# 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 1905.

TRENTON, N. J.:
THE JOHN L. MURPHY PUBLISHING CO., PRINTERS.
1906.

Report of the Entomological ...
Department of the New Jersey Agricultural College Experiment Station /

# TABLE OF CONTENTS.

# TABLE OF CONTENTS.

# REPORT OF THE ENTOMOLOGIST.

# REPORT OF THE ENTOMOLOGIST.

BY JOHN B. SMITH, SC.D.

## GENERAL REVIEW.

The winter of 1904–05 was not a severe one, albeit the cold was continuous and freezing weather extended well into the spring months. There were no spells of very low temperature, however, and altogether it was a good winter for hibernating insects. Fruit trees started at New Brunswick about a week earlier than in 1904, but were held back by subsequent cold until, by the beginning of June, a normal season was at hand. Then came a period of dry weather of unusual length, though not equally marked in all portions of the State. With this came also a few days of excessively hot weather, which had a serious effect upon some of the city shade trees, especially maples. After midsummer, when the drought was broken, there was rain in abundance everywhere. In a general way it may be said that the season was favorable to insect development, and if there were no remarkable outbreaks, there was at least a very uniform record of injury on many kinds of plants and trees.

## THE SAN JOSE SCALE.

This insect continues to be the most important of those affecting our fruit crops, and there are now few localities where it does not occur. Nevertheless, there are such localities, and in most of them the fruit-growers keep a close watch for signs of infestation. In many cases the owners of small, infested orchards have given up the fight, and some old orchards, especially of peach, have been abandoned. The peach trees usually die promptly enough, and disappear as a source of danger; the apples linger for several years, dying down slowly and gradually unless cut out. At the same time, even in localities where the scale occurs, there are orchards in which good, clean fruit is secured,

and which pay satisfactory returns. The early brood of larvæ in 1905 was unusually heavy, and more spotted fruit than usual was seen before the beginning of July. But the later conditions were less favorable for their development, and the second brood was not nearly so large as was threatened. Nothing new has developed in the life history of the species and no new natural check has been discovered.

It is not infrequently asserted that there is some natural enemy that is active on unsprayed trees, and it is undoubtedly true that some orchards that have never had treatment of any kind have remained remarkably clean. But this does not seem to be due to the presence of any parasite or specific disease; the insects simply do not multiply. Whether that is due to any surface condition of the trees or to some physiological peculiarity seems to be incapable of determination at present. It is certain, also, that some orchards that were once badly injured and left to themselves have in a way recovered and adapted themselves to the presence of the insect. But, on the other hand, the further fact remains that entire orchards of apple, pear, peach and plum have been completely wiped out by the scale, and that it would be taking large risks to trust to natural exemption when an infestation is first recognized.

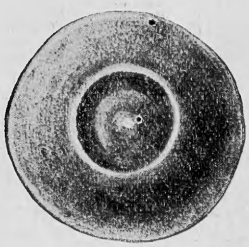

**Fig. 1.**
Half grown scale, showing condition in which winter is passed; much enlarged. From Bull. Va. Sta.

But, while nothing new in the life history has been discovered, it is believed that a somewhat different period of applying insecticides is indicated by experience. Heretofore the tendency has been to postpone the applications to the last possible moment, and we have advised spraying just before the trees made a start. This seems to be hitting at the insect while it is yet in its dormant and most completely protected condition and before spring development has begun. The reasons for advising this period has to do with the effect of the insecticides on the trees, and with the belief that late applications would remain long enough to be, in a way, protective as against the first brood.

Whale-oil soapsuds were found to be destructive to fruit buds if applied in early winter at a strength sufficient to kill the insects. Petroleum was found to be more likely to cause injury when allowed to soak for months into a dormant bark than when applied on an active

surface with sap-filled cells; and as to the oil, it was certainly true that a greasy coating remained long after the trees had started.

But experience seems to indicate that trees are almost equally resistant just before they become dormant, except against fish-oil soap and that the scales at that time, being still in the full tide of activity, are much more susceptible.

We know positively, now, that the soluble petroleum or emulsions will cause no injury to fruit buds or tree when applied in late October and early November, and such work as has been done with the lime and sulphur combinations indicates the same thing for them. The K.-L. has been used at almost all strengths during summer and winter, and should be no more harmful than undiluted kerosene, which has been safely and effectively used.

**Fig. 2.**
An adult female scale from below; the real insect is below and to the right, separated from its covering. Much enlarged. From Bull. Va. Sta.

My suggestion is, therefore, that the best time for spraying against the scale is when the fruit is all off; when the foliage is mature—just ready to drop—and while the scale is yet active. This period will vary with locality and with the kind of tree. By the middle of October, in the northern part of the State, peach trees may be treated, and by the first of November apple trees will be ready. In the southern section the scales have been found yet active early in December, but such specimens stand no chance of surviving.

No scale that begins to breed in fall lives through the winter, no matter how few young she has born, and no fertilized female ready to bear, survives. No larvæ born after the sap has ceased to circulate reach a stage that will carry them safely until next season. Only those survive that reach the half-grown black stage, when the scale is thickest and most closely applied to the trunk. These are the forms

that swarm on the trees as larvæ in early October, and these are the insects to be aimed at. The fact that no reproduction takes place until after June 10th, and that when it does begin almost every female is at work within a week, indicates a remarkable uniformity in the state of the development of the hibernating forms.

As to the insecticide, that may be anything that the fruit-grower is familiar with and in which he has confidence. Personally, I prefer the soluble oils, elsewhere described in this report, and they are probably almost equally effective. K.-L., properly made and thoroughly applied, would come next in order, and then the lime and sulphur combinations. If the regular boiled mixture is to be used, the amount of salt may be reduced to one-fourth of the normal quantity, assuming that the formula recommended by me is used. The self-boiled mixture, without salt, may be used if carefully made, but the caustic soda formula had better be used experimentally only. It is believed to be the caustic soda that causes injury to fruit buds, and for that reason no wash containing any large percentage of it can be considered safe. On peach orchards the lime-sulphur mixtures have a claim to first place because of their influence on leaf curl and other troubles, and because, somehow, they seem to improve the condition of the trees.

**Fig. 3.**
Scale on a branch, showing adult females and recent sets. Much enlarged. From Bull. Va. Sta.

Whatever is used should be applied as thoroughly as may be, and the spray should be driven into the trees with as much force as possible. One application, October 15th, and a second, November 1st,

**Fig. 5.**

The Niagara Sprayer and crew in action, at Newark. Two leads of hose each with 4 nozzles. From an original photograph.

may be made if the soluble oils are used, and the dilution for the first spraying may be 1 to 25. If only one spraying is made it should be 1 to 20. If the K.-L. is used and two applications are made, 20 per cent. kerosene will be sufficient for each. If the lime and sulphur mixtures are to be used one application only, at full winter strength, is advised; but in the case of badly-infested trees a second application may be made in spring.

It is believed that the practice here recommended will give much better results than any that has heretofore obtained.

## THE PEACH SOFT SCALE.

In 1904 specimens of small, brown, soft scale were sent in from Bridgeton, with the report that it was plentiful and injurious in some peach orchards. In the summer of 1905 further communications were received, and after some correspondence I sent Mr. Dickerson to investigate, on the occasion of a nursery inspection trip, and later visited the infested territory myself. The insect turns out to be a European species, which up to the present period had not been known to exist in New Jersey, and even now seems to be confined to a small area lying southward from Bridgeton. As there is a possibility of its spread it is deemed well to give, on another page, a brief account of the life cycle of the species, taken chiefly from a paper on "Some Scale Insects of the Orchard," published by Dr. L. O. Howard, in the Year-Book of the United States Department of Agriculture for 1904.

## SHADE TREE NOTES.

There has been much complaint of injury to shade trees of many kinds, and the general tendency has been to charge insects as the cause of the trouble, but not justly in all cases. Tulip trees have in many places lost a large part of their foliage, which turned yellow and dropped. Some of the leaves had one or more large brown or blackish blotches, and when these were sent to me I recognized the work of a leaf-miner, the larva of a small fly; but this did not account for the dropping of that vast majority that showed none of these spots. Conifers on lawns and in parks were also attacked by some disease that caused them to turn brown and die, and on these a little *lepidopterous* borer in the pine needles, or a plant-louse at their base,

were unjustly accused of the injury. Elms suffered less than some other trees, except that the injury directly due to the elm-leaf beetle was much intensified by the drought. Maples of all kinds suffered from one cause or another, and the hard maples were, on the whole, much more injured than the soft varieties. The latter were the especial hosts of the cottony scale, but that insect met with the expected natural check in the form of the little geminate *Hyperaspis,* as is detailed at some length in another portion of the report. The hard maples became infested after midsummer by the false scale (*Pseudococcus aceris*), but that was not accountable for the mortality among them. The trouble was described thus: "This begins by the top and outer extremities, or perhaps a limb dying the first year, and then the rest of the tree goes, until in two or three years the entire tree is dead." Complaints of this character came from many places, but more, on the whole, from the hilly towns on and near the base of the Watchung mountains. To attribute a probable cause to this effect would be mere guesswork, and as the insects were certainly not in fault, its investigation was not matter for this department.

Shade trees, as a whole, have had more care and attention throughout the State than ever before, and there has been a steady demand for copies of Bulletin No. 181, dealing especially with the insects injurious to them.

During the past season the Shade Tree Commission of the city of Newark has made systematic efforts to improve the condition of the trees in the streets and city parks which were placed under its jurisdiction. A 150-gallon Niagara gas sprayer was purchased, together with an outfit of poles, nozzles and hose that would make it possible to reach the tops of the highest trees. The sprayer worked well and proved especially satisfactory, because there was nothing in the way of machinery to get out of order, and because exactly the amount of pressure needed was always available. Kill-O-Scale as a contact insecticide and arsenate of lead as a stomach poison were used, and the insects especially dealt with were the cottony maple scale, the elm leaf beetle and the vaporer moth. Incidentally, of course, quite a number of other species were reached, and, altogether the condition of the trees was materially improved.

During the winter the trees had been shaped up, borer-infested limbs were cut off and dead wood generally was removed, all of which simplified the task of spraying materially.

**Fig. 6.**

Sugar Maples on Midland Avenue, East Orange, as shaped up by the Shade Tree Commission. From an original photograph.

**Fig. 7.**

Spraying outfit of the East Orange Shade Tree Commission; the Secretary, Mr. Solotaroff, at the front of the wagon. From an original photograph.

An interesting experiment was made, when, after the first brood of the *vaporer moth* had hatched and egg masses began to appear on the trees, a reward of ten cents per quart was offered for egg-masses, to be brought to a specified point at a specified time. Mr. Carl Bannwart, who was in general charge, reports that altogether a little less than $20 was expended. By actual count, one lot of two quarts contained 387 egg-masses, and a three-quart lot sent to me contained 425 egg masses, the balance being made up of cocoons, pupæ and the like. This makes an average of 166 egg-masses per quart. At my request, Mr. Dickerson counted the eggs in four masses of average size, obtaining as the result 369, 412, 327, 470, or an average rate of 349 eggs per mass. At that rate each average quart would contain about 65,404 eggs, and the 200 quarts for which $20 was paid, purchased 13,080,800 eggs. This is not exactly a bad investment, especially as experiments showed that most of the eggs were viable.

In East Orange the spraying outfit is modeled after that employed by Mr. E. B. Southwick, the Entomologist to the New York Park System, and a three horse-power Daimler gasoline engine furnishes the power. The cottony maple scale was the species more particularly aimed at there, and, instead of using an insecticide, a solid small jet was used to dislodge the insects when they became prominent. Two nozzles employed in this way cleaned a good-sized tree in twenty minutes. This method has the merit of simplicity and safety to foliage, and seems to have been very successful. In towns and cities with good water pressure, an ordinary garden hose could be used to good purpose for the same end.

In other cities and towns throughout the State various measures were adopted. Sometimes the governing bodies of the municipality provided the necessary funds, but quite frequently local improvement associations attended to the work from funds paid in by members or from those whose trees were treated.

## OYSTER-SHELL BARK-LOUSE.

The *oyster-shell bark-louse* as a shade-tree pest has not been heretofore especially troublesome; indeed, except on some butternut and walnut in the northern counties, it has been a negligible quantity. When it occasionally became rather plentiful on some orchard trees, a single treatment in June was advised and was generally all that was

needed. On lilacs, when it became troublesome, it was suggested that the worst infested shoots be cut out, and more than that has not been necessary.

Complaint has been made at Hammonton for two years last past that the city shade trees were badly infested by this insect, and that

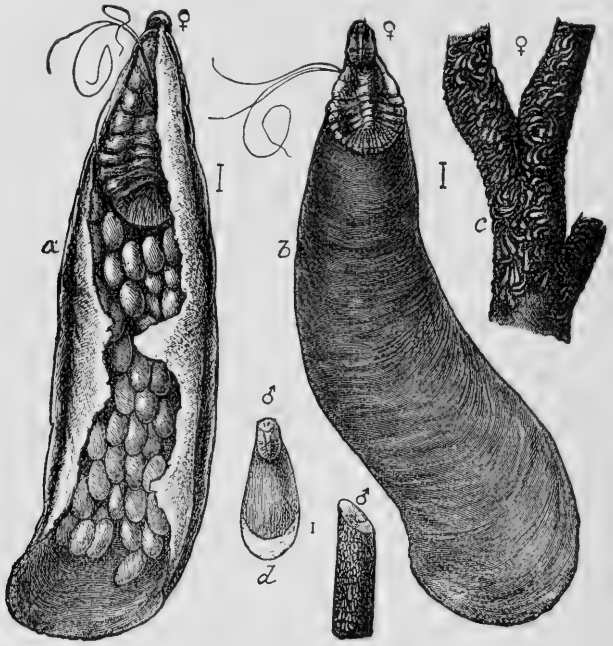


**Fig. 8.**

The Oyster-shell Bark-louse, *Mytilaspis pomorum* Bouché: *a*, female with the egg mass beneath the scale; *b* same from above, showing the normal appearance of the species; *c*, a twig infested by females; *d*, the male scale, natural size and enlarged. From Div. Ent., U. S Dept. Agric.

maples in particular were actually dying under the attack. When these complaints were renewed in the spring of 1905 I advised the application of whale-oil soap, one pound in five gallons of water, when the larvæ were active, and that active period began, as we observed from specimens sent in, as early as May 15th, young scales being already set May 26th. In mid-July specimens sent in contained what seemed a mixture of partly grown and hibernating scales, but a second sample, received a week later, proved that at Hammonton this insect is two-brooded, and that larvæ of the second brood begin to move during the

last days of July. I was also advised that, at the rate of one pound in five gallons of water, whale-oil soap was not satisfactorily effective, and at one pound in four gallons of water obvious injury was caused to the foliage of maple. No other kind of tree suffered quite as much; but it must be added that not all the injury to maple was due to insect attack.

### ELM-LEAF BEETLE.

The *elm-leaf beetle* has been more abundant during the past summer than for three years last past, and, assisted by the generally droughty conditions, the trees have shown marked injury. At New Brunswick the hibernating brood was not large and the early feeding was inconspicuous. Egg masses did not seem especially abundant, and it was decided that it would be unnecessary to spray; but the larvæ developed absolutely without check, the scraped leaves withered under the effect of the intense heat and dryness, and trees were almost defoliated early in August. At that time the brood was mature and beetles in great numbers had emerged. There was no killing off by fungous disease, and there is a heavier brood in hibernation than there has been at any time during the five years last past. It is, of course, impossible to say what the coming winter and spring of 1905–06 may bring forth, but unless some very marked disaster overtakes the insects there will be a heavier brood next summer (1906) than there has been for many years past. In other localities the injury has been less marked than at New Brunswick, but everywhere it has been notable.

### THE GYPSY AND BROWN-TAIL MOTHS.

Late in July reports of the alarming spread of the *gypsy* and *brown-tail moths* in Massachusetts began to be received, and assertions were made that the insects had been found in New York and even New Jersey. It was learned, also, that the legislature of Massachusetts had again appropriated a large sum of money to assist municipalities in dealing with it, and that Mr. A. H. Kirkland, formerly connected with the work done by the Committee of the State Board of Agriculture, was now in charge of this attempt. It was deemed wise, in view of this situation, to make a personal investigation, and this was done—first, between August 8th and 10th, and again later, between Sep-

tember 19th and 23d, in company with Dr. E. P. Felt, the State Entomologist of New York.

To the courtesy of Mr. Kirkland I owe the opportunity of getting over a large part of the infested territory and of making such inspections as I wished, and I have no hesitation in saying that the introduction of either or both the gypsy or brown-tail moths into New Jersey would be the greatest calamity that has ever visited the State.

As to the *gypsy moth,* its natural spread is slow, and a quarter of a century might elapse before it reached our State did it depend only on these natural powers. Unfortunately, communication by way of railroad, trolley and automobile is now so widespread that at almost any time a colony of the insects may appear at some point far removed from the present infestation. That this is not a fanciful danger is shown by the fact that egg masses have been found on freight cars and moths on passenger trains.

Since the cessation of the State work, about six years ago, the insect has extended into territory more than twice as great as that occupied by it when the work first began, and extermination seems now an impossibility. It is perhaps a question whether at least the southern half of New Jersey is not outside the climatic range of the gypsy moth, but that is not so certain as to make it a safe reliance. No present action seems desirable, but it will be well to watch developments.

As to the *brown-tail moth,* that has spread over the entire eastern section of New England, along the line of the prevailing southwest winds. It is active in both sexes, and its natural means of getting about are much greater than those of the *gypsy.* It is scarcely less destructive and has an additional offensive character in the poisonous hairs or spines with which it is covered. Fortunately, it is rather more easily dealt with in the town and orchard than the older pest, and, while a highly undesirable addition, is not so much there to be dreaded; but when it gets into the forest, while its range of food plants is not so great, its effect on deciduous trees is more severe.

A brief account of both species, taken chiefly from the Massachusetts reports and bulletins, appears in another portion of this publication.

## PEAR PSYLLA.

*Pear Psylla* has not been much noticed of late years, but was found in some Keiffer orchards in Cumberland county this summer in harmful numbers. Late in September I found larval and pupal forms, as well as adults, and the owner of the orchard informed me that his fruit had been materially checked by the attacks of the insects. This particular orchard had never been winter-sprayed, and I advised the soluble oil in late fall. Some orchards in the same general region that were in the past injured by the *Psylla* have been free from the pest since winter spraying for scale has become necessary. That is particularly true of those cases where crude petroleum has been applied.

**Fig. 9.** The Pear Psylla. Greatly enlarged.

## ROOT MAGGOTS.

Cabbage, cauliflower, radishes and onions suffer more or less each year from the attacks of *root maggots*—the first and last most severely. It happens, sometimes, that a season, or even several seasons, go by without much injury, and such period of exemption may be followed by a season or seasons of severe damage, when the insects seem to increase to such an extent as almost to prohibit the growth of the crop. On radishes the injury is usually slight, because the crop is quickly grown and quickly out of the way, so that only the first brood, from the hibernating females, can cause trouble. On cabbages the matter is more serious because of the longer period during which they are subject to attack, but cabbage-growers generally have learned how to deal with the insects by repellants, by fertilizers, by the application of insecticides or by using protective coverings. Not very much complaint of this particular species has been made of late.

The *onion maggot* has been most complained of during the two seasons last past, and from all parts of the State. Whatever the reason, complaints in past years have come mainly from the southern counties, but now all onion-growing sections are equally infested.

As against this kind of attack our remedial measures leave much to be desired; but for the information of the grower a brief life history of the species, with some account of its habits and the methods of dealing with it, is given on another page of this report.

## CORNSTALK BORER.

The *cornstalk borer* was unusually abundant during early summer, and was even more troublesome in tomatoes than in corn. On looking up the literature of the species it was found that the life cycle had not yet been completely made out, and that no practical methods of control were known. The missing facts were worked out, and it now appears that by simply keeping down the natural food plants—ragweed, burdock, pigweed and the like—in September, injury can be completely prevented.

## THE ROSE CHAFER.

After a series of years, during which little was heard of it, the *rose-chafer* (*Macrodactylus subspinosus*) has again appeared in what may

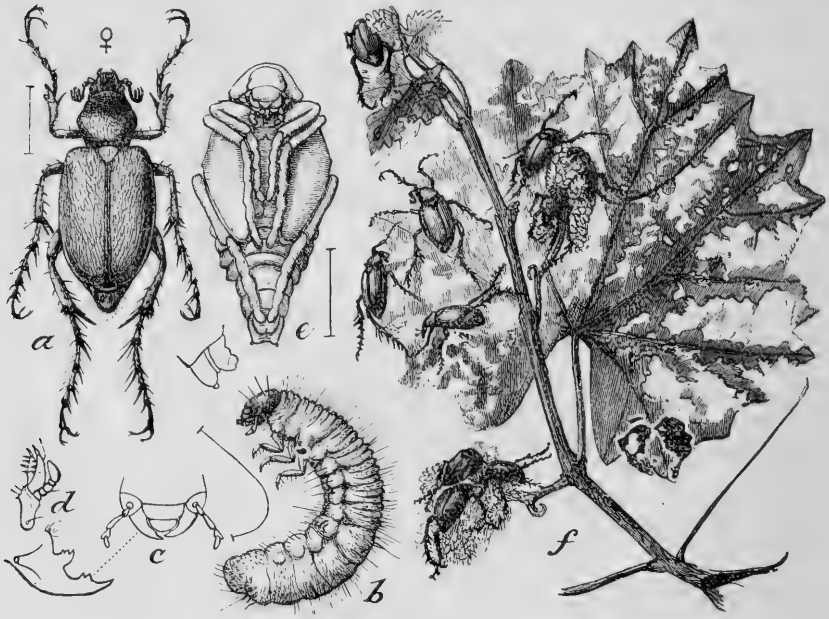


**Fig. 10.**

The Rose-chafer; *Macrodactylus subspinosus* Fabr.: *a*, adult female beetle; *b*, *c*, details of mouth structure; *d*, the larva; *e*, pupa—all enlarged; *f*, beetles at work on a grape leaf. From Div. Ent., U. S. Dept. Agric.

be considered injurious numbers. The species was by no means as numerous as it was in 1890, when I first became acquainted with it,

but was abundant enough to be troublesome in gardens, vineyards, and especially on apples. It was in Burlington county that I saw the insects, most commonly on young apples, but I am informed that they were equally conspicuous in other southern counties.

The matter becomes interesting from the fact that we are approaching the end of the twenty-year cycle referred to in Bulletin No. 82, issued in 1891, when the insect began to decline in numbers.

The records then made by me show that at Vineland, where my observations were carried on, the insects became plentiful enough to be offensive in 1885 or thereabouts, and they increased annually until, in 1900, the climax was reached, the vineyards having been by that time almost completely wiped out. I was then informed that a similar invasion had been observed nineteen years before, the climax coming after a four or five-year period. Most of those whose memory reached back to that time said "about twenty years ago," and the only definite date that I obtained left it open whether the year previous, making the twenty-year cycle, had not been as bad or worse. If history repeats itself, and there is really a somewhat definite period of rise and fall, the three or four years next to come will see a gradual increase of injury, culminating in 1909 or 1910.

Unfortunately, so far as methods of control are concerned, we have not advanced much since 1890.

## THE ASIATIC LADY-BIRD.

The record of the experiments made with this insect during the three or four years last past was rather fully given in my report for 1904, page 575, and at this time I need only record the observations of the current year. Up to the end of September, 1904, the insects were noted in the orchard, and up to October 12th, 1904, they were kept under laboratory conditions.

May 25th, 1905, Mr. Dickerson examined very carefully that section of the Du Bois orchard in which the insects had been released, and more especially those trees on which specimens had been found breeding in 1904. No treatment of any description had been given, and the trees were quite as much infested as at any time in the past, but no trace of the *Chilocorus similis* was seen. One larva and one adult *Chilocorus* were noted, but they were out of reach and were apparently *bivulnerus*. There was not the least appearance of any feeding upon the scales in any place.

June 19th, a second examination was made, much more carefully. The scales had begun to breed and new sets were already abundant, especially upon the fruit. Not only was the search made by sight merely, but branches were beaten over an inverted umbrella to reach concealed specimens, if any. No signs of the *Chilocorus* were apparent—neither larvæ, pupæ nor adults.

It was regretfully concluded that the experiment was a failure and that the insects had failed to survive the winter.

## INSECTICIDE EXPERIMENTS.

It is within bounds to say that more than 50 per cent. of all insecticide experiments result so unsatisfactorily from one cause or another that they are never recorded. A great many preparations are sent in each year, and so far as opportunity serves they are tested. But sometimes they come too late for a trial against those insects for which they are especially intended, or the insects do not appear in such numbers as to make an application conclusive. An adverse report is never made where the material has not had what I consider a fair chance, and in consequence a great deal of work goes unnoted, while the maker of the material deems the office neglectful. The truth is the Entomologist cannot afford to neglect the opportunity of getting a better or more effective insecticide than we have in our present battery, and everything that has the element of novelty in composition is investigated. In most cases flat failure results at the first trial, and the experiment closes without report; but where there is the least appearance of value the matter is carried further, even if not finally made the subject of a report. The farmer does not care to read a long series of tests of materials that prove of no use, unless they are such as are or have been offered to him in such a way as to make it important for him to know whether they are good for anything. His desire, as a rule, is to know what has been found useful and how it should be used.

It is not, therefore, a proof that a material has not been tested if no record of such a test appears. It simply means that there is nothing good to be said of it so far as the office experience goes. In the present report is given an outline of some of the results observed during the season of 1905.

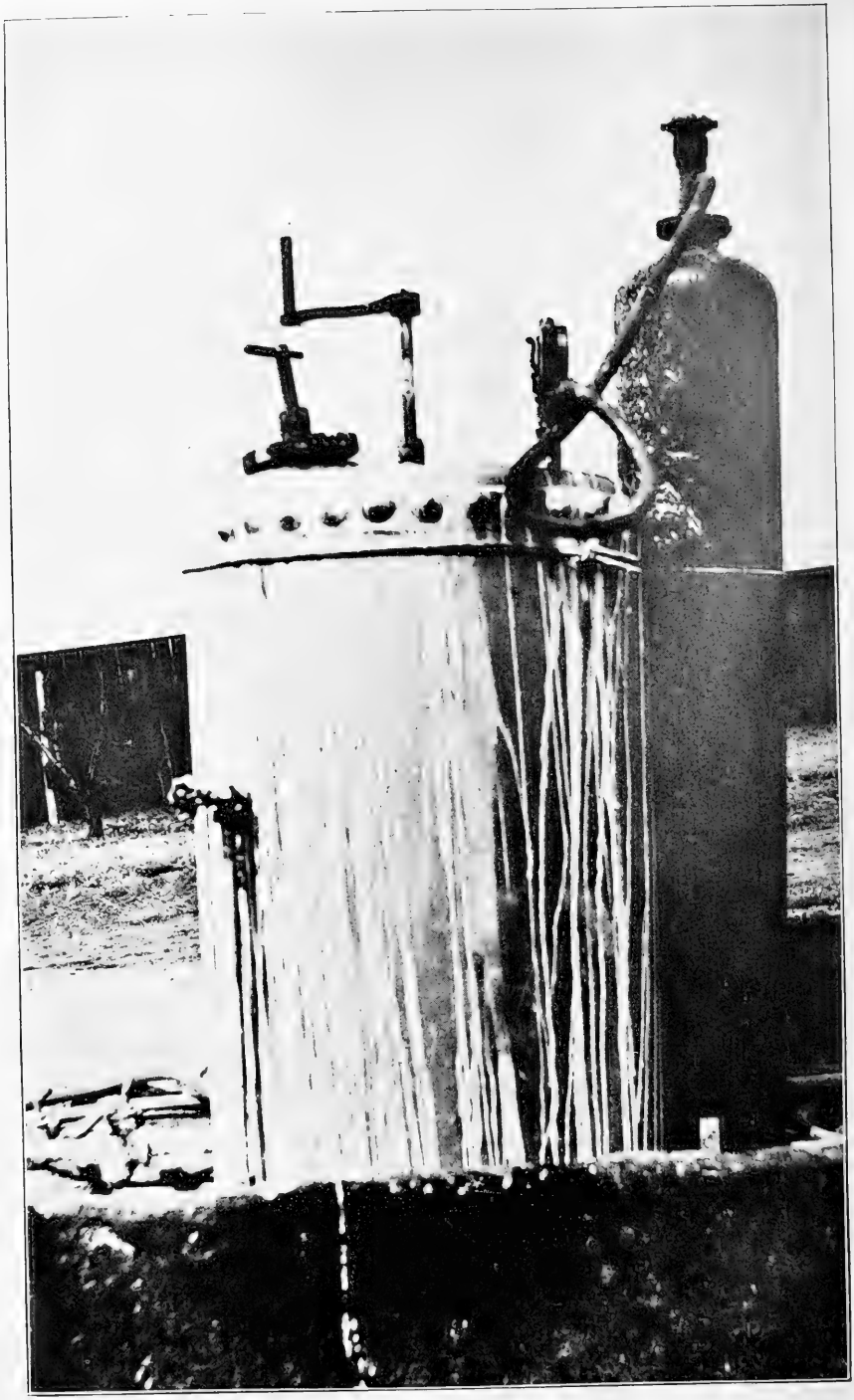

**Fig. 11.**

The 50 gallon Niagara Gas-sprayer in use on the College Farm; with two leads of hose
From an original photograph.

**Fig. 12.**

Plum orchard on the College Farm sprayed with lime, sulphur and soda. From an original photograph.

## WORK DONE ON THE COLLEGE FARM.

The small orchards on the College Farm are all somewhat infested with San José scale, and no radical measures were ever taken because, being under experimental culture, no applications were tolerated that might affect either a tree or its crop. An early inspection by Mr. Dickerson showed the peach and cherry plots in no immediate need of treatment; plum pretty generally infested; a scattering infestation in the apples and local infestation among the pears.

It was determined, under the circumstances, to use for most of the trees the lime, sulphur and caustic soda mixture—thirty-three pounds lime, seventeen pounds sulphur and four and one-half pounds caustic soda in fifty gallons of water, prepared without boiling. A fifty-gallon Niagara Gas Sprayer was used and the work was done April 6th, 7th and 10th, rain and other adverse conditions preventing continuous work. Hot water was used in getting the mixture in all cases, but cold water to dilute it to spraying strength. The combinations were made by or under the direction of Mr. J. A. Grossbeck; the spraying was done with Mr. E. L. Dickerson at the gas tank. The application was thorough and the wind was made use of on each day, directly and quartering. When it became necessary to spray against it, nozzles set at an angle were used, so that the men could keep out of the blowing mist.

An examination made June 22d, when the first brood of scales was in full swing, showed fairly good results. No trees appeared to have been completely cleaned, but nowhere was there more than a scattering of the larvæ apparent. Plums were yet the worst of the series, although comparatively clean.

A second examination, made July 21st, to compare more critically with the effect produced by the simple mixture of lime and sulphur, showed no worse condition of affairs and only confirmed previous conclusions. Indeed, the best method of comparing results is to say that on the peach trees, which it had not been deemed necessary to spray, more active larvæ was seen than on the treated trees.

Late in the season it developed that an error was made in neglecting the peach trees. Some of them became so badly infested as to endanger them, and furnished the prettiest object lesson of the danger of neglecting what seems a slight infestation; the sprayed trees are all in far better condition.

## MISCELLANEOUS.

Three bulletins have been issued from this department since the date of the last report—No. 178, on "Insecticide Experiments for 1904;" No. 181, on "Insects Injurious to Shade Trees and Ornamental Plants," and No. 186, on "Late Fall Spraying for the San José or Pernicious Scale."

The work of the State Entomologist has been continued along the same lines as in previous years, and eighty-one certificates were issued to growers or dealers in nursery stock. Not over a dozen nursery blocks, mostly peaches, proved to be so badly infested as to be unsalable, and these were destroyed. Altogether, many thousands of infested trees were kept out of the market, and the quality of stock set out has been materially improved. Mr. Edgar L. Dickerson is still in office as assistant and Miss A. E. Meske as stenographer and office aide. A full report of the work done in this capacity will be made to the State Board of Agriculture.

The mosquito investigation has been continued on somewhat different lines, under Chapter 80, Laws of 1905, and a detailed statement of what has been accomplished forms another section of this report.

Somewhat out of line with the general scope of the department work was the investigation and treatment of the New Brunswick water-supply with sulphate of copper to control the development of algæ and other organisms that tended to cause bad smells and tastes. A special report on the results obtained, which were very satisfactory, was made to the Director.

The mosquito collection installed at St. Louis, as mentioned in the 1904 report, was transferred at the close of the fair to the State House, at Trenton, where it was set up in a somewhat different shape and material additions were made. It now forms a permanent feature of the State Museum, and as such has attracted considerable attention. A number of boxes have been made up during the year out of the office collection, to add to this Museum, which is now of considerable extent and some scientific value on the entomological side. The general collections of the office have increased greatly and large additions have been made to the storage capacity of the department.

As to equipment and general outfit, the department is in better condition than ever before, and little more can be demanded at present in the way of laboratory facilities.

Two visits were made to Massachusetts, as already stated in connection with the gypsy moth and cranberry insect investigations, and in October a visit was made to the Canadian Agricultural College at Guelph and to the Experimental Farms at Ottawa, incidental to a meeting of the Entomological Society of Ontario. The usual relations were maintained with the societies at New York, Brooklyn, Newark, Philadelphia and Washington, and a meeting of the Cambridge Club was attended in September.

