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SCALE INSECTS:
SAN JOSE AND OTHER SPECIES.

Bulletins of this Station will be sent, upon application, free of charge,
to any Farmer in the State.

KNOXVILLE, TENNESSEE, U. S. A.

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SCALE INSECTS: SAN JOSE AND OTHER SPECIES.

CHAS. E. CHAMBLISS.

THE SAN JOSE SCALE: *Aspidiotus perniciosus* Comst.

In 1870 the San Jose scale was introduced into California. In 1873 it had become a serious pest in the San Jose Valley, hence its common name. Within ten years, the important fruit districts of southern California had become infested, and with the same alarming rapidity, it spread to other parts of the Pacific coast.

The presence of this scale in the Atlantic States was not known until August, 1893, when it was discovered on pear trees at Charlottesville, Va. This discovery led to a thorough investigation, which resulted in finding the San Jose scale in two large New Jersey nurseries, where the scale was introduced on some plum trees in 1886 or 1887. During the six or seven years that the scale had remained undetected in the East, it had been distributed, through the agency of these nurseries, to nearly every county of New Jersey and many states along the Atlantic coast.

Although the two New Jersey nurseries are responsible for the introduction of this pest into the East many smaller nurseries have assisted in spreading it, until now, the San Jose scale is found throughout the entire East.

The present distribution of the insect within the United States is as follows:

Alabama, Arkansas, Arizona, California, Connecticut, Delaware, District of Columbia, Florida, Georgia, Idaho, Illinois, Indiana, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Nevada, New Jersey, New Mexico, New York, North Carolina, Ohio, Oregon, Pennsylvania, South Carolina, Texas, Virginia, Washington, West Virginia. From the United States it has been carried into Ontario and British Columbia.

In Tennessee, it has been found in four localities. It was first located at Harriman, Roane county, in the orchard of the East Tennessee Land Company. On Sept. 3, 1896, all orchards in the vicinity of Harriman were thoroughly inspected, which resulted in finding this scale insect in the above named orchard, and in one private lot that contained a few trees which had come from this orchard. The insect was brought to Harriman on the first trees that were purchased by the East Tennessee Land Company, which was in 1891 or 1892. Until 1896 the insect remained unnoticed, during which time the orchard had become so infested that the trunk and large limbs of nearly every tree presented a scurfy appearance. From whom the trees were bought the present manager cannot say.

On December 28, 1897, specimens of this scale were received from Mr. R. E. Bratton, of Cedar Fork, Claiborne county, who stated in his letter that the trees from which the specimens were taken were purchased two years ago from a Virginia nursery. The Station has since learned from a reliable source that the nursery named by Mr. Bratton was not in business in Virginia at the time of the sale and has not been for about ten years.

On March 1, 1898, specimens were received from Mr. Thos. G. Fulkerson, of Tazewell, Claiborne county. The trees from which these specimens were taken were bought from the same parties and at the same time as those of Mr. Bratton.

On March 12, 1898, Mr. W. V. DeVault, of Austin Springs, Washington county, sent specimens with the statement that they were taken from trees which he bought four years ago from a New Jersey nursery.

The original home of this scale insect is not known. It is to be found in Australia, Chili, and Hawaii, but whether it was introduced into the United States from any of these countries is yet to be ascertained.

When trees are badly infested by the San Jose scale, the natural color of the trunk and limbs, especially the young of the latter, are obscured by a grayish scurfy deposit. The scales when numerous on the new growth stain the cambium layer to a deep red. Beneath the scales which form this deposit, soft yellow insects are found. The leaves and fruit are also attacked. On the leaves the scales arrange themselves in regular rows on either side of the mid-rib. On the fruit, they scatter themselves irregularly over the surface and give it a rough and distorted appearance.

The scurfy deposit on the trunk and limbs and deep red stain of the cambium layer of the new growth are characters which serve to distinguish this from other scale insects.

In searching for this insect all deciduous fruit trees should be thoroughly examined, especially pear, plum, peach, apple, and cherry. Many small fruits, shade trees, and ornamental shrubs are damaged by this pest.

The list of food plants is as follows:*

Orchard fruits: Pear, peach, apple, plum, cherry, persimmon, quince.

Small fruit: Strawberry.

Bush fruits: Raspberry, gooseberry, grape, currant.

Nut plants: Almond, chestnut, pecan, black walnut, English walnut, and Japan walnut.

