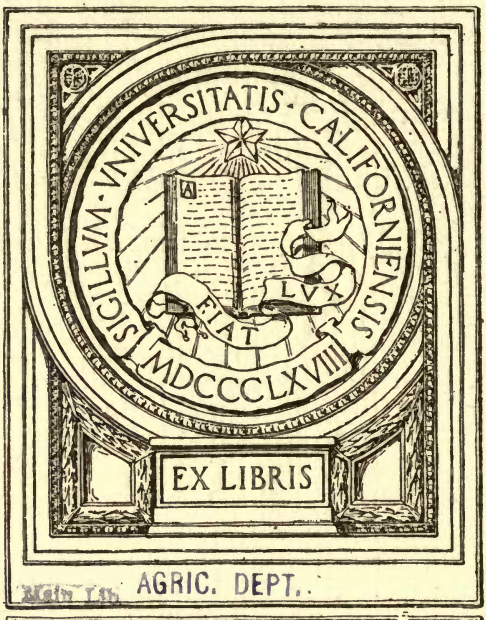
SCALE INSECTS ON DECIDUOUS AND ORNAMENTAL TREES. 1882

CHAPIN



SCALE INSECTS

ON

DECIDUOUS AND ORNAMENTAL TREES.

BY

S. F. CHAPIN, M. D.

Vice-President of State Board of Horticultural Commissioners.

A REPORT TO THE STATE BOARD OF HORTICULTURAL COMMISSIONERS.

[Reprinted for the Author from the PACIFIC RURAL PRESS of Oct. 28 and Nov. 4, 1882.]

Pacific Rural Press Print, San Francisco,
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The prevalence of scale insects in the orchards of Santa Clara valley during the past few years has afforded ample scope for their study, to which I have, for the past three seasons, devoted what time I could command. Assigned to this work by you, I shall report as concisely as possible the information gained and the results obtained by numerous experiments carried on and observed for two seasons. I shall here use in this paper as a part of it, a report presented to the Santa Clara County Horticultural Society, August 6, 1881, by Mr. D. C. Vestal and myself, with such revision and correction as another year has shown to be needed, and with added memoranda to the experiments detailed, in order to present their full effects after a lapse of more than a year. I shall also detail other experiments, and shall refer to work done on an extensive scale for the destruction of the scale pests, and which has shown most gratifying results.

All scale insects impair, to a greater or less degree, the vitality and productiveness of the tree or plant upon which they live. Of the seven species which have here been observed as infecting our deciduous orchard trees and fruits, five are of frequency and of such importance as to attract the attention of orchardists. These are the *Lecanium Oleæ*, *Aspidiotus Rapax*, *Aspidiotus Conchiformis*, *Aspidiotus Perniciousus* and the *Icerya Purchasi*, the two last named being the most dangerous of all scale pests which the orchardist has to encounter.

Lecanium Oleæ.—This scale is beginning to attack other trees than the orange and its kindred. A year since I examined an orchard where it existed in overwhelming numbers upon the German prune, Brigg's Red May and the Early Crawford peaches, upon the Moorpark apricot trees, and most of all upon the *Petite prune d'agen* trees. This is believed to be the direct result of planting a few orange trees close by. Mr. Ellwood Cooper has written fully upon this scale, and to whose reports I refer you.

Aspidiotus Rapax.—So named by Prof. J. H. Comstock. This scale is rapidly spreading, and is now found in many places where unknown a year or two ago. It seems to be most prominent that fall in its way are attacked, and every ornament in Santa Cruz county, where it can be abundantly found. I have, during the past two seasons, observed it in many places in Santa Clara county, and have had specimens sent me from San Lorenzo, Alameda county, where it was abundant upon pear trees, a branch sent being well covered with the old scale, and also newly hatched young crawling about.

This scale seems to be native to the willow and alder and other indigenous trees. It, however, is found in great numbers upon acacia trees, upon the black locust and poplar, and upon some of our orchard trees, as the pear and apple. This scale somewhat resembles the *Aspidiotus perniciosus*, and by many is confounded with it, but it is not to be compared to the latter for destructiveness.

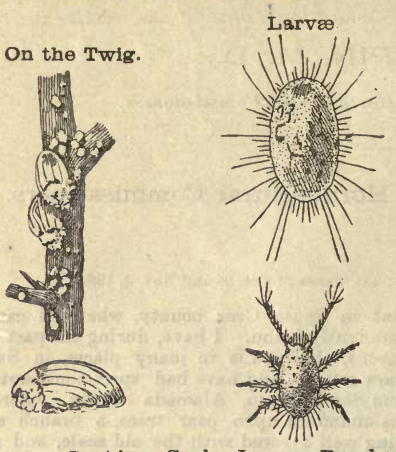
Aspidiotus Conchiformis.—The one longest known, and which was discovered and described in Maine in 1794, has ever since that time infested the apple tree particularly, although found upon other fruit trees and upon the currant. This is now found in great numbers upon almost all old apple trees on this coast, and is commonly known as the bark louse or the oyster-shell scale. It may be found described in works on entomology. This species has not caused so much injury as to alarm fruit growers to any great extent, although it is described by Dr. Packard as doing more injury to the apple tree than any other insect known.

Cottony Cushion Scale.

Next will be described a comparatively new scale heretofore, but one which has within the last two or three years been ravaging many localities in widely different parts of the State. This is the so-called dorthesia, or, as named by Maskell, *Icerya Purchasi*, and called by Mr. Matthew Cooke the cottony cushion scale.

This scale has been, it is asserted, known to be on the acacia for seven years in San Jose, but it is only during the past and present seasons that it has attracted attention. Its great prolificness and its destructive abilities have called widespread attention to it. This pest attacks everything in the way of tree, vine or shrub; all the evergreens as well as deciduous trees

mental shrub on the lawns of some portion of our cities will show its presence. The ivy, even, is not proof against it. In San Rafael, San Mateo, Santa Barbara and Los Angeles it is well established. While in San Jose it has not this season caused so great damage as last, yet in the citrus-growing regions it is becoming one of the most serious pests they have to encounter, and it is even stated that, should its ravages not be



Cottony Cushion Scale—Icerya Purchasi.