Institute work during the winter and attendance at State and county board meetings and at other associations of farmers and fruit-growers has kept the department in touch with the needs of the agricultural community, so far as the insect questions are concerned, and has enabled it to direct its work accordingly.

The correspondence of the department during the calendar year of 1905 has been larger than ever before, covering 3,000 pages of letter-book and representing upwards of 4,500 individual communications. In fact, the routine work and preparing answers to questions has come to occupy so large a proportion of the available time as to trench seriously upon the necessary investigation work.

## ENTOMOLOGY IN THE CROP BULLETIN.

Twenty-three numbers of the Crop Bulletin were issued between April 11th and September 12th, 1905, and in all save three of them insects of some kind were recorded as injurious.

The *San José scale* was first referred to and held the record throughout the season. April 11th the recorder summarizes as follows: "The outlook for orchard fruit is fairly good except in orchards where the San José scale is prevalent. In places in Mercer county many trees have been killed by this pest. Much spraying—more than ever before at this season of the year—has been done." On the 17th, two localities in Hunterdon county report the continuance of orchard spraying for this pest. April 25th, Plainfield, Union county, and Canton, Salem county, refer to the fact that the scale is infesting their fruit trees. May 2d, South Bound Brook, Somerset county, notes an increase in the numbers of this species. May 9th, Newton, Sussex county, notes that there had been "some plum trees killed by the San José scale." May 23d, the scale was killing "many trees" at Paterson, in Passaic county, and on the 30th only trees sprayed for

scale were doing well at Pottersville, in Somerset county. Not until August 29th is there another record, and then at Rowland's Mills, Hunterdon county, the "San José scale is doing great injury to the apple trees in this vicinity." September 5th, "San José scale prevalent" is reported from Merchantville, in Camden county, and in the last bulletin of the season, September 12th, San José scale was increasing at Sussex, in Sussex county; and from Basking Ridge, in Somerset county, we learn of many apple trees killed, while peach trees in the vicinity of Mine Brook had been kept in good condition by spraying.

*Cut-worms* were first referred to in the bulletin for May 16th, from Woodbury, Gloucester county, and May 23d had become quite numerous and destructive to corn and lima beans. Records also came from Flemington, Hunterdon county; Bridgeton, Cumberland county; Beverly and Moorestown, Burlington county, and Mickleton and Woodbury, Gloucester county. Even more numerous and from a greater range were the complaints on May 30th—cabbage, tomatoes and other vegetables being added to the crops injured. Specifically, reports came from Paterson and Charlotteburg, Passaic county; Delaware and Phillipsburg, Warren county; Moorestown, Burlington county; Berlin, Camden county; Bridgeton, Cumberland county; Woodstown, Salem county; Cassville and Toms River, Ocean county, and Dias Creek, Cape May county. June 6th the records had somewhat decreased in number and were chiefly from the more northern sections—Sussex and Fredon, Sussex county; Warrenville, Somerset county; Three Bridges, Hunterdon county; Imlaystown, Monmouth county, and Berlin, Camden county. June 13th was almost a repetition of the previous week, but cornfields especially seem to have suffered; Newton, Sussex county, reports entire fields destroyed, while Sussex and Layton, in the same county, make similar statements. Pittstown, Hunterdon county; Kingston, Somerset county, and Hazlet, Monmouth county, represent complaints from the central section, while Berlin, Camden county, is the only one of the southern section that reports them still numerous. June 20th the worms were yet very destructive to corn at Fredon, Sussex county, and that was the only report for that date. June 27th, Rowland's Mills, Hunterdon county, reports corn a very uneven stand, due to cut-worm injury. July 5th, a belated report from Moorestown, Burlington county, represents "cut-worms unusually destructive," and the last report is under date of August 1st, from Charlotteburg, Passaic county, stating that "cut-worms injured cabbage early in the season."

*Potato bugs* were first reported May 16th, from Warrenville, Sussex county, where they were "just beginning to appear;" Woodbury, Gloucester county; Marlton, Burlington county, and Bridgeton, Cumberland county, where they were already numerous and destructive. May 23d, Beverly, Burlington county; Woodbury, Gloucester county, and Canton, Salem county, report trouble and complaints of injury. May 30th, reports of injury came from Kingston, Somerset county; Berlin, Camden county, and Cold Springs and Cape May, Cape May county. June 6th, records were mainly from up-state—Charlotteburg, Passaic county; Warrenville, Somerset county, and Cranford, Union county. June 13th, only Layton, Sussex county, marks them as "destructive." June 20th, only Charlotteburg, Passaic county, and South Bound Brook, Somerset county, were having trouble, while on the 27th only Newton, Sussex county, reports "potato bugs very destructive," and that is the last record for the season.

*Asparagus beetles* were first reported as numerous May 23d, from Bound Brook, Somerset county, and on June 20th they were injuring young patches at Hazlet, Monmouth county. The third and last note comes from Cold Springs, Cape May county, where, on July 25th, the beetles were "very destructive."

*Root maggots* were unusually troublesome both on onions and cabbage, and some of this is reported. The first item is from Bridgeton, Cumberland county, where, on May 30th, the *onion maggot* was "very destructive." June 13th, the same insect was "bad in places" near Rancocas, Burlington county, and on the 20th it was "very destructive" at Farmingdale, Monmouth county, a statement which is repeated July 5th. June 27th, the *cabbage maggot* was reported from Hazlet, Monmouth county, and on August 8th, Moorestown, Burlington county, states that the injury to cabbage is "very severe."

*Rose-bugs* were first noted at Rancocas, Burlington county, destroying grape buds. June 20th and July 5th, Paterson, Passaic county, reports "much," and Vineland, Cumberland county, "slight," injury to vineyards. In view of the fact that this insect appeared in greater numbers than for many years past, this is a very scant record.

Among other insects that appeared locally or attracted attention only once is the *currant worm*, which was reported May 23d from Bergen Point, Hudson county, though it actually occurred more or less throughout the State. So the *Aphis* on peach trees, reported at

the same time from the same place, was almost universally distributed, though it did little or no injury. *Wire-worms* were reported as cutting corn badly at Woodstown, Salem county, May 30th, and were not later referred to. *Squash bugs* were "numerous" at Cold Springs, Cape May county, May 30th, and this seems to have been rather exceptional, because I did not see them anywhere in my trips in any numbers. "Bugs" on sweet potatoes were reported once only, from Berlin, Camden county, June 6th, and the tortoise beetles, or their larvæ, the peddlers, were probably intended. So, when Goshen, Cape May county, sets out, under the same date, that "melon vines are being destroyed by insects, necessitating the replanting of some entire fields," it is probable that the *striped beetle* was at fault, though it may have been *cut-worms*. Under date of June 20th, South Bound Brook, Somerset county, reports the "*grain moth* more numerous than for several years," but nothing that indicates a general increase has yet come to hand.

June 27th, Titusville, Mercer county, claimed that "a worm similar to the *potato stalk-borer* is doing much damage to tomatoes and corn," and while this is the only reference to the matter in the Crop Bulletin, a great deal of injury was actually caused in many localities, especially in gardens. Finally, "*grasshoppers* quite numerous in places" comes from Rowland's Mills, Hunterdon county, August 15th, without any statement that any harm was done by the insects.

## THE GYPSY MOTH.

*Porthetria dispar* Linn.

The gypsy moth is a well-known European insect, which was introduced into Massachusetts in 1868 or 1869 by the naturalist, Leopold Trouvelot, who was then engaged in a series of experiments with silk-producing caterpillars, native and exotic, hoping to find a substitute for or a supplement to the Chinese silk-worm. In some way this particular species escaped from confinement and established itself outdoors, under natural conditions. Although this fact was at once made public, it attracted no especial attention and the spread was at first very slow. It was not until 1889 that there was any extensive outbreak, and then it was found that the insect had gained a foothold in thirty townships, all adjacent to each other. In the elaborate report on

this subject, published in 1896 under the direction of the State Board of Agriculture by the State of Massachusetts, Mr. Edward H. Forbush, field director, gives a full account of its early spread, the individual efforts to check its ravages and the reasons why in so long a period so little spread had been made.

The conditions in the worst infested districts are described as follows: "The number of caterpillars that swarmed over certain sections of the town during the latter part of June and most of July, 1889, is almost beyond belief. Prominent citizens have testified that the 'worms' were so numerous that one could slide on the crushed bodies on the sidewalks; and that they crowded each other off the trees and gathered in masses on the ground, fences and houses, entering windows, destroying flowering plants in the houses and even appearing in the chambers at night. The huge, hairy, full-grown caterpillars were constantly dropping upon people on the sidewalks beneath the trees, while the smaller larvæ, hanging by invisible threads, were swept into the eyes and upon the faces and necks of passers. The myriads that were crushed under foot on the sidewalks of the village gave the streets a filthy and unclean appearance. Ladies passing along certain streets could hardly avoid having their clothes soiled, and were obliged to shake the caterpillars from their skirts. Clothes hanging upon the line were stained by the larvæ which dropped or blew upon them from trees or buildings. In the warm, still, summer nights a sickening odor arose from the masses of caterpillars and pupæ in the woods and orchards, and a constant shower of excrement fell from the trees. The presence of this horde of gypsy moth larvæ had become a serious nuisance and was fast assuming the aspect of a plague."

It should be explained here that, unlike most other caterpillars, that of the gypsy moth is almost omnivorous, feeding upon conifers as well as deciduous trees, and upon field crops as readily as upon roadside shrubs and weeds—practically nothing comes amiss.

So serious was the matter deemed that in 1890 the Legislature appropriated $25,000 "to provide against depredations by the insect known as the *Ocneria dispar,* or gypsy moth." In 1891 an additional appropriation of $50,000 was made; in 1892, $75,000 was provided; in 1893 the sum was increased to $100,000; in 1894 a similar amount of $100,000 was made available; in 1895 another increase brought the amount up to $150,000. Thus, up to the date of the report already referred to, just half a million dollars ($500,000) had been

expended by the State, and a very large sum in addition had been paid by individual owners in sections which the State forces had not yet reached. Between 1896 and 1900, when the last appropriation was made, $674,000 additional was provided, the sums reaching $200,000 in 1898 and 1899. With the appropriation for 1900 the work ended, and the statement of Mr. E. H. Forbush, field director, before the Association of Economic Entomologists, in the summer of 1899, gave a comprehensive review of what had been accomplished up to that time. February 1st, 1900, is the official date when the work was discontinued, and since then the State has done nothing, while Nature has moved on, slowly but surely, according to her own methods.

The *status* of the matter in Massachusetts at the present time is, therefore, that the State has expended $1,174,000, while the work of attempted extermination was carried on; that there has been expended since that time, by municipalities, not less than $60,000 annually, or $240,000, and by individuals $100,000 annually, or nearly half a million. Since the stoppage of the work in 1900 the insect has not only regained all its old ground, but has spread over additional territory, double in area that which it held at first. The money already spent is absolutely wasted because the work was discontinued when success was almost at hand!

My first visit to the gypsy moth district was in 1893, and my impressions at that time were recorded in a note to Dr. C. H. Fernald, the entomologist of the committee carrying on the work. This note is published in the report of 1896, on page xxxvi. of the appendix. My next visit was in the winter of 1897 (January), and my report on that visit, made to the Society for the Promotion of Agriculture, was never published.

The insect has again become so threatening and has again caused so much actual injury that the Legislature of Massachusetts has passed another law, providing for a fight against it on new lines and carrying an appropriation of $330,000, with an added obligation upon municipalities of practically twice as much, bringing the total contemplated expenditures during two years next ensuing up to the sum of over $900,000.

It needs no apology for presenting this record here if there is the least danger of introducing so injurious and expensive an insect into New Jersey, and my visit to the infested district in August has convinced me that while the danger is not at present imminent, it may

at any time become so. It is well, then, to know something of the insect, its appearance in all stages, its life history and the manner in which it is spread.

### Appearance of the Insect.

The gypsy moth belongs to a family or group allied to our common vaporer moth, and the male is not unlike it in general appearance, except that it is fully twice as large. The fore-wings are smoky-brown, with a yellowish tinge, and crossed by four undulating, blackish bands; the hind-wings are more uniformly dull, dark yellow. The antennæ or feelers are broadly feathered and conspicuous. This moth is active and flies readily, though not strongly, seeking the females in daylight as well as during the evening.

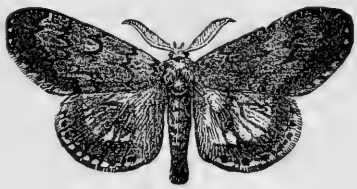

**Fig. 13.**
Male Gypsy Moth. From Div. Ent., U. S. Dept. Agric.

The female is decidedly larger and is a more heavily-built insect throughout. In color it is whitish, with a dirty, yellowish tinge, and the fore-wings are crossed by irregular blackish lines, which are much more distinct along the upper or front margin. There are also two black spots on the disc, so that when the insect is seen at rest on a tree trunk it has the form of an elongate triangle with apex up, and along each lateral margin a series of short, black lines, which fade out as they approach the middle. The abdomen is covered with yellowish hairs and scales, which are more dense toward the tip.

**Fig. 14.**
Female Gypsy Moth. From Div. Ent, U. S. Dept. Agric.

This female is sluggish and rarely flies. If she drops to the ground she may crawl to and on a tree trunk; but she is just as likely to crawl under a stone or on any other convenient foothold. Wherever she fixes herself she awaits the male, and after impregnation begins to lay her eggs.

### Egg-Laying.

Egg-laying begins during the last week in July and continues for nearly a month thereafter as adults mature, for some egg clusters begin to appear before the caterpillars are pupating generally, and a few larvæ may yet be found in the fore part of August, when egg masses are already abundant. I saw two females ovipositing September 20th.

These egg masses are oval or rounded clusters containing from 400 to 500 eggs on an average, and they are covered with yellowish hair from the body of the female, giving them a characteristic appearance like a small piece of sponge. These masses are deposited in every conceivable place—on the trees, on the ground, under stones, in or between fence rails or stone fences, and in fact wherever a female emerged in a shelter large enough for a caterpillar to crawl into. As a rule the eggs remain unhatched until the next season, except that in long, warm autumns a small percentage hatch; but the larvæ so produced fail to come to maturity.

Normally eggs hatch at any time between the end of April and the middle of June, depending upon the amount of warmth received.

### Larval Development and Habits.

When first hatched the caterpillars are about .14 of an inch in length, pale, brownish yellow in color, with a shining, black head. As they grew there is some change in appearance, and from four to seven moults or stages have been observed, the females requiring a longer period of development than the males. When full grown the caterpillar is from two to two and a half inches in length; the head dull whitish, mottled with brown and black; the body dull grayish, varying to blue or greenish, with bluish dorsal spots nearly to the middle and reddish spots behind that point to the anal end. From the tubercles on the segments are tufts of long, thin, but not very conspicuous hair. As the larva is figured herewith, no further words of description would seem to be needed.

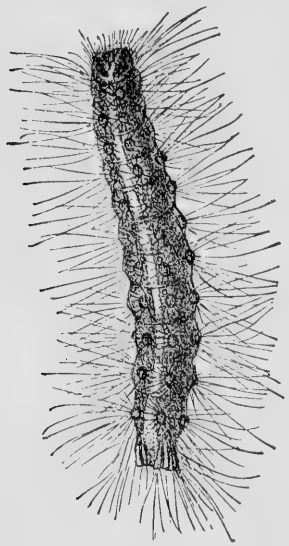

**Fig. 15.**
Caterpillar of Gypsy Moth: full grown. From Div. Ent. U. S. Dept. Agric.

When ready for the change to the pupa the caterpillar is apt to wander from its food plants, sometimes for a considerable

distance, in search of a place to pupate. Not that it is at all particular in regard to location, for any old place will serve; but this seems to be one of the provisions for the distribution or spread of the insect, to make up for the sluggish habit of the female. Where the caterpillars are abundant they often pupate in masses, so that hundreds of them may be found in an angle or crevice, or in a narrow space. They spin a few threads as a support—the merest apology for a cocoon—and then change to a brown, cylindrical pupa, blunt at the head and tapering to a point at the tail. In this stage the difference between the sexes is very noticeable, the pupa of the male being much the smaller, and having the antennal case broad and showing the characteristic pectinations. This stage lasts about ten days, a maximum of fourteen and a minimum of seven, representing the observed extremes.

**Fig. 16.**
Pupa of Gypsy Moth in loose cocoon.
From Div. Ent., U. S Dept. Agric.

As a rule the caterpillars feed at night and hide, or at least remain quiet, during the day. It is therefore quite possible to see the trees stripped, and yet at first see nothing of the insects that did it. In the early stages the little caterpillars spin readily and have the habit of suspending themselves by a thread. A sudden jar or alarm may also cause them to let go of their support and drop for a longer or shorter distance.

### Methods of Spread.

Emphasis has been placed upon the fact that the female moth is no traveler, and that under natural conditions the wandering habits of the caterpillars in the later stages provide for a limited extension each year. Accidental carriage of eggs, or even of adult females, by birds or other animals, comes within the range of possibility, and young caterpillars may be carried off for some distance. But these natural methods are very tedious, and the infested territory would extend but slowly were they alone to be considered.

Unfortunately the human element comes into the problem, and thus a spread of hundreds of miles in a year is among the possibilities. While the larvæ are small and suspend themselves readily by threads, many of them are carried away by pedestrians walking beneath the trees. When the insects are discovered the natural tendency is to brush them off to get rid of them, no matter where or how far away from the place where they were gathered. When they fall upon carriages, wagons or similar conveyances, the distance to which they may be carried is much greater, and on a trolley car the range is yet more extensive. Yet even the trolley range is a limited one and confined to a definite line. Railroad trains do not often travel on a line overshadowed by trees, so these are not so greatly important. Automobiles, however, go everywhere, and may carry young caterpillars for many miles in a single day. If at the end of a day's run the young larvæ find food convenient, and are in sufficient number to have both sexes represented, a colony may be established. No doubt many individuals have been so carried, have developed and have died for lack of a mate. It is only by a fortunate combination that a reproductive colony can be established in this way, but this combination may happen at any time, and perhaps has happened, for the present outer limits of infestation are by no means established.

When the full-grown caterpillars wander along the line of a railroad the danger becomes much enhanced. Freight cars on sidings, cordwood to be loaded and carried away, boxes, bales, barrels, crates and other carriers serve as excellent places for pupation, and from a single pair carried off in this way a colony could readily be established miles away. That this is not a remote contingency is shown by the fact that moths and egg masses were observed in some numbers on a railroad station building in the infested district, and freight cars were observed on sidings close to infested trees.

The danger of rapid spread increases as the infested area increases, and it is greater now than it has been at any time since the insect has established itself in this country.

At present the probability of an early spread to the New Jersey line is slight; the possibility exists of entrance through the medium of freight, freight cars or plants from the infested districts. Much now depends upon the amount of work that can be accomplished next winter under the new law in Massachusetts.

**Danger to New Jersey?**

In a careful study of the life history of the gypsy moth, the question arose: Assuming that the insect is introduced into the State, can it maintain itself here? As to the more northern sections, in all probability, yes; as to the region south of the red shale line, in all probability, no.

Dr. Fernald's careful study of the life history and development of the gypsy moth proves to demonstration that the matter of egg development is almost entirely a question of temperature. As soon as the spring temperature rises sufficiently, the eggs hatch—those in the warmest places first, the others as the general temperature rises. The egg masses formed in early August are, of course, subject to the same general laws of development. They are normally intended to pass the winter in that condition, and development of the embryo proceeds slowly. As the average temperature decreases through longer, cool nights, development is checked, proceeds more slowly, and soon ceases altogether until resumed under the influence of the spring sun. Yet, if the average temperature continues sufficiently high, development will continue, even to the hatching of the eggs, as was found in the season of 1895, at Woburn, Mass., where an unusually warm period in late August and early September induced the hatching of a large percentage of the eggs. None of the larvæ of this late hatching reached maturity.

Now, the climatic conditions in New Jersey south of the red shale line are just those of the unusual conditions of 1895, and we are entitled to conclude that the effects on the insects would be similar. In other words, assuming that a colony were established anywhere in Burlington county, it might develop normally until the eggs were laid in late July, but then the high average temperature of August and early September would induce these eggs to hatch, and long before the larvæ could come to maturity the food supply would be cut off or lessened to such an extent that none of them could develop.

As to the question that has been asked: Can we do anything to prevent introduction of the insect into New Jersey? the answer must be, no. It is possible, however, to keep a close lookout and to be in readiness to stamp the species out should it succeed in forming a colony. On that point the Department expects to keep itself posted, but it is dependent largely upon information that comes from those especially interested in trees or parks.

As to the methods of fighting the insects, nothing need be said here at present.

NOTE.—On the matter of climatic conditions, Mr. E. W. McGann, of the New Jersey State Weather Service, furnishes the following data: The mean August temperature for Boston is 68.5°; the mean temperature in 1895, when a partial second brood appeared, was 71°, or 2.5° above the normal. Early September also showed unusually high temperatures, but they did not continue. In New Jersey only the extreme northern stations report normals as low as that of Boston, while most of them, even north of the red shale line, report normals exceeding the exceptional Boston record of 1895. Those given by Mr. McGann are: Dover, Morris county, 71.9°; Deckertown, Sussex county, 71.2°; Boonton, Morris county, 73.2°; New Brunswick, Middlesex county, 72.6°; River Vale, Bergen county, 71.4°.

This would indicate that even in northern New Jersey there would be a tendency for the hatching of the summer eggs and a corresponding natural check to gypsy moth increase.

## THE BROWN-TAIL MOTH.

*Euproctis chrysorrhœa* Linn.

This is the other of the species that has been introduced into Massachusetts within recent years, scarcely second to the gypsy moth in destructiveness, while more annoying than that insect because of the fact that the hair or vestiture covering the caterpillar is more or less poisonous in the later stages. According to the reports of Dr. C. H. Fernald, from whose writings much of the information here given is obtained, the insect was first reported in this country in Somerville, Mass., in the spring of 1897, and careful inquiries revealed the fact that it had been observed by some of the residents of that locality for at least five years. In the center of the infested region is a florist establishment, where, previous to 1890, roses and other shrubs were imported from France and Holland, and it seemed very probable, from all the facts obtained, that the brown-tail moth was accidentally introduced on some of these plants as early as 1885.

Mr. A. H. Kirkland, writing several years afterward, puts the matter in a somewhat different shape. In a paper before the Association of Economic Entomologists, in June, 1900, he makes it: "Area infested in the fall of 1896, twenty-nine square miles; fall of 1897, 158 square miles; fall of 1898, 448 square miles; fall of 1899, 928 square miles. In the course of my visits to

the infested region, in August and September, 1905, I found that the insect then covered almost the entire State of Massachusetts, had extended into and through New Hampshire, covered a large part of Maine and had even crossed the border into New Brunswick. There has been comparatively little spread to the east and to the south because the prevailing winds in New England during the summer are from the south to southwest, and these determine the direction of distribution for the insect."

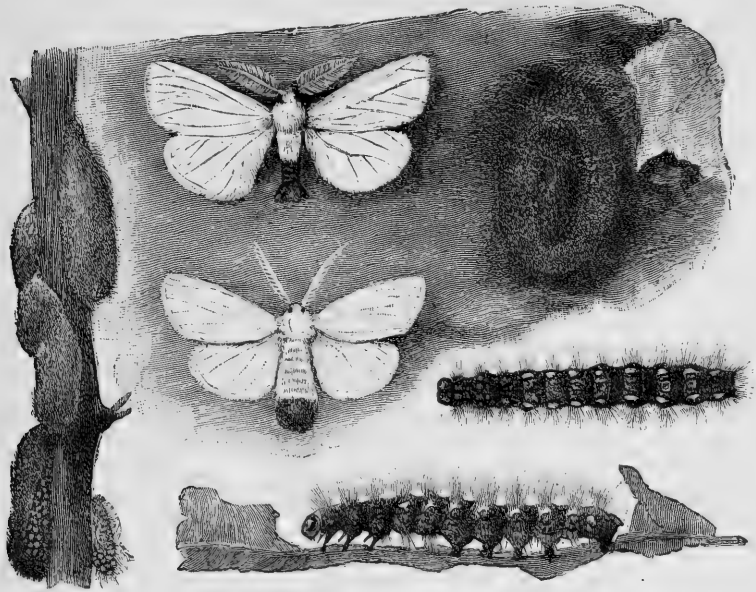

**Fig. 17.**

**The Brown-tail Moth, *Euproctis chrysorrhoea* Linn.: male moth above, female below, eggs at left, cocoon at right, larvæ below at right. From Howard, Div. Ent., U. S. Dept. Agric.**

In the brown-tail moth both sexes are capable of flight, but they are not very active or strong fliers, and rather drift with the wind than attempt to fly against it. Nevertheless, each year sees a spread even against the prevailing direction of the wind, and there seems to be no reason why this insect should not, in the not too distant future, spread over into the Middle States. It is approximately correct to say that it already infests almost or quite the entire New England district.

What may happen in even a single season is recorded by Professor Fernald in 1898. At the time that the species was first discovered as being present in considerable numbers, the area in which serious damage had been done was nearly circular in outline, with a diameter of about a mile, and the flying season, which is of limited duration, was at hand. It was exceedingly fortunate that a severe gale of wind occurred at the height of this season in 1897, which distributed these moths for a distance of ten or twelve miles to the north and northeast. Records are given showing the direction of the wind during the day, a matter which is of little importance in view of the fact that the insects fly only at night; but the records of the night wind directions correspond perfectly with the observed distribution of the insects during the next season.

In Europe the moth occurs almost everywhere, except in the extreme north, and extends to Morocco, Algeria and Asia Minor. In Great Britain it was formerly much more abundant than it is at the present time, and so far as records go it is never injurious to cultivated crops. There is nothing in the history of this insect that leads to the belief that it is not quite capable of maintaining itself throughout the entire Northern Atlantic States, and, of course, including the entire State of New Jersey.

As to its food plants, it lives on a great variety of both wild and cultivated plants, including all the ordinary orchard fruits and most of the common forest trees. Its favorite is perhaps the pear, among the orchard fruits, and such trees will be covered with webs where neighboring apple trees will be comparatively free.

### Life History.

The moths are on the wing about the middle of July, and each female lays from 200 to 300 eggs in an oblong cluster on the under side of the leaf, near the end of a branch, covering them with a dense mass of brown hair from the tip of the abdomen. The moths expand from an inch to an inch and a half, the males being the smaller, and are pure white in color. In the female the abdomen is much larger than it is in the male, and at the tip of both there is a round, dense tuft of brown hair, which gives the common name "brown-tail" to the insect. The moths are attracted to light, and I have seen photographs made of an electric light pole with the insects so densely clustered

upon it that there was scarcely room for another. So conspicuous are they that they are readily noticed, and their presence is easily determinable. The eggs hatch early in August, and the young caterpillars feed only upon the surface of the leaf, causing them to turn brown, as if they had been burned, somewhat like the effect produced on elms by the work of the larvæ of the elm-leaf beetle. The caterpillars also attack the fruits of the apple and pear. While still young they make a regular dwelling, in which they hibernate during the winter. This is constructed at the ends of the twigs, and made by drawing together a few leaves, lining them with silk and surrounding them with a mass of silken threads. They are thus rather conspicuous, and so firmly are the tents fastened to the twigs that they can rarely be removed without using considerable force. The young caterpillars cease feeding and retire into these tents late in September, and there they remain during the winter in a sort of half dormant condition. They become active again about the middle of April, or with the opening out of the new foliage, and feed upon the buds—in some cases even before the leaves have actually unfolded. When feeding upon the foliage they devour everything except the midrib, or, in leaves in which the veins are strong, they leave the entire skeleton, giving the tree a very curious appearance. When the caterpillars are numerous they devour not only the buds, leaves and blossoms, but even the green fruit, feeding continuously until early June; then they spin an open cocoon of coarse silk among the leaves, where they have been feeding, and transform to the pupal stage. They remain in this condition about a month, and then the moths emerge to begin again the life cycle which was started with their appearance. There is therefore only a single brood; but caterpillars appear twice, and where the insects are numerous there may be a defoliation of the trees in spring by the hibernated larvæ and again in the fall by those that hatched after midsummer.

**Irritation Caused by Hair.**

The caterpillars of this brown-tail moth are clothed with hairs that produce a poisoning or "nettling" effect when applied to the skin. From experiments made under the direction of Dr. Fernald, it seems very certain that there is no real poison involved, but the hair, when examined under the microscope, appears barbed and set with small spurs or processes, which break off very readily. When a few of these hairs are placed on the skin and rubbed lightly the small barbs break,

enter the pores and produce an irritation that is intensely annoying to most people and seriously troublesome to others—so troublesome, indeed, that the services of a physician are frequently required. It is not until the insects become nearly half grown that difficulty is experienced; but after that time, where the insects are plentiful, the air is likely to become filled with hairs when the caterpillars molt or change their skins, and when they pupate and spin their cocoon the loose hair is sometimes carried to considerable distances. It is quite possible, therefore, that without handling the caterpillars, or without even coming very close to them, an individual may become the victim of this nettling effect. When the hairs get into the eye a very troublesome inflammation is set up, and this, in most cases, requires the attention of a physician. In speaking with Mr. Kirkland about this matter, he referred to several cases where intense suffering and high fever were produced, and there are some cases in which death was the indirect result. As to the remedial measures employed, they are much the same as those in general use for plant nettling or for ivy poisoning.

This peculiar characteristic puts the brown-tail moth in a class by itself, and makes it really a nuisance to the community in which it occurs, as a menace to public health. Irrespective, therefore, of the injury that is caused to trees and other vegetation, the species is an undesirable one from every other point of view.

As to the methods of spread, it has been already shown that the insect flies, and that therefore it is not so dependent upon outside means of transportation for its distribution. Nevertheless, almost all of the methods by which the gypsy moth may travel may serve to distribute this species as well. Railroad trains are likely to play a great part in its spread, because if a fertilized female concealed herself during the day on a freight or passenger coach, the next evening may find her hundreds of miles away and in condition to take flight and start a colony.

## THE WHITE-MARKED TUSSOCK OR VAPORER MOTH.

*Orgyia leucostigma* S. & A.

This insect shared with other shade-tree pests in the conditions favorable to insect development and became extremely abundant throughout a large section of the State. Although it is not really particular as to its food, maples were, as a rule, more infested than

anything else save poplar, and the silver or soft maples were more hardly dealt with than any other variety. Injury became obvious quite early in the season, and the caterpillars were so unpleasantly conspicuous in many places that public attention was drawn to them and the question of abatement arose. In some places where organization existed spraying was resorted to, and while at no point were the insects entirely cleaned out, they were, at any rate, kept in severe check. At most places, however, the first brood matured, and when the cocoons and egg masses appeared attempts were made to gather and destroy them. The experiment made in Newark of purchasing egg masses is elsewhere referred to, and points out a practical method of dealing with the insect in midsummer and preventing or materially checking the development of a second brood, or, where no second brood occurs, of lessening the supply for the season following.

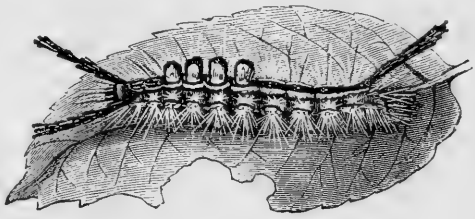

**Fig. 18.**
**Caterpillar of the Tussock Moth. After Riley.**

On this latter point it was found that the State is divided into two rather well-marked faunal regions. Egg masses obtained at Riverton during the early days of August hatched promptly, and the second brood of caterpillars was large. But from dozens of egg masses collected at New Brunswick only a scant hatching was obtained: by far the greater number of masses remained undeveloped, although the eggs, on examination of the undeveloped masses, proved entirely sound. The prompt collection of midsummer egg masses is therefore a much more important matter in the counties south of the red shale line than it is at New Brunswick or points further north, where the second brood is fragmentary or non-existent.

At Newark and in the immediately surrounding towns a curious condition exists. In some parts of the city all the eggs hatched and there was a full second brood; in others none hatched, and the late brood was altogether absent. In the suburbs, anywhere from none to 75 per cent. of the eggs hatched, and even the eggs of one cluster varied. In some clusters every egg was hatched; in others a varying percentage developed; in yet others all the eggs remained sound. Part

of Newark is really in a little extension of the upper austral zone, while to the north, west and southwest the transition zone, with only well-marked brood, obtains.

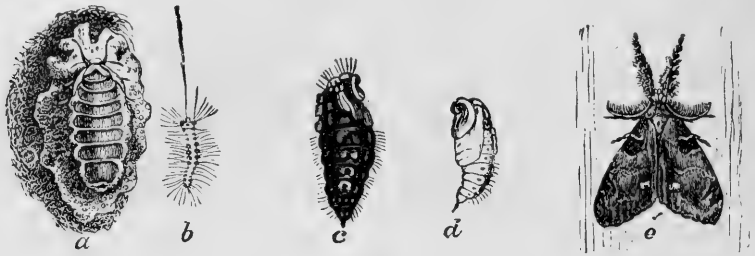


**Fig. 19.**

**The White-marked Tussock Moth: *a*, the female ovipositing on the empty cocoon; *b*, young caterpillar suspended by a silken thread; *c*, pupa of female; *d*, pupa of male; *e*, male adult or moth. After Riley.**

In many places sticky flypaper and other bandings were resorted to, to keep off the caterpillars or to prevent their increase, but in most cases without effect. Sticky bands are good and effective only if the trees are entirely free from egg masses, and if they are applied *before* the caterpillars hatch from the egg masses in the near neighborhood. Applied after the caterpillars are already feeding, it simply compels them to pupate above the band, and that is where the egg masses will then be formed. The whole theory of banding rests upon the fact that we have a clean tree to begin with, and the attempt is to keep outsiders from getting to the foliage.

