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THE SAN JOSE SCALE IN KENTUCKY.

LEXINGTON, KENTUCKY,

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LEXINGTON, KY.

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BULLETIN No. 67.

THE SAN JOSE SCALE IN KENTUCKY.

BY H. GARMAN, ENTOMOLOGIST AND BOTANIST.

In the recent history of horticulture in this country no other insect has excited so much apprehension among fruit growers and nurserymen. Its notoriety is well deserved for its pernicious character has been demonstrated over and over again wherever it has obtained a foothold. The death of trees which become infested with it seems to be only a question of a few years. The secret of its destructiveness lies in its small size and unfamiliar shape and habit, coupled with its extraordinary powers of multiplication. Because of these characteristics it is often introduced on trees into orchards and nurseries, where its presence is not detected until its deadly effect on infested plants draws attention to it; and even then so little does it resemble ordinary destructive insects with which every fruit grower is familiar that its nature as a living animal is not readily perceived. Writing of the pest in 1896 Messrs. Howard and Marlatt, of the United States Department of Agriculture, say: "The Los Angeles Horticultural Commission reported in 1890 that if this pest be not speedily destroyed it will entirely ruin the deciduous fruit interests of the Pacific coast. Its capacity has been more than demonstrated since its appearance in the East, and it has been, if anything, more disastrous to the

peach and pear orchards of Maryland, New Jersey, and other Eastern and Southern States than in California and the West."

"We are therefore justified in the assertion that no more serious menace to the deciduous fruit interests of this country has ever been known. There is no intention here to arouse unnecessary alarm, but mainly to emphasize the importance of taking the utmost precautions to prevent its introduction into new localities, and to point out the extreme necessity of earnest effort to stamp it out where it has already gained a foothold."

ITS NAME AND ORIGIN.

Insects of this sort are called scale insects because the body is covered and concealed by a buckler shaped plate, consisting partly of moulted skins and in part of a secretion. The edges of this scale cover are closely applied to the bark or leaf so that no trace of legs or other organs is visible. But when the scale is removed the insect to which it belongs will be found beneath with its long proboscis inserted in the plant upon which it rests. Even when thus uncovered it is necessary to use a compound microscope to show clearly its general resemblance in structure to ordinary insects. When such insects become abundant on trees the scales are so thickly placed that they overlap each other and conceal the bark, forming a continuous layer with a slightly glistening appearance.

The scale insect with which we are here dealing became known to American fruit growers as the San Jose scale because it was first observed in this country on fruit trees in the San Jose Valley of California. It has been asserted that it was brought to California from Chili, but the evidence is not conclusive, and since it occurs in other parts of the world from which trees have been brought to California, it is still uncertain where it did come from.

ITS HISTORY IN THE UNITED STATES.

Since its appearance in the San Jose Valley, about 1870, the scale has spread over most of the fruit growing sections of the West, and about four years ago was discovered in Virginia, to which State it was brought on fruit trees obtained at New Jersey nurseries. The latter are believed to have received the scale on plum trees obtained from California in 1886, and had thus in all probability been sending out infested stock for several years before the fact became known. From these nurseries it now appears that most of the Eastern States have received more or less infested stock, but the centers of greatest abundance for the scale appear to be New Jersey, where San Jose scale probably occurs in every county, Eastern New York, Maryland, and Ohio.

It is so insidious, however, in its spread and injuries that it is likely to be encountered at any time in any Eastern State, and Kentucky fruit growers must not hope to escape its injuries without exercise of the greatest care and watchfulness. It has been for some time on our borders just across the Ohio River in Ohio, Indiana and Illinois. It is known to me to have been brought in at least one instance to Kentucky, and I would advise every fruit grower and nurseryman in the State to examine any trees recently obtained from infested localities, and if any are found which appear to be infested to report the fact to this Station.

ITS FOOD PLANTS.

San Jose scale attacks most, or all of the deciduous fruit trees and shrubs. It spreads from them at times to other plants, such as linden, elm, osage orange, etc., but is preeminently a fruit pest, and as such has no equal at present in this country.