Miscellaneous ornamental plants, forest and shade trees: Rose, hawthorn, spirea, cotoneaster, euonymus, English huckleberry, linden, acacia, elm, osage orange, alder, sumac, weeping willow, English willow, golden willow, laurel-leaved willow, milkweed, *Catalpa speciosa*, Lombardy poplar, Carolina poplar, golden-leaved poplar, silver maple, cut-leaved birch, mountain ash, Japanese quince, actinidia, *Citrus trifoliata*, red dogwood, snowball, Juneberry, loquat, laurel and akebia.

In Tennessee it has been found on the following: Apple, peach, plum, pear, apricot, grape and English walnut. When the orchard at Harriman was first inspected, the Le Conte pears which were in one row, were found to be entirely free from this scale, while the adjoining rows were badly infested. This seemed to indicate that this variety of pear would remain free from this pest, but on the last inspection of the orchard, November 12, 1897, a few scales were found on one tree. All the trees in the orchard were set out at the same time, and within six or seven years there was no question about the presence of the San Jose scale on all trees but the Le Conte. From this, it may be safely concluded, that although the Le Conte pear is not entirely exempt, it is less liable to an attack of this insect.

The real insect is concealed by the scale, a waxy covering which is secreted from the body of the insect. In outline, the mature female scale is circular with a slightly raised centre. It averages in diameter about one-sixteenth of an inch. The scale is gray, except the more elevated part, which is usually yellow. (See illustration). The scale of the male is about twice as long as wide, with an average length of one thirty-second of an inch. In color the male is usually darker than the female scale.

*Bull. No. 12, n. ser., Div. Entom., U. S. Dept. Agr. p. 13. Howard, L. O.

Under the protection of the scale, the insect in different stages of growth passes the winter. In this latitude, the full grown female probably begins in the latter part of March to give birth to a new generation.

As a rule among insects, eggs are deposited, but in the case of the San Jose scale, the young are brought forth alive. For a short time after birth the young insect remains motionless, with its legs folded beneath its body. Soon the legs unfold, and immediately the almost microscopic insect begins to search for a suitable place in which to insert its beak. When this is accomplished, the legs disappear and the oval body contracts to a nearly circular form. The secretion of the scale begins, and the young creature if a female, becomes fixed for life. In the case of the male the attachment is temporary.

Within thirty days from birth, the female becomes sexually mature, and in a few days later the young begin to appear. The period of reproduction covers about six weeks, in which time 400 or more are born. The reproductive power of this insect is wonderful. It has been estimated that the product of a single female in one season would be 3,216,080,400 individuals. This estimate is based upon four broods in a year and upon the survival of all the insects. In Tennessee, where there are at least five broods, this number will be greatly increased. Active larvae were found at Harriman as late as November 12, and though not observed, it is probable that the young emerge as early as the latter part of March or first part of April.

The male does not become so degraded in structure as the female. In about twenty-six days from birth the male emerges from the scale as a tiny two-winged insect. The antennae or "feelers" and eyes are well developed. Possessed of wings, it flies in search of its mate.

As the female has no power of locomotion, except during the first hours of its existence, the means at its command for transportation are rather limited. The spread of the scale in an orchard from one or more infested trees can be accounted for in several ways. Insects, birds, the wind, and even man may serve as distributors. Since Mr. E. A. Schwartz has found the scale larvae upon two small beetles and one ant, there can be no doubt but that insects act as carriers. If this be so, birds may serve in the same capacity. Men and teams at work under an infested tree may distribute the scale in the same manner. Yet with these possible means of distribution, the infestation could only be local.

The wide distribution of the San Jose scale in the United States has been brought about through the transportation of nursery stock and grafting material. It was through the same means that the insect entered this country. For this evil, the remedy lies in the enactment and enforcement of national laws for the inspection of nursery stock. The action of the National Association of Nurserymen at their last meeting in drafting a bill relating to interstate and international legislation against insect and fungous pests is significant. The bill "provides rules and regulations for the importation of trees, plants, shrubs, vines, grafts, cuttings and buds, commonly known as nursery stock and fruits into the United States. And for rules and regulations for the inspection of trees, plants, shrubs, vines, grafts, cuttings, and buds, commonly known as nursery stock, grown within the United States, which become subjects of interstate commerce." Every fruit grower can and should assist in securing the passage of this bill by requesting his representative in Congress to vote for the measure.