Where there is an organization sufficient to keep one or two good men going all winter, an enormous number of trees, not too badly plastered with egg masses, can be thoroughly cleaned, and if, then, early in the season these clean trees are banded well up on the trunk, it will prevent caterpillars that may hatch from egg masses concealed on nearby fences and other shelter from getting to the foliage. It would seem to be almost unnecessary to call attention to the importance of gathering the egg masses on the fences, railings and buildings near trees that have been infested; but I have seen trees carefully cleaned and dozens of egg masses left on the railings and staircase of a closely adjoining building. The young caterpillars are not bad travelers and can live without food for a day or two after hatching. Where numerous egg masses occur on large trees it will cost very heavily to clean up, and several sprayings in summer are much cheaper; but where

the infestation is not heavy, most of the egg clusters are well down on the trunk and branches, and can be easily reached.

Winter work, then, against this insect should be practiced as far as possible, leaving the growing season free for dealing with other pests that can be reached at that time only. Small boys, employed to collect egg masses at a fixed rate per measure, would prove useful in reaching the more obvious material, leaving to the careful inspector the task of finding the less obvious or more inaccessible clusters. There seems to be no real reason why thorough work for a year or two should not result in the almost complete elimination of this insect.

Quite a number of parasites were bred from material gathered at New Brunswick, but from some information gained in Massachusetts, it is a question whether almost half of these parasites were not really secondary. In any case the percentage of parasitism was not sufficiently great in 1905 to keep the insect down to normal limits. Outside of cities and towns it was rarely met with.

## CRANBERRY OBSERVATIONS.

The question has been asked, at times, how late in the season water should be held on a cranberry bog to destroy the eggs of the blackhead (*Eudemis vacciniana*)? This is a matter of great practical importance, and yet it has not been possible to answer it heretofore with any degree of definiteness. We know that the eggs may hatch on exposed vines before even a start is made, and I have found the young larvæ dead, in leaf tissue, when water was drawn from a bog by the middle of May. In general, my recommendation has been, hold as long as you dare without risking injury to the crop. On badly-infested bogs water has been held as late as June 1st, with absolute success as against the insect, but the practical loss of the crop.

At the discussions before the American Cranberry Growers' Association, at its winter meeting, January, 1905, it appeared that late holding did not produce exemption during the preceding summer, and that many bogs were seriously injured. But it appeared, also, that the species at fault was the yellow-head (*Teras minuta*), which hibernates as an adult and lays eggs in spring. Late holding in this case, therefore, means only preventing access to the vines until the moths have laid their eggs elsewhere. Further inquiry developed the fact that while the season was unusually late the water was drawn at about

the usual time, and, also, that sections of bogs not entirely covered by water were first and most seriously infested, later broods starting from these centers.

The explanation was simple enough with all the facts at hand. The moths remained dormant a week or ten days later than usual, and when they were ready to oviposit the bogs were wholly or partly bare. The highest vines were cleanest and most nearly ready to start, hence were selected by preference. Drawing, therefore, should not be wholly by date, even if the yellow-head only is aimed at; but it should be at a date when nature has reached a normal May 1st period. Oviposition usually begins before the middle of April, and by the 1st of May well-advanced larvæ may be found, the hibernating adults themselves having disappeared.

Water temperatures do not enter into this *Teras* problem at all, but the matter is different with the black-heads, where the eggs hibernate on the leaves. We know that these eggs hatch on exposed vines before the water is normally taken off, and larvæ may make their appearance on flooded bogs a few days after the water is drawn. The problem here is to discover the hatching temperature and how long the egg must be submitted to it before the larva develops under water—if it develops at all.

To ascertain these points a series of observations was planned, including temperature records on the water covering the bogs. Mr. I. W. Budd, of Pemberton; Mr. A. J. Rider, of Hammonton, and Miss Elizabeth C. White, of New Lisbon, agreed to co-operate, and under my immediate direction Mr. E. L. Dickerson, my assistant as State Entomologist, was to make observations at Jamesburg. And then began the chapter of accidents! It was found, when the thermometers were ordered, that none adapted for taking water temperatures at varying depths were carried in stock, and they had to be especially made. When completed, some failed to work on receipt and others were broken in transit, so that it was not until April 19th that any records were made. Fortunately this proved to be early enough, because the air temperatures could be supplemented by the records of the State Weather Service, and the relation of water to air temperature appears fairly from the records made.

## MR. THAYER'S NOTES.

Mr. Henry J. Thayer, of Boston, Mass., proprietor of the Indian Head cranberry bogs at Plymouth, Mass., was present at the Cranberry meeting in January, and he was good enough to supply me with a series of temperature observations made on his bogs, from which he drew the following conclusions:

*First.* That the fierce heat of the sun is (almost) entirely dissipated within two or three inches of the surface of the water and greatly diminished at even one inch.

*Second.* Between depths of four inches and twenty inches the temperature of the water is (practically) the same, and shaded portions do not differ materially from those exposed to direct sunlight.

*Third.* Below twenty inches the direct heat of the sun is lost, and rise and fall of temperature corresponds to the seasonal change in the warmth of the earth.

*Fourth.* A daily rise in temperature occurs within twenty inches of the surface, whether the day is cool or hot, clear or cloudy, and the daily range is nearly as great on an ordinary cloudy day as under a clear sky and hot sun.

*Fifth.* Even under an ice covering a daily change in temperature occurs.

*Sixth.* Sharp extremes of day and night temperatures somewhat affect the following daily record, but not to any very great extent, and the changes that do occur are more in the nature of a seasonal than of a daily or weekly change.

In a general way, these conclusions have been borne out by the records received. At from three to four feet there was a constant increase of temperature from a minimum of 46° on April 19th, to a maximum of 64° on May 10th, though the outdoor temperature ranged in the same period from 23° to 84.5°. Many things had to be considered in making the records and in drawing conclusions from those that were made, for no two bogs are alike in exposure, in the source of the water-supply and in the amount of flow in the water-body. The effort was to get at conditions as they existed in a practically permanent water-body without a definite channel or current through it. The larger the body of water the more uniform its temperature; and where the supply to keep up the head came from a reservoir or large storage area, it was more uniform than where it was

derived from a large stream. In a current the water was always two degrees colder than in a stagnant area, and a shallow had as great an advantage over a deep pool. Where one foot was the depth of the water, the temperature at that depth was from two degrees to four degrees higher than at one foot, with three or four feet of water as the depth of the pond. At a gate the water was always a little lower in temperature at the same depth than in any other portion of the bog. Temperatures taken in the swamps and ditches from which the bogs were supplied were like those at three feet depth, and may be considered the ground warmth. They varied little, no matter what the air temperature might be. Locality had little effect on the deep water. May 6th, the Jamesburg, White, Budd and Rider bogs varied less than two degrees at three feet, and very little more at the surface. The records are not entirely comparable, because the dates on which observations were made were not identical; but here the records of the State Weather Service are brought into comparison, and the intervening dates are filled in from Hightstown, which is only a few miles from Jamesburg, and Lakewood, which is in a territory similar to the other bogs. Surface temperatures ranged from 48° to 74° between April 19th and May 20th, and while usually from 5° to 10° below the air temperature, were on one or two occasions from 2° to 3° above it. This came when after a very warm day came an abnormally cool one, the water, even at the surface, responding slowly to the change. Readings were taken in all cases of the air temperature; of the surface water, the bulb only being submerged; then at six, twelve, twenty-four and thirty-six inches. Additional readings at extreme depths on the bogs varied nothing from the three-foot depth.

## Record of Water Temperatures on Cranberry Bogs Observed in April and May, 1905.

| DATE. | Air temp. | Surface. | Six inches. | One foot. | Two feet. | Three feet. | Four feet. | Five feet. | Over five feet. | Recorder. | Location of bog. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| April 19... | 50° | 48°—52° | 48°—52° | 48°—52° | 48° | ..... | ..... | ..... | ..... | Dickerson.. | Jamesburg ... | Higher temperatures are at upper part of bog; lower at gate. |
| " 19... | 56° | 48° | 47° | 47° | 47° | 46¾° | 46½° | ..... | ..... | White ..... | Hanover Sta.. | |
| " 21... | 83½° | 67° | 64° | 62½° | 59½° | 58½° | 56° | 56° | ..... | White ..... | Hanover Sta.. | |
| " 24... | 66° | 61° | 60° | 60° | 59⅓° | 59° | 57° | ..... | ..... | White..... | Hanover Sta.. | |
| " 25... | 61°—64° | 58°—61° | 58°—61° | 57°—60° | 57°—60° | 57° | 57° | ..... | ..... | Dickerson.. | Jamesburg.... | Lower bogs at various points. |
| " 26... | 68° | —— | 60° | 60° | 60° | 60° | ..... | ..... | 57° | Rider. ..... | Hampton Pl.. | Eight feet lowest depth. |
| May 1... | 58° | —— | 61° | 60° | 60° | 60° | ..... | ..... | 59½° | Rider ... .... | Hampton Pl.. | All the observations on this day rate the water as higher than the air and, in fact, the temperature reached frost line that night. |
| " 1... | 56° | 57° | 57° | 56½° | 57° | 57° | 57° | 57° | ..... | White..... | Hanover Sta.. | |
| " 1... | 53°—58° | 59°—64° | 59°—64° | 59°—61° | 60°—61° | 60°—61° | ..... | ..... | ..... | Dickerson.. | Jamesburg.... | |
| " 2... | 60° | —— | 55½° | 55° | 54° | 53° | 53° | ..... | ..... | Budd ... .... | Pemberton ... | Heavy frost, making ice, at night. 34° at 6 A. M. |
| " 3... | 81° | 68° | 65° | 63½° | 62° | 62° | 60° | 57½° | ..... | White..... | Hanover Sta.. | |
| " 5... | 57° | 58° | 58° | 58° | 58° | 58° | 58° | 58° | ..... | White..... | Hanover Sta.. | Query. Whether this record is accurate? Too uniform. |
| " 5... | 63° | —— | 64½° | 64½° | 62½° | 62° | ..... | ..... | 62° | Budd. ..... | Pemberton ... | Probably nearer right. |
| " 6... | 66°—68° | 63°—64° | 59°—62° | 56°—62° | 61° | 62½° | ..... | ..... | ..... | Dickerson.. | Jamesburg.... | In shade and sunshine. |
| " 8... | 73° | —— | 69° | 68° | 65½° | —— | ..... | ..... | 64° | Rider ..... | Hampton Pl.. | |
| " 8... | 69½° | 69°—72° | 68½°—72° | 68½°—71° | 68½°—69½° | 68°—69° | 68½° | 67½° | ..... | White ..... | Hanover Sta.. | Water being drawn and high temperatures are from reservoir. |
| " 10.. | 67° | 68° | 68° | 63° | 62½° | 62° | 62° | 62° | ... .... | White..... | Hanover Sta.. | Temperature in reservoir. |
| " 12... | 80° | —— | 64° | 65° | 61° | 60½° | ..... | ..... | 60½° | Budd.... ..... | Pemberton ... | |
| " 15... | 80° | —— | 67° | 64° | 62° | ..... | ..... | ..... | ..... | Rider ... .... | Hampton Pl.. | Water being drawn and temperatures taken in stream. |
| " 16... | 78° | —— | 74° | 67° | 65½° | 64° | ..... | ..... | 64° | Budd.... .... | Pemberton.... | |
| " 20... | 64° | —— | 60½° | 60½° | 60° | 59½° | ... ..... | ..... | 59½° | Budd.... .... | Pemberton ... | Reflowing and the water is all of uniform temperature. |

## OBSERVATIONS ON THE INSECTS.

It would be of little avail to gather statistics like the above without carrying on at the same time a series of observations on the insect to be affected. Opportunity for this was found at the Jamesburg bogs, which have always suffered from the black-heads, and where vines have been allowed to grow on the dams and on some ridges above the water line.

*April 19th.*—Mr. Dickerson, when making his first temperature records, made, also, a careful search for eggs of *Eudemis,* and found quite a series of them, in good, plump condition, above the water line. Some of these were brought to New Brunswick, where, after two or three days' exposure to the dry air of the laboratory, they collapsed. No trace of larvæ was found at this date.

*April 25th.*—A second examination was made and more eggs were found—some in the same condition as before, more of them plump and apparently ready to hatch, a few just hatched and boring into the leaf tissue. The place where a larva had hatched and entered was marked by a minute lump of frass or excrement, and when that was removed a little chamber between the upper and under surface of the leaf became obvious, sheltering a caterpillar hardly more than a day or two old. Obviously conditions were favorable for a general hatching, and April 23d was probably the earliest date at which any larvæ appeared. Some specimens were brought to New Brunswick for observation; other sprays containing eggs were tied into a mass and submerged, so as to observe the effect of a water covering at that stage of development. The specimens taken to the laboratory did not remain within the leaf tissue, but began to eat the cells of the lower side, forming characteristic, gnawed surfaces.

*May 1st.*—The eggs above water had hatched generally, but there was no sign of a leaf-folding anywhere. The casual observer would have concluded that no larvæ were yet present, while practically the entire brood was out. The submerged plants were taken out, examined, and as no change was apparent in the eggs and no larvæ had hatched, they were replaced under four inches of water. It seems certain that either the difference between air and water temperature had checked development or that the physical effect of the covering had produced that result. Additional material was brought to New Brunswick and on May 3d one specimen molted; just ten days after

the first larva was seen, and not over twelve days from the first hatching. At this time the first signs of leaf-folding were noticed. The larvæ abandoned the leaves upon which they had first fed,

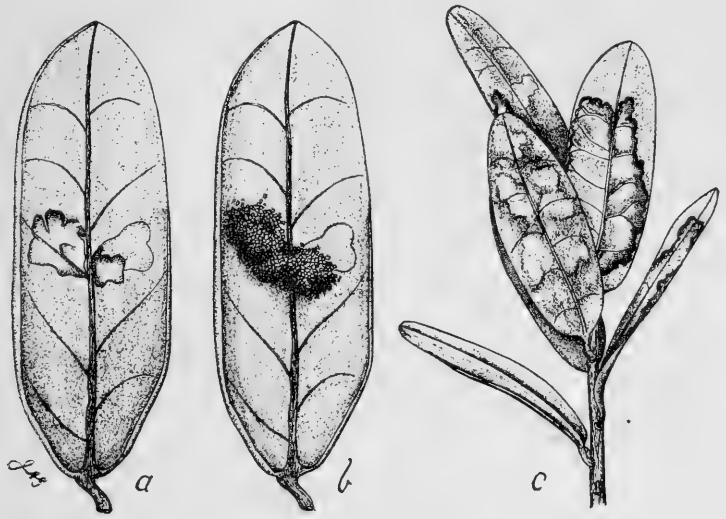


**Fig. 20.**

**Work of young black heads on cranberry leaves: *a*, the mine in the leaf, free of excrement; *b*, the mass of excrement on leaf which indicates a young larva; *c*, feeding done on old leaves before the tips are spun up; all much enlarged. Original.**

crawled nearer to the tips of the spray and, where two leaves approached, fastened the under side of the one to the upper side of the other. This was at the end of the first or the beginning of the second stage, hence there was no superficial sign of larval development on a plant until the caterpillars were already more than a week old. Unhatched eggs on the leaves brought in had mostly collapsed, though a few were yet present in good condition.

*May 6th.*—All the eggs along the bogs had hatched. Most of the larvæ had abandoned their first quarters and had begun to fasten leaves together. There was a general change to the second stage, and any cranberry grower could then realize that the "worms had hatched." The submerged vines were again examined, no larvæ were found, and, as the water on the bogs was to be drawn on the 8th, they were brought to New Brunswick. Examined on the 8th in the laboratory, it was found that most of the eggs were dead; a few were apparently alive, but only one appeared normally developed and ready to hatch.

*May 10th.*—The water was off the bogs, and it was now possible to examine all those patches that had been over water. In every case well-developed larvæ were found, and in some cases the largest of these were ready to pupate May 12th. On the high ground, along the dams, tips were spun up everywhere, and the yellow head larva of the *Teras* was noted as being present in good quantity. No close examinations were made of the vines on the fully-flowed portions of the bogs.

*May 22d.*—Most of the larvæ on the upper portions of the bog were in the last stage, ready to pupate, but no pupæ were found. On those parts of the bog that had been winter-flower only an occasional spun tip was found.

*May 31st.*—Many of the tips had been abandoned by the larvæ, who sought a place to pupate nearer the ground. In a general way it might be said that everything was full grown, in the pupal stage, or ready to come out, and whatever damage was to come from the first brood, had been done.

*June 8th.*—All the middle and later stages of the *Eudemis* were found, and a large number of adults were flying on the bogs. The first brood had matured, or was about to mature, and very little indeed had come from any of the vines that had been water-covered during the winter. Practically, so far as Jamesburg is concerned, none of the vines that were water-covered up to May 8th produced larvæ of either the *Teras* (yellow-head) or the *Eudemis* (black-head). This is a matter of great importance, as it fixes the dates of development under what may be considered natural conditions.

The date at which an insect hatches from the egg is, normally, a matter of calendar quite as much as of temperature. A low temperature at the date of normal development retards for a very few days; if it lasts a week the young are mostly killed. So if the eggs of *Eudemis* hatch normally on or about April 25th, the larvæ will emerge as near to that date as possible, water-covered or in the open air. In extreme cases new larvæ of the first brood may be found when adults of the summer brood are already fully developed, but that happens only when the conditions are absolutely prohibitive of earlier hatching. The usual result is that when the normal date comes around and the conditions are not favorable the eggs die instead of developing.

No date earlier than April 23d can be reasonably assumed as normal for hatching, and it becomes interesting to determine the conditions just immediately preceding that time.

For Hightstown the temperature varied from a maximum of 82° to a minimum of 24°, all within a space of three days, but the mean maximum was about 63° and the mean minimum was about 36°. On no day was the minimum temperature as high as 60°. Turning now to our bog records at Jamesburg, 60° at a two-foot depth was recorded April 25th and May 1st, and 61° May 6th. At a one-foot depth one degree higher was recorded on the dates given. On the White bog 63° was recorded at one-foot depth, and 62.5° at two-foot depth, May 10th. Very similar temperatures for corresponding dates were recorded by Mr. Budd and Mr. Rider. In other words, the same actual average temperature was reached in the water a very little later than in the air. There was less fluctuation and the warm temperature was continuous, promoting a slow, equal development. On the other hand, the direct influence of the sun and the stimulation of extreme temperatures undoubtedly promoted more rapid growth, as indicated by the fact that the first larvæ were found where the vines themselves were already most advanced. The large number of collapsed eggs found after the water had been drawn indicates that the direct effect of the warm water is such as to destroy the vitality of the ovum, but the fact that I secured sound eggs from below the surface in March, indicates that the water covering only was not at fault. No eggs that had hatched under water were secured this season, but in previous seasons I have found such not infrequently.

## CONCLUSIONS.

May 1st, in a normal season, may be safely assumed as the date when all the eggs of the *Eudemis* have hatched on vines that have been uncovered all winter.

A normal season in the cranberry regions of New Jersey is one in which the mean day temperature during April has reached or only slightly exceeded 62°.

Eggs on vines covered by water are in an unnatural position, and, while they maintain their vitality during the winter, they begin to lose it when the water reaches a temperature approaching 60°, especially where the covering is eighteen inches or more.

Vines covered with less than six inches of water are affected by the surface conditions, and eggs will develop or die within a few days after they do on uncovered vines. May 5th may be ordinarily con-

sidered a safe period for that purpose, and water may be safely drawn from such vines May 10th.

Vines uncovered for a week have reached the normal, outdoor conditions, and sound eggs will hatch in due course if development was not started under water—that is, a bog from which the water was drawn April 1st would develop eggs at the same time as on vines that had remained uncovered. A bog drawn April 20th would begin to develop eggs a week later than the normal date, say May 1st, and hatching would not be universal until May 8th.

Two weeks under deep water—eighteen inches or more—at a temperature of 60°, will destroy the vast majority of all the eggs of *Eudemis,* the result being due to some physical influence and not to a favoring of larval development, as I had believed from previous observations.

To determine the period of drawing water from a bog infested by black-heads, where reflowing is not possible, test the water temperature at a two-foot depth, beginning about April 15th. When it reaches 60° allow it to remain for two weeks longer.

## PRACTICAL SUGGESTIONS.

The observations made during the latter part of 1904 and the early part of 1905 have led me to believe more firmly than ever in the importance of keeping the immediate bog surroundings, and especially all dams, as free as possible from cranberry vines. There should not be on the bog itself any point that is not completely water-covered; and this will prevent centers of infestation for *Teras,* or yellow-head, start. So far as possible the brush should be cleared up, even into the woodland, and that will do away with hiding and breeding places for species that resort to the cranberry as an alternate food plant. In general, the cleaner the bog and its surroundings the easier it is to control the pests.

As to the management of the water, so many considerations enter that it is somewhat unsafe to give positive advice. Every grower must know just how much water he has, how much he can do with it and what points he means to gain.

Speaking only from one point of view—that of insect control—when there is water enough to reflow completely I would advise drawing no later than April 1st. That will give the bogs a chance to start slowly

with the season, and the development of the insects will be uniform. By the middle of the month the *Teras* will be at work ovipositing, and by the 25th larvæ of both yellow and black-heads will be gener-

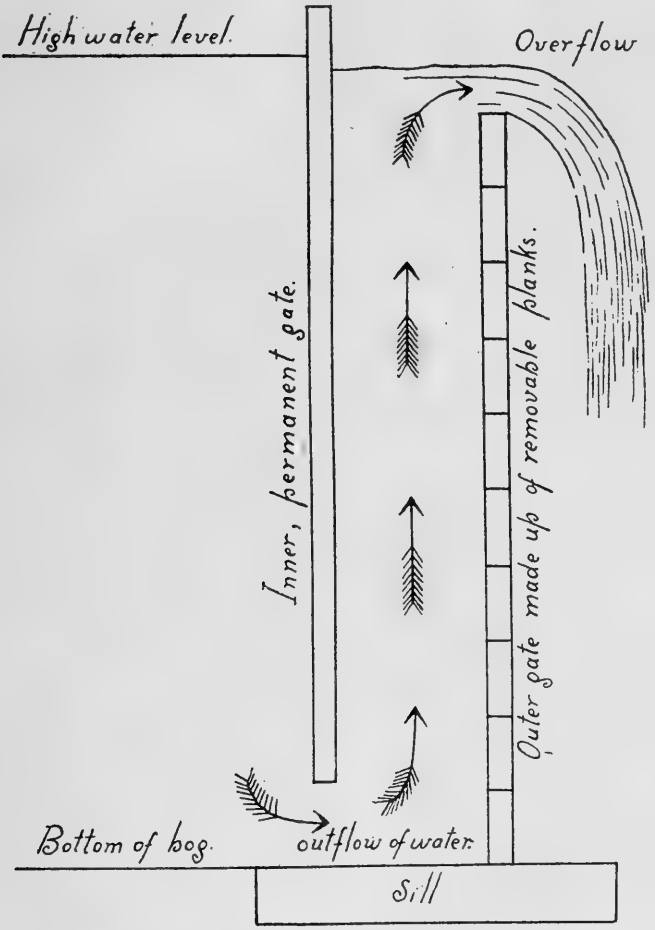


**Fig. 21.**
**Sectional plan of a gate for drawing water from bottom. Original.**

ally hatched. Reflow May 1st if the season is normally advanced and larvæ are generally observed. It is a good plan to wait until half-grown larvæ appear, because then one is almost certain that no sound eggs remain unhatched.

If the bogs have water enough to cover completely but not enough to reflow, another method must be adopted. Under no circumstances should the bogs be uncovered until after April 15th if yellow-head injury is to be averted. If the season is late and early April is cold, even that is too early, and April 25th to May 1st is safer. If the black-head (*Eudemis*) is also to be guarded against, dates should be less depended upon, and the temperature of the water gives the safest guide. Two weeks after 59° or 60° is recorded at two feet in a quiet part of the pond, *i. e.*, not in a direct current or near the gates, it will be safe to draw. That will usually bring it to the first week in May, and if an arbitrary date is desired May 10th will be more often right than wrong.

If it be desired to draw earlier and slowly, that can be done by a double gate to take off the water from the lower levels first. The accompanying sketch is self-explanatory, and shows in sections how the water enters at the bottom of an inner solid plant wall into a compartment closed at the bottom and opened at top for the overflow. This outer wall is made up of planking in the usual way, and the scheme leaves the warm upper layers, bringing the vines gradually under the influence of the higher temperature and causing the collapse of any eggs that may yet remain sound at lower depths.

## OBSERVATIONS ON REFLOWING.

In the preceding recommendations it is assumed that reflowing the bogs is a certain remedy in all cases, provided the water is kept on the bogs at least twenty-four hours and provided all the larvæ are hatched. In ordinary cases this assumption seems to be warranted. It is certain that I have seen bogs reflowed and completely cleaned where there had been caterpillars in great plenty before. It is also certain, from direct experiment, that pupæ are nearly as much affected by the water covering as the larvæ, and this was proved by a simple laboratory experiment.

July 19th, pupæ of the *Eudemis* were submerged in vials filled with water. No. 1 contained two pupæ, which were left covered forty-six hours, and were then transferred to a dry vial carefully kept from jars. Nos. 2 and 3 contained two pupæ each, which were left covered sixty-five hours and then dealt with as before. The five remaining pupæ

were kept submerged for ninety hours before they were placed in dry quarters. In no case did any pupæ develop.

Based upon previous experience and observations, when, early in May, I found all the *Eudemis* eggs hatched, I wrote Messrs. White, Budd and Rider, suggesting that the time to reflow had arrived; a conclusion which had been in part anticipated in one case at least. But the results were not at all as complete as was expected. Great quantities of young larvæ were destroyed and were found floating on the surface, but in every instance there was a large surplus remaining that made itself appreciably felt in early July, when the second brood was at its best, or worst. In one case the trouble was admittedly due to uncovered vines in great part; in at least one other that factor was altogether excluded, and, on examining the records made by Mr. Dickerson, the probable explanation is that the survivors were those half or two-third grown examples that were lodged between two closely spun-up leaves. All the very recently hatched insects were reached, and all those that were full grown or in the pupal stage probably succumbed to the covering, but those that remained quiet in their shelter, especially in the deeper parts of the bogs, escaped. The probability is increased by the observation that spun-up tips kept submerged for four days rose readily to the surface after their weight which kept it down was removed. The reflowing then, during the early days of May, was too late to reach the half-growth forms and too early to catch any of them in the pupal stage when they are not so well protected. Covering not later than May 1st would have been more effective, because, while all the eggs had hatched, there would have been fewer in the protected stage. On the other hand, allowing the insects to develop until pupation was general would have left very few in the protected stage. That period was about May 30th, and reflowing at that time would be likely to be more effective than the earlier period.

On the whole, the question is now whether, after all, late holding is not the easiest as well as the most effective way to use the water as against the two species of vine worms.

## THE CRANBERRY FRUIT-WORM.

*Mincola vaccinii* Riley.

This insect, ordinarily much more plentiful in Massachusetts than in New Jersey, was unusually abundant on our bogs this year, and a brief review of our present knowledge of the best methods of dealing with it would seem to be in place.

During the two years last past a series of systematic observations and experiments have been made by Mr. Henry J. Thayer, of Boston, Mass., and the results of these he has been kind enough to communicate to me. It appears now that the life period of some of the stages is very much longer than had been believed and the development is much more irregular. It appears, also, that while insecticides are entirely useless to lessen injury, a proper handling of the water is very effective, and Mr. Thayer has reduced the injury done on his bogs to a very small percentage.

The adult moths appear on the bogs, in ordinary seasons, early in July, when the fruit is just beginning to set, but isolated examples are on the wing much earlier, Mr. Thayer's breeding records showing the first example June 16th. They remain on the bogs throughout July and probably most of August, some hibernating larvæ yet remaining unchanged to pupæ in the early days of that month. The heavy flight, however, is probably over soon after the middle of July, when young larvæ are already quite plentiful. That the development is very uneven is shown by the fact that in early September caterpillars are sometimes found in all stages of growth, but this, again, varied with the season, for practically none was found in the berries September 23d, when I visited Mr. Thayer's bogs.

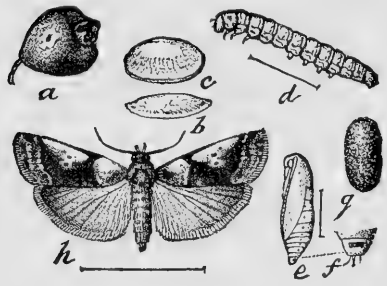


**Fig. 22.**

**Cranberry Fruit-worm: *a*, berry showing egg; *b*, *c*, egg; *d*, caterpillar; *e*, *f*, pupa; *g*, cocoon; *h*, moth: all save *a* and *g* enlarged. After Riley.**

The moth, with wings expanded, measures about three-fourths of an inch, and is of a glistening ash-gray, mottled with white and blackish; the fore-wings narrower and rolled up, so as to cover the hind-wings

when at rest. It usually sits on the stem during the day, head down, and does not fly readily. When disturbed it flies with a darting motion for quite long distances, so it is not often seen and recognized by the ordinary grower. Of dozens of insects sent in as fruit-worm moths, it is rare to find even a single example of the true species, and that usually in such condition as to be unrecognizable.

The eggs are pale yellowish in color, nearly round in outline, almost flat, and so soft that they adapt themselves readily to any inequalities of the surface upon which they are laid. Usually they are laid upon the young berry, preferably at or near the calyx end, but they may be found anywhere on its surface, and probably, also, on the leaves. The worms emerge in about five days, and for a day or two feed on the outside of the fruit. Then the little fellows bore into the berry itself, and each one closes the tiny opening by a dense web of silk, so skillfully made that it is difficult to find the point of entrance. The seed capsule is at once attacked, eaten out and then the larva seeks new quarters. The abandoned berry soon after turns red, shrivels and dies. Several fruits may be eaten out by a single caterpillar, and until it is half grown or more the insect always closes up the opening it makes very carefully. When nearly full grown it becomes careless of this and leaves a jagged opening, through which frass or excrement is often extruded—opening the way, thereby, to the parasites to which it is subject. Sometimes it even fastens together several adjacent berries, eating from one into the other and ruining all. By the time the fruit is half grown on a badly-infested bog it will begin to turn red, and to the ordinary observer will appear to be ripening. But the grower knows better and realizes that it is all lost to him, a harvest of dried shells only being left at picking time.

Full growth comes, ordinarily, in late August or early September, some worms being already out of the berries August 25th, but more of them leaving every day after September 1st. At picking time all the moths have disappeared; many, perhaps most, of the worms have left the berries and worked below the surface; but many are not yet full grown and a few still are so small as to have the silken covering over the point of entrance.

Mr. Thayer records collecting two quarts of worm-infested "Howes" August 27th, and that several larvæ left the berries and entered the sand less than an hour thereafter. September 4th, eighty-five cocoons were found and more wormy berries were added. September 11th

there were 141 cocoons, and September 16th there were yet all stages down to small larvæ in silk-closed berries.

The full-grown larvæ are rather more than half an inch in length, of a bright green color, with a variably-marked, reddish tinge on the back. The head is a little narrower than the first body segment and is yellowish, except for the brown mouth parts. The body segments are transversely wrinkled and clothed with a few sparse, rather long hairs.

These caterpillars winter in silken cocoons, which they make by first rolling in the sand, gluing the surrounding particles together with saliva, and then spinning their web inside the rough casing thus formed. The moist sand of the surface of a cranberry bog is just such a surrounding as the insect needs. If the bog remains unflooded during the winter the great majority of all the larvæ will survive to complete their transformations. If the bog is covered with water a considerable percentage will be killed off, this percentage increasing in proportion to the earliness of the flooding.

Mr. Thayer's notes show that of the cocoons collected and submerged soon after they were formed, practically none survived, and that late submergence and early withdrawal in all cases favored the insects.

Pupation does not take place within the cocoon until shortly before the moths are due to emerge. May 23d is the first date at which pupæ were actually noted in confinement, and June 17th is the earliest for actual bog conditions. As to the latest change, that did not occur until August, when some of the new larvae were already almost full grown. There is no actual record of a lap-over, but by the time the last moth is on the wing the first-born caterpillars are already full grown, if not actually in cocoon.

### Remedial Measures.

These have been indicated in the discussion of the life cycle and in the references to Mr. Thayer's results. Flow as soon after picking as is convenient and safe, and keep on the water, either altogether or for two or three weeks, if improvement or other work is necessary on the bogs. But in no case flow permanently before the middle of October unless the foliage has ripened and turned. This process is advantageous also as against the girdle-worm where that occurs, so that a

double point will be gained. The date of drawing the water in spring is less important, but late holding is better than early drawing.