THE NATURE OF ITS INJURY.

Insects might be arranged in two groups, according to their manner of attacking plants. Such as the army worm, tobacco worm and potato beetle gnaw away and devour the substance of plants, and can generally be destroyed by putting poisons like Paris green on the plants they attack. But a more troublesome group is composed of insects that are provided with piercing beaks by means of which they suck up the sap of plants. Because of their manner of feeding they cannot be readily killed unless some preparation with corrosive or other destructive properties can be brought in contact with their bodies.

The San Jose scale is one of these puncturing insects, and if one of the scales is removed and the insect beneath is carefully detached from the bark, the slender beak, consisting of several very fine threads, will by the procedure be withdrawn from the bark and may be seen under the microscope arising from the mouth near the front end of the body.

Now a single scale insect such as this, or even a hundred, would do no serious harm to a thrifty tree, but the San Jose scale increases at so rapid a rate that the bark of infested trees soon becomes thickly covered, and the insects may spread thence to leaves and fruit. It has been stated that the offspring of a single female during one season would if all the eggs produced young and these matured, reach the astonishing number of three thousand millions. The rate of increase is undoubtedly extraordinary, and the figures given serve in a general way to explain why so small an insect can quickly become so very destructive. The millions of minute mouths constantly engaged in pumping out the sap drain infested plants of the materials they elaborate for their own growth and sustenance, and the result is a gradual decline and ultimate death. The injury may not be ac-

accompanied by any unusual growth, though badly infested twigs and fruit are sometimes deformed, but the tissue of both bark and fruit about the attacked scales often assumes a quite characteristic reddish color.

SAN JOSE SCALE ESPECIALLY LIABLE TO BE DISTRIBUTED FROM NURSERIES.

Unlike many other insect pests which frequent nurseries, this scale insect remains on the trees all the year round. It is present on the twigs of young trees when these are shipped in the fall and spring. Otherwise than by this means it does not spread very rapidly, and hence it is believed that a rigid inspection of nursery stock will in great measure restrict it to localities in which it is now established.

THE DETECTION OF SAN JOSE SCALE.

While the San Jose scale may be recognized with a useful degree of certainty by any intelligent man who is provided with a good hand magnifier and has a definite idea of its appearance, it is a rather difficult matter to decide positively the question of species, because of the presence on certain fruits of scale insects belonging to the same genus (*Aspidiotus*), and of very similar appearance. Some little familiarity with the use of the compound microscope is necessary, as well as a knowledge of methods of preparing small objects for microscopic examination. It is best for the practical man when in doubt to submit the question for definite determination to some one who has at hand conveniences for doing this kind of work. The Experiment Station at Lexington will make such examinations free of charge. Those sending us infested twigs for examination are requested to enclose them carefully in tight boxes. A small piece of infested twig which can be sent through the mail will be sufficient for the purpose.

DESCRIPTION.

The female scale is nearly circular in outline, rather flat, and has a small round nearly central cap. It varies in diameter from 1-25 to 2-25 inch. It is so closely fastened to the bark commonly that its outer margin is not clearly apparent even under a hand magnifier. The color varies from gray to reddish brown and dark ash.

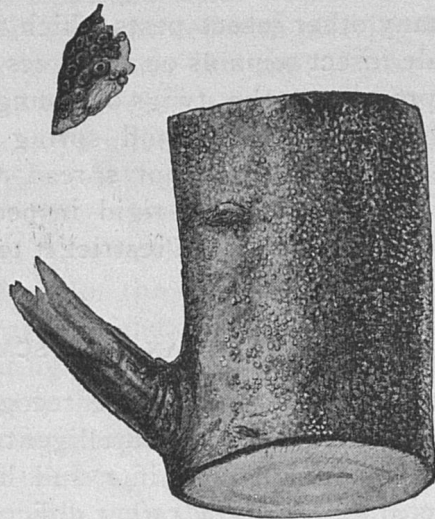


FIG. 1. Showing the San Jose Scale as seen on the bark of twigs, Natural size.

