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REPORT

OF THE

ENTOMOLOGICAL DEPARTMENT

OF THE

New Jersey
Agricultural College Experiment Station,

New Brunswick, N. J.

BY

JOHN B. SMITH, Sc.D.,

For the Year 1904.

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Report of the Entomologist.

Report of the Entomologist.

By John B. Smith, Sc. D.

GENERAL REVIEW.

The winter of 1903-'04 was remarkable for continuous cold weather; the temperature did not reach points as low as in some preceding winters, but maintained for a long period a level far below freezing and often very close to the zero mark. As a result some kinds of plants and trees suffered severely and it became a matter of some interest to learn what the effect had been upon insects. It is sometimes easy, but not always just, to charge any abnormal appearance in plant or insect life to the weather, and it is yet more difficult to prove a charge. However, practically all peach blossoms were killed in the experiment orchard, a few young trees died and my privet hedge was killed nearly to the surface of the ground; so as these were chargeable to the cold, some of the peculiarities of insect distribution may be equally so referable.

First of all, the most obvious feature of the year was a tremendous increase in the *San Jose* or *pernicious scale* throughout the State. Before the season opened there were many inquiries as to whether the severe winter had not destroyed or severely checked it. I discouraged all hopes of this kind but an unusual delay in starting brought a renewal of the inquiry. It was not until after the middle of June that the first larvæ were seen on the trees and it was nearer the 20th before they were at all obvious; but during the early days of July I found the heaviest set of young on the trees that I had ever seen. The rate of increase during July and early August was not so unusual; but in September and early October it was simply phenomenal. Trees that had been considered reasonably clean in spring were almost incrusted in early fall and some growers that had left trees untreated in the belief that they would stand it safely another year, found twigs and branches dying from scale attack. Nothing seemed to stop them. The records of the Experiment Orchard, and of the work done in the Marsh Orchard will show that out of apparently small remnants, thorough infestations were built up, and our orchards as a whole

are this early winter of 1904, more completely infested than ever before in the history of the species. And not only orchards have suffered; trees and shrubs in gardens have become infested as never previously and yet a real effort to deal with the insect in such places was made in many localities!

Unfortunately the results of the efforts were not all that was hoped; for as the effects of the winter—for lack of a better reason—some of the insecticides used failed utterly to kill or even to check. The lime and sulphur combinations which had been made our main reliance were absolutely ineffective in some cases and relatively so in others.

Parasitic and predatory insects were distressingly rare in most localities and as to insect diseases, nothing was seen of them. In a few places the twice-stabbed lady-bird, *Chilocorus bivulnerus*, appeared early in the season and matured one brood of larvæ. Later on, in mid-summer, *Pentilia misella* was more or less plentiful in some orchards, but even that was not nearly so numerous as usual.

Connected with this matter is the attempt to introduce and acclimate the Asiatic lady-bird, *Chilocorus similis*. During the season of 1903 a number of colonies were distributed in New Jersey and these seem to have been wiped out of existence; at all events nothing was seen of them. To restock, if possible, I made a trip to Georgia during the latter part of July because during the year preceding these beetles had increased largely in that State. But Georgia was little better off than New Jersey in this respect, the insects appearing as a scant remnant where they had occurred in abundance. Nevertheless I secured a portion of that remnant and introduced them into an infested orchard not far from New Brunswick, where no sprayings are intended and where the insects will be allowed to develope undisturbed. It is to be feared, however, that after the exhibition of comparative hardiness as between scale and beetle, it will be unsafe to depend much upon this natural check.

While the introduction of the Chinese Mantis *Tenodera sinensis* is not of equal practical interest at present, it is interesting to note that it also seems to have registered an objection to our climatic conditions and to have reduced itself almost to the vanishing point. All my reports were negative until I saw Mr. Collingwood on Hope Farm, November 14th. He told me that they found occasional specimens and that the children had reported them from time to time. But the Hope Farm man treats all

things so considerately that in sheer gratitude the insects may have survived for him and no one else.

Shade tree insects attracted attention because of an unusual development of the Cottony Maple Scale, which, however, was largely limited to cities near the Atlantic coast. Climatic or other causes not entomological had severely affected many maple and some other trees in Newark, Montclair and the Oranges and the officers in charge and residents became concerned in consequence, tending to charge all things to insects and demanding of the entomologist a cure for all ills. A consideration of the Cottony Scale will be found on another page.

Hardly had the fear of the one scale subsided, when the *Pseudococcus aceris* made its appearance on the trunks and branches causing further inquiry. But this did not become especially abundant and was very local in its manifestations.

The Vaporer Moth was also locally abundant; but was limited even in the cities in which it appeared. Thus, in Newark, only a few streets in certain sections of the city showed any sort of infestation. In the surrounding towns the insect was almost entirely absent.

The *elm-leaf beetle* was so little in evidence that no spraying was done on the College elms and there was little evidence of the work anywhere in New Brunswick. So in Newark, Elizabeth and the smaller surrounding cities and towns there was not enough to attract especial attention. On the whole, elms have not looked so well in years and the brood that came to maturity in mid-summer was the smallest I have known for some seasons. Nevertheless there is a brood in hibernation and, while not a very large one, it is of sufficient extent to cause trouble next year (1905) should climatic and other conditions be favorable.

Cabbage worms became locally abundant during the latter part of the season; but were not nearly so bad as they have been in some years past. Nevertheless considerable injury was done and the demand for information as to methods of treatment was heavy for a time.

Onion maggots were more widely distributed and more generally complained of than in any previous year. There had been local outbreaks of a severe character, and in some places growers have to deal with more or less of the insects each year; but never before were they so generally abundant and injurious. Root maggots are difficult things to deal with at best because they are beyond the reach of ordinary insecticide applications. On light land the quick-acting fertilizers were advised with general good suc-

cess. They act as a stimulant to growth and when run in along the rows close to the plants seem to exercise a positive effect as well. On heavier land they do not seem to act as well, and there the carbolic acid emulsion was advised. In every case taking out and destroying the infested plants was urged. This does not of course save anything for the present season, but it prevents the maggots or larvæ from coming to maturity and in that way lessens the supply for next year. In taking out infested plants in such cases a trowel or similar tool should be used that all the maggots attached to the outside of the bulb may be secured. Simply pulling the plant out usually results in leaving a portion of the maggots in the soil to make their way to another plant or come to maturity as the case may be. Growing onions in a section infested by the maggot demands constant attention, prompt action and a looking to the future effect of whatever action is taken.

Potato beetles were, on the whole less abundant during the early part of the summer than usual; but that must be taken as a very general statement, for in some places they appeared in normal numbers. After mid-summer they increased rapidly and, as in general, the potato crop was beyond reach of injury, no destructive action was taken they swarmed over everything eatable for them late in the season. The hibernating brood is, therefore, unusually large and promises to make up in activity next year what was missed during the early days of 1904.

One of the interesting features of the season was the almost entire absence of the *corn worm, Heliothis armiger*, in localities where usually it is a pest so universal that growers take it as a matter of course and unavoidable. From several points in Gloucester and Burlington counties where sweet corn is grown for the city market in great quantity, farmers advised me of this unusual fact; some claiming the total absence of the insect as against an 80 per cent. infestation in previous seasons. This put me upon inquiry and I found that almost throughout the State the insect was less abundant than usual; but that in the southern half of the State the difference was uniformly more apparent. Grocers and marketmen with whom I spoke confirmed this general conclusion and there seems little doubt that the winter of 1903-'04 was unusually hard on this insect and destroyed a large percentage of the hibernating pupæ. Just how this desirable result was obtained is less clear.

Fig. 1. The Strawberry Weevil; **a**, strawberry plant with blossoms cut by the beetle; **b**, the cut buds; **c**, the egg; **d**, the larva; **e**, its head; **f**, pupa; **g**, an open blossom showing holes eaten by the beetle; **b** to **f**, much enlarged. From Div. of Ent., U. S. Dept. of Agl.

The *Strawberry Weevil* was locally abundant, and especially in parts of Atlantic county where the injury was attributed to a saw-fly. There was no very general occurrence throughout the State, however, and no very large loss was reported. From information received and reports at hand it would seem as if in some of the more southern States an unusually heavy loss was inflicted.

A large part of the time of the entomologist was devoted to practical *tests of insecticides* and the study of the results obtained by others in actual field and orchard work. While these tests were chiefly directed toward securing a reliable remedy for the pernicious scale, the results are applicable to a much wider range of insects and will also determine the effect upon the trees and plants to which they were applied. Quite a number of the preparations tried represent commercial attempts to secure a scale killer and the indications are that these attempts will be successful. In a general way the usefulness of the lime and sulphur compounds for summer work was under consideration and, besides the Experiment Orchard, some 300 trees in the peach orchard of Mr. George O. Marsh, near Chester, were used as subjects.

Another index to the increasing interest in insecticide applications is the increase in variety of *spraying machinery*. Power

sprayers are no longer rarities and at least one of our fruit growers has two of them in service and a large "dust-sprayer" as well. Most of the makers of spray pumps now have also a power outfit and sell equipments with wagons, spray towers and everything else, complete. The city of Newark, through its Shade Tree Commission, contemplated the purchase of a spraying outfit and intrusted the matter of securing bids to me. The result showed an unexpected number and variety of machines so that choice was difficult. A distinctly useful new form is that type of machine geared from the axle to an air pump which, as the wagon moves along accumulates pressure to do the active work of spraying. This is an improvement upon the machine geared from axle directly to the pump, which stopped whenever the wagon did. Now, in driving from the yard to the orchard, sufficient pressure to spray several trees is accumulated, and this is kept up in the driving through the orchard in actual spraying work. The greatest advance in this direction is a machine in which the expansive power of liquid carbonic acid gas is employed in securing a uniform pressure.

Miscellaneous.

Two Bulletins have been issued from this Department since the date of the last Report: number 169, "Insecticides and Their Use", and number 171, "The Common Mosquitoes of New Jersey." Material is in hand for an essay on shade tree insects and some attention has been paid of late to those becoming troublesome or injurious indoors.

The work of the State Entomologist has continued along the same lines as in previous years and Mr. Edgar L. Dickerson is still assistant. During the winter I attended a meeting of the Horticultural Inspectors at Washington, D. C., where the general subjects of interest were fully discussed by representatives from all sections of the country. A full report on this work, which is of vital importance to the fruit-growing industries of the State, will be made to the State Board of Agriculture.

The mosquito investigation has been completed and the final report has been handed in for publication. It is believed that the solution of this problem in our State has been worked out, and that by patient labor, tending to convince communities of the feasibility of the plan proposed, together with some assistance from the State, the final control and practical extermination of the mosquito pest is a matter of a comparatively short time.

During the winter of 1903-'04, it was suggested by the State

FIG. 2

The Mosquito Case ; with a small part of the exhibit of Forestry Insects, at St. Louis. From a photograph.

Commissioners of the Louisiana Purchase Exposition that an exhibit illustrating the work done in the State might be interesting, and after some conferences with Colonel Lewis T. Bryant, Secretary of the Commission and Mr. Silas R. Morse, Curator of the State Museum, under whose general supervision the exhibits were to be installed, it was agreed to prepare such an illustration. The cases were built at New Brunswick by Howard V. Buttler and Co., from plans prepared by me and the work was carried on with the assistance of Mr. Edgar L. Dickerson and Mr. John A. Grossbeck, the latter of whom prepared all the large charts and drawings. The transparencies, 104 in number, were made by Mr. F. H. Dodge, of New Brunswick.

The following is a summary of the material in the collection:

Boxes or trays, containing specimens	26	
Salt marsh tray	1	
Charts illustrating mosquito life history and development of malarial parasite	12	
Transparencies of all sizes	104	
Fish specimens	83	
Fish specimens in glass vials	34	
Mosquito enemies in alcohol, specimens	87	
Mosquito enemies in glass vials	37	
Pinned specimens	613	
Mosquito specimens in alcohol	1,600	
Contained in glass vials	158	
Pinned material, specimens	1,500	
Drawings and plates, each with several figures	56	
Making a total of vials		158
Specimens, dry or in alcohol		3,183

There are also 23 vials of repellants, and 14 specimens of other material used to either kill or repel mosquitoes.

For this Exhibit a Grand Prize was awarded to the Experiment Station, under whose auspices it was made; and a Gold Medal was awarded to the writer for his work in planning and preparing it. The Exhibit was in place, practically completed on the opening day and was installed by me personally. On two other occasions during the summer I visited St. Louis for the purpose of looking after the collection, which was one of the attractions of the Forestry Fish and Game Building, in which it was installed.

In addition to the Mosquito Exhibit there was also a series of cases illustrating Forestry Insects, which had been prepared by this Department from time to time for the State Museum. That Exhibit contained as follows:

Total number of boxes in three stands	36
Number of vials with alcoholic specimens	93
Number of specimens	465
Number of adults, pinned	1,011
Number of samples of injury	98
Number of early stages, etc., dry—estimate	115

For this display a Gold Medal was awarded to the State Museum. It is matter of gratification that the work of this Department should have ranked so high at an International Exposition.

The Department further contributed to the Entomological Section of the Experiment Station Exhibit in the Educational Building, where individual contributions were combined into one comprehensive whole by Prof. C. P. Gillette of the Colorado Station, who was in charge.

The collections of the Department have been materially increased during the past year by the direct field work of the members of the staff, by the mosquito staff and, to a small extent by purchases of economic series. A summary of the material in the collection was prepared for and at the request of the President of the College, and transmitted to him. The type collections and, in fact, the entire collection of Butterflies and Moths is now housed in a small room in the Ralph Voorhees Library, beyond the danger, it is hoped, of fire and flood. While the present arrangement is a decided improvement upon previous conditions, it is not what is needed and separates the Department from a part of its collections. A fire proof building sufficiently large to house the Entomological Laboratory and its collections is one of the real necessities. It goes without saying that there would be no objection to its housing other Departments as well.

Direct relations have been maintained with all the active Entomological Societies of the Country and with the leaders among the working Entomologists. This has kept the Department abreast of the times in all respects and has enabled it to preserve a leading position in the Scientific work in Entomology.

Addresses have been given as usual before the State Agricultural and Horticultural Societies, and at Institute and County Board Meetings; bringing the work of the Department directly to the farmers and securing at the same time a knowledge of local needs that is of value in directing the course of its work.

The correspondence of the Department during the calendar year 1904 covers 2500 pages of letter books, representing upward of 3000 individual communications and excluding circular letters.

Miss Augusta E. Meske yet continues her service in the Department and adds materially to the prompt attention that it is desired shall be accorded to all correspondents.

ENTOMOLOGY IN THE CROP BULLETIN.

The Crop Bulletin for 1904 was not so rich in insect notes as usual, possibly because insects did not attract so much general attention, and perhaps because no one insect was abnormally abundant.

San Jose Scale. The first records were in the Bulletin for April 19th and referred to the San Jose Scale. This was very prevalent at Pittstown, Hunterdon county, where considerable spraying was being done. At Hightstown, in Mercer county, it was also recorded that spraying was in progress; the material being lime, sulphur and salt. At Flemington in Hunterdon county, spraying was being done and a variety of mixtures was employed. April 26th, the scale was causing no little anxiety at Newark, in Essex county. At Park Ridge in Bergen county, the prospect for all fruit, except peaches, was favorable where the trees had been sprayed to check the San Jose Scale. Thousands of trees are said to be affected. At Paterson, Passaic county, the scale was said to be very prevalent and some pear and peach trees had been killed. May 2nd, Paterson, Passaic county, reports that spraying for the scale still continued. May 24th, the San Jose Scale was reported as destructive in Sussex, Sussex county At Park Ridge, in Bergen county, many trees were said to be dead from a combination of scale and severe winter. At Kingston, in Somerset county, Japan plum trees were severely injured by the scale. May 31st, Sussex, in Sussex county, again reports the scale as destructive to pear trees. At Mount Holly in Burlington county, the scale was destructive where no spraying had been done. August 22nd, Canton, in Salem county, reports that the scale louse is increasing on fruit trees and that no spraying was done. August 30th, Moorestown, in Burlington county, states that the San Jose Scale is spreading; and that ends the record of this insect for the season. It is in some respects the longest that has appeared in the Crop Bulletin.

Tent Caterpillars. These were first reported May 10th, from Baptisttown in Hunterdon county, as numerous on apple trees. From Pittstown in the same county they were reported as generally numerous. May 31st, Baptisttown again reports the insects as still numerous. June 28th, Moorestown in Burlington county,

reports a remarkable absence of tent caterpillars, and that closes the record for this species.

Cut Worms. These were first reported as numerous May 17th, from Moorestown in Burlington county, and Woodbury in Gloucester county. May 24th, early vegetables were damaged at Clayton in Gloucester county. They were working at Millville in Cumberland county; were very numerous at Forest Grove in Gloucester county, and were again reported as injurious from Moorestown, Burlington county. May 31st, Cape May, in Cape May county, reports these insects as numerous, and Beasley Point in the same county, reports them as destructive to all kinds of melons. Forest Grove, in Gloucester county, was still suffering from these same species. June 6th, cut worms were very troublesome at Berlin in Camden county; they were destructive at Clayton, in Gloucester county; destructive to tomatoes at Marlton, in Burlington county, and very numerous at Beverley in the same county. June 14th, Trenton in Mercer county, reports them as plentiful. June 21st, Forest Grove in Cumberland county, states that they are still active; but that seems to have wound up the crop; at all events there were no later reports.

Potato Beetles. The reports concerning this insect show an interesting series of contradictions. The insects are first referred to May 31st, as numerous at Cape May, in Cape May county. June 6th, Gillette, Morris county, reports no potato bugs, and so does Rowlands Mills in Hunterdon county. June 14th, Huntsberg in Sussex county, reports no bugs; Plainfield in Union county, no bugs so far, and Trenton, in Mercer county, has nothing worse to say on the subject. June 21st Gillette, Morris county, admits a few potato bugs; at Woodbury, in Gloucester county, they were numerous and destructive; at Moorestown, in Burlington county, vines were being sprayed and dusted. July 5th, Hightstown, in Mercer county, reports no trouble from bugs; while in Woodbine, Cape May county they were numerous and destructive. July 26th, the insects had again disappeared from Gillette in Morris county, and subsequent to that there was no report.

Onion Maggots. These were first referred to as doing great injury at Bridgeton in Cumberland county May 31st. They were again referred to from the same locality June 14th, and then so far as the Bulletin is concerned, their work was done, although, as a matter of fact, this particular species was more abundant in 1904 than for many years previously.

Strawberry Weevil. This was first referred to June 6th, from Cologne, Atlantic county, as the saw fly, and it was said to be

very destructive to the crop. It was again mentioned from the same place, and the statement was added that strawberries would be a low crop because of the injury caused by this insect.

Cabbage Worms. July 19th, Bergen Point in Hudson county, reports the caterpillars more numerous than for several seasons past. August 2nd, the green cabbage worms were doing considerable injury at Phillipsburg, in Warren county. August 22nd, they were numerous at Cologne, in Atlantic county. September 6th, they were very numerous and very destructive at Rancocas, in Burlington county. September 13th, in the last Bulletin of the season, the cabbage worms are mentioned twice, once as being very destructive at South Bound Brook in Somerset county, and in almost the same terms from Moorestown, Burlington county.

Cranberry Insects. Cranberry insects are not very often mentioned in the Crop Bulletins and when they are it indicates their presence in considerable numbers. They are first referred to July 26th, from Hammonton in Atlantic county, in the statement that reporter refers to the crop as having been seriously injured by these insects. August 22nd, Mount Holly, Burlington county, charges this same insect with being one of the important factors that cause a shortening of the crop by one half.

Miscellaneous. May 31st, *Gooseberry worms* were reported as numerous from Lakeview, in Passaic county. June 14th, *Wire worms* were numerous at Trenton, in Mercer county; there were some worms on tomatoes at Beverley in Burlington county, and at Forest Grove in Gloucester county, insects were numerous and destructive. July 5th the *Hessian fly* was in wheat at Delaware, in Warren county, and on August 30th, *Grasshoppers* were very numerous and destructive at Baptisttown in Hunterdon county; unfortunately it was not stated to what crops they were destructive.

THE COTTONY MAPLE SCALE.

This species was unusually abundant during the summer of 1904 throughout most of the coast section of the State; but much more plentiful in the northern portion than toward the south. In the cities especial attention was attracted, and scarcely a day during the early summer passed without bringing some inquiries or specimens for determination. The local authorities in some of the cities and towns became interested in the matter, and began to inquire what could be done to preserve and keep clean the shade trees, of which the maples form a large percentage.

An outbreak of this kind is not at all unusual, and during the summer of 1896, we had an appearance very much like that of the past season. At that time I wrote: "In some parts of the State the Cottony Maple Scale seems to have been quite numerous and some alarm was occasioned by its occurrence; but it disappeared, as was to be expected, toward the end of the season, and the set of young where I had an opportunity to make an examination did not seem to indicate any very large increase for next year." In the Report for 1897 I wrote: "No complaints were received of the Cottony Maple Scale, which last year occurred in numbers and this is what I suggested would happen in my last Report. There was a great mortality among the young scales and few breeding females were seen where they were most abundant in 1896." From that time on the insects have again gradually increased in numbers and in almost every report there is some reference to the species from the eastern cities. The season of 1904 seems to have been the culmination of a period of increase, and judging from what has happened in the past I would expect very little, or no serious infestation for 1905.

The truth is that this insect, like all those that are constantly with us, has its periods of rise and fall. It is subject to the attacks of numerous parasites and there are a number of predatory insects that feed upon it. It is also subject to a variety of insect diseases, and these, when the insects are most numerous, find their best opportunity for spread and development. From specimens brought into the laboratory this year, we obtained a greater number of parasites than ever before in our experience, and it is fair to suppose that the material secured by us was not in any way abnormal, or was not a fair representation of that which occurred on the trees. So far as examination has been made, there seems to be no very heavy setting of young scales, and as these have yet the entire winter before them, it seems a fair conclusion that not a very large percentage of them will be in condition to develope next summer.

That this insect is subject to many destructive attacks is also indicated by the enormous number of young that it developes. Every separate aggregation of white cottony tufting represents one scale insect and this white tufting is simply an excretion of the insect itself, meant to protect the minute brown eggs, which are produced in almost incredible numbers. Every individual scale produces several thousand eggs and these remain in the cottony mass until ready to hatch. When they emerge from the eggs the young creatures have six tiny legs, and by means of these they

FIG. 3
A maple twig badly infested by the cottony scale: about natural size.
From an original photo.

make their way through the parent covering and on to twig and foliage. From the thousands upon thousands of crawling larvæ that swarm over all portion of the infested trees in early summer only a small set of young scales is derived. These young may set on either the leaves, or on the twig or new growth, and they have none of the white appearance of the parent. They are, in fact, little, oval, black or grayish scales somewhat like minute barnacles and they arrange themselves when on a leaf, by preference along the veins or ribs.

The males, which are winged, come to maturity during the latter part of the summer or early fall. The females at that time are apparently only half grown, nevertheless they are sexually mature and copulation takes place some time during September. The males then die and only the females remain attached to the tree. Those of them that may be attached to leaves make their way to the twigs, or if they do not, they fall to the ground and are lost. As a rule, however, it is the male scales that are found on the leaves and the females that are found normally attached to the twigs, so that no change of position is made necessary. Soon after the trees are in full foliage in spring, the female scales begin to increase in size. This increase in size seems meant to provide material for the enormous quantity of eggs that are to be produced. About the beginning of June the eggs are ready to be laid, and then the first appearance of the cottony or, really waxy mass, becomes obvious. The maximum size of these masses is obtained about the middle of June and about this time the earliest larvæ begin to appear. Hatching continues, however, until well along in July, and in fact, the beginning of July may be marked as the period when the young are most active. From that time on the cottony masses begin to look ragged, their function is completed and sooner or later wind and rain strip them from the trees, carrying also the dead and dried bodies of the females that have attempted to provide for future broods.

Remedial Measures.

Any attempt to deal with this insect is almost bound to result unsatisfactorily. The texture of the scale is such that it is not easily penetrated by insecticides that are safely used on foliage. When the young appear they are protected by the body of the female and by the waxy covering until they are ready to move about and to set. At that stage of their existence they are, of course, easily killed; but in order to kill off even a single brood,

it would be necessary to spray at intervals of two or three days for nearly three weeks;—a task that very few communities would care to undertake.

There is, of course, the resort to winter applications; that is, spraying during the period when the trees are dormant, with some material that will kill the female scales that are set on the twigs. The practical difficulty comes in here, that these scales are set far out at the very tips of the twigs, and at the very worst points to be reached by insecticides. To be effective the material would have to be either very caustic or very penetrating. Extremely caustic applications are barred out from their effects upon the persons that could be employed to apply them. Penetrating applications would be in the nature of petroleum or kerosene and these offer the best opportunity for successful work in cities and towns.

Where only a small number of trees is to be protected, a summer application of soap and kerosene has proved very useful when the application was made after the white tufting had become fully developed and before the young had begun to hatch. The oil penetrates the cottony masses and carries the soap with it. As the oil evaporates it leaves the soap residue to mat together the mass in which the eggs are laid so that the young will be unable to work their way out through it. The mixture to be used is the ordinary kerosene emulsion diluted with soap suds instead of clean water, the soap suds to be at the rate of one pound of any kind of hard soap in four gallons of water. The kerosene emulsion may be diluted with ten times its own bulk of soap suds prepared as just described.