Where wormy berries are picked and get into the storehouse the larvæ will emerge when they are fully developed and will find some crevice or shelter in which they will spin up and attempt to complete their development. It will be the part of wisdom to furnish plenty of shelter for them in the way of loosely-piled slats or boards, which can be burned during the winter. Boxes and trays can be examined and cleaned of cocoons, and the cranberry-house itself should be thoroughly cleaned out. But even if nothing is done, few of the larvæ tempted to spin up indoors come to maturity. They need moisture in spring when ready to pupate and die when kept dry.

Mr. Thayer records that cocoons were found in late fall in great numbers in spaces between floor boards, but that the field mice cleaned them nearly all out before the next following spring.

## THE ONION MAGGOT.

*Pegomyia cepetorum* Meade.

This is really only one of several species that feed in the onion bulb, and is an imported or introduced form, but in New Jersey the other kinds are not common, and one, at least, seems to follow injury caused by some other agency rather than act as first cause.

Hibernation is in the adult or fly stage, in barns or among rubbish and other shelter, largely in the places where onions are stored, and activity begins in spring as soon as the weather becomes settled. This hibernating adult somewhat resembles the ordinary house fly in appearance, and may be mistaken for it, but it is much paler, gray or yellowish in color, with prominent, black bristles, and in shape it is rather narrower, more elongate and more cylindrical.

These flies are in the field as soon as the young onions begin to develop, and lay their elongate, whitish, almost spindle-shaped eggs in little masses at the base of the plant; if possible, a little below the surface if there is an opening. There is no horny, egg-laying tube, so the insect cannot pierce the growing tissue, nor can it force its eggs into the soil; but there is a short, extensile and flexible ovipositor, by means of which it takes advantage of any opening or crevice that may exist around the stalk.

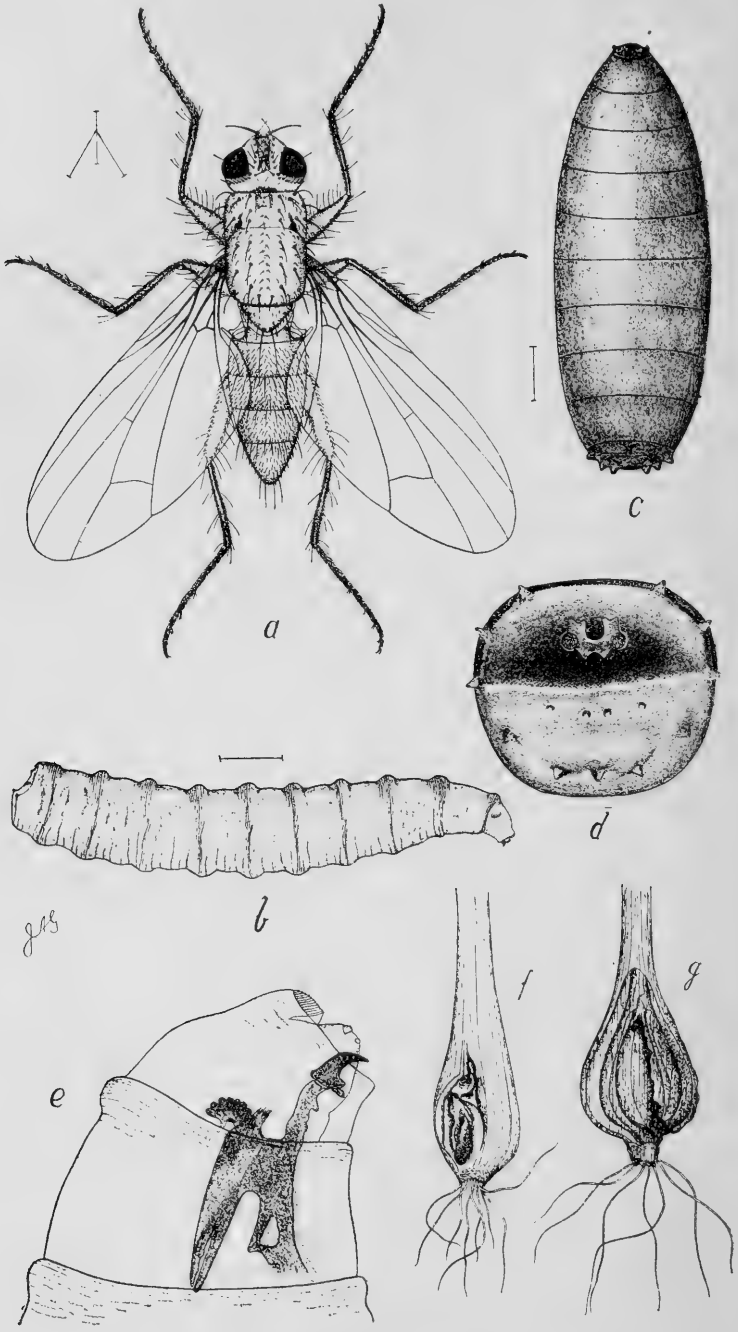


**Fig. 23.**

**The Onion Maggot,** *Pegomyia cepetorum* **Meade:** *a*, the adult fly; *b*, the maggot; *c*, pupa; *d*, anal end of maggot, with breathing holes; *e*, head, showing mouth parts—all very much enlarged; *f*, young onion plant showing injury by maggots; *g*, section of bulb further advanced, showing the extent of the injury. Original.

The eggs hatch very soon after being laid, and the young appear as small, footless maggots, tapering toward the mouth end and squarely cut off or truncate behind. They attack the young onion, bore into the tissue, and decay begins around them almost at once. The young plant is very sensitive to this kind of injury and the leaves wilt and droop.

If we examine the half-grown maggot more closely we will note that it has no distinct head, no feet and no other obvious organs of locomotion; but it is ringed or wrinkled and moves along by extending its body forward, holding its position by the anterior wrinkles and drawing the hinder part of the body forward.

The posterior, or cut-off, portion of the body is set with little hillocks or conic tubercles, and there are two well-protected spiracles or breathing holes.

The pointed or head-end is furnished with a small mouth opening, with a pair of fleshy lips or jaws and two pointed, curved, hook-like, corneous structures. By means of these sharp-pointed jaws the larva scrapes and punctures the surface of the onion, and by means of the fleshy, lip-like structures it gets the exuding plant juices into the mouth and so on through the gullet into the stomach. The dark framework seen within the enlarged anterior rings of the larva in Figure 23, shows the chitinous support for the muscles that work the sucking or pumping structures of the gullet. Without biting mouth structures, then; the insect is nevertheless able to get into a young onion, and, once in, progress is even more rapid, because of the aid given by the organisms favoring decay. Rarely there is a single maggot in a small bulb; more commonly there are half a dozen or more. The first brood comes to maturity about the middle of June, and perhaps the most serious part of the early injury has been done at that time. When the larva is full grown it begins to contract, becomes shorter, more regularly oval and cylindrical and changes to a dull brown color. In this—the pupal—stage it is inactive and is really only a cover to the real pupa which develops within the dried larval skin. In this condition it remains for a few days only before changing to the adult or fly stage already described.

It is said that there are three broods during the season, and that is indicated by the dates at which larvæ have been found, but the later broods are not so numerous in specimens as the earlier, or at least seem to do much less mischief.

### Injury Caused.

There is no stage in the growth of the onion, from the seedling to the seed-bearing bulb, that is not subject to attack, but it is the small onions, from one-half to one inch in diameter, that seem to suffer worst. At that stage of their development the amount of tissue is not great; the injury caused by several boring maggots becomes quickly felt, and disease enters at once. A large onion may stand considerable local injury without showing it very much, and may even outgrow a slight attack if there is plenty of stimulating plant food. When decay begins in an onion, be it ever so slight, it is apt to give entrance to a colony of white mites small, spider-like creatures; which live just at the edge of the decayed portion and work ever further forward into the sounder tissue. Naturally, such a bulb develops little and the plant above ground turns yellow, droops and dies.

When the maggots are very numerous and the onions small they may and do go from one bulb to another, and in leaving one bulb the company does not remain together, but may divide into several parties, each taking a different victim.

The indications of an attack are seen in the wilting and drooping plants in a row, and as soon as this is noticed active measures are in order.

### Remedial Measures.

These are of two kinds—preventive and destructive. Preventive measures are those which aim to keep off the flies so that they will not lay eggs, because either the odor of the used material is offensive or it is really harmful to the insects.

*Kerosene and sand,* at the rate of a pint of kerosene to ten quarts of dry sand, thoroughly mixed, is spread around the plant or along the row, and exercises a deterrent effect, if it does not also kill young larvæ that may be hatched from eggs already on the plants. This should really be put on before the flies have begun to oviposit.

*Tobacco.*—Finely-ground tobacco, or tobacco dust, may be liberally applied along the rows without danger to the plants, but rather to their advantage, because it is a good fertilizer. It should be finely ground, for, as a dust, it is a better repellant, and also more likely to kill any young larvæ that may come into contact with it. When it rains the tobacco extract will be more abundant, will go down deeper into the

ground and will be more quickly fatal to young maggots and stimulating to the plants. I prefer the tobacco to the kerosene and sand because of the double value.

A good preventive measure is to avoid the use of manures and decaying vegetable material generally, so far as possible. Maggots are essentially feeders and inhabitants of vegetable decay, and moist, soft soil attracts them. The advice is, therefore, depend upon mineral fertilizers so far as possible and so far as the crop will be favored.

In the way of destructive measures, fertilizers also have a place on the light soils of Southern New Jersey. As soon as infestation is noted, turn a shallow furrow from the row, as close to it as is safe. Apply a liberal dressing of nitrate of soda, with kainit or muriate of potash, and turn back the soil. Use nitrate at the rate of 300 pounds per acre and kainit or muriate at about the same rate. The application acts best made just before a rain, and is, of course, a stimulant as well as a remedy.

On heavy land this application does not work as well, but its effect as a stimulant is useful, and, in any event, the growing onions should always have an abundance of available plant food.

Another method of prevention is to avoid all accumulation of rubbish, or to allow the accumulation in fall, with the object of burning during the winter, to destroy hibernating insects. So the sheds and barns where baskets, trays and other paraphernalia necessary to the handling of the crop are stored should be thoroughly cleaned, and, if possible, fumigated with sulphur during the winter. Baskets, trays and the like can be put into a tolerably tight building and thoroughly cleaned of all hibernating forms. Open sheds are more difficult to deal with, and for these a thin whitewash, to which carbolic acid has been added, may be used by spraying the material with as much force as possible into all cracks and crevices in which the flies may find shelter.

About the only insecticide that seems to have been at all effective is the carbolic acid emulsion, prepared as follows: Dissolve one pound of soap, shaved fine, in one gallon of boiling water; add one pint of crude carbolic acid and make into an emulsion with a force pump; dilute with thirty parts of water and apply liberally to infested plants. A modification of this formula, given by Mr. Chittenden, doubles the amount of carbolic acid and suggests a dilution with from thirty-five to fifty parts of water. Here, also, it is important that the appli-

cation be made at as early a period as possible after the work of the maggots is noticed, for the smaller the insects the less they have bored into the plant and the more easily are they reached and killed.

It is also a good plan, wherever a wilting plant is noticed, to take it out with a trowel, so as to be sure to get all the maggots around it, and put plant, maggots and all into a pail. When all infested plants are collected in this way, drench with kerosene and bury at least six inches deep, firming the ground so that in case a pupa escapes the oil the developing fly will be unable to work its way out.

Finally, onions should not be grown on the same ground two years in succession if it can be avoided, and the new field should be as far removed as possible from the old one.

Growing onions under these conditions means work and constant observation, but while neglect is apt to result in ever-increasing injury, constant care and attention will result in an ever-decreasing percentage of loss.

## THE CORNSTALK BORER.

*Hydroccia nebris* Gn.

Each year there is some complaint of a borer in corn and tomatoes; occasionally, also, in potatoes, and sometimes, as in the season just past, considerable injury is done. The borer, when first noticed in middle or late June, is a slender caterpillar about an inch in length, with the two ends of the body unlike in markings. There is a dark band on the back that extends from one end to the other, but on the sides the stripes extend only to the middle of the body, where there is a dark belt.

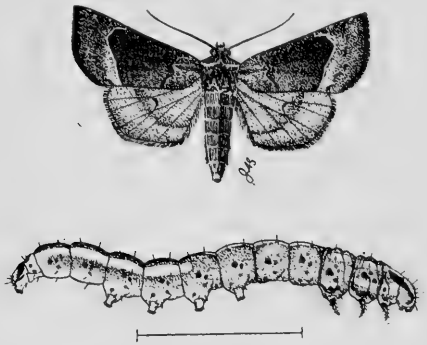

**Fig. 24.**

Cornstalk borer, *Hydroccia nebris* Gn.: moth above; half grown larva below—the latter enlarged. Original.

It is at that season and in that stage that it attracts most attention, and when most of its notable injury is done. Later in the season, say about the end of August, when the borer is full grown, it is altogether different in appearance. It is then

over one and one-half inches in length, quite a stout, though by no means a chunky caterpillar, livid, whitish brown, without stripes, with some blackish tubercles, bearing tufts of short bristles, the head and anterior feet black. In that stage, if in corn or tomatoes at all, it is far down in the stalk, and any infested plants then found have either outgrown the injury, as in corn, or have little or no crop, as is usual in tomatoes.

It is rare that the borer is found in large fields of either corn or tomatoes, and it is usually the garden or the small field that suffers most. Nearly or quite thirty years ago, when Dr. C. V. Riley wrote of this species in the Missouri reports, its injuries were of the same character and of the same irregular occurrence. The life history, as then written, has been copied ever since, with little variation and no question even in very recent bulletins.

**Fig. 25.**
**Work of the stalk borer in tomato vines. Original.**

When the caterpillar reaches its full growth, in August, it changes to a dark, chestnut-brown pupa, either in the infested plant, near the surface of the ground, or in the soil close to it. The moths begin to appear about the 10th of September, and are modest, mouse-gray in color, with lighter powderings, and a pale, transverse shading across the outer part of the wing—much better marked in some specimens than in others. The figure (24) shows the general appearance and average size fairly well, while the caterpillar, not much more than half grown, is somewhat enlarged. Dr. Riley believed that the moth lived through the winter and laid its eggs in the spring, as many of these Noctuid moths do, and so he stated without having actually seen the eggs. This statement was accepted as a fact and has since been repeated as such, instead of a mere probability.

When seeking for a means of checking the injury caused I was led to question the accepted period of egg-laying, and wrote to all my entomological friends of whom I believed that they might be able to give definite information, but no one had actually seen the insect deposit its eggs and no definite information was available. At my

request a number of these correspondents collected larvæ, and in the laboratory some 200 were gathered together by Messrs. Brehme and Grossbeck. Mr. Henry Bird, of Rye, N. Y., who has made rather a specialty of the moths belonging to this group, was good enough to place at my disposal his notes and observations, and Mr. William Beutenmuller, of the American Museum of Natural History, bred out and observed a lot of the specimens, and was the first to actually note the egg-laying period. From the information thus gathered, supplemented by personal observation and laboratory experiments, the following life history is made out.

**Life History.**

The moths make their appearance in early September and lay their eggs, preferably on the stalks of ragweed, but also on dock, pigweed or almost any other thick-stalked weed that they can find. It is probable that, in the absence of other plants, corn, tomato or potato stalks would be used. The eggs are compared by Mr. Beutenmuller to a minature muskmelon, flattened above and below, with the sides grooved. An individual female may deposit 400 or more of them, this number being determined by counting the eggs in the body of some of the females that were bred in the office.

The eggs remain on the plants during the winter, and by far the greater number perish before the advent of spring. Such as do survive hatch during the last days of May and early days of June, and the little caterpillar bores into the stem of the first suitable plant that it can find—ragweed preferred. A great many of these small plants die as the result of the attack, and the larva is compelled to change its quarters. It is even likely that other reasons may induce a change, and toward the end of June they appear in the cultivated plants. Growth is not rapid, and it requires the whole time between the beginning of June and the end of August—a period of nearly or quite three months—to mature the caterpillar. The most rapid feeding seems to occur in late June and early July, when the effect upon the plants becomes most noticeable.

In August, sometimes a patch of the giant ragweed will have every stalk infested, and burdock is only less susceptible to attack. Infested plants are readily recognized by an irregular, blackened hole in the stem, near the base, through which the excrement is forced. From the

number of such larvæ sometimes found it seems surprising that the insect is no more widespread than it is, and Mr. Bird explains it thus:

"Happily, nature has the matter pretty well in hand. With no other species [of *Hydroecia*] does parasitism exist so severely as it does with *nitela* [another name for this insect]. Two hymenopterous and two dipterous parasites play the very mischief with the species, and while others also suffer, it falls to *nitela* to bear the brunt. It seems enough for the female *Hymenopter* to merely find a burrow and thrust therein an ovum—the young maggot appears to be equal to keeping up his end of the contract. It seems able to live for some time in the moisture and frass of the burrow and trust to a chance contact with the host. The small *Dipter,* however, I believe, enters the burrow and places her eggs on the larva to the number of twenty or more. I have yet to get the name of this fly, but we know the larva's name from this time on is *Dennis.*"

The pupa also seems subject to numerous perils, and, on the whole, only a small proportion of the insects reaches the adult stage. As adults they are occasionally attracted to light, but are hardly ranked as common in collections anywhere.

### Remedial Measures.

No satisfactory method of reaching borers in herbaceous plants has yet been proposed, and it is usually best, when an infested plant is found, to take it out and destroy it, borer and all. But in this instance it appears that the cultivated plants are not the normal food of the insect, and that attacks are exceptional rather than the rule. It appears, also, that the real food plants are some of the common, large weeds, without which the borers would not occur at all.

The suggestion is obvious—keep down all such weeds in and around your fields and gardens, and in no event allow them to overrun the ground late in the season. A weedy field in September is an invitation to the moths to lay eggs, and there is always a chance that in preparing the ground for next year's crop some of these eggs may survive. Abolish the ragweed, burdock, pigweed and the like, and no further trouble need be apprehended. The danger period is September, when eggs are being laid and dirty fences and roadsides offer points of survival from which there may be an invasion of the neighboring fields during the June following.

## THE PEACH SOFT SCALE.

*Lecanium persicæ* Modeer.

This is a well-known European species, whose general life history was written there one hundred and sixty years ago, and in the United States, in some detail, by Howard, in 1894. At that time the insect was already present in ten States or territories and the District of

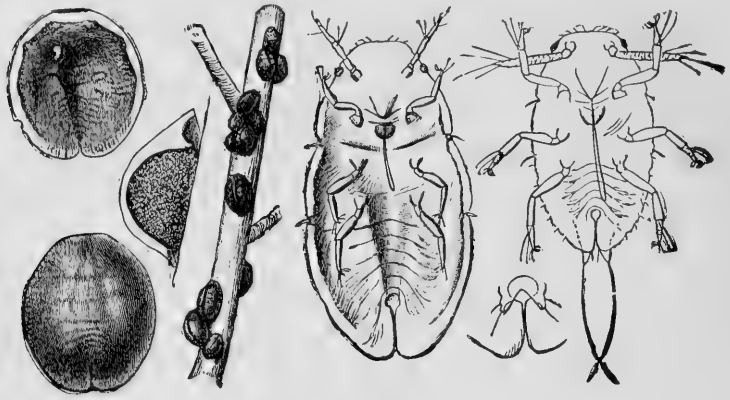

**Fig. 26.**

**The Peach Soft Scale, *Lecanium persicæ* Mod.: newly-hatched larva at right; unimpregnated female next; twig with full-grown females; at left are females from above and below and cut longitudinally; all save twigs are enlarged. From Howard, Div. Ent., U. S. Dept. Agric.**

Columbia, ranging from New York to New Mexico. Only a few localities were known in each State except Maryland, and New Jersey was not mentioned in the list of affected States. How the insect was originally introduced into the United States is not known, but no complaints of serious or widespread injury seem to have been recorded. It is confined to peach in our experience, and when very abundant has been known to cause the death of young trees. On older trees it clusters during the winter upon the twigs and young shoots so as to completely cover the surface in the worst cases.

### Life History and Habits.

The insect appears to over-winter mainly in the advanced female condition, in which stage it is a hemispherical, slightly elongated, mottled brown object, rather more than an eighth of an inch in average

diameter. Eggs begin to form in May and to hatch in June, according to published accounts, though all the early stages can be found at almost all times during the summer. The young are yellowish in color, almost transparent in appearance, and set on the under sides of the leaves, along the veins, in great numbers. Only a few examples were found set on the twigs in August. The insects excrete honey dew in considerable quantity, and wherever it falls a black soot fungus develops upon it. This has a tendency to choke the leaves and cause them to drop, and when it appears on the fruit makes the latter unsalable. The male is a very minute, two-winged fly, orange red in color, and resembles in a general way the same sex in other species. The impregnated females that have set on the leaves migrate to the twigs in late summer and grow rapidly to the winter condition.

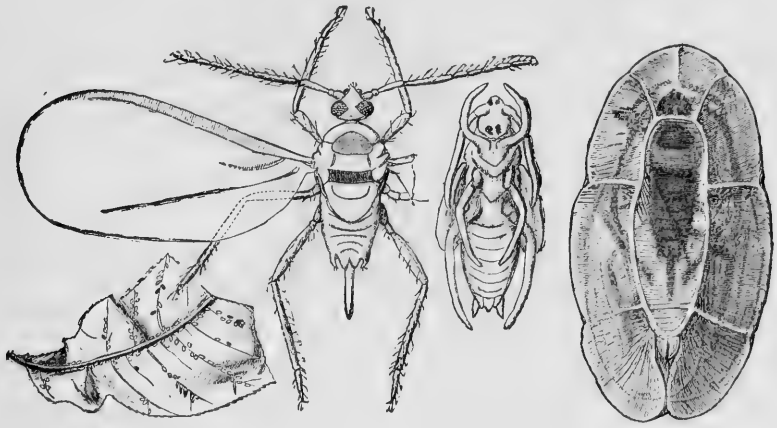

**Fig. 27.**

**The Peach Soft Scale, *Lecanium persicæ* Mod.: male scale at right; pupa next; adult male next; leaf with young male scales at left—last natural size, all others greatly enlarged. From Howard, Div. Ent., U. S. Dept. Agric.**

At the end of the first half of August the infested trees near Bridgeton had still a considerable number of over-wintered females, which were yet bearing young. A very few eggs were found, but under most of them was a little mass of newly-hatched larvæ. In fact, so general was this condition that it was at first believed that the young were born alive, no traces of the eggs being apparent. Only on close search were a few examples found in which there were some unhatched eggs in the mass. Moving larvæ were few in number, but recent sets on the leaves were abundant. Well-advanced females were distin-

guished by their broader, more oval form; but the majority seemed to be males in the pupal stage, or just about ready to emerge. Every stage in the entire life cycle was therefore present at the same time. September 28th all the females had left the leaves and no young were observed. Infested trees were easily recognizable by the sooty appearance and the foliage was mature and ready to drop.

### Remedial Measures.

A great deal can be done to lessen the numbers of this insect by judicious trimming in the winter. The insect does not get readily from tree to tree, and once clean, a plant is not quickly reinfested. Very badly-affected trees should have all the worst twigs and branches cut out, and on young trees it will pay to cut back vigorously, even at the expense of a crop. The tendency of the scales to set toward the tips of the twigs makes this trimming more practicable.

Summer applications on scales have not proved satisfactory, and on peach are likely to be less so than on other fruits, because the foliage is more susceptible to injury. Besides, the long period during which young develop would make it necessary to make several sprayings to reach all those that are born.

The lime, salt and sulphur wash applied in late fall will probably be as effective as anything that can be used, and will serve to clean the soot fungus from the trees, enabling them to start the season following with fresh energy.

The recommendation is, therefore, to spray all infested trees late in October or early in November with a lime and sulphur wash, preferably the boiled mixture, with some salt. After midwinter go through the trees carefully and cut out all badly-infested wood and all such as appears to have escaped the spray. If, in spring, there is still a notable remnant of apparently living scale, duplicate the application just before the trees make a start.

Instead of the lime and sulphur, the soluble petroleum may be used and will probably be quite as effective against the scales. It will not be so useful as a tree cleaner, however, and will not so completely remove the remnants of the soot fungus. In those orchards where only a few trees are infested or where the infestation is slight, all the scaly wood should be cut out.

## THE COTTONY MAPLE SCALE.

*Pulvinaria innumerabilis* Rathv.

### General Observations.*

This insect derives its name from the cottony covering that it secretes for its eggs, which are deposited beneath the posterior portion of the body. While it has been found infesting grape, Virginia creeper (*Ampelopsis quinquefolia*) and other plants to some extent, it occurs most commonly on the soft or silver maple (*Acer saccharinum*), and in New Jersey is found almost exclusively on that species. As with many other injurious insects it occurs more plentifully some years than others, and sometimes becomes a real pest. This was the case in 1904, when it was unusually abundant at Montclair, Newark and several other points, and seemed likely to be as plentiful in 1905. Although the insect has been briefly treated in several of the reports and bulletins, this occurrence offered a good opportunity for a careful study of its habits and life history, as well as its natural checks. Accordingly, in February, 1905, infested localities were visited and the condition of the trees and insects was noted, while throughout the spring and summer twigs were collected and received from several points, though principally from Montclair, through the kindness of Mr. Malcolm H. Smith and Mr. W. D. Kearfott.

February 2d, infested twigs were collected in Newark to determine the condition of the hibernating insects, which were mostly scattered along the under side, with now and then a few on the upper surface. They usually lay parallel with the twigs, extending from near the tip back on to the older growth. In some places somewhat torn, cottony masses, the remains of the previous year, were observed, and under the edges of several of these a few very small, parasitic larvæ and pupæ, in rather hard cocoons, were found. In all some sixteen twigs were examined, averaging about a foot in length, with some sixty insects on each, one-third of which were alive and two-thirds apparently dead. These hibernating insects were small and dark brown in color, about one-sixteenth of an inch in length and about half as broad. They were oval in outline, a little convex, with a slight ridging along the center. A few smaller, darker and more

* This narrative is by Mr. E. L. Dickerson, who made the direct observations under my direction.

convex forms, each with a small hole in the upper surface, were also noted, and were scales of the previous season from which parasites had emerged.

February 17th, more infested twigs from Newark were examined, with practically the same result, except that these were more thickly

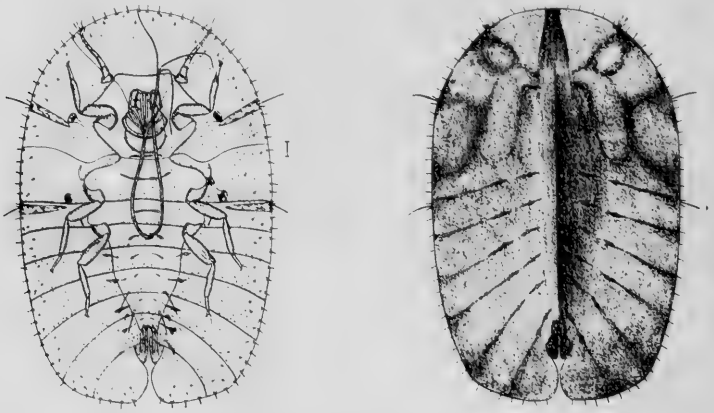

**Fig. 28.**

**A wintering scale, taken February 1st. Seen from below to the left—from above on the right; much enlarged. Original.**

infested. Twigs received from Montclair, March 1st and 15th, showed considerable difference in the amount of infestation, some bearing a large number of insects, others very few, while on some twigs torn, cottony masses or a small number of old parasited scales were apparent.

During the latter part of March and early April parasites emerged in the laboratory from cocoons found February 2d, and these were determined by Dr. William H. Ashmead as *Eunotus lividus* Ashm.—a small, dark blue, parasitic wasp, measuring about one-sixteenth of an inch in length.

April 11th, some seventy-five infested twigs were received from Montclair, collected at three points, where the infestation had been bad the previous year, but in general their condition was the same. Several of the twigs had no scales, others only a few, while upon some there were a number of insects. About two-thirds of the scales were apparently alive and slightly larger than those examined earlier in the season. In a few places there were remains of old cottony masses, with some old parasitic cocoons and a few good ones, and a number of old parasitized scales were also noted. At this time the insects

were attached by their beaks, and in some cases so strongly that the mouth parts were pulled out in removing them from the twig. This was not the case earlier in the season, when the insects seemed more loosely fixed. That a much larger proportion of individuals appeared alive on these twigs is due to the fact that many of the dead ones had fallen off or had been removed in some other way. April 18th, more twigs were received from Montclair, with the insects in a similar condition.

Several times during the latter part of April infested twigs from Montclair and Newark were examined and showed the scales to be developing somewhat irregularly, about one-third being alive and ready to move when disturbed. On twigs received April 29th, two distinct forms were found. The one similar in appearance to the hibernating form, but distinctly larger; the other, of the same size as the winter form, more convex and shining. This was, in fact, a parasitized form like the old ones found early in the season, although at this date neither larva nor pupa was readily discernible within the parasitized scale.

May 9th, more infested twigs were examined and a distinct increase in size was noted, as well as the fact that the insects were fixed more

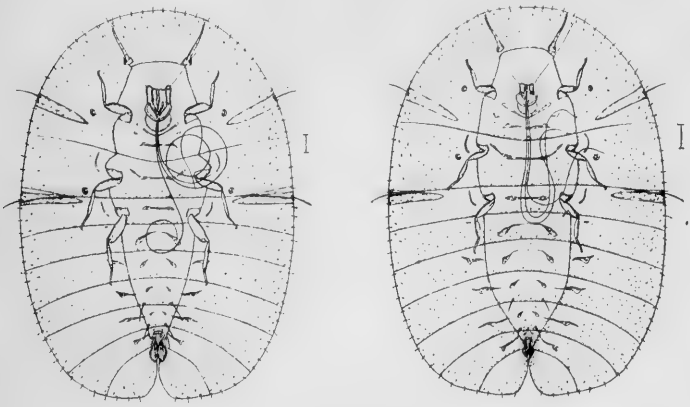

**Fig. 29.**

**Scales increasing in size; to the left taken April 23d, to the right taken May 1st; the legs are of the same actual size as in Figure 28, and will serve to show their proportion to the developing female; much enlarged. Original.**

closely to the twigs. The parasitized scales were more apparent, and, on the whole, there were nearly twice as many of these as there were healthy examples. The parasitic larvæ were now easily recognized

within the parasitized insects. Conditions continued the same for the next few days, except that the scales developed rather rapidly and irregularly. By May 15th many of the insects measured three-sixteenths of an inch in length, while the smallest were only about half as large. The character and condition of the scales also varied considerably. In many cases the healthy and parasitized scales were about equal in number, while on other twigs there were only a number of partly developed, dead insects, and occasionally some old parasitized forms. Sometimes the live scales were grouped, while in other cases they were set pretty evenly along the lower side. Some of the parasitized forms were placed in a bottle to develop.

May 17th, a few twigs were received from Montclair and the insects on them carefully examined and counted. There were 180 live, de-

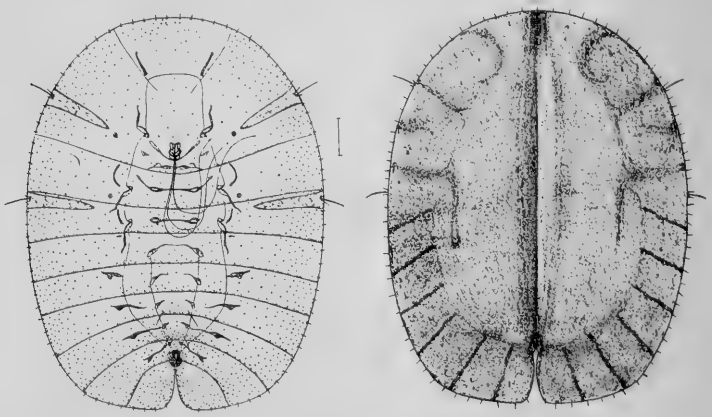

**Fig. 30.**

**Full-grown female scale ready to reproduce; underside on the left; upper surface on right; legs same actual size as in Figure 28; much enlarged. Original.**

veloping scales, 440 parasitized scales and several undeveloped and half-grown dead forms, or by actual count two and one-half times as many parasitized as healthy insects. As compared to the conditions in February, the twigs examined at this time averaged eight inches in length and showed eleven good scales and twenty-nine that were parasitized.

May 18th, seventeen parasites emerged from the scales in the bottle, and these were determined by Dr. Ashmead as *Coccophagus lecanii* Fitch., a very small, black *Hymenopterous* insect, with a yellow spot between the base of the wings. May 23d, when more twigs were examined, 108 developing scales, 252 parasitized forms and a few dead or

**Fig. 31.**

A twig badly infested by the Cottony Maple Scale; about natural size. Original.

undeveloped insects were counted. On this and several successive days numerous parasites emerged in the laboratory from the collected material, but it was not until the 26th that I found them outdoors.

About this time a new phase in development occurred. On twigs collected at Newark it was noted that some of the insects were beginning to secrete from points on the under surface a cottony material, and apparently the increase in size had ceased. This cottony material was excreted from narrow areas near the base of the anterior and hind legs, extending in a line to the margin and from a spot near the anus, making five in all. These places had been noticed in the hibernating insects before any secretions occurred, but a few days later (June 2d), when the insects showed the cottony secretion in greater amounts, it was noted that it was also exuded in single fibers, from minute openings situated in a rather broad group along the margin, extending somewhat parallel with and back from it, and especially abundant around the anal area.

