MANUAL
OF
FRUIT INSECTS

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New York
The Macmillan Company
1914
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York and Michigan,—there is one full generation and usually a partial second, the completeness of the latter depending on the length of the season. In Nebraska, Missouri and Virginia there are two full generations; in Arkansas there are three and in Georgia three and a partial fourth. In Washington, Oregon, Utah and Idaho there are two full generations and there is strong evidence that there are at least three in Arizona.

While the codlin-moth is distinctly an apple pest, it is also an important enemy of the pear. In 1898 Slingerland estimated the loss to the pear crop in New York at $500,000. Wild haws, crabapples and quinces are also quite freely eaten by the larvae. In California English walnuts are generally infested to a slight extent by the larvae of the later generations. It has been reported as injuring plums in Canada and also in New Mexico.

Natural enemies.

The eggs of the codlin-moth are parasitized by a minute chalcis-fly, *Trichogramma pretiosa* Riley, four of these tiny flies having been reared from a single egg. The eggs are also attacked by a mite, *Trombidium* sp. The larva is attacked by the hymenopterous parasites, *Pimpla annulipes* Brullé, *Macrocentrus delicatus* Cress., *Ascogaster carpocapsae* Vier., *Goniozus* sp., *Bethylus* sp., and by two Tachina flies, *Hypos-
*lenta variabilis* Coq. and *Tachinophyto* sp. In Georgia a small chalcis-fly (*Hallicella* sp.) has frequently been reared from the pupa. A European parasite (*Calliephialtes messor* Grav.) has been introduced into California, but apparently with little success. The larvæ of a number of beetles have been found killing the larvæ and in the South several species of ants attack the larvæ and pupæ in the cocoons. In Utah a wasp stocks its burrows with the larvæ.

Both in this country and in Europe larvæ have been found infested by hair-snakes.

In spite of this array of insect enemies the codlin-moth is able to maintain itself as the most destructive enemy of apples and pears. Its most effective natural enemies are the birds, over a dozen species of which are known to feed on it. The
The Ribbed Cocoon-maker of the Apple

*Bucculatrix pomifoliella* Clemens

The small but conspicuous whitish, distinctly ribbed cocoons, about \( \frac{1}{4} \) of an inch long, of this insect, often occur in large numbers in autumn on the undersides of the smaller branches of apple trees (Fig. 60), and may first reveal to the fruit grower its presence in the orchard. It is usually a local pest in widely separated orchards, but has a wide distribution over the eastern half of Canada and in the United States from Maine to Texas. Although it is capable of doing much damage to foliage, it is rarely a serious pest, and attacks only the apple, other fruit trees being apparently immune even when growing in close proximity to apples. A little brown pupa hibernates in the white cocoons, and when the leaves are unfolding in May it works halfway out of one end of the cocoon and there emerges a tiny, light brown moth about \( \frac{1}{10} \) of an inch in length with each front wing marked with a large, dark brown spot (Fig. 61). In a few days, minute, pale green, elliptical, iridescent, roughened eggs are laid singly on the under surface of the leaves. The tiny caterpillars which hatch from these eggs in from 6 to 10 days burrow directly into the leaf, where for about a week they make narrow mines.
nearly $\frac{3}{4}$ of an inch in length. It then comes out of this mine and makes a thin, white, silken molting cocoon (Fig. 62), within which its skin is shed in a few days, and the greenish-brown caterpillar feeds openly on the surface of the leaves near the edges. A second larger molting cocoon is made in about 4 days. Two days later the caterpillars appear in their last stage and proceed to skeletonize the foliage for about a week, finally wandering about to find a suitable place to spin their true ribbed cocoons early in July on the leaves, young fruits or twigs and larger limbs. It requires 3 or 4 hours to build one of these ribbed cocoons (Fig. 63). The pupal stage lasts from 1 to 2 weeks in these summer cocoons, most of the moths emerging by August 1 in New York. The mines of the young caterpillars are usually near the centers of the leaves, while most of the skeletonizing is done near the edges and always on the upper surface. When badly eaten, the leaves turn brown and curl. The caterpillars often hang suspended from the leaves by silken

Fig. 62. — Apple leaf showing mines and "molting cocoons" of the caterpillars, enlarged.
threads, and may be blown on to other food-plants near by, where their cocoons are sometimes found.

In Maine there is apparently but one brood of this insect annually, as the moths did not appear until spring from pupæ formed August 1. In southern New York, however, there are two distinct broods, the moths emerging in July lay eggs early in August and the second brood of caterpillars work on the leaves during August and September in the same manner as the first brood. Being more numerous, the work of the second brood is usually more conspicuous and extensive than that of the spring brood. Eighty per cent of the cocoons made in autumn are within two feet of the ends of the branches on the lower third of the trees.

The summer brood is far less liable to be attacked by parasites and diseases, moths emerging from 80 to 90 per cent of the cocoons in July, whereas it is unusual for moths to emerge from more than 50 per cent of the winter cocoons. Five tiny hymenopterous parasites, Cirrospilus flamicinctus, Encyrtus bucculaticris, Mesochorus politus, Apanteles cacacae and Zaporus sp., play an important part in checking this pest. Many of the cocoons are often stripped from the twigs by birds in winter, and in

Fig. 63. — The ribbed cocoon-maker building its cocoon. Enlarged.
summer the caterpillars are frequently found in webs spun across
the surfaces of the leaves by the spiders, *Dictyna foliacea* and
*Araneus displicatus*. There is also a great mortality, sometimes
nearly 50 per cent, among the larvae and pupae in the cocoons
in autumn, due apparently to some disease, causing them to
shrive and become dry and hard.