Practically I do not think that it is necessary to make use of insecticides against this species. That it causes some injury when it is as abundant as it was during the season of 1904 there is no question; but the injury is really slight and such as the tree will readily outgrow in that period when the scale is not so plentiful.

THE CODLING MOTH.

This insect exacts a tax on every apple orchard in the State, no matter how well treated, and on several varieties of pear. Although in a general way the good orchardists keep the insect down by spraying, yet under the most favorable conditions for the trees some insects escape and provide for a continuation of the species. There is, in addition, the constant supply from the uncared-for trees which, often of large size, set heavily and by mid summer have strewn the ground beneath them with wormy

fruit. In the more northern parts of the State where a single brood is the rule, the careful horticulturist does not suffer so much from his negligent neighbors, but further south, where there is a partial second brood of considerable extent, mid-summer infestation is sometimes quite serious. Spraying against these second crop worms is not practiced generally, if at all, in New Jersey, and at best, is not nearly so effective as the applications against the first brood, because of the difference in habits of the insects.

Any method that will be likely to lessen the injury done by the second brood, small as it is in proportion to the first, should receive the attention of growers and I have several times called attention to the value of trap bandings to attract the full grown larvæ. This method is in universal use in European countries and is about the only measure in general use. For some reason, however, the recommendation has not been favorably received nor generally acted upon. But the Messrs. Repp, of Glassboro, did act upon it with excellent results, and their experience has led several others with orchards of considerable size to follow. For this reason it seems advisable to describe the method in some detail and to explain how it acts.

The larva of the Codling Moth, or apple worm, when just hatched, makes its way to the blossom end of a young apple, then usually of hazel nut size or thereabouts, and after a little feeding on the outer surface, bores into the fruit to the core, working around the seed capsule. Spraying with a proper arsenite at the proper time, lodges a coating of poison in the calyx cup where the insect does its first feeding, and kills it before the apple is entered. After it has entered the fruit, the insect is beyond the reach of insecticides and becomes full fed about mid-summer, whether the apple remains on the tree or drops to the ground—provided the drop has not been before the insect became half grown.

When full growth is attained, the larva or "worm" leaves the apple and hunts a hiding place for its further development. Usually, but not necessarily, that hiding place is on the tree itself, under a loose bark scale on trunk or branch. A thin cocoon or covering of whitish silk is spun around it, and there the larva lies unchanged, until the following spring in a one-brood region, or for a week or two only, where two broods develope. Then comes the change to the pupal stage, which lasts only a few days before the adults emerge. If they are mid-summer adults, the larvæ or "worms from the eggs laid by them enter the apples or pears at almost any point; but by preference either at the calyx end or where two apples touch. These larvæ mature in early September,

leave the apples and seek hiding places in which to pass the winter.

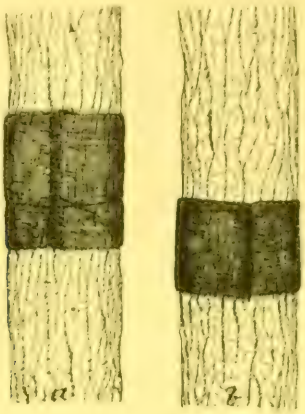

Fig. 4. How to put on a Codling Moth band; a, band as tied to trunk; b, when folded over. Original.

The trap method simply takes into account this tendency to seek a hiding place, and supplies it in the form of a band of some kind around the trunk of the tree. The simplest form is a mere bundle of straw which may be removed and burnt in mid-summer or at the end of the season, as the case may require. A better method and that which is recommended, is a banding of burlap, applied as shown at figures 4 *a* and *b*. The burlap bands may be new or may be made of fertilizer or other bags provided only there is no repellant odor remaining. The burlap should be cut into strips about 10 inches or a foot wide and wound on a roll. For each tree cut off a piece long enough to completely encircle the trunk and lap two inches or, in the case of a large tree, a little more. Tie flat against the tree trunk about breast high, with soft twine, about two or three inches above the bottom of the band (fig. 4 a). Then turn down the upper part of the band so as to cover the string and all below it, and there will be a very attractive, partly doubled petticoat around the trunk, that will be selected as a place for pupation by practically all the larvæ that get on it. A band prepared and put on in that way can be examined in all its parts without much trouble and, after killing what may be beneath it, restored to its original position.

The banding should be in place as soon after the middle of June as possible, and in those places where there is one brood only, no

attention is needed until fall. Then, any time after the crop is off, the bands may be removed and either burnt with all their contents, or boiled long enough to kill all "worms" that they may harbor. In the former case it means a new set of bands next year; in the letter, the cleaning and sorting out for convenient use the following season.

In those localities where there is a second brood some of the bands should be examined every five or six days until caterpillars are noticed beneath them. Thereafter all the bands should be examined once every week, at least, and all larvæ or pupæ found beneath them should be killed. As every female moth is responsible for 50 or more eggs, meaning nearly that many wormy apples, and as, even in well sprayed orchards from ten to a dozen of the caterpillars are sometimes found under one band, the direct benefits of this method are obvious.

Accessory Measures.

This banding process is not intended to be a substitute for early spraying. Under present conditions there are so many chances for successful hibernation of apple worms, that the protection given by a proper application of an arsenical poison cannot be dispensed with. The banding method will pay best as an accessory in a well sprayed orchard and will tend to greatly lessen the number of infested fruits that the imperfections of our spraying methods seem to render inevitable.

Yet another method that should be more regarded is the systematic disposal of dropped fruits. Where hogs or sheep cannot be utilized to dispose of them, they should be picked up as often as possible, and utterly destroyed in some way. The number of curculios developing in dropped apples is legion, and so long as these insects are allowed to multiply, practically unchecked, there will be imperfections in the fruits, due to their punctures. Plowing or cultivating under does no good, since that is exactly where the curculio larva wants to get, and will get of its own accord, if left to itself. But the mass of apples, if not used, might be buried beneath at least a foot of soil, with a good chance of preventing the emergence of many specimens. I am quite aware that the labor problem enters into the acceptance of this recommendation; but it is an important one, nevertheless.

CRANBERRY INSECTS.

An unusual amount of complaint was received from cranberry growers of injury done by the yellow-head caterpillars. It appears that on most bogs the water was drawn at the usual time and reflowing to kill off insects was also done by date, rather than according to the condition of the insects on the bogs. The continuous cold of the water seems to have had the effect of retarding the movements of the hibernating moths and they did not become active until much later than usual. The result was, that there seemed to be no hurry about oviposition, and eggs were not laid until the water had been drawn from the bogs. Some eggs were laid along the edges where the reflowing was not complete and on portions of the bogs where highland left vines above the surface. The consequence was that even the first brood became noticeable, while the second, which appeared just about the time that the vines were setting fruit, spread over a very large extent of territory and completely wiped out some of the bogs. An estimate of fifty per cent. of fruit destroyed was made by a grower whose crop ordinarily runs into the thousands of bushels and almost everywhere some injury was done. Curiously enough the *Rhopobota*, or black-head caterpillar, was almost entirely absent.

After some discussion at the meeting of the Cranberry Growers' Association, and after visiting some of the bogs in the Pemberton district it was decided to carry on a series of experiments which will tend to fix the hatching point for insects of this character when covered by water. A great many bogs are very uneven and in the deeper portions are fully a week behind the upper parts of the bog in starting after the water has been drawn off. Where a grower depends upon late holding, it becomes important that he should know the temperature which must be reached by the water before he can hope to destroy the insects on the vines.

Grasshoppers were again complained of; but the evidence is no more decisive as to the injury done than it has been in previous years. However, it might be well in this connection to call attention to the fact that in Canada and in some sections of the northwestern United States, where grasshoppers are often very destructive it has been found that they have an abnormal fondness for horse manure, they will readily leave green succulent plants to feed upon it. Taking advantage of this, the farmers have made a mixture of horse manure and Paris green and spread it in

the fields where grasshoppers are abundant. The results have been wonderful; in some cases millions of the insects being killed and crops protected. As the grasshoppers which appear on the cranbery bogs are near relatives to those which are destructive in the north, it might be worth while to try this mixture. In the reports of Dr. James Fletcher, Entomologist to the Canadian Department of Agriculture, the Criddle mixture is especially recommended and in the Report for 1903, Mr. Criddle himself states that "it was found that one pound of Paris green could be mixed with five patent pails* of horse droppings with absolute success. Weaker mixtures were not quite so successful." He adds further that the insects feed most in hot weather and that when the mixture is put out during cold wet weather it is not so attractive. Furthermore, the insects in the early stages prefer the mixture moist and he recommends spreading a little every other day in the morning rather than a large quantity at one time. This remedy is easily prepared and is inexpensive; therefore it might be worth trying on those bogs where grasshoppers are most abundant and where the damage charged against these insects is most marked.

Incidentally, and as confirming the results obtained in New Jersey with the Locust Fungus, the Canadian experimenters report equally ill success. It is another illustration of the fact that local insect control very frequently depends upon local conditions, which cannot be duplicated in other places, even though some of the factors can be reproduced.

THE ASIATIC LADY-BIRD BEETLE.

In the reports for the years 1902 and 1903, I made record of what efforts had been made to colonize this insect in New Jersey and in the report for 1903 I gave as complete a life history of the insect as was available, with illustrations made for the U. S. Department of Agriculture, and kindly loaned through the Entomological Division.

*A "patent pail" holds 3 gallons.

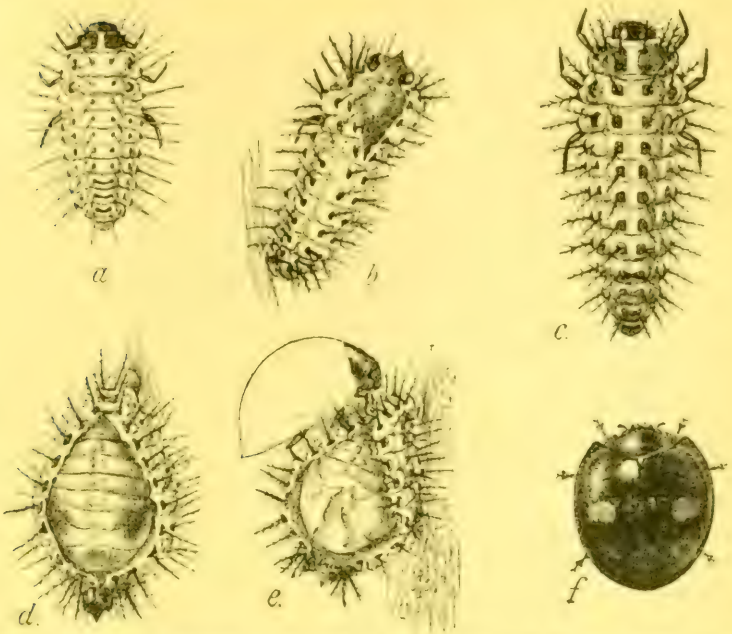

Fig. 5. Chilocorus similis: a, second larval stage; b, its cast skin; c, full grown larva; d, pupa as its appears in the split larval skin; e, adult just emerged; f, fully colored adult; all enlarged to same scale. From Marlatt, U. S. Dept. Agl.

I gave also a list of 15 localities to which beetles were sent so as to get them to as many different places as possible in the hope of finding some one point especially favorable to their development or to their survival.

Nearly all the parties to whom the beetles were sent have reported to me personally or by letter, and in most of the localities either Mr. Dickerson, assistant to the State Entomologist, or myself, have made personal search for the insects. In no case is there any evidence that even a single example survived. In two cases the reports were apparently favorable; but in both, on investigation the insects found proved to be our native *Chilocorus bivulnerus*, the twice-stabbed lady bird beetle, which, by the bye was locally quite abundant. In the case of Mr. B. F. Maul, at Greenwich, which I investigated personally, the conditions would have been considered almost ideal for the survival of the beetles.

There was a plum orchard with plenty of infestation, yet for the most part in good condition; rather closely planted, in close proximity to plenty of shelter along fences and buildings. At

the time I visited the place not much was to be seen of Coccinellids in any stage; but Mr. Maul informed me that earlier they had been much more abundant; a statement borne out by the number of cast larval and pupal skins that were found. Close examination of these cast skins showed, however, that it was not the introduced Asiatic species but the native form that had been present.

In most of the places spraying had been done during the winter; but not in all and no difference was observed so far as prevalence of Coccinellids is concerned between the sprayed and the unsprayed orchards. Indeed, there is no reason why there should have been any, especially where the lime and sulphur mixtures were used. The lady-birds hibernate as adult beetles, not necessarily on the trees, or, if on the trees, then under such shelter as would protect them from anything save, possibly, an oil spray. There was, unfortunately, in every case plenty of food left for any hibernating beetles and even for a good brood of larvæ; indeed the natives developed under these conditions.

The winter conditions were very severe, the temperature being low for a much longer period continuously than usual in our State, though the thermometer did not go as law as it has done in my experience. Nevertheless the weather was severe enough to harm many trees and shrubs and it may be responsible for the apparently complete disappearance of the species.

In my report for 1903 the following paragraphs are found:

"In Georgia, conditions seem to be much more favorable, for the colony there, introduced at the same time that I received specimens in New Jersey, has now multiplied enormously. Mr. Marlatt writes on this point as follows:

"The rather successful Georgia colony, to which I referred in my letter to you of the 3rd of July, was visited by Mr. Kotinsky and Mr. Scott a little later, and found to be in the most flourishing condition. They estimated that in this orchard of some 17,000 trees there was upwards of 30,000 or 40,000 beetles, these creatures having spread all over the orchard. Adjacent to this orchard is a much larger one, belonging to the same person, of 250,000 trees, also infested by the scale, into which the beetle will soon migrate or be carried. Furthermore, a good many colonies have been sent out locally from this one, and in one or two instances it seems to have gone to adjacent orchards of itself."

"If, as is to be expected, these insects hibernate well in Georgia, it will be my effort to secure a goodly supply early in the season

of 1904, that they may have a chance to spread in some of our own orchards during the summer."

Pursuant to this suggestion I secured a promise of co-operation from the State Entomologist of Georgia and quite early in the season wrote to Mr. Wilmon Newell, asking whether arrangements could be made for a continuing supply during the summer. To my surprise the report was that the insects had not done well and that the office could not undertake the long journeys necessary to secure material. One sending was made, however, and then it was decided to investigate personally.

Investigations Made in Georgia.

Atlanta was reached July 18th, and Mr. Wilmon Newell, the State Entomologist, was good enough to call on me and arrange for such a trip as would bring all the factors under direct observation.

To Mr. Newell thanks are due for devoting nearly an entire week to me, guiding me to just those localities of importance and introducing me to just those persons from whom information could be obtained. In no other way could I have covered so much territory in so short a time and secured the same amount of information. The objects to be attained were to ascertain the conditions under which the Asiatic beetles had been placed originally; how they had flourished and the reasons for their apparent disappearance, if possible.

Throughout that part of Central Georgia covered in this trip the pernicious scale occurs more or less abundantly. In some places considerable injury has been caused; but in most instances the growers have it in fairly good control. The point has been reached, indeed, when the owners of these orchards of from 10,000 to half a million or more trees must count upon the scale as a constant factor to be dealt with each year. There is every indication that they have learnt how to do it and on that point my Georgia experience will be again referred to under another head.

Tuesday, July 19th, reached Fort Valley and found Mr. W. M. Scott, formerly State Entomologist of Georgia, but now with the U. S. Department of Agriculture. Mr. Scott had been in the District for several weeks and from his observations the beetle seemed not only to be disappearing; but that it had done no perceptible good even in those places where it was most abundant in 1903. It seemed to resolve itself into a question whether the

trees were to be sacrificed in the hope of saving the lady bird, or whether the trees should be treated to save them, at the risk of destroying the insect. The decision was usually in favor of spraying and whether from this or because of the severe winter the insects had practically disappeared. On this point of temperature and severity of winter weather, it should be said that while the winter was severe and the temperature low for Central Georgia, it was mild and the temperature high compared with even a moderate winter in New Jersey. If the Georgian winter of 1903-'04 was really in fault, there can be little reasonable hope of establishing the insect in New Jersey.

On Wednesday the 20th, after a visit to the Hale Orchards, Mr. Newell and myself made a careful examination of the Wright Orchard where in 1903, *Chilocorous similis* had flourished. For over an hour we looked over tree after tree where the insects had been most abundant without finding even a single specimen in any stage. There were plenty of infested trees and, while the orchard had evidently been sprayed, the work had been carelessly done and there was an abundance of food for many hundreds of beetles and their larvæ.

The next point was the Fernoyd orchard which had been colonized in 1903, and where Mr. Scott had found some specimens in May, 1904. We had been advised of the exact point where the insects had been seen and after some search we found a few adults and later 11 larvæ and 9 pupæ, all of which were sent into New Jersey and duly received later. This portion of the orchard was at the edge of a grove of tall trees and near a packing shed or cabin which possibly furnished shelter for the insects during the winter. At all events no specimens were found elsewhere in the orchard. Quite a variation was observed in the larvæ, some examples having a transverse banding almost as marked as in *bivulnerus*.

From such information as could be obtained it appears that the insects were then less abundant than they had been in May and there seemed no doubt that, as a factor in scale control at Fort Valley, they could not be considered. This seemed to be the general opinion and I could not learn of any one at all inclined to rely upon the work of this insect for freedom from scale attack.

On the evening of the 20th, went by train to Marshallville, 8 or 9 miles south of Fort Valley, and on Thursday, July 21st, visited the Rumph Orchard where the original colony obtained from Washington was first introduced. This is a very large orchard, covering several hundred acres and containing many

thousands of trees. We found the original cage where the insects had been confined, and the trees upon which they had been first found at large in 1903. According to the story, hundreds of specimens could be found on single trees during the summer of 1903, and a great many colonies were sent out. Almost anywhere in the orchard specimens could be found without difficulty and it really seemed as if the beetles had made themselves at home. Nevertheless, in spite of this increase in the number of

Fig. 6. **Chilocorus similis: a,** beetle thrusting egg under a scale; **b,** scale raised to show edge of egg beneath it; **c,** scale lifted, to show egg under it; **d,** scale from beneath, showing egg; **e,** egg; **f,** three eggs under a flap of bark; **g,** same natural size; **h, i,** newly hatched larvae; **j,** same, feeding on scales; all save **g,** much enlarged. From Marlatt, U. S. Dept. Agl.

beetles, the scale had increased even faster and so serious was the infestation by the end of 1903, that the owner sprayed with lime, sulphur and tar. The spraying was quite effective, though there was yet plenty of living scale and a new crop coming on. Here we spent a considerable time in close search, taking tree after tree and selecting especially bad examples for closer scrutiny; but not a single specimen did we find of any stage. The insects had absolutely and completely disappeared from a place where, last

year, they occurred in almost countless numbers. It seems incredible that the spraying done should have been so thorough as to kill off these insects completely and yet leave plenty of scale uninjured.

Walked from the Rumph to the Willingham Orchard, a small plantation for that part of Georgia, and found a plum orchard quite badly infested by a white scale, *Pulvinaria amygdali.* Into this orchard the beetles had been introduced from the Rumph Orchard in 1903, and had increased abundantly. The orchard had been sprayed, but not effectively and there was plenty of living and moving pernicious scale. Here we found *similis* in all stages, larvæ, pupæ and adults; but on only a few trees and feeding only on the white scale; the pernicious scale was apparently untouched. Remained at this place until noon and in that time collected about 80 specimens which we divided into four colonies; two of them for New Jersey and two of them for Florida, where Mr. Newell is trying to establish the species in a yet warmer climate, hoping to bring later generations north if they multiply. On the best tree we found 25 specimens in all stages; but most of them had none at all and few had more than a single specimen.

On these trees, Mr. Scott and Mr. Kotinsky of the Entomological Division at Washington found the native *Chilocorus bivulnerus* in swarms in May and with them a very few *C. similis.* Some colonies of these mixed species were collected and sent out, while Mr. Kotinsky carried one colony with him and liberated the specimens at Dublin a day or two later.

It is worthy of note that the *C. bivulnerus* has in Georgia similar habits to those that I noted in New Jersey, viz., there is a brood in spring and then the beetles disappear until fall. In our week's collecting only one *C. bivulnerus* was taken, and that Mr. Newell found on a sunflower at Marshallville.

The plum orchard in which these collections were made is on a hillside and most of the trees on which specimens were actually found were pretty well down and along a water course which was dry at the time. There seemed to be nothing in this position that reasonably accounted for the survival of the insects; yet they were not found elsewhere.

By way of Macon and Hawkinsville, we reached Dublin, Friday, July 22nd, and called at the home of Col. John M. Stubbs to secure permission to investigate his home orchard. This consisted of about 100 plum trees of selected varieties, all infested by scale, some of them dead or dying, and on these we found specimens of *Chilocorus similis,* mostly in the adult stage. In two

hours we secured two colonies, one for New Jersey and one for Florida. At that time, near the middle of the day the beetles were on the undersides of the leaves and it was difficult to see them since they choose the denser and most sheltered parts of the tree. Mr. Newell asserted that they were more active in the early morning and late afternoon and that then they could be found on the trunks and branches. To test this we went to the orchard again after 4 p. m., after a heavy downpour of rain which lasted from about 1:30 to 3:30 p. m. There was intermittent rain until nearly 6 o'clock and during the time that we were among the trees we collected two additional colonies. There was a little difference in the habits of the species and more of them were on the branches, actively feeding. On one tree which we had collected over very thoroughly in the morning, intending to strip it, we found as many more examples in the afternoon. One other colony was secured early on the morning of Saturday, July 23rd. These plum trees had all been sprayed with the lime, salt and sulphur wash, during the previous winter, and already, on July 4th and 5th, Mr. Newell had collected two colonies from the same trees. This would seem to indicate that the beetles might live over in spite of spraying; but unfortunately there is another suggestion.

Mr. Kotinsky asserts positively that he examined every tree in this lot in May and found no trace of *C. similis* in any stage. Thereupon he liberated in the orchard the colony of mixed *C. bivulnerus* and *similis* that he had collected at Marshallville. The suggestion is, of course, that the specimens taken by Mr. Newell and myself were descendants of this liberated colony in the second generation, a matter which cannot be disproved for the contention that spraying does not necessarily kill the Coccinellids.

Saturday evening we were back in Atlanta, whence I started for New Jersey next day. During the trip as a whole, Mr. Newell and myself gathered in the four different places visited about 200 specimens in all stages of what seemed to be, certainly, *C. similis*. Rather more than half of these went to New Jersey and the remainder to Florida.

Of other predatory insects feeding on the scales the little *Pentilia* occurred sparingly; but Mr. Newell claims that it is much more common in the northern part of the State. From the practical standpoint it is no more effective than the species of *Chilocorus*.

The net results of the investigation made is that the *Chilocorus similis* in Georgia has done no better than it has in New Jersey.

FIG. 7.

View in the DuBois Orchard, in which the Chilocorus similis have been placed. From an original photo.

It has survived the winter in some places; but not in all, even where no effective spraying was done. Even at its best in 1903, where thousands of the beetles occurred, they did not keep the scale in such check as to make it safe to allow the trees to go unsprayed. It is unfortunate, perhaps, that the insects were not given a chance to live over in an absolutely unsprayed orchard, for the only possible chance of effectual work comes in when the hibernating beetles and the first brood of larvæ can feed on the hibernating scales before reproduction begins. Every scale eaten in April or early May means a breeder gone and an enormous reduction of the late summer broods.

It seems impossible that in New Jersey this Asiatic lady bird, *Chilocorus similis* can ever reach a point where it will be able to control the pernicious scale; yet if the insect can be established it will help in those cases where Osage Orange and other hedges are infested or plants outside of cultivated orchards become sources of danger.

On my way north I stopped over at Washington long enough to learn that their outdoor colony was almost completely wiped out. Fully 60 per cent. of the broods in 1903 were parasitized, the severe winter killed off most of the others and what remained was being cultivated in the laboratory.

Such experiments as were made in our laboratory are recorded by Mr. Dickerson who also gives a statement concerning the disposition made of the specimens sent into New Jersey.

The outcome of this year's work is unexpectedly bad and offers no encouragement to the hope that this particular species will ever be of any economic value as an aid in controlling the pernicious scale.

CHILOCORUS SIMILIS AT NEW BRUNSWICK.

Specimens of this insect, mostly in the adult stage, were received from Georgia in four different lots which reached New Brunswick Friday, July 8th, Friday, July 22nd, Saturday, July 23rd, and Tuesday, July 26th. In each instance the insects were well supplied with food, arrived in good condition, and were apparently healthy, with the exception of a very few pupæ of the second lot.

A few of the specimens, mostly pupæ, were retained in the laboratory in order to ascertain whether they would mature and reproduce; but the majority were consigned to an infested fruit farm within a short distance of New Brunswick. This farm

formerly contained a large number of fruit trees of various kinds, but within the last few years it has become so badly infested with San Jose Scale that at the present time many of the trees are dead or dying. The apple trees on which the *Chilorocus* were placed, although more or less infested, are in such a condition that they will probably last for a year or two longer and so afford an opportunity for the insects to get foothold at least.

