moth. Page 26.
   b. Slender, pale green larvae.
      (See Leaf-roller, under B.)
2. Opening buds wholly or partly eaten by beetles.
   a. Elongate flat, click-beetle or "snapper."
      Bud Click-beetle. Page 45.
   b. Oval-bodied beetles with long snout. Drop to the ground and play dead when disturbed.
      Bud-weevils. Page 44.
3. Cream-colored beetles, with or without black stripe on middle line of body. Eat holes out of opening leaves and blossoms.
   Syneta Leaf-beetle. Page 42.
4. Tiny, slender, black insects, just big enough to be visible, crawling about inside of opening buds, sometimes causing them to turn brown and die.
   Pearthrips. Page 31.
5. Climbing cutworms sometimes devour buds, particularly on young trees. They work at night and while evidence of their injury is found, it is necessary to dig about in the loose surface soil adjacent to the tree to disclose the culprit as a tightly curled, naked, greasy, grey caterpillar.
   Cutworms. Page 45.

B. Feeding on leaves.
1. Conspicuous black or reddish blisters or galls on leaves.
Blister-mite. Page 29.
2. Small larvae working between the two leaf surfaces.
Leaf Miners. Page 47.
3. Leaves curled and discolored. Trees sometimes defoliated. Microscopic mites.
Foliage-mite. Page 34.
4. Small insects feeding mostly on under side of leaves.
a. Soft-bodied plant lice causing leaves to curl.
(1) Pink or brown, mostly on fruit spurs.
Rosy Apple-aphis. Page 23.
(2) Green, mostly on terminals and water sprouts.
Green Apple-aphis. Page 25.
b. Pale, slender, jumping, or flying insects on apple.
Leaf-hopper. Page 34.
c. In midsummer, leaves turn yellowish; underside shows minute spider-like creatures, reddish or greenish black, usually on webs.
Red Spider Mites. Page 32.
d. Flattened bugs with lace-like wings amid cast skins and shiny black specks of excrement.
Apple Lace-bug. Page 28.
e. Elongate, white or black insects, barely visible to naked eye. Common in blossoms. Rasp surface of leaves and may cause small holes along the veins.
Pear-thrips. Page 31.

5. Caterpillars.
a. Feeding or resting in webbed tents.
(1) Spring and early summer. Small compact tents in crotches of trunk or branches. Caterpillars feed outside of tent, devouring foliage, leaving only the midrib.
Tent Caterpillars. Page 36.
(2) Late summer. Large gauze-like tents enclosing foliage. Caterpillars feed within tent; skeletonize foliage.
Fall Web-worm. Page 38.
b. Leaves rolled or webbed together, caterpillars feeding singly within.
(1) Slender green worm, head black or brown. Wriggles backward out of rolled leaf and hangs by a web when disturbed.
Leaf-roller. Page 13.
(2) Small chocolate-colored larva hiding among closely webbed mass of young leaves, in spring.
Bud-moth. Page 26.
c. Enclosed in small hard case, shape of a cigar or a pistol.
Cigar Case-bearer.
Pistol Case-bearer. Page 46.
d. Feeding free.
(1) Hairy caterpillar with four cactus-like tufts of white hair on back and two long black brushes of hair at each end.
Tussock-moth Caterpillar. Page 37.

(2) Feeding in groups. Caterpillars with black stripes.
Yellow-necked Caterpillar. Page 40.
Red Humped Caterpillar. Page 41.

(3) Feeding at night. Sleek, greasy, hairless, gray caterpillars, concealed at base of tree during day.
Climbing Cutworms. Page 45.

(4) Fat, green or brown, hairless caterpillars, feeding on leaves and young fruit.
Fruit-worms. Page 16.

(5) Measuring worm or loopers. Naked, slender caterpillars with no legs in middle of body.
Canker-worms. Page 41.

(6) Pear only. Small, light-green larvae cutting circular holes in leaves, straddling edge of leaf where cut.
Pear Leaf-worm. Page 44.

(7) Pear. Slimy, slug-like, greenish brown, or black larva, skeletonizing leaf on upper surface.
Pear and Cherry Slug. Page 27.

APHIDS OR PLANT LICE

Apple-leaf-feeding aphids occur as small, soft-bodied creatures clustered on the under surface of the leaves. The leaves are curled and crumpled and of an oily or sooty appearance due to the honey dew exuded over the surface by the aphids.

In considering aphids of the apple and pear and their control we may divide them into two groups: (1) leaf-feeding aphids and (2) woolly aphids attacking the twigs and roots.

Of the leaf-feeding aphids the injurious forms are largely confined to the apple. Aphids sometimes occur on young pear trees in injurious numbers and should receive attention.

Bearing pear trees do not ordinarily require an aphis spray and the discussion of leaf-infesting aphids and their control is more particularly applicable to the apple. There is a woolly aphis similar to the apple woolly aphis attacking the roots of the pear in Southern Oregon. A brief discussion of this pest is given under its proper head below.

THE ROSY, BROWN, OR PURPLE APPLE-APHIS[5]

The most generally serious apple-aphis.

The Injury. Attack the unfolding leaf and blossom clusters as they open in the spring. Collect on under surface of leaves adjacent to blossoms. Also attack blossoms and very small apples. The foliage about these fruit clusters becomes cupped and tightly curled affording a protective covering for the aphids crowded within. From the attack on the blossoms and fruit and due partly to the excessive foliage injury, the apples in affected clusters become malformed and dwarfed (Fig. 3). Seriously in-

[5]Aphis sorbi.

jured "aphis apples" have a characteristic wrinkled appearance around the calyx and where not removed will remain on the tree as "mummied" fruit during the winter.

Seasonal History. The winter is passed as minute, elongate, shiny black eggs half-concealed in crevices and roughened areas on the bark, occurring most commonly on the second-year or older wood. (See Fig. 13.)

Eggs hatch as the blossom buds show tips of green in the spring. Aphids crawl to these opening clusters and begin to feed. When mature they begin reproducing living young. The rate of increase is enormous. Soon both winged and wingless forms are found clustered on under surface of curled and cupped leaves. They wander to the stems, embryo fruits, and flowers to feed.

Fig. 11. Rosy apple-aphis.

Winged aphids leave apple in early summer and fly to plaintain where they feed and breed until fall. They return to apple in fall, produce eggs, and so pass the winter.

Control

The attack begins so early and the irritation is so severe that the foliage is curled and crumpled very early in its development. It is practically impossible, as a commercial orchard proposition, to drive the spray into the curled

leaves and wet the aphids; and to kill them it is necessary that they be actually wet with the spray.

Use nicotine sulfate 40% at the rate of ¾ pint to 100 gallons of spray solution. For the sake of economy it is usually combined with one of the early lime-sulfur applications. For maximum control the aphis spray should be applied in the "early pink" stage of the apple tree. Therefore, if the aphis spray is added to the delayed dormant spray, delay the date of this application somewhat; if added to the pink spray, hasten date of this application slightly; planning in either event to get this spray on in the early pink blossom bud stage.

Later applications may reduce the infection. They will not control the Rosy apple-aphis.

Fig. 12. Green apple-aphis.

GREEN APPLE-APHIS[6]

The Injury. Similar to that of Rosy aphis. Less tendency to seek fruit clusters, and leaves not so tightly curled. Lateral limbs, water sprouts, and any rapidly growing tips are most subject to heavy infestation.

Seasonal History. Pass winter as eggs on bark of apple. Eggs appear same as Rosy aphis but placed on water sprouts and stuck in fuzzy pubescence at tips of twigs. They are usually found in dense clusters.

Attack the tree about the same as Rosy aphis; tend to remain on apple tree throughout the season. Often even where spray program is carefully followed a reinfestation

[6]Aphis pomi.

of the trees occurs in July resulting in a sticky and moldy exudate of honey dew on maturing fruit.

Control

Same as for Rosy aphis. For summer infestation in July use Black Leaf 40, ¾ pint, soap 5 pounds, water 100 gallons. Or combine July aphis and codling-moth spray, adding nicotine ¾ pint to regular arsenate application. To increase efficiency in aphis control add 1½ pounds of caseinate spreader to 200 gallons of solution.