*Remedial measures.*

Sprays of whale-oil soap (1 pound in 1 gallon of water), the
lime-sulfur wash, and probably the miscible oils (1 gallon in
10 of water) applied thoroughly at any time during the winter or
early spring, while the tree is dormant, will soak through the
white cocoons and kill the hibernating pupae. Judicious prun-
ing and burning of infested twigs in winter would destroy
many. The application of a poison spray in the latter part of
June will kill many of the tiny caterpillars then feeding on the
leaves.

*Reference*


**The Lesser Apple Leaf-roller**

*Alceris minuta* Robinson

Throughout the eastern United States a small, pale yellowish-
green caterpillar, about 1/2 of an inch long, with a yellow head and
thoracic shield, often draws the opposite edges of apple leaves
together upwards and fastens them with silk. Living within
the shelter of this folded leaf it feeds over the inner surface,
often partially skeletonizing the leaf and causing it to turn
brown. Sometimes nursery stock and young orchards are so
badly infested, a majority of the leaves being folded and brown,
that from a distance the trees appear as if a fire had swept
through them, and much injury results. Older bearing trees
are rarely seriously damaged by the insect. Besides being a
serious menace to young apple trees, and sometimes attacking
can be destroyed by plowing infested orchards either in late fall or early spring. Thoroughly cultivated orchards will rarely suffer serious injury from this miner. Experiments indicate that many of the larvæ and pupæ can be killed in the mines by thorough applications of 10 or 15 per cent kerosene lime emulsion. Just as effective work with less danger of injuring the foliage could doubtless be done with "Black Leaf 40" tobacco extract, one pint in 100 gallons of water, adding 4 pounds of soap to each 100 gallons to make the liquid stick and spread better.

References


Some Lesser Leaf-miners of the Apple

The following four species of small caterpillars work as miners in the leaves of apple, and while often numerous enough to attract attention, they rarely appear in sufficient numbers to do serious injury.

The spotted tentiform leaf-miner (Lithocolletes blanchardella Fabricius).

The tiny light yellow caterpillars, only $\frac{1}{5}$ of an inch long, make a small mine about $\frac{1}{2}$ an inch long on the lower surface of the leaf, which causes a slight crimping of the leaf, thus giving the mine a tent-like appear-

Fig. 76. — The moth of the spotted tentiform leaf-miner ($\times$ 12).
ance. From the upper surface, the mine has a spotted appearance due to the caterpillars not mining out the whole interior, but eating a little here and there in the mine. The mines are finished in September, the caterpillars transform to pupæ therein, and the winter is passed in this stage on the fallen leaves. The minute Tineid moths which emerge in the spring have golden brown front wings marked with white streaks and spots and a black apical spot (Fig. 76). This European miner is quite common on apple leaves in the eastern United States, but has not yet been recorded as doing serious injury.

References


The unspotted tentiform leaf-miner (*Orni*ngemini*lla* Packard).

The tentiform mines of this insect are larger, and distort the leaves more than those of the preceding species (Fig. 77). The grayish caterpillars, about 4 of an inch long, have a row of 6 black spots across the head and 4 larger ones across the dorsum of the first thoracic segment. They eat the whole interior except the veinlets, so that the mine appears brownish but not spotted on the upper surface. When nearly full-grown the cater-

![Fig. 77. — Mines of the unspotted tentiform leaf-miner.](image-url)
pillars leave their mines, and rolling over the edge of the leaf feed beneath for a short time, then line these retreats heavily with a silken cocoon within which they pupate. There are several broods each season. The tiny, dark, steel-gray moths emerge in the spring and measure only \( \frac{1}{3} \) of an inch across the expanded wings. This miner is widely distributed across the northern half of the United States, and is apparently more common than the spotted tentiform miner. In some cases two-thirds of the leaves in orchards have been distorted by from 2 to 4 of the unspotted mines, yet no very serious injury resulted. The insect also attacks pear and wild cherry foliage.

References


The serpentine leaf-miner (Nepticula pomivorella Packard).

The tiny, dark, emerald-green caterpillars, about \( \frac{1}{10} \) of an inch long, make narrow, tortuous or serpentine mines, often 2 inches in length and less than \( \frac{1}{10} \) of an inch wide just beneath the upper surface of the leaves of the apple and pear. The first half or two thirds of the mine is broader and nearly filled with a continuous zigzagging thread of black excrement. The insect is quite common in Canada and the northeastern United States. In October, the tiny green caterpillars are sometimes seen hanging by silken threads from the leaves. They soon find their way to the twigs, where they spin small, oval, dense, brown cocoons about \( \frac{1}{6} \) of an inch long on the back, often in a crotch. These cocoons resemble, and could be easily mistaken for, Lecanium scales. In May the caterpillars transform through brilliant green pupæ to the minute, shining, purplish-black moths with tufted, reddish-yellow head, that emerge early in June. Thus far no very serious injury has been recorded by this interesting little Tinecid serpentine miner.
The resplendent shield-bearer (Coptodisca splendoriferella Clemens).

Throughout the northern United States, from Maine to Minnesota often there may be found attached to the bark of apple, pear, quince, thorn-apple and wild cherry trees curious little, oval, disk-shaped, seed-like, yellowish bodies about $\frac{1}{10}$ of an inch long (Fig. 78). From these little shields or cases, fastened to the bark at one end by a silken button, there emerges in May a tiny, brilliantly colored, golden-headed moth (Fig. 79). The basal half of the front wings are leaden-gray with a resplendent luster and the remainder golden with silvery and dark brownish streaks. These beautiful little creatures run about on the leaves in the sunshine and lay their eggs, from which hatch the tiny, light, yellowish-brown, legless caterpillars about $\frac{1}{8}$ of an inch in length. These make an irregular dark-colored blotch mine, about $\frac{1}{4}$ of an inch in diameter, in the leaves and observable from both surfaces. When full-grown, the caterpillars line a portion of the mine with silk, deftly cut it out and thus form their seed-like shield. Dropping from the leaves in July by a silken thread, they finally reach the bark or the ground, or are blown to other trees, where the cases are fastened. A second brood of the little miners works on the leaves in September and during October they fasten their cases to the bark and hibernate therein as caterpillars.