On this date, too, eggs were observed under some of the insects. Several scales, each with a small hole in the upper surface, near the end, through which a parasite had emerged, were also noted, and a few of the parasites were observed on the twigs. The developed scales at this period were somewhat variable in size, but averaged about a quarter of an inch in length and were broadly oval in outline. Owing to the fact that they were filled with eggs they were rather plump and convex.

Development was proceeding at about the same rate in all the infested localities, although somewhat irregularly. Twigs from Montclair, June 5th, showed eggs within the cottony masses, and they were similar to those observed at Newark, but some insects had not yet begun to even show the cottony secretions. By this time most of the parasites had emerged, but a few in the Montclair material had not, and upon opening infested scales I found fully-developed adults ready to emerge and one still in the pupal stage.

With the increase in the number of eggs deposited, the cottony material also increased and became more prominent than the insect itself, the posterior part of which was lifted by eggs and cottony material until it formed almost an angle of forty-five degrees with that part of the body which remained against the twig. The insects were found in this condition at Montclair, as early as June 15th.

The examination at this time also showed that numbers of a *Coccinellid* larva were upon the twigs, attacking the *Pulvinaria* egg

masses and eating the eggs. A few egg masses that appeared normal were torn open, and in several I found a *Coccinellid* larva—in one case two—and the eggs partly destroyed. These larvæ are white in color and the upper surface of the body is covered with a material resembling that secreted by the *Pulvinaria.* It seemed probable that these were the larvæ of *Hyperaspis signata* Oliv., as we had found this beetle associated with the *Pulvinaria,* and subsequent breeding proved this to be the case. An example of the *Coccophagus* was also observed on the twigs, but although I watched it for some time I could not observe any effort to deposit eggs.

June 20th, another trip was made to Montclair in company with Mr. Malcolm H. Smith. There were several badly-infested spots in the town, and the infestation in each case gradually lessened away from the infested centers. Many of the egg masses were found infested by the *Coccinellid,* and in some instances the larva within the cottony mass would cause it to become enlarged. These larvæ varied considerably in size and seemed to be in all stages, from very small to those large enough to pupate. Twigs with the *Coccinellid* and *Pulvinaria* were placed in a battery jar to bring the *Coccinellid* to maturity and also to obtain larvæ of the scale. June 20th, a few scale larvæ were observed in the laboratory, on twigs collected some days before, and on June 25th they were observed on an infested tree in Newark. In that city the infestation was not as great as in Montclair, and neither were there as many *Coccinellid* larvæ in evidence, although a few in about the same condition as at Montclair were observed.

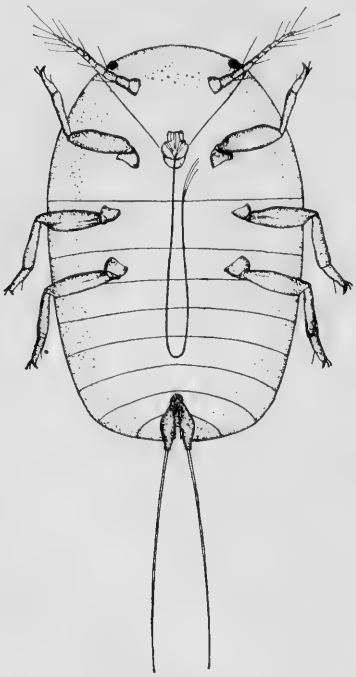

**Fig. 32.**
Larva just hatched; actual size a mere point. Original.

To determine how the number of live scales at this time compared with the number observed in the hibernating stage, the insects on several twigs were carefully counted, with the result of an average of

thirty-seven fully-developed live scales with egg masses to a twig ten inches long. These twigs were badly infested and the egg masses were ranged closely, one behind the other, but there were many like this on badly-infested trees.

June 24th, infested twigs were received from Keyport and showed scales from which parasites had emerged as well as some *Coccinellid* larvæ. On this date the first pupæ of the *Coccinellid* were found in the laboratory, but an examination made at Montclair did not show any pupæ, although a few larvæ were crawling on the tree trunks and getting into crevices, apparently ready to pupate. Examinations made at Newark two days later showed a few *Coccinellid* larvæ and one pupa within the cottony mass of *Pulvinaria.*

June 28th, examining the infested trees at Montclair, it was found that the egg masses had been pretty well torn apart, and not one could be found which was not infested by *Coccinellid* larvæ, or had not been eaten out by them. In one spot I found eight larvæ clustered around and in three or four egg masses. Some of these larvæ were quite small, while others were of good size, ready to pupate, and while a few larvæ had pupated under the cottony material, most of those found at this time occurred in crevices in the bark or in cavities beneath it. The great good which had been done by these larvæ in destroying the eggs and young larvæ of *Pulvinaria* was shown by the small number of the latter which had set upon the leaves at Montclair, as compared with those at Newark, where the *Coccinellid* was more scarce, or to the amount of setting there would have been under normal conditions.

One adult of the *Coccinellid* was also observed at Montclair, and, judging from its appearance, it had just emerged from the pupa.

Also visited East Orange to examine the trees, especially along Halsted street, where the infestation had been very bad the previous year. I found them pretty badly infested in some places, but as they were nearly all trimmed high, it was impossible to examine the scaly twigs. However, I observed a few *Coccinellid* larvæ crawling on the trunks and a few pupæ in crevices in the bark. The *Pulvinaria* egg masses, too, appeared somewhat torn, but not as much so as at Montclair, and, altogether, it seemed as if conditions might be similar to those in Newark.

June 30th, I examined the material collected at Montclair and made careful search for eggs of the *Coccinellid.* None were found, although larvæ in all stages, as well as several pupæ, were observed. The egg masses and most of the scale larvæ had been pretty well de-

stroyed, so that there were very few of the latter crawling about. The breeding females had also been eaten out, but this was doubtless a secondary attack, after the eggs were laid, rather than due to the *Coccinellid* larvæ, as the females, after depositing the eggs, dried up. In one place, under a cottony mass, I found three parasitic pupæ, and in one of the breeding females I found a pupa and a couple of parasitic larvæ which resembled very much those of *Coccophagus lecanii*.

July 5th, a box of infested twigs was received from Englewood. There was a *Coccinellid* pupa in the box, and several larvæ were feeding on the *Pulvinaria* egg masses. Apparently they had destroyed the eggs and larvæ to a large extent, and if they were as abundant in Englewood as indicated by this sending, the conditions there must have been similar to those in Montclair.

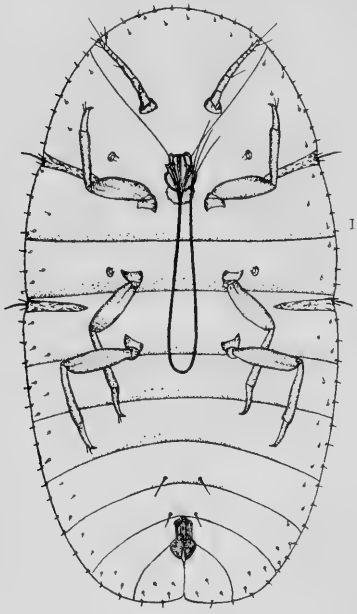

**Fig. 33.**
Young just set, after the first moult; much enlarged. Original.

The next visit to Montclair and East Orange was on July 6th. In both places the *Coccinellid* larvæ were still found in various stages, but more pupæ occurred, and, contrary to my first observations, most of them were under the cottony masses rather than in the bark crevices.

July 7th, a few beetles were observed in the box in which the pupæ were observed June 24th, so that the duration of the pupal stage is about two weeks. July 10th, when the jars in the laboratory were examined, 150 beetles were found, the insects proving, as previously surmised, *Hyperaspis signata* Oliv., a small, nearly round and convex, black "lady-bird" beetle, with a single red spot on each wing cover. Most of the pupæ were found in the "eaten out" cottony masses of the *Pulvinaria*, while a number were in the dry, curled-up leaves. In the latter places there would often be from half a dozen to a dozen clustered together.

About this time infested twigs were received from Elizabeth, and

in one of the cottony masses was found a larva which may have been that of *Lætilia coccidivora* Comst., a *Lepidopterous* insect that is sometimes found feeding on this scale.

July 11th, again examined the infested trees at Montclair, and found them in the same condition as the twigs at the laboratory. On many trees a few beetles were on the trunks, while several were on the infested twigs and branches, sometimes resting in or on the cottony masses or on the under side of the leaves, and observation showed that the beetles climbing up the trunks were those which had emerged from pupæ in the bark crevices. Apparently a large proportion of the beetles had emerged, but there were still a few pupæ, and a very few young larvæ were found crawling on the trunks of the trees.

At South Orange and Maplewood the *Coccinellid* was also plentiful on infested trees, but on the whole not so far advanced as at Montclair, a much larger proportion being in the pupal stage. Here, too, nearly every egg mass of *Pulvinaria* was or had been infested, and it was in these that most of the pupæ were found.

About this same time a few infested trees on Townsend street, New Brunswick, were examined, and conditions were found somewhat similar to those in other localities. Although the scale was not as abundant as in the worst infested places, yet there was considerable setting of larva on the leaves. Neither was its enemy, *Hyperaspis signata,* mostly in the pupal stage, as plentiful.

July 15th, some of the beetles were placed in a jar together with leaves on which *Pulvinaria* larvæ had set, and the beetles soon began to devour the young scales.

It being now evident that the *Pulvinaria* occurred throughout the region between Newark and New Brunswick, it was deemed important to know the extent and amount of infestation. Accordingly, on July 17th, I went by trolley from Newark to New Brunswick. In most of the places through which I passed, namely, Newark, Elizabeth, Roselle, Westfield, Plainfield, Dunellen and Bound Brook, very little or none of the infestation was seen along the trolley line. Going into Elizabeth and coming out a little infestation was observed, and a greater amount occurred on a small group of soft maples between Roselle and Westfield. At certain spots in Elizabeth and Plainfield a rather bad infestation was observed on old trees, but here, as elsewhere, the infestation was irregular. As the trees were large and the branches high, I could not see how prevalent the *Coccinellid* beetle was, but I found a few specimens crawling on the trunks. In Bound

Brook there are a number of fine, large silver maples, but there were no signs of the *Pulvinaria* anywhere in the place.

A day or two later a report was received from Mr. Charles Whitehead, of South River, stating that the scale was very abundant on his trees and had caused a dropping of leaves. Upon investigation I found that the insect had been plentiful on his large silver maples, but more so on some trees than on others, and that most of the infested wood had been removed. However, I obtained a few infested twigs and found that here, also, the *Coccinellid* was present, a few larvæ and pupæ being observed in the egg masses, while on leaves on which a number of scales had set were a few adults. These trees were the only ones in South River upon which the scale was observed.

Placed all the beetles which had been collected and brought to the laboratory in one jar, with some leaves infested with *Pulvinaria* sets for them to feed upon. A few days later these leaves, which had dried up somewhat, were taken from the jar and carefully examined for eggs of *Hyperaspis,* which should occur if there was a second brood; but no eggs were found. The beetles appeared restless until fresh, infested leaves were placed in the jar, when they settled down and began feeding upon the young sets.

July 24th, on infested leaves at New Brunswick, it was found that a few sets on each leaf were parasitized. These resembled those of the hibernating insects, except for their small size. They were much more convex, plumper and darker than the normal sets on the same leaves, and upon examination I found parasitic pupæ. Some, of a lighter color, a few of which I found resembling the dark forms, but a little softer, contained the parasitic larvæ. The parasitized scales were placed in a bottle to bring the parasites to maturity, while the rest of the sets were placed in the jar containing the beetles, to serve as food. For the most part the beetles were resting within the dry, curled-up leaves, and the majority were as active as ever, only a few having died.

At Montclair, July 25th, I observed less of the scale than on the previous examination. On many leaves not more than two or three sets were to be found, while scarcely a leaf contained more than a dozen, and part of these were parasitized, so that the adult beetle had done very effective work in destroying the sets. The *Coccinellids,* however, did not appear as abundant on the leaves at this time, although there was a slightly larger number on the trunk and several were resting near the cottony masses. Two were found in the masses,

resting in the pupal skins, and, consequently, had become adults within a few hours. However, the great majority had emerged several days previous, as not a live pupa could be found.

In East Orange conditions were similar, except that there were more sets on the leaves, owing, undoubtedly, to the fact that the *Coccinellids* had not been as abundant. Both on the trunks and in the cottony masses a careful search was again made for eggs of the beetle, but none was seen. None of the *Coccinellids* was observed in copulation either on the trees or in the jars at the laboratory.

There was apparently an extended period of hatching of the eggs of *Pulvinaria*, as larvæ were yet observed crawling on one of the twigs. It was also noted that the young sets were not fixed permanently, but would readily move when urged to do so. When an infested leaf dried up the insects would move to a twig, or if the leaf was lying on the table they would leave as soon as it began to dry and crawl some distance, always toward the light, looking for fresh food.

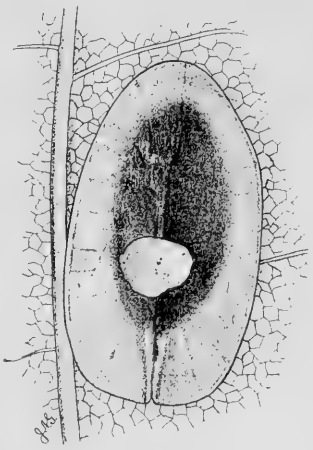

**Fig. 34.**
Parasitized Scale on a leaf; shows characteristic discoloration and hole from which parasite has issued; enlarged. Original.

July 26th, the first adults emerged from the parasitized sets, and on each succeeding day more parasites were obtained. They closely resembled those of the hibernating scales, except that they were distinctly smaller. They were determined as *Coccophagus flavoscutellum* by Dr. Ashmead.

July 27th, a few leaves were collected from slightly-infested trees in Newark. There were only a few of the cottony masses on the twigs from which these leaves had been obtained, but the latter were well set with young. By actual count, I found over 400 on one, and from all appearances this would have been a moderate estimate for the majority of the infested leaves. Apparently the *Coccinellid* had not been present on these trees, and I found this apt to be the case where the infestation was slight. Parasitized sets were also observed on some of these leaves; some bore two or three, while one bore six. All were situated along the veins on the underside, but undoubtedly this was

due to the fact that the majority of sets were on the under side, as previously parasitized forms had been observed on the upper side of the leaf. A few of the parasitized sets showed the holes through which the adults had emerged, so that at this time the parasites were emerging out of doors.

August 1st and 3d, again visited Newark, and on the latter date also Montclair, East Orange and Passaic. In the latter place there are comparatively few soft maples, but some of these showed a slight infestation. In Newark some of the infested leaves showed quite a number of parasitized scales, while others were light in color, showing that the parasite within them was in the larval stage. On one leaf an adult parasite was seen running about.

In East Orange I did not observe any *Coccinellids,* while in Montclair and Newark there were not nearly so many as at the previous examination. In both places I found a single beetle in a dry, curled-up leaf, as if in hiding. A few days later a few sets, some of which were parasitized, were observed on linden and osage orange in Newark.

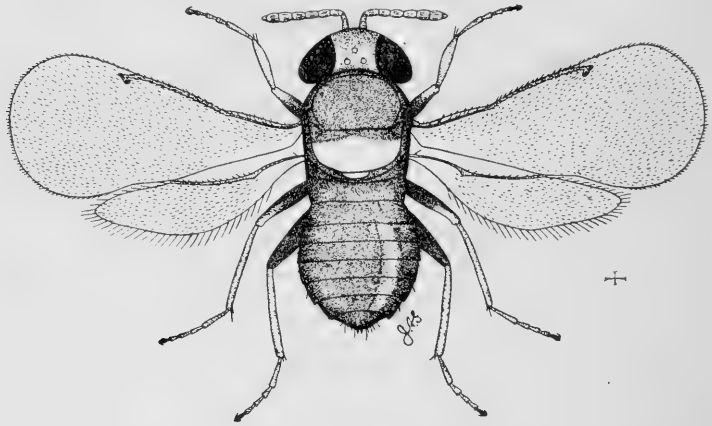

**Fig. 35.**

*Coccophagus lecanii* Fitch: one of the scale parasites; much enlarged. Original.

August 11th, some leaves were collected from an infested tree in New Brunswick. There seemed to be few cottony egg masses on the twigs and branches, but the leaves were pretty well set with the young. On one of them I observed a parasite which seemed to be ovipositing in the good scales. It was also noted that some of the scales were slightly narrower than others, and upon examination it was found

that these were males, which were now in the pupal stage, resting beneath the scales. One large leaf, bearing a number of parasitized scales, was examined with the following result:

| | |
|---|---|
| Total number of scales on the leaf | 898 |
| Good scales—apparently females | 723 |
| " " " males—in pupal stage | 108 |
| Parasitized scales—parasites not yet emerged | 32 |
| " " " emerged | 35 |

Judging from the condition of the males, they were mature and ready for copulation.

August 30th, other twigs collected at New Brunswick were examined in a jar at the laboratory. A number of parasites and male *Pulvinaria* was found, and a few of the latter were copulated with the females. As previously observed the insects moved readily when disturbed.

A few days later a box of twigs was received from Plainfield, with the insects in the same condition, while the upper surface of the leaves was quite black and sooty, caused by a fungus growing on the "honey-dew" excreted by the insects.

In Montclair, also, I found that some of the very few scales on the leaves were males, while the female scales were mostly parasitized, so that with the *Coccinellid* larvæ eating the larger part of the eggs and young larvæ, the beetles devouring the young sets and the parasites infesting the remainder, the scale has been about cleaned out where it was so abundant in 1904.

A few infested leaves were collected from trees along South Orange Avenue, in Vailsburg, and on one of them I found 298, while another showed 136 parasitized scales, and many of the leaves showed just as many. Infested leaves gathered in New Brunswick now showed nearly as large a number of parasitized forms.

September 13th, at Irvington, I observed several maples on which there was considerable infestation, and here, as elsewhere, there were parasitized forms. I also noticed that a few of the insects were starting to migrate from the leaves to the twigs. Up to this time the sets had been, with few exceptions, on the leaves, but now a few were observed on the leaf petioles and on the twigs. However, the general migration took place later, and, as it was gradual, was not completed this year until after the middle of October. Even then a few tardy insects were caught and fell with the leaves. Several examinations

were made after the middle of September, but little or nothing was seen of parasites or beetles, and the latter, in the laboratory, had evidently gone into hiding in the clusters of dried leaves; but owing to the unnatural conditions a number of them died.

The last twigs examined were collected October 25th, from two localities in New Brunswick. In appearance twigs and insects resembled very much those examined in February, and as then, the number of insects upon the twigs varied considerably. Most of the leaves were still on the twigs, and some showed a few live scales as well as parasitized forms. Some of the latter appeared in good condition, but upon opening them I found the parasites dried up. Leaves on the ground also showed live scales in some instances, while the parasitized scales on them appeared similar to those on the adhering leaves.

**Life History of the Scale.**

The life history of this insect, briefly stated, is as follows: The hibernating females are found along the twigs and branches, generally on the under side. They are oval, slightly elongate, the upper surface somewhat convex and slightly ridged or carinate along the center. They measure about one-sixteenth of an inch in length, and in color are dark brown, except for the slight, secreted waxy layer, which is more or less broken over the upper surface. On the under side, besides the legs and antennæ, a minute, groove-like structure extends from near the base of each of the anterior and hind legs to the lateral margin. From these four areas of waxy substance are produced, that, with the beak, keeps the insect attached to the twig. There are also many minute openings or spinnerets along the margin, and these are espeically abundant in the anal region.

When the sap starts to flow in the spring the insects begin to feed and develop. By April 1st a distinct increase in size is noticed, due largely to the developing eggs, and this continues until the latter part of May or early June, when growth ceases and egg-laying begins. At this time the insect is somewhat lighter in color, about one-quarter of an inch in length and broadly oval, with the upper surface convex. The spinnerets are more in evidence, and from those in the anal region the cottony secretion comes in minute threads.

This secretion, which is really waxy rather than cottony, begins slightly before the egg-laying and continues until the insect has de-

posited between 1,000 and 2,000 minute, reddish-yellow eggs, and has secreted so much that the hind body is raised to an angle of forty-five degrees with the twig. It is at this time—early in June—that the insects become conspicuous, and the cottony masses often remain on the trees for months. Soon after the eggs are deposited the larvæ hatch and crawl to the leaves on which they settle. The larvæ are minute creatures, of about the same color as the egg, oval in outline, with distinct legs and antennæ, and at the extremity of the body two long spines. They generally settle on the under surface, along the veins, but a few get on the upper surface, and very rarely some are found on the twigs. Late in June or early in July the leaves on a badly-infested tree will be thickly set with the insects.

Soon after the young have set two moults take place, and if they are examined later two forms will be found, one somewhat narrower than the other. The latter is the female and the former the male, which passes through a true pupal stage, and during the early part of August reaches maturity. It is then a minute, two-winged insect, which, some time in August or early September, emerges and copulates with the female. The females remain on the leaves, feeding, until after the middle of September, when they migrate to the twigs and settle down to pass the winter. Even under normal conditions many of the insects do not reach maturity, while in some years most of them are destroyed by their enemies.

### Enemies of the Insect.

Several enemies of the *Pulvinaria* were found in our examinations, the largest and most conspicuous being the *Coccinellid* or "lady-bird" beetle, *Hyperaspis signata* Oliv., and its larvæ. This was first observed June 15th, when larvæ in various stages were found in newly-formed egg masses. These larvæ, when full grown, are about three-sixteenths of an inch long, white in color, and have the upper surface covered with a material resembling that secreted by the *Pulvinaria,* so that it might be overlooked when resting in one of the egg masses. Often, however, a larva would be found feeding within an egg mass when the latter appeared perfectly normal, except perhaps for a slight enlargement.

Larvæ were observed during the examinations in all the infested localities, but more plentiful in some places than in others. They

were particularly in evidence in Montclair, where, in late June and early July, scarcely an egg mass could be found that was not or had not been attacked by them. Development was somewhat irregular, and some larvæ were found as late as July 15th, but by that time most of them had pupated. The first pupa was observed June 26th, and according to observations in the laboratory, remained in that stage about two weeks. At first the insects appeared to prefer crevices in the bark, but later most of the pupæ occurred in the "eaten-out" egg masses. During July many of the beetles were seen, sometimes feeding upon the young sets, but by the end of the month the majority had disappeared,—presumably into hibernation. The pupa is a chunky, hairy little creature, brown in color, but generally, in whole or in part, covered by the white, secreted material of the larva. The adult is a small, nearly round and very convex beetle, measuring about one-eighth of an inch in length, although varying much in size. It is black, with a single, round, red spot near the center of each wing cover, and in the males has the head, and front and sides of the thorax yellow.

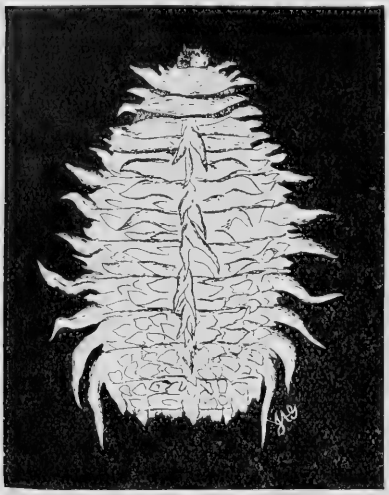

**Fig. 36.**
Larva of *Coccinellid, Hyperaspis signata* Oliv.: enlarged. Original.

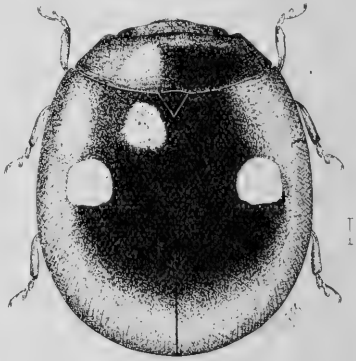

**Fig. 37.**
The *Coccinellid, Hyperaspis signata* Oliv.: enlarged. Original.

The great good done by this insect was most evident in Montclair, where so many young scales were destroyed that not more than a dozen sets remained on a leaf, where, under ordinary conditions, there would have been between 500 and 1,000.

The other enemies observed were minute *Hymenopterous* parasites. The first one noted was *Eunotus lividus* Ashm., a small and very dark

blue insect, with transparent wings, measuring one-sixteenth of an inch in length. Larvæ and pupæ were found in April, in small, stout cocoons, grouped together under the old cottony masses, and the adults emerged late in March and early April.

The other two parasites did nearly as effective work in destroying the scale as did the beetle. The one, *Coccophagus lecanii* Fitch, is about half the size of the *Eunotus,* black, with the scutellum or spot between the wings of a bright yellow, and with portions of the legs light in color. This is parasitic on the hibernating scale; but not until the latter part of April were any such parasitized scales observed. They were readily distinguishable from the live scales by their dark color, more elongate and convex form and smaller size. They were observed among all the lots of insects examined in the trees or in the laboratory, but it was not until near the middle of May that adults were observed. During the rest of that month and during June they occurred more or less abundantly, but toward the end of June disappeared. The efficiency of this insect was apparent in several places, where two or three times as many parasitized as live scales were found.

The other parasite, *Coccophagus flavoscutellum* Ashm., resembles the preceding very closely, and as a matter of fact would be taken for it except for its smaller size. It was found only in the young sets and scales of the summer months. Among scales examined July 24th some parasitized forms were found exactly resembling those of the hibernating insects, but smaller, and in them the parasitic larvæ and pupæ were noted. They became more abundant as the season advanced, some leaves showing 200 or 300, and from all appearances there were several broods. This species, as well as the preceding, was observed in all the infested districts, but much more common in some than in others, and the number of scale insects to go into hibernation has been much reduced.

Another species sometimes observed destroying the *Pulvinaria* is *Lætilia coccidivora* Comst., a *Lepidopterous* insect, the larva of which is found in the egg masses feeding on the eggs and larvæ. In our examinations no signs of it were seen, except, perhaps, on twigs from Elizabeth, July 10th, in which a young larva that may have been this species was observed.

Other parasites and enemies of this scale have been recorded, but if they occur in New Jersey they must be rare, as they were not observed during the past season.

**Insecticide Work.**

The worst injury that this scale causes on even a badly-infested tree is a dropping of the leaves and the death of some of the smaller branches, although when abundant it makes a tree unsightly. Often much of the infestation occurs on the lower branches, so that by trimming these out much good can be accomplished. However, in some spots where the infestation was very bad the past season, it was apparent that if we could find a material which could be used to destroy the scale while the trees were in foliage much would be gained, and accordingly several mixtures were tried.

The first was a "soluble petroleum." In April several twigs with scale in the hibernating stage were in part painted and in part sprayed, at the rate of one part to twenty-five parts of water. Several days afterwards the insects on those twigs which had been painted were somewhat loosened, and the mixture had penetrated beneath them to some extent, while on those which had been sprayed most of the insects appeared to be in good condition. This mixture was again used May 23d, when parts of some elms and sugar maples were sprayed at the rate of one part to twenty, twenty-five and thirty parts of water. When examined several days later all the leaves had been injured to some extent, so that they were more or less brown and curled, especially with the stronger mixtures. The elms suffered less than the maples and also recovered more quickly.

Kill-O-Scale was used June 9th, on a sugar maple, at the rate of one part to twenty-five parts of water, while some limbs on a Norway and on a silver maple were sprayed at the strength of one part to thirty parts of water. A few days later the leaves on the sugar maple were brown and burned, those on the silver maple were brown and curled at the edges, while those on the Norway maple were only a little spotted. June 10th, a few infested silver maples at Newark were thoroughly sprayed with this mixture, at the strength of one part to twenty-five parts of water. Three days later I found that where the trees had been drenched the scales were apparently dead, but the leaves were brown, curled and many had dropped.

Another soluble oil (Emulsion No. 3) was given a trial June 8th, when a few twigs to which the healthy insects had moved from the leaves were treated, a portion at the rate of one part to twenty-five of water and the rest at the rate of one part to fifteen parts of water. An examination made a few days later proved the insects to be dead.

A few leaves, which were pretty well hit by the spray and bore a number of parasitized scales, were placed in a jar, and later the parasites emerged, showing that the material had not affected them.

Later this same mixture was used on a Norway, a sugar and part of a silver maple. Examination a day or two thereafter indicated that the material had not injured the foliage, except in the case of a few of the younger and tender leaves on the silver maple.

A rosin-naphtha mixture was applied to a sugar maple May 29th, at a strength of one part to twenty parts of water. Several days later I found that the leaves were burned as badly as any of those receiving the strongest mixture of soluble oil.

Two soap mixtures were used. One of these, Tak-a-nap, was applied June 9th to a Norway and a silver maple, at the rate of one pound in four gallons of water. The leaves on the Norway maple showed little or no bad effects, while those on the silver maple showed a very slight burning at the edges. June 15th, sprayed a few badly-infested twigs on which the egg masses were of good size, with Tak-a-nap soap, at the rate of one pound to four gallons of water, and a few others with fish-oil soap, at the rate of one pound to five gallons of water. Next day it was noted that on those sprayed with Tak-a-nap the egg masses were discolored, but very little penetrated, while on those sprayed with the fish-oil soap the solution appeared to have penetrated the egg masses much deeper. An examination made some time later showed the results slightly intensified. Those sprayed with the Tak-a-nap soap remained in fairly good condition, while those sprayed with the fish-oil soap became considerably matted and lost their cottony appearance. However, *Pulvinaria* larvæ, as well as parasites, were obtained from both lots of twigs, so that neither material was thoroughly effective.

June 19th, used the fish-oil soap, at the rate of one pound in four gallons of water, on a silver maple; at the rate of one pound to five gallons on a silver maple and a sugar maple, and at the rate of one pound to six gallons on a sugar maple, with the result that the leaves on all the trees were more or less injured.

It is apparent from these experiments that a mixture strong enough to destroy the insects, except as larvæ or recent sets, would seriously affect the foliage. Recent sets and larvæ may be reached by comparatively weak mixtures, but as the period of emergence and setting lasts about six weeks, it is not practical to spray. Moreover, by the

application of summer mixtures, many *Coccinellid* beetles, as well as their larvæ and pupæ, would be destroyed, although those protected by the cottony masses and the parasites would not be. Thus it is evident that spraying operations against the scale must be carried on in winter, while the trees are dormant. At that time any of the soluble petroleum preparations, kerosene emulsion, lime-sulphur or soap mixtures will be effective when used at winter strength.

**Distribution of the Insect.**

A point of interest is the extent of territory in this State now infested by the insect. This is from Englewood and Passaic, on the north, to New Brunswick and Keyport, on the south, and lies east of the Watchung mountains. It is interesting to note, also, that throughout all the infested region the enemies of the scale were found with it, and undoubtedly will reduce it next season in the same manner that they have done this year at Montclair. As a result, the insect will probably not be as abundant again for several seasons.

**Practical Suggestions.**

From the observations recorded by Mr. Dickerson it would seem that, in general, the natural enemies may be trusted to gain control of this cottony scale before it has caused serious injury to the tree. It is indicated, further, that summer applications of insecticides are not practical, but that winter treatment would probably be effective. The difficulty would be in the cost and in getting the work thoroughly done.

The East Orange Shade Tree Commission has solved the problem by mechanical means. They spray there with water only, and direct a small, solid jet at the developing cottony masses, readily dislodging and scattering them. An insect in that stage, once dislodged, cannot regain its hold, and larvæ hatching from eggs on the ground are incapable of making their way to the trees. I have very generally recommended the use of a garden hose, with a solid jet, wherever city water pressure was available, and as the infestation is usually on the lower branches and on the under side, that works in most cases.

Where water pressure is not available a solid jet from a pump will answer, and the jet need not have over one-sixteenth inch in diameter at the nozzle: it is the force behind the water, rather than the size of the stream, that counts. This application should be made as soon as possible after the cottony masses make their appearance, and before the eggs begin to hatch. The actual time is indicated in the preceding account of observations made.

## RECORD OF INSECTICIDE WORK.

Only a part of the experimental work done is here recorded, and that is especially the case with the oil preparations. The object is to give the results obtained, without too much detail, and with yet enough facts stated to show that there is a basis for the conclusions reached. Over a dozen preparations other than those here mentioned were received, and some were not used simply because no satisfactory opportunity developed. These will be tested next season if possible.

In the case of the oil and sulphur combinations, field observations are included, though the applications may not have been made under control. It is as important to know what results the average farmer obtains as to learn what can be done when all factors are favorable. The ideal insecticide is that with which failure is impossible, even in ignorant hands, provided only that the application is complete.

### Lime and Sulphur.

The question of just how the armored scales are killed by the combination of lime and sulphur is not satisfactorily settled, and it was suggested by Mr. P. H. Pough, of the T. & S. C. White Sulphur Company, that the lime might be merely a carrier to divide the sulphur and favor decomposition, a result that might be reached by simply mixing very fine sulphur dust with ordinary milk of lime. To test this view, a bag of very fine sulphur dust was sent in and was used April 6th on the College Farm.

Thirty-three (33) pounds of lime were slaked with cold water and diluted until the thick milk of lime was entirely cold, then seventeen pounds of the sulphur dust were stirred in thoroughly, so as to form an even mixture, which was diluted to make about fifty gallons, and sprayed on Standard pears and one side of three rows of apple trees.

July 21st, Mr. Dickerson made a critical comparison and found little difference in effect between the lime, sulphur and soda and the lime and sulphur dust. There was a little advantage for the soda combination, but not a great deal. The infestation was not bad in any case, and both combinations destroyed insects enough to carry the trees safely through the summer.

