8-1-1905

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Glenn W. Herrick

Mississippi Agricultural Experiment Station.

BULLETIN No. 90.

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By GLENN W. HERRICK.

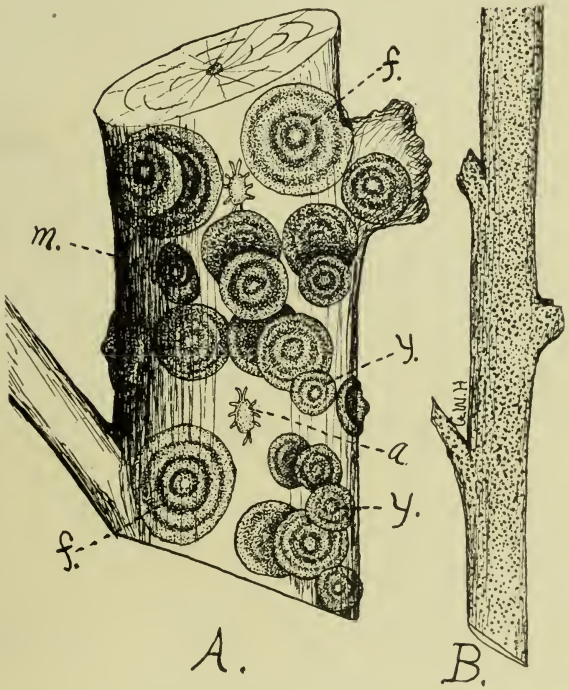

FIG. 1.—A, scales on branch; f, female scale; m, male scale; y, young scales; a, young, unprotected scale insect—all greatly enlarged B, branch showing scales as they appear to the unaided eye.

AGRICULTURAL COLLEGE, MISS.,
August, 1905.

TUCKER PRINTING HOUSE, JACKSON, MISS.

THE SAN JOSÉ SCALE IN MISSISSIPPI,

AND THE LIME-SALT-SULPHUR WASH.

Introduction.—Probably no single insect in the United States has been the subject of more discussion and experimentation than the San José scale (Aspidiotus perniciosus), and small wonder, for there is no insect that is capable of producing greater injury to the fruit interests of our country than this one. As near as can be determined, this insect was introduced into the grounds of Mr. James Lick of San José, California, in the early seventies. It soon spread to adjoining orchards where it was found and first described by Prof. J. H. Comstock in 1880, who quickly recognized its capabilities as an orchard pest, for he named it *perniciosus*, the pernicious scale. By '86 or '87 it had been imported on fruit trees into eastern nurseries and from this time began to spread over the East and South. Mr. Marlatt, of the U. S. Bureau of Entomology, has lately found this insect on native trees in a remote province of China where there seems to have been no introduction of foreign trees or fruit. He, therefore, concludes that the scale must be a native of China and that it has been introduced from that country into this, on imported plants.

The scale in Mississippi.—It is impossible to say when or where this insect first appeared in the State. Prof. H. E. Weed, my predecessor, writes me that he knew of only two points of infestation in the State prior to 1897. One was here at the College and the other at Ocean Springs, Miss. Whether this insect was present in other places at that time I am unable to say, but in my investigations since '97 I have found it widely distributed throughout the State—in Hinds, Lee, Harrison, Lauderdale, Warren, Pike, Sunflower, Jones, Madison, Jefferson, Washington, and other counties. A most significant fact in connection with this distribution is that the introduction of the scale has been definitely traced, in most instances, to nursery stock imported from outside nurseries. It is probably safe to say that this fruit pest will now gradually spread over the whole state and will always have to be reckoned with as one of the liabilities in peach, plum, apple, or pear production.

Description of the insect.—It must be borne in mind that the San José scale is a very small insect, usually smaller than the head of an ordinary pin. Moreover, the female, except for a few hours immediately after birth, lives beneath a hard, waxy scale and consequently is well protected. This scale is circular in outline, slightly conical, and about the size of a small pin-head. The rate of increase is very great and from a single infestation thousands upon thousands of individuals may develop in a season and the tree may become literally covered from the trunk to the outermost branches in two or three years. The young scales are whitish in color, but later they turn dark and are hard to distinguish from the bark. It is difficult to find the scales on a tree at the beginning of an infestation, for they are, of course, few in number and very small; but later, when the insect becomes abundant, the branches assume an ash-gray color and present a scurfy appearance. The females are wingless but the males possess two delicate wings, and when mature crawl out from beneath their scales and fly away.