Several quite serious outbreaks of this tiny shield-bearer
have occurred at Washington, in Connecticut and in Michigan on apple, quince and wild cherry, sometimes 25 or 30 mines occurring in a single leaf. The bark of the trunk and larger branches were fairly covered with the hibernating cases, 47 having been counted on a spot not larger than a dime.

**Reference**


*Natural enemies of the lesser leaf-miners of the apple.*

All of these little leaf-miners have enemies which are more or less effective aids in preventing their occurrence in injurious numbers. At least two tiny Chalcid parasites, *Sympiesis nigrifemora* and *Astichus tischeriae* attack both the spotted and unspotted tentiform-miners. Ants often tear open the cases of the resplendent shield-bearer and devour the inclosed caterpillar or pupa; two minute hymenopterous parasites also attack this miner. We have bred a tiny parasite from the serpentine miner, and many of the scale-like hibernating cocoons have been found in the stomachs of chickadees.

*Remedial treatments.*

In well cultivated and thoroughly sprayed orchards, leaf-miners rarely become abundant enough to cause appreciable loss, and special treatment is therefore rarely necessary. As all of these lesser leaf-miners feed inside the leaves they cannot be effectively reached with poison sprays. For the tentiform-miners, resort to the treatments recommended for the trumpet leaf-miner. Possibly a spray of "Black Leaf 40" tobacco extract, 1 pint in 100 gallons of water, to which 4 or 5 pounds of soap have been added would penetrate mines and kill the caterpillars of the shield-bearer and serpentine-miner. When very numerous many of the cases of the shield-miner could be scraped from the trees and destroyed.
THE SPRING CANKER-WORM

Paleacrita vernata Peck

Canker-worms are among the oldest and most destructive of American orchard pests. The term "canker-worme" apparently originated in England in 1530, and was used for several different insects in the first authorized English version of the Bible in 1611. As early as 1661, John Hull quaintly related that "the canker-worm hath for four years devoured most of the apples in Boston, that the apple trees look in June as if it was the 9th month" (meaning November). Several other serious outbreaks of canker-worms were recorded in New England during the next century. Although the scientific name of vernata was applied to these canker-worms in 1795, and another name, pometaria, was proposed for some of the moths in 1841, it was not demonstrated until 1873 that two quite different species of insects had been masquerading as the canker-worm in America for more than 200 years.

Canker-worms belong to the Geometrid group of moths whose caterpillars are called measuring-worms, span-worms or loopers from their peculiar manner of walking. Although several kinds of these measuring-worms are destructive to fruits, often working in the same orchards, the term canker-worm is restricted to the two distinct species recognized in 1873 and then given the common names of the spring canker-worm and the fall canker-worm.

Both of these native species often occur together in injurious numbers in the same locality. The apple and elm are favorite food-plants, although several other fruit and shade trees are often attacked. The caterpillars appear on the trees in early spring and work mostly during May, skeletonizing the leaves, which soon turn brown. In June badly infested trees or orchards often appear from a distance as though a fire had swept
THE WHITE-MARKED TUSSOCK-MOTH

*Hemerocampa leucostigma* Smith and Abbot

There are three species of these tussock-moths that may injuriously infest orchards. Two of these are native American insects and one is an old and common European species.

Fig. 111. — Caterpillar of the white-marked tussock-moth, full-grown (×1½).

With their many hairs arranged in striking pencils, tufts and tussocks or brushes, the caterpillars of the white-marked tussock-moth present a very handsome and characteristic appearance (Fig. 111). They are about 1½ inches long when full-grown and of a general dark gray color with a broad velvety black band bordered by yellow stripes on the back and a similar yellow stripe along each side below the spiracles. The head, thoracic shield and two raised glands on the back of the 6th and 7th abdominal segments are bright vermillion-red. Their striking characteristics are dense, brush-like, cream-colored tufts or tussocks of hairs on the back of each of the first
four abdominal segments, and pencils of long plume-tipped black hairs projecting from each side of the first thoracic segment and from the back of the eighth abdominal segment. These strikingly beautiful caterpillars are common in orchards, especially on apple, pear, quince and plum trees, in Canada and over the eastern half of the United States. Considerable injury often results from their work on the foliage in orchards, and in one case 25 per cent of the apples were ruined by the caterpillars gnawing into the sides. But the insect often becomes a far more destructive and formidable pest in cities and towns on shade trees, especially the horse chestnut, poplar and elm.

In the North there is but a single annual brood, but in southern New York and southward there are two or three broods. The caterpillars feed mostly from the underside of the leaves during June, and in July they transform to pupae (Fig. 112) in their silken cocoons, in which their long hairs are inter-

Fig. 112. — Pupae of the white-marked tussock-moth. Enlarged.

Fig. 113. — Female white-marked tussock-moths depositing egg-masses on cocoons.
woven, on the bark in the crotches of the trees or on fences or houses near by. In about two weeks the moths emerge. The hairy, grub-like, light-grayish females have mere stubs of wings, and usually remain on their empty cocoons until after they mate and lay a mass of from 150 to over 700 eggs thereon (Fig. 113). The nearly spherical, yellowish-white eggs are covered by a mass of conspicuous white, frothy material. The ashy-gray colored male moths have feathery antennae and well developed wings, which expand about 1 3\text{\textfrac{3}{4}} inches (Fig. 114). The front wings are crossed by undulated bands of darker shades and bear a conspicuous white spot near the anal angle, hence the name \textit{leucostigma} or white-marked. The winter is always passed in the egg stage, the caterpillars hatching late in May in New York.

Natural enemies.