The first sending of the insects which arrived July 8th, contained 13 beetles and 2 of these evidently had reached the adult stage en route as there were two pupa skins in the box when it arrived. All the specimens of this lot were taken to the fruit farm and placed on an apple tree badly infested with the scale in all stages of development, including a multitude of crawling larvæ. Numerous specimens of the small black beetle, *Pentilia misella*, and its larva were also observed on this tree. The *Chilocorus* were placed on adjoining limbs so that they would have the best opportunity for mating, and several days afterward a person, living on the farm, reported having seen the beetles on some of the fruit on this tree.

The next sendings of *Chilocorus* came July 22nd and 23rd, That of July 22nd contained 4 larvæ, 5 pupæ and 1 beetle, while that of July 23rd contained 7 larvæ, 12 pupæ and 70 odd beetles. These sendings also were taken to the infested fruit trees and seven scaly apple trees in the vicinity of the tree on which the beetles of July 8th were placed, received 9 beetles and 4 larvæ, 12 beetles, 10 beetles and 2 larvæ, 10 beetles, 9 beetles and 3 larvæ, 12 beetles and 6 beetles and 2 larvæ respectively, making a total of 68 beetles and 11 larvæ placed on the trees on which also numerous specimens of *Pentilia misella* in various stages were observed. The remaining insects consisting of 15 or 16 pupæ and a few adults were placed in a jar with some badly infested plum twigs in the laboratory.

Tuesday, July 29th, the last sending, consisting of 12 beetles and 2 pupæ, was received and these insects were all kept at the laboratory and placed in another jar. At intervals of a few days fresh supplies of food, consisting of fruit and twigs infested with scale, were placed in the jars and the old twigs were taken out and examined to ascertain whether oviposition had taken place and to what extent the beetles had been feeding. On Wednesday, August 10th, when the jars were cleaned out and a fresh supply of food was added, there were 18 beetles in one jar and 10 in the other, and on August 18th there were still 14 beetles active in one jar and 10 in the other.

On this same day an examination was made of the infested trees on which the insects had been placed July 8th and 25th. On the tree receiving the insects July 8th about a dozen full grown larvæ and pupæ in groups of twos and threes were observed on the underside of leaves in close proximity, so that the insects were about to complete a generation after having been on the tree forty days. A few beetles were also observed on the trees on which they had been placed July 25th and doubtless there were many more which escaped observation, as they are easily overlooked. Thus the insects up to this date had developed to some extent at least and the effect of their feeding on the scales could be seen in several spots.

The material in the jars was again examined carefully August 30th, and this time the examination was rewarded by the finding of eggs, very young larvæ and the remains of the eggs from which they had emerged. These, however, were not allowed to develop; but preserved for future reference. Thus oviposition had taken place and development started within a little over a month after the beetles had been received and placed in the jars. The eggs were concealed, in the characteristic manner of this insect, under old scales from which the scale insects had been removed and probably devoured. All the eggs, however, had not been observed and September 26th, when the jars were again examined, there were 10 beetles and 2 partly grown larvæ in one jar and 7 beetles, and 2 partly grown larvæ in the other in apparently good condition. The beetles were taken to the infested trees and placed on a scaly limb. At this time a few pupæ and beetles were observed on the trees on which the insects had previously been placed and *Pentilia misella* were as abundant as ever. The *Chilocorus* larvæ remained in an apparently healthy condition for several days when they were killed and preserved for future reference and thus the supply of *Chilocorus* at the laboratory was exhausted.

How the insects upon the infested trees will pass the winter and, if successful in that, whether they will develope further next season can be determined only by future examination.

THE CHINESE MANTIS, TENODERA SINENSIS, IN NEW JERSEY.

The Chinese Mantis, *Tenodera sinensis*, made its appearance near Philadelphia in 1898, and since then has increased and become established in that locality. During the early part of 1901 an effort was made to establish it in New Jersey, and, as told in

the report for that year, 150 egg masses were received from Philadelphia through Mr. Philip Laurent, who also supplied them on succeeding occasions. These were distributed in the vicinity of Glassboro, Riverton, Moorestown, Burlington, Cologne and in the experiment orchard at New Brunswick. As a result of the placing of these egg masses insects were observed at none of the places except New Brunswick where several immature and two mature specimens were seen the following summer and several egg masses the following winter. A male also was found early in October of the same year in a nursery at Elizabeth where it had probably been received with nursery stock either in the egg stage or as an immature insect.

Another lot of egg masses was received from Philadelphia in April, 1902, and as stated in the report for that year they were distributed near Mount Holly, Hightstown, Arlington and Newark. At all these places adults were observed later in the season, and in October several male and female specimens, the descendants of last year's insects, were seen in the experiment orchard at New Brunswick. A few egg masses also were placed at Fort Lee early in the season and later it was reported that part of these had hatched.

During the winter of 1902-'03 egg masses from introductions made the previous spring were observed in Burlington, Gloucester and Atlantic counties and also at New Brunswick, so that it was evident that the insect was becoming established in some localities, although apparently not spreading to any extent. Nevertheless, to increase the chances of success, another consignment of egg masses was secured and distributed in February, 1903, in lots of 30 masses each. These were placed in the vicinity of Mount Holly, Palmyra, Cologne, Woodruff, Eatontown, Woodbine, Glassboro, Moorestown and on the College Farm near New Brunswick. Those sent to Woodcliffe were not used until the insects had hatched and then the insects themselves were well distributed. From the first three named places reports were received later in the season that partly grown specimens of the insect had been observed. Thirty-five egg masses were also distributed in favorable situations along the road between South Orange and Hemlock Falls, making a total of about 350 egg masses distributed during that year.

No egg masses were distributed during the present year, but early in the spring an examination was made* of the locality in the vicinity of South Orange where they had been placed a year

* By Mr. E. L. Dickerson who has prepared this record.

Fold-out Placeholder

This fold-out is being digitized, and will be inserted at a future date.

previous and a single egg mass was found. This was taken to the laboratory to determine its condition, but as nothing emerged the eggs apparently were dead and this proved to be the case upon examination. The killing may have been due to the severe winter and if that was the case it is probable that many of the egg masses in other localities suffered similarly and this would mean that the establishment and distribution of this insect in the State had received a check.

In all, the egg masses have been distributed in seventeen different localities, four of which received them for two years. This has given a variety of conditions and situations under which the insect might develope and become a fixture.

RECORD OF EXPERIMENTS MADE IN THE MARSH ORCHARD.

Early in 1904, I arranged with one of my assistants in the mosquito investigation, Mr. Harold O. Marsh, for a series of experiments with Insecticides, to be carried on in the peach orchard of his father, Mr. George O. Marsh, near Chester, Morris county. I had seen the orchard personally and knew it to be badly infested with scale; so badly that a considerable number of trees were already dead or dying, and others had considerable dead wood. The trees had passed the winter fairly well and there was some fruit prospect, but altogether, conditions were such that if radical measures were not adopted, the orchard was doomed. As Mr. Marsh had not intended to adopt these active measures himself, and as my experimental work promised at least a measure of relief he assented readily to my request.

The outfit for the first experimental applications consisted of a Gould Bucket Pump with additional lengths of hose and a bamboo spraying rod; but this was almost immediately replaced by a Deming "Gardener's Choice" outfit, consisting of a half barrel tank on a pair of iron wheels, moved by a hollow iron handle. The pump was mounted on the tank over the iron support, and altogether this proved a very practical outfit for sloping orchard work, on trees not over 15 feet high in any case. We had Vermorel, Mistry and Bordeaux nozzles, but the Vermorel was chiefly used. Additional lengths of hose brought the amount up to 20 feet, and the bamboo spray rod supplied for the bucket pump was transferred to this outfit.

The actual spraying was done, first by Mr. E. L. Dickerson, my assistant as State Entomologist with Harold O. Marsh at the pump, and afterward by Harold with such assistance as could be

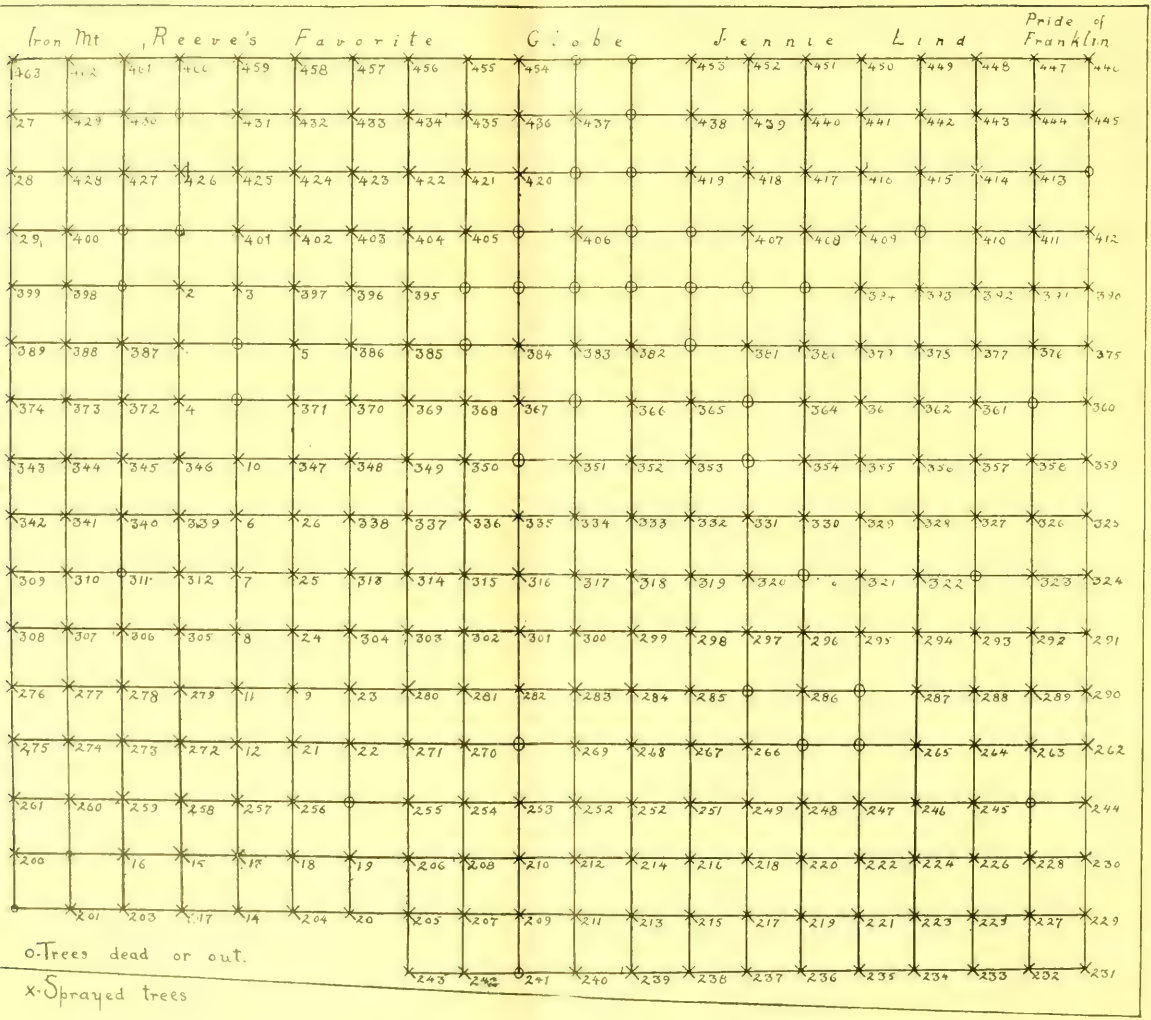

FIG. 8
Diagram of the Marshl Orchard, showing arrangement and varieties.

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FIG. 9
The Spraying Outfit in the Marsh orchard. From an original photo.

Salt, or "Con-Sol." Use at the rate of 1 to 50, experimentally on 1 tree, and examine 24 hours later. If no material injury appears, prepare 50 gallons of the mixture and spray as many trees as may be thoroughly covered with it.

It will be noticed that the object here is to test the lime and sulphur preparations as summer washes, and peach foliage, being least resistant, furnishes the best subject.

Pursuant to instructions, trees Nos. 1, 2 and 3 were sprayed with the Potassium sulphide 1 pound in 5 gallons of water. Trees 4, 5 and 10, were sprayed with the same, 1 pound in 3 gallons of water. Trees 6, 7 and 8 were sprayed with the Potassium sulphide and lime as directed in Experiment 3. Tree 9 was sprayed as a test with the sulphite of soda, 1 pound in 5 gallons of water, on June 18th, and on June 20th, additional trees 13, 14, 15 and 16 were sprayed. Tree 12 was sprayed as a test with the sulphide of soda and lime under Experiment 5, June 18th, and on the 20th, additional trees 17 and 18 were sprayed. Tree 11 was sprayed with the "Con Sol," 1 to 50, June 18th, and on the 20th, additional trees 19, 20, 21, 22, 23 and 24 were sprayed. The number of treated trees was less than directed in some cases; but good reasons existed for the departure from instructions.

Experiments 1, 2 and 4 were not afterward duplicated, hence they can be finally recorded at this point. In all cases the trees had a few small dead twigs and branches. No crawling larvæ were observed on the 18th, but there were many examples beneath the adult scales, ready to emerge. A few young were observed on the 19th, and not until the 20th was there any general movement.

Experiment 1—Potassium 1 pound. water 5 gallons; a simple solution; applied to trees 1, 2 and 3, June 18th. Trees 1 and 2 were fully covered until everything looked wet; tree 3 was sprayed to a drip. Afternoon warm and the trees dried rapidly, having a washed appearance and a slightly bluish tint.

June 19th, the leaves at the centre of the tree had a scalded appearance; June 20th, the damage to the foliage was more apparent, while no decided effect was noticeable on the scales. July 3rd, most of the old leaves had dropped and new foliage was developing at the tips of the twigs. On tree 3, the tender shoots at the center of the tree, where the drenching was most complete, were partly killed. The variety was Reeves Favorite. As to the scales, there had been, undoubtedly, a thinning out; but active larvæ and recent sets were found on each tree in considerable abundance. July 16th, the scalded foliage had disappeared, the

new foliage was more abundant and so were the recent scale sets. As a whole the trees looked a little better than before. July 30th, except for the thin foliage, confined mainly to the outer portion of the trees, no abnormality was obvious. The scales had increased steadily in number and all stages from active larvæ to breeders were well represented. August 13th, something had happened; the older scales were mostly dead, the recent sets were not so numerous as before; and the moving larvæ were very scarce.

But from this point the insects made a new start and on September 7th it was decided to respray with the "Con. Sol", 1 part to water 40 parts. Even this application, at winter strength did not check the increase and, when I saw them, October 3rd, the trees were in an extremely bad condition with scale simply swarming everywhere. The proportion of scales killed in the first application had not been sufficiently large to prevent complete re-infestation before mid-summer. The apparent check in August could not be credited to the June application, all traces of which had long since disappeared. The severe effect on the foliage would have reacted upon the fruit had there been any.

EXPERIMENT 2—Potassium sulphide 1 pound, in water 3 gallons; a simple solution; applied to trees 4, 5 and 10, all Reeves Favorite, June 18th, under the same conditions as in Experiment 1.

June 19th and 20th progressive scalding of the leaves was noted, and on July 3rd, the trees were almost completely defoliated; only a little start being made from the tips. Part of the young shoots in the center of the tree were killed. As to the effect on the scale; a large percentage had been killed, without doubt; but there were yet a fair number of living adults, a number of new sets and also some crawling larvæ. July 16th, the trees were slowly recovering from the shock and the scale situation had improved, materially; most of the older sets examined seemed to be dead, and the number of young had been materially reduced. July 30th, there had been no material change and that was also the record August 13th. September 7th, there had been sufficient increase to warrant spraying with the "Con-Sol," but this helped nothing and, October 3rd, when I saw the trees, there had been an enormous increase, every tree swarming with larvæ and recent sets.

The effectiveness of this application cannot be reasonably doubted; but the foliage suffered so severely that it cannot be recommended. It was not, in any event, sufficiently active to bring the scale down to such a point that the trees could be safely

left to themselves until the end of the season. The fearful increase in September completely re-coated the trees and left them in as bad a condition as they had been before.

EXPERIMENT 4—Sodium sulphite 1 pound, water 5 gallons; a simple solution; applied on tree 9, Reeves Favorite, June 18th. The application was thorough, to test effect on foliage, etc. The tree had a few smaller twigs and branches dead, was very scaly, without active larvæ, but plenty of young beneath the parent scales, ready to move. When dry the tree presented a washed appearance, but no discoloration. Next day there was no trace of injury to the foliage and, on June 20th, no adverse appearance having developed, trees 13, 14, 15 and 16, of the same variety and in the same general condition as 9, were carefully covered with the same solution. At that time the scale on tree 9 seemed to be as little affected as the tree itself. July 3rd, when all the trees were examined, no effect was noticeable on foliage or scales; the soda was harmless to both. No better results developed on future examinations and the trees became rapidly worse—in no respects different from those entirely untreated.

The second set of applications was made July 1st to 4th, inclusive, under the following directions:

EXPERIMENT 7—Use the concentrated solution ("Con-Sol") 1 to 50, on one row or block, including all the varieties in the orchard, even if it is necessary to spray an isolated tree in a row separated from the others. It is estimated that 45 to 50 trees can be sprayed with that amount of solution.

EXPERIMENT 8—Potassium sulphide, 1 pound; lime, 2 pounds; water, 5 gallons. Prepare as before and make up 50 gallons; estimated to spray about 50 trees.

EXPERIMENT 9—Sodium sulphite, 1 pound; lime, 2 pounds; water, 5 gallons. Prepare as before and make up enough to spray 50 trees.

EXPERIMENT 10—Make up the lime, soda and sulphur mixture, according to formula on page 14 of Bulletin No. 169; but double the amount of water. Try this experimentally to see whether it injures foliage. If no harm is done after 48 hours, spray 50 trees. If injury is apparent, abandon the wash.

Assuming that the last named mixture cannot be used and that the trees yet unsprayed are badly covered with crawling larvæ, spray with the mixture referred to in either Experiment 8 or 9; whichever appears to have been most effective.

EXPERIMENT 11—Test the two Dreer mixtures. One part to 25, by weight: i. e., 1 ounce by weight of the material in 25

ounces by measure of water. Spray only one tree with each, to test effects on foliage.

The "Dreer Mixtures" were two small samples in a pasty condition of lime and sulphur combinations with certain additions to add to the effect. They were primarily intended for winter application, but I decided to give them a summer test as a preliminary. It was intended, should they prove satisfactorily effective, to put them on the market.

It will be noted, also, that the amount of lime in the combination with the Potassium and Sodium is much reduced. This was done to make spraying easier and clogging of the nozzles less likely.

Pursuant to these instruction, trees number 302 to 355 inclusive were sprayed July 2nd, with the "Con-Sol"; trees 200 to 249 inclusive were sprayed July 1st, with the Potassium and lime combination; trees 250 to 301 inclusive, were sprayed, July 1st and 2nd, with the Sodium sulphite and lime combination; trees 25 and 26 were sprayed, July 1st, (as a test) and trees 356 to 376 inclusive July 4th, with the lime, soda and sulphur combination; trees 28 and 29 were sprayed July 2nd, with the Dreer Mixture No. 1, and tree 27 was sprayed with the Dreer Mixture No. 2 July 2nd.

Examinations were made of the treated trees July 16th and 30th and again August 13th. On the July examinations notes were made on the individual trees in each series of tests, but no further examinations were made. August 13th the following points were looked to, under instructions:

1. Make notes on each group of trees, as was done in the last series.
2. Note the numbers of all trees that are very badly infested, and their general character, i. e., whether very large, straggling, rough-barked, etc.
3. Note the numbers of all trees that are very slightly infested and their general characters as in No. 2.
4. Note whether the sprayed trees as a whole are better than those unsprayed, in color of foliage, etc.
5. Note any apparent difference in color of foliage as between the different groups of applications.
6. Spray any of the experiment trees that demand it, with the "Con-Sol," 1 to 40.

The general result was, that taking the orchard as a whole, it had a yellowish, sickly appearance without apparent sections indicating sprayed trees. On closer comparison the color of the foliage was no better on the sprayed trees, while the leaves were

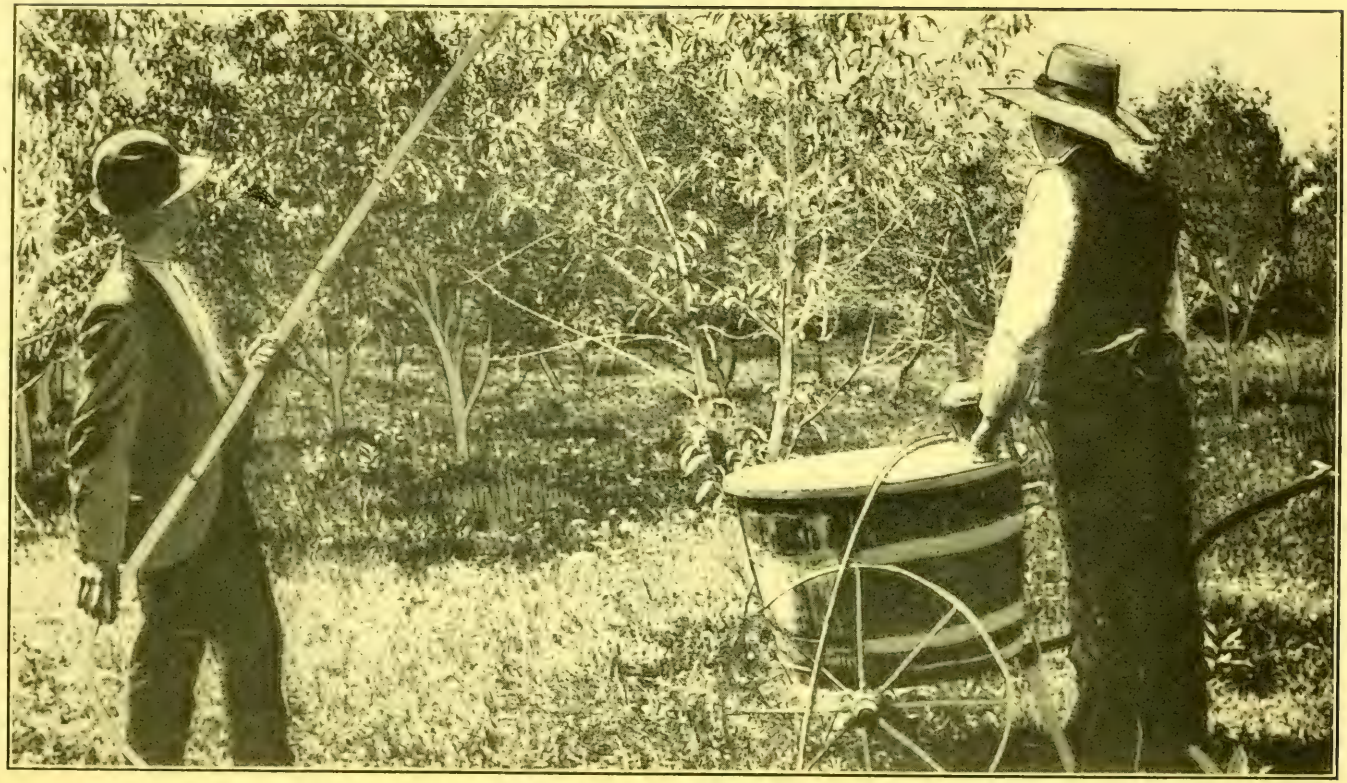

FIG. 10
Spraying with potassium sulphide and lime in the Marsh orchard. From an original photo.

somewhat ragged and mottled compared with those that had not been treated. The only other difference was that on most of the sprayed trees the foliage was thinner, indicating injury caused by the applications.

There were scales on the older leaves of almost all the trees, and large, plump scales on most of the new growth, both sprayed and unsprayed.

As between the treated trees, the foliage on group 200 to 249 (Potassium, sulphide and lime) was a little thinner than normal, a little ragged, and somewhat mottled. The foliage on group 250 to 301 (Sodium sulphite and lime) was a little ragged, but otherwise nearly normal. The foliage on group 302 to 355 ("Con-Sol" .1 to 50) was somewhat mottled and showed a little scalding. The foliage on group 356 to 376 (lime, soda and sulphur) was a little thin and ragged, but hardly apparent. The foliage on group 377 to 390 ("Con-Sol", 1 to 40) was well mottled and more ragged than on any of the other groups.

In the order of apparent effectiveness as against the scale, the materials ranked: Lime, Sulphur and Caustic Soda; Potassium Sulphide and Lime, with little to choose between them; "Con. Sol", 1 to 50; "Con. Sol", 1 to 40; Sulphide of Soda and Lime. That the "Con. Sol.", 1 to 40, was apparently less effective than the weaker mixture may be due, in part to the fact that the treatment was made later, when the trees were more infested.

August 16th, trees 250 to 301 (Sulphide of Soda and Lime) were sprayed with "Con. Sol.", 1 to 40, as were the test trees 3, 9, 12 and 13. Trees 391 to 463 were sprayed for the first time with the same combination.

September 1st, the following instructions were prepared:

1. Examine the trees as on the previous visit, to determine the relative effectiveness of the mixtures used.

2. Determine what trees need re-spraying and spray with the "Con. Sol.," 1 to 40.

3. Examine the trees sprayed at the last visit and note the effect of the work on the insects and on the trees.

4. Are there any trees that could be safely allowed to go into the winter without further treatment?

The replies are as follows:

1. The mixtures rank in effectiveness: 1, Potassium sulphide and lime; 2, "Con. Sol.," 1 to 50; 3, and nearly equal to 2, lime, sulphur and caustic soda; 4, sulphite of soda and lime, resprayed with "Con. Sol.," 1 to 40;

5. "Con. Sol," 1 to 40; 6, remainder of orchard, sprayed August 16th with "Con. Sol.," 1 to 40, is much the worst of the lot.