These female scales are the ones most likely to attract attention, and constitute the greater part of the layers which occur on bark. They are not likely to be confounded with any of the common scale insects occurring on fruit trees except, as already noted, members of the genus *Aspidiotus*. The oyster-shell bark louse, common North, but not very common in Kentucky, is much larger and shaped like a rather slender oyster shell. The scurfy bark louse of apple, a common scale on Kentucky fruit trees, is also larger, averaging about 1-10 inch in length, is much longer than wide, and is of a dirty white color, the color alone being sufficient commonly for its recognition.

The male scale is only about half the size of the female scale and is oval in shape, and averages darker in color.

In searching for the San Jose scale the characters to be kept in mind are :

1. The circular, very slightly convex, female scale, with central cap or nipple.
2. The small size, averaging less than 1-10 inch in diameter.
3. The obscure color, not contrasting sharply with the color of the bark, except when very abundant, in which case the natural glossy surface of healthy twigs gives place to a slightly roughened, scurfy coat, of a grayish color, consisting of the crowded and overlapping scales.
4. The reddish color produced about the scale on young twigs and fruit, and in the inner layer of bark.
5. The destructive effect of the attack.

LIFE HISTORY.

Once established on the bark the female insect remains at all times under her scale, and never changes position. In the spring of the year the male insect comes out from under its scale as a winged fly of very minute size, so small indeed is it that it is rarely seen even by entomologists. The females begin to produce living young in May, and continue to give birth to offspring for a period of about six weeks. The young of both sexes are active for a short time, and leave the shelter of the mother's scale provided with legs and feelers much like those of ordinary insects. They run about with considerable activity at this time searching for a suitable place on the bark to insert their beaks and settle down to the sedentary life of the adults. Some of them find their way upon the feet of birds and are thus carried to other trees. They are very likely to make their way to trees growing close beside the infested ones.

Most of them, however, become fixed to the bark of the tree upon which they were born. It is said that they attach themselves to the bark in a few hours after leaving the mother's scale. The young are about twice as long as wide, and are of a yellow color. As soon as they become fixed to the bark the body shortens, and the

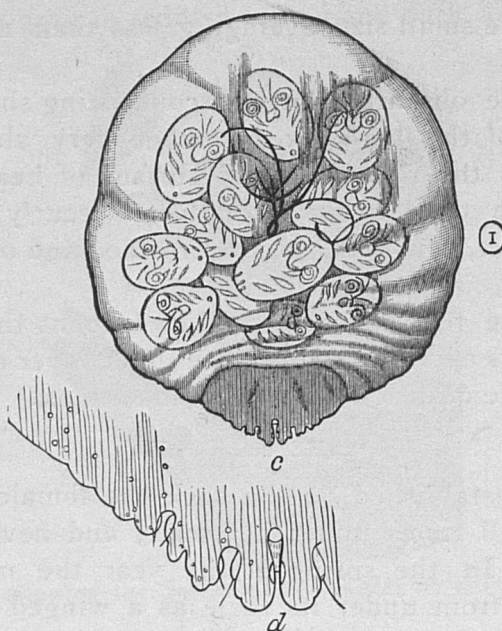


FIG. 2. *c*, Female San Jose Scale removed from under scale and greatly enlarged. *d*, Hind margin of body as seen under compound microscope.

small circular cap or nipple, so noticeable on the fully formed scales, is developed on their backs. They do not subsequently move about, but the males become elongated and later yield the winged flies as already recounted.

The females become mature and are ready to produce young in about one month. The males mature several days earlier. According to the excellent account* of the

* Bulletin 3 (new series) U. S. Dep. Agr., Division of Entomology, 1896.