This tussock-moth is beset by many enemies. At least 10 different birds eat the caterpillars and doubtless do much to keep the insect in check in orchards and the open country. Several species of shield-bugs and the southern wheel-bug attack the caterpillars and pupae; the pupae are also eaten by small red ants. The grubs of two Dermestid beetles and a species of mite may devour the eggs. And as many as 90 per cent of the caterpillars and pupae sometimes fall a prey to more than 20 different kinds of hymenopterous and dipterous insect parasites, the most effective of these little enemies being \textit{Pimpla inquisitor}, \textit{Chalcis ovata}, \textit{Tachina mella}, \textit{Frontina frenchii},
and *Euphorocera claripennis*. Unfortunately, however, there are 14 hyper-parasites which work on the true parasites and thus materially lessen their effectiveness. There are also tertiary parasites which destroy these hyper-parasites, thus presenting a very complicated and interesting case of insect parasitism.

**Remedial measures.**

A practicable and effective method of controlling this pest is to collect and burn the eggs in autumn or winter. The grayish egg-masses are quite conspicuous on the bark and they are often attached to a dead leaf or two fastened to the branches. Where shade trees are infested in cities, it will pay to employ laborers to collect the eggs, and sometimes the school children can be induced to do very effective work by offering prizes or by paying liberally for certain quantities of the egg-masses. The latter method was employed successfully several years ago in Rochester, N. Y., during a severe outbreak of the pest.

Before they are half-grown the beautiful caterpillars will succumb to thorough applications of a strong poison spray, such as Paris green (1 pound in 100 gallons) or arsenate of lead (5 or 6 pounds in 100 gallons). One or two applications of such a spray will usually control this pest. Later when the caterpillars are larger, the poison is not so effective. As the caterpillars drop to the ground by a silken thread when the tree is jarred, some orchardists have found it practicable to capture them on curculio-catchers or sheets. Or after jarring them off, they can be prevented from ascending the trees by means of a sticky rope band around the trunk. Treat the rope with a tanglefoot mixture of resin and castor oil, as recommended for cankerworm bands.

**References**


THE WOOLLY APHIS OF THE APPLE

Schizoneura lanigera Hausmann

Practically wherever the apple is grown in any part of the world, there may often be found during the summer on the trunk, branches and water-sprouts above ground and on the roots also bluish-white, cottony patches (Fig. 164) consisting

of many small, reddish-brown plant-lice or aphids scarcely one tenth of an inch in length. Above ground the bodies of the aphids are nearly covered by a woolly mass of long, waxy fibers that are much shorter on the root-inhabiting aphids, and gives them a whitish mealy appearance. Although for many years considered as distinct species and now often discussed as different forms, the aphids living underground on the roots and those on the branches or trunk are absolutely identical
structurally and one can readily colonize the branch-inhabiting aphids on the roots and vice versa; furthermore, the aphids may often be seen during the growing season wandering from roots to branches or going down the trunk on to the roots, and in either case soon establishing themselves in their new location.

This woolly aphis has ranked as a serious apple pest for more than a hundred years both in Europe and America. In spite of much discussion and controversy, it is not definitely known which of these countries is its native home; it is found upon native apple and thorn trees in both countries. In America the insect is commonly known as the woolly aphis, but in England it is the "American blight" and in Germany it is called the "blood-ouse" from the red color of the crushed bodies of the aphids.

The woolly aphis sucks its food from the tissues of the bark and often causes an abnormal growth or swelling where it works. Above ground colonies of the aphids often develop about the leaf axils on sprouts or new growths and particularly at abrasions (Fig. 165) on the bark or where a branch has been cut off. The aphids often prevent the injured bark from healing normally, and as considerable enlargements of the surrounding tissues result, infested branches often present a swollen and scarred appearance. A favorite location for their work is on the crown of the tree just above the roots. Underground the aphids cause conspicuous, rounded, nodular swellings or galls to de-
velop on the roots, finally resulting in their decay. Usually most of the injury resulting from the work of this pest is due to the greater numbers of the aphids infesting the roots, the more conspicuous but less numerous colonies above ground, rarely doing much damage, especially on larger trees. In some regions, and especially in Europe, the trees are often seriously injured by a majority of the aphids working above ground. In cases of severe infestation the woolly aphids swarm over the whole tree above and below ground, even attacking the foliage and fruit. The foliage on badly infested trees often presents a yellowish, sickly appearance, and the trees are easily uprooted, as many of the roots have decayed from the work of the pest. Apple trees of all ages and varieties are liable to attack, but usually young trees, especially nursery stock, suffer most. Some varieties, like the Northern Spy, are often more or less exempt from attack. Pear, quince and the mountain ash are also recorded as host-plants; it also passes a part of its life history on the elm, causing a characteristic curling of the leaves (Fig. 166). The insect may injuriously infest the roots of trees growing in various kinds of soils, and it works destructively over a wide range of latitude. Many thousands of nursery trees are annually either killed by the insect or rendered unsalable and destroyed in America. Infested nursery stock is largely responsible for its wide distribution. In most localities large, thrifty orchard trees are not seriously injured by this aphis, but sometimes under favorable conditions it breeds so rapidly that it ranks among the most destructive of the insect enemies of the apple.