2. Everything really needs respraying and all the trees except those sprayed August 16th were actually re-sprayed with the "Con. Sol," 1 to 40. In all 164 trees were sprayed and 175 gallons of the mixture were used.

3. Trees 391 to 463, first sprayed at last visit, have the foliage mottled and show quite a little burning. There were a few dead scales on the trees; but heaps of living ones. There is a general and heavy scattering of white sets and crawling larvae—more of the latter than of the former. Trees 250 to 301, re-sprayed August 16th, have the foliage very distinctly mottled and somewhat scalded. There were a great many dead scales on the trees; but also plenty of living ones. There is a general and rather dense scattering of larvae and recent sets.

4. The cleanest trees in the orchard are 1, 2, 3, 4, 5 and 10 and group 200 to 249 (potassium sulphide); but if the scales now on the trees are allowed to continue the trees are sure to be well infested.

Matters were left then, until I saw the orchard October 2nd, and of a surety it was a case for prompt action if the trees were to be saved. There were differences, of course, and some groups of trees were not so bad as others; but all were so bad that unless the trees could be relieved from the burden of insects then infesting them, they would probably never put out again. I do not wish to suggest that no good had been accomplished by the applications made. On the contrary, I doubt whether any tree would have been alive without them. Only it demonstrated clearly that so far as peach is concerned, the lime and sulphur combinations are not to be relied upon for summer work.

I had a small supply of "Kill-O-Scale," a petroleum preparation elsewhere referred to, and that I sent up at once and had it applied 1 to 20, October 11 and 13th. The record of the trees then sprayed is missing if one was ever made; but the report October 21st is clear.

"Although there are millions of dead scales on these trees there are still quite a good many living females and under a good part of these are newly born larvæ. There is also a very thin scattering of white sets and more or less dead ones. There are not many crawling larvæ on the trees and judging from the number under the females there probably were many more which have been washed off by the rain. Fully half and may be more of the older sets are dead; and the foliage is a little mottled. There is no difference between those sprayed on the 11th and those sprayed on the 13th."

October 24th, P. M. "There are still a few live females with larvæ under them on these trees. There are also a few older sets:

but it seems that a larger proportion of them are dead than I thought when I examined them on the 21st. There are no crawling larvæ or live white sets."

October 22nd, with a new supply of material, another spraying was made with "Kill-O-Scale", 1 part, to water 20 parts, and 106 gallons of mixture were applied to 134 trees, representing practically all those trees that were in such condition as to be worth the saving. At this time Mr. Marsh eliminated all those trees that were so badly injured as to be practically worthless, or which would have to be cut back to the branches to make a new growth. Only those were retained which were yet sound enough to mature the fruit set indicated by the developing buds. Of the lot sprayed October 11th, fourteen trees were left as a check to determine whether two sprayings would be more effective than one, and whether any injury would develope on fruit buds. In view of the spreading quality of the material and the fine mist in which it was applied, it will be seen that the treatment amounted to a drench.

October 31st, the final examination was made and Harold O. Marsh reports: "There are practically no live scales on these trees except for an occasional adult or older set. One of the adults had newly born larvæ beneath it. The trees have a darker appearance than those unsprayed and some of the branches are gray with dead scales. A very few, if any at all, of the fruit buds are injured. There are quite a few more live scales on the 14 check trees in the last two rows, which were not resprayed with "Kill-O-Scale", than on those which were resprayed. The fruit buds are the same as on those resprayed."*

It may be noted here that all scales that begin breeding in fall, die during that same fall and no females that once begin to reproduce, survive the winter. That accounts for these occasional late females that continue to bear young long after there is any chance for the latter to reach the hibernating condition. Those young that are born after the sap ceases to circulate and the foliage drops, never reach a stage that will enable them to resist the winter. The larvæ noted on the 31st of October have absolutely no chance of surviving. Those that do survive are of the lot that set during the latter part of September or even a little before, reach the half grown stage and then, covered by a dense black scale, become dormant.

Taking up in somewhat greater detail the individual experiments, I have already reported on the simple solutions of Potassium sulphide, and Sodium sulphite, and the results have shown

*In April 1905 scarcely a live scale could be found and not a fruit bud had been harmed.

that the applications of the former were very effective while those of the latter were ineffective. The addition of lime changed results somewhat.

EXPERIMENT 3—Potassium sulphide 1 pound; lime, 5 pounds; water, 5 gallons; prepared as already written (p. 588).

June 18th, sprayed trees 6, 7 and 8, Reeves Favorite, 6 being covered throughout, while 7 and 8 were sprayed so as to avoid hitting foliage more than absolutely necessary, while reaching all of last year's and older wood. The trees were all badly infested, scale ready to reproduce, but no young actually on the move. The material combined readily, was yellowish in color when applied, and left an almost white coating on the tree when dry. June 19th and 20th, the trees appeared as if coated with whitewash, and it seemed as if the lime was in excess for best results. There was no appearance of injury to foliage; but the material seemed to exercise a drying-out effect.

July 3rd, a part of the lime coating had been washed away; there was a little defoliation and the scale covering was very dry, partly uplifted, exposing the generally dark and watery-looking insects beneath. There were very few larvæ or recent sets; but more on trees 7 and 8 than on 6; probably due to the difference in the methods of application.

July 16th, the trees were much alike as to scale infestation, all with a general scattering of larvæ and recent sets and a sprinkling of older specimens. On tree 6 the foliage was a little ragged, evidently as the result of the treatment, while on the others there was no appearance of harm. On the 30th, there was little change in condition of either tree or scales. August 13th there appeared to be a decided improvement in scale conditions. There were very few larvæ or recent sets, while of the earlier settings by far the larger part was dead and dry. But this seemed to mark the limit of effectiveness because, from that point the scale took a new start and, on September 6th, larvæ and new sets were so abundant that the trees were re-sprayed with the "Con. Sol.", 1 part, to water 40 parts, and became part of the general orchard.

In its beneficial effect this was about equal to the simple solution of Potassium sulphide, the addition of the lime serving to prevent injury to foliage.

EXPERIMENT 8—Potassium sulphide, 1 pound; lime, 2 pounds; water, 5 gallons; prepared as before. The difference between this and the previous mixture is in the amount of lime. It was applied July 1st, by Messrs. Marsh and Dickerson, to trees 200 to 249 inclusive, taking in all the varieties in the orchard. At that

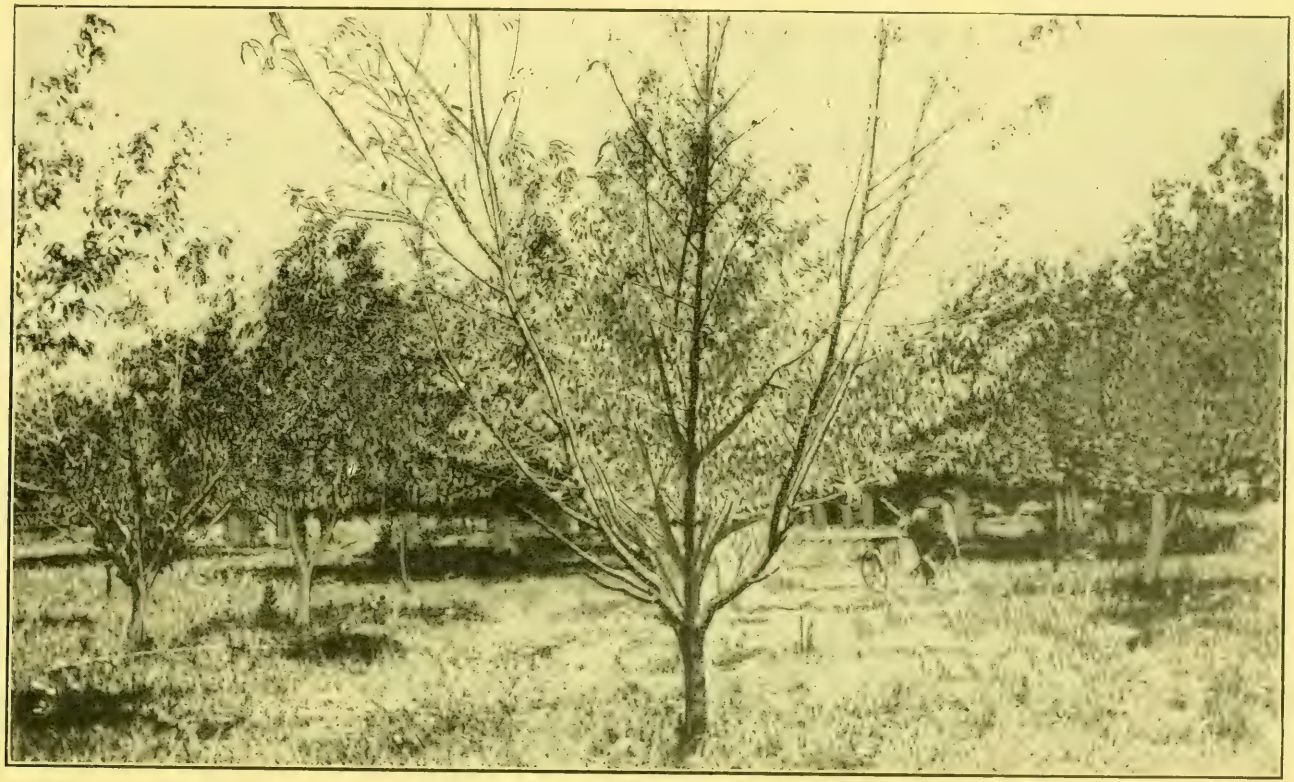

FIG. 11

Effect of potassium sulphide without lime, 1 lb. in 3 gallons of water ; Marsh orchard. From an original photo.

time larvæ were active on all trees, plenty of recent sets were in evidence and there was already, quite an appearance of half grown black individuals. The exact amounts were as follows: "Used 14 pounds of lime, 7 pounds of Potassium sulphide, and 35 gallons of water. Slacked the lime in 4 or 5 gallons of water, then while still warm added the sulphide dissolved in 2 gallons of water. This mixed well and nearly all the lime was taken up; but there was a slight settling and the mixture gave a dark orange red color." The trees at first sprayed—8 in number—dried out white, perhaps because the excess of lime settled rapidly; most of the others dried out to a bluish tint. July 5th, all the trees showed some injury to foliage; but in a general way the less lime was apparent, the greater was the burning effect; in no case was it very bad, however.

July 16th the record for these trees was very good. Only a few trees showed any larvæ or recent sets; dead adults with dead larvæ beneath them were numerous, and in a general way it appeared as if there had been a killing off that was almost complete. On all varieties the foliage had been somewhat scalded and some leaves had dropped; but in no case was the tree injured, nor had there been any unfavorable effect on the fruit. July 30th the record was still good; but active larvæ and recent sets were now found in small numbers, on all the trees: evidently the survivors of the first brood were beginning to reproduce. August 13th while there had been some increase in the scale, the trees were among the best in the orchard and the application was ranked in effectiveness next to the lime, sulphur and caustic soda, with little to choose between them. The foliage, at that time was noted as being a little thinner than normal, a little ragged and somewhat mottled, but otherwise natural.

September 2nd, this series was first in order of condition, though much worse than at the previous examination. According to the reports there were quite a number of breeding adults; many large plump specimens on the new growth and at the bases of the leaves, and some of these were reproducing or were ready to do so. There was also a general, though rather thin scattering of white sets and active larvæ. Altogether matters were not considered satisfactory and, on September 6th, all these trees were sprayed with the "Con. Sol", 1 part, to water 40 parts, and the experiment was closed.

Taking all these applications of Potassium sulphide together, the conclusion is that the mixture last used can be effectively employed on peach trees in summer, with little danger of injury to the foliage or fruit, and good effect as against the scale. The

best period for the application is when the first brood is in full swing and the trees are covered with larvæ and recent sets. The indication is, further, that well advanced young under black scales are little affected and will begin to reproduce when little or none of the material remains on the tree. In early September re-infestation will be well under way, and a second application will be necessary so this had better be deferred to the 20th or thereabouts for a maximum effect. The cost of the sulphide is 25 cents per pound, making 5 gallons of mixture; a cost for materials, including lime of about 6 cents per gallon. At the rate of 1 gallon per tree, which is fair for trees five or six years old and normal form, two applications will cost 12 cents per tree, exclusive of labor. At the end of the season there will be scales enough remaining to re-infest and make identical treatment necessary the year following.

Experiment 5—Sulphite of soda, 1 pound; lime, 5 pounds; water, 5 gallons; made up as directed, and applied June 18th to tree 12, a Reeves Favorite peach. This was to test the effect on the foliage and, after it dried the tree had a dirty, somewhat orange white appearance. June 20th, the whole tree was thoroughly coated with the material and none of the leaves showed any trace of injury. Trees 17 and 18 were therefore treated as before, and thoroughly coated. When examined July 3rd, the trees, including foliage, were still coated and apparently uninjured. There were plenty of active larvæ and recent sets on all the trees; but, for some reason fewer on tree 17 than on either of the others. July 18th conditions had not changed much either way, except that there were a few more recent sets and some of the earlier sets had attained the nearly grown black stage. This was also the report on the 30th of that month, the scale seeming to be almost dormant. August 13th the conditions had changed and there was a full set of scales from the first brood, ready to reproduce. Tree 12, indeed, was in such condition that it was deemed best to re-spray, August 16th, with the "Con. Sol.", 1 part, to water 40 parts. Trees 17 and 18 were allowed to stand until September 2nd, when they received a treatment of the same kind and this experiment ended.

Experiment 9—Sodium sulphite, 1 pound; lime, 2 pounds; water 5 gallons; prepared as directed and applied July 1st and 2nd, to trees 250 to 301 inclusive. The materials combined well, but there was a little settling, leaving a cloudy, watery solution on top, which became limey on stirring. When dry the trees had a

dirty white appearance with a slight orange tinge. A very slight burning was noted on some foliage July 5th.

The report on July 16th was good on the whole, indicating a wholesale killing of scale, with a decided remnant of black sets of the first brood. A very slight scalding of the foliage was noted; but not enough to be regarded as an injury to the trees. July 31st matters were not much worse, although an abundance of nearly mature sets was noted. These began reproducing in early August and, on the 13th of that month, the trees were in worse condition than any others in the orchard. It was therefore decided to respray the group, which was done on August 16th with the "Con. Sol.", 1 part, to water 40 parts.

This closed the series in which Sulphite of soda was used as a base; that material having failed to produce any good results in any used combination.

EXPERIMENT 12—The "Dreer Mixtures" were both used July 2nd at the rate of 1 part in 25 parts of water. No. 1 mixture dissolved easily, but had some sediment which it was necessary to strain out before using. Sprayed trees 28 and 29, which, when dried, had a slightly bluish appearance. Examined July 5th, there were no moving larvæ on either tree; but beyond that no effect could be noticed on the scales. The foliage seemed uninjured. July 16th, there were not so many recent sets, but plenty of the older forms. The leaves had turned a reddish brown color and many had dropped off. July 30th, quite a marked difference was recorded as between the trees; on No. 28 there were only a few scales in any stage; on No. 29 there were a great many in all stages. On both, the foliage was very ragged. The same difference in scale conditions was noted August 13th, but afterward both rapidly became worse and were sprayed, September 7th, with the "Con. Sol.", 1 part, to water 40 parts.

Mixture No. 2, dissolved with difficulty and, indeed, was left in soak for 12 hours before it was deemed fit to use. There was some coarser sediment which it was necessary to strain out before using. One tree only, No. 27 was sprayed and this could not be distinguished when dry from those treated with the first mixture. July 5th, there had been no apparent effects on the scales, nor had the foliage been injured. July 16th there were plenty of living scales of all stages and the foliage had become mottled, discolored and lifeless. July 30th, the recent infestation was very obvious and the earlier sets were, in general, nearly ready to reproduce. August 16th, matters were still worse and on September 7th, sprayed with the "Con. Sol.", 1 part, to water 40 parts, closing the experiment.

Neither of these materials produced the least good result and no further trials were deemed desirable.

EXPERIMENT 10—Lime, sulphur and caustic soda made up as described in Bulletin No. 169 at page 14, but with just double the quantity of water; a half strength. The test application was made July 1, on trees 25 and 26 on which there was an abundance of active larvæ and recent sets. Examined July 3rd and 4th, and finding no notable injury, sprayed trees 356 to 376 inclusive. Next day trees 356 to 362 and 371 to 376 were very white, the others were not so contrasting and, in all cases, the young scales seemed to have been wiped out. The foliage had been a little scalded on some trees, but not generally nor to an injurious extent. July 16th a very few larvæ and recent sets were seen on trees 25 and 26, but most of the older scale was dead. The foliage was discolored and mottled but none had dropped. On trees 356 to 376, very few living scales were found in any stage. Larvæ had been killed under the parent scales and very few could be found active on the tree. The foliage was generally discolored or mottled and, on some trees, near the centre, the leaves were badly burnt and had dropped. July 30th, the foliage on many trees was a little ragged, but on the whole was not noticeably bad. There was a general though rather thin scattering of white sets and crawling larvæ, probably from scales that were nearly mature before the application was made. Tree No. 360 was exceptionally bad, being already well covered with very recent sets and moving larvæ.

August 13th, conditions were not much worse, and the trees treated with this mixture were ranked as the best in the orchard. The foliage was more noticeably ragged than before; but the scale situation seemed to have improved. September 2nd, this group had dropped to the third rank, though a close rival of the "Con. Sol." There were many breeding scales now on trunk and branches, and a few plump adults on the new growth. There was a general scattering of white sets and moving larvæ and on the whole it was deemed unwise to allow the trees to go longer. September 7th, sprayed with "Con. Sol.", 1 part, to water 40 parts, and closed this experiment.

Judging by the effect on the foliage, the danger limit was reached in the strength of the mixture and, while reducing the amount of water would probably add materially to the killing power of this combination, it would be likely, also, to make it unsafe to use on peach trees at least. It is posible that an application made two or three days earlier might have been more suc-

cessful. The insects that escaped were those early sets that had almost reached the adult stage and were sealed under a black scale at its toughest condition. There was almost a complete destruction of larvæ and recent sets, and a standstill period until the survivors of the first brood began to reproduce generally. It might have been safe to duplicate the application instead of using the "Con. Sol.", but on the other hand, the danger was that foliage already weakened by the first application might succumb to the second. The effect was almost as good as that produced by the Potassium sulphide and lime, and the injury to foliage was less. The cost of the material is not nearly so great, and it may be that on trees with more resistant foliage it has a field in summer work. At all events this point is worth a further test.

EXPERIMENT 6—"Con. Sol.", a concentrated solution of lime, sulphur and salt, combined so as to make a liquid that is stable so long as it is kept from contact with the air. It was put out as a winter mixture to be applied at the rate of 1 part of the solution in 50 parts of water. I received it too late for winter work and decided to at least attempt its use as a summer spray at the full recommended strength. I had used a little in the experiment orchard but not under such circumstances as to enable me to determine its effectiveness. June 18th, the mixture of a deep orange red color, 1 to 50, was thoroughly sprayed on tree 11. A few of the smaller twigs and branches of the tree were dead; but otherwise it was in rather good condition though very scaly. The scales were ready to reproduce but no larvæ had as yet actually emerged from beneath the female covering. June 20th, as there was no apparent injury on the tests, sprayed trees 19 to 24 inclusive with the material at the same strength. July 3rd, when these trees were again examined, very few larvæ or recent sets were seen and the great majority of all the older scales was dead. The foliage at that time was very slightly burnt.

Having determined with reasonable certainty that the mixture 1 to 50 could be safely used on peach, trees 302 to 355 were thoroughly sprayed July 2nd. On the 5th the trees had a washed appearance and were somewhat darker in color than normal, while the foliage appeared altogether unaffected. As a whole, the larvæ and recent sets had been pretty well cleaned off except on trees 302, 318 and 354; where, however, the larvæ at least were not very active.

July 18th, tree 11 had only a very few live insects in any stage and an unaffected foliage. Trees 19 to 24 varied somewhat, all of them had some moving larvæ and recent sets, but some more

than others and the greatest variation occurred in the relative proportion of the well advanced black scales; survivors of the first brood. Trees 302 to 355 had a general, though in most places rather thin scattering of white scales and crawling larvæ. There was no preceptible injury to foliage.

Some correspondence having been had with the makers of the mixture and a new and supposedly stronger solution received, sprayed trees Nos. 377 to 390 inclusive, with the "Con. Sol." at the rate of 1 part to 40 parts of water. In other words a mixture which the makers said was stronger, less diluted than that previously applied.

July 30th, trees 11 and 19 to 24 were a little worse infested than before, the individual trees remaining dissimilar in the amount of infestation. As to trees 302 to 355, the report is that there are a number of live adults and a general, in some places a rather thick scattering of larvæ and white sets. Trees 377 to 390, only recently sprayed, had the leaves slightly mottled and somewhat burned, indicating a more caustic mixture than before; but on the other hand while a great many insects had undoubtedly been killed, there was yet a general if rather thin scattering of larvæ and recently set scales on all trees.

August 13th, the "Con. Sol.", 1 to 50, stood third in rank of effectiveness and the same 1 to 40 stood fourth. Tree 11, which was the first one treated was the best of all, and had only a few scales in any stage. Series 19 to 24 were not much worse than at last reports, but there seemed less difference between them. In the series 302 to 355 also, conditions had remained practically unchanged, but the report now indicated a great number of specimens approaching maturity and which would shortly begin to reproduce. Trees 377 to 390 were the worst of this series; more scaly than those sprayed with the weaker solution and more ragged in foliage.

Series 250 to 301 had by this time reached a dangerous condition, and to check further development were sprayed with the "Con. Sol." 1 to 40. Trees 391 to 463, which had not been heretofore sprayed at all, also received a dose of the same kind.

September 2nd, 6th and 7th all applications previous to those made August 16th, were re-inforced by a spray of "Con. Sol." 1 to 40, including series 302 to 355, which had previously received the same material, at the rate of 1 to 50.

The net result a month later, when I saw the orchard, was that not a tree was in fit condition to go into the winter safely. The total effect of all the applications being a bare maintainance of a

FIG. 12
Trees sprayed with potassium sulphite and lime. Marsh orchard. From an original photo.

level; i. e., the trees, all of which had had at least one application of "Con. Sol." of winter strength, were quite as badly infested as they were in spring and would, left to themselves, have become very much worse.

I cannot, as a result of these applications, look with confidence for good results from winter work with this combination.

RECORD OF THE EXPERIMENT ORCHARD.

General Notes.

The work in the orchard during the past season was chiefly to test the various insecticides that were either recommended or advised; both on the insects against which they were applied, and on the trees. All the applications were made with a Leggett compressed air pump through a Vermorel nozzle except where otherwise stated.

Work began March 9th, on a clear, bright, sunny day, temperature 36° at 8.15 A. M. Material used, caustic soda, 97°-98°, at the rate of 1¼ pounds in 2 gallons of water. Two lilac bushes were first sprayed; one of them very badly, one moderately infested. Aside from these, trees 4, 6, 22, 23, 26, 33, 34, 39 and 41 were sprayed. Details will be found under the tree numbers where also the effects of the application are noted. Next day all the sprayed trees were blue, some quite decidely so, some with only a bluish tinge but the universal and even occurrence of the shade testified to the thoroughness of the application.

March 10th, applied the "Universal Insecticide and Scale Killer", which is a chemical combination of lime and sulphur with some other materials added to enhance effects. The day was bright, clear and cold. There were ten gallons of the "killer" and to these one gallon of hot water was added. Trees sprayed were 1, 2, 7, 8, 9, 16, 17, 22, 30, 31, 38, 44 and 46. A bluish white deposit formed on the bark when the material was dry.

Beginning March 11th, came a stormy period; first rain, then with a drop of the temperature a coating of ice on the trees; a day of sunshine; a heavy snow; a thaw; a freeze and all that other variety of weather characteristic of the second half of March.

April 5th was a clear, warm spring day and in the afternoon sprayed trees 15, 16, 18, 19, 21 and 23 with "Salimene", 1 pound to 1 gallon of water.

April 15th sprayed tree No. 46 from one side very thoroughly with a concentrated lime, sulphur and salt mixture, the "Con-Sol" of the American Horticulture Distributing Co. The sample was diluted with 40 parts of water as per direction and the appli-

cation was a drench to see whether on a single tree the effectiveness of an application could be determined by the difference between the sprayed and the unsprayed sides.

June 18th examined the trees casually and found crawling larvæ or recent sets only on trees 8, 38 and 40. Made up two solutions of caustic soda (97°-98°) to test its effect on foliage; the first at the rate of 1 pound in 4 gallons of water, the other at the rate of 1 pound in 8 gallons of water. With the stronger mixture sprayed trees 17 and 39, covering all foliage as well as the wood to the base of the ground; on tree 40 sprayed one branch only. With the weaker mixture sprayed tree 36 completely and certain branches on trees 8 and 33. In addition sprayed two raspberry bushes with the stronger solution and one arm of a grape vine with the weaker. Used the "Utica Blizzard Sprayer" for these applications, and found that it required more work to obtain the desired result than any other piece of apparatus it was ever my ill fortune to get hold of.