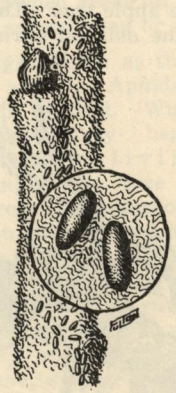


Fig. 13. Aphis eggs.

BUD-MOTH[7]

The Injury. Clusters of tip leaves webbed together, crumpled and brown. Frequently where fruit is adjacent to webbed leaves, the leaves are webbed to the fruit, and surface of fruit shows shallow feeding punctures (Fig. 5). A common, widespread, and fairly injurious pest. Of minor importance on apple and pear where arsenicals are regularly applied. Ordinarily the July application for codling-moth kills the majority of the young worms of the new generation while feeding on under surface of foliage.

Fig. 14. Bud-moth.

[7]Tmetocera ocellana.

Seasonal History. Pass winter as small chocolate-brown worms in compact flattened cocoon at base of bud. The cocoon is difficult to discover. It appears as a slightly misplaced bud scale.

Larvae become active as buds unfold. Attack opening leaf clusters, particularly at tips of twigs. Weave unfolding leaves together and feed within protective cluster.

Larvae mature in late May, transform within cluster of now dead and crumpled leaves. Adults appear in June. In size and general appearange they resemble codling-moth. Scale-like eggs deposited on surface of leaf.

Larvae of new generation appear in July. They feed for a brief time along midrib and veins on under surface of leaves. Later as partially grown chocolate-brown worms, seek buds, and spin hibernating cocoon. In this form they pass late summer and winter.

Control

Where special control measures appear warranted as indicated by fairly common occurrence of these tip clusters of dead and crumpled leaves: add lead arsenate 2-100 to cluster bud (delayed dormant) scab spray of lime-sulfur.

PEAR AND CHERRY SLUG[8]

The Injury. Upper surface of leaf devoured leaving skeletonized vein structure. Greenish brown to blackish slug-like larvae usually in evidence. (See Fig. 15.)

Seasonal History. Winter passed in soil. Adult is a sawfly which appears in early May and deposits eggs within leaf tissue. Slugs hatch and feed on leaf, skeleton-

[8]Caliroa cerasi.

izing surface. Mature in late June; drop to soil and again transform to adults. New generation of slugs on foliage during late July and August.

Control

Codling-moth application of lead arsenate 3-200 in 30-day spray will control. This spray applied when pest appears is also effective. Dust applications, road dust, air-slaked lime, sulfur, or any similar finely divided material dusted over infested foliage will control.

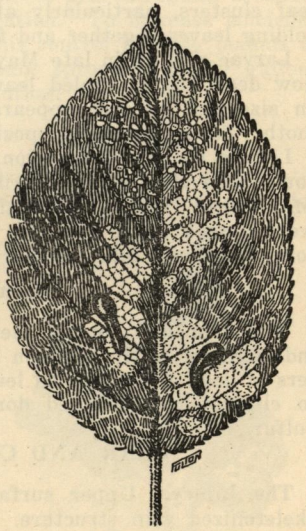


Fig. 15. Pear and cherry slug.

APPLE LACE-BUG[9]

Occurs rarely and is seldom serious.

The Injury. Foliage in early summer appears yellow or brown, tree has general devitalized appearance. Examination of under surface of affected leaves shows moderately small, flattened bugs with peculiar lace or gauze-like wings held close to the back; lower surface of leaf spotted with shiny black pimple-like specks of excrement and with cast skins of bugs. (See Fig. 16.)

Seasonal History. Of little importance in this discussion.

[9]Corythuca sp.

Control

Use Black Leaf 40 ¾ pint to 100 gallons water plus 5 pounds of soap. Use angle nozzles and direct the spray upward to wet under side of leaves.

PEAR LEAF BLISTER-MITE[10]

The Injury. Foliage shows small, highly colored, roughened galls, pimple-like or blister-like in appearance. On pear these galls are greenish or red at first and turn dark brown or black; on apple, at first pale, turning reddish brown. The spots increase in size and become corky in texture and the leaves become crumpled and distorted. On the under surface the galled areas become thick and corky and of darker color.

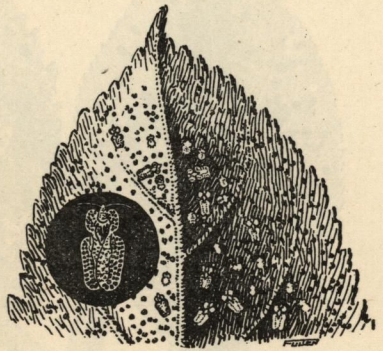


Fig. 16. Apple lace-bug.

The fruit and fruit stems are often attacked, showing the usual highly colored blisters and distorted appearance.

Seasonal History. Mites are microscopic in size; pass the winter crowded down in the outer bud scales. As leaves show green in spring they tunnel within the tissue of the leaves. During the growing season of the tree the mites work and breed within the tissues where it is impossible to reach them with sprays.

[10]Eriophyes pyri.

Control

Thoroughness is the keynote to successful spraying for the blister-mite. Where well done, one application of spray in three years is usually sufficient.

Use lime-sulfur 9-100 in the fall after leaves have fallen.

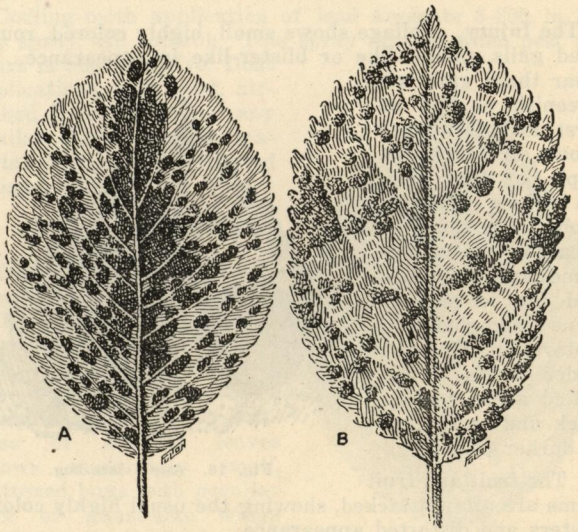


Fig. 17. Blister-mite. A. Pear. B. Apple.

Treated trees should appear as if whitewashed. Early spring applications of lime-sulfur as a dormant spray are also effective and probably more generally used than the fall application. Spring application must be on before leaf growth is sufficient to permit mites to conceal themselves, before March 1 on apple.

PEAR THRIPS[11]

The Injury. The chief destructive work of this insect is accomplished by the adults, as minute black insects feeding in the blossom buds at the time they are opening.

A characteristic "blighting" results. Small cluster buds

Fig. 18. Pear thrips injury.

develop blackish patches and if heavily infested they shrivel and turn brown. Those which escape destruction may produce fruit which is short-stemmed, misshapen, or with a russeted surface. Although this insect lives on all fruit trees its chief injury is to pear and prune. It is

[11]Taeniothrips inconsequens.

a serious pest in some localities but its distribution is very irregular. It has been known completely to destroy a crop.

Seasonal History. These insects winter in the soil and emerge as adults early in spring; enter buds as soon as they open and rasp the tender parts; deposit eggs before blossoming time in leaf petioles, blossom stems, and young fruit. Minute white larvae, barely visible to naked eye appear later and feed on young leaves and fruit, passing to the soil early in June where they remain until following spring.

Control

Where this insect is serious, spraying must be efficient, and applied at proper time. A few days delay may result in total loss. For first spray use a light miscible oil (3 to 100) or distillate emulsion (5 of stock solution in 100 gal.); to either one add nicotine sulfate ½ pint to 100 gallons of spray. Apply on first bright warm day when thrips begin to gather on buds just as they are beginning to burst. This is supplemented by adding nicotine sulfate to sprays before and after blossoming to kill as many larvae as possible. Thorough spraying must be done each year to obtain the accumulative effect.