The interesting and rather complicated life history of this woolly aphis is little understood by orchardists, and a few details are still lacking to make it complete. During the summer only the little wingless, agamic female aphids occur on the apple trees. A dozen generations of these may be developed during the summer, each mother aphid bringing forth living young,
sometimes at the rate of two to twenty a day for two or more
weeks. The baby aphids or nymphs are usually born enwrapped
in a thin pellicle, which is soon cast off. The little creature
begins to suck its food through a beak longer than its body,
and its waxy coating is secreted in a few hours. As these little
nymphs feed and grow their skin is shed four times, a new waxy
coating being secreted each time, and they may become full-
grown in from eight to twenty days. Many of these wingless,
agamic nymphs persist on the roots, and some of them even on
the tree above ground, all the year through even in New York
state and other cold northern latitudes. These aphids mostly,
if not wholly, cease breeding, however, even in southern localities
during the winter months. During the autumn months, some-
times beginning in August, there is developed both above and
below ground many minute, winged, greenish-brown-bodied,
agamic female aphids with the body more or less covered with
the woolly secretion. These winged forms may fly or be blown
to near-by elm trees. They are destined to play an interesting
and important rôle in the perpetuation of their kind. In a few
days these winged, agamic migrating forms give birth to from
six to twelve young, about half males and half females. Both
sexes are wingless and do not grow after being born, having no
mouth parts with which to take food. The reddish-yellow
females are about one-twentieth of an inch in length and twice
as large as the slenderer, olive-yellow males. A few days after
mating the female lays a single long, dark, cinnamon-colored
oval egg nearly as large as her body in a crevice of the elm bark.
Some of these eggs have been found in crevices of the apple
bark where there had been colonies of the lice during the sum-
mer; others record them as laid on the bark on the crown of
the tree near the roots, but as a rule they are laid on the elm.
These winter eggs hatch in early spring and the stem-mothers,
as the first brood of lice are called, are found on the opening
elm leaf buds. They are wingless, and feed on the under surface
of the leaves and are soon surrounded by a numerous family of young aphids. The presence of the lice cause the elm leaves to swell and curl, as shown in Figure 166. The next generation is also wingless, but with the third brood winged forms appear and continue abundant throughout the summer. Some of these fly back to the apple and there establish colonies on the branches, others probably found colonies on the tender elm branches, and some of those appearing early in the season may migrate to other elm leaves. When living on the elm the woolly aphis has been known as the woolly elm leaf aphid (Schizoneura americana Riley).

Enemies.
The woolly aphis has its natural enemies, which help to keep it in check. Spiders often spin their webs over a colony of the aphids and then live at their ease. Many of the aphids are parasitized by the minute chalcis fly, Aphelinus mali, and the larvae of lace-wing flies and a syrphus fly, Pipiza radicum, often work destruction in the woolly clusters. The larvae and adults of several ladybird beetles, particularly the small, brown Scymnus ceryicaulis, and the nine-spotted Coccinella 9-notata, are also active enemies of the woolly aphis, but the combined efforts of all these foes do not often sufficiently control it, so as to make remedial treatments unnecessary, especially on young trees.
egg punctures. It causes little injury, however, because the inner bark continues alive and there is no dead area between the slits.

*Ceresa taurina* Fitch and *C. borealis* Fairmaire, two forms closely related to the buffalo tree-hopper, deposit their eggs in

![Image of apple twigs showing egg-scars of the buffalo tree-hopper.](image)

the buds, within the outer bud-scales. They cause no appreciable injury.

**Reference**


**The San José Scale**

*Aspidiotus perniciosus* Comstock

The San José scale has attained greater notoriety, has been the cause of more legislation, both foreign and interstate, and has demonstrated its capabilities of doing more injury to the fruit interests of the United States and Canada than any other insect. The ease with which it is widely distributed on nursery stock, the practical impossibility of exterminating it in a locality, its enormous fecundity enabling it to often overspread the bark, leaves and fruit of trees in a very few years, and the fact that it attacks practically all deciduous fruit and ornamental plants,
makes it of the greatest economic importance. No other scaleinsect has ever equaled it in capacity for injury to plants.

China is believed to be the native home of this pest, and more appropriate common names for it are the Chinese scale, or the pernicious scale, from the very pat name given it by Professor Comstock when he described it in 1880. It first became established in America at San José, Cal., about 1870, and derived its name therefrom. Previous to its introduction into Eastern nurseries in 1886 or 1887, the scale had gradually spread over most of the states west of the Rocky Mountains. It was not until 1893 that it was discovered in Virginia in the East, but it was soon found to have been already widely spread from these nurseries through thirteen states from New York to Florida. So rapidly has it been spread that important orchard sections in nearly every state and territory, and in Canada and British Columbia, are infested, and it is only a question of time when it will extend over practically all the fruit-growing areas of North America within its climatic range. It occurs also in Hawaii, Chili, Japan and Australia, but stringent legislation has thus far prevented its becoming established in Europe.

The San José scale attacks all parts of fruit trees, including the trunk, branches, leaves and fruit, and usually causes reddish discolorations of the bark or skin of fruit (Fig. 169). Clusters of the scales often occur around the stem and blossom end of the fruit, rendering it unsalable, and sometimes giving a pitted appearance. In bad infestations the scales are crowded together and present a grayish, roughened, scurfy deposit on the bark. If scraped, a yellowish liquid results from the mashing of the soft yellow insects beneath the scales. The fruits commonly infested are apple, pear, quince, peach, plum, prune, apricot, nectarine, sweet cherry, currant and gooseberry. Lemons and oranges, except the trifoliate varieties, many shrubs, forest trees and evergreens are practically exempt from attack.

The fears that shade trees and forests would be ravaged
and become permanent breeding grounds have not been realized, as the pest confines its depredations mostly to fruit trees and ornamental shrubs.

The scale is a waxy secretion covering the soft, yellow, sac-like body of the insect beneath. The largest scales cover the full-grown females and are nearly circular, gray, about the size of the head of an ordinary pin (1/16 of an inch in diameter) with a central dark nipple surrounded by a yellowish ring (Fig. 167b). The smaller scales are nearly black with a central gray dot surrounded by a black depressed ring bordered by a grayish ring. The San José scale can often be readily distinguished from the closely related species, Putnam’s scale, European fruit-scale and cherry scale, even with a hand-lens by these peculiarities of the young scales. In the other species the nipple is usually one side of the center and orange or yellow in color, and the scales are not so black or lack the depressed ring of the nipple. The elongate-oval male San José scales, only about half as long as the diameter of a mature female scale, are dark gray with the circular raised exuvial portion near one end and usually darker but sometimes yellowish (Fig. 168). The male scales are sometimes more numerous than the females during the early part of the breeding season.