The San Jose scale is not without natural enemies. Numbered among them, are four parasitic and two predaceous insects. In Tennessee only one from this list has been found. *Pentilia misella*, a small black beetle, is in the infested orchard at Harriman, but though present in large numbers, its work has not been effective. The parasitic and predaceous insects are valuable in reducing our insect enemies, but their usefulness should not interfere with the proper use of insecticides.

In fighting the San Jose scale it is very important that each scale is reached by the spray. As there is a continuous emergence of young during the growing period, this could not be accomplished in summer without a great loss of time and material. So for success, winter operations must be adopted in combating this insect.

The object of the following experiments was to test the effectiveness of whale oil and caustic potash soaps as winter washes.

Whale oil soap at the rate of two pounds to one gallon of water was used. By means of a spray pump two applications were made. Experiment 1. Trees with rough bark that were very badly infested were selected and severely pruned. The first application of the wash destroyed 85 per cent. of the scales; the second, the remaining scales. Experiment 2. Trees with *very* rough bark that were not badly infested were selected and properly pruned. The first application of the wash destroyed 70 per cent. of the scales; the second, 95 per cent. of the remaining scales. Ex-

periment 3. Trees with smooth bark that were badly infested were selected and properly pruned. The first application of the wash destroyed 95 per cent. of the scales; the second, the remaining scales.

Caustic potash soap at the rate of two pounds to one gallon of water was used. By means of a spray pump, two applications were made. Experiment 4. Trees with *very* rough bark that were badly infested were selected, severely pruned and *brushed*. The first application destroyed 95 per cent. of the scales; the second, the remaining scales. Experiment 5. Trees with smooth bark that were badly infested were selected and properly pruned. The first application destroyed 95 per cent. of the scales; the second, the remaining scales.

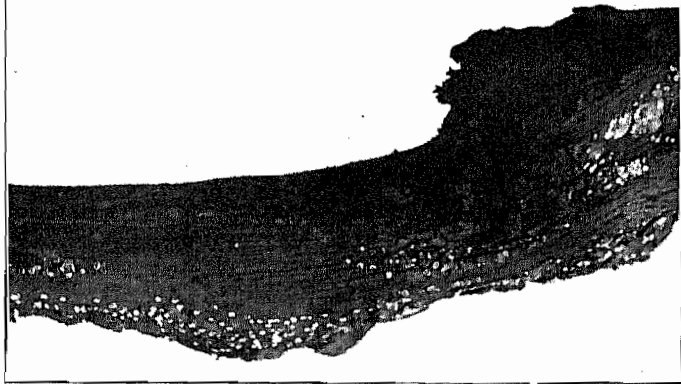
From these experiments, we learn that if two applications are made, either whale oil soap or caustic potash soap used at the rate of two pounds to one gallon of water, is effective. We also learn that the effectiveness of the wash on trees with very rough bark is increased by brushing the trunk and larger limbs, and that properly pruned trees always insure better results. In addition, the effectiveness of any measure depends upon the thoroughness of the work.

(The loss of labels prevents a report on the spraying of other trees with weaker solution).

THE OYSTER-SHELL BARK LOUSE: *Mytilaspis pomorum* Bouche. In Tennessee, this scale insect is quite common. Localities in the State from which specimens have been received are as follows: Knoxville, Sweetwater, Wanita, Muddy Creek, Dayton, Rockwood, Tazewell, Pomona, Harriman, Loudon, and Lookout Mountain. In the North it is more common than in the South.

On account of its size, the scale is not conspicuous unless in large numbers. It measures about one-sixth of an inch in length, and in shape looks very much like an oyster shell. (See illustration). The scale adheres very closely to the bark of the tree, and resembles it very much in color. During the winter, it shelters the eggs.

The eggs are small and white, and number from twenty to one hundred or more. They occupy the broader end of the scale, while the smaller end is filled with a dark, shriveled object, the remains of the female. In East Tennessee, the eggs hatch during the last two weeks of April. If the weather is cool, the young lice remain under the scale for several days, but if warm they leave this shelter at once.



The Grape Scale,
(*Aspidiotus uvae*.)



The Peach
Lecanium.
(*Lecanium
nigrofasciatum*.)



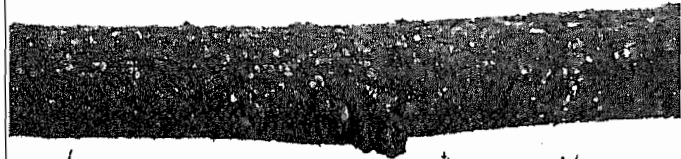
The Scurfy
Bark Louse,
(*Chionaspis
furfuris*.)



