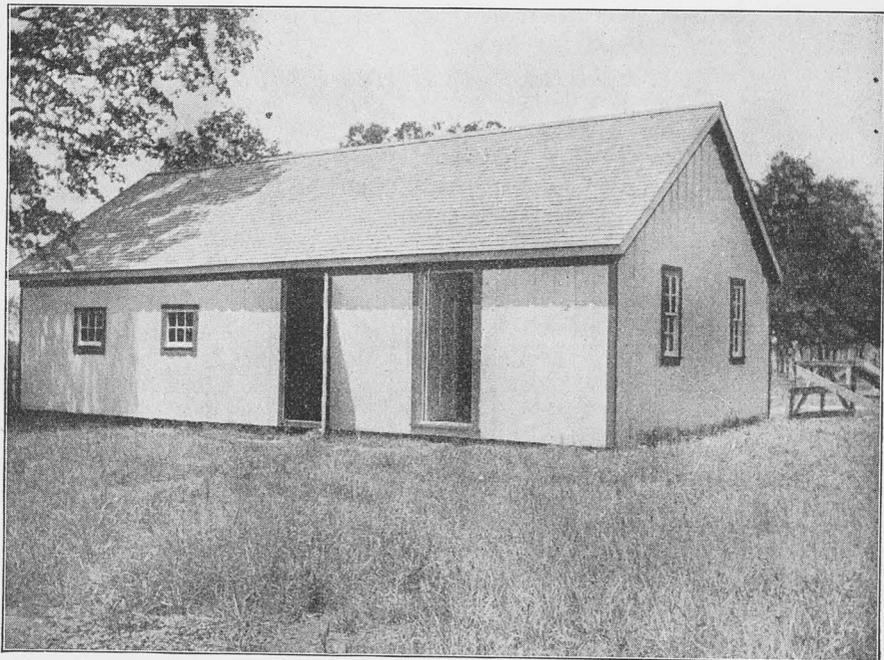


TEXAS AGRICULTURAL EXPERIMENT STATIONS.

BULLETIN No. 87.

THE SAN JOSÉ SCALE

Control,



Insecticide and Spray Machine Laboratory, Department of Entomology, A. and M. College.

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SAN JOSE' SCALE

(*Aspidiotus perniciosus*, Comst.)

With the rapid growth of the fruit industry in Texas and the occurrence of the San Jose Scale within our borders, we are confronted with one of the gravest entomological problems. The Scale is spreading and there is no way at present for knowing how widely it is distributed in the State, as we are far from having a satisfactory knowledge of orchard conditions where its presence often is not recognized until it has become very serious. The State Entomologist receives letters like the following: "I send you in this mail under separate cover a twig that has some disease; the tree is dying. Can you tell me what it is and the remedy?" I wish to state that such letters do not come from our large nurseries, but from small orchardists.

The San Jose Scale is definitely known to occur in a number of localities in Texas east of the 98th meridian, and one case is known to occur farther west. The office of State Entomologist has observed developments with scrupulous care and made personal investigations as far as the small funds at its command enabled it to do so. In a number of instances we have left the case undecided where we could not make a personal investigation and the material sent to the office was not in condition to make an undoubted determination possible. All such cases are on record, however, and will be kept in mind. It is for the fruit growers in Texas to act promptly and decisively. We can get the pest under control much easier now than we will ever be able to do in the future. It is spreading and every succeeding year makes the problem more and more difficult of control.

Let us briefly consider what the insect is, its habits and life history; also review the work that has been done in Texas, and we will be in position to make recommendations as to what should be done in the future.

HISTORICAL.