The sulphur supply in this case was the dust swept from the beams of the works, where it had settled, and was an almost impalpable powder, much finer than the "flowers." The experiment has little practical bearing, but does indicate that no actual chemical combination with lime is needed to produce an insecticide effect.

**Lime and Sulphur, Self-Boiled.**

The results of the self-boiled lime and sulphur combinations, so far as I saw them in previous years, were so unsatisfactory that I could not recommend them. What I saw in June, in the peach orchards of Mr. A. N. Brown, at Wyoming, Del., and afterward in the apple and pear orchards of Mr. E. S. Holmes, at Riverton, N. J., has convinced me that, with proper care in making and applying, this combination can be effectively used. As to the application, it should be noted that both Mr. Brown and Mr. Holmes use a gas sprayer, with which a good pressure is easily maintained, and use nozzles fine enough to make a satisfactory covering. Both are usually liberal in their applications and unquestionably have shown that they can make a satisfactory mixture without boiling.

The process is as follows: Use forty pounds of lime, twenty pounds of sulphur flowers and fifty gallons of water. The lime should be of the best quality, and flowers, not ground sulphur, should be used.

Place the lime in a barrel and dust in the sulphur with it, so that the two may be well mingled. Add boiling-hot water enough to start a brisk slaking and cover with a heavy blanket to confine the heat. Add hot water as needed, to keep up the slaking, and stir occasionally with a hoe or similar implement. Keep this up until all the lime is completely reduced and mixed with the sulphur. Then let the mixture stand covered for at least half an hour, to maintain its heat; afterward dilute with warm water to the desired strength and spray at once.

**Lime, Sulphur and Salt.**

This combination has remained the reliance of quite a number of our fruit-growers, and results have been better, as a whole, than during the year previous. On peach and plum some excellent work has been done, and on apple and pear better effects have been obtained in most cases. It seems now, by comparing applications, that the amount of force behind the spray is a matter of great importance. The tendency of the wash, especially when an excess of lime is used, is to form a superficial coating, not closely applied to the surface of either waxy twigs, like those of pear, or fuzzy shoots, like those of apple. The natural inclination is to use a nozzle with large opening, throwing a coarse or fan-shaped spray, which is directed over a tree and allowed to fall down on it in a fine shower or rain. This process covers, of course, but it does not drive the mixture into close contact with the bark or the scales that set close to it. The consequence is that two men may spray two similar trees, equally infested, with the same kind of wash, at the same time, and yet obtain dissimilar results. The man who applies a coarse spray, without much force behind it, may cover a tree as completely as his neighbor, who applies a fine spray with force enough behind it to drive it into close contact with the bark, but in the first case the mixture may wash or scale off without much harm to the insects, while in the latter the insects are directly affected. It seems like a small matter, but it is really, I believe, a vital one, and I am led to that belief because, in all the successful cases examined, I found the lime particles in close contact with the scales and surface. On peach and most plums the surface of the bark seems to favor the adhesion of the lime particles.

As to the formulas used, the tendency has been to lessen the amount of lime so as not to exceed in weight the sulphur; to reduce the amount of salt to about one-third the weight of sulphur, and to reduce the time of boiling, fixing this rather by the appearance of the wash than by an absolute period. There is the same complaint of trouble in making and of the difficulties in application, but as the fittings for preparing the material become more complete the matter of application also becomes better understood.

In some of the fruit-growing districts in Delaware, peach-growers, especially, depend altogether upon this combination, and seem to believe their trees benefited irrespective of scale infestation. I still

believe the formula giving fifty pounds each of lime, salt and sulphur to 150 gallons of water to be the best, though little is lost by reducing the amount of salt by one half.

The caustic soda combination seems to have been little used, and the only definite record that I have is of the application made on the College Farm and recorded in the general review.

### Napthol-Sulphur.

As the sulphide preparations have proved to be effective scale destroyers, and one of the chief objections to their use is the task of preparing them, it is natural that chemists should try to get a concentrate that would simplify the use of the material.

A small sample of Napthol-Sulphur, in paste form, was sent in, and applied March 6th, on a bright, sunny day, with a moderate wind, on trees 19, 20, 31, 32, 33, 34, 42, 44 and 47 of the Experiment Orchard. The dilution was, as recommended, to give the theoretical strength of the normal lime, salt and sulphur wash. It mixed easily in water, sprayed freely, and left the trees with a greenish-gray covering. The application was well made, and the drip discolored the snow to a uniform yellow. Trees 32, 33, 34, 44 and 47 had been sprayed in October with Kill-O-Scale, and must be left out of consideration in estimating the value of this mixture.

June 25th, the trees were examined and no appreciable benefit was noted—indeed, tree 19 shortly became the worst on the place, and received early summer treatment. The results were not encouraging in any case, and no further attempt to use the material was made.

### Soluble Petroleum.

There are at present four distinct forms of what may be roughly termed soluble petroleum upon the market, differing somewhat in the percentage and grade of oil used and in the emulsifying agent. If we include the "Textil Oil," which is not primarily intended as an insecticide, there are five. All of these combinations mix readily with water, form a milky emulsion and spray and cover perfectly.

The composition of "Kill-O-Scale," of "Scalecide" and of the "Target Brand Scale Emulsion," I know, approximately, from the makers, and these I have tested personally, more or less thoroughly.

"Sure-Kill" I know nothing about from personal experience, and have no direct knowledge of its composition. It seems to be somewhat unlike the others in the character of the oil used, but may be just as effective. But these combinations by no means represent the number of those that were actually made, tried and rejected. "Kill-O-Scale" is sold by the Griffith & Turner Company, of Baltimore, Md., and was, up to the present season, the best, as it was the first combination regularly upon the market. It differs from the others in containing an appreciable amount of free sulphur, and it has approved itself a safe and reliable insecticide. But even this is better now than it was when first put upon the market, and the emulsion is more stable. On this point of stability there is something left to be desired, and all these combinations should be used as soon as possible after their receipt, and none should be exposed to freezing, or even low temperatures, if it can be avoided. Mineral oils in any form or combination work best in warm weather, while the emulsions tend to separate at frost lines.

The makers of the "Kill-O-Scale" have afforded me every opportunity of making a thorough test of their product, and have been liberal with samples for experimental purposes.

"Scalecide" is made by the B. G. Pratt Company, of 11 Broadway, New York, and while it is an independent development, it is, in essential composition, not unlike "Kill-O-Scale." From this firm I had a great variety of combinations; some made from Texas crude, some from Pennsylvania crude, and some from distillates of all grades to high-test kerosene. "Scalecide" is the outcome of these experiments, which have shown that any grade of mineral oil may be prepared so as to be readily miscible in water. Experiments are yet in progress which will, it is hoped, produce a material that may be safely used in summer, when plants are in full foliage.

The "Target Brand Scale Emulsion" is sold by the American Horticultural Distributing Company, of Martinsburg, W. Va., and is the result of a long series of experiments made by their chemist, Dr. P. Karntz. The method of securing the emulsion is quite different from that of the other preparations, but the percentage of mineral oil is approximately the same. Dr. Karntz has prepared for me several samples of oil combinations in quantity sufficient for practical tests, and if not all of these are reported here it is simply to prevent overburdening by a record of failure, which are important only because they resulted in final success.

All the preparations above named contain about 60 per cent. of actual mineral oil. All are to be diluted with twenty parts of water for winter work, and all may be expected to give a similar result. As to "Sure-Kill," sold by Siebrecht & Son, 425 Fifth avenue, New York, it may be equally reliable, but there has not been opportunity to test it. I have no knowledge of how this was developed.

The experiments made with the "Target Brand Emulsion" are not recorded, because the material now on the market under that name is an altogether different preparation, better, I think, from the material applied by me. It would be obviously unfair to credit the new material with the successes of the old or to charge it with the failures, while a record of experiments with a material no longer on the market is futile.

**Textil Oil.**

When I first began to urge the importance of obtaining a soluble petroleum upon those chemists who had manifested an interest in the subject, I was informed that there was already such a combination in existence and in use in the trades. It was something known as "Textil Oil," used in softening the fibers of certain fabrics and said to be very poisonous.

I succeeded in obtaining a very small sample of this material, reported to be made up of 70 per cent. mineral oil (petroleum in some form), 20 per cent. animal oil (character not given), 10 per cent. alkali and water.

About the most scaly tree I had on the place, and the one I cared least about, was No. 1, Mariana plum, and I determined to sacrifice that to the oil should it prove as poisonous as it was said to be. From the records of the Experiment Orchard, in the Report for 1904, page 606, it appears that on October 15th of that year, after a series of unsuccessful applications, the tree was in such condition that I sprayed it with "Kill-O-Scale," one part in twenty of water. November 2d, "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 application 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."

The last sentence of the record determined the application of "Textil Oil," and on Saturday, March 4th, Mr. E. L. Dickerson treated one side of the tree with an atomizer, using one part in twenty of water and seeking to give to all the infested growths a careful dose of the spray. The wind being high on March 4th, only one side of the tree was sprayed. March 6th, the rest of the tree was sprayed in the same proportion, but with a compressed air sprayer, through a Vermorel nozzle. The entire tree was, in fact, sprayed at this time, but the heavier application was made from the side which had not been reached on the 4th. The result was, a tree so clean that up to the end of August not a live scale was seen on it. There was no appreciable injury to the fruit buds and certainly none to the tree. Only two fruits reached maturity, but that has been, practically, the record of past years as well, and there was bloom sufficient for a full enough set had it made properly.

Of course this application is not so conclusive as it would have been had there been no "Kill-O-Scale" applied in October, for it is impossible to say definitely how much good that did. That it was very effective the record shows; that I considered winter spraying necessary at the November examination is also shown. Practically, there was a double application of soluble petroleum, with results that were as nearly perfect as could be reasonably expected. "Textil Oil" carries more petroleum than "Kill-o-Scale," forms a milky emulsion with water and sprays perfectly.

**Kill-O-Scale.**

The report for 1904 contains, on pages 646 and 647, a brief reference to this material and the results that had been obtained from its use up to that time. The conclusion then recorded was: "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."

The conviction expressed in this paragraph has been verified in every particular. Partly by purchase and partly by the courtesy of the Griffith & Turner Company, of Baltimore, Md., material was secured for use in the Experiment Orchard, on the Marsh orchard, the Howell orchard, the Dickerson orchard and the Barton orchards. The

Marsh, Howell and Dickerson orchards are in Morris county, and are mostly peach. The Barton orchards are in Burlington county, and are mostly peach and some apple. In addition, several other orchards, mostly apple, were treated in various parts of the State at varying times and under varying conditions.

The experience obtained in the past and a close watch on the developments of the present season made it possible to explain almost every bad and every good effect that was obtained.

The records of the Experiment Orchard and of the applications in the Marsh peach orchard are detailed in the report for 1904. It remains to add that in both cases the work was nearly perfect. The details as to the Experiment Orchard for the present year are given elsewhere in this report. In the Marsh orchard, on the trees that were twice sprayed before they became dormant, scarcely a live scale had been seen up to late August, and those that had been sprayed once only were almost as good. The single spraying was made just before a heavy rain, and it may be that this exerted some influence.

In the latter part of March some 900 trees, mainly peach, but also some apple and pear, were sprayed in the Dickerson and Howell orchards, near Chester, most of them with "Kill-O-Scale," but some, also, with "Anti-Scale," or its precursor. This lot of material had been exposed to a very low temperature, and one barrel of "Kill-O-Scale" had become partly separated, so that there was some free oil in the mixture. That this influenced the result was shown in the July examination, in which it appears that a slight scattering of scale remained throughout the orchard, but nowhere enough to make summer treatment really necessary.

In the Howell orchard the trees were perhaps a little the worse infested, but these were sprayed last, with fresh material, which had not been exposed to frost, and which mixed without a trace of free oil at the surface. Here the results are almost as good as in the Marsh orchard, though the original infestation was not nearly so bad. In any event, there were nearly 1,000 peach trees treated in late October or late March, and no appearance on any of injury to trees or fruit set, while the scale was as nearly wiped out as any single application can ever hope to accomplish it.

Five barrels of diluted mixture were used in a neighboring orchard of apple and pear trees, in comparison with lime, sulphur and salt, and in midsummer the oil proved to have been much the most effective.

Except the last, the above applications were made by or under the direction of Mr. E. L. Dickerson, my assistant as State Entomologist, or Harold O. Marsh, who had acted as field and office assistant during the summer of 1904. Mr. Dickerson, in his notes on the applications, remarked that "where plenty of pressure was put on the pump and the spray was driven into the tree, it adhered much better and covered much more completely:" and this was before attention had been specifically directed to this point.

A barrel of "Kill-O-Scale" was sent into Burlington county and was used experimentally on a variety of trees in two or three different orchards. These applications were not under control, were in part put on as side issues, and were not as effective as they should have been. Good and even excellent results were obtained, but they were not nearly so complete and convincing as those obtained in the orchards dealt with under direct supervision.

A very interesting observation was made in an old apple orchard near Bound Brook, which was sprayed by a local nurseryman with material ("Kill-O-Scale") furnished by the owner. I was advised of the time when the spraying would be made and sent Mr. Dickerson to watch it. It proved to be an excellent illustration of how spraying is often done, and I advised the owner at once that he must not look for satisfactory results. The object seemed to be to get over the greatest number of trees in the least possible time, and whenever the spraying rod had been over as many movements as might be reasonably required for a covering, the work was considered finished. Such work is bound to be unsuccessful, no matter what the material applied, and it is regretfully concluded that much of the work usually done is of this same general character.

Nothing will be gained by recording duplications of the results already given: some are favorable and others unfavorable; but the central fact remains that, diluted with twenty parts of water, this "Kill-O-Scale" will kill the pernicious scale at all periods of the year—though most certainly in fall: provided always, of course, that the mixture actually reaches the insects aimed at.

For summer work "Kill-O-Scale" is absolutely useless. I tried it at all sorts of strengths on foliage of all kinds and always with bad results. The experiments were not confined to fruit trees, but were extended to the ordinary shade trees, upon which the effect was identical. The actual percentage of oil in a dilution with thirty parts

of water is so low that it would seem as if it could harm nothing, but the combination that makes it effective against the scales evidently makes it hard on foliage as well—especially when the latter is in the growing stage. When the leaves are fully mature they seem to suffer little.

The matter of price may be alluded to, because it is an important one to the farmer. At $1.25 per single gallon, with expressage added, a spray gallon would cost about eight (8) cents, or altogether too much for orchard work, in comparison with the two (2) cents for the lime, salt and sulphur, or five (5) cents for K.-L. For the garden with small trees it will answer very well; for an orchard of old apple trees it is prohibitive. It is fair to say that there is a material reduction in price in barrel lots, but at even the best figure quoted the cost is very high when the necessity for thorough applications is considered.

**Scalecide.**

This is the outcome of a series of experiments made at my suggestion by the B. G. Pratt Company, 11 Broadway, New York, and the material now on the market has not been practically tested by me personally, but the other preparations leading up to it have been tested, and in each successive lot the defects of the preceding samples have been corrected. The company was good enough to send me, at my request, a list of the New Jersey purchasers of five-gallon lots or more, and I have communicated with nearly all, and have been over the treated trees in several instances.

Among the materials used in combination were Texas crude, Pennsylvania crude, various distillates and refined kerosene. "Scalecide," as it is now, is based on a distillate, combined with a sulphonated oil and a percentage of rosin.

Some ten gallons of Texas oil, made soluble, were tried in the Dickerson peach orchards, near Chester, in comparison with "Kill-O-Scale." The material was exposed to cold and did not mix so well as other samples, partly due, perhaps, to the asphalt base. Nevertheless the results were good and there was no sort of injury to the trees. It was decided, however, that this Texas oil would not work up as satisfactorily as the Pennsylvania type. The dilution was one to twenty, as with "Kill-O-Scale."

A ten-gallon lot, based on Pennsylvania oil, was sent to Mr. D. D. Denise, at Freehold, and he distributed in smaller quantities to several of his neighbors. The treated trees were seen by me in late May, and the results were as variable as the men that did the work. Where the treatment was thorough the result was good; but the bulk of the application has been made in a young apple orchard, sprayed from one side only. As a test of effectiveness this could not be considered at all; but incidentally it was determined that the soluble petroleum did not creep or spread so well as the undiluted crude, with which the balance of the orchard had been treated. The crude oil discolors the surface so markedly that it was easy to see just about how the application had been made and how much the oil had soaked around the limb or branch. This was always considerable, and in smaller branches was sometimes complete. Occasionally a limb would be ringed with the oil in places, and an almost perfect record of the delinquencies of the sprayers could be worked out. The marks left by the soluble oil are much less conspicuous, but are traceable, and nowhere was there anything like the same amount of creeping just above described, though there had been some spread.

To test the oil under conditions somewhat unlike those in New Jersey, I sent a lot of the Pennsylvania mixture to Mr. A. N. Brown, Wyoming, Del., and saw the apple trees to which it had been applied, June 16th, after the breeding had started. Although there was no especial difficulty in finding live scale, and a few larvæ were observed, it was obvious that the results had been very good, and in August Mr. Brown told me that, whereas in 1904 he had no salable apples from these trees because they were so scaly, he expected this year to harvest them all in good condition. Mr. Brown made his application very thoroughly with a gas sprayer, and the fact that the results were not more complete indicate the difficulty of reaching all parts of a vigorous, good-sized apple tree. I have no doubt that all the scales that were actually reached by the oil were killed, and the survivors are simply those that escaped the soaking in some way.

Mr. S. B. Ketcham, of Pennington, received five gallons of the Texas product and applied it March 18th with very satisfactory results. Mr. Ketcham has had some very unfortunate experiences with the caustic qualities of lime, sulphur and salt, and expresses himself as especially gratified with the ease and simplicity of preparations and application.

Eight of the parties who purchased "Scalecide" directly received the product which is now on the market, and in every case the response indicates satisfaction with the product. One orchard examined by myself did not give so good a record, and this was where the largest amount of the material had been used. It seems probable that low temperature and the method of application were somewhat in fault here, because the K.-L. was completely ineffective, also, and none of the applications were really satisfactory.

On the whole, the record is not quite equal to that of "Kill-O-Scale," which had, however, a much more thorough test under somewhat more favorable conditions, in that fall applications were made.

The price of "Scalecide" is $1 per single gallon, and in barrel lots fifty cents, F. O. B. at New York. This brings the cost down to a figure that makes it available for orchard work.

**Kerosene Limoid or K.-L.**

This combination is made by adding four pounds of limoid to one gallon of kerosene and stirring thoroughly until a sloppy mass is formed. If then a little free oil appears on the surface, add a little more limoid and stir until it is completely taken up and no more oil appears. Add water to equal the amount of kerosene, stirring constantly and hard. Then, after this forms an even mixture, add water sufficient to reduce to spraying strength, *i. e.,* if a 20 per cent. mixture is desired, four gallons of water should be added to every gallon of kerosene used. When all the water is added, stir violently by pumping the mixture back into the spray tank until a smooth, even emulsion is formed, that is quite stable and sprays readily through the finest nozzle, provided no foreign material has been allowed to get into the tank.

Limoid is a finely-ground and very light, dry-slaked magnesium lime: corson's lime, which is a similar product, has been used for the same purpose; and carefully slaked and sifted dry hydrate of lime does almost equally well. The lime, in its very finely divided condition, takes up the kerosene and forms a carrier, by means of which it is evenly suspended in the water. To be equally effective in all its parts, the diluted mixture must be very thoroughly emulsified, so that there shall be no settling of heavier particles and no free oil. That makes the necessity for the churning process by pumping back into the

spray tank. A properly-made mixture has been allowed to stand over night and was found to be in good shape for spraying next morning.

The lime adds nothing to the kerosene, which is the real killing agent: it is simply the medium by means of which the oil is spread over a greater surface in a thinner film. The quality or character of the lime is therefore only of importance in so far as its fineness and even character are concerned. A lime with heavy or gritty particles will allow the formation of a sediment in the bottom of a tank, which may interfere with spraying.

The combination originated in Delaware and was developed by Prof. C. P. Close, of the Experiment Station in that State. I had the pleasure of seeing the results of some of the work done under his supervision, and he, in turn, had the opportunity of looking over some of the New Jersey results.

One experimental application was made at South Branch, under the direct supervision of the office, on March 18th, 1905, on an orchard of old apple trees. Twenty per cent. kerosene was in the spraying mixture, which was made in strict accordance with formula and directions by Mr. E. L. Dickerson. The combination was readily obtained, and several variations were attempted, none of which equaled that above given, which is in accordance with Professor Close's recommendation. A Gould pump, mounted on a barrel, furnished the power, and the spraying was done through Vermorel triplet nozzles on a gas-pipe rod. After the first day's work the matter was left in the hands of the owner, who did all the mixing and spraying personally, following out closely, so he asserts, the practice shown him by Mr. Dickerson. The limoid running short, 300 pounds of Corson's lime were used, and that gave some trouble because of a gritty sediment. One point developed in this work was that it will not do to leave any spraying mixture in the barrel when a new lot of K.-L. is to be prepared.

June 26th, the results of the work were examined, and, while undoubtedly a very large percentage of the scale was killed, a large percentage was yet alive and breeding rapidly. There could be no question of lack of thoroughness here, because the trees were sprayed from four sides, and the material was yet quite prominently visible on all the trees. As between the limoid and Corson's lime no difference in effect was noticeable. Both applications had done fair work, but too many living specimens remained to make it really satisfactory.

In the Moorestown district of Burlington county, and in the immediately adjoining portion of Camden county, over 20,000 trees, mostly apple and pear, had been sprayed with the K.-L., containing 20 per cent. kerosene. Examined June 6th and July 10th, the results were most disappointing. Larvæ were swarming, recent sets were numerous and some of the fruit was already entirely unsalable. The orchards really were in much worse condition, despite the application, than they had been during the previous summer. Professor Close went over this same territory later, and claims that the poor results were due to the fact that the kerosene and lime were not properly combined; the mixture was made according to formula, but not churned by pumping back into the spraying tank. It was admitted by some of the growers that this was not done, but all of them claimed that they had an apparently even mixture, without obvious free oil. Certainly the results seemed uniform enough to point to a very uniform mixture.

At a number of other places similar imperfect results were noted, and in some cases there seemed to have been a difficulty in getting a good mixture. It seems also as though there might have been some difference in the character of the limoid, because some claimed that they always had a troublesome sediment, and, in two cases, where lots were purchased at different times, one lot was entirely satisfactory and the other showed the sediment.

The other side of the shield was seen in Mercer county, where an orchard of peach and pear, with a few apples and plums, was almost completely cleared of infestation. In this locality 1,000 gallons of kerosene and a carload of limoid was used, with results that were, on the whole, very satisfactory. In some places quite a bit of scale remained, mostly due to incomplete work, and in almost all cases some young and recent sets could be found, especially on apple fruits, but nowhere was there anything like the failure found in the Moorestown region.

The sprayed trees in Delaware were mostly on the orchard of Mr. A. N. Brown, of Wyoming, and were chiefly peach. These were treated under the personal supervision of Professor Close, and the result was about like that in Mercer county—there was some breeding apparent on every tree, large and small, but very little. Later in the season Mr. Brown informed me that, as compared with the lime and sulphur and soluble oil preparation, the K.-L. was decidedly inferior.

This combination should be, theoretically, a very effective one, and and I am not at all sure that good results will not be obtained by using a 25 per cent. mixture in late October or early November.

**Kerosene Napthol.**

This is a preparation sent in for trial, with directions to dilute with twenty parts of water. The formula sent with the material showed 60 per cent. of petroleum distillate, combined so as to be readily soluble in water—a combination which promised well and which left nothing to be desired as to ease of application. One barrel lot was used on the grounds of Mr. James Neilson, beginning February 25th—in part on a few trees in his garden, but mostly on a long, Osage orange hedge. The outfit consisted of a horizontal lever pump, of much greater power than needed, bolted to a wagon, and pumping from a fifty-gallon barrel to two spray rods with Vermorel nozzles. The emulsion was diluted with two or three times its bulk of warm water, and, when thoroughly combined, cold water was added to make up the quantity. It will be noted that at the dilution given the spray contained a little over 2 per cent. of actual oil, but it was believed that the character of the combination was such that that might be sufficient.

Examinations were made June 27th, and only a very partial effect was noted. There had been some destruction of scale, without doubt, but nothing like the percentage necessary to carry the trees through the summer. The new shoots of the hedge were already well set with larvæ, and promised a worse condition by the end of the summer than existed when the application was made. One plum tree especially, which had been quite badly infested, was swarming with young.

A smaller lot was tried on a few trees of the Experiment Orchard, March 6th, diluted with only ten times its bulk of water. Six trees were treated, but unfortunately five of these had been sprayed with "Kill-O-Scale" in October, 1904, and only one tree, No. 29, could be used as a fair test. This was by no means a badly-infested tree, yet on June 25th scales were noted on the fruit, and a few days later they had become abundant enough to make it advisable to use fish-oil soapsuds in an effort to prevent further infestation.

The outlook was not encouraging, but it was hoped that it might have a field as a summer application. The small balance of material

in my possession was tried on various kinds of foliage when scale breeding began, but much to my surprise the effect was so severe that it was necessary to abandon it altogether.

I am not ready to believe that this combination may not prove a useful one, but it must be much less diluted and must be applied in the late fall, before the scales are dormant. The maker suggests that possibly the mixture had been exposed to freezing weather and had become modified and the emulsion destroyed. It is a fact that this was true of the larger lot, but not of the smaller sample. Nevertheless, the mixture deserves a further test, and, as already indicated, it may do better as a fall wash.

### Rose Nicotine.

A four-ounce sample of this was sent in by the manufacturers for trial, with a statement of their belief that it was more active and effective than any similar preparation. It was said to be, not a tobacco extract such as is obtained by boiling and then evaporating down, but a preparation of the nicotine poison itself. The directions for use contemplated two to three tablespoonsful of the extract to ten quarts of water. I used it at the rate of two ounces in eight quarts, partly against apple-leaf hoppers and partly against larval scales. In neither case was there any beneficial result. The application was as thorough as one could be made, and if it were at all useful some benefit should have been noticed; but even the half-grown or larval hoppers, that were thoroughly drenched, minded it not in the least. As for the larval scales, they were no more affected than they would have been by so much water. This is in line with previous results from applications of other tobacco preparations on similar insects.

### Dust Spraying.

To speak of a "dust spray" is a contradiction. Nevertheless, the term has made a place for itself and means simply the substitution of some form of dry powder—usually lime—in place of water as a carrier of insecticides or fungicides. In ordinary spraying an insecticide, say Paris green, is mixed with or stirred into a definite amount of water, and the mixture is then spread over a tree in the form of a fine spray, through a nozzle, by the force of a pump. The water, as

such, adds nothing to the Paris green; it is merely the carrier by means of which the poison is spread over a large surface. The water dries off soon after the application and leaves a very fine coating of the dry green. Any other method of producing the same mechanical result is likely to be equally effective. Water is sometimes difficult to get in quantities necessary for spraying purposes, especially in hilly regions or in the arid plains of the central and further west. This has induced an effort to develop dusters in the form of rotary fan-blowers to apply the same poison mixed with the dry hydrate or one of the prepared forms of ground lime. In the form of a dry application on potato vines, New Jersey growers are familiar with the general principle involved, and not a few up-to-date fan-blowers are in use in the State for this purpose. It seems a far jump from a blower to cover a potato vine to one that will cover a tree, nevertheless is has been made, and "spraying" an orchard with dust is no longer a difficult task, even if the trees be of good size.

In New York and in Delaware experiments have been made and reported upon by the Experiment Stations, but there is no record of any considerable number of horticulturists following the method. In New Jersey there are only two of the large orchardists using the dust process, and here I had a chance to see the practical working of the machines. There is no doubt that a tree can be more rapidly covered by a cloud of dust than by a spray, and, when properly made, the application seems to be quite as complete. The work with a good machine is easier, and there is much less carting. A surprising amount of surface is covered by the dust, and its cost per tree is decidedly less than where the liquid spray is used. In the Delaware and New York experiments a double purpose was held in mind, and both copper sulfate and Paris green were used. The New York conclusions are, in brief: Labor and expense of applying dust sprays appears to be less than for sprays in liquid form. Six applications of dust were not more effective on apple than two applications of Bordeaux. Brown rot on peach and plum were not prevented; but the experiments are not conclusive. Dust should be applied in early morning or late afternoon and powder must be strictly dry. Damp, not wet, conditions of atmosphere and tree are desirable, if not essential.

The Delaware conclusion is a little more favorable in the results on apples, and it is believed that for some purposes the dusting may replace liquid sprayings.

In the New Jersey orchards the results demonstrated that, as against the codling moth, the dust was quite as effective as the liquid sprays, and no more applications would seem to be necessary. As to the effect in preventing disease no notes were made, and I have no opinion to offer. An application containing sulphur, applied in mid-summer to check scale development, was entirely ineffective.

The present *status* of the matter seems to be that one pound of Paris green or green arsenoid, thoroughly mixed with fifty pounds of fine, dry hydrate of lime, or any one of the prepared or process limes, may be dusted on apple trees with as good results against the codling moth as could be obtained with liquids. The date of application is the same in either case, and three dustings are desirable, though two will answer if the time be properly chosen. If the application is made when the trees are a little damp the material will stick quite as well as the liquids.

As against any leaf-feeding caterpillars or other insects, this method is equally available, and on rough foliage it will be more satisfactory than on smooth or waxy leaves, from which the dust blows or washes easily. The lime alone, or with flowers of sulphur intermixed at the rate of one pound of sulphur in twenty of lime, will be effective against most plant lice, especially the green varieties, and it is probable that fine tobacco dust would be even better.

There is no warrant for believing that any of the dust applications can be in any way effective against scale insects.

## RECORDS OF THE EXPERIMENT ORCHARD.

There is a constant decrease in the number of trees in this little lot, due chiefly to the increased size of a few, but also, in part, to a disinclination to replace trees in situations that invite trespass.

After the conclusion of the record for 1904, tree No. 22, which was in a very bad place, overshadowed by No. 35 and by a grapery, was removed and set in the place of No. 46, removed October 1st, 1904. There were no winter treatments.

March 6th, 1905, on a bright, sunny day, moderate northwest wind, sprayed trees 2, 7, 8, 29, 30 and 38 with kerosene-napthol, one to ten. Sprayed trees 19, 20, 31, 32, 33, 34, 42, 44 and 47 with napthol-sulphur, one to thirty-two. Sprayed tree No. 7 with textil oil, one to twenty, applying thoroughly.

April opened warm and forced development. General examinations were made April 12th and 30th, and notes were made at intervals during the month, as individual trees started and developed. At the end of the month and early in May, cold winds and almost freezing temperature checked development until the early start had been neutralized and a normal seasonal development was noted.

May 19th, all the apples and most of the pears were sprayed with arsenate of lead, one pound to twenty gallons of water, until the leaves dripped. On the 25th, used soluble petroleum, one to thirty, on cherry and rose, to kill plant lice, and on the 27th noted that, while most of the insects had been killed, all the foliage was more or less injured. Nevertheless, as a further test, sprayed parts of trees 30, 32, 33 and 40 with the same, one to thirty mixture, and failed later to find any material injury.

May 29th, sprayed all apple trees a second time with arsenate of lead, one pound in fifteen gallons of water.

June 11th, sprayed parts of trees 42 and 43 with Tak-a-nap soap, at the rate of one pound in four gallons of water, to determine effect on foliage as well as on the insects. No satisfactory results noted later.

After an earlier examination to determine condition, examined for scale development June 25th, finding several infested trees on which breeding had not yet started. July 3d, these trees, 24, 25 and 26, were again examined and plenty of larvæ were found: the delay was due to the shaded position of the trees, which seemed unfavorable to the growth of the insects.

July 5th, examined all the trees that were treated with "Kill-O-Scale" October 14th, 15th and 19th, 1904, and found that all were yet free from living young or signs of breeding. These trees, 1, 7, 8, 17, 23, 30, 32, 33, 34, 38, 39, 44 and 47, are all in excellent condition and in strong contrast to those that were untreated. Sprayed trees 24, 25 and 26, and half of tree 2, with soluble petroleum, one to thirty. On the 8th, sprayed Nos. 18, 19, 21 and half of trees 2 and 29 with fish-oil soap, one pound in four gallons of water, producing only a temporary check in each case. At this time the effect of the drought became noticeable, and in spite of occasional watering the dry July materially checked growth.

August 19th, made a general examination for record, and in the evening sprayed trees 18, 19, 21 and 29, and the top of tree 38, with fish-oil soap, at the rate of one pound in seven gallons of water—with

very little good result. Larvæ were moving in great numbers, and it was desired to determine whether a mixture of this strength had any marked effect:—it had not.

August 21st, applied a kerosene and resin emulsion, from Mr. P. Karntz, to trees 8, 19, 20, 21 and 24, as recorded under the tree numbers. There was some difficulty in getting the solution, and next day it appeared that a very uneven piece of work had been done and material injury had been caused. The combination must be improved to be of any use.

August 22d, sprayed trees 15, 16, 23, 35, 42, 47 and 48 with arsenate of lead, one pound in nine gallons of water. Except on trees 15 and 16, the application was chiefly to test the material which had been made in Newark, for the Shade Tree Commission of that city, to replace a lot that had been condemned as unsafe. No injury of any kind developed on any tree and the material was reported as acceptable.