The Oyster-
shell Bark
Louse, (*Mytil-
aspis pomorum*)



The Rose Scale,
(*Diaspis rosae*.)



The San Jose
Scale.
(*Aspidiotus per-
niciosus*.)

For several hours, the young wander over the twigs in search of a suitable place in which to insert their beaks. When this has been accomplished, they soon lose the means of locomotion and become permanently fixed for life, except the males, which, in development, acquire wings. After the females have become fixed, they molt twice and begin the formation of the scale, which is secreted from the posterior portion of the body. About the end of the eighth or ninth week, the females begin to deposit eggs under the scale.

Although the apple is the usual food plant in Tennessee, the cottonwood and maple are sometimes badly attacked. The insect has been reported upon the following plants: apple, pear, plum, quince, wild red cherry, hawthorn, rose, buckthorn, raspberry, wild grape, maple, water locust, spireas, honeysuckle, fig, ash, bittersweet, Juneberry, willow, black ash, poplar, swamp willow, white ash, white birch, and red birch.*

THE SCURFY BARK LOUSE: *Chionaspis furfurns* *Fitch*. Unlike the preceding species, the scurfy bark louse seems to flourish better in the warmer parts of the South. Specimens have been received from the following localities in this State: Knoxville, Leiper's Fork, Cagle, Tazewell, Harriman, and Powell's Station.

The female scale is flat and very irregular in outline. When numerous its grayish white color gives to the trunk and larger limbs the appearance of having been sparingly treated with white-wash. (See illustration). During the winter, the female scale furnishes shelter to ten to seventy-five purplish red eggs. In the vicinity of Knoxville, these eggs hatch during the latter part of April. The stages in the development of this insect are almost identical with those of the oyster-shell bark louse. The male scale of this insect is smaller, whiter, and marked by three elevated longitudinal ridges.

This insect has been found upon the following plants: apple, pear, crab-apple, quince, black cherry, currant, mountain ash, peach, and Japan quince.†

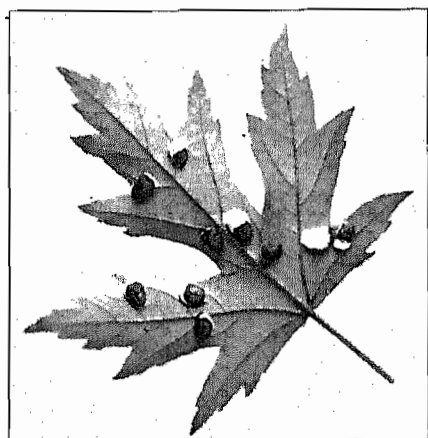
THE ROSE SCALE: *Diaspis rosae* (*Sandberg*). While more common on the rose, this scale infests the raspberry, blackberry, and currant. Specimens have been received from the following localities in the State: Knoxville, Harriman, Tazewell, and Maryville.

*Yearbook of the U. S. Department of Agriculture for 1894, p. 256, Howard, L. O.

†Yearbook of the U. S. Department of Agriculture for 1894, p. 260, Howard, L. O.

The female scale is circular and white. The pure white scale is very conspicuous against the green background of the stem and branches on which it is generally found. (See illustration). The presence of the pest is easily detected by this strong contrast. The female scale shelters during the winter, the adult, half-grown larva or eggs. The eggs are red and number from twenty to fifty. The male scale is narrow and small.

Taken as a whole, the life history of this insect is quite similar to the two preceding species. It has been noticed that portions of rose bushes which are partly sheltered are more commonly infested.



The Cottony Maple Scale (*Pulvinaria innumerabilis*) before the entire egg mass has been deposited.

THE COTTONY MAPLE SCALE: *Pulvinaria innumerabilis* Rathv. This scale insect is one of the troublesome pests of the maple tree. However, it is not confined to the maple alone, for it has been reported on box-elder, osage orange, linden, locust, sumach, beech, willow, grape, currant, rose, and Virginia creeper.

From the middle of May to the first of June, the females, which have remained in a torpid condition on the under side of the twigs and branches during the winter, migrate to the leaves. It is at this time

that they attract so much attention. (See illustration). Upon reaching the leaves, the gravid females begin to excrete beneath their bodies, a mass of white, cottony material, in which the eggs are placed. When all of the eggs, which often number two thousand or more, have been deposited, this white mass is more than one quarter of an inch in length. The batch of eggs is held together and fastened to the leaf by the adhesive character of the material in which it is embedded.