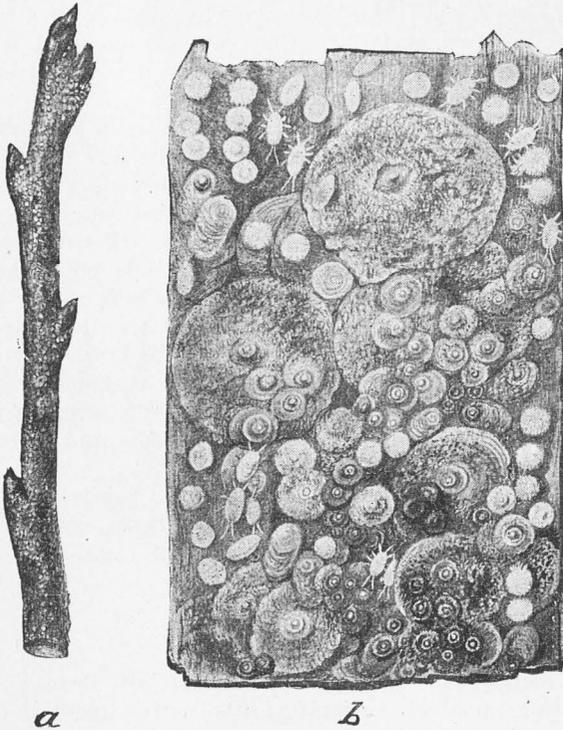
According to the investigations of C. L. Marlatt, Bureau of Entomology, U. S. Department of Agriculture, the native home of the insect is China. It was discovered in this country in 1873, when it had become a serious pest in the Santa Clara valley in California. In 1880 Prof. J. H. Comstock, then entomologist of the U. S. Department of Agriculture, described it and gave it the appropriate name of "Pernicious Scale." Its introduction into California was for some years a mystery until it was found that trees imported from China were infested with the pest. In 1901-'02 Prof. C. L. Marlatt made a trip to Japan and China for the purpose of locating its native home. He found it in the country north and west of Peking.

While it spread over new territory in California it was not until 1893

that it was discovered in the East. It was at Charlottesville, Va., where it had been introduced from nurseries in New Jersey. Subsequent investigations showed that it had been shipped to New Jersey as early as 1886 or 1887 in a consignment of Kelsey plums from the San Jose region of California. All these years from 1886 or 1887 to 1893 these New Jersey nurseries had been selling and shipping stock to other parts of the country. Wherever infested plants were received new centers of infestations broke out, and thus the insect spread over the fruit sections of our country.

DESCRIPTION OF THE SCALE.

The full grown female scale is circular in shape, of an ashy gray color, with a small protuberance, called nipple, at the center. Around the nipple are two or more concentric rings, the general shape being conical



San Jose Scale. a, infested twig; b, view of infested bark magnified.
(From Howard and Marlatt, Bureau of Entomology, U. S. Dep't.
of Agr.)

except when crowded, when all kinds of shapes may be found. When the scale is raised with a knife blade, the small orange yellow body of the insect may be seen below it.

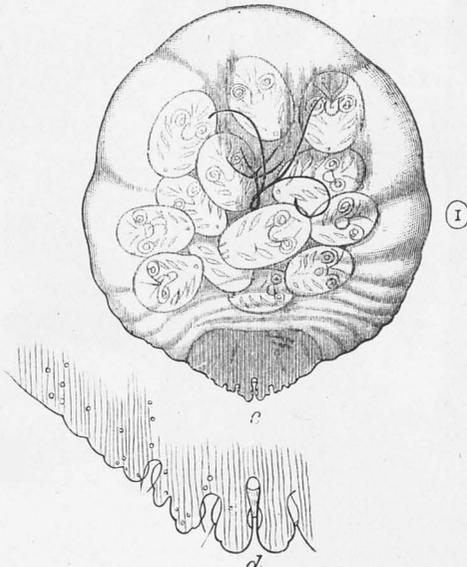
The male scale is more elongated, smaller, and frequently darker. The nipple is not at the center but near the anterior end of the scale. When young the scale of both sexes is nearly jet black and often very difficult to see with the naked eye.

LIFE HISTORY.

The females never leave their scales; under them they live and die. The male, however, molts in early spring, and leaves the scale as a minute active insect with two wings. It dies after mating. The female gives birth to living young. The newly born scales are very minute, oval in shape, but their bright orange-yellow color makes them conspicuous on the bark. After wandering about for twelve hours to a day they settle down to feed. The insect then inserts its beak into the tissues and sucks the sap. Here it remains during the feeding period. The male becomes full grown in about 25 days, but the females require a little longer time. In from 10 to 18 days the young of the next generation appear. During the season of activity each female may give birth to from 300 to 400 young. The over-wintering females produce about 100 young which become full grown in about 30 days. As from 5 to 6 broods occur in a single season calculation will show that one pair of insects can theoretically give rise to over 3,000,000,000 offspring in a single season.