This insect has its mouth-parts modified into a long, slender beak, which is inserted through the outer bark into the tender tissues of the tree thus enabling the insect to suck the juices from the plant; and, where the scales are in abundance, the tree is greatly weakened or killed outright.

Life history.—The mature scale insects pass the winter beneath the wax scales. From the middle to the latter part of May, the young are produced in great numbers. They look like small yellow lice, and can be plainly seen with the unaided eye after they issue from beneath the scales and are actively crawling over the bark of the infested plants. Instead of laying eggs the mother insect brings forth her young alive, after which she dies. In a short time after birth the young crawl out from under the old scale and begin scurrying about over the tree in search of places to settle. In a few hours they settle down, insert their beaks through the bark, begin secreting a scale and growing in earnest. Messrs. Lowe and Parrott give 49.5 days as the average period of growth in New York but I believe this period is somewhat shorter here although I have no absolute data on this particular point. If the brood in May, which I have repeatedly seen, is the first brood and a brood appears every fifty days, there are certainly four

broods in this latitude during a season. The last brood in autumn passes the winter in hibernation beneath scales.

Plants liable to infestation.—Peaches, pears, apples, plums, rose, pecan, elm, almond, apricot, maple, chestnut, corn, sugar cane, currant, persimmon, quince, raspberry, gooseberry, osage orange, hawthorne, willow, cherry, etc. are some of the plants affected with the San José scale insect.

Means of distribution.—Since these insects, males excepted, live a fixed life they are distributed entirely by outside agencies. High winds breaking off leaves and blowing them here and there scatter these pests to some extent. The young insects, no doubt, cling to the feet of birds and large insects and are carried from tree to tree. They become attached to the horses, harness, plows, cultivators, etc., used in cultivating the orchard and in this way are carried to other parts of the farm. The foregoing methods of distribution are those occurring over local areas. The spread of this insect from state to state is very largely due to its transportation on fruit or on nursery stock, chiefly the latter. It is well known that pears and apples become infested with the insects and in this way they are shipped to all parts of the country along with the fruit. One can go into the fruit markets of almost any large city and find scale infested fruit. But, without doubt, the main method of distribution of this insect is through the agency of nursery stock,—young trees, scions, buds, etc.—that may be infested with living scales. This is undoubtedly the manner in which the insect came into the United States, and it is the way by which it came into Mississippi. We find it in Vicksburg on trees bought in Florida, in Guntown on trees from a nursery in Georgia, in Ellisville on trees from a nursery in Tennessee, and so it goes everywhere in the state. Mississippi has no law requiring the inspection of nursery stock and the fumigation of the same with hydrocyanic acid gas before entering the state. Such a law should be enacted at once to protect the fruit growers in the future from this insect and other pests and infectious diseases.

Methods and Seasons for combatting this insect.—There are two seasons of the year during which the San José scale may be fought, namely, winter and summer. The more effectual treatment may be given during the winter, but much good may be done by summer treatment at which time the insect can certainly be greatly checked.

We believe the wash known as the lime-salt-sulphur wash is the *ne plus ultra* remedy at present for the San José scale. It has been used for a long time in California and in the dry climate of that state has proved a most efficient wash. It was supposed that in the eastern United States where the precipitation is so much greater the lime-salt-sulphur wash would not be of much value. Indeed, the first trials made seemed to substantiate this idea. Within the last few years, however, the wash has been tried repeatedly under all sorts of conditions and in widely separated localities, and, in nearly every case, has given excellent results.

Work with the lime-salt-sulphur wash in this state.—In the early part of February, 1903, the scale was reported as present in an orchard at Guntown, Miss. On the 18th of Februàry the owner and myself applied the wash to 300 trees. The trees had not been pruned and the wind was blowing hard from the north which made it very difficult to coat the trees on the south side. Moreover it was a cold day with some rain and sleet causing considerable discomfort and making the work unsatisfactory. Unfortunately the trunks of the trees had been treated to a thick coat of whitewash not long before in hope of killing the insects. As we shall see this was a drawback in our results. We used the following formula for the wash:

20 lbs. quick lime.
15 lbs. sulphur
10 lbs. salt
45 gallons of water.