June 19th made a closer examination as to scale conditions and found some on almost every tree with groups of larvæ beneath them, ready to emerge, but there were few that were actually moving. The sprayed foliage was twice examined during the day. On the raspberries more than half the leaf tissue was actually killed with probability of further extension; on the grape foliage the weaker mixture had done little apparent injury. On tree 8 the leaves on the sprayed portion were distinctly spotted as were also the soft shoots. On tree 33 both foliage and fruit were badly spotted, but there was no apparent harm to the shoots. On tree 36, both foliage and shoots were badly spotted and some of the leaves and tips are entirely killed. All the above were treated with the weaker solution.

Of those to which the stronger solution was applied tree 17 had the foliage badly spotted and some of the tips killed. Some of the tender shoots were also black spotted, but, on the whole, the injury was less than had been anticipated. On tree 39 the leaves were dry and brown around the edges, but it was impossible to estimate the full extent of the injury. On tree 40 the sprayed foliage was black spotted and some of the tips were killed; yet the damage was not really serious.

June 30th, Trees 2, 18, 21, 30 and 38 were thoroughly, and tree 1 partly sprayed with "Pyrol Tree and Plant Spray", 1 part to 40 of water, using the "Mistry" nozzle. The weather was fine when the spraying was done, but a shower came up in the evening and it rained more or less during the night.

July 5th, tried the "Horticultural Compound", a soap material and applied at the rate of 2 ounces in 1 gallon of water to the entire grape row to test its effect on leaf hoppers. Thereafter trees 18, 19 and 21 were sprayed, using 5 gallons on the three trees—a perfect drench. The general effect seemed to be good and, on the 8th, sprayed trees 1, 2, 7, 8, 15, 20, 23, 24, 26, 30 and 31 with the same material at the same strength.

July 13th, sprayed trees 16, 29, 34 and 47 with Rose-leaf tobacco extract, 1 pound in 5 gallons of water.

August 19th, sprayed trees 1, 2, 7, 18, 24, 30 and 38 with the Horticultural Compound at the strength of 2 ounces in 1 gallon of water. A heavy rain began that evening and continued through the night so, on the 29th, another spraying seemed indicated and trees 1, 2, 7, 18, 19, 21, 23, 24, 26, 30 and 38 were again treated with the same mixture.

September 16th, trees 18, 19 and 21 were sprayed with equal parts of soluble petroleum and water, tree 18 not so thoroughly as the others and next day most of the scales seemed to have been cleaned out. This application was made with one of the large atomizers sold for garden use.

September 26th, sprayed trees 24 and 26 with 1 part soluble crude petroleum to 4 parts of water, with an atomizer.

October 14th, trees 1, 8, 17, 30, 32, 33, 38, 39, 42 and 47 were sprayed with Kill-O-Scale at the rate of 1 part to 20 of water. October 19th, sprayed trees 7, 23, 34 and 44, with the same mixture.

It will be noted that four winter and six summer mixtures were used and from the fact that the same trees were sprayed again and again it will be concluded that none of them were especially effective—and that conclusion would accord with the facts. Nevertheless, there was quite a difference in results and, in any case, no trees were killed by scale.

The severe winter affected the trees badly, and the peach trees especially, which went into the winter with a heavy setting of fruit buds came out poorly. There were not a dozen blossoms all told and not half a dozen fruits. Incidentally it may be said that some of the lilacs were injured and that my privet hedge was killed nearly to the ground.

The specific record is as follows:

TREE 1—*Mariana Plum.* March 10th, sprayed with the "Universal Insecticide and Scale Killer" and applied a drenching dose from all sides so as to reach all save extreme tips.

Leaf buds began to start April 17, blossom buds began to ap-

pear on the 26th. First blossoms open May 7th, in full bloom May 10th, petals began to drop on the 11th and on the 17th the tree was entirely out of bloom. May 27th there was a scant set of fruit compared with the amount of bloom.

June 27th the tree looked sick; some of the branches were dying at the tips and the foliage was not vigorous in appearance. Cut out the dead and dying wood. Very little fruit left and most of that was stung by the Curculio. There was scale throughout the tree, more on the branches than on the trunk and some parts pretty well covered. There were a few crawling larvæ, quite a number of recent sets and a large number of females with groups of larvæ beneath the scale. The winter application had been completely ineffective.

June 30th sprayed with Pyrol tree and plant spray 1 part to water 40 parts; covering thoroughly from the house side, but leaving the fence side unsprayed. Some injury to foliage developed and early in July quite a number of leaves toward the center of the tree appeared to be badly burned. At the same time there were live scales in plenty and especially toward the house there was a pretty coating, with crawling larvæ and new sets pretty well scattered.

July 8th sprayed with the horticultural compound 2 ounces in 1 gallon of water, covering thoroughly from all sides. This seemed to have a rather good effect for larvæ and recent sets became much less plentiful and continued so until after the middle of August when there was again so general a movement and setting on the tree that it was resprayed, August 19th, with the same compound at the same strength as before. Rain came almost immediately and very little effect was noted on the 25th; so, on August 29th, another similar application was made. This seemed to kill off the moving larvæ and some of the recent sets, but in a few days matters seemed about as bad as ever. The tree was left to itself however, becoming ever more infested until October 15th when it was sprayed with Kill-O-Scale, at the rate of 1 part to 20 of water.

October 20th, very few live adults were found on the tree. All the larvæ and white sets and nearly all the black sets were dead. There was a very slight burning of the leaves and the tree looked and smelt about like those treated with the soluble petroleum.

November 2nd, the foliage was about half gone; what remained was somewhat spotted and traces of the oil were everywhere visible on the trunks and branches. There were no larvæ and no recent sets and wherever examinations were made the insects

seemed to be dead. Where the scale scurf is thickest it now comes off in soaked flakes and this last has been, without doubt, the most effective application of the year. There is little doubt, however, that there are yet enough living scales well out on the twigs to provide for a brood in 1905, unless winter applications are made.

TREE 2—*Yellow Transparent Apple.* March 10th, sprayed thoroughly with the "Universal Insecticide and Scale Killer", covering evenly to the tips of the twigs.

April 26th, buds began to start; May 10th, first blossom clusters open; May 17th, was in full leaf and petals began to drop. The tree made a fair set of fruit which dropped during early June until, on the 28th, only 20 nicely developing apples were left. These were all taken off to prevent raids into the garden. At that time the tree was in at least fair condition, but there was scale everywhere. Not so many larvæ as recent sets and breeding females. Obviously the March application had been practically ineffective.

June 30th, sprayed thoroughly with the Pyrol tree and plant spray, 1 part to water 40 parts, and gave a thorough coating. July 8th, there were as many larvæ as before, and plenty of new sets. Very little if any benefit had been derived from the Pyrol, and an application of the Horticultural Compound, 2 ounces in 1 gallon of water, was made.

July 13th, conditions had improved. There were fewer larvæ, very few recent sets and much of the scale throughout the tree seemed dead and dry. Conditions remained fair until well along in August, when another brood began maturing and reproducing so as to give a sprinkling of white sets all over the tree. On the 19th it was again sprayed with the horticultural compound as before. Rain soon after the application seemed to lessen its effectiveness and, a few days later, matters were almost or quite as bad as before.

August 29th, made a third spraying of the compound of the same strength as before, and again there was some reduction among the younger stages; but the breeders and those about to become so were not reached, and by the middle of September there was as bad an infestation as at any time during the summer.

September 21st, sprayed with 1 part of soluble petroleum to 3 parts of water and 5 days later the greater part of the adults, all of the larvæ and recent sets, and many of the older sets were dead. There were some larvæ ready to emerge, but altogether the scale condition was better than at any time previous during

this season. Some of the leaves had turned brown and a few had dropped, but there was no serious injury to the foliage.

October 16th, there were a few live adults, quite a few white scales and an occasional larva. Quite a number of living specimens were among the older sets, though most of them were dead.

November 2d, the foliage was nearly all off. There had been some recent breeding, but none seemed to have gotten beyond the white stage, though some of the older black scales were undoubtedly alive. The infestation extended to the tips of the shoots, but was not bad. On the old wood, where the infestation was heaviest, the scale seemed to be dead. Traces of the oil were yet obvious, and without doubt the last application was an effective one.

Sexed forms of the apple louse were found on the few remaining leaves, but apparently egg-laying had not begun at all seriously.

Tree 3—*Black Tartarian Cherry.* Leaf buds were ready to open April 17th; the first blossoms opened May 3d, was in full bloom May 7th, and out of bloom on the 11th. Made a fair set of fruit, which reached that stage of ripeness at which it was attractive to boys and birds June 15th. To avoid trouble, as the family was about to leave, all the fruit was taken off. The tree made its usual good growth during the season, and November 2d was yet in almost full foliage. No scale at any time, and no treatments of any kind.

Tree 4—*Dwarf Pear.* This tree had been grown for the trellis in Europe, remained one season in a New Jersey nursery, where it became moderately infested with scale and was set here October 28th, 1903.

March 9th, 1904, sprayed with caustic soda, 1¼ pounds in 2 gallons of water, and drenched thoroughly.

Not until May 17th was there any sign of starting, and then from buds far down on the trunk. On the 27th all of last year's wood was dead and dry, and, June 8th, it was cut off 18 inches above ground, to which point the live wood extended. No scale was noticed during the early summer; but on August 18th there were a few adults, a few recent sets, and a few crawling larvæ. It did not become much better as to growth, nor worse as to scale, during the remainder of the season, and was ordered cut out November 2d.

Tree 5.—Removed in 1903, and not replaced.

Tree 6—*Greensborough Peach.* March 9th, this tree, being very scaly, received a thorough drenching with the solution of

caustic soda, 1¼ pounds in 2 gallons of water. The application was made especially heavy, to get a maximum effect on both scale and fruit buds. At the time the application was made the tree seemed plump and full of life, but soon afterward it began to dry and shrivel until, during the early days of May, it was found to be entirely without life. June 13th it was taken out.

Just what killed this tree, it is difficult to say. The tree was young, yet well established; it was scaly, yet plump, and, apparently, full of life. The application of caustic soda was severe, and may have been the cause of death; yet, though I would not have been surprised to see some of the smaller branches killed, I would not readily believe in the killing of the entire tree. The intense, continued cold of the winter, which affected all my peach trees to some extent, may be responsible, and, I am inclined to believe, is really the greatest factor, though the others contributed, I have no doubt.

TREE 7—*Champion Peach.* March 10th, applied the "Universal Insecticide and Scale Killer" thoroughly, from all sides, aiming especially to get at the base of last year's wood.

April 26th, when the tree began to make a start, it was found that there was considerable dead wood in the upper portion, and, in general, toward the ends of the longer branches. The only really vigorous part was in the center, among the new wood made last year. May 7th, a good start was made on all the live wood, and on the 11th several blossoms were found.

Matters were left to move along until early June, when new and vigorous shoorts were starting from all the living parts of the tree, and then all the dead wood was cut out.

June 27th, there was not much living scale, but there had been some breeding, and some recent sets were found on last year's wood. July 8th, there was a little increase, and the tree was sprayed with the horticultural compound, 2 ounces in 1 gallon of water. At all times, when examined during the next month, a few specimens of all stages were found, and these increased in number until August 19th, it was deemed best to respray with the others that had been similarly treated. So in the same way a third application was made August 29th, using the horticultural compound at the same strength as before. The material seemed to have little effect at this time, and, even two days later, there were plenty of larvæ and recent sets. The rate of increase was not very rapid, yet, on October 19th, it was deemed best to spray with Kill-O-Scale, 1 part to water 20 parts. Next

day live scale was found only near the tips of the twigs next to the fence, obviously due to imperfect spraying. The leaves were quite a little burnt in places, though not to any serious extent. October 25th, most of the leaves were off, and what remained were spotted.

November 2d, on the final examination, the Kill-O-Scale seemed to have been quite effective. It left an oily appearance on the twigs, and seemed to have cleaned up the scale pretty well. There is quite a heavy set of fruit buds, and, while the oil has caused some discoloration on the outside covering, most of the buds when cut into appeared to be sound. The application on this tree was excessive, and appearances indicate that some care is required in applying this mixture when the buds are forming. The foliage was not yet all off, and what remained was not abnormally spotted. Where the scales were thickest the oil seemed to have been most effective, though even those half-grown black forms well out on the branches and close to the buds, which ordinarily form the hibernating corps, seem to be pretty generally dead.

Tree 8—*Grimes' Golden Pippin.* March 10th, this tree was found to be very badly infested and, to give it the best possible test, I drenched with the "Universal Insecticide and Scale Killer." When dry, the tree was evenly bluish white to the very tips, showing work as nearly perfect as can be reasonably expected.

April 26th, the tree had made a start, and it was apparent that there would be considerable dead wood. May 8th, the first blossom opened, and May 11th was in full bloom, indicating a set of fruit much greater than the tree could possibly bear. Petals did not begin to drop until after May 17th, and between that time and the 8th of June, I cut out considerable dead and dying wood. At the latter date, there was a heavy set of fruit; the cutting out had given a ragged irregular appearance and new shoots were making from the center. There was yet plenty of live scale, and I could not find that there had been any material benefit from the March application of Scale Killer.

June 18th, the lower branches were sprayed with caustic soda at the rate of 1 pound dissolved in 8 gallons of water, simply to determine what effect the material would have on the foliage. Next day the leaves were distinctly spotted and burnt at the edges, and the soft, new shoots were also spotted. June 27th, the tree looked bad; the foliage was thin, yellowish, the wood brittle, with a tendency to break at points where the scale was

massed. There were no active larvæ, but there were white sets in some number, and yet some breeding adults. The foliage that had been sprayed with caustic soda was no worse than when examined on the 19th, and none seemed to have dropped; certainly no permanent injury had been caused.

June 28th, all save a few of the fruits were taken off to prevent injury from raiders. Some 150 or more fruits were taken off, a goodly portion of which would, undoubtedly, have developed. July 8th, though the conditions were not very bad, it was deemed best to spray with the horticultural compound, 2 ounces in 1 gallon of water. This caused some burning of the foliage near the center, but killed off most of the scales, so that not until the end of August was there any general re-infestation, which increased all through September. October 14th, sprayed with Kill-O-Scale, 1 part to water 20 parts. November 2d, about half the foliage was off, and the balance looked ready to come off. The tree as a whole was very scaly, and some parts of it as scaly as they could well be. There were no larvæ and no recent sets; the old scale came off everywhere in great flakes, showing no life beneath, and such black scales as were lifted on the new wood had only dry or collapsed insects beneath them. Traces of the oil were obvious everywhere, and there is no doubt that the insect was severely checked by the October application. The tree goes into the winter more free from scale than in 1903, but also much more injured by the summer development, so that the prospect is for a considerable winter killing of the worst infested branches.

Tree 9.—Taken out in 1903, and not replaced.

Tree 10—*Greensborough Peach.* March 10th, was thoroughly drenched with the "Universal Insecticide and Scale Killer."

April 17th the buds began to swell, and it seemed as if there would be a heavy bloom; but development ceased, and, on the 26th, when the leaf buds began to put out, it became obvious that the flower buds were dead. May 7th the leaf buds began to develop irregularly, and branches to shrivel up, until, on the 7th, it was found it would be only a cripple at best. June 8th it was more than half dead, and was taken out a few days later.

This case is very like that of No. 6, which acted the same way, but was treated with caustic soda instead of scale killer. The indications from the two records point to the winter as the proximate cause of the death of both trees.

Trees 11, 12, 13 and 14 are out, not to be replaced.

Tree 15—*Japan Golden Russet Pear.* April 5th, sprayed thoroughly with Salimene, 1 pound in 1 gallon of water. The mixture, when dry, leaves a whitish green deposit, something like that of the Bordeaux.

Leaf buds began to open April 26th, first blossoms opened May 7th, in full bloom May 11th; pretty well out of bloom, with a full set of fruit, May 21st.

June 27th, the tree was in good healthy condition with plenty of fruit, all of it looking well. As the tree is well back in the garden, not easily seen from the street, the fruit was allowed to remain. Dead scale pretty generally throughout the tree, but also some that was alive. There were some larvæ moving, and some recently set scales; but none on the fruit as yet. There had not been much scale on this tree last fall, and I could not see that the Salimene had lessened what there had been.

July 8th, though there was no real necssity for it, sprayed with the horticultural compound, 2 ounces to 1 gallon of water. There did not appear any marked lessening of scales, but, on the other hand, neither was there any apparent increase later on, nor did any get on the fruit.

November 2d, the foliage was nearly all off, and the tree was in excellent condition, though with a small sprinkling of scales throughout; less, if anything, than were present at the same period in 1903. The crop amounted to about two baskets of medium-sized fruit:—too much for a tree of this size.

For some reason, trees 15 and 16 do not become stocky, *i. e.,* the trunk does not increase very much in diameter. The trees are trellised, and the tall shoots above the framework are cut back each year, tending to a dwarf effect. Whether that is an explanation or not, I am not certain.

Tree 16—*Japan Golden Russet Pear.* March 10th, sprayed with "Universal Insecticide and Scale Killer." The tree did not really need the application, but there was a little of the material left, and no other tree on which I cared to put it, so I covered thinly and evenly. April 5th, sprayed with Salimene, 1 pound in 1 gallon of water, and gave a very thorough dose, giving the tree a whitish green appearance when dry.

Began opening leaf buds May 1st; first blossoms opened May 7th; was in full bloom May 11th; pretty well out of bloom May 17th, and had made a fair set of fruit May 27th.

June 27th the tree was healthy in appearance, and had as much fruit as was good for it. Plenty of dead scales were all over the tree, but there were also some living ones, some moving

larvæ and some recently set scales. The combined effect of the two materials used was exactly equal to the single effect secured on No. 15.

July 13th, there were some larvæ and some recent sets, as well as a sprinkling of older scales—not enough to really demand attention; but I, nevertheless, sprayed with Roseleaf tobacco extract, 1 pound in 5 gallons of water, chiefly to determine the effect on foliage. July 29th, there had been no injury of any kind to foliage, and there were few live scale insects in any stage, a record which was duplicated August 18th, September 15th and September 28th. September 5th, harvested nearly two baskets of very decent fruit. November 2d, the foliage was about all gone; there was scale everywhere, but in small quantity; no larvæ, but some recent sets which had collapsed. Plenty of material for next year's crop, and not enough to demand treatment this winter. As a whole, this is a little inferior in almost every respect to No. 15.

Tree 17—*Trellised Peach.* Set October 27th, 1903. A foreign tree that had grown one season in a New Jersey nursery and became scale infested. March 10th, applied a thorough covering of the "Universal Insecticide and Scale Killer," after first cutting back pretty well. Not until May 7th did the tree show signs of life, and not until the 17th did it really start from the lower branches. May 27th, practically all the growth of the previous year and some of the older wood was dead; but a very fair growth was making from the lower branches and trunk. June 18th, sprayed with caustic soda at the rate of 1 pound in 4 gallons of water, to test effects on foliage. The entire tree was covered to the surface of the ground. Next day the foliage was badly spotted and burnt, some of the tender shoots were black spotted, and there was a generally dilapidated appearance; but, on the whole, the injury was not so great as I had expected it to be. Though no larvæ were seen, I nevertheless sprayed the trunk and branches very carefully, to reach any that might be ready to crawl from beneath the parent scale. June 27th the tree looked badly. Some of the tips were curled; many of the leaves were burnt and curled at the ends; there were crawling larvæ and recent sets, as well as older live scales on the trunk. This examination indicated that the caustic soda application at a strength sufficient to burn foliage is not effective as against the scale insects. The tree was left undisturbed during the remainder of the growing season, but examined from time to time, always to find a few larvæ and recent sets, with

an ever increasing number of black scales until, October 14th, matters were bad enough to indicate an application of Kill-O-Scale at the rate of 1 part to 20 parts of water. On the 20th the leaves showed some burning, but only one living scale.

November 2d the tree was in much better shape than I had expected to find it, with some very decent shoots fairly set with fruit buds, which were apparently healthy, and with little, if any, living scale anywhere. It is a dwarf, of course, and its growth has not been symmetrical; but in trellised stock this can be partly remedied, and so the tree will be allowed to stand.

Tree 18—*Vermont Beauty Pear.* Trees 18, 19 and 21 are the only survivors of a series of pear trees received from the nursery row as Keiffers; and so they looked to be at first. But as they grew I noted the small size of the foliage, the rough trunk, and the habit of growth, all of which was referred to and charged to adverse conditions. When the fruit ripened, I noted the early date, the small size and good quality, and believed I might have a sport. When the pear midge and the sinuate borer evinced a fondness for the trees I felt sure there was something wrong; but not until this past season, when the trees bore a fair crop of fruit typical in size and color, did I recognize the true variety. The Vermont Beauty is not a common variety in our New Jersey orchards, hence I was not so familiar with it as I might have been; but having recognized it now, I commend it to those who like a good table pear for their own garden. It looks beautiful, is of moderate size, good pear shape, fine flavor, comes in early September, but is no keeper, and probably will not ship well if at all ripe. Tree 18 was thoroughly sprayed with Salimene, 1 pound in 1 gallon of water April 5th, leaving when dry, a whitish green coating.

Leaf buds were pointing out, though not opening, April 26th, a few blossoms were open May 7th; was in full bloom May 11th, and going out May 17th. A moderate set of fruit was made which was marked by the Curculio, but not seriously harmed. June 27th, though the tree did not seem to be very scaly, there were numerous larvæ and recent sets, some of them already invading the fruit. So bad was it that, on June 30th, I sprayed with Pyrol tree spray, 1 part to 40, the application being very thorough. The results were not satisfactory, so I sprayed again, July 5th, with the horticultural compound, 2 ounces in 1 gallon of water. July 7th, a rather careful examination showed all moving larvæ killed off, and most of the white sets collapsed; but the older scales and the reproducing

females seemed to have been uninjured. Nevertheless, the result of the application was a severe check to the insect, and not until August 19th was another application made of the same material, at the same strength. The rain following immediately thereafter interfered with the result, and, on August 29th, a third spraying was made with the horticultural compound. Though this was more effective, it was only a temporary check, and, on September 16th, sprayed with equal parts of water and a soluble petroleum, the application being made less thoroughly than on Nos. 19 and 21. September 19th many of the adults were dead, but many were yet alive; there were some crawling larvæ and some white sets. The bark, where the application was properly made, had a dark greasy appearance, the leaves were more or less glossy, some of them had turned black, and a few had dropped. Injury had intensified September 26th, and more leaves had dropped; while, on the other hand, the effect on the scales had not increased. October 15th, there were a few live adults, a few white sets, an occasional crawling larva and quite a lot of live half-grown forms.

November 2d, the foliage was all gone, the tree was pretty generally infested, and in some places the scale coating was heavy. Most of the insects have been killed; but around the branching of the small twigs there are plenty yet left alive. There seemed to be a question whether there has not been some injury to the buds; but it was too early to determine that. It should have been said that a small crop of very nice fruit ripened during September.

Tree 19—*Vermont Beauty Pear.* April 5th, sprayed very thoroughly with Salimene, 1 pound in 1 gallon of water.

April 26th, leaf buds were pointing out all over the tree; May 7th, a few blossoms were open; May 11th, was in full bloom, and May 17th, was almost out of bloom. June 27th, the tree was doing well and had made a fair set of fruit, which was developing nicely. There was a small set of scales, many of them dead, but some producing young, quite a number of which had set, and had already found their way upon the fruit. July 5th, sprayed thoroughly with the horticultural compound, 2 ounces in 1 gallon of water. On the 7th, examined rather carefully, and found no moving larvæ, most white scales collapsed, but none of the half-grown sets nor reproducing adults injured. Nevertheless, there was a check to the breeding, and a new application was not considered necessary until August 29th,

when a second application of the horticultural compound was made. Two days later there were fewer larvæ and white sets than before, but yet a plenty of living insects. September 16th, sprayed thoroughly with a mixture of equal parts of soluble petroleum and water. On the 19th, most of the adults were dead, but there were yet some white sets and recently hatched larvæ. The bark had a dark greasy appearance, the leaves were more or less glossy, and some had turned black. On the 29th, the number of larvæ, recent sets and living insects had decreased. October 15th, the condition had improved yet further, but there were still many live, older sets. November 2d, the foliage was all off, and, apparently, there was a heavy set of fruit spurs. The tree is very scaly, and much of the sap wood is purple. Many of the small twigs are dead. There were no larvæ, no recent sets, and most of the black sets were dead; but there were yet some living examples at almost every joint.

During the month of September a very satisfactory crop of pears was secured from this tree. Some of the more highly colored outside fruits were removed before they were quite ripe, but they mellowed nicely indoors and made good eating.

Tree 20—*Meech Quince.* Leaf buds began opening April 26th, but were not generally open until May 11th. Blossoms began to open May 19th, and the tree was in full bloom May 21st. On the 27th, only a few flowers were left. June 27th, the tree was in good healthy condition, with a scattering of live scales, a few crawling larvæ, and a few white sets. Although the infestation was very slight, sprayed with the horticultural compound, 2 ounces in 1 gallon of water, on July 8th, when surrounding trees were treated. The spraying made little or no difference in the condition of affairs, and all stages continued to be found in small numbers throughout the season.