HOW TO DETECT SCALE.

When a shipment of nursery stock has been received even fumigation should not be depended upon. The orchardist should keep close watch over such shipments when they arrive. The plants should be carefully



San Jose Scale. c, female; d, margin of pygidium magnified. (From Howard and Marlatt, Bureau of Entomology, U. S. Dep't. of Agr.)

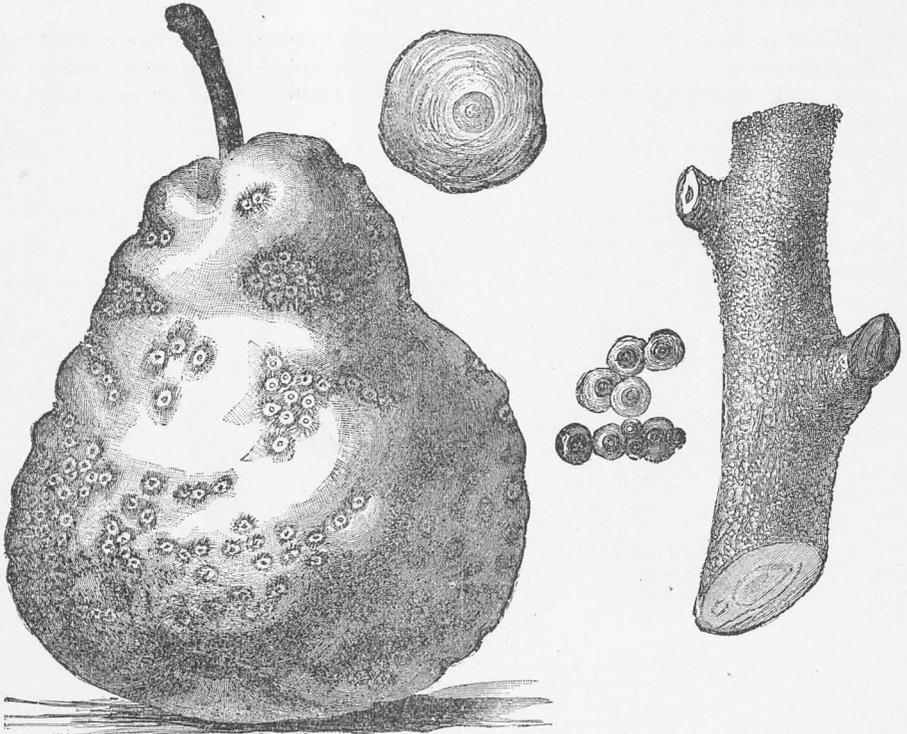
gone over with a reading glass, paying special attention to the crotches, and anything on the bark that may suggest an appearance like the description given above should be removed without touching it directly, packed securely in a regulation mailing case and sent to the office of State Entomologist for identification.

In light infestations the leaves and fruit are but sparsely attacked, but on badly infested trees the insects settle anywhere on the plants where tissues are exposed for them to feed on. They become so crowded as to overlap, creating an ashy gray scurvy incrustation on the bark.

They may occur on both sides of the leaf causing purplish, grayish or reddish discolorations on the young wood of peach. The bark turns red and when cut the coloration may be seen to extend to the wood. Individual scales cause reddish spots with a diameter several times that of the scale. The winter is passed in all stages of growth from half grown to mature insects. Many of the adult females die and these dead and dried up scales are always in evidence. When a knife handle or or some other hard object, or the thumb nail, is rubbed over the surface of a badly infested twig the insects are crushed under the scales and a yellowish fluid appears.

HOW THE SCALE SPREADS.

In the first part of this paper we noticed how the scale was introduced into the United States and how it came to the East and from a few nur-



San Jose Scale. Infested Fruit and Branch and Enlarged Scales. (From Howard, Bureau of Entomology, U. S. Dep't of Agr).

series spread over the country. The fact that it has thus spread should urge upon every one the extreme importance of using the most scrupulous precautions in handling trees to keep it from being disseminated.

We have explained that the young are motile the first day after birth. As the broods are not defined these crawling specimens are in evidence on every infested tree during the entire growing season. They may then be carried by birds, bees and other insects. They may be blown by the wind, and frequently, while spraying an infested orchard, careless operators carry them on their hands and clothing. After they have become stationary they may be carried by the plowman when cultivating the orchard. Correspondents often wrap infested twigs carelessly when transmitting them through the mails for identification.