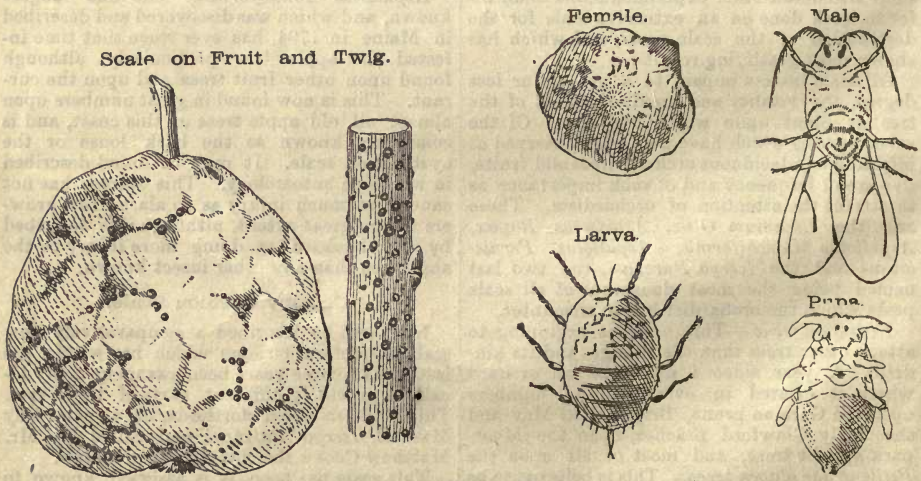
checked, orange and lemon culture will have to be abandoned.

From the rapid destruction which follows the presence of this scale, it is well that it should be widely recognized, and its first invasion noticed and checked. In San Jose, in 1881, it was first noticed in May as the fully developed female, from which the first brood of young then appeared.

haps the twenty-fifth of an inch in length. The body is pale red; the six legs and two antennæ are black. The antennæ are long and club-shaped, and have from six to nine joints, as they are further matured. The antennæ are covered with long hairs, which bristle forth prominently. The eyes are small and black. Between the pair of forelegs on the under side of the body is to be seen the beak or sucker, by which the insect secures its nourishment.

The females partly grown are of a variety of colors, orange red mostly, and spotted over with white and green; some are nearly entirely a dirty white, and many are a pea green. It seems that the coloring matter of the plant they are upon colors them to some extent. Their body is ovoid and elongated and flattened, the back being ridged up with several segments quite prominent. Around the rim of the body are a multitude of hairs, standing out prominently. Around the rear half of the body on its rim are a row of tubercles or spinarets, from which a white secretion issues, forming a cottony cord, and these placed side by side and the interspace filled up by the same material running lengthwise the body and projecting from it, gives the whole a ribbed, satin-like appearance whitish in color. Gradually as the insect matures these projecting ridges approach each other at the ends, and are joined together and curved under slightly at the point, while the sides are at the same time curved under the whole length, and the edges joined together like a flat ribbon-like band, the whole forming, when complete, a soft elastic white sack, the size, and somewhat the shape of a medium sized white bean. The length, when mature, is about three-eighths of an inch; the width one-fifth of an inch.

Inside the sack are deposited the eggs of the female, among the interstices of a mass of cot-



SAN JOSE SCALE INSECT—Aspidiotus Perniciosus.

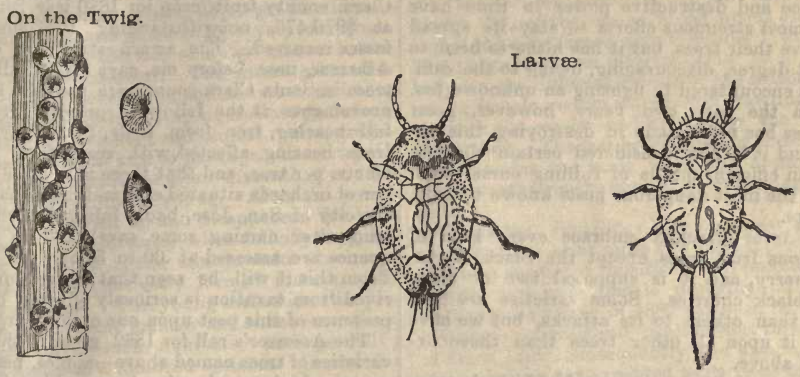
This present season of 1882 the first young appeared May 25th, the mother insect having gradually matured her eggs from the opening of spring until the young were hatched. The egg of the *Icerya* is small, pale or orange red, elongated and ovoid. The young just hatched out are very active, and are very minute, per-

ton-like fiber, which under a high magnifying power is shown to be round, and not more than one-sixth part the thickness of pure cotton fiber, with which it was compared in the same field. This mass of cottony fiber is filled with a great amount of granular matter, for the purpose, it may be, of affording sustenance to

the young insects within the sack. The young hatch out in this sack, and make their way out into the world through a rent in the soft and tender underside of the sack.

The female, after finding her home and during maturity, does not move, although she does not lose her legs, but clings tenaciously with her feet to her support, leaving the body tipped up in the rear and the cottony mass movable in any direction. The male insect was only found during a period of about two weeks from Sept. grown and with the young hatched out and crawling in the same sack. In 1881 they rapidly increased from about the first of August, and were continually appearing, and still hatching out in December.

Every female, it is estimated, produces from 200 to 500 young. The young will mature and produce a new brood in about three months. Where this scale infests deciduous trees it may be readily destroyed by the application now found to be successful in treating the *Aspi-*



BLACK SCALE—Lecanium Oleæ.

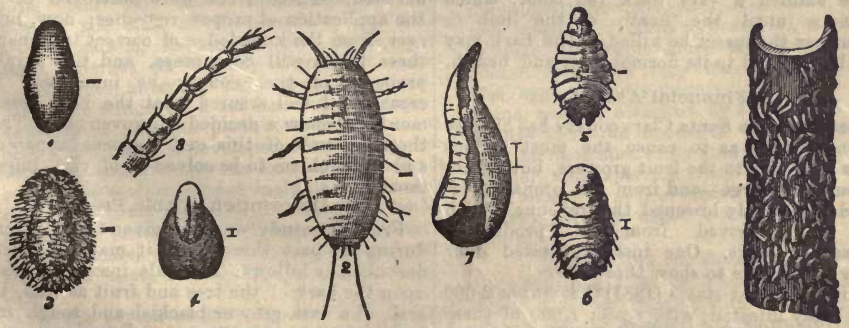
25th. This was the observation of 1881, when I found them in great numbers. I have failed to find the male insect this season. It has a long red body, six legs and one pair of very long, dark and transparent wings, prominent eyes and antennæ very long and covered with hairs, arranged very much as the feathers of a peacock.