ORCHARD SPIDER MITES (RED SPIDERS)[12]

The Injury. Foliage of trees in midsummer appears a sickly yellow. Trees devitalized as from drouth. Examination of under surface of leaves shows numbers of fine webs with minute, reddish, spider-like creatures hurrying about.

Seasonal History. Varies somewhat for the two species. The orchard mite (T. telarius) passes winter as mature

[12]Tetranychus telarius.
Bryobia pratensis.

and nearly mature mites protected under webs about base of trees and elsewhere. The bryobia mite (B. pratensis) passes the winter as minute scarlet eggs on the roughened bark of the twigs of trees. Where plentiful, they occur in solid masses appearing like bits of "rust" on the twig.

Fig. 19. Spider mite injury.

Fig. 20. Spider mite eggs.

Both forms attack foliage in the spring. Moist weather is detrimental to them and their increase is retarded until drier weather prevails. During growing season eggs are deposited among groups of mites on under surface of leaves.

Control

Sulfur is particularly effective against spider mites. Lime-sulfur, standard strength, in the dormant or the green-tip stage is the standard orchard mite spray. For outbreaks in midsummer use self-boiled lime-sulfur, or weak oil emulsion sprays.

THE FOLIAGE MITE[13]

The Injury. Difficult to diagnose. Leaves undersize, appear slightly cupped or contracted. On pear, leaves turn brown and leathery, having somewhat the appearance of pear blight. Foliage tends to turn black and drop. Mites microscopic in size.

Seasonal History. Not fully determined. Pass winter as active mites clustered in bud scales. Attack opening leaves and later the foliage itself. Most prevalent on under surface but swarm over both sides of leaf.

Control

Lime-sulfur sprays as applied in early season for other troubles, and sulfur dust will control. It is reasonable to assume that sulfur in any form that is safe for the tree will effectually check this pest.

LEAF-HOPPERS OF APPLE[14]

The Injury. Leaf-hoppers feed on under surface of foliage of apple. Upper surface of leaves first shows whitish flecks. The pale areas spread as feeding continues until most of foliage shows sickly yellow cast; tree appears devitalized. An indirect injury occurring on the nearly mature fruit is the smutty or dirty deposit of excrement from the feeding hoppers.

[13]Eriophyes sp.

[14]Empoa rosae.
Empoasca unicolor. Spends the entire life cycle on apple.

Seasonal History. Rose leaf-hopper passes winter as eggs in the bark of rose, blackberry, and loganberry canes and in the stems of strawberry; hatches in April and feeds to maturity on foliage of these plants. Foliage shows mottling of white specks and yellowing.

Adults appear in late May; fly to apple in June. Eggs are deposited during July in midrib and petiole of leaf. A new generation follows immediately and serious injury on apple develops in late July and August. Adults return to rose and other winter hosts in late September.

Fig. 21. Leaf-hoppers.

Control

Rose leaf-hoppers show a marked preference for the rose and cane fruits for winter egg deposition. Where these are adjacent to the orchard so far as practicable they should be cut out and removed.

Lime-sulfur as applied for scab in bearing orchards in the 10-day and 30-day spray if thoroughly applied will kill the young hoppers present on the leaves. Where summer sprays are required use Black Leaf 40, ½ pint; soap, 5 pounds; and water, 100 gallons.

TENT CATERPILLARS[15]

The Injury. Limbs stripped of foliage; leaf remnants, excrement, and cast skins inclosed in web.

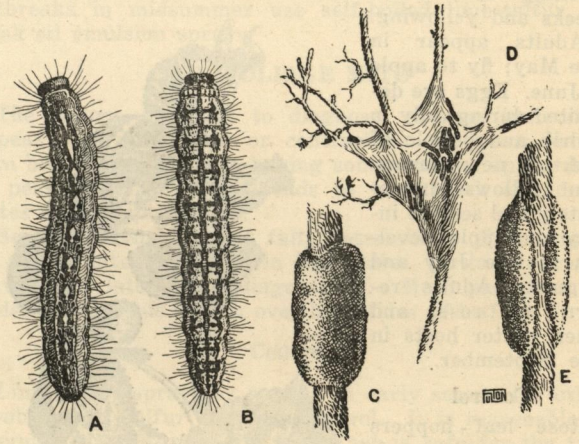


Fig. 22. Tent caterpillars, showing egg masses and tent.

Seasonal History. Winter passed as eggs in compact cluster on twigs. Depending on species, egg mass occurs as ring about twig or as mass two-thirds encircling twig. (Fig. 22, C and E).

Larvae appear in May, usually abundant until late June, feeding gregariously on foliage of branches. Generally spin tent-like web in crotches of trunk or branches,

[15]Malacosoma pluvialis.
M. disstria.

where they collect at night. Mature larvae spin cocoons in rolled leaves and transform to adults.

Adult moths, present in June and July, are about one inch long, pale brown in color, with wavy bands of cinnamon brown across wings. They are attracted to lights at night. Moths deposit characteristic egg masses and die.

Control

These worms are rather difficult to control with ordinary dosages of poison spray. For light infestations, b u r n out tents after dusk with t o r c h e s. A quick flame of insufficient duration seriously to injure limbs will kill.

Where infestation is g e n e r a l spray with lead arsenate 4-100.

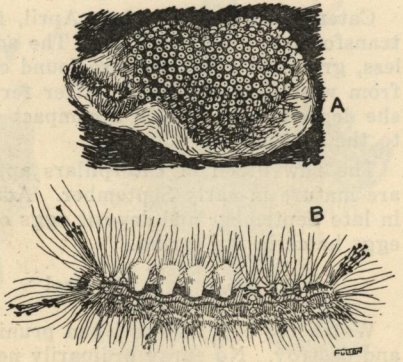


Fig. 23. Tussock-moth. Eggs and larva.

TUSSOCK-MOTHS[16]

Not ordinarily sufficiently prevalent to prove serious.

The Injury. Very small larvae feed on upper surface of leaves, giving them skeletonized appearance. Older caterpillars devour all of leaf tissue except the midrib; may attack fruit (Fig. 9, B), though rarely. Tendency is

[16]Notolophus antiqua.
Hemerocampa vetusta.

to defoliate tree. Ordinarily caterpillars are found feeding where injury is discovered. The caterpillar is elongate, fuzzy; general color is black or blue with knobs and brush-like tufts of rather long black, white, and yellowish hairs.

Seasonal History. There are two broods during the year. Winter is passed as eggs. These occur in compact clusters pasted to surface of cocoon. The cocoon may be fastened to twigs, or to a partly rolled leaf.

Caterpillars hatch in late April, feed to maturity, and transform to adults in June. The adult female is a wingless, grub-like gray creature found clinging to the cocoon from which she emerged. After fertilization by the male she deposits her eggs in a compact cluster, sticking them to the cocoon.

The new brood of caterpillars appear in late July and are mature in early September. Adult moths are present in late September and deposit eggs on the cocoons. These eggs hatch in the spring.

Control

Watch for egg masses when pruning in winter; remove and destroy. No spray ordinarily necessary. Should pest be bad in a section, spray with lead arsenate 2-100 in the pink. In case a midsummer application should be necessary use lead arsenate 4-100.

FALL WEB-WORM[17]

The Injury. In general, character is similar to work of tent caterpillars. Occurs in late summer instead of spring; tents larger, more gauze-like; web encloses foliage on which caterpillars are feeding. Caterpillars more fuzzy;

[17]Hyphantria cunea.

tendency to skeletonize foliage rather than to devour all but midrib.

Seasonal History. Winter passed as pupae. Adult moth appears and lays clusters of pale-green eggs on both upper and lower surfaces of leaf, covering the cluster with white hairs from her body.

Fig. 24. Fall web-worm.

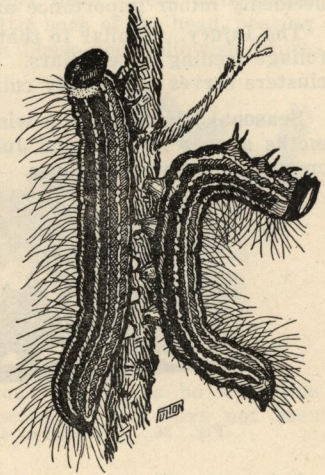


Fig. 25. Yellow-necked apple-caterpillar.