FOOD PLANTS.

The following is a list of food plants upon which the scale has been found and recorded by Dr. L. O. Howard:

ORCHARD FRUITS.

Pear
Peach
Apple
Plum
Cherry
Rocky Mountain Dwarf Cherry
Persimmon
Quince
Flowering Quince

SMALL FRUITS.

Strawberry

BUSH FRUITS.

Raspberry
Gooseberry
Grape
Currant
Flowering Currant
Black Currant

NUT PLANTS.

Almond
Chestnut
Pecan
Black Walnut
English Walnut
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
Red Dogwood

Juneberry
Laurel
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, Snowball, Loquat, Akebia.

REMEDIES.

During the last ten years almost every ingredient that appeared to have any insecticidal value has been experimented with in the hope of finding an effective method for controlling the scale. The most important spray mixtures in use are lime-sulphur salt, lime-sulphur, whale oil soap, kerosene, crude petroleum, Kero-water, and kerosene or crude oil emulsions. All these preparations are mainly winter sprays, being applied when the tree is dormant and leafless. They vary in price and other points of merit, and each grower must be guided by his own judgment in every case.

LIME-SULPHUR WASH.

This is today the standard spray used in commercial orchards. It is the cheapest and superior to all others in point of safety, as it does not injure the trees. It not only is effective in killing the scale, but it is also valuable in controlling fungi, notably the peach leaf curl. In view of the efficiency of the spray as compared with others in Texas during the past year, no commercial fruit grower is justified in substituting other sprays simply because the Lime-Sulphur wash is more difficult to prepare and has a corrosive effect on apparatus.

In the original California wash, salt was used. It also formed a part of the mixture in the East until recently it was found that the salt was of little benefit, if any, except that in rainy seasons it adheres better. The washes in this State were as effective without any salt as those containing it.

WHALE OIL SOAP.

This wash consists of a solution made by dissolving two pounds of potash soap into a gallon of boiling water. It is applied while hot. The solution is safe to use on all kinds of trees. When applied while cold, however, it clogs the apparatus and causes considerable inconvenience in getting it on the tree. It is more expensive than the Lime-Sulphur wash.

KEROSENE.

In some States coal oil or kerosene has been experimented with and used in commercial orchards. As this treatment is very apt to injure the tree it must be applied with scrupulous care. The finest nozzle obtainable should be used. Barely enough oil should be applied to merely moisten or saturate the scale crust, but not enough to cause it to flow down the tree. It should be used only on bright, dry days, when the oil will evaporate rapidly. Although it has been used successfully in commercial orchards, the grower should bear in mind that he takes the chances of injuring, and it may be of killing his trees. It is a substance easily available, generally very effective and cheap. It is much more injurious to peach and plum than to apple and pear, and the trees should be sprayed in spring before the buds start.

CRUDE OIL.

The bureau of Entomology and those stations that have experimented with the oil recommend to those desiring to use it a grade of 43 degrees Baume. "A grade lower than 43 degrees is unsafe and more than 45 degrees is unnecessarily high." It is applied like the kerosene, the same precautions being necessary. It is not so penetrating as the refined oils, and as the light oils readily evaporate, a film of heavier oil remains serving as a palliative, somewhat like the lime that remains after a lime-sulphur application.

KEROSENE-WATER MIXTURE.

For this spray a specially constructed Kero-water pump is necessary. The pump is provided with a gauge so that any desired per cent of oil can be applied. For a winter treatment an oil of 20 per cent mixture is used and must be applied with the same precautions as pure kerosene.

PETROLEUM EMULSIONS.

This department has not experimented with this emulsion as a winter wash. It consists of 2 gallons of petroleum, $\frac{1}{2}$ lb of whale oil soap, (or one quart soft soap) and one gallon of water. On pear and apple it is used with water diluted to contain approximately 15 per cent of oil, and for peach and plum about 10 per cent.

SUMMER WASHES.

The summer washes mainly recommended are 20 per cent Kero-water mixture, a 7 per cent petroleum oil emulsion for apple and pear, and a 4 per cent for peach and plum. Both these sprays, as well as the whale oil soap, at the rate of 1lb to 4 gallons of water, are effective in checking scale during the summer where they multiply rapidly. They must be frequently applied.