At Knoxville, the eggs begin to hatch during the early part of June, and continue for about two weeks. The larvae scatter over the leaves and in a day or two attach themselves along the ribs of the leaves where

they begin to feed and grow. While the females increase in size, they undergo few changes of form during the summer. On the approach of autumn, they change from flat to convex bodies and before the falling of the leaves migrate to the branches, where they establish themselves on the under surface. The winged males appear in August.

THE GRAPE SCALE: *Aspidiotus uvae Comst.* The grape scale is not common in the State. It has been collected at Knoxville in only one vineyard.

The female scale is flat and nearly circular. It measures about one-twelfth of an inch in diameter. The male scale is smaller and elongated, being about twice as long as broad. The color of both scales is yellowish brown, which is always a little lighter than the part of the vine which they infest. (See illustration). It appears that only the older parts are subject to an attack of the insect. From observations made last winter, it seems that the habits of this insect are quite similar to those of the San Jose scale.

THE PEACH LECANIUM: *Lecanium nigrofasciata Modeer.* This insect has been collected on peach and plum trees in this State, at Knoxville, Dayton, and Harriman.

If not numerous, the scale might be taken for a roughness on the bark, but if abundant, its position on the branch makes it conspicuous. It has the form of a half sphere, the border of which is marked with fine lines of red alternating with broader ones of pale brown. It measures from one-eighth to one-sixth of an inch in diameter. The general color is a very dark brown. (See illustration).

The eggs are deposited by the middle of May and begin to hatch in the early part of June and continue to hatch for about a month. The winged males appear towards the latter part of July. About a month later, the females become attached to the branches and twigs.

NATURAL ENEMIES OF SCALE INSECTS. There are many predaceous and parasitic insects that prey upon scale insects. They are active in preventing a too rapid increase of the scale insects, but beyond

this, they are of no practical service to the orchardist. Insecticides and pruning can furnish the only means for total extermination.

Lady birds are among the most active destroyers of scale insects, and the most abundant of the beetles is the twice-stabbed lady bird (*Chilocorus bivulnerus*). This insect is recognized by its polished wing cases with a blood-red spot on each. The black spiny larva is more active in the work than the adult beetle. The larvae of Syrphus flies and lace-winged flies are to be numbered among the predaceous species, but they are not so effective in their work as the lady birds. Some mites and a few predaceous bugs are also formidable enemies. The internal parasites are numerous and probably do more active service than the predaceous species. They are the larvae of minute wasp-like insects.

REMEDIAL MEASURES. For an early summer treatment, kerosene emulsion, diluted ten times with cold water, has been found effective against the scurfy bark louse, oyster-shell bark louse, the rose scale, and peach Lecanium. The application of this insecticide should be made just after the hatching of the eggs, when the young larvae are not protected. Plants affected with scurfy bark louse, oyster-shell bark louse, and rose scale should be sprayed during the last two weeks of May. For the peach Lecanium, the spraying should be done during the latter part of June.

The formula for the kerosene emulsion is as follows:

Whale oil or some hard soap (or one quart soft soap).....	1-2 pound.
Water	1 gallon.
Kerosene	2 gallons.

It is prepared in the following manner: One-half pound of whale oil soap is finely divided by means of a knife and then completely dissolved in one gallon of water, by boiling. This solution while hot is added, away from the fire, to two gallons of kerosene and violently churned or agitated, preferably by means of a small force pump, until the whole mixture assumes the consistency of cream, which usually takes ten minutes of continuous work. If the emulsion is perfect, it will keep indefinitely. It should be diluted with cold water only when needed.

Caustic potash soap used at the rate of one pound to one gallon of

water will probably serve as an excellent winter wash for plants that are affected by either of the above species.

It is usually the lower branches of the maple tree that support the cottony maple scale. When numerous, the cottony masses which contain the eggs of the insect are very conspicuous on the leaves of these branches, during the early part of June. By removing these branches at this time a decided check is given to the increase of the species. The other parts if affected can be sprayed with a solution of whale oil soap at the rate of one-third of a pound to a gallon of water. The solution does not affect the eggs, but reduces the egg mass to a more compact form and surrounds it with a soapy coat which the larvae cannot penetrate when they emerge from the eggs. A thorough brushing of the lower branches in the late autumn will greatly reduce their number.

For the grape scale, a thorough winter wash such as whale oil or caustic potash soap used at the rate of one and one-half of a pound to one gallon of water may prove effective.