In late autumn all stages of the San José scale, from those just born to the fully developed insects, are to be found on the trees, but practically only the small black scales covering the
half-grown insects hibernate, all the other stages being killed by winter conditions. In New York the winged males emerge in May, and the females mature and begin giving birth to living young during the latter part of June. The young develop inside the body of the mother in thin membranous, sac-like eggs and most of them burst through the sac and are born alive, but some of these eggs may be laid before the young hatch, so while the insect is usually ovoviviparous it may be partially oviparous. A single mother is capable of giving birth over a period of six weeks to nearly 600 young but doubtless does not average more than 100 to 200; many of these are males, and some soon die. The tiny yellow, six-legged young crawl from under the mother scale and often spend about a day in finding a suitable place to settle down and insert their long, thread-like mouth parts with which they suck their food from the interior tissues of the plant. In a few hours the body becomes covered with a mass of white cottony and waxy fibers which in 2 or 3 days mat into a pale grayish scale that gradually becomes larger and darker until in about two weeks the first molt of the insect occurs. Up to this point the males and females and their scales have been indistinguishable, but after this molt they both lose their legs and antennæ and the females their eyes also. The males have large, purple eyes and undergo two more molts, gradually developing into delicate, orange-colored, two-winged, fly-like insects in from 3 to 4 weeks. The yellow female insects, with their thread-like, sucking mouth parts two or three times as long as the body, remain circular, flattened and sac-like in form, molt a second time in from 3 to 5 weeks, and in a few days mate with the males. In molting the old skins split around the edge of the body, the upper half adhering to the scale beneath the central nipple and the lower half forming sort of a ventral scale next to the bark; the second and third cast skins of the male are pushed out from beneath the scale.
At Washington, the females may attain their full growth in 30 days from birth, but it requires about 50 days in the fall in New York. As the females bear living young over so long a period, the broods overlap and it is difficult to trace the number of generations, but there are apparently three broods annually in the latitude of New York and four broods at least south of Washington. Breeding begins in the North in June and a month or more earlier in the South. The progeny of a single San José scale giving birth to only 100 female young in the spring could, but doubtless never does, amount to the enormous total of over 100,000,000 females by fall if there were four generations annually. At this fearful rate of multiplication, unequaled by any other injurious scale-insect, it is no wonder that infested plants rapidly succumb to the drain of so many thousands of tiny pumps sucking out their life.

The widespread distribution of the San José scale is due almost entirely to infested nursery stock. Rigid nursery inspection, compulsory fumigation, and interstate quarantine legislation doubtless help much, but fail to fully protect the fruit-grower, and the pest continues to reach both old and new localities on infested nursery stock bearing supposed "bills of health" in the form of inspection and fumigation certificates. Many have feared that new infestations might be brought about through infested fruits, especially apples and pears, which are distributed world-wide. Foreign nations enacted strict quarantine regulations against infested American fruit, even though it were dried. However, there are no authentic cases of infestation from scaly fruit, and while there is a bare possibility that it might occur, the chances are so small as to be practically ignored. The scale may be spread locally from tree to tree or to other orchards in several ways. As the newly born lice are active and often crawl about for a day before settling down, they may be able to crawl on to other trees, especially in nurseries where the branches interlace and touch. Strong winds
may blow these crawling young to neighboring trees, and many of them are doubtless carried to other trees or orchards by other insects and by birds which often go from tree to tree. The crawling young have been found on the bodies of black lady-bird beetles, black ants, grasshoppers, *Chrysopa* adults, flies, and beetles, these insects thus furnishing ideal steeds or "flying machines" on which the scale may ride to new pastures.

While the San José scale is one of the greatest insect scourges that the fruit industry has ever encountered, it has taught some valuable lessons. Nurserymen are growing and shipping cleaner, healthier, better stock. Fruit growers are selecting their trees with greater care, and giving each tree individual attention in the orchard, an invaluable feature in orcharding. Many have been forced into spraying, which most progressive fruit growers find to be one of the best paying operations in orchards. The scale is so small and so difficult to reach and kill, that the efforts to successfully combat it have resulted in better spray mixtures, machinery and methods not only for this scale, but for other insect and fungous enemies of orchards. Fruit growers in general are spraying more skillfully, more easily and more effectively, and many of them are satisfactorily controlling this tiny but terrible foe — the San José scale.

While the San José scale is beset by many natural enemies, its marvelous fecundity usually enables it to develop in injurious numbers in spite of them. The following nine species
of minute Hymenoptera are true parasites of the scale in America: *Aphelinus fuscipennis* and *mytilaspidis*, *Aspidiotiphagus citrinus*, *Anaphes gracilis*, *Physcus varicornis*, *Prospaltella aurantii*, *P. perniciosi*, *Ablerus elisiocampae* and *Rhopoidens citrinus*. Most of these parasites are widely distributed in the United States and other countries, and they are all general feeders on other species of the armored scales. Sometimes these parasites destroy enormous numbers of the scales, and they will always be very potent factors in Nature's efforts to help man in controlling this pest.

About a dozen ladybird beetles have been found eating the San José scale in America. The most important and useful of these are the twice-stabbed ladybird, *Chilocorus bivulnerus*, the tiny black *Micrweisea misella*, another tiny, dark, wine-red colored species of the same genus, *M. suturalis*, and a Malachiid beetle, *Collops quadrimaculatus*. The most useful and interesting of these is the tiny black *misella*, which is widely distributed in the United States. The little beetles stand astride the full-grown female scales, push their heads under the margin of the scale and devour the soft, yellow insect beneath. The grubs of the beetle feed upon the smaller scales. The chief natural enemy which kept this scale in check in its native home in China was found to be a ladybird beetle, *Chilocorus similis*, which is almost identical in the beetle stage to our native American twice-stabbed ladybird, but differs in the reddish color of the grub and it also breeds much faster. This Asiatic ladybird beetle was introduced into the United States and readily attacked the scale, multiplied rapidly at Washington, and was sent into other localities both North and South. Lack of food and a native parasite destroyed the Washington colony and the insect failed to thrive in the North. It bred in great numbers for a time in Georgia, but man's spraying operations soon cut off its food supply and it was nearly exterminated.