EXPERIMENTS IN TEXAS.

When the writer took charge of the Department of Entomology two years ago, it was apparent that the San Jose Scale problem was coming to confront us and developing rapidly. Although no funds were available for thorough experimental work, some spraying experiments were carried on during the winter of 1904-1905. This was followed by another series during the past fall and winter. A number of summer applications were also made. The results thus far obtained, and especially when considered in the light of experiments carried out in other Southern States, justify us in coming to some tentative conclusions, which, however, are to form but a basis for extensive experimental work that is to follow, provided always that the State will support this Department with a loyalty that would be in keeping with the importance of the subject.

The earliest notes are from South Texas, where peach and pear trees were sprayed with the 5-5-50 formula of Lime-Sulphur-Salt four years ago. It was applied as a fall spray after the trees were leafless, and the

results were very satisfactory. If spraying had been repeated another winter the pest would have been under control, but it was discontinued after the first application.

In the fall of 1904, ten peach trees were carefully sprayed with kerosene in Central Texas under very favorable weather conditions. Although severely injured, the trees recovered, but the effects on the scale were very unsatisfactory.

During the past winter upwards of 83,000 trees were sprayed with various preparations with the following results:

EXPERIMENT NUMBER 1.

Stone Lime.....	15 lbs.
Sulphur	15 lbs.
Salt	15 lbs.
Water	50 lbs. Gals

The sulphur having been mixed with a small quantity of water to form a paste, was added to 15 gallons of boiling water in an iron kettle and thoroughly stirred. While boiling the stone lime was added, the slaking of which caused a violent cooking. After the lime had been slaked the salt was added, and the entire mixture violently boiled for 45 minutes, when it became a dark amber color. It was applied while hot. This application was made to peach trees in February and was very effective. There were very few live scales on sprayed wood. Young scales became fairly abundant on young shoots due to the imperfect spraying in covering the terminals. The trees were not pruned.

EXPERIMENT NUMBER 2.

Lime-Sulphur Wash.

Lime	15 lbs.
Sulphur	15 lbs.
Water	50 gals.

This was prepared the same as No. 1, except that the salt was omitted. It was applied during February and March. It was a large orchard and the work was rushed, so that it was impossible to give the closest possible attention to details. The effect was very satisfactory. The percentage of scales killed varied from 60 per cent on some trees to 90 per cent on others, and on a few trees it was completely eradicated. The results were fully as satisfactory as those of the Lime-Sulphur Salt. The abundance of living scales on some trees was accounted for by the fact that the wind was blowing heavily on the day of the application and frequently only one side of the trees was completely covered. In a few sections of the orchard the mixture had not been boiled a sufficient length of time, and the sulphur and lime separated. Most of the trees had a heavy coat of lime during May and formed a preventative to the young scales in setting upon such portions of the tree.

EXPERIMENT NUMBER 3.

In this experiment the Georgia formula consisting of Lime, Sulphur and Water, was applied in December. The owner became frightened at having the scale so cut down and burned all the trees before the result of the experiment could be determined.

K-L MIXTURE.

This was applied to a lot of peach trees in February, but the results were so variable that recommendations are withheld until after another winter's experimentation. It is not recommended for use to growers this season, except in an experimental way. Any one desiring to use it for experimental purposes is requested to correspond with this office.

PROPRIETARY MIXTURES.

Several proprietary mixtures were experimented with. These have the advantage of easy preparation, but at the present time we cannot recommend their use to Texas growers, as the results were very inferior to the Lime-Sulphur washes. The experiments with these mixtures will be continued another winter.

FUMIGATION.

Upon the receipt of nursery stock, unless the grower has undoubted evidence that it was fumigated according to law, it is always best to fumigate immediately. The gas is made as follows: Potassium cyanide (98 per cent) 1 oz., commercial sulphuric acid, 1 oz., water 3 oz. for every 100 cubic feet of space. The fumigation should be continued for 45 minutes. The room or box should be gas-tight, and provided with ventilators and doors so that the charge can be liberated promptly. By means of the ventilator the gas can be removed rapidly at the end of the fumigation period. It must never be forgotten that the gas is deadly poisonous, and that under no circumstances must the least amount be inhaled.