It made and ripened during October a very decent little set of fruit, and on November 2d was yet in almost full foliage. It had at that time more scale than at any previous period in its history, yet it was not a bad infestation. There were no larvæ and no living recent sets, but the half-grown black scales were generally alive, and they were grouped chiefly at the branchings.

Tree 21—*Vermont Beauty Pear.* April 5th, sprayed very thoroughly with Salimene, 1 pound in 1 gallon of water. Leaf buds were pointing out April 20th, blossoms began to open May 7th; was in full bloom, a perfect mass of flowers, May 11th; petals began to drop May 17th, but was not out of bloom until the 20th. June 27th, the tree was doing well and had made a fair

set of fruit; there were scales scattered pretty generally on the outer branches, yet not a bad infestation. Moving larvæ were plentiful, and recent sets were quite dense on some branches, the fruit itself also showing some infestation. June 30th, sprayed thoroughly with Pyrol tree and plant spray, 1 part to water 40 parts; but, no obvious benefit being noted, sprayed, July 5th, with the horticultural compound, 2 ounces in 1 gallon of water. On the 7th, there were no moving larvæ, and the white sets had collapsed, the older scales seeming to remain unaffected. For the time the spread was checked, but in August the insects were again so plentiful that the tree was resprayed with the compound at the same strength as before, August 29th. The check this time was less marked, and, on September 16th, sprayed with equal parts of soluble petroleum and water. This application killed off a very large proportion of the insects, but did not reach all the breeders, and, at all times until October 15th, a few moving larvæ could be found. November 2d, the foliage was practically all gone, and the tree had matured a small crop of very nice fruit spurs. Where the scale was thickest, the scurf was dry, and no living insects were found; but further out on the branches, at the bases of the shoots, and around the joints there was a plenty for next year.

TREE 22—*Japan Chestnut.* March 9th, gave the tree a moderate spraying with caustic soda, not because it was scaly and needed it, but to test the effect on that kind of tree. Leaf buds began to open May 7th, and, apparently, no harm had been done by either the winter or the application. No scale was found at the June examination, and though, later, single individuals occurred, there was no breeding. There was a heavy bloom, and the tree set a ridiculously large crop for one so small. I was curious to see the result, which was a lot of small and imperfectly developed nuts.

November 2d, was yet in almost complete foliage, and no scale was apparent. The tree has a bad position, partly shaded by a grape arbor and crowded by other trees.

TREE 23—*Greensborough Peach.* March 9th, sprayed with caustic soda, 1¼ pounds to 2 gallons of water. The tree was only slightly infested, and did not really need the application, so no attempt was made to reach the tips of twigs. The infested wood was very thoroughly coated, however. April 5th, after trimming, sprayed with "Salimene," 1 pound in 1 gallon of water, to see what would happen.

Leaf buds were pointing out April 26th; there was one

blossom May 7th, a second May 8th, and both were done May 11th; one fruit had set May 27th, to drop during early June.

June 27th, the bark of the trunk and branches looked as if it had been polished, and most of the scales were dead, but some were alive and breeding, as a few larvæ and recent sets bore witness. These increased in number until July 8th, at which time the tree was sprayed with the horticultural compound, 2 ounces in 1 gallon of water. This kept the tree fairly clean until August 29th, when it needed and received a second spraying, with material as before. Even this left a residue, however, so that a month later the number of developing insects was such that on October 19th sprayed with "Kill-O-Scale," 1 part to water 20 parts. On the 23d, the little remaining foliage was spotted, and no live scales were found, on such examination as was made.

November 2d, the foliage was all gone; there was scale all over the tree, though nowhere bad, and all that were examined were dead. All were oil-soaked, and came off readily. The fruit buds were abundant, well developed, and there was no appearance of injury caused by the oil.

Tree 24—*Greensborough Peach.* Leaf buds were pointing out all over the tree April 26th, and a good start had been made May 7th, not a blossom developing, however. June 27th, the tree was found to be slightly infested, a few larvæ crawling about, and some recent sets already apparent on the leaves. It was, therefore, included in the list sprayed July 8th with the horticultural compound, 2 ounces in 1 gallon of water. This seemed to act as a stimulant to the insects, and, August 19th, a second application was made, which, being washed by rain, was supplemented by a third, made August 29th, all applications being of the same material and strength. This acted as a slight check only, and, on September 26th, sprayed with the soluble petroleum, 1 part to water 4 parts. September 28th, it was noted that some of the leaves had been injured, but not enough to cause them to drop, and, thereafter, no living scale insects were noted except near the tips of the new growth.

November 2d, the foliage was nearly all off; there were scales all over the tree, but oil-soaked and no live insects under those that were examined. The oily appearance is everywhere obvious, but the heavy set of fruit buds seems to be entirely normal, and without appearance of injury.

Tree 25—*Apricot.* April 17th, leaf buds were beginning to point out; the blossom buds seemed to enlarge, and I noted that

a heavy bloom was promised, and no injury from the severe winter apparent. But on the 26th, while the leaf buds made great advances, the blossoms were yet undeveloped, and, on May 7th, half a dozen clusters only represented the promise of the buds.

June 27th, the presence of living scales was noted, and at each examination during the summer larvæ and recent sets in small numbers were recorded. No treatments were deemed necessary, however, and, on November 2d, the tree was yet in full leaf. It now forms a complete screen, 8 feet high and 10 feet in length, with new shoots extending above the line from 5 to 6 feet. There is some scale on the trunk and branches; more, indeed, to all appearance, than ever before in the history of the tree, but where it is most plentiful on last year's wood, the insects beneath it are dead as a rule. There remains, nevertheless, quite a little living scale.

Without any treatment, summer or winter, since the early spring of 1903, there has been very little increase of the scale infestation. The tree feels the injury of those that occur on it, deep pits forming in the bark, especially when the rapidly growing shoots are infested, but somehow little development takes place in the insects.

Tree 26—*Nectarine.* March 9th, though the tree was only a little infected, sprayed thoroughly with the caustic soda solution, 1¼ pounds in 2 gallons of water. Leaf buds began to start April 7th, and developed normally until May 17th, when the tree was in full leaf, but without having developed a single blossom. The wood had a polished appearance from the soda, and many scales on it were dead. Early in June the foliage became a little ragged, and there was an appearance of leaf curl, which soon disappeared.

June 27th, the examination developed breeding scales, with larvæ and recent sets in some numbers; hence, on July 8th, sprayed with the horticultural compound, 2 ounces in 1 gallon of water. This checked development to such an extent that re-spraying was not necessary until August 29th, when the previous application was duplicated. This last treatment had very little effect, and by the latter part of September the infestation had become pretty serious. On the 26th, sprayed with 1 part of soluble petroleum to 4 parts of water, and on the 28th a good effect was noticeable, though some of the leaves were more or less burned.

November 2d, the foliage was more than half off, the tree was

in good general condition; but very scaly. Most of this scale was dead, and scraped off readily as a dry scruf; even in those places that first became infested during the past summer. There were living scales, however, especially at the bases of twigs. The remnant of oil was obvious on the surface of the tree, but there was no appearance of any bad effect on the development of the fruit buds.

Tree 29—*Gravenstein Apple.* March 10th, sprayed thoroughly with the "Universal Insecticide and Scale Killer." The tree was not very badly infested, and did not really need the application, but there was scale enough to test the effect of the spray.

Some of the terminal leaf buds began unfolding April 26th; was leafing out fully May 7th, and, on May 11th, had three blossom clusters well up in the tree, which set no fruit.

June 27th, the scale situation was in so far satisfactory as there were only a few breeding adults, and there had been no great number of recent sets. July 13th, though there was only a thin scattering of white sets, it was deemed desirable to test the effect of the Roselcaf tobacco extract, and the tree was sprayed with it, at the rate of 1 pound of the extract in 5 gallons of water. The application did not harm the foliage, and while it undoubtedly killed some scale, left matters, on the 29th of July, just about as they were before the application was made. But for some reason things did not become worse; and, on November 2, there was merely a scattering of scale, massed only at a few points at the bases of twigs. At that time, the tree was in fine general condition, the foliage about half off, and everything pointing to a crop for 1905. Sexed forms of the apple-plant louse occurred in some numbers, but as yet there were no eggs.

Tree 30—*Grimes' Golden Pippin.* On March 10th, gave this tree a very thorough spraying with the Universal Insecticide and Scale Killer. It was quite thoroughly infested, and needed the application.

Leaf buds began opening about May 1st, and, on the 7th, some of those in the upper part had not opened yet. At that time the blossoms were showing pink, but none were open; on the 11th, there was a mass of bloom. Petals began to drop May 17th, when some buds had not yet opened, and not until after the 20th was the tree entirely out of bloom. May 27th, the set was heavy, and it continued to develop until after the middle of June, when most of the fruits in the upper part were

entirely removed. Some specimen fruits were allowed to develop, and were matured in late September.

June 27th, there was a heavy set of white scales, and it was obvious that the March application had been ineffective. On the 30th, sprayed with the Pyrol tree and plant spray, 1 part to water 40 parts, and drenched thoroughly. As that did not seem to have any immediate effect, sprayed, July 8th, with the horticultural compound, 2 ounces in 1 gallon of water, and that arrested the further development. August 18th, there were a few adults; there was a thin scattering of white scales, and there were some active larvæ. Although hardly necessary, I sprayed with the horticultural compound as before and, after the washing rains, duplicated the application, August 29th. For a few days this seemed effective; but then every day added to the infestation at a rate greater than earlier in the season, and, on October 14th, sprayed with Kill-O-Scale, 1 part to water 20 parts. October 20th, the leaves were quite a little burned, but living scales were almost wanting, except near the ends of the branches.

November 2d most of the foliage was off, and the balance dry and discolored, the discoloration without doubt due to the insecticide. The wood throughout shows signs of the oil, in the dark color and general greasy appearance. There is plenty of scale on the tree, but most of it is dead, except at the base of the twigs and spurs. There has been no penetration into the forming buds.

Tree 31—*German Prune.* March 10th, was found to be moderately infested, and received an application of the Universal Insecticide and Scale Killer.

Buds did not show until April 26th, but after that the advance was rapid, and, May 7th, was leafing out everywhere, and a few blossoms were already open. There was a good bloom, but irregular, petals beginning to drop May 17th, when some buds were yet unopened. Only a small set of fruit was made, which was promptly attacked by the Curculio, and, eventually, less than a dozen very fine fruits came to maturity.

June 27th, on the general examination no larvæ nor recent sets were found, but plenty of adults, ready to reproduce. July 8th, so many of the young had set that it was deemed wise to spray with the horticultural compound, 2 ounces in 1 gallon of water. This seemed to dispose of all the then recent sets; but, July 13th, there were more larvæ and more sets. Development was not rapid, however, and, though at every examination larvæ

were noted, showing continuous breeding on the tree, no further insecticide applications were deemed necessary.

November 2d, most of the foliage was off; the tree was quite scaly, and a specimen of the twice-stabbed lady bird (*Chilocorus bivulnerus*) was noted feeding upon the insects. The tree is bad enough for winter treatment.

Tree 32—*Mountain Rose Peach.* Set October 27th, 1903, to replace a Lawrence Pear taken out. Made no real start until well along in May, and then developed irregularly. There were no scales found June 27th, but on August 18th, all stages from larva to adult occurred, and these developed until it was deemed necessary to spray, October 20th, with Kill-O-Scale, 1 part to water 20 parts. This cleaned out things pretty well, and caused a little burning of the leaves.

November 2d, the foliage was about all off and what remained was spotted by the oil. The buds, however, were unharmed, and such scales as were examined were dead.

Tree 33—*Dwarf Duchesse Pear.* March 9th, received an application of caustic soda solution, 1¼ pounds in 2 gallons of water, and needed it.

Buds began to swell April 17th, but no start was made until the 26th; first blossoms opened May 5th; was in almost full bloom May 7th; petals began to drop May 11th, and was out of bloom May 17th. Had set a fair crop May 27th, but some of the fruits had been already eaten out, probably by May beetles, and, June 8th, only two fruits remained. These, however, came to maturity in good shape.

June 18th, one of the branches was sprayed with the caustic soda solution, 1 pound in 8 gallons of water, to test the effect on the foliage. Next day both leaves and fruit were black spotted, but there had been no bad effect on the shoots. It simply gave the tree a ragged appearance.

June 27th, there were only a few recent sets, no moving larvæ, and it was not deemed necessary to spray. Development was slow for some reason, and, although moving larvæ and white sets were reported at each examination, there was nothing to demand attention until October 14th, when the tree was sprayed with Kill-O-Scale, 1 part to water 20 parts. On the 20th, there was a mere trace of injury to the foliage, while only a few living scales could be found. November 2d, the foliage was all off, the tree had made several very long shoots from the top, and had some of the original lower branches, so that it is now neither dwarf nor standard, and has little, if any, bearing wood. Live

scales were found only at the base of the new shoots. The infestation is certainly no worse than in 1903, and it is remarkable that the history of slow summer development is almost identically the same for the two years.

TREE 34—*Lawrence Pear.* March 9th, the tree was moderately infested on the trunk, less so on the branches, and was sprayed with caustic soda solution, 1¼ pounds in 2 gallons of water. Leaf buds were pointing out April 26th, blossom buds began to open May 7th; all the flowers were open May 11th, and some petals were already dropping. Only one fruit set, and that held on for a few days only. June 27th, only a few live scales were found, and most of these were new sets. These increased in number, so that, on July 13th, sprayed with Rose-leaf tobacco extract, 1 pound in 5 gallons of water. This was quite effective, and development later in the season was so slow that not until October 18th was it deemed desirable to treat. Sprayed, October 19th, with Kill-O-Scale, 1 part to water 20 parts. On the 25th few living insects were noted, some of the leaves were spotted, but that did not seem to be due to the spraying. November 2d, most of the foliage was off, and what remained was discolored. There was a scattering of scale on the tree, very little on the new wood, and not much anywhere. That which is on the old wood is dead.

TREE 35—*Japanese Walnut.* April 26th, terminal buds began to unfold; May 7th, blossom clusters well advanced. June 27th, when the scale examination was made, there was quite a scattering of half-grown black scales; but, on examination, every example was dead. No larvæ or recent sets were noted at any time during the season. November 2d, all the foliage was gone; the tree had made its usual good growth, and had matured a small crop of good-for-nothing nuts. There was the usual scattering of half-grown black scales, and, also as usual, few of them showed any live creature beneath.

TREE 36—*Redmond's Favorite Peach.* Set October 27th, to replace an apple. Did not pass the winter well, and showed some dead wood below the pruning. Made an irregular start May 17th, and, on June 18th, I decided that I could not get a satisfactory tree out of it. On that day, drenched with caustic soda solution, 1 pound in 7 gallons of water. June 19th, foliage and shoots were black spotted, and some of both leaves and tips were entirely killed. June 28th, there had been no recovery. The foliage was pitifully burnt, and there had been no effort to start from the dormant buds on the old wood. August 18th,

the first scales were noticed as larvæ, and on September 15th some recent set was noticed. November 2d, the foliage had dried up, and all the shoots in the upper part of the tree with it. Nothing remained except a couple of suckers from below the bud, and the tree was taken out.

TREE 37—*Duchesse Pear.* October 28th, set an imported Duchesse pear, which had been grown for trellising, had remained one year in the New Jersey nursery, and was somewhat infested with scale. It was not a good tree, hardly dormant, and had the gnarled appearance of a specimen too often transplanted and too long in the nursery row. Remained plump and apparently alive until early May; then began to wilt, and by the middle of the month had lost all signs of life. June 13th it was taken out.

TREE 38—*Baldwin Apple.* Quite a scaly tree, to which, March 10th, a thorough application of the Universal Insecticide and Scale Killer was made. April 26th, began an even start, and, May 7th, was in almost full leaf and blossoms ready to open. May 8th, first blossom opened; May 11th, was in full bloom, and, May 17th, flowers about all gone. Made a full set of fruit, much of it at the tips of the twigs, in bunches. This made it very conspicuous, and as, July 16th, the shoots were beginning to drop as the apples increased in size, all the outside fruit, amounting to nearly a basket was taken off. The less conspicuous inside set was allowed to develop, and made nearly a basket more when mature. Almost every one of the fruits taken off the tree was more or less set with scale, although the body of the tree and the branches were quite free. It is one of those cases where the larvæ were driven to the outside to escape the effect of the sprays that were applied.

June 28th, found a scattering of live scales, mostly on last year's wood, with quite a lot of larvæ and recent sets. Sprayed thoroughly, with the Pyrol tree and plant spray, 1 part to water 40 parts, on June 30th. The application showed no good effects, and, on July 8th, sprayed with the horticultural compound, 2 ounces in 1 gallon of water. July 13th, there were yet more recent sets and moving larvæ than I cared to see, and, therefore, sprayed with the Rose-leaf tobacco extract, 1 pound in 5 gallons of water. July 29th, there were no larvæ, and, apparently, no reproducing adults; but there were quite a number of half-grown examples. These matured during early August, and began to reproduce, making desirable a spraying with the horticultural compound, 2 ounces in 1 gallon of water. The rain

following closely interfered with the effectiveness of the compound, and, on August 29th, another application was made. This resulted in a brief check, followed in mid-September by a rapid increase which made necessary a spraying, October 14th, with Kill-O-Scale, 1 part to water 20 parts. October 20th, the foliage had been somewhat scalded; but very few living scales were found.

November 2d, most of the foliage was off. There was quite a coating of scale in some places, but all of it was oily, and flaked off readily without signs of living insects beneath. Very little live scale was found. The tree has done very well during the season, and the only shoots entirely bare were skinned by a brood of *Datana* in early September.

TREE 39—*Trellised Apple.* October 28th, 1903, "set an imported apple, grown for trellising, which had been in a New Jersey nursery one year, and had become somewhat scaly. It is not a vigorous looking tree, but seems dwarfed."

March 9th, gave a thorough drench with the caustic soda solution, 1¼ pounds in 2 gallons of water.

Not until May 7th was there a sign of life, and not until June 8th, was there a start from the entire length of the trunk, the lower shoots being well developed before the upper started. June 18th, gave a thorough spraying with caustic soda, 1 pound in four gallons of water, to test the effect on the foliage. June 19th, the leaves were brown and dry around the edges, and the injury increased until, June 28th, the entire foliage looked scalded. At that time scale breeding had begun, but the infestation was slight, at worst. There was a slow increase throughout the summer, and, October 14th, was bad enough to receive an application of Kill-O-Scale, 1 part to water 20 parts. This did not improve the foliage, though it wiped out most of the scales. November 2d, the tree was still alive, and that was all that could be reasonably said for it; was, therefore, taken out about the middle of the month.

TREE 40—*Lincoln Coreless Pear.* Leaf buds were pointing out all over the tree April 26th, and by May 7th was in full leaf. No fruit buds or blossoms. May 27th, the tree was growing as usual, but in some places showed the effect of scale injury. The tree apparently throws off the scale every season, and there was little, indeed, then present; but the bark had been hurt in vitality, and quite a number of shoots were rough and broke easily.

June 14th, the first moving larvæ were seen, and thereafter all stages were observed whenever examination was made.

November 2d, the foliage was about all off, and the tree was as a whole, in about the same condition as last year. There had been considerable scaly; but very little remained at that time. In some places the bark had become roughened and checked; but the cause of the trouble had disappeared. The only unusual appearance was a slight infestation of Pear Psylla.

Tree 41—*Elberta Peach.* A clean tree, 6 feet trunk, and stout in proportion, set October 27th, 1903.

March 9th, applied caustic soda, 1¼ pounds in 2 gallons of water, to test the effect of the material upon a young, recently set tree. Not until May 7th was there any sign of a start, and that came low down. Up to the middle of April the tree had appeared to be alive; but after that the little spurs left by pruning began to die; but the main stick appeared to be alive until May 15th. Thereafter it died down gradually, almost to the ground, and on June 13th I took it out.

It would be unfair to charge the death of this tree to the caustic soda application, in view of the severe winter effect on others. The tree when set was first class in every respect, and was put in carefully by me, personally. There was absolutely no reason why it should not take hold as well as any that I have ever put into the ground. Yet it may be that the very size of the tree, indicating a quick, sappy growth, made it less able to resist the severe weather; and when to that is added the effect of the intensely caustic application on the buds, the combination might well effect what neither alone could have accomplished.

Tree 42—*Elberta Peach.* Started growth April 26th, doing well, and making a good bushy head. June 28th, a few dead, but no living, scales were observed, and not until August 18th had a few examples matured, and begun to breed. Matters progressed rapidly thereafter, and, October 14th, it was deemed necessary to spray with Kill-O-Scale, 1 part to water 20 parts. October 20th, there was a slight burning of the foliage, but the scales had been mostly cleaned out.

November 2d, the foliage was about all off, the remainder spotted by the oil. The tree had made a good growth, and some of the shoots are well set with fruit buds. The trunk was quite scaly, but everywhere appeared to be oil-soaked. A mechanical injury near the base of the trunk will probably affect the future growth of the tree, and may necessitate its removal.

Tree 43—*Early Richmond Cherry.* Blossom buds began to

swell April 17th, but not until May 3d were any open. May 7th, was in almost full bloom, leaf buds began to open, and the injury due to winter weather began to be evident. Made only a small set of fruit, which ripened normally, birds being discouraged by scarlet streamers. May 27th, the tree was altogether unsatisfactory in appearance, some twigs dead, the foliage thin and poor; altogether, a sickly look. Later on it began to recover a little, and, on November 2d, when about half the foliage was off, a good growth and heavy set of fruit buds was noted. There was practically no scale on the tree at any time, and nothing apparent in the tree can be charged to that cause.

Tree 44—*Elberta Peach.* March 10th, sprayed thoroughly with the Universal Insecticide and Scale Killer. This tree has been cut back, and had an excellent set of apparently living fruit buds for 1904. There was not much scale, and the spraying was done chiefly to determine the effect of the material upon buds.

April 26th, all the leaf buds had started well, but not a blossom bud had moved and, on May 7th, it was regretfully concluded that all were dead, probably as the result of the winter weather. The tree grew well, and only a few live scales were noted in the examination made June 28th. These increased in number so slowly that not until October 19th, was it considered necessary to spray. Then applied Kill-O-Scale, 1 part to water 20 parts. October 25th, the little remaining foliage was somewhat scalded, and very few living scales remained.

November 2d, the tree had made a decent growth, and an abundance of fruit buds for 1905; foliage practically all off; some scale all over, but not much anywhere. A very little is on the new wood, and only at the base of the first growth is there any considerable number of specimens, all of them showing the effect of the oil application.

Tree 45.—Out and not to be replaced.

Tree 46—*Mountain Rose Peach.* March 10th, gave a rather thorough drenching with the Universal Insecticide and Scale Killer. The tree was not very badly infested, but could hardly have stood safely another season without summer treatment.

April 15th, sprayed from one side with the "Con-Sol," more with the idea of noting effects upon fruit buds than of adding to the effect of the previous application.

Leaf buds began to point out May 7th; considerable dead wood was noted, and the blossom buds had not started. May

11th, there were a few blossoms near the top of the tree, none of which set fruit. Growth continued, but was very slow, and the foliage was thin and yellow. Toward the end of June, it was apparent that the tree was dying slowly; but it held on until early September, when the leaves began to drop, and in a few days was all gone.

Scale breeding began June 28th, and continued throughout the season in almost as half-hearted a way as the growth of the tree itself. Whatever happened could not be charged to scale injury, at any rate. October 1st, the tree was taken out.

Tree 47—*Greensborough Peach.* Leaf buds began pointing out generally, April 26th, and started well, May 7th. Out of a heavy set of fruit buds one large showy blossom opened May 11th, and another May 17th, neither of them setting fruit. The tree grew well and symmetrically throughout the season.

June 28th, a few living adults and a few recent sets were recorded, but not enough to require attention. The number increased as the season advanced, but not very rapidly until September, and, on October 15th, it was found desirable to spray with Kill-O-Scale. October 20th, the foliage had been slightly scalded, and all but a few of the scales were killed.

November 2d, had made a good growth, and a heavy set of fruit buds, none of which showed any signs of injury from the oil spray; all the foliage was off. The trunk was pretty well infested by scale, and the branches showed a very considerable sprinkling. Everywhere, however, the effect of the oil was visible, and it seemed to have penetrated the great bulk of those black scales that otherwise would have provided for next year's crop.

Tree 48—*Black Tartarian Cherry.* Buds began to open April 26th; a few blossoms opened May 3d; was a mass of white flowers May 7th, and practically out of bloom May 11th. The fruit set was moderate in proportion to the bloom, but enough for the tree. June 8th, fruit began to color, and the tree was hung with red streamers to keep off robins. Thereafter it was a race between the children and the birds as to who should get the cherries as they ripened. There was no scale at any time.

November 2d, most of the foliage still on, but brown and discolored. The tree had done fairly well, had made a heavy set of fruit buds, and was practically free from scale.