First noticeable injury occurs in late July and August when typical webs are observed enclosing fuzzy caterpillars busily feeding. Injury most common on shade and nut trees and on native trees including madrone. All fruit trees are subject to attack.

Control

Cut out or burn tents during the day as soon as observed. Where general infestation warrants a spray, use lead arsenate 4-100.

YELLOW-NECKED APPLE-CATERPILLAR[18]

A defoliating caterpillar of late summer. Usually of decidedly minor importance and local in range.

The Injury. Similar to that of tussock-moths and other foliage-feeding caterpillars. Presence of caterpillars in clusters serves to identify culprit.

Seasonal History. Pass winter as pupae in soil. Adult moths appear in June and July. Eggs placed in clusters on under surface of leaves. Larvae appear in late July

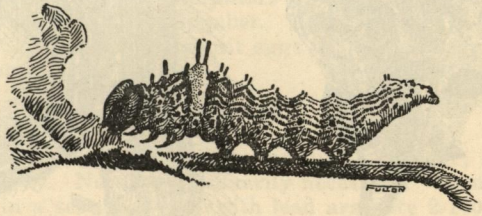


Fig. 26. Red-humped apple-caterpillar.

and August. They are typically marked with stripes of yellow and brown; are sparsely covered with rather long hairs. When disturbed rear both ends of body in characteristic attitude.

Control

This worm is seldom present in numbers sufficient to require organized control. It may usually be controlled

[18]Datana ministra.

by hand picking. Where numerous, spray with lead arsenate 4-100.

RED HUMPED APPLE-CATERPILLAR[19]

Discussion in general for yellow-necked caterpillar fits here. It is seldom sufficiently prevalent to require control sprays.

Worms tend to feed in groups, have a very conspicuous red band across body just a little back of the head, bearing red spines; body striped with black and yellowish white.

Control

Same as for yellow-necked caterpillar.

CANKER-WORMS

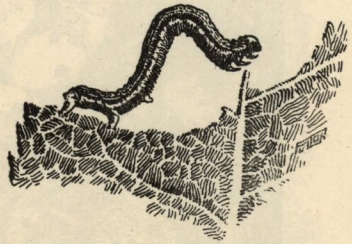


Fig. 27. Canker-worm or looper.

The Injury. Several species of canker worms, often called "loopers" or "measuring worms," infest the apple and pear. Occasionally they become numerous enough to be a serious pest, especially in old sod orchards that have not been systematically sprayed.

Seasonal History. Moths appear in late fall or early spring. The females are generally wingless, grub-like creatures while the males are winged. Eggs are deposited in clusters on the branches. The larvae hatch out about the time the leaves are expanding in spring. In midsummer they become full grown and go into the ground to pupate.

[19]Schizura concinna.

Control

Lead arsenate as regularly applied in the cluster-bud and blossom-pink sprays serves to control these insects. Cultivation destroys many of the pupae in the ground. Since the females do not fly, they may be prevented from

Fig. 28. Syneta leaf-beetle.

crawling up the trees to deposit eggs by encircling the trunks with bands of tree tanglefoot, or mechanical protectors. (See Bud-weevil Control, pp. 44-45.)

SYNETA LEAF-BEETLE[20]

The Injury. Occurs in April and May. Creamy white beetles about one-fourth inch long on foliage, fruit clusters, and in open blossoms. Holes eaten in leaves and blossom petals. Shallow cavities gnawed out in fruit and fruit stems. Some fruit drops, more shows at maturity

[20]Syneta albida.

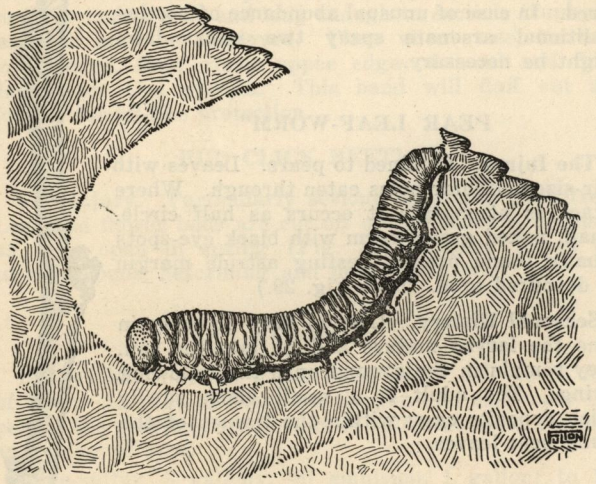


Fig. 29. Pear leaf-worm.

a russeting similar to that caused by fruit-worms. Wounds in small fruits generally more shallow and irregular, with less tendency in mature fruit to irregularities or malformations.

Seasonal History. Winter is passed as grubs in soil which transform to adults in spring. Adults emerge during late April and May and attack trees. Eggs dropped to soil by feeding beetles. Young grubs tunnel into soil and probably feed on fibrous rootlets of vegetation and trees.

Control

Commercial orchards which receive the calyx spray of arsenate are usually not seriously injured. In case of unusual abundance of beetles, additional arsenate spray two weeks later might be necessary.

PEAR LEAF-WORM[21]

The Injury. Confined to pears. Leaves with fair-sized circular holes eaten through. Where attack is at margin it occurs as half circle. Small, naked green worm with black eye-spots usually found present resting astride margin of devoured area. (See Fig. 29.)

Seasonal History. Late in May or early in June the larvae mature and go into the soil. They remain in the ground until the following spring. The adult is a small black sawfly which deposits eggs within the tissues of the young pear leaves.

Control

The arsenate of lead in the calyx spray will usually control this insect.

BUD-WEEVILS

Fig. 30. Work of bud-eating insects.

The Injury. Young trees are most seriously injured. Small gray and brown snout beetles eat off leaf and fruit buds as they unfold in the spring. Limbs are found with all or many buds cut off clean or the heart of the bud devoured. (Fig. 30).

[21]Gymnonychus californicus.

Control

Jar trees to dislodge weevils. Band trees with tanglefoot or use mechanical protector. Strips of cotton batting cut four inches wide and long enough to encircle trunk and lap well may be employed. Place about tree, tie near lower edge, then grasp upper edge of band and draw down over tied margin. This band will fluff out and form a funnel-like protection.

BUD CLICK BEETLE[22]

The Injury. Particularly serious on young pear trees. Leaf and flower buds are cut off or the heart is devoured as buds open in spring (Fig. 30). Injury forces out terminal buds, deforming and misshaping tree.

Control

Beetles hibernate in great numbers in soil about base of trees. In soils of Southern Oregon and elsewhere that permit the practice, use flowers of sulfur about brace roots and collar of tree.

Lime-sulfur, 3 gallons; oil emulsion, 1 gallon; to 100 gallons water is suggested as a spray which should serve to repel the beetles.

CLIMBING CUTWORMS

The Injury. Unfolding leaf and flower buds snipped off or ragged as they unfold in the spring (Fig. 30). Large holes eaten in low hanging fruit in late summer. This injury is more likely to occur where a cover crop is present on ground. Serious injury infrequent, mostly confined to opening buds of young trees on newer land. They feed at night; offender is discovered only by digging in

[22]Limonius discoideus.

soil about base of tree. Cutworms found as tightly curled, greasy, naked gray worms.

Seasonal History. Of no essential value in this discussion.

Control

Use protective devices about base of young trees to prevent cutworms climbing tree. Patented mechanical protectors good. Prepare strips of cotton batting 4 inches wide and long enough to encircle trunk and lap at least an inch. Tie cotton band near lower edge. Grasp upper edge and draw down over lower edge. A funnel-like protector is thus formed.