The antennæ are 16 or 17 jointed. The winged male is easily seen and easily caught, as it moves slowly about, and is not readily disturbed so as to fly away. The female insect lives upon the trunk of the tree and large *diotus Perniciosus*, and detailed further on in this report.

Where, however, evergreens are involved it is a far more serious problem. The best treatment for the *Icerya*, so far found, is that used by Mr. Cooper, of a strong and hot infusion of tobacco, applied by spray as near as may be at 130°.

Aspidiotus Perniciosus.

By far the most injurious scale pest infesting our orchard trees and fruit is the new species of *Aspidiotus*, which, so far as known, originated



THE OYSTER SHELL BARK LOUSE—Aspidiotus Conchiformis.

limbs and down to the smallest twigs, around which it may be seen clinging in clusters sufficiently great to completely hide the branch; also upon the leaf, along the stem and ribs of which it is fixed, both above and below, although more abundant on the underside of the leaf.

There are three broods of this insect in the season; the first appearing in May, the second in August and the third in October, or about three months apart. I have just observed, October 15th, the mature female with eggs fully in San Jose, and for some years was confined to this locality. It has been known as the San Jose small, round, black scale and named by Prof. Comstock *Aspidiotus perniciosus*. The spread of this scale over the State has been gradually taking place, until now it can be found in a number of the fruit-growing counties, notably San Joaquin, El Dorado, Nevada, Placer, Sacramento, Yolo, Solano, Sonoma, Alameda, Santa Cruz, San Benito and others, and I am told even in Humboldt in the north and in the southern counties. This scale produces ter-

rible results in an orchard when once established. Its ravages have caused widespread alarm, and unless checked soon causes entire destruction of the trees infested. The trees become entirely covered with the scale, so that no portion of the bark can be seen. The fruit also becomes covered in the same manner and is rendered unfit for use. The losses caused by the ravages of this insect cannot be easily computed. Whole orchards are literally destroyed by it. In many cases those who have recognized its presence and destructive power in time have made most strenuous efforts to stay its spread and save their trees, but it has hitherto been, to a great degree, discouraging, owing to the difficulties encountered in fighting an unknown foe. Within the past two years, however, great progress has been made in destroying this insect, and it is now considered certain that we have an efficient means of ridding ourselves of one of the most dangerous pests known to fruit growers.

The trees attacked embrace every kind of deciduous fruit trees except the Black Tartarian cherry, and it is supposed two or three other black cherries. Some varieties are less liable than others to its attacks, but we have found it upon all other trees than those excepted above.

Poplar and other ornamental and shade trees give it a support. It infests hedges of Osage orange and the wild cherry, many of which have been destroyed in the past two years, and have been dug out. It is found on the currant, and quickly destroys the bush. It has been found upon rhubard, and tomato plants growing in orchards among infested trees. This scale evidently prefers some varieties of trees, but yet, when placed upon others not so well liked, will stay and colonize to some extent.

The effect of this scale insect upon the tree is peculiar. After a short residence there, the green layer of the bark becomes stained a very dark red color, which continues until the death of the limb or tree unless the insect be killed. The bark may then be restored to its normal color and health.

A Financial Aspect.

The damage in Santa Clara county has already become so great as to cause the most serious losses not alone to the fruit growers, but also to the public at large—and from the orchards effected has greatly lessened the revenue which has been derived from the production and sale of fruit. One instance stated definitely will suffice to show these losses.

This orchardist states (1881) that he has 2,000 trees badly infested with scale; 1,000 of these trees are totally destroyed, and will be dug out this season; the balance are badly injured, but can probably be saved. This portion of his orchard in health returned at least $5,000 per year. His loss on crop from these trees in 1880 was over $2,000. For 1881 there was a total loss of crop on 1,500 trees. This orchard has regularly paid an interest of 10% on $1,000 per acre. The scale pest alone has cost a loss of $20,000 to the owners.

Further on reference will again be made to this orchard. The Assessor's roll for 1881 reports in this county 335,537 bearing trees of the apple, pear, plum and peach. This does not include the large number of trees which have been destroyed and are unfruitful; neither the immense number of young trees that have been planted, but not yet paying; and, as observed, it leaves out the large number of other varieties, cherries, almons, apricots, etc., in bearing, which, it is estimated, would make a grand total of 1,000,000 trees. Should the losses experienced by the orchardists now suffering be carried out to all, you can readily estimate the astounding result. The value of the Santa Clara county fruit crop for 1880 was returned at $976,475, notwithstanding the immense losses incurred. The sworn statement of the Assessor, now before me, says "That all fruit trees in Santa Clara county are assessed as improvements at the following prices: Trees in full bearing, free from scale, $1.50 per tree; trees bearing, affected with scale, from .00 to 50 cts. per tree, and that there is a large number of orchards situated east and northeast from the city of San Jose, badly infested with scale (and after naming some, says), and in consequence are assessed at .00 to 50 cts. per tree." From this it will be seen that the revenue derived from taxation is seriously affected by the presence of this pest upon our orchard trees.

The Assessor's roll for 1882 gives of the four varieties of trees named above—apples, peaches, pears and plums—bearing trees subject to taxation 280,347, a deduction from the previous year's assessment of 55,190 trees. This loss is in fact upon apple, plum and peach trees, as the young pear trees coming into bearing, and being assessed for the first time, more than equal the loss on that variety. So it is seen that the loss in assessed value on these three kinds of trees totally destroyed has amounted in the one year to $82,785. This is actually but a small part of the loss, as other varieties of trees destroyed, and the losses of previous years from the scale as well as the reduced value of trees affected but still bearing, cannot well be enumerated. These trees were destroyed before the application of proper remedies; now, however, from the knowledge of correct treatment, these losses will soon cease, and the taxable property of the county be immensely increased. I feel assured that the next assessment will show a decided improvement. Thus the magnitude of this evil becomes apparent, and the problem to be solved is of vast importance.