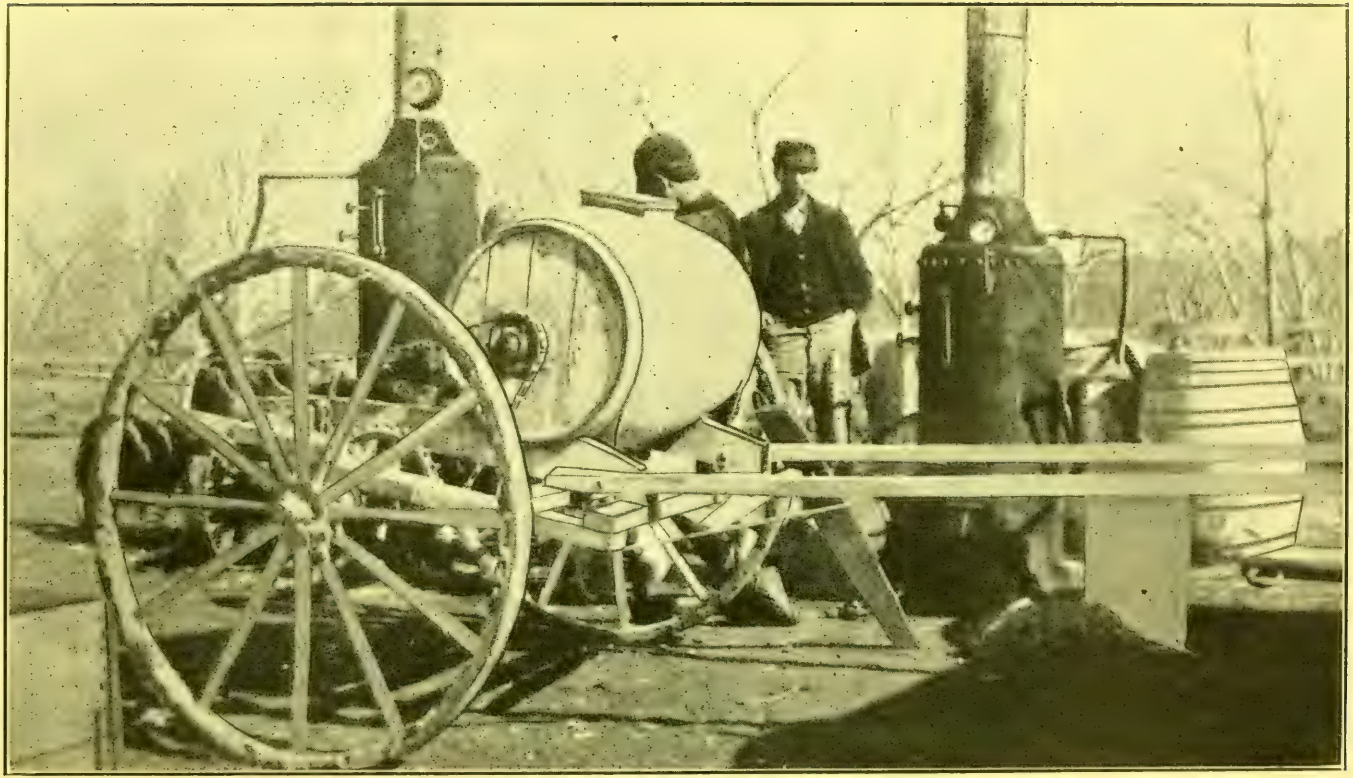

FIG. 13
Portables engines for boiling lime, sulphur and salt wash in Mercer County. Geared spraying Cart. Not a usual type for orchard work. From an original photo.

THE LIME AND SULPHUR WASHES.

Nothing is more disappointing than to find that after a series of apparently conclusive trials some unforeseen and unrecognized factor has come in to upset or confuse, or destroy confidence.

Nothing seemed better established by the results of work done and experiments made by practical fruit growers, horticulturists and entomologists than that the lime, salt and sulphur mixture, properly made and applied, was an almost complete remedy for the scale. Everybody seemed to be able to report success, no matter what the combination, nor how it was prepared, so that only it reached the insects. There was almost universal regret that we had not known it all before, and a thinly veiled suggestion that those who reported failure when first the washes were tried in the East, knew very little about their business.

And yet failure is the almost universal report that has come as the result of applications made in New Jersey during the winter of 1903-04; failure unexplained and unexpected, and all the more discouraging therefor. To be sure, the failures were not equally bad, nor unrelieved by occasional success: but these differences in result bring out a curious difference in the action of the washes on different trees. All successes were with peach and plum, and to their credit stand all the satisfactory applications that were made. The failures are in apples almost universally, and in pear generally. And those that failed were not novices, nor ignorant, careless farm hands; they were of the very best of our horticulturists, and the most experienced in dealing with both scale and wash. One large apple grower, who in early 1903 had congratulated himself that at last he had the insect under definite control, when questioned by a fellow sufferer in the summer of 1904, admitted that "for the last ten years I have had the scale, now the scale has me!" and that, in spite of a more thorough and faithful application of the boiled wash than was ever made before.

Another, among the first to proclaim the success of the wash under New Jersey conditions and who had, himself, started hundreds of growers to using it, admitted to me after midsummer that his orchard was then scaly as never before; that some trees showed dying branches and that others would need prompt attention to save them from the most serious injury.

In the belief that results were sufficiently positive to be reliable I started a farm to farm visitation in parts of Mercer and Mon-

mouth counties, examined orchards, and made personal appeals to fruit growers to treat their trees. There was a very general response to my efforts and on an area of several square miles almost every infested tree was sprayed. Many of the growers bought pumps and all necessary outfit; others put in or adapted steam boilers; and yet others engaged one of several individuals that made a business of spraying for hire. One grower of violets and carnations connected his boiling barrels with his greenhouse heating outfit, and prepared material for himself and his clients at least possible expense. The time was ripe for the campaign and everything pointed to success.

About the middle of July I sent Mr. Dickerson to make the round of sprayed orchards in Mercer county, and his report was the worst confirmation of rumors that had begun to reach me. Over so large a territory, on so many kinds of trees, with so many men at work, with applications beginning in January and ending only with the actual opening of leaf or blossom buds, I was prepared for reports showing a great diversity of results, and had arranged to secure details that might explain lack of success; but the reports were all one way, and it seemed as if neither time or the man at the nozzle, had much to do with it. As a rule the material seemed to have been well prepared, and that was made certain as to those spraying for hire, during the winter. With few exceptions the applications were thorough, and as to that it was possible to judge fairly, even so late as July 15th. A badly infested plum orchard, fairly coated with the scurf had been sprayed by one of those in the business, and it was a complete piece of work; not a larva recent set or live scale to be found. But on the Keiffer pears near by, sprayed by the same man, same time, same material, prepared in the same way, plenty of live scale. I verified this a month or more later, and found the difference striking.

Without going into details, it may be said that the applications on peach and plum had been reasonably successful in most cases; the exceptions readily explainable by conditions. On pear, and especially on Bartletts, failure had been almost complete and on Keiffer there was only a little better result. Peach and pear are very generally grown together in that section of Mercer county, and the contrast in the action of the material on the two kinds of trees was thus sharply brought out. Where trees alternate in a row, and the row is sprayed by one man or one gang, in one tour, and from the one barrel or tank, there can be no question of a difference in conditions.

Any difference in the result must be charged to a difference in the action of the material applied.

On this territory, too, while the boiled wash, made according to the formula in Bulletin No. 169 was used as a rule, there had been a number who had used the caustic soda combination without boiling and the results were approximately the same. Yet others had used the simple solution of caustic soda, usually at the rate of one pound in five gallons of water, and there the result was uniform on all kinds of trees. It made the bark look beautiful and cleaned off all the dead scales; but it left those that were dormant and furnished a nice clean place for the young to set.

During the past summer and fall, Mr. Dickerson and myself covered almost the entire State in the course of nursery and orchard inspections, and had opportunity to follow the results of applications of the most diverse kinds. Incidentally, it also developed the fact that most of our fruit growers are subscribers to one or more agricultural papers, and that they read them. I do not believe there was a single formula published during the winter of 1903-04 that was not used by some one. Furthermore, it appears that papers run to localities; one being almost universally referred to in one section, while some other was the favorite elsewhere. We therefore found men who had combined lime and sulphur with the heat of the slaking lime only; those that had omitted the salt in the boiling, and those that had added everything they ever heard of to the mixtures. It is fair to say that almost all the lime and sulphur combinations showed some benefit on peach and plum—even the simple lime and sulphur combination; but only the boiled wash had produced any really satisfactory results in actual reduction of infestation. On apple and pear the results were *nil.*

During September I was in a large orchard of apple and pear in Gloucester county, whose owner had in the past depended entirely upon crude oil for controlling the scale. The trees are nearly all old, in full bearing, the apple trees good for several barrels each, and with a spread of from 20 to 40 feet. Trees of this kind when once infested, can never be completely cleaned, because of the impossibility of reaching all the insects by our present mechanical devices, and spraying in some parts of the orchard is necessary each year. Impressed with the reports of the value of the lime, salt and sulphur, and the suggestion that the continued use of the oil would eventually kill his trees, he sprayed about half of the older trees with the boiled wash and

treated the remainder with oil, as usual. The results when I saw the trees were startling. Where the oil was used, fruit in great quantity, almost or entirely free from scale. First quality in every respect; both apple and what remained of pear; 2,000 baskets of Bartletts, all in good shape, having been previously taken off. In the lime-sulphur-salt section, fruit all spotted and gnarled, plenty as to crop, but much of it unsaleable and little of first quality. Pear almost worse than apple. The winter application had been as nearly wasted as anything can possibly be, and I doubt whether the trees could have been in worse condition had there been no treatment whatever.

In an apple orchard in Burlington county I made inspections twice, during September. These trees, in full bearing and excellent general condition, had been sprayed with the boiled wash during the winter of 1902-03, and the owner had been enthusiastic about the good result; and with reason, as I found by personal examination. He determined to make a final and complete job of it in the winter of 1903-04, and had two steam sprayers at work, plastering on the boiled wash as thoroughly as such a job can ever be done. The result in September was a greater scale infestation than ever before, with twigs and branches in some cases beginning to die on the more susceptible trees. So thorough had the application been, that traces of it were present on trunk and older branches in mid-September.

The owner found, too, on figuring the cost, that this wash is really about as expensive as any application that can be put on, when the cost of making and the quantity needed is considered. It is not a cheap wash by any means, and it is hard on the apparatus as well as on the men.

An explainable peculiarity was noted on some apple trees that had not been very scaly, had been very thoroughly treated, and on which the fruit became badly infested very early. In these cases the applications had been made late and held on well; but toward the tips of the twigs the fine, dense pubescence of plant hair, had caught and held the lime wash away from actual contact with the wood, and with the scale that had set on it. The first hatching very naturally made its way to the fruit, as the most attractive place for setting, and the latter broods remained as near at home as possible; giving a badly infested crop on a lightly infested tree. This feature is really a weak point in the lime and sulphur combinations. They are all so thick that the tendency is to put them on in a coarse spray, which

forms a coating *over* the fine, dense plant hairs. A great many scales are thus protected, especially near the tips, from actual contact with the wash, and mature undisturbed.

The experience of a Mercer county pear grower, who has used the lime-salt-sulphur boiled wash and the crude oil side by side for three years in succession, leads him to the conclusion that the boiled wash cannot be in the long run, satisfactory on old trees, especially those with the Bartlett habit of growth. It tends to intensify the roughness and scurfiness of the bark and twigs, and this affords shelter to the scale. The oil has the opposite effect; penetrating all crevices, softening the tissues and apparently stimulating growth. For the best effect the oil should be slightly warmed and put on in a very fine mist.

The experience of the past year has been instructive if disappointing. It is scarcely probable that at any time the material will make a worse showing, yet its value on peach and plum has been established, and its use is recommended. Judging the future from the past, it seems scarcely probable that the incomprehensible lack of effect on apple and pear will be duplicated at once. Yet if the material is not to be relied upon, it would be better to make two applications rather than one: the first any time after the trees are dormant, the second just before the trees make a start. The fall application will not injure fruit buds. On pear the oil is recommended applied under the restrictions given in Bulletin No. 169.

As to the make-up of the wash, I have drawn on the experience of not only our own growers, but those of other States, and the reports from other stations, and on the whole I prefer to adhere to the formula and directions of Bulletin No. 169, as follows:

Lime—stone or shell	50 pounds.
Sulphur—flowers or ground	50 pounds.
Salt	50 pounds.
Water	150 gallons.

Slake the lime with water enough to do it thoroughly, and during the process add the sulphur. Boil one hour, with just water enough to prevent burning and until the mixture becomes of a deep amber color. Dissolve the salt in water enough to do it quickly, and add slowly to the boiling mass. When all is thoroughly mixed together and has actually boiled at least one hour, add water enough to make up the 150 gallons and apply quite hot. If ground sulphur is used, boil at least one and one-half hours, to dissolve it all.

There are several modifications of the formula above given, which do not, in effect, change the real character of the mixture. The salt may be materially reduced, or omitted altogether. It is chiefly used to add to the sticking quality of the wash, but it is not certain that the combination of lime and sulphur is not favorably influenced by it. The lime may be considerably increased, and some formulas call for twice as much lime as sulphur, while lessening the salt by one-half. This gives an excess of lime that adds nothing to the value of the mixture, and may even be harmful by causing it to scale off more readily.

The point to be gained is a union of the lime and sulphur to make a double sulphide of lime, and this is accomplished by the boiling. Equal parts of each gives more lime than enough, but the excess is not in the way.

In Georgia, Mr. Hale sprayed his immense peach orchards with the boiled lime and sulphur combination, using no salt at all, and the results were excellent when I saw the trees late in July. Yet, as I understand, Mr. Hale will add salt in his next applications. It is not really necessary to add as much as the formula calls for, and probably fifteen pounds would answer as well as fifty. My opinion as to the amount of lime to be used is confirmed, and the thinner the wash, the better it will cover the entire surface. As to the time of boiling, practice also differs, and when steam is used a shorter time may suffice than in the open-pot method. The point to be gained is the complete combination of all the materials, and that is indicated by the color and transparency of the material. It requires a little experience to recognize the proper condition; but once recognized, the time of boiling will be whatever is required to obtain it.

Caustic soda, lime and sulphur is separately referred to, yet it may be in place here to express confidence that this also will redeem itself, though it may not be so good as the preceding.

The combinations effected by the heat of the slaking lime alone have not proved themselves of sufficient value in my experience to enable me to recommend them; but in case they are to be employed, boiling water should be used to mix the sulphur into a paste and to slake the lime with it. Heat is the great essential in effecting the combination and none can be wasted in heating the water used on the lime if a decent result is to be obtained.

LIME, SULPHUR AND CAUSTIC SODA.

The formula published in Bulletin No. 169 is as follows:

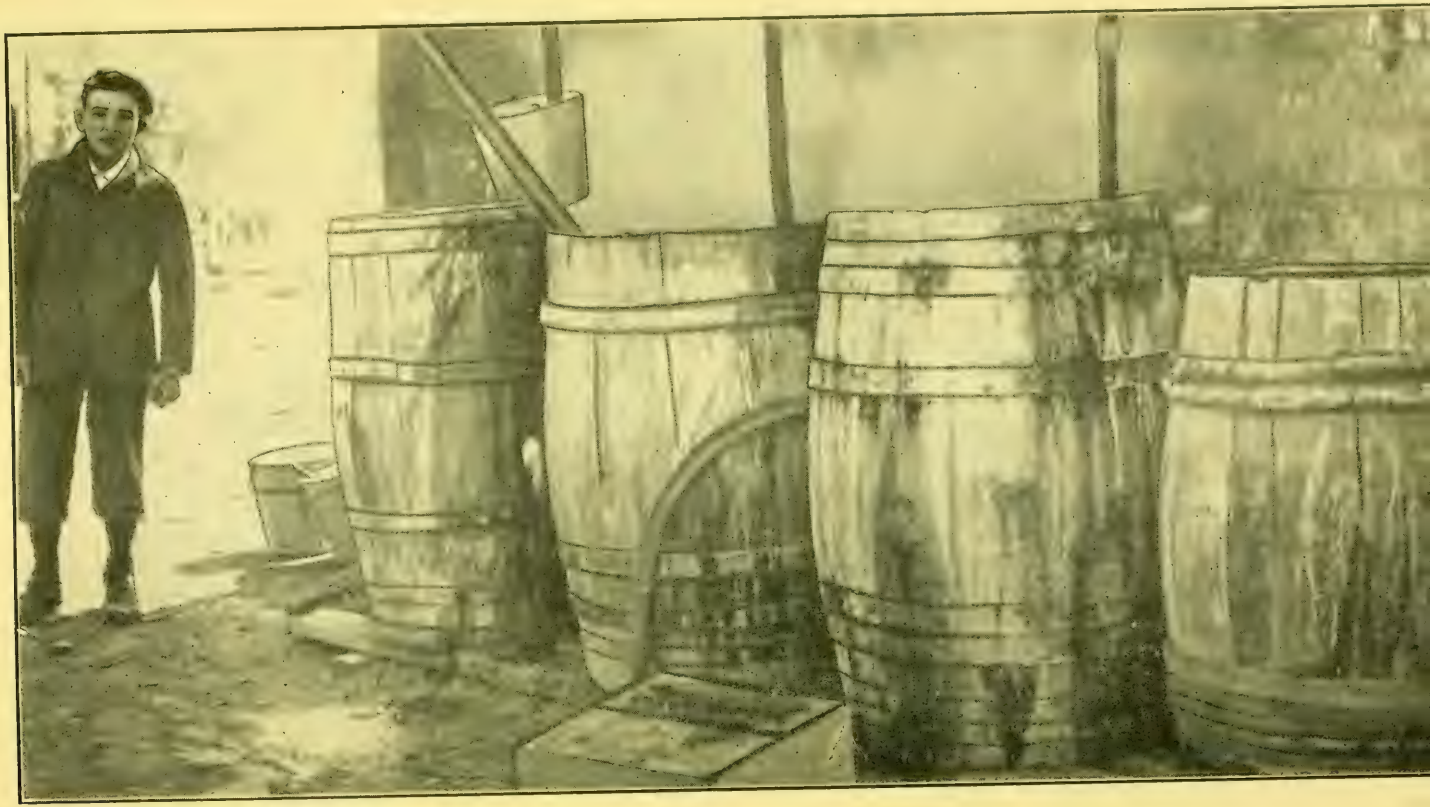

FIG. 14

Lime salt and sulphur boiling by pipes from a greenhouse heating plant. Steam pressure is always ready. From an Original Photo

Lime	33	pounds.
Sulphur—flowers	17	pounds.
Caustic soda	4½	pounds.
Water	50	gallons.

"Slake two-thirds of the lime with water enough to prevent either burning or drowning, and during the process sift over and stir in half the sulphur. Then add the remainder of the lime, with more water and, as the boiling continues, stir in the balance of the sulphur. Add water as needed, stirring to help the combination. While the mixture is yet steaming, add one-third of the caustic soda, which will cause a violent boiling, and before this is over add another third. If then, the mixture has not reached a brick red color, add the remainder. If too much water is used at the beginning or during subsequent operations, it may be necessary to use more soda than the formula calls for, to insure the red color of the mixture. This is then diluted to make fifty gallons."

"If warm water is used in the process the chemical action will develop heat enough to make a good combination of the lime and sulphur, and if warm water be used to dilute, a perfect spraying mixture will result. A good quality of stone lime should be used and a good quality of caustic soda or potash. Any of the usual "lye" preparations will answer; but it must be remembered that a can of "lye" does not equal a pound. Ground sulphur should not be used here, because it does not combine so readily as the flowers."

"This wash has been found quite effective, but it is not so good as the boiled mixture, and costs a little more. Its use is yet in the experimental stage; but as it is easily prepared, it will prove useful when only a little is needed. The combination originated with the New York Geneva Station."

Since the above was written it has seemed well to modify the suggestion that "Any of the usual 'lye' preparations will answer." Experience has proved that they are so variable in composition that it is almost impossible to anticipate what their action will be or how much will be needed. It will be cheaper and much better to purchase the caustic soda of 74 per cent. or over, in ten-pound cans. After the wash has been once made with this material, it can be again used in the same proportion with a fair prospect of securing a similar result.

Prof. Parrott, of the New York Geneva Station, has modified this formula slightly, using 30 pounds of lime, 15 pounds of sulphur and 6 pounds of caustic soda.

Mr. Wilmon Newell, State Entomologist of Georgia, has modified both the proportions and the method of making, and his formula is as follows:

Lime	16 pounds.
Sulphur	8 pounds.
Caustic soda—commercial	8 pounds.
Water	50 gallons.

"Mix the sulphur into a thick paste with a small amount of *boiling hot water*. Then add the caustic soda slowly (do not dissolve the soda in water), keeping the mixture thoroughly stirred. A brick red color will appear almost at once. Continue the addition of the soda, and continue stirring, adding small amounts of hot water as may be necessary to prevent the mixture getting too thick. The soda should dissolve all the sulphur in a few minutes, producing a clear, deep red liquid. Unless the liquid is entirely clear, with no particles of undissolved sulphur remaining, the mixture must be heated until all the sulphur is dissolved. *It is absolutely imperative that all sulphur be dissolved and a clear liquid obtained, before the lime is added.* To the clear liquid described, add the stone lime, previously weighed out, and while it is slaking keep well stirred. The completed preparation will have the familiar yellowish green color characteristic of the lime-sulphur preparations. Dilute with cold water to the desired point and spray at once." * * * * * *

"The effect upon the scale by this wash is not as good as the regular lime-sulphur wash, and in the case of badly infested trees therefore, two sprayings should always be given, the first in December and the second in February before the buds open."

The essential peculiarities of this wash are: That a chemical combination changing the sulphur and soda into liquid form is produced before any lime is added, and this combination unites readily with the lime; that it contains more caustic soda and less sulphur than any of the other formulas; and that the actual diluted material for spraying there is only one half as much sulphur and lime as in the original New York formula. Nevertheless, Mr. Newell ranks this as one of the best three winter washes, the boiled mixtures being given the precedence. Peach and plum, especially the former, seem to have been chiefly in mind in all the suggestions made.

I recommended the combination as published in Bulletin No. 160, throughout the winter of 1903-04, in all cases where only

a few trees were to be treated and had the opportunity of trying it in an infested apple orchard at South Branch. The trees were all in bearing and of good size, about twelve trees in a row and about seven rows in the orchard. The work was done with a Gould Kerowater barrel pump, the kerosene tank and pump disconnected, and the spray rod was a ten-foot gas pipe, with a triplet of Vermorel nozzles. The actual application began March 17th, under the direction of Mr. E. L. Dickerson, who made up the mixtures closely in accordance with the formula in Bulletin No. 169, and sprayed the first series of trees until the man in charge thoroughly understood the work to be done. The trees were sprayed from two sides and, though the application was not under supervision after the first day, there is reason to believe that it was faithfully made.

July 11th, Mr. Dickerson inspected the results of his work, and found considerable fresh scale and active larvæ at the ends of the twigs. Toward the center the trees were comparatively clean; but toward the tips the story was otherwise. "This, I think, was not due to poor spraying, but rather to the inefficiency of the material used, for on some of the young shoots growing at the center of the trees, where the application was heaviest, were a number of fresh sets. However, the trees on which I saw the numerous crawling larvæ and recent sets, have been very scaly. On three or four of the younger trees, which, however, are good, large bearing trees, there was little or no signs of scale."

Another orchard in the vicinity, sprayed a little later by the same man, with the same outfit and with material made up in the same way, showed most of the trees comparatively free, and only three or four, which had been very badly infested, had active larvæ in any considerable numbers. After midsummer the scale increased in the first orchard, peppering the fruit badly and bringing the trees at the end of the season into about the condition in which they were in early spring. Without any doubt a large percentage of scales was killed by the application made; but it did not prevent the serious spotting of the fruit, and absolutely no gain was made in cleaning the trees. They looked better in midsummer than they had appeared the year before, and something had been gained in that way; and at the worst no ground had been lost, while all around trees were dying.

The worst news came from those places which were believed to be especially within the range of this form of lime-sulphur-combination. In some of the gardens and grounds of cities and

towns like Plainfield, Montclair, the Oranges, Red Bank, etc., the pernicious scale had proved so destructive that the owners had become seriously desirous of obtaining some relief, and applied to the local florists, gardeners and nurserymen, who in turn applied to me. In almost every instance I advised this lime-sulphur-soda combination and went to considerable trouble in getting this matter of local spraying agents started rightly. A very large number of trees and shrubs of all manners and kinds were accordingly treated, and while nowhere extermination was promised, yet material improvement was foretold. Had there been a record of failure from one or two persons only, it might have been charged to carlessness or ignorance, but the reports were almost uniform of practical failure to get satisfactory results.

In the "Notes from the Rural Grounds" of the *Rural New Yorker,*" October 8th, 1904, the general situation is depicted in strong, yet not overdrawn colors. Among the orchardists where this material was used the results were the same, almost universally. The summer experiments with the half strength wash are recorded in the records of the Marsh orchard experiments.

CAUSTIC SODA.

This material came into prominence through publications in the *Farm Journal,* during the early months of 1904, and very positive assertions were made as to the effect of the simple solution, 1 pound of soda in 7 gallons of water, in California. As it seemed probable that a considerable amount of soda would be used as a result of this suggestion, repeated in other agricultural papers, it was determined to keep track of some applications made in New Jersey, and to make a few trials myself. I had the fortune also to learn of the results of applications made in Georgia during my visit there, and Mr. Newell has been good enough to send me an early copy of his published results.