The lime was slacked in three or four gallons of hot water. Before this quit boiling the sulphur was added and enough hot water to make a very thin paste. This was boiled vigorously for two hours. The salt was then added and the whole boiled 45 minutes longer. We used an iron kettle holding ten gallons to boil the mixture in, but had a forty-gallon kettle in which to heat the water. As soon as the wash was sufficiently boiled it was strained through a gunny sack directly into the barrel holding the pump, enough water added to make 45 gallons of mixture and applied while hot. We used a barrel spray pump having two leads of hose, each 20 feet long and fitted with Vermorel nozzles attached to the ends of poles about ten feet long. The barrel was placed in a heavy wagon while the men directing the nozzles remained on the ground. One man ran the pump while another drove the team.

Results of treatment.—I examined the trees on May 26th. Only slight traces of the wash were present. Remember it had been applied in a rain-sleet storm. The insects beneath the old coat of whitewash had been protected from the lime-salt-sulphur wash and served as a means of reinfestation. Never coat scale infested trees with whitewash if you are going to spray to kill the insect. On the parts of the tree not whitewashed I judge 90 per cent. of the scale were killed.

Second treatment.—In the autumn of the same year (Dec. 17) we treated the whole orchard again and in a much more thorough, careful manner. Moreover, we had clear, sunny weather which is nearly always to be had up to Christmas in this state. The mixture was made in exactly the same way and after the same formula and applied in the same manner.

Results.—The owner wrote me in February that the mixture was still on the trees in very good shape. In the early part of April I examined the orchard closely and found that our results were most satisfactory. It seemed to me that we had killed a very large part of the insects and in my notes made at the time, I estimate that over 90 per cent. were dead. In the rush of work on the farm, the owners had not had time to prune the orchard before spraying. As a consequence, we found occasional scales on the tips of the small branches where we could not apply the wash thoroughly. In fact, the tips of limbs cannot be coated, therefore, trees about to be sprayed should be very severely pruned—the tips of all the branches should be cut back and as many branches cut off as can possibly be spared.

Altogether, our experiments with the wash show that the scale may be kept under control in Mississippi by the use of the lime-salt-sulphur mixture.

How to make the wash.—In the first place, only the very best quality of quick lime should be used. In the second place, two iron kettles should be procured, each one holding at least 20 gallons, but the more they hold the better. The 20 pounds of lime should be slacked in three or four gallons of hot water in one of the kettles. When the lime is nearly slacked, but before it quits boiling, add the 15 pounds of sulphur and enough hot water to make a thin paste of the lime and sulphur. Stir the whole vigorously until they are thoroughly mixed, then boil vigorously for 45 minutes. It will be noted that this is a much shorter time than we boiled the mixture in our foregoing work.

Since the experiment at Guntown, rather extensive experiments to determine the length of time the mixture should be boiled to bring about the proper chemical combination between the lime, salt, and sulphur, have been carried out by several Stations. The results of these experiments show that the wash can be made just as effective with a much shorter period of boiling than was formerly supposed to be necessary. This is a very important consideration because the length of time spent in cooking the wash has made it somewhat objectionable heretofore.

After the lime and sulphur have *actually boiled* 45 *minutes*, add the ten pounds of salt, and boil *vigorously* 15 *minutes more*. It will become necessary during the boiling to add a little hot water now and then to keep the mixture thin. When through boiling add enough hot water to make 45 gallons, strain through a gunny sack, and apply hot.

The two kettles, spoken of above, are intended to furnish a cooking outfit for a small orchard, say of a thousand trees. If one has a large orchard and is obliged to make this mixture on a large scale, it will be more economical to buy a boiler of 15 or 20 horse power. A discarded threshing engine that is capable of standing a pressure of 5 or 6 pounds of steam will answer admirably. The boiler should be connected with half a dozen barrels, or more, if desired (fig. 2). Some of the barrels may be used for cooking the wash and some for heating the water. In this way, two or three wagons, each carrying a 45 gallon barrel spray pump, may be kept at work with no loss of time. It will be found most satisfactory to have the barrels mounted on a platform three or four feet high. Of course, the mixture is made in exactly the same manner and in the same proportions as when the kettles are used.