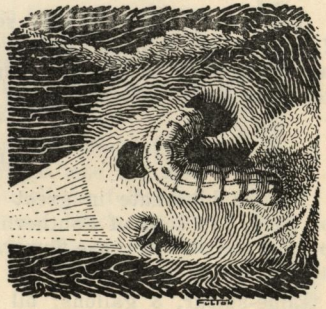


Fig. 31. Cutworms on mature fruit.

Go out after night and with heavy club, wrapped to prevent barking tree, jar tree sharply to dislodge feeding worms. Scatter poison about base of tree consisting of bran 15 pounds, lead arsenate ½ pound, salt 4 ounces, sirup 1 quart and water to make a moist, crumbly mash. A handful at base of tree is more than sufficient.

CASE-BEARERS

The Injury. Case-bearers resemble tiny cigars or pistols fastened by one end to the leaf surface; a small caterpillar lives within the case. Feed on leaves from time the buds open, forming small, whitish blotch mines or skeletonize leaf over a small area.

Seasonal History. Larvae pass the winter in the cases fastened to bark. In spring they attack opening buds. In summer they enlarge the cases and later transform to small moths. Eggs are deposited on under side of leaves and upon hatching the larvae feed as leaf miners for a time before constructing cases.

Fig. 32. Case-bearers.

Control

Seldom serious. Lead arsenate in the green-tip stage or the cluster bud spray is ordinarily effective in controlling these insects.

Fig. 33. Trumpet leaf miner.

LEAF MINERS

The Injury. Mines between the two surfaces of the leaf. A common form of mine is one shaped like a trumpet or cornucopia; another is a large blotch between two of the main veins, with lower wall gathered into a series of wrinkles.

Seasonal History. The mines are formed by the larvae of small moths. There are two or more generations during the summer. Larvae of the last brood line the mine with silk and pass the winter in the fallen leaf.

Fig. 34. Tentiform leaf-miner.

Control

In cultivated orchards leaf miners are rarely abundant enough to cause serious loss. Burning the fallen leaves would destroy the hibernating larvae and late fall or early spring plowing would prevent many of them from emerging.

PART III. INSECTS AFFECTING THE ROOTS, TRUNK, BRANCHES AND TWIGS

A. Affecting the roots.
   1. Plant lice with conspicuous cotton-like covering on bodies. Cause knots and warts on small roots.
      Woolly Aphis. Page 58.
   2. Small white grubs 6-14 inches below ground feeding on rootlets.
      Syneta Leaf-beetle. Page 42.
   3. Borers tunneling into roots.
      a. Small, elongate flat-head borer. Works under bark and through wood.
         Flat-headed Borer. Page 54.

B. Affecting the trunk and branches.
   1. Cottony masses, usually in cracks or depressions.
      Woolly Aphis. Page 58.
   2. Cocoon under loose bark scale containing pinkish caterpillar or brown chrysalis.
      Codling-moth. Page 7.
   3. Egg masses.
      a. Cluster of eggs on side of old cocoon.
         Tussock-moth. Page 37.
      b. Small brown or white, oval masses of over-lapping scale-like eggs.
         Leaf-roller. Page 13.
   4. Minute scale-like bodies incrusting the bark; (scale insects).
      a. Round ash gray with black center, attacks trunk, limbs, twigs, leaves and fruit.
         San Jose Scale. Page 52.

b. Elongate dark gray or brownish scale crescent-shaped or like mussel shell.
Oyster-shell Scale. Page 53.
Light gray or whitish scale broadly rounded at larger end, tapering to point of shiny light brown.
Scurfy Scale.
Large rounded, raised, slightly wrinkled, somewhat shiny brown scale.
European Fruit Lecanium. Page 54.

5. Borers in wood or under bark.
a. A flattened, white larva with slender body and large head. Works between bark and wood.
Flat-headed Apple-tree Borer. Page 54.
b. Small pinkish white grubs, ⅜ inch long found in clusters just under bark. Bark over area size of dime filled with small holes.
Bronze apple-tree weevil. Page 58.
c. Small "shot holes" scattered over bark and into wood, made by small black beetles.
Shot-hole Borers. Page 55.

C. Affecting the twigs and small branches.
1. Cottony masses covering clusters of small, soft-bodied insects. Work in wounds or cause knots or galls to form on twigs.
Woolly Aphis. Page 58.

2. Green plant lice, on water sprouts and terminal twigs.
Green Apple-aphis. Page 25.

3. Robust, flying insect, with large square head and transparent wings held roof-shaped over body. Rests on twigs and deposits eggs.
Cicada or Dog-day Harvest Fly. Page. 60.

4. Grasshoppers sometimes strip bark completely from smaller twigs and branches.

5. Scale insects. See B-4 trunk and branches.

6. Rows of deep punctures in twigs, fine wood splinters protruding.
Cicada Egg Punctures. Page 60.

7. Egg masses.
a. Egg cluster on side of cocoon fastened to twig or a dead leaf.
Tussock-moth. Page 37.
b. Small brown or white oval masses (⅛ inch long) of overlapping scale-like eggs.
Leaf-roller. Page 13.
c. Compact masses of eggs encircling twigs, appearing as a mass of hardened foam.
Tent Caterpillar. Page 36.

8. Eggs scattered or grouped in cracks.
a. Round red eggs barely visible to naked eye, clustered in growth rings at base of bud.
Red Spider Mite eggs. Page 32.
b. Elongate oval, shiny black eggs 1/20 inch long. Common on growing tips and water sprouts.
Aphid Eggs. Pages 23-26.

SAN JOSE SCALE[23]

The Injury. Bark of trees with small ash gray or blackish, pimple-like scales clustered over surface. Removing scale covering discloses a flattened lemon-yellow insect beneath. Where back of thumb-nail is drawn over surface with some pressure, oily substance is crushed out from under scale.

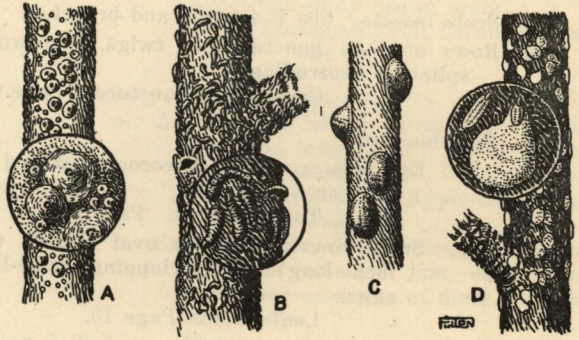


Fig. 35. Scale Insects.

A. San Jose scale.
B. Oyster-shell scale.
C. Fruit lecanium.
D. Scurfy scale.

Bark of infected trees becomes thin; cutting into cambium reveals a purple discoloration. Trees become bark bound and devitalized; foliage is off color. Infested fruits show red spots (Fig. 4).

Seasonal History. Pass winter as nearly mature scales. Mature in spring; three generations during season. Young are produced in April, July, and October; are active for

[23]Aspidiotus perniciosus.

a time, then settle down and begin to feed, and scale forms over them.

Control

Standard San Jose scale spray is commercial liquid lime-sulfur applied during February at a strength of 11 gallons of lime-sulfur to the 100-gallon spray tank (see lime-sulfur dilution table, page 68, for amounts to use where strength of commercial material varies). For best results one must take care to choose a period of settled, fairly clear weather for applying the solution.

Oil emulsions, particularly the heavier miscible oils and distillate oils are equal in effectiveness to the lime-sulfur. Use at dilutions recommended, which for the better oils will be about 5-7½ gallons of oil to the 100-gallon tank. It is doubly essential in the use of oils that periods of settled weather follow the applications of spray.

Application may be delayed, where it seems desirable to avoid extra application, until buds show green leaves at tip. Simply increase the regular strength to the standard 11-100 scale spray.

OYSTER-SHELL SCALE[24]

The Injury. Seldom so pronounced but similar to that of San Jose scale. Scales are shiny brown and gray, flat, elongate, rather crescent-shaped; occur on bark and fruit.

Seasonal History. Pass winter as eggs under scale. Young are active in spring. There is probably one prolonged generation during season.

Control

Lime-sulfur 11-100 in February as for San Jose scale. Oil emulsions are particularly effective.