Caustic potash and caustic soda are not new in New Jersey, and many of our fruit growers have used one or the other as a winter wash on trunks and branches to clean them of moss and other undesirable growths. The treated trees usually appeared, next summer, as if they had been polished, and there seems little doubt of the usefulness of the caustic soda applied in keeping the trees clean and in destroying such insects and fungus or other spores as might lodge on parasitic growths or

under loose bark scales. But so used, the strength of the mixture was generally in the neighborhood of 1 pound in 1 gallon of water, and I doubted very much the value of so weak a solution as 1 pound in 6 or 7 gallons of water. My personal work was, therefore, done with a solution of 1¼ pounds of 97 per cent. to 98 per cent. caustic soda, in 2 gallons of water. With this I sprayed two badly infested lilac bushes in the garden, and the following trees in the Experiment Orchard, March 9th, 1904:

Dwarf Pear, 1; Dwarf Duchesse Pear, 1; Lawrence Pear, 1; Greensborough Peach, 2; Elberta Peach, 1.
Trellised Apple, 1.
Nectarine, 1.
Japanese Chestnut, 1.

All of these trees showed a characteristic bluish tinge when dry, testifying to the thoroughness of the application and, later, the bark showed the clean, polished appearance already referred to. On the badly infested lilacs all the old scurf was cleaned off before the leaf buds unfolded, and on the surface so cleaned the real hibernating forms,—the black, nearly full-sized scales,—were seen in fine relief. Almost all the insects beneath these scales were plump and healthy, and during the latter part of June a full brood of larvæ testified that appearances had not been deceptive.

Of the treated trees the dwarfed pear died almost to the ground and remained fre from scales until August, neither facts being attributable to the soda. The Dwarf Duchess developed a small brood of larvæ late in June; but probably no fewer than the small infestation would have supplied otherwise. On the Lawrence pear, new sets were found June 27th, and these increased at such a rate that a summer application became necessary July 13th.

Of the peaches, one of the Greensboroughs died without making a start, but the death was not chargeable to the soda; the other was only slightly infested, yet on June 27th, larvæ and recent sets were present, and increased at such a rate that as early as July 8th, it was sprayed to check development. The Elberta also died before scale breeding began, although it did make a start.

The Japan Chestnut was treated only to see whether the caustic would have any appreciable effect upon it, and the answer was in the negative.

The Nectarine was only a little infested, yet, on June 27th, larvæ and recent sets were already present in such numbers that treatment was necessary July 8th.

The Trellised Apple received not only the March application but, on June 18th, a second spraying with caustic soda, at the rate of 1 pound in 4 gallons of water. The foliage was severely injured, but the scale began to breed normally, just the same.

A few summer applications were made with the soda solution, 1 pound in 4 gallons and 1 pound in 8 gallons of water. The main object of these was to determine the effect on the foliage, and this was such, in all cases, as to discourage its use altogether. I may add that my chief reason for distrusting the soda as a remedial agent was that it was one of the materials first tested when the scale was discovered in New Jersey, and was soon abandoned as useless.

In Georgia, the material was generally used at the rate of 1 pound in 6 gallons of water, and the testimony was almost uniform that no benefit whatever had been derived. Mr. Newell's published conclusion from his experiment plat is: "Compared with untreated trees upon the check plats, no difference in degree of infestation was observable."

The applications on the Rural Grounds resulted, October 8th, in the following: "The plain caustic soda solution, so confidently boomed in certain quarters, was extensively tested, and so far as heard from has been entirely useless as a scale killer, though most effective in excoriating the hands and inflaming the faces of those who applied it."

Early in the summer the clean and polished look of the bark, misled some growers into the belief that their applications had been effective, and that is excellently expressed in the following letter, dated September 8th, while the scale was yet breeding and hardly at its heighth: "After carefully examining the Keiffer pear trees, sprayed last winter with caustic soda, on the farm of my brother-in-law, I can now give you a better description of the results obtained. Mr. H——— informs me that he used the best quality of soda obtainable, and that it was 98 per cent. pure, and to each barrel of about 50 gallons of water he used 10 pounds of the soda, and covered the trees pretty thoroughly. In the spring, several weeks after spraying, he said the trees looked beautiful, and he was inclined to recommend the mixture as being very effectual; but he has since changed his opinion. The trees that were sprayed with caustic soda last winter and which promised so well, are now about as thickly

covered with scale as any I ever saw, and do not look at all thrifty, but are dark and sickly looking. Mr. H—— is preparing to have the trees taken out and destroyed, as he considers it a waste of time and money to spray with caustic soda and he does not think they are worth experimenting on with other spray mixtures."

A somewhat similar case occurred at Greenwich, where a small orchard of plum trees were very thoroughly treated in March, with 98 per cent. soda, at the rate of 1 pound in 5 gallons. Writing to me on June 6th, the owner believed the scale "to be dried up and killed," while his trees were making an excellent growth. July 7th, I saw the trees after the insects had begun to breed, and there was a different tale to tell. Quite a number of trees looked as if a considerable quantity of scale might have been destroyed, yet in nearly all cases the larvæ simply swarmed and recent sets were abundant. On some trees it seemed almost impossible that any scales had been killed. On a few there seems to have been a distinct check; but there is no way of determining whether or not it is due to the soda. Most of the trees were heavily loaded with fruit; but a few were almost bare. This was charged to the soda and, as the trouble was confined to Red June, unsprayed trees of which had a fair set, the charge may be well founded. There is certainly nothing in this orchard to favor the soda as a scale remedy.

On an orchard at "Bacon's Neck" the same owner had a good sized peach orchard—one of the finest in the State. In that orchard some half a dozen trees, badly infested by the scale, were discovered last year, and most of them severely cut back. The entire orchard of over 600 trees was sprayed at once with the caustic soda, 1 pound to 5 gallons of water, just as the trees were about to start. The infested trees were sprayed every time the wagon passed that way, the first application being in all cases the most thorough. In all cases the application seemed to have been an almost complete success. No injury had been caused to fruit buds and trees by any of the applications.

It will hardly serve any good purpose to multiply instances of failures observed in my trips through the State or communicated by growers. In general it may be said that the results were not sufficient to check the development of the scales to any appreciable extent. There may have been, and undoubtdly were, many insects killed; but on the other hand not enough to prevent a complete reinfestation by midsummer.

It was with some surprise therefore, that I heard several farmers speak of having obtained good results from their applications at the Somerville meeting of the Somerset County Board of Agriculture, October 15th. Both apple and peach trees had been treated, and while the scale had not been cleaned out, seemed to have been materially reduced in numbers. That locality had nothing to do with it, is proved by the fact that one of the most complete failures of the soda occurred not far from the meeting place, in an orchard of mixed apple and pear, where in early September every tree was almost literally plastered with scale after an early spring treatment with the soda.

In any case I cannot recommend the material as offering any reasonable prospect of producing good results.

SALIMENE.

Salimene is a grayish or bluish white powder, apparently a mixture of some lime compound, which was advertised very positively as a scale destroyer. It is manufactured by a Monmouth county corporation, which very courteously sent me a supply to be tested.

Most of the material was used with results that could not be accepted as a test of the real value, because of neglect on the part of the experimenter; but on six of my own trees I made the application and noted results myself.

All the applications were made April 5th, on the afternoon of a bright, warm spring day, when the trees were dry, and just before the buds began to swell out. The proportion was 1 pound in 1 gallon of water, and for convenience, warm water was used. It was first mixed into a paste, then stirred into the pail, from which it was transferred to the sprayer. It remained in suspension very well and was readily applied. When dry there was a whitish green deposit, something like that of the Bordeaux mixture. In each case the Vermorel nozzle was used and the application was thorough.

The trees treated were:

Pear—Japan Golden Russet, 2; Vermont Beauty, 3.
Peach—Greensborough, 1.

The Japan pears were not much infested in the first place and should have formed excellent subjects for the action of the insecticide; yet on June 27th, when an examination was made,

larvæ and recent sets were seen. They were not very abundant, for these trees never become very badly infested; but they were plentiful enough to make it desirable in one case to spray with another material July 13th. In the other, an application of caustic soda on June 18th added something to the effect, and re-spraying was not necessary until late in the season.

The Vermont Beauty pears were worse infested, and on all the treated trees larvæ were already setting on the fruit June 28th, just after breeding began. There was not even that check to the early brood that usually carries a treated tree into mid-summer before re-infestation becomes generally noticeable.

The peach was not badly infested and had received a dose of caustic soda solution before it was treated with Salimene; nevertheless, larvæ and fresh sets appeared quite as early as they did anywhere else.

Altogether, while the material has not had as extended a test as I intended to give, the results obtained were unsatisfactory throughout and not sufficient to warrant further trials or favorable recommendations.

UNIVERSAL INSECTICIDE AND SCALE KILLER.

This material, manufactured by a company bearing the same name as its product, and located at Flemington, New Jersey, was brought to my attention during the late summer of 1903, by inquiries from persons who had either bought or intended to buy it. As the company was devoloping quite a trade in Hunterdon county despite the high cost of its material, it was deemed best to give it a careful test.

At my request, the company sent me for trial a ten-gallon can, and also the approximate formula. The liquid, when received, had the appearance of the solution that forms in the lime, salt and sulphur wash when the lime settles to the bottom. There was very little sediment even after long standing and no formation of sulphur crystals. There was an odor of ammonia and some other disinfectant and, avowedly, the material was a lime and sulphur combination, with additions supposed to enhance its effectiveness.

The directions were simple: Add 5 or 6 gallons of hot water to each barrel, and spray. To my 10 gallons I added 1 gallon of boiling hot water, and the 11 gallons were applied, March 10th, to thirteen trees, some of them requiring only a pint to cover, others 1½ to 2 gallons. In each case the application was

as thorough as I could make it, and when dried, the trees had a bluish white appearance. In order to make the test as fair as possible, a variety of trees was selected, all of them infested by the pernicious scale and some of them badly infested.

The trees were as follows:

Plum—Mariana, 1.
Prune—German, 1.
Peach—Champion, 1; Greensborough, 1; Trellised European, 1; Elberta, 1; Mountain Rose, 1.
Apple—Yellow Transparent, 1; Grimes Golden, 2; Gravenstein, 1; Baldwin, 1.
Pear—Japan Golden Russet, 1.

Details of the applications, all of which were in the Experiment Orchard, and were made by me or under my personal supervision, are in the Records of the Orchard, printed elsewhere in this report.

Briefly stated here, the results were totally unsatisfactory. In not a single instance was a tree so far cleaned as to preserve it for the season, and in every instance where the tree was at all badly infested, the first brood developed in such numbers that immediate treatment was demanded.

It is perhaps too much to say that the mixture did not kill any of the scales; but it certainly did not kill more than a very small percentage. Based on my own experience, better results can be obtained with materials costing only one-fourth as much; hence, any use of the Universal Insecticide and Scale Killer as against the pernicious scale, is a mere waste of money.

PETROLEUM PREPARATIONS.

Petroleums, crude or in the refined forms, have maintained themselves as scale killers during the past season, though there was less oil used than during the years last preceding because of the general rush to the lime-sulphur compounds as safer and equally effective.

There is, unfortunately, no doubt that the mineral oils are dangerous to plant life and that all the factors that constitute this danger are not yet understood. Some few growers have learned to used them with confidence, to the benefit of the trees and the discomfiture of the scale; but they are in the minority, and most men in using the undiluted oil, stand at least an even chance of causing injury. To obviate this trouble and to reduce the oils, emulsions with soap and mechanical mixtures, have

been proposed and used with greater or less success. The kerosene emulsion with milk and soap, first prepared in the course of the work of the Entomological Division of the United States Department of Agriculture, is of course well known, and has been widely and successfully used. But there was the work of preparation, and the fact that, without soft water, it was difficult to get any emulsion at all. The farmer or fruit grower does not ordinarily like to make complicated mixtures, or those requiring any special apparatus for preparation. Hence, the kerosene emulsion was never given the wide use that its merits deserve. Used as a winter wash as against the pernicious scale, it developed that, when used in a dilution containing 15 to 20 per cent. of kerosene it was much more injurious to trees than even undiluted kerosene; hence, its application to this purpose was never urged. More recently, especially through the efforts and experiments of Dr. Howard E. Weed, now of New Hampshire, the idea of a mechanical mixture of kerosene and water was developed, and after many experiments, pumps so arranged as to spray kerosene or other oils and water in definite proportions were put upon the market by a number of manufacturers. These pumps were intended to bring to the nozzle oil and water in uniform proportions, the globules of oil and water so mingled as they emerged from the nozzle that the effect would be that of a very thin, evenly distributed coating of oil, which would be sufficient to kill insects, yet not enough to injure vegetation. This gave the oil a much more extended field, and a large number of emulsion pumps, knapsack, barrel and tripod, were soon in general use. As a whole the results were good; but even the best of the pumps proved erratic in action sooner or later. Of two pumps of the same make one would work beautifully when received; the other would be unreliable from the start; or an obstruction to one pump or valve would result in an application of all water or all oil, or a percentage different from that intended, and the consequences would be either injury to the tree or lack of effect against the insects. Nevertheless, much good was accomplished with combination or emulsion sprays, containing 20 to 25 per cent. of kerosene, and these were usually safe upon trees and shrubs of all kinds. But the necessity for a special pump, even if it could be disconnected so as to be used for a simple mixture was a drawback, and there was real demand for some method of using the oil without all the bother of either an emulsion or special pump.

When the question of dealing with mosquito larvæ arose one

of the investigators demanded an oil that would be soluble in water and would diffuse through it, so as to reach larvæ everywhere, even if they retreated to the bottom. This set chemists at work and there were, in a short time several preparations, all of them purporting to be crude oil, rendered soluble in water. The most complex of these—taking the manufacturer's word for its combination—is Kill-O-Scale, which is elsewhere dealt with. I have, besides, three other samples, two of them based on the heavy Texas oil; one of them from the Ohio fields, with a vaseline base. All of these dissolve in or combine readily with water, forming a milky emulsion. One of them only has been actually tested in the Experiment Orchard, in a very limited way. All of them offer fair chances for success as against the scale insects without harm to the trees.

The advantage of crude oil as a scale killer over all other insecticides is its penetrating power, combined with lasting qualities. If this can be held in a preparation that will mix readily and evenly with water, whether we call it an emulsion or a solution, it will simplify our battle against the insect and encourage a more general fight. Many men will not try to clean their trees simply because of the caustic character of the mixtures most generally recommended. With a soluble oil, obtainable in any desired quantities, ready for a simple mixture with water, effective against insects and safe on plants, the temptation would be to at least try to clean trees and other infested plants.

Up to this point I have used the soluble oils only as summer mixtures and as such they have approved themselves. Whether they will act equally well at the same dilution against the dormant scales, remains to be proved.

KILL-O-SCALE.

This is a combination put upon the market by the Griffith & Turner Company of Baltimore, Maryland, concerning which they wrote me early in September, suggesting a trial. In answer to my request for its composition and character, they advised me that it was a combination of heavy kerosene, sulphurated oil and resin, made soluble in water "by a process known only to the manufacturers." They advised me of forwarding a gallon for trial, and suggested that it be used, in part at the rate of 1 to 20, and the remainder 1 to 25, of water. They further wrote concerning it, "that Kill-O-Scale is not a summer application; it is a dormant spray, but can be used after the fruit is taken

from the trees up until blossoming time in the spring. If used in hot weather it will defoliate the trees, and we do not recommend it for summer work."

After a preliminary test I ordered 10 gallons of the material sent to the Marsh orchard, retaining the sample for use in the Experiment Orchard. The price of the material is $1.25 per gallon, which when diluted by 20 parts of water, will bring the cost of 1 gallon of diluted mixtures to 6¼ cents per gallon, exclusive of the cost of transportation and application.

The percentage of actual oil in the material when diluted was so low that I decided to make use of it at the rate of 1 to 20 of water, in an attempt to control the late fall development of the scale.

Applications were made under my direct supervision in the Experiment Orchard, and at my direction in the Marsh orchards, by Harold O. Marsh. In each case the applications were made in October, and on trees that had been ineffectively treated with other materials during the summer. In the Marsh orchard peach trees only were treated; in the Experiment Orchard, plum, apple, pear and peach, 14 trees. In all cases there was a more or less obvious mottling, discoloring or scalding of the foliage; but that did not, in any instance, amount to a material injury to the tree. In every case the effect upon the scale was marked. Larvæ and recent sets were wiped out of existence at once, wherever the material reached them. Breeding adults were killed in most cases; but apparently adults that were ready to reproduce but had not yet begun, escaped in many cases. So, it is probable that some of the half grown black scales were sufficiently resistant to protect the insects beneath them. Unlike the other materials used, this exerts a continuous action for some time, the resin perhaps holding it in contact with the insects and giving opportunity to penetrate.

The time during which the material has been kept under observation is not sufficiently long to authorize a final determination; but certainly we have come nearer to a preparation of petroleum which may be diluted with water, and it offers the best chance of a satisfactory effect of any of the preparations now on the market—though at a somewhat unreasonably high cost.

PYROL TREE AND PLANT SPRAY.

This is in the nature of a pine tar preparation, manufactured

by the Southern Oil and Chemical Company, Mobile, Alabama. Added to water it forms milky emulsion, fragrant in odor, and leaves when drying, a thin, sticky residue.

There was only a small amount of material supplied, and it was used at the rate of one part of Pyrol to 40 parts of water, although 1 part to 50 was recommended. Application was made June 30th, through a "Mistry" nozzle, and the trees were thoroughly covered. Unfortunately, within two hours thereafter, it began to rain and was showery throughout the night. It is more than probable, therefore, that the material was washed away in great part, and did not produce as good an effect as it might have done otherwise. Lack of material prevented my duplicating the experiments.

Six trees were treated:

1. *Mariana Plum.* With many recently set scales and active larvæ. The application was imperfect in that the tree was sprayed from one side only; but from that one side the application was thorough. July 8th, the foliage appeared to be somewhat scalded in the center; but no apparent effect upon the scale could be discerned.

2. *Apple.* Gravenstein, 1; Yellow Transparent, 1; Baldwin, 1. All of these were pretty well peppered by developing young and recent sets—ideal conditions for a material of this kind—and all were thoroughly treated. A week later conditions had not improved, but were on the contrary, much worse; the material had been absolutely ineffective..

3. Pear. Vermont Beauty, 2. Were in the same condition as the apples, were treated as thoroughly and the result was identical; the scale was in no way reduced. No sort of injury was caused to the foliage of either apple or pear.

HORTICULTURAL COMPOUND.

This is a soap mixture, originally manufactured at Port Monmouth, New Jersey, and intended for general insecticide work; more especially as against plant lice and the like. It has the appearance of a resin soap, containing also tobacco as an accessory, and in texture is like a hard butter. It dissolves quite readily in warm water. All applications were made through a Vermorel nozzle, at the rate of 2 ounces in 1 gallon of water, or double the strength recommended on the circular received with the material.

July 5th, sprayed my entire row of grapes, about 75 feet in length, to test against the leaf hoppers, which were very abundant

in all stages, from the minute young to the adult. The application was very thorough, made so as to hit the underside of the foliage, and extended beyond the vine limits to hit the flying specimens. Two days later the number of leaf hoppers had been very decidedly reduced. There were still a considerable number of adults and partly grown individuals, but not nearly so many as there were when the spraying was made. A distinct coating was left on the underside of many of the leaves, making them look discolored; but as a matter of fact there was no real injury of any kind to the foliage. The application may be considered as rather a satisfactory one and would have been duplicated had it not been desired to test another material on the same class of insects.

On July 5th, sprayed experiment trees 18, 19 and 21, all Vermont Beauty pears, on which larvæ and recent sets were moving in considerable numbers and spotting the fruit. Five gallons were put on these trees, making the application a regular drench. Two days later no moving larvæ were found on the sprayed trees and many of the recent sets had collapsed; but the older sets seemed to have escaped injury very largely. On tree 18, the scales recovered so fast that it was necessary to re-spray August 19th, and again August 29th, with the same material, and on September 16th, a soluble crude petroleum was applied, closing the career of the compound on this tree. Tree 19 was not resprayed with the compound until August 29th, but the effect here was also so unsatisfactory that the soluble petroleum was resorted to September 16th. Tree 21 had the same history as tree 19.

July 8th, sprayed experiment trees 1, 2, 7, 8, 15, 20, 23, 24, 26, 30, 31 and 38.

Tree 1. *Mariana Plum.* Had been previously treated with a winter wash and with the Pyrol spray; but was again in need of attention. This application produced very temporary results and others were made of the same strength, August 19th and 29th, resulting only in checking development until October, when Kill-O-Scale was substituted.

Tree 2. *Yellow Transparent Apple.* Had been previously treated with a winter wash and with Pyrol tree spray; but again needed attention. The further history as to re-spraying is as for No. 1, except that it became necessary to substitute petroleum as early as September 21.

Tree 7. *Champion Peach.* Had been previously treated with a winter wash, which had not been effective. This application

lasted only until August 19th, when a second and, August 29th, when a third application was made. These lasted until October 10th, when a petroleum spray was considered essential for the tree.

Tree 8. *Grimes Golden Apple.* Had been winter treated, but was then infested by larvæ and recent sets. The check produced was sufficient to carry the tree safely to October 14th, when it received a petroleum treatment.

Tree 15. *Japan Golden Russet Pear.* Had been winter treated, but was then infested with larvæ and new sets. The application reduced the insects to so low a point that no further treatment was deemed necessary that season.

Tree 20. *Meech Quince.* Had not been previously treated and was only a little infested. The application was sufficient to keep the tree in good condition during the rest of the summer, but left it pretty well infested in November.

Tree 23. *Greensborough Peach.* Had been winter sprayed and was only moderately infested by larvæ and recent sets. So many survived the application that respraying was necessary August 29th, and that carried the tree until October 19th, when it needed, and received an application of Kill-O-Scale.

Tree 24. *Greensborough Peach.* Had no winter or other previous treatment and the infestation was not yet bad. Almost no good resulted, and on August 19th was resprayed, in much worse condition than the month before. August 29th, received the third application, and yet needed and received a petroleum spray September 26th.

Tree 26. *Nectarine.* Had received a caustic soda application, but was then generally infested with larvæ and fresh sets. This checked the scale until August 29th, when it was again abundant enough to require a treatment which lasted until September 26th, when a petroleum application was made.

Tree 30. *Grimes Golden Pippin.* Had been ineffectively winter treated and had received a Pyrol treatment June 30th. Was yet infested sufficiently to demand another application, and that lasted until August 19th, when a new application was made, though not really necessary. Ten days later, however, it needed the third spraying, received at that time, and that carried the tree to October 14th, when it was worse than any time before in the season and received an application of Kill-O-Scale.

Tree 31. *German Prune.* Had received a winter application and was not very badly infested; the treatment was sufficient to

carry it to the end of the season, though in quite a scaly condition.

Tree 38. *Baldwin Apple.* Had been ineffectively sprayed in March, and on June 30th with the Pyrol spray, which yet left a very heavy lot of larvæ and recent sets. The check was satisfactory until August 19th, and the spraying at that time lasted until the 29th, when the third application was made. Infestation increased thereafter until, October 14th, the tree was treated with Kill-O-Scale.

August 19th, trees 1, 2, 7, 18, 24, 30 and 38 were sprayed as before. All of these were resprayings, more or less urgently needed. Rain rendered this application of little effect, and on August 29th, sprayed trees 1, 2, 7, 18, 19, 21, 23, 24, 26, 30 and 38. All of these were also re-sprayings.

In all 15 trees had been treated, 3 of them once only; 4 of them twice, and the others three times, always with the mixture of the same strength. In each case there was a temporary check, the larvæ and recent sets being killed; but always the older scales were left alive and in a week or two matters were nearly as bad as before.

A stronger mixture than that used would be likely to hurt foliage and could not be advised; in all, while this horticultural compound is a tolerably good insecticide and would probably be entirely satisfactory against plant lice, it cannot be recommended as against the San Jose, or pernicious scale.

ROSE-LEAF TOBACCO EXTRACT.

This preparation is my usual reliance in dealing with such plant lice as appear on roses and other usual garden plants, and I am not particular as to the exact proportions used—getting enough to make a strong tobacco water in all cases. This past season I determined to test it as against leaf-hoppers and scale larvæ.

July 13th, sprayed my row of grape vines, about 75 feet long, with the extract at the rate of 1 pound in 5 gallons of water. The vines were infested by the common grape leaf-hopper and had been already sprayed with the Horticultural Compound, July 5th, with very good effect. There were, however, many of the insects yet remaining, and as my neighbor's vines are much worse infested than my own, I believe part of the supply then on hand came from him. The spraying was done with an adjustable nozzle, so as to hit the underside of the foliage, and the

spray under considerable pressure, was forced around the vines so as to fill the air and hit the insects attempting to fly away. The result was excellent, and while leaf-hoppers were present during the remainder of the season in small numbers, they were not plentiful enough to seriously affect the foliage, which remained on longer and in better condition than ever before in my experience. None of the leaves turned completely rusty and dry before maturity, and the amount of benefit derived was easily observable by comparison with other nearby vines.

On the same day sprayed also 1 Japan Golden Russet pear, 1 Lawrence pear, 1 Gravenstein apple and 1 Baldwin apple. The results were unsatisfactory and inconclusive. Examinations were not made until several days after the spraying and at that time matters were in much the condition they were when the work was done. It appeared probable that most of the moving larvæ and some of the recent sets had been destroyed· but there certainly had been no effect upon the number of older forms nor upon the breeders. A simple tobacco mixture is evidently not sufficiently active to reach these scale insects in any but the naked stage.

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