Description of this Pest.

From the study we have given to this scale during the past three years it may be briefly described as follows: The scale insect is massed upon the bark of the tree and fruit as well, the scale of a dark gray or blackish and tough material which covers the insect being very small and round in shape over the female, while that covering the male is much smaller and elongated on one side. In both, the higher and central portion of the scale has a yellowish color, and directly under which may be found the insect itself, which is soft and delicate in structure and of a pale straw color. There is no connection between the cover and the insect, which is merely protected by it from harm. The shell-like scale is formed by either the cast-off skins of the larva or by a waxy secretion of the body of the insect. The microscope shows the young female insect oval in shape and flattened. At

first it is very small and hardly perceptible to the naked eye, but careful observation will detect it as a minute yellow dot on the bark of the tree, crawling about with the six legs with which it is provided, and seeking a favorable locality upon which to fix itself for life. It will crawl about for only a day or two, and then fastens itself to the bark by a beak-like protuberance which it inserts, and procures nourishment from juices of the tree. Immediately upon fixing itself it begins to be covered with a silvery material, which, as it grows older, is gradually changed in color to a very dark hue, and enlarges to the size of about one-sixteenth of an inch in diameter. The insect soon after fixing itself loses its legs and antennæ, and thus remains through life, keeping its flattened shape but growing wrinkled and almost round, gradually increasing in size to perhaps one-sixteenth of an inch in width and one-fifteenth of an inch in length when full of young. After the young emerge it is dried up and disappears. We have counted from the female, when full of young, between 50 and 60 of the minute sacks which contain the young perfectly formed insects ready to crawl about. The young male insect is produced in the same manner and at the same time, though not in such numbers; perhaps half a dozen males to a hundred females. In size the male is about one-third that of the female, and in shape very different, being elongated and more angular, provided with six legs placed differently up on the body, with two antennæ and two eyes, and with a teat-like protuberance at the rear end of the body ending with a point.

At this stage of its existence the male has no wings, and it cannot be discerned without the aid of a magnifying glass. The color of the young male is not a yellow, but of a steel-like or whitish hue. It crawls about and fixes itself upon the bark, as does the young female, and becomes covered with a scale in the same manner, but which is elongated upon one side, and not more than one-half the size of the scale of the female. The male, after remaining its allotted time in the pupa state, emerges as a fully developed insect, having eyes, antenne, six legs and one pair of very long wings of a reddish and transparent appearance, and the protuberance at the rear end of the body is developed into a very long tapering point, nearly as long as the body itself. The perfect winged male is so minute it can with great difficulty be discerned by the naked eye, crawling and flying about in search of the female, which it impregnates under the scale and then, having fulfilled its mission, it dies.

In the season of 1880 we saw the winged males first appear on March 23d, and in great numbers for a few days. The first brood of young scales appeared the latter part of April. On June 27th we found the males from the first brood under the scales and nearly developed with appendages and wing pads, and on July 2d large numbers of them flying about; also as late as July 25th, and still later, on August 2d, a few were seen. On July 23d the trees were covered with the young of the second brood; August 2d the young males of the second brood were found crawling about. Bark scraped clean on the 23d of July was found on the 25th alive with young insects, and some of them already commencing to be covered with scale. As it was expected at the time these observations were made, a third brood would appear about October, so we found it. On October 17th we found the male scale insect in the first pupa stage of development in the winged form, and also on the same day found the perfect winged insect of the third brood moving about on the tree.

These facts prove conclusively that there are three distinct broods of these insects in the season, the earliest portion of the first brood about March 23d, of the second brood about July 2d, and of the third brood about October 17th, there being apparently an interval of 14 to 15 weeks between the different broods of the season. The young female insects were found crawling about through the season and as late as the last of November. The last brood remains through the winter under the scale until the approach of warm weather in the spring, when they again appear.

While the *Aspidiotus Conchiformis* will develop but one or at most two broods per season, this new species of *Aspidiotus* will produce three broods, and each female probably 50 young. This present season of 1882 has been in the development of fruit and insects about three weeks or more later, consequently the appearance of the scale was not expected as early as last year. The first winged male scale insects of this species were discovered this year on April 25th crawling about on an English hawthorn tree. At that time no young female scale insects were to be found, but the old females under the scales were approaching maturity, and in due time the young appeared.

Foes of Scale Insects.

The natural enemies of the scale insect are the larvæ of some varieties of the *Coccinellidæ*, or lady-birds.

The season of 1881 developed in great numbers an important enemy of the scale, viz.: the *Chrysopa* or lace-winged fly, the larvæ of which prey upon it. This is a beautiful, slender and delicate fly, bright green in color, with large golden eyes, and very long wings like lace. The eggs are very minute, white and oval in shape, and are attached by a long and slender pedicle to the underside of leaves or the fruit. The larva is about one-quarter of an inch long, slender, and tapering from the middle toward both ends. It is provided with jaws, each perforated, through which it sucks the juice of its victim.

Remedies for Scale Insects.

In 1881 Mr. J. H. M. Townsend, of the Santa Clara County Horticultural Society, kindly placed at our disposal a large number of trees infested with scale for the use of the committee in making such experiments as were desired. A series of careful experiments for the destruction of the scale pest were made and the results carefully noted. Other experiments had been under way in our own orchards for many months.

These expriments demonstrated on one hand the inefficiency of many applications, and on the other hand showed a certain means for the destruction of the scale insect. The remedies which have proven successful will destroy all the varieties of scale, as the one under treat-

ment is the most difficult of all to overcome. A portion of these experiments are numbered, and the results obtained, stated as observed, at different dates up to this time, October, 1882.

No. 1. Concentrated lye of the American Lye Co., one pound; water, two gallons. February 22, 1881—Applied by spray upon two peach trees infected by scale; washed in the afternoon when the trees were dry; effect, scale killed; the tenderest wood was killed also. July 5, 1881—New wood grown over the trees four and five feet long.