Pumps and nozzles.—There are several pumps that give splendid results with this mixture. The "Pomona" pump, manufactured by the Gould Manufacturing Co., Seneca Falls, N. Y., the "Century" pump, manufactured by the Deming Co., Salem, Ohio, and the "Empire King" pump manufactured by the Field Force Pump Co., Elmira, N. Y., are all good hand power pumps, applicable for use in an orchard of two or three thousand trees. All of these companies, however, manufacture large power spraying outfits, prices of which may be had upon application to them.

It is customary to put a barrel pump in a wagon and draw it around among the trees in this; but we have found it much more

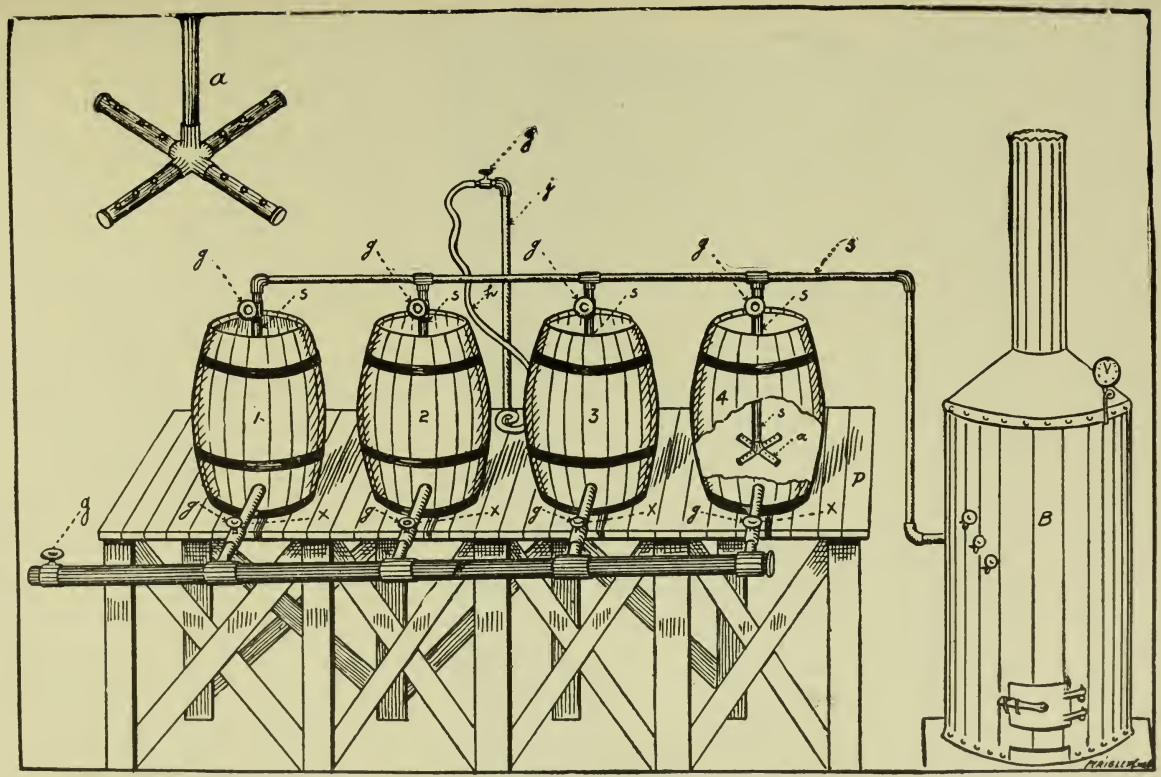

FIG. 2.—An outfit for preparing the lime-salt-sulphur wash; ss, steam pipes; gg, globe valves; 1, 2, 3, and 4, 50 gallon barrels. xx, pipes for drawing off boiled mixture; a, lower end of steam-pipe with cross-arms and one-eighth inch openings for escape of steam. (By courtesy of Newell and Smith, Georgia State Board of Entomology, Bull. 14.)

satisfactory to mount the barrel on a simple drag, or sled. This can be made very cheaply by selecting two saplings of required size, with bowed noses for runners. Then nail short pieces of plank crosswise on the runners, placing the latter about three feet apart. Such an apparatus places the pump low where it can be operated from the