Several fungous and other diseases sometimes attack the San
José scale with much effectiveness, especially in its southern range. Some of these can be transferred from tree to tree and it is in the range of possibilities, with more careful study, that artificial cultures can be made and distributed and yield results of practical value in the control of this scale. No harm can come from such introduction of natural enemies or diseases, and the time will doubtless eventually come, as it apparently has in some localities in California especially, when these enemies and diseases, together with man's vigorous warfare, will rob this insect of most of its present terrors, making it a much less dangerous orchard pest.

**Remedial measures.**

Its minute size rendering it difficult to detect unless very numerous, the ease and rapidity with which it may be distributed on nursery stock or cuttings, its marvelous fecundity enabling a few scales to soon re-infest a whole tree and the skill required to hit all the tiny scales with a spray, make the San José scale one of the most difficult insect pests to successfully control. Extermination is practically impossible except on limited areas where the infested plants can be destroyed root and branch, and then a new infestation may occur at any time if more plants are set. The destruction of infested trees is advisable in a very young orchard where only a few trees are involved, so as to put off as long as possible the general infestation, which will usually follow sooner or later. In older bearing orchards many fruit growers have succeeded in getting the pest under thorough control without the loss of a tree, but it means a big and continuous fight by a man determined to win.

Fruit growers should become familiar with the appearance of the scale from dead specimens readily obtained from infested localities. The pest can be combated more easily and effectively while it is in hibernation as half-grown scales on dormant trees. In starting new orchards get certified, fumigated stock from reliable sources, carefully examine each tree, and then thoroughly
fumigate the stock again with hydrocyanic acid gas before setting. Fumigation with this gas, if properly and thoroughly done, is the most effective and practicable treatment for nursery stock. The dipping of such trees in the lime-sulfur wash or other sprays is not so effective and may injure the trees, especially if the roots are dipped.

After much experimentation with fumigation tents, whale-oil soap, undiluted kerosene and crude oil, and mechanically mixed oil-water sprays, these have been largely superseded by the cheaper, more effective and safer sprays of oil emulsions, miscible oils and the lime-sulfur wash, which must be brought in contact with each scale. Several applications of a 10 to 15 per cent kerosene emulsion spray during the summer has been safely used on apples to check the development of the pest, and a 25 per cent crude petroleum emulsion (formula, p. 486), makes an effective spray for use on old apple trees as the buds are swelling in the spring. The miscible oils should not be diluted more than 1 gallon of oil to 10 or 12 of water to get satisfactory results. The lime-sulfur wash should be used in preference to other sprays on peaches, for when applied in early spring it kills the scale and also acts as an effective fungicide against the destructive peach leaf-curl fungus. Badly infested trees should be sprayed twice, first in late autumn after the leaves drop and again in early spring before growth begins. Some are able to successfully control the pest with only one application in early spring. The cheapest and safest spray, the one which has withstood the severest tests of experimenters and orchardists, and has given the most uniformly successful results, is the lime-sulfur wash. The oil emulsions or miscible oils are non-corrosive, more agreeable to use, spread better, so that less material is necessary, and they penetrate more effectively the crevices of the bark or the fuzzy coated twigs of apple trees, but unless properly applied there is always more or less danger of injuring the trees. The market brands of miscible oils are simply
poured into the required amount of water and quickly form, upon stirring slightly, a perfect and stable emulsion-like mixture ready for use. None of these sprays recommended for use on dormant trees can be safely used on trees in foliage. Where very large, old, rough-barked apple trees are infested, only the most thorough kind of spraying will conquer the pest. On such trees it is recommended to use the crude oil emulsion spray just as the buds are swelling in the spring.

The most effective work can be done with about 100 pounds pressure per square inch, using a fine spray through a nozzle of the cyclone type. The judicious pruning away of the tops and long sprawling branches of infested trees will often enable the orchardist to do more thorough work. Remember that the San José scale is not larger than a pin head; that the insect itself is well protected under the scale; and that it is therefore necessary to hit each tiny scale so thoroughly that the spray covers the insect. To do this requires powerful pumps, good nozzles and, most important of all, an experienced and determined man behind the gun who can shoot straight and thoroughly cover the bark of the tree with the spray from the surface of the ground to the tips of the smallest twigs.

Reference


Nearly every Agricultural Experiment Station has published bulletins or circulars giving full directions for fighting the San José scale under local conditions.

The Oyster-shell Scale

*Lepidosaphes ulmi* Linnaeus (*Mytilaspis pomorum* Bouché)

This cosmopolitan insect is doubtless the commonest, most widespread and best known of the scale-insects infesting fruit-trees in America, where it has been injurious in the northeastern
United States for a century. By 1850 it was abundant throughout the northern states east of the Mississippi. Spreading rather slowly, it has now reached most of the orchard sections in the far West, the South and all through Canada, but it is most injurious throughout its northern range from Nova Scotia southward to the latitude of Washington and westward to Montana. In the North the scales often develop on the fruit itself, causing red spots similar to those produced by the San José scale (Fig. 174).

The oyster-shell scale is readily distinguished from all other scale-insects injuriously infesting deciduous fruit-trees in America by its peculiar shape and color, resembling a miniature elongate, curved oyster shell of a dark brownish bark-like color. The convex scale covering the body of the female is about \( \frac{1}{6} \) of an inch long and consists of two minute cast skins at the smaller end and a large scaly portion gradually secreted from the body of the insect underneath. The male scale is much smaller and rarely seen on fruit-trees; they are often abundant on ash. Old lifeless scales often adhere to the bark for several years.