No. 2. Concentrated lye, one pound; water, two gallons. March 10, 1881—Applied by spray upon two peach trees infested by scale. washed in the morning when the trees were damp with dew. July 5, 1881—Scale killed; buds and twigs not injured; fruit abundant and trees most healthy.

No. 3. Concentrated lye, one and one-half pounds; water, one gallon. June 23, 1881—Applied by pouring from a dipper upon two pear trees infested with scale and with numerous limbs dead. Lye so strong as to burn bark and foliage. August 2, 1881—Scale entirely destroyed; bark being restored and new foliage appearing.

No. 4. Concentrated lye, one pound; water, one gallon. July 5, 1881—Applied by spray upon a large apple tree badly infested by scale; bark and leaves burned. August 2, 1881—Scale killed; green layer of bark being rapidly restored and new leaves and blossoms appearing all over the tree. The foregoing trees have since been mostly killed by the application of a low grade of coal oil.

No. 5. Concentrated lye, one pound; water, one gallon. February, 1881—One almond tree, one Easter Beurre pear tree and two apple trees, grafted, were washed by brush with this strength of lye in order to destroy the red spider and its eggs, which could not be destroyed by previous applications of lye, one pound to five gallons, and also one pound to three gallons; another and the main reason being to ascertain the effects of very strong lye upon the trees. No scale upon these trees. This application destroyed the red spider and its eggs on these trees so that it did not appear for months; but, however, later on the trees became again infested. While the strong lye will destroy a large number of the eggs of the red spider it is found that all cannot be reached. The effect upon the bark and health of these trees was wonderfully good, the bark being very smooth and having a bright green, velvety appearance and totally free from all moss or other parasites.

No. 6. Concentrated lye, one pound; water, one gallon. The experiments in this number were made upon a section of orchard in a square block comprising 357 Ickworth plum trees, cut down and grafted into Petite prune; some yearling prune trees having been put in in places and washed as were the plums, of these 126 trees were washed in February, 1881, with the above strong lye, applied with a brush. Among the 357 trees were eight trees badly infested with scale. No others had any scales upon them. The infested trees were scattered about as follows, and washed as indicated:

No. 10 in first row and 4 in 11th row were washed with lye, one pound to three gallons of water. The effect was not quite sufficient to completely destroy the scale, though so injured that they did not breed. Afterward these two trees were washed with one pound to one gallon, and this effectually ended the scale. No. 7 in 6th row, 10 in 7th row, 11 in 12th row, 8 in 14th row, 3 in 17th row and 11 in 17th row were washed with lye, one pound to one gallon of water, with the effect of completely destroying every scale upon them, and not one has appeared upon any of these trees since that time. These trees have been in the finest possible condition from the time of this application.

Among the trees not washed with the strong lye, two were found, in June, 1882, to have scale upon them; one of these, the top having become badly broken by wind, was dug out and burned, the other was washed soon as discovered with the whale-oil soap and sulphur mixture; owing to the foliage upon the tree not every part of it could be touched. Yet, however, the scale was destroyed, so far as could be found.

No. 7. Concentrated lye, 1 pound to one and one-half gallons water. Five Bartlett pear trees obtained from the nursery and planted in 1881 and scattered among a considerable number, although carefully examined at the time for scale, were found in June, 1881, to have a few scales upon them. These were at once washed with the above strength of lye, which destroyed the scale completely upon three of those trees, so that none subsequently appeared. On two of them, however, a live scale or two must have remained on the trunk of the tree at the surface of the ground untouched by the lye, as in September following a few young scales were discovered, located close to the ground. These were again washed in the same manner. Since that washing no scale has been found upon either of these trees until this month (Oct. 16, 1882). On one of them has been found a few young scale. The tree was immediately washed with the whale-oil soap and sulphur mixture. On another Bartlett pear tree, not, however, numbered with the above, was found some scales, Nov. 7, 1881. This tree, being entirely dormant, was washed with lye one pound to one gallon water, completely destroying the scale, as none can be found on it this year. Among the Yellow Egg plum trees, one was found January, 1882, with scale upon it, and washed at once with lye one pound to one gallon water, and repeated in February. No scale were left, as none can be found at this date. Another Egg plum tree was found infested in June of this year. To this was applied, by a brush, the whale-oil soap and sulphur mixture with some lye added. No scale can now be found upon it.

The trees in experiments five, six and seven are in an orchard of 50 acres. I have constantly and carefully watched all these trees, and at this date no scale can be discovered in the entire orchard. Should any hereafter appear, the treatment will be by lye one lb. to one gallon water. With this success in my two years' individual practice, I feel justified in repeating the statement I made at the first State Fruit Growers' Convention, that young orchards

can be kept free from the *Aspidiotus perniciosus* by the right use of concentrated lye as a winter wash, and the whale oil soap and sulphur mixture for summer.

In the following experiments the trees were all badly infested with scale:

8. Concentrated lye, one and one-half lbs; water one gallon. June 24, 1881—Applied to two Clairgeau pear trees; brush used in order to save foliage; many limbs dead from effects of scale. June 27—Trees burned considerably; scale killed where reached. July 2d—Much of the bark showing a healthier appearance. July 23d—Trees still better. August 2d—No sign of scale; green layer of bark being restored very rapidly; the fruit quite clean, because no scales of second brood were upon it. April 25, 1882—Examined the trees, and found a very healthy top. and with new bark where burned with the lye when washed in the summer. All the surface was not touched by the lye, and where not washed the scales still existed. Wherever the bark was washed, owing to the time that it was done, it was cracked across. Yet underneath this cracked surface was found new and healthy bark. October 14, 1882—There has been a good growth of new wood this season, and the under bark has maintained its fresh and healthy appearance over entire tree.

9. Concentrated lye, one and a half lbs.; water, one gallon. June 24, 1881—Applied on a portion of tree to ascertain the effect upon the stain of bark. July 23d—The bark where washed shows much less stain; lighter in color. and the green layer being restored. August 2d—Stain rapidly disappearing.

10. Concentrated lye, one lb.; water, one gallon. July 5, 1881—Mixed accurately, and applied same day upon pear tree. July 23d—Scale where reached entirely destroyed; bark burned by the lye, but otherwise healthy and good where it was previously sound. April 25, 1882, and October 14, 1882 — Observations nearly the same as in the preceding number, the bark under the cracked outer layer being all renewed, and with a bright, healthy, green layer free from stain; free growth of new wood during the season.