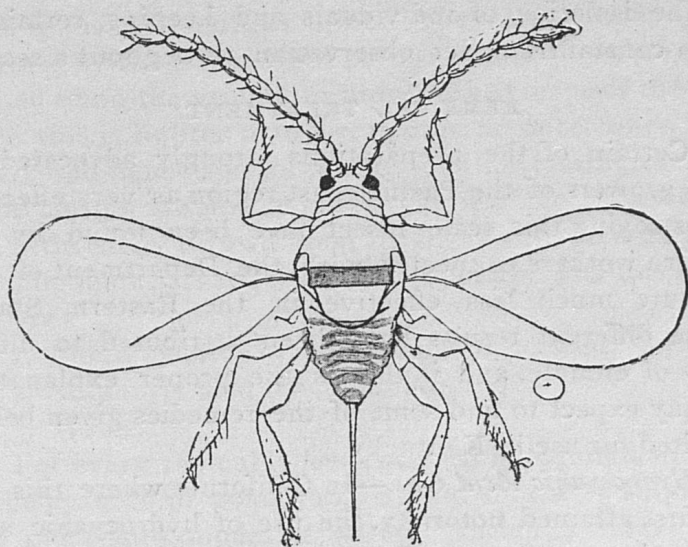


FIG. 3. The male San Jose Scale. Greatly enlarged.

insect published by Messrs. Howard and Marlatt of the United States Department of Agriculture, four generations develop in a season, and as a single female was observed by them to produce as many as 585 young it will be seen that the total number of offspring of one individual would by the end of a season reach startling proportions. The authors mentioned estimate that one female San Jose scale may produce in a season 3, 216, 080, 400 descendants, and in this connection remark. "It is not to be expected, of course, that all the individuals from a scale will survive and perform their functions in life, but under favorable conditions, or in the case of a tree newly infested or not heavily encrusted, the vast majority undoubtedly go through their existence without accident."

The period for reproduction is so prolonged that at almost any time during the summer the insect can be found in all its form and stages of growth, and the facts concerning the number of broods and the number of offspring produced by one individual have only been learned

by the isolation of individuals and keeping certain of them constantly under observation throughout a season.

REMEDIAL TREATMENT.

Certain of the preparations strongly advocated by fruit growers of the Pacific coast region as very effective in destroying this scale insect have been found by the Eastern workers connected with the Department of Agriculture much less effective in the Eastern States. These different results have been attributed to differences of climate, and if this is the proper explanation we may expect to find some of the remedies given below unsuited for use in Kentucky.

Hydrocyanic Acid Gas.—In California where this insect first attained notoriety, the use of hydrocyanic acid gas has been very generally adopted and is highly recommended by practical fruit growers. Gas treatment is theoretically one of the most perfect devised against injurious insects. The fumes can be made to penetrate every crevice of bark and foliage, so that they can be expected to destroy every insect present. The only practical difficulty in the way of its use is the labor and cost of making and handling tents of a size sufficient to cover fruit trees of large size. The difficulty is met in California by leaving the work of treatment to men who make a business of it, going from farm to farm with tents, derricks for operating the same, and supplies of the chemicals necessary for generating the gas.

Fruit growing as a business is perhaps not at present sufficiently general in Kentucky to warrant any one in undertaking the business, but the treatment of small trees with gas is less difficult and requires much less outlay, and will undoubtedly come into favor as a means of ridding young trees, and especially nursery stock, of the pests they harbor.

The trees are covered with sheets or tents made of eight-ounce duck, painted with linseed oil and yellow

ochre to make them gas tight. They are thrown over the trees by the aid of light poles, and the edges are then pressed upon the ground to prevent the escape of the gas. Since this is lighter than air, it rises at once when generated, and hence special precautions for closing the tent at the bottom are not required. A few pieces of wood, or a little earth, thrown upon its edges will be sufficient.

The materials required to produce the gas under the tent are:

1. Fused cyanide of potassium (58 per cent. pure).
2. Sulphuric acid (commercial).
3. Water.

For every 180 cubic feet enclosed is required 1 ounce of the cyanide of potassium, 1 fluid ounce of sulphuric acid and 3 fluid ounces of water. An open stone jar is put under the edge of the tent, and the sulphuric acid and water are poured into it. Then the cyanide is added quickly and the tent closed. The fumes escape at once, and are left about the enclosed tree from fifteen to forty minutes, the time required varying with the size of the tree and the thickness of its foliage.