If at any time from September to May the female scales formed during the preceding summer be overturned, they will be found to cover from 30 to 100 minute, white eggs and the much
shriveled, dead body of the mother tucked away at the smaller end (Fig. 173). Thus hibernation in the egg stage lasts for 8 or 9 months, the time of hatching in the spring depending much on weather conditions. Hatching may begin as early as the middle of May in the North, but in 1907 it was a month later in New York. The mere specks of active six-legged, pale yellowish-white young (Fig. 171) that hatch from the eggs soon crawl out from under the scale and in a few hours settle down on the bark, insert their long, thread-like sucking tube, secrete a covering of cottony fibers, and the females never move from that spot (Fig. 172). The sexes are alike at birth, and after feeding a few days shed their skin, becoming grub-like creatures without legs or antennæ. Growth continues with no apparent difference between the sexes until it is necessary to molt again, when it is seen that a winged insect, the male, is being developed under some of the scales. This second cast skin of the female is added to the scale-covering; a few days later the fully developed, delicate, two-winged male insect without mouth parts
emerges and seeks its mate. The yellowish females continue to increase in size, remain grub-like in form and secrete the large, brown portion of the scale, becoming full grown in August or early September in the North. Egg-laying soon begins, the body of the mother gradually shrinking into the smaller end of the scale, and the 30 to 100 eggs occupying most of the space beneath the scale. In New York, egg-laying sometimes begins early in August, but in 1907 it was delayed until October in some localities. There is but a single generation of the oyster-shell scale in the North, but in southern New Jersey and Pennsylvania and farther south there are two generations annually.

Fig. 172. — Old and recently set oyster-shell scales on willow.

This oyster-shell scale has a wide range of food-plants. It often nearly covers the bark of the larger branches (Fig. 170), and even the twigs of apple and pear trees, and is often equally as numerous on lilac bushes, willow, mountain ash and poplar trees. It may also attack quince, plum, raspberry, currant and fig among the fruits, and includes more than twenty-five shade trees and shrubs in its list of host-plants. It infests trees of all sizes and ages, often killing young trees and severely injuring large ones. Orchards that are kept in a thrifty growing condition and the trees not crowded rarely suffer serious injury from this scale, but we have seen the lower limbs especially, and sometimes the whole of large trees, killed by the insect where the trees were crowded and neglected. Usually the bark of the tree only is
infested, but occasionally a few of the scales develop on the fruit even in the North, where there is but a single generation annually.

The oyster-shell scale is beset by many natural enemies. Some of the ladybird beetles, the twice-stabbed ladybird especially, devour many, and the eggs beneath the scales are preyed upon and often a large proportion of them, 50 to 75 per cent in some cases, eaten by a mite, *Hemisarcoptes coccisugus*, in France, and in America by the larvæ of at least five minute parasites, *Aphelinus mytilaspidis*, *abnormis*, and *fuscipennis*, *Anaphes gracilis*, and *Chiloneurus diaspdinorum*. These parasites emerge through pin-like holes in the scales and often a majority of the scales on a tree show these holes. It usually requires two of the parasitic larvæ to destroy all the eggs under a scale, one larva often leaving from 2 to 20 eggs. A few birds, the brown creeper, black-capped chickadee and white-breasted nuthatch, are also reported as feeding on it. The combined efforts of all these natural enemies often prevent serious injury by the oyster-shell scale and occasionally nearly exterminate it in a locality.
spring take an upward course, either through the pith or in the wood just beneath the bark (Fig. 294). They become full-grown (Fig. 295) in July and burrow out to the surface of the cane but leave the epidermis intact over the opening. The pupa is about $\frac{3}{4}$ inch in length, of a reddish-brown color, and has the front end armed with a sharp-pointed process used in breaking away the epidermis over the end of the burrow. The pupal stage lasts 25 to 30 days. When about to transform the pupa works itself part way out of the burrow, so that after the moth has emerged the empty pupal skin is left protruding from the opening. The moths usually emerge in the afternoon and mating takes place in the early evening.

This borer may be held in check by systematically digging out the larvæ whenever a dying or wilting tip indicates its presence. All wild berry bushes in the vicinity of berry fields should be destroyed to prevent the breeding of the moths.

References

The Rose Scale

**Aulacaspis (Diaspis) rosæ** Bouché

The stems of roses, blackberry, raspberry and dewberry growing in damp, shady places often become densely coated with a snow-white, nearly circular scale-insect, the larger ones about $\frac{1}{16}$ of an inch in diameter, with the two light yellow
exuviae or cast skins at the margin. Among these larger female scales are many of the shorter, narrower, three-ridged, white scales of the male insect (Fig. 297).

This rose scale is practically a cosmopolitan insect, occurring wherever roses are grown, and it is widely distributed over the United States and Canada. It is not often a serious pest in berry plantations and is usually readily controlled.

In New Jersey, and doubtless also in more southern localities, the rose scale may hibernate in all stages from the egg to the gravid females, mostly, however, as young scales of both sexes, as male pupae and as full-grown females. Observations in Canada also indicate similar hibernation conditions and at least two generations annually. Breeding is almost continuous after April, and three or more broods may occur in New Jersey and southward.

Two little hymenopterous parasites, *Aphelinus diaspidis* and *Arrhenophagus chionaspis*, destroy many of the scales.

**Remedial measures.**

In berry plantations cut and burn all badly infested canes soon after the fruit is off, or in winter, and thus prevent serious infestation of the new canes. Thorough applications of a soap spray (1 pound whale-oil or other good soap in 1 gallon water) or the lime-sulfur spray in winter or early spring have been found to effectively control this insect.