11. Concentrated lye, one pound; water, one and one-half gallons. Tree washed same time as above and with about the same results, although an unthrifty tree. October 14, 1882—The tree had been pretty well destroyed by the scale last year. and shows but a little growth of new wood.

12. Concentrated lye, one lb.; water, two gallons. Same as above. except that the tree was still more thoroughly ruined by scale, and at this date has not recovered; but little new wood; what there is, however, being healthy.

13. Concentrated lye, one lb:; water, three gallons. This tree had been washed by spraying April 1, 1881, with this strength of lye, which proved too weak to destroy the scale. July 23, 1881—Young scale insects covered the tree; the tree was left to itself with that washing. April 25, 1882—Observed that the scale was abundant and fast accomplishing the destruction of the tree. October, 14, 1882—The tree is dead to within one foot of the ground, but from the collar many new sprouts have grown.

No. 14. Concentrated lye, 1 lb; water, 5 gals. June 23, 1881—Applied to two trees, one slightly and the other badly infested with scale. This wash was used by pouring it upon the trunk of the trees and allowing it to run down and soak into the ground; the tops of the trees were not touched. This experiment was made, as it had been publicly stated that this weak lye used in this manner was an effectual remedy. July 2, 1881—No effect produced upon the scale where not reached by the lye. August 2, 1881—No effect other than noticed above; scale only injured where touched by the lye, and second brood of young scale insects crawling all over the top of the trees. April 25, 1882—Trunk quite clean and healthy, but the top full of scale insects of the last season alive and approaching maturity. October 14, 1882—Tree covered with scale, old and young; the trunk, however, where washed, appearing far more free than the upper portion; the bark where washed is healthy.

Use of Kerosene.

In the following experiments with kerosene, the action of that agent was reported as it *then* appeared at the date of report, but the subsequent effects which will now be stated, show how important it is to allow ample time to elapse before coming to a conclusion upon the merits or demerits of a particular proposed remedy. The use of coal oil when the tree is full of sap is plainly shown to be unallowable. These will be detailed as they appeared at the time, and also as seen this season.

No. 15. Kerosene, low grade and heavy, 110 test. June 1, 1881—Applied to two pear trees, spraying, with coarse spray used and oil thrown over the entire trees. June 27, 1881—Observed that the foliage had been killed and the trees considerably affected; scale killed. July 2, 1881—New leaf buds coming out. July 23, 1881—New foliage all over the trees, and seemingly new vigor throughout; new shoots six inches long; no scale to be found, and the green layer of the bark healthy to all appearance. August 2d—Foliage increasing rapidly all over the trees, and, apparently, the trees were gaining in health. Thus they appeared up to August, 1881. The observation of these trees on April 25, 1882, showed a very different state; the trees were dead.

No. 16. Kerosene, high grade, 150 test. June 1, 1881—Applied by spray upon two pear trees. June 27, 1881—Observed that the foliage had not been killed, but that the scale had all been destroyed; the trees apparently uninjured. July 2d—New leaf buds coming forth. August 2, 1881—Trees appear healthy; foliage uninjured; scale showing no signs of its presence, and the fruit showing less effects from scale on account of the wash it had received. April 25, 1882—Trees were dead.

No. 17. Kerosene, high grade Diamond brand, 150 test. July 27, 1881—Applied upon two pear trees with a coarse heavy spray over entire trees; trees very badly infested. August 2—Effectually destroyed the scale; the trees and foliage apparently entirely healthy. No perceptible effect upon the trees, but completely dryiug up the scales, so that they are blown away by the wind. The fruit is not affected by the kerosene, but the scale upon it is killed, and the fruit is very clean. It is observed that

kerosene of 150 test evaporates rapidly, and leaves but little signs of having been applied. April 25, 1882—One tree dead; the other not dead but nearly so. October 14, 1882—Examination showed trees to be dead.

No. 18. Kerosene, same brand. July 27, 1881—Applied upon a pear tree by spray atomizer, which produced a very fine mist only. August 2, 1881—The same effects produced as in No. 17; scale appeared to be entirely destroyed; no apparent effect upon tree or foliage. April 25, 1882—Tree not dead, but with many scales upon it. October 14, 1882—Old wood dead, but new wood from near the ground.

No. 19. Gasoline. July 27, 1881—Applied upon pear tree by heavy syringe spray thoroughly over the tree and foliage. August 2, 1881—Not effectual in destroying the scale; too volatile; many of the insects killed, but a large portion unaffected; no apparent effect upon the tree or foliage at that time; on this tree the young male scales just hatched out were found crawling about. April 25, 1882—The tree has been almost killed by the scale infesting it. October 14, 1882—Tree still alive, with some scale upon it.

No. 20. Gasoline. July 27, 1881—Applied upon pear tree by the spray atomizer. August 2d—Result same as the preceding. October 14, 1882—This tree did not suffer from the effects of the application, but this season has made a vigorous growth of new wood quite clean from scale. The foregoing applications of kerosene and gasoline were made in full strength.

Whale Oil Soap and Sulphur.

No. 21. Whale oil soap and sulphur mixture 1 lb., water 1 gal. June 23, 1881—Applied by spray over pear tree, covering foliage and fruit thoroughly. July 23d—Scale killed; tree gaining in health; green layer of bark being restored; fruit greatly improved in appearance. August 2, 1881—Tree still improving, also fruit. April 28, 1882—Tree very healthy and appears clean from scale; green layer of bark being fully restored, and parts of the tree that were nearly killed by the scale are forming new bark rapidly; the tree has a very fine top of new growth. October 14, 1882—The tree has grown very thriftily through the season and the wood is all very healthy; some scale are found upon the tree, however. These trees are in an orchard badly infested, and it is to be expected that the insects will return. This wash is an effectual summer wash, and where there is any scale present should be used in the strength here given, as a wash of one-half the strength has proven ineffectual.

Soft Soap and Sulphur.