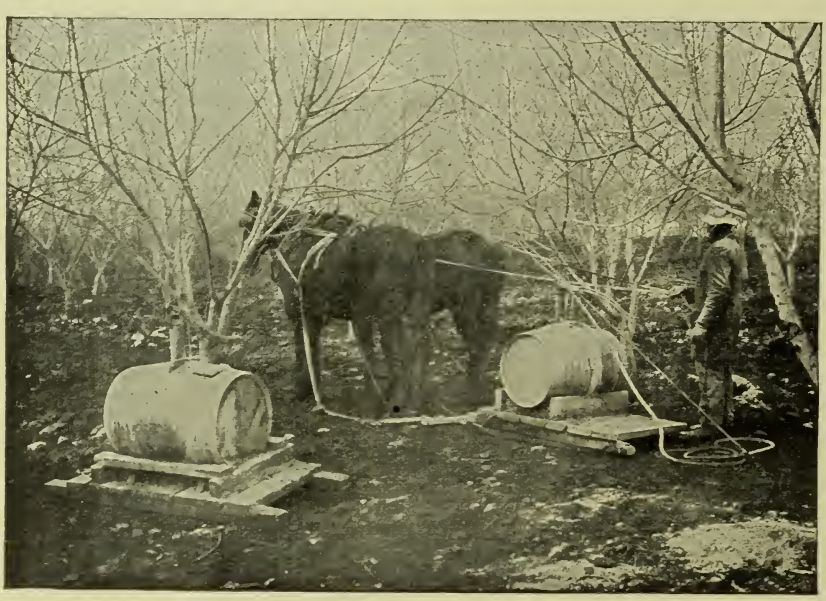

FIG. 3.—Barrel mounted on a drag, or sled. (By courtesy of Dr. W. E. Britton, from Bull. 146, New Haven, Conn.)

ground (fig. 3). In addition, the barrels can be filled from the supply kettles more easily, and finally, the sled can be drawn over rough, uneven, and muddy ground much more easily than can a wagon.

As to nozzles, we have found the Vermorel nozzle with a large opening to give by far the best satisfaction. Each pump ought to have two lines of hose 15 or 20 feet long, each fitted with a Vermorel nozzle. Moreover, it will be found advantageous to have the ends of the hose firmly tied to poles, about ten feet long. This will enable the operator to stand on the ground and reach the remotest parts of the trees.

The liquid should be strained through gunny sacks to remove particles of unslacked lime that otherwise would clog the nozzles.

Precautions to be observed.—Since the lime-salt-sulphur material is a caustic substance, gloves should be worn on the hands and a simple mask made from a piece of cloth with two eyelet holes, should be worn over the face. The horses or mules used in the work should be protected by cheap blankets made from gunny sacks or some like material. Moreover, the pumps, nozzles, and hose should be thoroughly cleaned after use by rinsing them out with two or three changes of water. If this is not done, the wash will corrode the metal parts, weaken the hose, and unfit the whole apparatus for use when needed again.

Pruning.—The orchard should be thoroughly pruned before starting the spray work. The ends of all the branches should be cut back and just as many branches cut off as can be spared. The pruning is an exceedingly important matter and must be done if the best results are to be obtained.

FIG. 4.—A view of the stumps after the orchard was pruned.

In this connection it will be interesting to give an experiment carried out at Guntown. The owners of the infested orchard were not satisfied to hold the scale in check but were anxious to exterminate the pest. To accomplish this, they began in April after the trees had bloomed and were in full leaf, to cut off all the branches, leaving only the bare trunks with the stubs of the larger limbs (fig. 4). After this was finished, they washed the trunks with a strong solution of home-made soap and water and followed this with a thick coat of the lime-salt-sulphur wash applying it with a *paint brush by hand.* I examined these trees on the 21st of the succeeding month of October and could find no scales on the trees, the trunks of which had been treated with the wash by the owners themselves. It is a significant fact that a few scales were found on some of the trees that had been treated by two negroes. These insects were found in the crotches of the large limbs where, evidently, the wash had been carelessly applied or not applied at all. I would emphasize the necessity of skilled and intelligent labor for such work. I believe the San José scale can be exterminated in an orchard by this method. In passing, I might say that the trees made a most remarkable growth and the orchard is practically a new one now.