It is important to remember in using the gas that cyanide of potassium and sulphuric acid are poisonous, and should be kept in jars plainly marked with the word *poison*.

It is important also to keep in mind the fact that cyanide of potassium loses "strength" when exposed to the air, and the substance should therefore be kept in a cool place and in air-tight receptacles. To be used successfully as above recommended it must be of the strength given (58 per cent.), and purchasers should insist upon this when buying. The best time to apply the gas is at night, in the evening, or during cloudy weather, since the experience of California fruit growers shows that trees are less liable to injury at such times than when fumigated in bright sunlight.

The cost of treatment with gas is slightly greater than by spraying, but Mr. D. W. Coquillett, of the Department of Agriculture, after extensive experience in such work in California writes: "At the present price of the chemicals used the cost of treating citrus trees with this gas will vary from 5 cents to \$1 per tree. This latter sum may seem an exorbitant one to pay for ridding an orange tree of the scale insects that infest it, and yet our fruit growers find themselves well repaid for expending so large a sum of money for this purpose. At a recent meeting of the County Horticultural Commissioners, Mr. B. J. Perry reported having treated 47,000 citrus trees at an average expense of less than 25 cents per tree. This is but slightly in excess of what it would cost to spray them, and this slight difference in the cost is more than counterbalanced by the better results obtained, the less labor involved, and the better condition the trees are left in after the operation is completed."

The San Jose scale can be treated best with this gas in the fall and winter when the leaves are gone, and the cost of treatment under these conditions is considerably less than when trees are loaded with leaves. In treating 326 trees and shrubs infested with San Jose scale at Charlottesville, Virginia, Mr. Coquillett expended \$30.19, making an average of a little over 9 cents for each one. His itemized list of expenditures is instructive, and will serve as a guide to those who may wish to use the gas. It is as follows:

42 pounds cyanide, at 39 cents per pound.....	\$16 38
90 pounds sulphuric acid, at 3½ cents per pound	3 15
4 men 2⅔ days, at \$1 each per day	10 66
	<hr/>
Total	\$30 19

In the case of nursery stock the cost of treatment can be still further reduced by fumigating large numbers of young trees at the same time, after they have been taken

up and healed in. The process is recognized by our best authorities as especially adapted for use in the nursery.

Salt Lime Sulphur Solution.—This preparation is in favor with many California fruit growers as a remedy against San Jose scale. A formula for its preparation recently furnished to the Department of Agriculture by Mr. H. B. Muscott, Chairman of the San Bernardino County Board of Horticultural Commissioners, is as follows :

Forty pounds of lime (unslacked), 20 pounds sulphur, 15 pounds coarse salt.

Add 40 gallons of water to the above materials, stirring thoroughly while the lime is slacking. Boil fully three hours, then add enough water to make 80 gallons of the solution, then strain through burlaps and apply warm. Use only on deciduous trees and when said trees are dormant.

Mr. Coquillett, of the Department, did not, however, when in California find this preparation as effective as it is sometimes claimed to be, and from recent experience with the scale the entomologists at the National Department of Agriculture have reached the conclusion that this and certain other washes recommended for use in California are not effective in the East.

Kerosene Emulsion.—This is a standard remedy for such insects as San Jose scale, but appears not to be as effective as the soap wash given below. It is commonly prepared as follows :

Coal oil, 2 gallons.

Soap (whale oil), $\frac{1}{2}$ pound.

Water, 1 gallon.

The soap is dissolved in 1 gallon of hot water, and at once thoroughly churned with the coal oil by passing it through a force pump and returning it to the vessel whence it is pumped. Soaps other than the above are sometimes substituted, but they vary to such an extent

in composition that there is some danger of getting an imperfect emulsion with their use. A quart of soft soap may be used in place of whale oil soap.

It is customary to dilute the above quantity of emulsion with 3 to 4 times as much water before applying it to the leaves of plants. For use in winter against insects on the naked branches it may be used stronger, without injury to the trees.