No. 22. Soft soap, one pound; sulphur, one pound; tobacco, one pound; water, three gallons. July 5, 1881—Applied upon two trees by spray, covering trees, foliage and fruit thoroughly. July 23, 1881—Seemed quite effectual at the time; many scale destroyed, but not all; trees, not affected by the wash; fruit improved in appearance. Subsequent observations, however, showed that but little was accomplished in destroying the scale. October 14, 1882—This tree shows an abundance of live scale in all stages of growth. This wash was used with good effect in another orchard, June 1, 1881, on a Fellenberg prune tree, clearing it from scale, which, up to this time, have not returned.

No. 23. Soft soap, one pound; sulphur, 1 pound; water, three gallons.

No. 24. Soft soap, 1 pound; water, 3 gallons; The two washes named above were applied June 23, 1881, and with no effect, neither has it shown any result this season.

Whale Oil Mixture.

No. 25. Whale oil, one pint; kerosene, one pint; borax, one ounce; water, one gallon. June 23, 1881—Applied by spray to a pear tree at the different dates in 1881; the effect has been observed; it has been apparent that the oil is decidedly injurious to the tree, applied in this manner or at this time; it is therefore not recommended. Applied to another tree in one-fifth the strength above given; it has no effect upon either scale or tree. April 25, 1882—The tree first treated is nearly dead; but, however, having the top cut off, new wood is coming along; scale appears to be destroyed. October 14, 1882—The old wood is dead; the sickly growth of new wood springing out from the lower portion of the tree shows some scale.

Carbolic Acid.

No. 26. Carbolic acid, three ozs.; water, two gallons. June 23, 1881—Applied by spray upon a pear tree badly infested with scale. June 27, 1881—Failed entirely. This tree afforded a constant succession of insects in all stages of development, both male and female. From it some of our most interesting studies were made; we repeat it as it appeared at each visit on that date (June 27, 1881); we found the male insect under its scale partially developed, with wing pads, but wings not yet out. July 2d—Found plenty of winged males of the second brood flying and crawling about. July 23d—Tree was covered with young female scale insects of the second brood crawling, and with a few of them just located and commencing to be covered with their scale. July 25th—A few of the winged male still found; bark scraped clean on this date was in two days covered with young scale and with a slight formation of scale over them. Aug. 2d—Tree entirely covered with young scale on this date; two or three winged males were found. April 25, 1882—Tree almost dead from effects of scale; top dead and removed and a few feeble shoots coming forth. October 14, 1882—Shoots have grown from the trnnk of the tree to some extent, but the whole having been so seriously infested the tree is considered worthless.

The entire orchard in which these trees are situated, other than the ones experimented on, from 8 to 26 were washed this past winter with a very low grade of coal oil called "tree wash;" the result is not satisfactory; the owner tells me (October 14, 1882) that he is satisfied that the oil has seriously injured his trees.

San Jose. October 25. 1882.

Experiments with Steam.

It was at one time thought that steam might be effectually applied for the extermination of insect pests upon trees. In the summer of 1881 a test of this agent was made in an orchard near San Jose. A large tent was made to hang upon a frame, which could be run on either side of,

and overhanging the tree; the tent then being dropped, the tree was entirely enclosed in an air-tight bag, into which the steam and other ingredients were forced, and left to act upon the tree and insects as long as was thought necessary.

Horticultural Commissioner D. C. Vestal and myself carefully noted the experiments made and placed the results upon record. These experiments are also numbered for convenience in describing.

No. 1. Sept. 8, 1881. An apple tree infested with scale insect, wooly aphis and other pests, was covered by the tent, under which was hung upon the tree cloths saturated with bi-sulphide carbon, one-half pound. It was thus left for three-fourths of an hour, and then the tent was removed. Result, apparently of no effect. The woolly aphis was not injured, but found crawling about. The red spider was found crawling about; also a small caterpillar was observed unharmed. The scale insects were not affected in any way, so far as could be observed. Sept. 12, 1881—Examination made on this date showed that no effect had been made by the application upon any of the insects mentioned as infesting this tree. Mr. J. H. Wheeler, the maker of the bi-sulphide carbon, thought that the agent had not been properly brought into contact with the insects, and for that reason failed to destroy them.

No. 2. A pear tree was treated with steam forced under the tent covering the tree. The temperature was raised to 165°, and maintained for 10 minutes. Observations immediately afterwards showed that the foliage of the tree and the young wood of the tree was destroyed. Everything was cooked thoroughly. September 12th—The tree and the scale were both killed.

No. 3. An apple tree was treated in the same manner, with steam at 140°, for three minutes, and afterwards with sulphur fumes (caused by putting two handsful of sulphur upon live coals) for five minutes. The result showed that the tree did not appear quite so much injured at this time as the preceding tree at first showed, but as seen on September 12th the effect was the same. The scale was killed, and also the entire tree, except the oldest part of the trunk.

No. 4. Apple tree steamed for five minutes at 140°; dried for five minutes, and then fumed with sulphur for five minutes. Result the same as the preceding.

No. 5. Apple tree moderately covered with scale and woolly aphis. Steam applied with which had previously been mixed three gallons of kerosene, pumped into the boiler of a threshing engine. This application was made at 110° and maintained for four minutes. September 12th—No effect was perceptible upon the tree, except that the foliage was somewhat injured. The scale insect was not killed or even injured. The woolly aphis was found alive and uninjured.

No. 6. Steam and coal oil applied four minutes at 140°. September 12—Tree pretty nearly killed. Only the oldest wood alive—all new wood and buds killed.

No. 7. Steam and coal oil for six minutes at 130°; No. 8, same for six minutes at 150°; No. 9, same for 12 minutes at 120° to 130°. This tree was steamed four minutes, and then, after an interval of six minutes, was steamed two minutes more. September 12th—The result upon these trees was the same. The trees were all destroyed excepting the trunk and oldest wood.

From these experiments it will be seen that steam cannot be applied in such manner and at a temperature sufficiently high to destroy the insects without, at the same time, destroying the tree.

During the season of 1881 strong efforts were made to introduce the use of

Various Patented Mixtures,

Which were claimed to have great merit in destroying the scale insect. One of these was to be used by simply spreading it on the trunk of the tree, which application it was stated would, through the poisoning of the sap, kill the insects. This, as well as others of a like nature, were given careful consideration and tested, and resulted in entire failure.