[24]Lepidosaphes ulmi.

EUROPEAN FRUIT LECANIUM[25]

The Injury. Twigs, limbs, and occasionally leaves with conspicuous reddish brown, very convex and somewhat wrinkled scales clustered over surface. Tree shows some effect of feeding, though mostly the sooty black, moldy honey dew on leaves and fruit indicates presence of pest.

Seasonal History. Winter passed as nearly mature scales on bark. Eggs are produced in abundance in spring. Young hatch and settle on bark and leaves.

Control

Where regular lime-sulfur spray program is followed pest seldom becomes important. Oil sprays 5-100 in early fall after leaves are off is ideal spray.

BORERS

A fact of first importance in connection with the presence of borers on apple and pear is that the more commonly injurious borers do not ordinarily successfully attack vigorous, healthy trees. There must be some primary cause for the devitalized condition of the tree: poor drainage, roots cut off or injured by cultural practices, drouth, winter injury, etc. The attack and injury by borers is secondary to this initial trouble.

In combating borers, therefore, the first and most important step is to discover the initial cause of devitalization and attempt by better cultivation, drainage or the use of fertilizers to restore the impaired vitality.

FLAT-HEADED BORERS[26]

The Injury. Most noticeably serious on young trees. Trees devitalized, leaves yellow. Flat-headed, waxy white

[25]Lecanium corni.

[26]Chrysobothris femorata.
Chrysobothris mali.

borers working beneath the bark of the trunk, limbs, and (C. mali) roots; burrowing out broad, flattened channels. The bark over the burrows is usually discolored and shrunken, the burrows often filled with frass. Young trees, and limbs on older trees, are often girdled and killed by these borers working beneath the bark. The root-infesting form often tunnels directly through the heart wood.

Seasonal History. Adult beetles are active in spring. They place eggs in crevices on bark. Borers hatch and tunnel inside bark and begin characteristic burrows. Burrows enlarge in size as borers grow.

Control

See general remarks above. Protective white washes containing one pint of crude carbolic acid to 10 gallons of the wash, applied in the spring before May 10 will afford some protection. Particularly advisable on young trees.

Fig. 36. Flat-headed borer.

SHOT-HOLE BORER[27]

The Injury. Trees devitalized, foliage yellow, off color. Trunk or limbs or both show numerous small "shot-hole" burrows through the bark and into the sap wood; borings evident about base of tree. Holes generally on southwest side of tree and on limbs

[27]Xyleborus dispar.

where bark is most exposed. This is not always the case. Cutting into burrows usually reveals small, blunt, black beetle.

Seasonal History. This borer belongs to a group known as "ambrosia beetles" in which only the adult beetles excavate tunnels. In these tunnels the beetles plant a fungus known as ambrosia. It is on this fungous growth that the grubs feed. They are incapable of tunneling in wood as do the grubs of most borers.

Fig. 37. Shot-hole borer.

This fungus grows best in the presence of "sour" or fermented sap. The shot-hole borers choose for attack, therefore, devitalized or injured trees which have developed a sour sap condition in which to dig and plant the fungus for the feeding of their young.

Winter passed as adult beetles in the burrows in the tree. Beetles active from middle of March to early May. Attack sick trees, burrowing in at bud scar or some slight depression on bark. Tunnel directly into wood about one-quarter inch. Later construct side channels from main burrow. Eggs are deposited in side channels and fungus is planted for sustenance of young. Tunneling and egg laying continue until late May. Grubs feed on fungus, develop to maturity and transform to adult beetles in fall, remaining in burrows until following spring.

Control

Shot-hole borer breeds successfully only in sick trees affected with sour sap. Use every reasonable means to

revitalize tree by cultivation, drainage, irrigation, fertilization or whatever is most needed.

Paint infested trees, over infested portions only, with following:

Water	3 gal.
Soft soap, liquid fish-oil soap	1 gal.
Crude carbolic acid	½ pt.

Mix thoroughly and apply at weekly intervals, until three applications are given. Treat only infected portions.

BRANCH AND TWIG BORER[28]

Fig. 38. Branch and twig borer.

The Injury. Most common on pear though all fruit trees are attacked. In spring of year twigs are found with round hole nearly one-fourth inch in diameter and three-fourths inch deep above base of bud. Twig usually wilts and dies above burrow. Frequently burrow found with brown, round-headed beetle still present.

Seasonal History. Not well known. Breed in native trees, probably oak. Beetles excavate burrow above buds of trees in spring and remain in tunnel for brief time and then depart.

Control

No preventive measures known. Kill all beetles found. Ordinarily insect not disastrously common nor present for any period of years.

[28]Polycaon confertus.

BRONZE APPLE-TREE WEEVIL[29]

The Injury. Areas of bark the size of a dollar or larger observed shrunken and dead. Often area of bark about size of dime shows numerous small egg punctures. Cutting to the inner bark reveals worm burrows and small pinkish grubs.

Fig. 39. Bronze apple-tree weevil.

Seasonal History. Small bronze-black snout beetles active in spring. Eat small holes in leaves, crawl sluggishly over bark. Puncture bark with beak, usually several holes in small patch, and deposit eggs. Grubs hatch and feed and tunnel about in inner bark. Mature in fall, hibernate over winter as grubs, transform to adults and emerge in spring.

Control

Practice cultural methods to revitalize trees. Cut out infested bark and paint over with a disinfecting paint composed of creosote, 1 part; coal tar, 2 parts. Mix well and paint thoroughly over wound. Repeat when any cracks or breaks in protective coat are found.

WOOLLY APPLE-APHIS[30]

The Injury. Conspicuous clumps of cotton-like masses on bark, twigs, or roots. Sometimes hangs in festoons

[29]Magdalis anescens.

[30]Eriosoma lanigera.

from the limbs. Digging into cottony mass reveals clusters of wriggling, brownish, soft-bodied plant lice. Knots

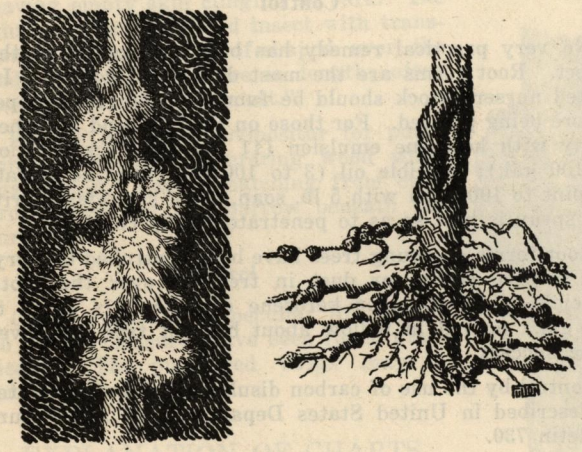


Fig. 40. Wooly apple-aphis. On twigs and roots.

or galls are formed on the twigs or roots wherever clusters of these aphids feed. Foliage on badly infested trees has a yellowish, sickly color.

Seasonal History. Aphids live all the year round on the roots and, in limited numbers, above ground; pass through many generations each year; largely cease activities in colder months.

Winged forms are produced in summer, which spread to other trees. Elm trees serve as alternate host, harboring eggs over winter. Aphids hatching from these eggs

live on elm in early spring, causing leaf galls. A later generation develops wings and migrates to apple.

Control

No very practical remedy has been developed for this insect. Root forms are the most difficult to control. Infested nursery stock should be fumigated or roots dipped before being planted. For those on the bark and branches, spray with kerosene emulsion (11 gallons stock solution to 100 gal.); miscible oil (3 to 100); or nicotine sulfate (1 pint to 100 gal.) with 5 lb. soap, for a spreader. Driving spray is best so as to penetrate woolly coating.

Root forms on young trees have been controlled by burying tobacco scraps or dust in trenches over the roots. Miscible oil (5-100), or kerosene emulsion (14 stock to 100 gal.) poured in hollow about base of tree has given some success.

Control by the use of carbon disulfide dissolved in water is described in United States Department of Agriculture Bulletin 730.