The following letter from the owner written June 27, 1905, gives in a very clear manner the results of this treatment: "Yours of recent date relative to our 'cut back' trees to hand. In reply, I would say, trees were cut back in April, 1904, after we saw crop was killed. You know how severely they were cut. About 1% of them died, either from the severe cutting or from the treatment, I am unable to say which. They were treated with the lime-salt-sulphur solution, same strength as you use but it was applied with brushes. Where *we* did the work it was a *complete extermination* but where the negroes did it there were a few trees, say 12 to 20, that a scale or two escaped by their not doing the work thoroughly. These trees have made a surprising growth (fig. 5) and, had the crop not been killed this season, would have made one bushel of peaches to the tree."

Time to spray.—It must be remembered that the lime-salt-sulphur wash is a winter remedy only and cannot be applied to the tree when it is in full leaf, unless great care is exercised and it is confined to the trunk and main branches. In such cases it should be applied only by hand. If possible, two applications should be made, one in December after the wood is fully matured, and one in February before the buds start. I believe the best time to apply it is in the month of De-

cember for then we nearly always have the most favorable weather, and if only one application is to be made, by all means do it in the fall. In February we are apt to have so much rain that no opportunity will be found for the work. But, if possible, a second application should be made at this time.

FIG. 5.—Photograph taken in the following November to show the growth of an average tree in one season after the pruning.

Summer treatment.—It often happens that the scale is not discovered in an orchard until late in the spring or in the summer, and by this time it is too late to treat with the lime-salt-sulphur wash. Nevertheless, something should be done at once to hold the pest in check until a more thorough treatment can be given in the winter.

Oil emulsion.—Perhaps the best substance for combatting the scale in summer is an emulsion of kerosene oil and soap which may be made after the following formula:

2 lbs. hard or soft soap.
4 gallons of soft water.
8 gallons of kerosene oil.

Place the soap (if hard soap is used it should be shaved in fine pieces) in the water over a fire and heat until it is thoroughly dissolved. Pour the oil into the barrel in which the spray pump is sitting, and when the water and soap are boiling hot pour them into the barrel with the oil. Pump the mixture vigorously back into itself by directing the hose into the barrel after the cap of the nozzle has been removed. Direct the stream from the hose downward so that all the mass will be agitated. It will probably take ten or fifteen minutes of vigorous pumping to make a creamy, white emulsion. When the emulsion is obtained, add enough water to make 80 gallons of mixture. This will give a ten per cent. solution, which is the only safe one for summer use. When the water is poured into the emulsion it may not mix readily. In this case, direct the hose into the barrel again, and pump back into the mixture as was done at first. If, for any reason, the soap and oil fail to emulsify, the whole batch might as well be thrown away and another attempt made. Care must be taken to use rain water or some soft water.

This emulsion is best applied with the same kind of pumps, nozzles and hose, used in applying the lime-salt-sulphur wash. Moreover, it will be most effective if applied to the trees when the insects are breeding and the young are travelling about on the bark. This will be in May, and every 40 or 50 days thereafter.

Lime-salt-sulphur wash for summer use.—As we have already pointed out, this is a winter wash but it can be used very effectively in the summer also in the following manner: Make it in the same way and according to the same formula as already explained, and, while hot, apply it by hand with a wide brush or mop to the trunks and larger branches or to any portions of the limbs infested with the scale, taking care not to get it on the foliage. By applying this mixture carefully and thoroughly the scale will be greatly checked until a thorough winter treatment may be given.

Summary.

The San José scale is widely distributed in the state and is a serious menace to fruit culture.

There is great danger of obtaining this insect from infested nurseries and every purchaser of fruit trees should demand that his trees be accompanied by a certificate of inspection from a competent entomologist to the effect that they are free from scale, and he should also demand

a sworn statement that his trees have been fumigated with hydrocyanic acid gas.

Winter is the best time to fight the scale. Infested trees should be treated in December after the wood is fully matured and in February, before the buds start, with the lime-salt-sulphur wash.

This wash has given very satisfactory results in this state in holding the insect in check.

The San José scale may be treated in summer with a ten per cent. mixture of kerosene emulsion and also with the lime-salt-sulphur wash. The latter should be applied by hand and only to the trunk branches, and never to the foliage.

We have pretty strong evidence that the scale can be exterminated by cutting the trees back until nothing is left except the stumps which are then treated once or twice to a coat of lime-salt-sulphur wash. This should be applied by hand, very thoroughly and with care. The pruning and treatment should take place, either in the fall or in the spring before the trees come into leaf.