Soap Solutions.—Solutions made by dissolving soap in hot water have been strongly recommended recently by Drs. Howard and Marlatt, after an extended experience with the San Jose scale, in the course of which they have made most thoroughgoing comparative tests of the different washes recommended by western fruit growers. A solution consisting of two pounds of whale oil soap in one gallon of water, should according to these authors be sprayed upon infested trees in the fall or spring, so that every part is thoroughly drenched. Applications made in the fall may have the effect of preventing fruiting the following season. Applications made in the spring, even when trees are in partial bloom, have been found to do no special injury.

The soap used should be of uniform grade, and it will be best always to get whale oil soap where possible, since it has been proved to be well suited for the purpose. Bought in large quantities it costs about 4 cents per pound, in smaller quantities (100 pounds or less) it sells for about 6 cents per pound.

LEGISLATION AGAINST SAN JOSE SCALE.

This subject has been much discussed of late at meetings of the horticultural societies, by fruit growers, nurserymen, and Station workers, throughout the United States, and the opinion seems to be general that laws are needed to check the further spread of San Jose scale.

Nurserymen were among the first to recognize the fact that their interests were identical with those of the fruit grower in this matter. Systematic inspection of nursery stock has been very generally decided on as the only feasible plan of securing anything approaching safety in this regard, and bills have now been framed for presentation to the Legislative Assemblies of most of the States likely to suffer severely from invasion, the basis of which is inspection by State Entomologists. In a number of States such laws have already been adopted, and the probability is that in the course of the next three or four years every State in the Union will have such a law in operation. Kentucky should not be behind her sister States in protecting the interests of her fruit growers, and it is to be hoped that the resolution adopted by our State Horticultural Society at its last meeting requesting the Governor of the Commonwealth to include the consideration of this subject in his call for a special session of the General Assembly may lead to the passage of an effective law requiring that no infested nursery stock shall be shipped to buyers in this State.

There can be no question about the need of such legislation. That is conceded by everybody concerned. Nor should there be any concerning the necessity of immediate action. Professor S. A. Forbes, Chairman of the Committee on Entomology of the American Association of Agricultural Colleges and Experiment Stations, writes in a recent letter:

"Action cannot be taken too soon in this direction, since danger of the importation, establishment and spread of injurious insects and fungus diseases of fruits increases rapidly with the very great increase in interstate and international commerce in fruits and nursery stock. The nursery business is being largely revolutionized by specialization, each kind of stock being grown

most generally in some region especially adapted to it and thence shipped far and wide on the orders of nurserymen.

Imminent danger of the introduction of the San Jose scale has greatly stimulated this movement, and those States that are prompt and energetic are the ones which are most likely to escape great horticultural losses. I am glad to see that Kentucky people are moving in this direction, and hope that their efforts to protect themselves against invasion from without and to prevent the multiplication and spread of the fruit pests already established in that State may be successful."

State legislation alone can not be expected to protect us from the inroads of pests imported on nursery stock from foreign countries. A large number of the most troublesome species have been brought to this country in this manner. It is important that there should be inspection, under Federal authority at ports of entry. A bill recently framed by a National Convention (held at Washington, D. C., March 5 and 6, 1897) of fruit growers, nurserymen and Station workers, providing for such inspection, has been presented to Congress. This convention made the following recommendations with reference to State legislation against insect and fungus pests:

1st. That each State should provide for the proper inspection of nurseries and other premises for the detection of the presence of the San Jose scale, or other dangerously injurious insects or plant diseases.

2d. That each State should provide for the proper and timely application of the most approved remedial or preventive treatment when found necessary.

3d. That should packages of nursery stock, etc., be shipped into a State contrary to law, *i. e.*, without proper inspection certificates attached, it ought to be so handled as to receive proper inspection and not be destroyed unless condemned by proper and competent authority.

4th. That each State co-operate in securing the passage and enforcement of a National law, providing against the introduction and dissemination of San Jose scale and other dangerously injurious insects and plant diseases by means of imports through inter-state commerce.

These recommendations have the endorsement of the foremost practical fruit growers in this country, and with intelligent and progressive men such as these earnestly advocating laws of this character there can be no excuse for failure to put them on our statute books.