PEAR WOOLLY-APHIS[31]

Attacks pear only and lives entirely on the roots. Control measure described for the apple wooly-aphis on the roots applies to this insect also.

CICADAS

The Injury. Rows of egg punctures in twigs from which splinters of wood project. Twig often dies beyond area of punctures, or resulting scars form point of attack for borers, woolly aphis, and disease.

[31]Eriosoma pyricola.

Seasonal History. The larvae live in soil, feeding on roots for a period of several years. Pupae crawl up tree trunk in early summer. Adult emerges leaving empty skin clinging to bark. The adult is a broad-headed insect with transparent wings held roof-shaped over the body, one inch or more in length; often incorrectly called a "locust."

Female has sharp ovipositor for puncturing twigs and lacerating wood while egg laying. Larvae hatching from eggs drop to ground and burrow beneath the surface.

Control

On account of the peculiar life-history no control measures have been found practicable. The punctured twigs may be pruned off and burned.

Fig. 41. Cicada and egg punctures.

EXPLANATION OF CHARTS

The accompanying charts illustrate in a graphic way the intimate relationship which exists between the development of foliage and fruit, and the activities of insect pests and their control.

Certain more or less definite developmental stages of the tree are illustrated and named. Below are arranged some of the more commonly injurious insect pests. The black bars opposite the word "injury" indicate the stages in which the insect is doing destructive work. The widest part of the bar shows when the pest is most numerous and active.

The black bar opposite the word "control" indicates the stages in the development of the tree in which control measures may be employed. The heavier bars show the most effective and desirable time to combat the insect, while the narrow bars denote other stages when control is possible.

The various stages in development may be explained as follows:

(1) **Dormant.** Before the buds burst in the spring. Sprays may be applied advantageously in the fall. If in the spring, some advantage in effectiveness is gained by delaying until buds begin to swell.

(2) **Green Tip.** When the young leaves show at tip of bud tightly curled and in a compact mass.

(3) **Cluster Bud** (Delayed Dormant). When the cluster of blossom buds appears and before they separate. Very important stage in spray program.

(4) **Blossom Pink** (Pink). Blossom buds separated and showing pink petals, before blossoms open.

(5) **Full Blossom.** When trees are in full blossom no control spray should be applied.

(6) **Calyx.** After at least two-thirds of the petals have fallen and before the calyx lobes of the central or main blossom of the cluster close.

(7) **Ten** to fourteen days after the calyx spray.

(8) **Thirty** to forty days after the calyx spray. See discussion under codling-moth.

(9) **July spray.** Variable, from fifth to twenty-fifth. See codling-moth.

(10) **August spray.** August 5 to Sept. 8. See codling-moth.

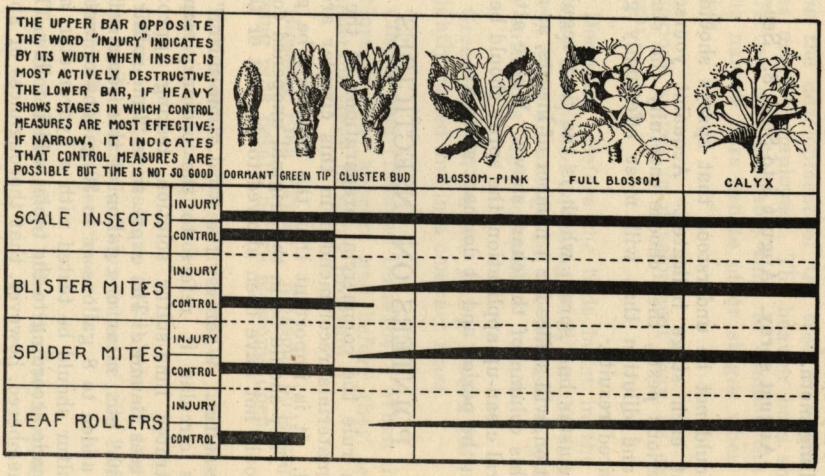
It should not be understood that sprays should be applied at each stage indicated. Acquaint yourself with your serious pests, then choose carefully the stage, material, and dilution that will most effectually give you the desired results.

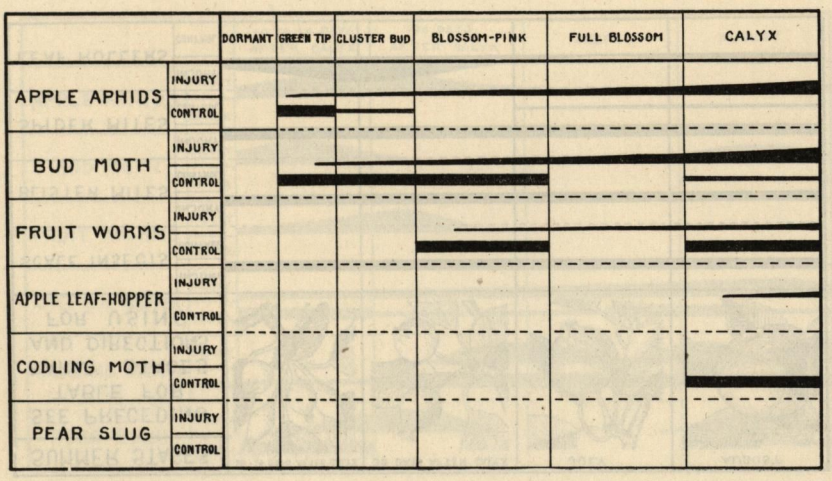
The cluster bud spray, which is the first regular scab application, will suffice for a number of insects, as a glance down this column of the chart shows. Where attempting a general clean-up application, the spray should be applied early in the period and at dormant strength.

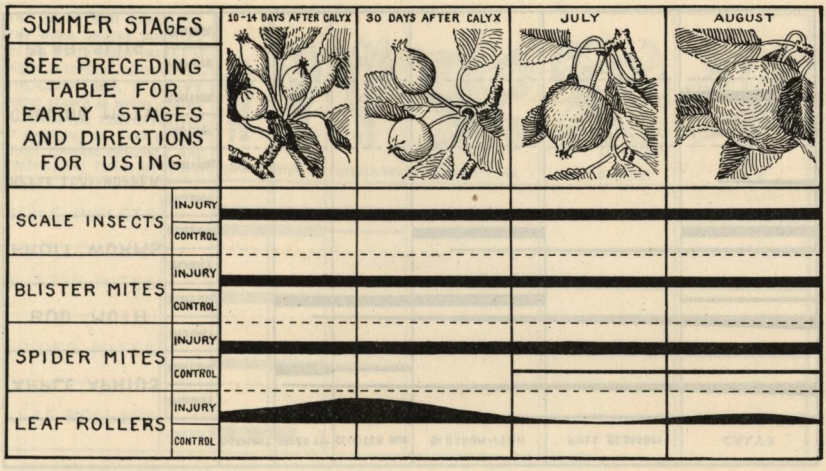
POINTERS ON INSECTICIDES

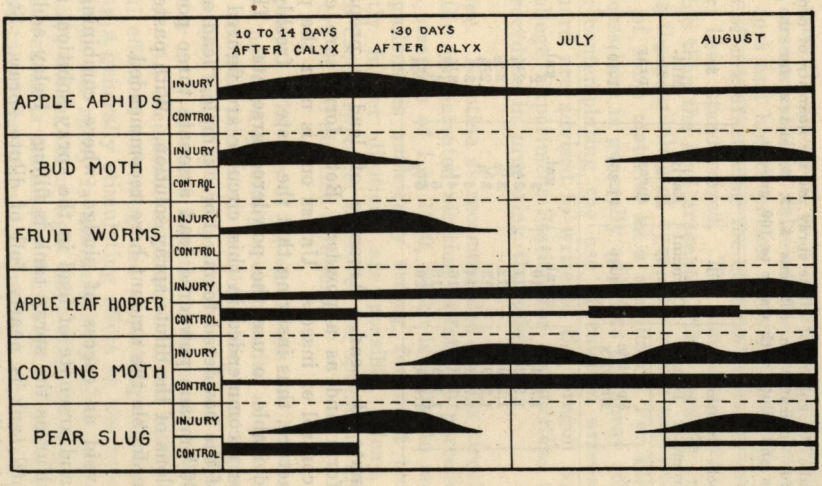
As a rule the commercial preparations of the various spray materials recommended in this circular are standardized. It is important that the materials be pure and fresh. They should be in the original unopened containers and should not have been allowed to dry out or to freeze.