August 26th, all the fruit was removed from all apple trees and from the Vermont Beauty pears. The house was to be shut up for three weeks, and to avoid raids the fruit was removed unripe. Only the Japan Russet pears, quinces and Dwarf Duchesse pears remained.

August 28th, all trees, save peach and nectarine, were sprayed with arsenate of lead, one pound in twenty gallons of water, by Mr. Dickerson. The application was made to prevent injury from fall webworms, one nest of which appeared on tree 3 and other colonies of which were indicated. The application proved effective.

August 31st, sprayed with No. 3 emulsion, one to thirty, trees 19, 24 and 33. This is another of the kerosene and resin mixtures, which worked very well in the pump and mixed almost perfectly. Results are noted under tree headings.

During September no general applications were made, and the insecticides used were all on a small, tentative scale. October 1st, a general examination was made to determine conditions and outline later practice. On the 20th, trees 21 and 40 were cut out, the former because it was crowded out, the latter because it was good for nothing.

October 24th, started with the intention of spraying all the trees, save cherry, walnut and chestnut, with "Scalecide," at the rate of one to twenty; but though there was no wind in the early morning, it arose when the work began and became so high that some trees could

not be sprayed at all and others were incompletely done. A general record was made, especially as regards foliage conditions.

October 30th, all the peach, apricot and nectarine trees were thoroughly sprayed with "Scalecide," one part to twenty parts of water.

November 16th, all the trees were thoroughly sprayed with "Scalecide," one part to twenty parts of water, and as a test of injury, cherry and nut trees were sprayed as well as fruit trees. On the 20th most of the apples and the quinces were yet in pretty fair foliage, but most of the other trees were quite bare.

Tree 1—*Mariana Plum.* The tree ended the season of 1904 in bad condition, with much dead wood and a bad coating of scale. Some of the dead wood was cut out during the winter and some of the scaliest branches were removed.

March 6th, drenched with Textil Oil at the rate of one part to twenty of water, and as the tree had had an application of "Kill-O-Scale" in October, 1904, this made the second dose of petroleum for the season.

The tree had started April 12th, and blossoms were out on the 30th; but development was irregular, both in leaf and blossom, and up to May 11th it was in bad shape. At that time I cut out considerable wood from the inside, shaped up in general and gave the tree a decent outward appearance. But the bloom was straggling; there was almost no set, and not until May 25th was it in full foliage and of a decent appearance.

May 27th, sprayed to a drench from the northwest side with soluble petroleum, one to thirty, to test the effect on foliage, and on the 30th noted that no apparent harm had been done.

As the season advanced the condition of the tree improved steadily, and on the examinations during June and July no scale breeding was noticed. Two fruits matured August 3d, freedom from scale continued during the month, and on September 13th the record was: "Practically no scale. The tree is freer now than it has ever been at this season." On October 1st the record was: "There are some scales; but they must be sought, and at first view the tree seems clean."

October 24th, was yet in full, healthy foliage and looked better than it had for two years past. No dead wood; no coated twigs or branches. Sprayed from the southwest with "Scalecide," one to twenty, and covered as completely as possible by quartering, in a high wind.

TREE 2—*Yellow Transparent Apple.* Was sprayed September 21st, 1904, with soluble petroleum, one to three, imperfectly applied with an atomizer.

March 6th, 1905, was drenched with Kerosene-Napthol, one to ten.

April 2d, the buds were well advanced; on the 30th leaflets were unfolding and blossom buds ready to open, and on May 7th was in full bloom and almost in full leaf.

May 19th, sprayed to a drench with arsenate of lead, one pound in twenty gallons of water, and on the 29th repeated the application. On the 25th a good set of fruit was obvious, and, while the bark looked pretty rough, the tree was otherwise in good condition.

June 2d, the lobes of calyx were closing. On the 25th a few larval scales and recent sets were noticed, but nothing on the fruit, which was developing well. Web-worms (*Hyphantria*) started at several points, but never got beyond the first leaf or two.

July 5th, sprayed with "Anti-Scale," a petroleum preparation, one to thirty, from the house side only, and on the 9th found both fruit and leaves scalded and spotted by the application. Applied fish-oil soap, one pound in four gallons of water, to reach those points that the oil application had not hit. July 9th, the oil injury had intensified, while no harm seems to have been done by the soap. On the 16th there were some worms where apples touched, but none from the calyx end. On the topmost branches some of the fruits were scaly, and these had evidently escaped the sprays. On the 20th and 21st, picked off all the fruits—nearly three baskets—not quite ripe, but very attractive to boys.

As the foliage was suffering from leaf-hopper, sprayed on the morning of July 21st with fish-oil soap, one pound in six gallons of water. A few hours later the leaf-hoppers were as active and numerous as ever. On the 22d, sprayed with soluble petroleum, one to twenty-five, covering very lightly. On the 26th there was no appearance of injury to the trees, while many of the leaf-hoppers had been killed. Nevertheless, these insects were yet abundant enough, in all stages, to discolor the foliage and to cause some of the leaves to drop early in August. On the 19th of the latter month, sprayed with "Rose Nicotine," four ounces in two gallons of water, and applied thoroughly. I actually saw the mixture hit and wet young and half-grown forms, which four hours afterward were as lively as ever. The material was absolutely ineffective.

As to scale, the tree remained quite free until nearly midsummer, though some larvæ were noticed in June. August 19th, I found, on a careful examination, that there were two points well up in the tree which had evidently escaped the spray and from which the insects were then spreading. October 1st there were larvæ throughout the tree, but the infestation was light except on one branch.

October 24th, the foliage was yellow and brown—ready to drop; some already gone—due mostly to leaf-hopper injury. Sprayed with "Scalecide," one to twenty of water, but did not make a good job of it because of the high wind.

TREE 3—*Black Tartarian Cherry.* The tree started to open leaf buds April 12th, began to blossom on the 21st, was in full bloom three days later, was dropping blossoms on the 30th, and out of bloom, with a moderate set of fruit, May 7th. It was not cut back last year, and I attribute the small set to the enormously long shoots to be supported. What was left of the fruit ripened in June, and it was a race between the children and the robins as to which should get each cherry as it colored up. No scale was found at any time during the season, and the tree remained in good condition, save for a little slug work, until November, when the foliage began to drop.

TREES 4, 5 and 6 are out and not to be replaced.

TREE 7—*Champion Peach.* This tree was drenched with "Kill-O-Scale" October 19th, 1904. March 6th, 1905, was thoroughly treated with Kerosene-Napthol, one part to ten parts of water.

April 12th, leaf buds were fully open, blossom buds were well advanced and on the 26th some flowers were open. Was in full bloom April 30th, and in almost full leaf with all the blossoms gone May 7th.

May 7th, the tree was shaped up; the dead wood was cut out, the branches that overhung the fence were shortened back or taken off, and altogether the tree was improved in appearance. The fruit set was good, and while there was considerable drop in June, there was on the 25th as much remaining as the tree should have and no appearance of scale. The same record as to scale continued during July and early August, while the fruit developed as well as the dry weather permitted. August 20th, all the fruit was taken off, just short of being ripe, though fully colored, and at that time a few scale larvæ could be found on close search.

October 1st, was yet in full green foliage, not in the least loosened, fruit buds were making in fair numbers and there was only the merest scattering of scale. On the 24th, sprayed with "Scalecide," one to twenty, the application somewhat imperfect, due to high wind and foliage, which, however, was then about ready to drop.

It should be noted that this was a very scaly tree and so much injured that some branches were already dead or dying. The application in 1904 was made long before the tree was dormant and was believed to be so excessive as to endanger the buds. Nevertheless, a full bloom was made, and all the fruit that the tree should reasonably bear developed normally. I do not credit the Kerosene-Napthol with adding to the effect of the "Kill-O-Scale," and neither material caused injury of any kind. The tree is in far better shape than at the corresponding period last year.

October 30th, yet in full foliage, was sprayed with "Scalecide," one part to water twenty parts, thoroughly applied.

Tree 8—*Grimes' Golden Pippen.* Was treated October 14th, 1904, with "Kill-O-Scale." March 6th, 1905, was drenched with Kerosene-Napthol, one part to ten of water. The tree had started irregularly April 12th, buds were ready to open May 1st, was in full bloom May 7th and out of bloom May 11th. On the 19th sprayed with arsenate of lead *versus* codling moth, and renewed the application May 29th. Woolly lice appeared early in June and some small colonies continued present throughout the season.

The fruit set was not very large, but developed normally except as checked by drought. It began to ripen about the middle of August, and was not Grimes' Golden; but I could get no name for it, and so it must stand as it is for the present. It is very like that on tree 33, marked Baldwin, but that also is untrue to label. In the fruit as gathered August 26th there was no codling moth at the calyx end, but at several points worms had entered where two fruits touched.

Up to August 3d, no scale was seen on the tree, and then a few sets were noted on the fruit. On October 1st, there was very little infestation visible anywhere from the ground, and none that was bad. The effect of the October 14th application was entirely satisfactory.

While this tree did not suffer quite as severely as No. 2, leafhoppers nevertheless became quite abundant on it, and on August 19th sprayed with Rose Nicotine, two ounces in one gallon of water, with absolutely no effect. On the 21st, sprayed with kerosene and resin,

one part to twenty of water, applying thoroughly in the lower part of the tree, but not on the upper shoots, which could not be reached by the little compressed air sprayer used in the experiment. Next day the foliage was brown-spotted, especially on the under side, and the fruit was also brown-spotted where drops gathered. As against the insects the effects were very good; but the material is out of question while fruit remains on the tree.

October 24th, was yet in full foliage, without tendency to drop; sprayed with "Scalecide," one part to twenty of water, but made an imperfect job because of the wind.

Trees 9, 10, 11, 12, 13 and 14 are out.

Tree 15—*Japan Golden Russet Pear.* April 12th, buds were fully developed and flower clusters beginning to show; on the 21st the clusters were separating; on the 27th some flowers were open, and on the 30th was in full bloom—a mass of white flowers. May 19th, sprayed with arsenate of soda, one pound to twenty gallons of water, to guard against codling moth, and on July 21st repeated the application to head off a second brood. A good set of fruit was made, which grew well for a time and then stopped; some beginning to crack early in August, when some leaves also turned yellow and dropped. Later, when the drought was broken, growth was resumed, and soon the branches began bending under their load. September 13th, they were breaking under the weight of finer and better fruit than ever before, and almost free from "worms." Before the crop was off a number of branches were broken by a high wind. August 22d, sprayed with arsenate of lead, one pound in nine gallons of water, to test the material.

As to scale, very little was seen until the middle of July and not much at any time during the season, none at all getting on the fruit. October 15th, the foliage was yellow, ready to drop, some of it gone; not much scale anywhere, and what there was, localized. The tree has really outgrown the trellis and is neither standard nor trained at present. Sprayed with "Scalecide," one part to twenty of water, from one side only, but gave a fair covering to all but a little strip.

Tree 16—*Japan Golden Russet Pear.* The record for tree 15 may, on the whole, answer for this as well. The tree is a little smaller, the crop was not quite so good and there is perhaps a little more scale, but in essentials there is little difference. The two trees together turned in half a barrel of fruit, of no great value except to stew. The

spraying, October 24th, was done more thoroughly than on No. 15, because it was better possible to get around it.

TREE 17—*Trellised Peach.* This received an application of "Kill-O-Scale" October 14th, 1904; began to start slowly and irregularly early in April, and on the 21st some blossom buds were ready to open. Some did open on the 23d, and the tree was in full, if scant, bloom on the 27th. Only one fruit set, and on June 25th, when half grown, began to rot and was taken off. It is smooth-skinned and more like a plum in texture, though obviously a peach in other respects.

Growth was irregular and one branch died, but the other sent out long, vigorous shoots, so that at the end of the summer it seemed possible to get it into usable shape as a dwarf. Plant lice attack became obvious May 25th, and soon after leaf curl developed. The latter persisted until late in June, after the lice had disappeared.

May 25th, sprayed the infested tips with soluble petroleum, one part in thirty parts of water. June 2d, there was no appearance of injury from the oil, nor, on the other hand, did the plant lice show much if any effect: the mixture was too dilute to do either good or harm.

No scales were seen until July 9th, when there was a slight trace that may have come on from the outside, since there were only single small specimens on the new shoots. October 24th, there was still only a scattering, but all over the tree, and enough to provide for a good infestation next year. Foliage still perfect at that time and "Scalecide" was thoroughly applied at the rate of one part in twenty of water.

October 30th, received a second application of "Scalecide," at same strength; foliage still perfect.

TREE 18—*Vermont Beauty Pear.* Started early in April, and on the 12th leaf buds were well advanced and blossom clusters beginning to separate. A few blossoms opened April 27th; on the 30th more than half of them were out, and on May 7th the tree was already beginning to go out of bloom. The set of fruit was small, owing to adverse weather conditions, and on May 26th it was noted that a large percentage of it was infested by the pear midge. This was quite unexpected, as its almost total absence last year led me to believe that it had worked itself out.

June 25th, only a small set of fruit remained, and on this scale larvæ were rapidly setting, there being a full brood in evidence. July 8th, sprayed thoroughly with fish-oil soap, one pound in four gallons

of water. Next day no moving larvæ were seen, and it was hoped that a good effect had been obtained. A week later, however, all the fruit was horribly infested and larvæ and recent sets abounded: only the moving larvæ had been affected by the spray, and breeding had not been even checked. July 21st, sprayed with arsenate of lead, one pound in twenty gallons of water, as against codling moth and leaf-feeders generally. On the 22d, sprayed with fish-oil soap, one pound in six gallons of water, and applied a drench aimed especially at the fruit. July 26th, quite a number of the leaves showed a scalded effect, especially at the edges, but this injury did not intensify, and there was a lessening of larvæ and recent sets, which, however, was due to an intervening period of breeding rather than the insecticide.

August 19th, the fruit was so marred that it was commercially valueless, and a new brood of scale larvæ was present in countless numbers. In the evening, sprayed with fish-oil soap, one pound in about six gallons of water, until every leaf dripped, and I believe every twig and branch was reached. Next day the tree smelled fishy, but there was no apparent injury to foliage, nor was there any lessening of scale larvæ, which literally swarmed everywhere.

August 21st, sprayed with a kerosene-resin mixture at the rate of one part in fifteen parts of water. This was an experimental material, not well combined, and which did not dissolve well in the spraying tank. The last part of the mixture applied seemed almost pure emulsion, and I tried to dilute this by immediately spraying clear water. On the 22d the foliage was pretty well blackened, especially where the settlings had hit, and while a good result had been obtained against the scale, the leaves had been seriously injured. Injury intensified during the next few days, and on the 26th many of the leaves were dead, either black or yellow, as if touched by frost, while the fruit was made absolutely useless. September 13th, much of the foliage was off, the remainder scalded. All save a few badly-speckled fruits were off and on some branches the scale seemed dead; there being plenty left, however, at other points.

October 1st, most of the foliage was off, scale was swarming and there was one bunch of blossoms near the top of the tree. On the 24th the foliage was nearly all gone. There was much dead wood in the tree and it looked and was a serious case. Applied "Scalecide" at the rate of one part to water twenty parts and gave a very fair covering in spite of the high wind.

TREE 19—*Vermont Beauty Pear.* In a general way this has the same history as No. 18, but was never quite so badly infested. It was sprayed March 6th with Napthol-Sulphur, one to thirty-two, the application being thorough enough to discolor the snow from the drippings. There was no appreciable effect from this, and during the summer the arsenate of lead and soap mixtures were applied as for No. 18, and with no greater effect.

August 21st, sprayed with kerosene and resin, one part to water fifteen parts, and made thorough work of it. An attempt was made to hit all the foliage from the outside. The fruits were especially aimed at, and most of the branches were sprayed from below. Some injury developed, but not very much, and the fruits were taken off on the 26th so infested as to be useless. August 31st, applied kerosene-resin emulsion No. 3 at the rate of one to thirty, so thoroughly as to run down the trunk in a stream. The mixture was irregular, and some of it seemed to carry much more resin than others. September 13th, there was quite a bit of burned foliage and some had dropped. The scale situation was not so bad as it had been and some benefit had been derived from the spray.

October 24th, applied "Scalecide," one part to water twenty parts, and covered pretty thoroughly. The tree was not quite so bare as No. 18, but almost as bad in condition.

TREE 20—*Meech Quince.* Sprayed March 6th with Napthol-Sulphur, one part to water thirty-two parts.

April 12th, leaf buds were starting; on the 30th, was practically in full leaf; May 11th, first blossoms were open; on the 14th, was in full bloom, and on the 26th, all the blossoms had dropped. Only a small crop set, but the tree did well otherwise, except that by July 16th it had more scale than ever before in its history. On the 22d, drenched with whale-oil soap, one pound in six gallons of water. At this time the dry weather had stopped all growth except in the developing fruit. After conditions improved fresh growth started, and on August 19th the tree looked very well, though there was a heavy crop of larval scales on the move.

August 21st, sprayed with a kerosene-resin mixture, one part in fifteen parts water, and soaked all parts of the tree. On the 22d the wood looked as if it had been varnished, some of the foliage was discolored and the young and recent sets seemed to have been wiped out. Injury intensified and extended to the fruit, crippling some that re-

ceived the heaviest dose. Yet, though the foliage looked bad, not much of it dropped and some very fair fruits ripened in October, when there was less scale than there had been earlier in the year. October 24th, while yet in tolerably complete foliage, applied "Scale-cide," one to twenty, thoroughly.

Tree 21—*Vermont Beauty Pear.* Its history during the early part of the season was much like that of No. 18, and like that it suffered from the pear midge. Not until almost the last day of June did any scale larvæ develop, but then in a few days they covered every fruit and swarmed on leaves and twigs. The tree was shaded by No. 35, which towered above it, and shoots from the grapevines were running into it, forming a shade that seemed to delay the scale development somewhat. Treatments with fish-oil soap were made and resulted as already noted for No. 18.

August 21st, sprayed with a kerosene-resin mixture, one part to water ten parts, and got over all parts of the tree thoroughly. Little injury to foliage was noted next day, but on the 26th much of it was yellow and some leaves had dropped. The scale situation was not encouraging, and as the fruit was utterly useless it was taken off. September 13th, there seemed more scale than on even 18, and though it still held its foliage remarkably well, October 1st I had it taken out. It would have been quite possible, I think, to conquer the scale, but the position of the tree was such that it could not grow properly and was really in the way.

Tree 22—*Japanese Chestnut.* This is another of those trees that was so shaded by No. 35 and the grapevines that it was taken out and set in the place of No. 46, under which number the record will be continued.

Tree 23—*Greensboro Peach.* This tree was treated October 19th, 1904, with "Kill-O-Scale," one part to water twenty parts, and had no winter treatment. It started early in April and on the 12th some blossom buds were already showing pink; April 27th, some blossoms open; April 30th, in full bloom; May 7th, practically out of bloom, and May 11th, all the blossoms were gone and the tree was in full leaf. A good set of fruit was made, and while the tree is somewhat lanky, due to its shaded position, it was doing well. The crop ripened during the last days of July and early August and was good in size and quality, a little too tender, however, to make a good shipper when fully ripe.

Not until August 19th was any living scale seen, and then a very slight scattering became apparent, as though from a new infestation or a few survivors. Up to October 1st the specimens were not numerous enough to be obvious and the tree was then still in good foliage.

August 22d, sprayed with arsenate of lead, one pound in nine gallons of water, to test the quality of the insecticide, and no injury of any kind developed on the foliage.

October 24th, foliage yet in good shape and fruit buds developing well; sprayed with "Scalecide," one part in twenty parts of water, and covered fairly well. On the 30th the application was repeated more thoroughly, though the foliage still held on well.

Tree 24—*Greensboro Peach.* Started early in April, leaf buds opening out on the 12th, some flowers open on the 27th, while on the 30th the tree was in full bloom. May 7th was almost, and on the 11th altogether, out of bloom and leafing out well. May 26th, a good set of fruit had been made and a little leaf-curl developed, which remained obvious until the early days of June.

The "June drop" was heavy, but enough fruit to tax the tree remained and developed gradually, so as to furnish pickings from July 25th to August 5th, when it was all off.

This is another of the shaded trees, and no scale-breeding was observed until late June, but in July a brood was on the move, so heavy as to demand immediate attention.

July 5th, sprayed thoroughly with "Anti-Scale," a petroleum preparation, at the rate of one part to thirty of water. Severe injury to foliage became apparent July 9th, some leaves being badly spotted, others turning yellow and dropping. It was questioned, however, whether the dry weather was not, in part, responsible for this premature falling. Early in August the yellow spotting on the foliage disappeared, leaving small, irregular holes in its place. August 19th, so heavy a second brood was on the move that it was deemed wise to spray on the 21st with a kerosene-resin mixture, one part to ten parts of water. As the foliage was thin it was possible to reach most of the branches without hitting the foliage very much, but enough was applied to test its effect. On the 22d the leaves had more holes than before, but otherwise were not hurt. On the 26th injury had not intensified, but there was another brood of larvæ on the move, and I sprayed with emulsion No. 3, kerosene-resin, at the rate of one part to forty of water, on one branch only, to test its effect. August 27th,

no injury was apparent, and while the leaves showed a coating of resin, the scales did not appear to have been much checked. August 31st, sprayed thoroughly with emulsion No. 3, at the rate of one part to water thirty parts. The wind was rather high and I could spray only from one side and quartering—enough to reach all foliage, but not all the wood.

September 13th, more than half the foliage was gone and the rest had numerous shot-holes, but crawling larvæ were few and there seemed to be less scale than at the date of spraying. October 1st, the situation was not much worse in any direction, and the remnants of the foliage hung on well and of good color until October 24th, when the tree was sprayed with "Scalecide," one part to twenty parts of water, but rather imperfectly, owing to a high wind. On the 30th the application was duplicated and much more thoroughly, the foliage yet as before.

Tree 25—*Apricot.* The tree started early in April and on the 12th was one mass of pink buds, just about ready to open. On the 21st was coming out rapidly, and on the 22d was a mass of beautiful flowers. Was out of bloom and growing well May 10th, and that record continued until late in June, when, probably owing to drought, the shoots stopped growing and the foliage lost its bright, vigorous appearance. During the first days of July a heavy brood of young scales was produced, and on the rather close examination then made it was found that there were several well-developed fruits present—two of them already attacked by the rot. As this tree had never set fruit before, none was looked for and thus it escaped earlier discovery. None ripened, though some became fully colored, and all of it was off by August 3d.

July 5th, sprayed thoroughly with "Anti-Scale," a petroleum preparation, at the rate of one part to thirty parts of water. The result was disastrous, the tree being almost defoliated July 9th, and the remaining leaves wilted. Even the now exposed fruits were spotted and suffered as much in their way as the leaves. As to the scale, it was present in all stages, and while some were undoubtedly killed, more than enough remained.

August 19th, the second brood of larvæ developed in goodly number, and the tree did not seem to stand defoliation or injury at all well.

August 26th, applied No. 3 kerosene-resin emulsion, at the rate of one part to forty parts of water, to two shoots, to test the effect on foliage. No appearance of injury on the 27th. The same shoots were sprayed a second time and examined on the 31st. At that time there were few larvæ or recent sets left and some benefit had undoubtedly resulted from the application.

Injury did not intensify, and the scale-breeding seemed to have been decidedly checked on September 13th. October 1st there was only a skimpy lot of foliage, and while there was considerable scale at some points, the bulk of the tree was practically clean. Attempted to spray October 24th, but the wind prevented that. On the 30th sprayed thoroughly with "Scalecide," one part to water twenty parts.

TREE 26—*Nectarine.* Just starting April 12th; first blossom out on the 27th; full bloom April 30th; out of bloom and in full leaf May 11th. A rather bad attack of leaf-curl began to develop at this time, accompanied by gummy exudations from some of the branches, so that by the end of May it looked rather ragged. During June conditions improved until about the last of the month, when a very heavy brood of young scales made its appearance and in early July demanded attention.

July 5th, sprayed thoroughly with "Anti-Scale," at the rate of one to thirty of water. Injury developed during the days next following and some of the foliage dropped. Many of the scales were killed, but the brood was so tremendous that some remained over and new larvæ were again numerous July 9th. Some of the remaining leaves were badly spotted and these spots formed holes as the season advanced, giving the tree a ragged appearance.

A small set of fruit was made, which developed very slowly, and not until about the first of October did it mature about a dozen indifferent fruits of irregular size.

August 19th, the second broom of larvæ was in evidence, and later the tree was always full of moving young and recent sets. The foliage was still in very fair shape October 24th, when most of the trees were sprayed, but high wind prevented application to this. October 30th, sprayed thoroughly with "Scalecide," one part to water twenty parts.

TREE 29—*Gravenstein Apple.* On March 6th, sprayed thoroughly with Kerosene-Napthol, one part to ten parts of water. The tree started early in April, leaf buds pointing out on the 12th, while the

first flowers opened on the 27th. Bloomed very full, but rather irregularly, some petals dropping May 7th, when some buds were not yet open.

A heavy set of fruit was made, and on May 19th sprayed with arsenate of lead, one pound in twenty gallons, repeating at the rate of one pound in fifteen gallons, on the 29th, until the foliage dripped. The fruit developed normally until, August 3d, the tree was almost breaking under its load. Left directions to thin, which were misunderstood, and almost half a barrel of unripe fruit was removed. On the 19th I had the balance taken off, almost a barrel being harvested. Though unripe when picked, the fruit matured very nicely in the cellar and was all used. But it is not a Gravenstein, and just what it is I could not determine. There was practically no codling moth and only a speckling of scale. So far as condition and appearance went the fruit was first-class, but it was undersized.

As to scale, the tree was not badly infested in 1904, and received no radical treatments; the March application of Kerosene-Napthol was scarcely to be credited with much effect, and yet very little scale was seen June 25th. Sprayed from one side with fish-oil soap, one pound in four gallons of water, and up to the middle of August very few larvæ or recent sets were noted.

August 19th, just before the fruit was removed, I noted that the upper portion of the tree was becoming speckled, and as leaf-hoppers were making themselves conspicuous, I sprayed with Rose-Nicotine, two ounces in one gallon of water, to note its effect. With that end in view I literally soaked the tree, drenching scale larvæ and leaf-hoppers equally. When all was dried off none of the insects were any the worse for their bath, and in the early evening sprayed with fish-oil soap, one pound in seven gallons of water. This seemed to be quite as harmless as the Nicotine, and I let matters go without further interference.

October 1st, the foliage was beginning to brown up, but all was yet fast and good. The trunk and main branches and most of the lower part of the tree were free from scale, but upward and outwardly there was more infestation. On the 24th the foliage was beginning to thin a little, and I sprayed with "Scalecide," one part to twenty parts of water, covering quite thoroughly.

Tree 30—*Grimes' Golden Pippin.* This tree was sprayed with "Kill-O-Scale," one to twenty of water, October 14th, 1904, and

drenched with Kerosene-Napthol, one to ten parts of water, March 6th, 1905. Did not start until April 12th, and was moving slowly on the 30th. Was in full but scant bloom May 7th, and made a small set on the 14th. May 19th, sprayed with arsenate of lead, one pound to twenty gallons of water, and repeated the application ten days later, at the rate of one pound to fifteen gallons.

The fruit developed normally and up to the middle of August there was practically no scale on the tree. On the 19th of that month a few fruits showed a trace of recent sets on the side nearest to 31, and there was the merest indication of codling moth.

August 26th, all the fruit was removed, and in view of the fact that this tree was at one time very badly infested, and has had applications of about everything that was ever used, from tobacco to crude petroleum, it will be interesting to note its condition, premising that owing to its premature removal it was undersized. In all there were 109 apples, of which ninety-one were absolutely clean and eighteen showed scales or scale marks. Of the infested specimens seven had one scale only, or a scale mark counted as a scale; six had two scales; three had a sprinkling of small scales, and two had three or more scales of the first brood. Besides this there were two fruits excluded from consideration because they had codling moth—the only wormy apples on the tree. Irrespective of scales, fifty-six of the apples were perfect, thirteen were slightly marred by outgrown curculio punctures, and the remainder were seconds, most of them getting their rank because of curculio marks and spots.

The balance of the season seemed to give added vigor and color to the tree, and on October 24th it was yet in perfect foliage, the leaves of a rich green color and the picture of vigor. Sprayed with "Scalecide," one to water twenty parts, as thoroughly as the mass of foliage would allow.

In view of the past history of this tree its present condition is remarkable and seems to indicate that so long as there is a sound stock and plenty of food the scale can be practically eliminated.

Tree 31—*German Prune.* Sprayed with Napthol-Sulphur, one part to water thirty-two parts. Made a start early in April, buds beginning to show green on the 12th, while flowers opened on the 30th. Was out of bloom and in full leaf May 11th, and made a good set of fruit. The curculio began to get in its work about the middle of June, and early in July fruit began to drop as the result of the attack.

More than half of it was gone at the beginning of August, and as soon as what remained began to show a tinge of color the rot set in. Eventually not a fruit ripened, the rot destroying each before it matured.

Scale larvæ were first noted June 25th, but the brood was not heavy and had ceased running July 16th, at which time some of the foliage had a scalded appearance, due to the spray that slopped over when treating tree 18. July 22d, applied fish-oil soap at the rate of one pound in six gallons of water, and this caused serious injury. Many of the leaves were burned at the edges and were browned, while others wilted, turned yellow and dropped.

Early in October much of the foliage was already off, while more of it was ready to drop at a touch. Some was yellow and discolored, but quite a bit looked green and firm. On the 24th, sprayed thoroughly with "Scalecide," one part in twenty parts of water.

Tree 32—*Mountain Rose Peach.* This was badly infested and sprayed with "Kill-O-Scale," one part to water twenty parts, October 14th, 1904. March 6th, 1905, sprayed with Napthol-Sulphur, one part to water thirty-two parts. The tree started normally in early April and developed as the season advanced. It had no bloom and made a satisfactory growth, all the foliage being still present in late October, when a good set of fruit buds had formed.

May 27th, sprayed with an atomizer, soluble petroleum (sample), one part to water thirty parts, to test the effect on foliage. A little burning and spotting developed during the week following; but not enough to be considered a real injury.

No live scales were found until July 9th, when a few recent sets were seen and these may have come on from the outside. As the season advanced the infestation increased slightly, and in October there was a scattering set throughout. On the 24th sprayed with "Scalecide," one part to water twenty parts, and covered well. On the 30th the application was duplicated with equal thoroughness.

Tree 33—*Dwarf Duchesse Pear.* Was sprayed with "Kill-O-Scale," one to twenty, October 14th, 1904, and with Napthol-Sulphur, one part to water thirty-two parts, March 6th, 1905. During the winter rabbits got at this tree and girdled one of the lower branches, which died in consequence. For some reason this tree is a favorite resting place for the few wild rabbits that come into the garden, and it is the only one that suffers from them.

Growth started early in April, and a few blossoms opened on the 27th. On the 30th was in full bloom and on May 11th was out of bloom, in full leaf, with indications of a moderate set of fruit. From one cause or another the set diminished until the crop consisted of ten pears, harvested late in September.

May 27th, sprayed one of the lower branches with a soluble petroleum (sample), one part in thirty parts of water, to test effect on foliage. Three days later not only foliage but even some of the sappy shoots showed so much injury that the material was discarded for summer use.

August 31st, sprayed with Kerosene-resin Emulsion No. 3, one to thirty parts of water, until the tree dripped from every leaf. No marked injury developed later, and up to late October the foliage maintained its hold. On the 24th of that month leaves began to drop readily and the tree was sprayed with "Scalecide," at the rate of one to twenty parts of water, covering thoroughly.

TREE 34—*Lawrence Pear.* Was sprayed with "Kill-O-Scale," one to twenty, October 14th, 1904, and with Napthol-Sulphur, one to water thirty-two parts, March 6th, 1905. Began to start slowly and irregularly in early April, but toward the end of that month stopped, began to wither, and early in May died off. Just what killed this tree is not clear; it was not scaly enough to endanger its life, and both "Kill-O-Scale" and Napthol-Sulphur were safely applied to so many trees that neither can be fairly charged with its death.

TREE 35—*Japanese Walnut.* Started early in April and bloomed heavily in May, toward the end of which month the spikes were entirely developed. Set quite a heavy crop of nuts, which disappeared mysteriously about the time I expected to gather them.

During midsummer the dry weather caused some of the leaves to turn yellow and brown before dropping, and this thinned out the foliage materially. The tree was not bare, however, until the beginning of November. On August 22d, sprayed with arsenate of lead, one pound in nine gallons of water, to test its effect on foliage. No harm was done, but the application probably wiped out a brood of *Datana* larvæ which developed during the early part of September.

The scale condition is as usual. There are always some half-grown specimens scattered about, but I have found no fully-developed females and no brood of moving larvæ. The appearance is as if the insects were carried to the tree, set, reached the half-grown condition, and then died.

This is now quite a large tree and dominates its surroundings. It is of no value as a nut producer, but it is rather a satisfactory sort of shade tree for the position that it occupies.

Trees 36 and 37 are out and no others were set into their places.

Tree 38—*Baldwin Apple.* Was treated October 14th, 1904, with "Kill-O-Scale," one to twenty of water, and on March 6th, 1905, sprayed with Kerosene-Napthol, one part to ten of water, until fully drenched.

Started early in April, and by the end of the month was leafing out nicely and blossom buds were pink and ready to open. Some did open May 1st, and on the 7th was in full bloom, a mass of pinky-white, which had practically disappeared by the 14th, when a heavy set of fruit was indicated.