Another method, which was persistently forced upon the public, was that of boring into the trunk of the tree to the centre, and filling the auger hole with the so-called cure. A careful investigation of many trees so treated was made by Mr. Mathew Cooke, Mr. D. C. Vestal and myself, for the purpose of determining the actual effects, if any, of this treatment. Oct. 17, '81, we visited the orchard of one person, who had allowed his name to be used in recommending this exterminator, and first examined two pear trees bored and the holes filled with the preparation. These trees were found to be covered with live scale insects in all stages of development, and showing no signs of injury. The young female insects were found crawling about the trees in great numbers. The wood, the seasons growth, was covered with scale. An apple tree, the trunk and large limbs of which had been washed the previous winter with strong lye, showed that the scale which completely covered it when the lye was applied were entirely destroyed where the wash had reached, but on the smaller wood which had not been washed with the lye the scale was found alive. This tree had also been bored and treated with the application referred to, and which had no effect whatever. On the trunk of this tree, where the lye had been applied, the green layer of bark was found replacing the old, which had nearly been destroyed by the scale. At another place we examined a pear tree which had been bored and treated with this preparation. This tree was in no manner whatever affected by this so-called remedy, but was completely covered with scale insects in every stage. We found the young females crawling about, and on this tree was found the male scale in the first pupa stage of development for the third winged brood, and also on this tree was discovered the perfect winged male of the third brood. In no case has the slightest good resulted from these secret and patented preparations. We have treated this subject thus fully because, to our knowledge, prominent and careful horticulturists have been induced to purchase these things at an exhorbitant charge.

The treatment of trees by

Crude Petroleum

And its different products has been thoroughly

cited to show the efficacy of lye as an insecticide, but sufficient facts are stated.

How the Insects are Spread.

Attention must be called to the means of spreading this serious pest, the *aspidiotus perniciosus*. The system of "return boxes," and packages of any character, is known to be pernicious and a fruitful source of the spread of all kinds of noxious insects, which, either as insects, eggs or larvæ, are fastened to them and taken into the orchard, to be developed in due time, and then to spread devastation to everything attacked. Indeed, to me, so obnoxious is the return box that I will not permit one to be brought into the orchard or on the premises. I prefer to pay the cost of new boxes, and give them with the fruit sold. As the female insect has no wings, she can, of course, only be spread about by becoming attached to something by which she is carried to different localities, and by crawling about during the short period after hatching before becoming fixed for life.

Birds will carry them most frequently about an orchard, and it is thought that one source of danger is little regarded, viz: carrying them about on one's clothing by brushing against infested trees.

If boxes or packages are returned, they should be disinfected as soon as received by dipping in boiling water, to which is added not less than one pound of potash to 25 gallons of the water used.

The nursery trees sent over the State have been the means of spreading the scale extensively, and while nurserymen are anxious to make sale of their trees they must take every precaution to see that their patrons do not suffer by neglect to first destroy the scale, which may be done by dipping the trees in a solution of concentrated lye of 1 lb. to 2 gallons of water. I am glad to say that most nurserymen are desirous to do all in their power to destroy the scale.

Among other means of preventing the spread of scale, thorough and constant cultivation of an orchard should be kept up, and one prominent difficulty in the way of eradicating the scale I believe to be the practice so prevalent of growing other small crops in the orchard between the trees.

It cannot be too strongly impressed upon the mind of every owner of an orchard that he must personally watch his orchard and exercise such constant supervision that no infested tree shall escape observation, and, when found, the proper remedy at once be applied. In the orchard referred to where chance trees have been found infested, no other course would have saved me from the overwhelming spread of the scale.

The experiments of 1881 and the subsequent use of lye in instances mentioned, indicate the remedy. This should always be used when the tree is dormant, and when the foliage has disappeared from the trees. In our climate that time is the winter, and at any time before the trees put forth their buds.

Applying the Lye.

The strength of lye should be one lb. to one gallon water where trees are infested with scale. Where it is only desired to cleanse the tree from moss one lb. to three or four gallons of water is sufficient. The best method of applying the concentrated lye is by dissolving in boiling water, and throwing it upon the trees with a force pump through 40 or 50 ft. of [redacted] one-half inch rubber hose, to which is attached a nozzle, having for its opening a simple straight slit, very narrow in width, and one-sixteenth to one-eighth of an inch long. The best spray tip yet devised is that made at San Jose, called the Merigot Spray Nozzle. The pumps most used for this purpose are the Gould pump and the Merigot pump. The latter is made at San Jose, and is cheaper than the Gould pump. Great care should be taken to cover the tree entirely with the solution of lye, as upon its thorough application depends its success.

One of the greatest difficulties in the use of strong materials is from the spray falling upon the person of the operator and burning and injuring the skin. In order to overcome this obstacle, I have devised a simple "extension nozzle" of slight cost which is very light and which may be made of any length desired, say from four to 15 ft., or even longer. By the use of this extension it is perfectly easy to reach and spray any orchard tree without danger and discomfort. The cost of materials and apparatus may be given as follows:

The Gould pump costs about $16 without accessaries. The Merigot pump $12. The suction hose and the long hose will cost according to quality used, from 15 cents to 25 cents per foot.

The Merigot spray tip, if purchased alone, $1.50. If bought with pump, the pump and spray $13. The bamboo extension with globe valve seven ft. long $2.75. All excess in length over seven ft. 25 cents per foot. The concentrated lye, of the American Lye Co. in one-lb cans by the case of 48 lbs., $3 50 per case. English caustic soda in 600 pound drums, $33 to $35 per drum. The whale oil soap and sulphur mixture called the "Codlin Moth Wash" is manufactured in San Francisco and the price can be obtained by inquiring of Messrs Allyne & White.

In conclusion I will give the analysis made by Prof. Hilgard, of the State University, of a sample can of American Lye Co. concentrated lye. The can sent I took from a lot I had been using, and is supposed to be a fair sample of the manufacture. The analysis is as follows:

Caustic potash	8.3
Caustic soda and carbonate of soda	91.7
	100.0

With this I submit my report, expressing my firm conviction that ere long we shall be freed from the ravages of one of the most dreaded pests known to horticulturists.