Lime-sulfur. Wherever the word "lime-sulfur" is used in this circular it refers to the ordinary commercial concentrated lime-sulfur solution, testing approximately 32 degrees Baume'. The expressions "lime-sulfur 1 to 8," "1 to 30," etc., mean one gallon of this commercial lime-sulfur added to 8 gallons or to 30 gallons of water. The lime-sulfur should be tested with a hydrometer, and dilutions made according to the tables which follow. It should be remembered, however, that thoroughness of application is always more important than minute exactness of dilution.


THE UPPER BAR OPPOSITE THE WORD "INJURY" INDICATES BY ITS WIDTH WHEN INSECT IS MOST ACTIVELY DESTRUCTIVE. THE LOWER BAR, IF HEAVY SHOWS STAGES IN WHICH CONTROL MEASURES ARE MOST EFFECTIVE; IF NARROW, IT INDICATES THAT CONTROL MEASURES ARE POSSIBLE BUT TIME IS NOT SO GOOD
DORMANT
GREEN TIP
CLUSTER BUD
BLOSSOM-PINK
FULL BLOSSOM
CALYX
SCALE INSECTS
BLISTER MITES
SPIDER MITES
LEAF ROLLERS
INJURY
CONTROL


DORMANT
GREEN TIP
CLUSTER BUD
BLOSSOM-PINK
FULL BLOSSOM
CALYX
APPLE APHIDS
BUD MOTH
FRUIT WORMS
APPLE LEAF-HOPPER
CODLING MOTH
PEAR SLUG
INJURY
CONTROL


SUMMER STAGES
SEE PRECEDING TABLE FOR EARLY STAGES AND DIRECTIONS FOR USING
10-14 DAYS AFTER CALYX
30 DAYS AFTER CALYX
JULY
AUGUST
SCALE INSECTS
BLISTER MITES
SPIDER MITES
LEAF ROLLERS
INJURY
CONTROL


10 TO 14 DAYS AFTER CALYX
30 DAYS AFTER CALYX
JULY
AUGUST
APPLE APHIDS
BUD MOTH
FRUIT WORMS
APPLE LEAF HOPPER
CODLING MOTH
PEAR SLUG
INJURY
CONTROL

SIMPLIFIED LIME-SULFUR DILUTION TABLE

To make 100 gallons of dilute spray use the quantity of concentrated lime-sulfur indicated in columns 1, 2, 3, and 4 for the different strengths and dilute with water to 100 gallons.

Stock Solution of Hydrometer Test		1	2	3	4
Baume' scale	Specific gravity	Dormant spray (1-8)	Early spring spray (1-30)	Mid-spring spray (1-40)	Late spring spray (1-50)
		gal.	gal.	gal.	gal.
34°	1.304	10	3	2	1¾
32°	1.282	11	3¼	2¼	2
30°	1.260	12	3½	2½	2¼
28°	1.239	13	3¾	2¾	2½
26°	1.218	14	4	3	2½
24°	1.198	16	4½	3½	2¾
22°	1.179	18	5	4	3
20°	1.160	20	5½	4¼	3½

Arsenate of Lead. Arsenate of lead is prepared in paste form and as a powder. Both forms are effective in the control of insects. Unless one is near the place of manufacture, thus insuring that the paste be freshly made, it is advisable to use the powdered arsenate. The proportions recommended in this circular are figured on the basis of the powdered form. For example, "lead arsenate 3 to 200" means powdered lead arsenate three pounds to 200 gallons of the dilute spray solution. With paste arsenate, use double the amount here recommended.

To avoid an excess of sludge, where combining lime-sulfur and arsenate of lead in the spray solution, add the lime-sulfur as the spray tank is filling. Delay adding the lead until tank is nearly full of dilute spray. Start engine and while agitator is running, powdered arsenate may be poured directly into tank.

Arsenate of Lime. Arsenate of lime or calcium arsenate has recently appeared as a commercial substitute for the lead arsenates. The value of this material lies in the reduced cost and higher poison content pound for pound. Methods of manufacturing the calcium arsenate have not, thus far, been standardized. The calcium arsenates are less stable than the lead arsenate. This lack of stability increases the possibility of burn and makes necessary the addition of some material as a stabilizer. For this purpose, excess lime is generally added to the spray solution. Growers contemplating the use of calcium arsenates in the orchard are advised to write to the Oregon Agricultural College Experiment Station for instructions on the exact procedure in preparing the solution.

Nicotine. Nicotine as recommended in this circular refers to the concentrated nicotine sulfate, 40 percent solution. A strength of 1 to 1200, which is equal to one pint in 150 gallons, is sufficiently strong for most troubles; frequently higher dilutions are possible. Soap, lime-sulfur, or casein spreader improves the spreading and killing powers of the nicotine solution.

Oil Sprays. The use of oil emulsions for the dormant spray has not been generally recommended or practiced in Oregon. For certain insect troubles they are superior to other sprays, and they are probably of equal value with lime-sulfur as a dormant insecticide for scale, red spider mite, etc. An occasional application of oil spray has a beneficial effect in softening and smoothing the bark and producing a generally stimulating effect on the tree. The action of an oil spray is comparatively slow and where rain follows within six or eight days after the application, the effectiveness is materially decreased. Particular care should be taken therefore, to apply the oil during settled weather. In using oil from a barrel, thoroughly mix by violent stirring before drawing off the desired amount.

Oil emulsion in small amounts, 1 gallon to 100 gallons of spray solution, materially increases the spread and effectiveness of lime-sulfur spray for scale and blister mite and improves the arsenate spray for codling-moth. In using proceed as follows:

Procedure: Prepare the spray in the usual manner. Place the required amount of oil emulsion in a container of fair capacity; add small amounts of water with vigorous stirring until all the oil is incorporated in the thin milky emulsion. When the spray tank is filled to practically the required capacity with the dilute spray solution, start the engine and while the agitator is in motion slowly add the oil. If at all practical do not stop the engine after adding the oil, but drive to the field with the engine running.

Distillate Emulsion.

Water	12 gallons
Whale-oil soap	30 pounds
Distillate (32-34 degrees Baume')	20 gallons

Dissolve soap in boiling water. Remove from fire and add distillate, stirring vigorously. The solution must now be agitated until it assumes a thick, creamy consistency that does not separate on cooling. This condition is most readily brought about by the use of a small bucket pump, forcing the liquid through the hose and back into the container.

Kerosene Emulsion.

Whale oil soap	1 pound
Water	1 gallon
Kerosene	2 gallons

Stock solution is prepared in the same manner as for distillate emulsion.

Spreaders added to the spray solution increase its wetting, spreading, and adhesive properties and thereby increase the efficiency.

Oil emulsion, 1 to 100 (see above); glue, 1 pound to 100 gallons; and caseinate, 8 ounces to 100 gallons are materials we have tested. Because this work with spreaders is still in an experimental stage and our recommendations subject to change, we have prepared a circular of information on spreaders. This is for free distribution and will be sent on request. Address the Oregon Agricultural College Experiment Station, Corvallis, Oregon. For detailed discussion of tests with spreaders and suggestions for their use in codling-moth sprays see Oregon Agricultural College Station Bulletin 169, Insecticide Investigations. April, 1920.

The Spray Calendar. An orchard spray program for the season is a necessary supplement to the most intelligent and successful use of this book.

The Extension Service of the Oregon Agricultural College issues a spray calendar prepared jointly by the departments of Plant Pathology and Entomology. This is revised frequently in order that our growers may have the benefit of our latest investigations. This bulletin is sent free upon request.

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The regular publications of the Station are sent free to the residents of Oregon who request them

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