May 19th, sprayed with arsenate of lead, one pound to twenty gallons of water, and on the 29th renewed the application at the rate of one pound in fifteen gallons.

The tree developed normally until the end of June, when it was heavily loaded with fruit and no scale could be observed, but during the early part of July a little spotting of the fruit on the extreme top of the tree called attention to the fact that my compressed air sprayer, used in October, 1904, did not quite reach the top of this tree and that a center of infection existed at that point.

August 19th, had half a barrel of apples taken from the tree and that still left too many. In the lower portion most of the fruits are clean, but toward the top the tips show some of the apples to be quite scaly or becoming so from the second brood of larvæ. Some of the apples look very handsome and there is very little "wormy" fruit. In the evening, sprayed with fish-oil soap, one pound in seven gallons of water, aiming especially at those high points that had been missed by the late fall spray and where scale development was most marked. No harm was done to the tree, and it was not possible to determine that any had been done to the scales.

August 26th, all the fruit was taken off, unripe to be sure, but enough to make, with the lot of August 19th, a little less than one and one-half barrels. Although undersized and not colored, the fruit as a whole was fair, and such as was wormy was mostly entered from points other than the calyx.

The general condition of the tree remained satisfactory during the balance of the season, the foliage adhering until early in November.

At that time sprayed with "Scalecide," one part in water twenty parts.

This is another of those trees that was at one time so scaly that it seemed as if it must succumb, and I had actually directed my boy to cut it out. For some reason the direction was not at once obeyed, and I afterward decided to kill it first by experiments and have it removed afterward.

TREE 39—*Trellised Apple.* This did so little in 1904 that it was taken out, and the space was not filled during the season of 1905.

TREE 40—*Lincoln Coreless Pear.* Started early in April, and for the first time blossom clusters developed, some flowers opening on the 26th, while on the 30th was in full bloom—a mass of white. A heavy set of fruit was made, in which the pear midge appeared May 26th, materially reducing it. Only a little remained in June, and this developed irregularly until, in late September, about a dozen pears ripened, two of them of good size and typical form. On cutting they proved to be anything but coreless, and on tasting they proved to be the very worst I ever sampled:—therefore the tree was ordered out and was removed in October.

This tree has had an interesting history, the scale having been allowed to develop unchecked since it was set out. It was noted at once that for some reason the insects did not increase in numbers on it, and in the hope that an exempt variety might be developed, the tree was watched and kept free from all applications tending to decrease scale. As a matter of fact infestation never became very bad at any time, yet the tree undoubtedly suffered. The bark roughened, some of it scaled off, and in some places it split. The outer surface became hard and during the last year the foliage and growth were not up to the standard. This was especially true during the summer just passed, when many leaves turned yellow and dropped, while some small branches died. Whether this is all to be attributed to the scale may be a question; but at any rate the tree had served its purpose, and as the fruit was good for nothing it was removed.

TREE 41—Died in 1904 and was not replaced.

TREE 42—*Elberta Peach.* Sprayed with "Kill-O-Scale," one to water twenty parts, October 20th, 1904, and with Napthol-Sulphur at the rate of one part to water thirty-two parts, March 6th, 1905.

Started early in April, some blossoms opening on the 23d. while on the 30th it was in full bloom. Was out of bloom and in full leaf

May 11th, and continued to do well as the season advanced. A good set was made, but, as was anticipated, most of it dropped, and only six very fine fruits came to maturity in September:—all the little tree could be reasonably expected to do. Continued in full vigor throughout October, making fruit buds and holding its foliage in perfect condition. It is a little doubtful whether the tree should be allowed to remain, because it is so badly injured at base that, when it becomes heavier, it is almost certain to break off during a high wind.

June 11th, sprayed three shoots with Tak-a-nap soap, one pound in four gallons of water, to test its effect on the foliage. No injury developed.

August 22d, sprayed with arsenate of lead, one pound in nine gallons of water, to test effect on foliage and purity of insecticide. No injury developed.

As to scale, no living examples were seen until July, and only a mere trace developed during the season. As late as October 1st the tree was almost clean and received its dose of "Scalecide" October 24th, less because it was necessary than because I was spraying everything that supported the insect. On the 30th the application was duplicated with equal thoroughness, and on November 4th the leaves were all off, the tree in good condition and with plenty of fruit buds.

Tree 43—*Early Richmond Cherry.* Started early in April, buds being almost ready to open on the 12th, a few blossoms open on the 23d and everything out on the 27th. May 11th, was out of bloom, in full leaf, and had made a small set of fruit. The latter developed in due time and was mostly taken by robins.

May 25th, plant lice became apparent on the tips, and I applied soluble petroleum, one part to water thirty parts, causing no injury and wiping out most of the insects. June 11th, another lot of Aphids became obvious, more generally distributed than the earlier series, and the lower branches were sprayed with Tak-a-nap soap, one pound in four gallons of water. No injury was caused to the foliage and very little to the plant lice, which disappeared late in June.

The foliage is always thin on this tree and many of the leaves turned yellow and dropped in midsummer. Growth stopped early in July, and after an attack of slugs it looked ragged and worn. October 24th the tree was nearly bare. A few scales occurred during the summer, evidently brought on; but none of them developed and none was seen at the October examination.

TREE 44—*Elberta Peach.* Was sprayed October 19th, 1904, with "Kill-O-Scale," one to twenty, and on March 4th, 1905, with Napthol-Sulphur, one part in water thirty-two parts. This is one of the dehorned trees and was in good, vigorous condition. The tree started early, and on April 12th was a mass of swollen blossom buds, with leaf buds beginning to point out. Not until April 23d did any of the flowers open, but on the 27th the tree was in full bloom.

A very full set of fruit was apparent May 26th, and this grew well for a time until the hot, dry weather put a stop to growth and even affected the foliage so that some yellowed and dropped. After the drought broke in August, the fruit jumped and increased 100 per cent. in ten days. August 26th, about three baskets of fruit were taken off, unfit for use, because too unripe. At that time more rot than I cared to see had made its appearance and quite a percentage of the picked fruit developed the disease in a few days, before it was finally disposed of.

Up to August 19th no living scales were seen:—at that date a few full-grown examples were found, but there had been no breeding on the tree. October 1st, there was still very little scale; the foliage was beginning to turn yellow; fruit buds were making, and the tree as a whole was in fine, flourishing condition. October 24th, some foliage was off, and the rest was ready to drop: sprayed with "Scalecide," one part to twenty parts of water and covered fairly well. October 30th, sprayed again and more thoroughly, with "Scalecide," as before, and November 4th the foliage was all off.

TREE 45 is out.

TREE 46—*Japanese Chestnut.* This is the tree that has been previously recorded under No. 22. It was moved because the place in which it stood was becoming unsuitable by reason of too much shade.

Not until April 30th did the leaf buds begin to open, and matters moved along slowly until May 26th, when the tree was in full foliage and making rather weak strings of blossom buds. A check developed early in June and movement ceased. Evidently the tree started out on its reserve stock and developed until it became necessary to call upon the roots for growing material. These failed to respond properly, and the result was a standstill. Toward the end of June matters looked doubtful, but as the days advanced matters became no worse until the middle of August, when it looked decidedly sick. This was caused in part by plant lice and in part by yellow mites, which be-

came abundant on the under sides of the leaves. I feared to use insecticides, lest I turn the scale unfavorably, and up to October 24th the foliage still hung on, although thin, yellow and sickly. As there appeared now, also, some apparent shrinkage in the youngest shoots, a winter kill is not improbable.

TREE 47—*Greensboro Peach.* Sprayed with "Kill-O-Scale," one part to water twenty parts, October 15th, 1904, and with Napthol-Sulphur, one part to thirty-two parts, March 6th, 1905.

An early start was made, and on April 12th the tree was a mass of flower buds, with leaf buds just showing. No flowers opened until the 26th, but on the 30th everything was open:—a mass of showy blossoms. A heavy set appeared and this hung on until late in June, when a little dropped:—not nearly enough. Matters moved slowly early in July owing to the drought, and the fruits did not begin to ripen until the 20th. From that date until August 5th some were picked each day, good as to size, color and quality.

Throughout the season the foliage was good, and it was still intact October 24th, when fruit buds were making in good shape. August 22d, sprayed with arsenate of lead at the rate of one pound in nine gallons of water, to test effect on the foliage:—no injury developed. October 24th, sprayed with "Scalecide," one part to twenty parts of water, from the south side only.

As to scale, no living examples were seen until August 19th, when a few females, nearly adult, were found. A little increase was noted September 13th, and on October 1st there was a mere scattering in most parts of the tree. October 30th, duplicated the spray, but applied thoroughly from all sides.

TREE 48—*Black Tartarian Cherry.* Made a start early in April, but developed slowly and blossoms did not begin to open until the 21st. Was in full bloom on the 24th; petals began to fall on the 27th, and all were gone on May 7th, when the tree was in full foliage and a good set of fruit was indicated. This fruit developed normally, and when it began to color, June 2d, became a mark for the robins. By the 25th all fruit was gone, mostly to the robins, a little to the children.

Plant lice became obvious May 26th, when a number of the terminal shoots were affected. Sprayed a few of these tips with soluble petroleum, one part to thirty parts of water, getting the spray into the curled mass. Next day the insects had been killed off without ap-

parent injury to the foliage, and I sprayed others of the infested tips without making special effort to get into the curled mass—that is, I sprayed as an ordinary application would be made. On the 30th no harm had been done to the leaves, but on the other hand not much good, because the majority of the insects were protected from the spray by the curled foliage. During the early days of July the plant lice disappeared, but the unsightly tips remained, even after new growth had started above them.

August 22d, sprayed with arsenate of lead, one pound to water nine gallons, to test effect on foliage, no injury being caused.

No scale was found on the tree at any time during the season, and on October 24th it was still in full foliage.

# REPORT OF THE MOSQUITO INVESTIGATION IN 1905.

# REPORT OF THE MOSQUITO INVESTIGATION IN 1905.

BY JOHN B. SMITH, SC.D.

Chapter 80 of the laws of 1905 provided for a continuation of the mosquito work carried on for nearly three years, pursuant to chapter 98 of the laws of 1902, but on a somewhat different plan. The report prepared in 1904 and distributed during the early days of 1905 showed clearly enough which were the dangerous and troublesome species that it was necessary to deal with, and the methods of dealing with them were also determined. The new law, therefore, was intended to assist in the practical application of what had been learned, and an appropriation of $10,000 was made, $4,000 to become available in the fiscal year ending October 31st, 1905, and $6,000 to become available during the fiscal year ending October 31st, 1906.

This was to be used in aiding such shore communities as had the salt marsh species to deal with, not more than 25 per cent. of the amount to be paid by the State and not over $500 to go to any one municipality. The appropriation was made to the Agricultural Experiment Station, and the Director was authorized to appoint an executive officer to make such investigations and such reports as were necessary. The sum of $6,000, of which $2,500 was available in the fiscal year ending October 31st, 1906, was appropriated for the expenses of administration.

Organization was begun by the appointment of the writer as executive officer, to make the investigations and reports required by the law, and to act for the Director in all cases where the law allowed such action.

As field assistants and general investigators, Mr. H. H. Brehme, of Newark, and Mr. John A. Grossbeck, of Paterson, were appointed, and Mr. Wm. P. Seal, of Delair, was especially engaged during part

of the season in carrying on experiments looking to the introduction of the top-minnow, (*Gambusia affinis*), into the waters of New Jersey. Later in the summer Mr. Grossbeck was detailed to take charge of the office experiments in breeding and to assist in preparing the material for the necessary reports.

The character of the season was peculiar and, to a large extent, determined the nature of the work. The early spring was very dry all along shore, and there were no very high or storm tides; hence the marshes dried out rapidly; the first brood of the migrating forms was very small, and the usual second brood was reduced to a minimum. Except in a few bad places, breeding was almost at a standstill, until in late August and early September the drought was broken, the marshes became water-soaked by storm tides and frequent rains formed pools that bred out enormous numbers and flooded places that had been practically exempt earlier in the year.

In the woodland pools and large swamp areas the dry winter and spring produced a condition so unfavorable to mosquito development that not until after September did any considerable breeding take place—in fact, not even then was there anything like a normal output.

Real droughty conditions did not exist equally in all parts of the State; but after the drying out in spring the rains were never sufficiently heavy or frequent to soak the ground enough to permit the formation of pools.

The practical exemption of the shore resorts between June and late August lessened interest in the mosquito problem, and little work was done where it was most needed. Furthermore, the State law was not passed until the estimates and appropriations of the various municipalities had been made up and voted upon, so that few found themselves in a position to take advantage of the aid that was offered. The net result of the combination was that only one municipality—Elizabeth—took advantage of the State aid proposition, and only $500 was used out of the appropriation of $4,000, leaving $3,500 to be turned back into the State Treasury.

The city of Newark had expended $5,000 during the year 1904, and the board of health in that city was desirous of preventing mosquito development within the city limits, if possible, so application was made to the office for such inspections and information as might be necessary to attain that result. Mr. Brehme, was therefore

detailed to make a careful inspection of city conditions, and a copy of his report detailing breeding places located was supplied to the board. Almost or quite all of the places were abated before the end of the season.

The Essex County Park Commission was interested in the work, and, after a preliminary inspection by Mr. Brehme, the writer went over the ground with the secretary of the commission, Mr. Alonzo Church, and advised as to the line of action to be pursued. It is to the credit of the commission that every suggestion made was carefully carried out, and with the result that practically no mosquitoes were bred anywhere within the park system—which is not saying that no mosquitoes were to be found in the parks at times.

On the marshes the work done in 1904 approved itself in every particular. A very little additional ditching was found necessary; but every ditch that had not been interfered with worked perfectly, and altogether the whole marsh area except the so-called Ebeling tract was in excellent condition and not a mosquito developed on it. During the summer the board of health maintained a special inspector on the meadows, whose business it was to see that the ditches were not interfered with, and it is due to his efforts that, even on the Ebling tract, no larvæ developed until after September 1st.

Early in the season conditions on the meadow were so good that invitations were issued by the Conference Committee on Mosquitoes for a meeting to be held on the meadow during the first days of June, and a large attendance was secured, including the secretary of the State Board of Health and representatives of many neighboring localities. At that date the Elizabeth meadows had just liberated its first brood, which had extended into the city; but on the Newark meadows not a larva or pupa was to be found and only an occasional adult—a migrant from the southern territory.

Newark, at present may be considered as almost free from mosquito-breeding territory, and were the city dependent only on the local production the insect would be so rare as to be practically unnoticed. The only bad area that remains—the Ebeling tract—is to be dealt with in the near future. It is within bounds to say that not over one per cent. of all the mosquitoes found in Newark during the season of 1905 were bred within its limits.

Incidentally the elimination of Newark as a marsh breeder made it possible to make some interesting observations on the migrations of

the species, and the entrance into the city from the south of the Elizabeth brood was interestingly traced. Furthermore, the fact that Staten Island was a factor in the New Jersey problem was conclusively demonstrated by some investigations made by Mr. Brehme. Collections sent in from the Elizabeth marshes early in the season showed only *Culex cantator,* and that was also the record from the Linden and Rahway meadows. But on Staten Island *Culex sollicitans* was found to be the dominant species, and it seems certain that practically all the *sollicitans* found in early June in the Newark district of New Jersey were migrants from Staten Island. At the same time it was determined that the mosquitoes bred on the Linden and Rahway marshes followed up the valley of the Rahway and crossed the mountain range at the gap near Milburn; Morristown, Madison and the surrounding country being supplied with their mosquito troubles in great part from Linden and Rahway.

The Oranges and the immediately surrounding territory receive specimens from Elizabeth and Staten Island; quite a number of *sollicitans* coming from South Orange at a time when there were none bred in New Jersey so far as I or my agents could find.

Elizabeth, the first of all the municipalities to do satisfactory marsh work, appropriated $2,000 for the further drainage of the marsh lands within its border and received $500 of the State funds in addition. This sum was devoted to ditching work east of the Central Railroad of New Jersey, between Bound Creek and Elizabethport, under the direction of Mr. Louis J. Richards, health officer of the city, who used the True ditching machine to good advantage. Mr. Brehme made a preliminary survey of the marshes, locating the danger spots, and during the summer he made frequent, and I occasional, visits to the marshes. The conditions on these marshes are complicated by the dam carrying the New Jersey Central Railroad, which cuts the natural drainage and backs up the surface water without outlet, turning a once sound, clean meadow into a quagmire and a veritable mosquito mill.

Negotiations are in progress which will, it is hoped, result in a contribution of work or money from the railroad company to aid in restoring a satisfactory drainage scheme and in improving those natural outlets which the railroad work impaired. It is also expected that the city will make a further appropriation which, with what may be contributed from the State fund, will suffice to clean the Elizabeth

marshes before the breeding season of 1906 opens. The old work done at the mouth of the Elizabeth river has stood the test of time during the summer of 1905. It will probably require the entire season of 1906 and the expenditure of between $4,000 and $5,000 more to make Elizabeth mosquito-proof.

The marsh areas at Linden and Rahway were carefully surveyed, and it was estimated that about $5,000 would be required to clean out that territory, the bulk of the amount being needed at Linden. Efforts were made to reach the persons interested in the government and property of these municipalities; but absolutely without effect. No one seemed to care enough about the towns to consider the mosquitoes as a detriment. Yet the Linden meadows especially, are a menace to the territory lying to the north, northeast, west and northwest. It is from these marshes that the bulk of the supply gets up the valley of the Rahway and through the gap at Milburn into the Madison and Morristown regions. Their influence is therefore widespread, and so long as conditions remain as they are now, the localities just mentioned will be subject to periodical irruptions.

It may be of interest to note, in this connection that the conditions near Madison and Morristown were specifically investigated by Mr. Grossbeck, and that alone, or with Mr. Brehme, he visited the Great Piece meadows, finding them, this year, almost free from bad mosquito-breeding areas.

Irvington, Arlington and Kearny were all carefully surveyed at the request of the local boards of health, and on the whole these towns are in good condition except for that stretch of meadow belonging to Kearny, which lies south of the Pennsylvania railroad and at the junction of the Hackensack and Passaic. This corner is now in process of improvement by filling, and in another year will probably be eliminated as a mosquito breeder. During the season of 1905 an early brood of considerable extent and one very large late brood were developed, the specimens finding their way chiefly to nearby Jersey City and up the valleys of both the Hackensack and the Passaic. The marsh species were traced north into the mountains near Paterson by Mr. Grossbeck, and most of the specimens in the lowlands in both valleys were supplied from this source.

Jersey City has an easy problem to deal with, and a careful survey of the marsh land area showed that for $2,500 all the infested territory could be made safe. The local board of health was inter-

ested and took up the matter vigorously, exerting all its power to secure the necessary appropriation from common council—unfortunately without success up to the date of writing. There are no engineering difficulties whatever in the Jersey City territory, and it is a great pity that this municipality could not be induced to lend the force of its example to the surrounding, smaller places, which have small marsh areas, requiring only a few hundreds of dollars to clear.

The common belief that the low, swampy area along the Hackensack is a great mosquito-breeding place is so firmly fixed and so frequently stated that both Mr. Grossbeck and Mr. Brehme were sent in at various times and at various points during the season; returning always with the report that while mosquitoes were plentiful enough in the vegetation they were almost exclusively salt marsh forms and none was bred locally. That the Hackensack meadows abound in mosquitoes is therefore without doubt; but that they breed where they occur is not true. It is the belief that the mosquito-breeding area is practically co-extensive with the lowland swamp area, which makes most men of affairs consider the problem so great and hopeless that they simply decline to consider it at all.

I have had little difficulty in convincing members of boards of health, and especially the medical members, and a great deal has been accomplished locally under the Duffield amendment; but when the matter of securing appropriations had been brought up, the holders of the municipal purse strings refused to consider the matter seriously, or claimed that the whole thing was a State affair. Many hours of many days were spent by me in calling upon those in authority and urging action.

It has been mentioned that at times part of the New Jersey mosquito supply came from Staten Island, N. Y., and it was objected that, even if the New Jersey communities did their share, they would nevertheless be subject to attack from their political and geographical neighbor. This matter was discussed by the Conference Committee on Mosquitoes at Newark, and a committee was appointed to meet with Dr. Darlington, of the New York Board of Health, in an effort to secure the co-operation of that body to clear out at least the western shore of Staten Island. Dr. Darlington proved receptive and the matter was finally referred to Dr. Alvah H. Doty, State quarantine officer, and one of the members of the city board. After some correspondence with Dr. Doty and a trip along the shores in company with the

borough president and some residents of Staten Island, I detailed Mr. Brehme to cover the marsh area and estimate the amount needed to drain the dangerous portions. His report showed that $17,000 might be required, but would be sufficient, and an application to the New York Board of Estimate and Apportionment resulted in the appropriation of that amount. A contract was finally let for the drainage of all the mosquito-breeding marsh area on Staten Island within the amount estimated, and that work is now under way. It will be carefully watched by the office; but there is every reason to believe that before the opening of the season of 1906 Staten Island will be practically mosquito free, and will, at all events, have disappeared as a menace to New Jersey. It is believed that the work done and time spent on Staten Island resulted in a direct benefit to New Jersey.

Sheepshead Bay, L. I., and its vicinity have long suffered from mosquito attack and, partly to reclaim the salt marsh and partly to fill the breeding areas, elaborate plans of using ashes and dry refuse as collected in the city were made. Mr. Brehme and myself, alone and in company, made several visits to these dumping grounds and secured a good series of photographs showing the manner of doing the work. It is believed that in some localities similar methods may be employed and even more effectively than on Long Island. Simply to obtain information as to conditions in comparison with New Jersey, several trips were made during the summer to Astoria, Greenpoint, College Point, Flushing, etc., and some of the main sources of the Brooklyn mosquito supply were located. Most of this work was done by the writer, personally, as opportunity served during the season.

Much of the time of the office, as it thus appears, was devoted to the region containing the largest number of inhabitants and where, in the past the mosquito pest has been most seriously felt. While it has not been possible to accomplish as much as was hoped, nevertheless conditions have been materially improved, and matters will continue to become more satisfactory each year, as the feasibility of mosquito control becomes apparent.

At the request of the Board of Health of New Brunswick, formally made to the Director, the source of the mosquitoes troubling that city was located and proved to be almost entirely out of the city limits, and along the banks of the lower Raritan valley—the Amboy district. A formal report was made to the board, and copies were sent to the proper officers of the municipalities where the breeding area was sit-

uated. Unfortunately, as it turned out, several townships are involved, some disinclined to take action, others in no financial position to do so. At all events it proved impossible to get any concerted action, and there seems to be no immediate prospect of securing any.

Early in the season and at several other times during the summer Mr. Brehme went over the Shrewsbury river area and found that the work done in 1904 approved itself thoroughly, that the marshes were in excellent condition and that no mosquito breeding occurred. There is no doubt of the effectiveness of the method. Owing to the fact that the action of the tides and swells caused by passing steamers had a tendency to block the outlet ditches with sand and seaweed, it became necessary to maintain a man on each side of the river to keep the drainage system open. The work was also extended to include most or all of the area left undrained in 1904, so that this Shrewsbury area may now be said to be free from danger of mosquito-breeding. The effect of the work was noted this year for many miles around, and conditions in the entire region may be said to be greatly improved.

An effort was made to secure action by the city of Long Branch on the small marsh area within its jurisdiction; but because of some local difficulty nothing was done. The work required here is so slight that it seems a pity to allow a breeding place capable of supplying annoyance to the entire city to stand. It is a matter of less than $500 all told, and would free the balance of the marsh area between the highlands and the main shore at Long Branch.

At the request of some of the residents of Bay Head that territory was examined and reported upon by Mr. Brehme; but no action was taken upon the report. It seems probable that practical work will be taken up in this region during the season of 1906.

In response to questions from owners of pine lands which it was desired to develop, I made some investigation into the conditions existing in the Brown's Mills and Lakewood districts; finding, as I expected, that nothing that could be done locally would be of avail. The whole pine region is under the domination of the salt marsh mosquitoes. Several communities in the same territory who would have been willing to do local work were also advised that under existing conditions they were helpless.

On Absecon island conditions have been greatly improved, and within the limits of Atlantic City breeding places exist only in the northeastern section. In Ventnor most of the bad places have been

improved; but in South Atlantic there are yet enough breeding places to make it interesting. It is only a matter of a very few years before, in the normal course of improvements, all breeding places will be eliminated: it need be a matter of only one season with well-directed work.

At Ocean City much interest was manifested early in the season, and an organization to improve conditions was perfected. At the request of this organization careful surveys were made in the city limits and in this immediate neighborhood, and estimates were made of the amount of money that would be required to do the work. Unfortunately it proved here, as at other points, that there was no money available for work of this character, and the local government was simply unable to make an appropriation, because no item in the budget as passed could be drawn upon. Had the insects been as numerous as usual, it is possible that private interests might have contributed; but so long as there was no lack of custom because of mosquitoes there was no disposition to provide for a possible future infestation. The surveys and estimates have been made, however, and are available for any future work.

At Cape May the board of health and some of the persons interested in New Cape May made an effort to secure the amount necessary to improve conditions. In my report on the original investigation I showed that no place on the New Jersey shore could be more cheaply and completely rid of the mosquito pest than this point, and the board of health as a whole was in accord with the effort. As a preliminary, I sent Mr. Henry L. Viereck over the territory again, to secure definite figures of cost, and then presented the subject at a meeting of the common council. The desirability of doing the work was admitted, but again there was no fund available from which an appropriation could be made. Within the limits of Cape May City the board of health has done much to remove or abolish breeding places, and toward Sewell's Point the dredge filling by the Cape May Real Estate Company has done away with all chances of mosquito development. Unfortunately South Cape May, which has the greatest breeding area, has also the smallest population and taxable property, so, unless some combination can be effected it will be difficult to get the necessary money, even though the entire amount needed does not exceed $2,000.

Many inland communities have asked and received suggestions and advice as to the best method of dealing with local problems, and the

writer has been always at the service of individuals or bodies that desired to do practical work.

It is fair, perhaps, to refer here to the fact that, while in New Jersey the progress has not been in all respects so great as was hoped, other states have been influenced by her example, and the work done here has borne fruit elsewhere. The nearest point is New York, where the Staten Island work is of direct importance to us; but New Jersey methods have been adopted on the Pacific coast as well, some of the most desirable suburbs of San Francisco having been redeemed from the domination of a mosquito very similar in appearance and habits to one of our eastern marsh species.

All the conclusions reached in the report of 1904 have been confirmed by those that have investigated the subject, and in most of the Southern States active campaigns are now in progress or in contemplation.

There is practically no expressed doubt among medical men of the importance of mosquitoes in the transmission of disease, and the recent fight against yellow fever in New Orleans was conducted exclusively on the basis of such agency. So the exercise of the quarantine regulations at the port of New York is laid upon the same foundation. While not all mosquitoes are known to be direct transmitters of disease, there are none that are desirable or in any way useful, and there is absolutely no reason why, in New Jersey, we should continue to suffer from them, except the feeling that it will cost too much.

To answer this point, Mr. Brehme, whose experience in marsh work fits him most excellently for that purpose, was instructed to make a complete superficial survey of the salt marsh area from Jersey City to Cape May, and from the Cape along the bay shore and Delaware river, estimating the cost of drainage or filling at all points.

Lest it should seem as if such an estimate were mere guess work, it should be noted that for the thirty miles of marsh area on Staten Island, Mr. Brehme's estimate was slightly over what a responsible contractor agreed to do it for, and that his estimates on the Newark and Elizabeth marshes were always well within the limit for which good work was accomplished. I have little doubt that the amounts here given will be sufficient in most cases, and if in any case local conditions cause an increase, it would be balanced by the liberal estimates on the general work. It should also be noted that there is

not one grand estimate for the whole work; that might be readily considered a guess; but an estimate for section after section, which can be easily verified by any one familiar with such work.

In detail the estimates—some of them from earlier surveys—are as follows:

| | |
|---|---|
| The Jersey City marshes | $2,500 00 |
| The Bayonne meadow | 500 00 |
| The meadow bounded by Elizabeth on the north, Carteret on the south, Arthur Kill on the east, Linden township on the west; soil good for hand-ditching | 4,500 00 |
| The Elizabeth marshes are omitted as under process of cleaning, and the Kearny triangle is also treated as of no further importance. | |
| The meadow bounded by Carteret on the north, Perth Amboy on the south, Arthur Kill on the east and Woodbridge on the west; including Port Reading, Sewaren, Maurer, North Perth Amboy and Woodbridge to Port Reading R. R. | 4,500 00 |
| The soil is good east of the N. Y. & L. B. R. R., but on the west contains more clay: it will all have to be hand-ditched. | |
| The Raritan flats, extending on both sides of the river, from its mouth to the end of the salt marsh | 5,000 00 |
| The meadow bounded on the north by South Amboy, on the west by N. Y. & L. B. R. R., on the south by Morgan Station and on the east by Raritan bay, can be drained for | 50 00 |
| The area bounded by Morgan Station on the north, Lawrence Harbor on the south, Raritan bay on the east and Jacksonville on the west, will cost | 2,500 00 |
| The soil on this meadow is good and there are good creeks to drain into. | |
| The marsh bounded by Lawrence Harbor on the north, Cliffwood on the south, Raritan bay on the east, N. Y. & L. B. R. R. on the west. | 1,000 00 |
| Soil good for hand-ditching. | |
| The stretch bounded by Matawan on the west, Keyport on the east and Raritan bay on the north, can be ditched by hand and a perfect result obtained for | 1,500 00 |
| The meadow bounded by East Keyport on the west, the power-house of the Central Trolley Company on the east, Raritan bay on the north and Hazlet on the south, will cost not over | 800 00 |
| Soil and general conditions good. | |
| The territory between the Central Jersey Trolley Company's power-house on the west, Lorillard on the east and Raritan bay on the north—soil mixed with clay—will cost | 700 00 |
| The area bounded by Lorillard on the west, Keansburg on the east and Raritan bay on the north | 600 00 |
| The meadow bounded by Keansburg on the west, Port Monmouth on the east and Raritan bay on the north; soil good for hand-work, | 800 00 |
| The marsh bounded by Port Monmouth on the west, Belford on the east and Raritan bay on the north, will cost | 500 00 |

The area bounded by Belford on the west, Atlantic Highlands on the east, Raritan bay on the north..... $800 00

The soil near Belford is good for draining; near Atlantic Highlands is gravel and will require filling.

The area bounded by Water Witch on the north, Highlands of Navesink on the south, Raritan bay on the east, Central R. R. on the west; good ditching..... 200 00

The Sandy Hook Reservation is omitted from consideration: it belongs to the United States Government, the commandants in charge have been notified of the location of the breeding areas, and the whole territory can be cleaned without much expense by Post labor.

Most of the Shrewsbury area has been cleaned by private subscription, but a little work is yet needed.

The meadow bounded by Pleasure bay on the east, Little Silver creek on the west, the Shrewsbury river on the north and Eatontown on the south—good ditching; not above..... 700 00

The meadow between Pleasure Bay bridge on the north, Long Branch on the south, North Long Branch on the east and Pleasure bay on the west; good drainage..... 100 00

At this point the mainland reaches the shore and for several miles there is almost no salt marsh except in the Shark river section, and that is not a dangerous breeder. Such places as occur between Bradley Beach and Belmar can be cleaned up for about..... 200 00

Salt marsh begins again near Sea Girt, and the territory from that point south to Point Pleasant and between the ocean and the N. Y. & L. B. R. R., will cost..... 1,000 00

Some places can be ditched, but others must be filled: it includes Manasquan and Brielle.

The meadow bounded by Point Pleasant on the north, Metedeconk river on the south, Atlantic ocean on the east, including Bay Head; ditching in some parts, but mostly sand-filling, will cost.. 500 00

The area between Barnegat bay and the ocean, from Bay Head to Mantoloking, is partly marsh and partly depressions; a little draining is possible, but most is grading and filling, for which plenty of material is at hand..... 1,000 00

The marsh and depressions between Barnegat bay and the ocean, from Mantoloking to Chadwicks: mostly grading and filling.. 1,500 00

The stretch between Chadwicks and Lavallette, and ocean and bay, marsh and depressed area, mostly sand that will not stand ditching..... 500 00

Between Lavallette and Berkeley, ocean and bay, territory as before, and mostly to be filled, not over..... 2,000 00

Between Berkeley and Life-saving Station No. 14, ocean and bay, including Seaside Park; more filling than ditching..... 1,500 00

On the main shore, beginning at the head of the bay, from the Metedeconk river on the north to Kettle creek on the south, and from the bay to Metedeconk neck, the soil is good for ditching and little filling is needed; the cost will be..... 4,500 00

From Kettle creek on the north to Mosquito cove on the south, and from the bay west to Silverton, the meadow is susceptible to ditch drainage and little filling is needed; the cost will be..... 2,000 00

| | |
|---|---|
| From Mosquito cove on the north to Toms river on the south, and from the bay to Island Heights, ditching is possible and will cost | $8,000 00 |
| The marsh area bounded by Toms river on the north, Cedar creek on the south, Bayville on the west and Barnegat bay on the east; soil good for hand or machine ditching | 8,000 00 |
| The marsh area bounded by Cedar creek on the north, Forked River (town) on the south, Forked river on the west and Barnegat bay on the east; soil good for hand or machine ditching; cost to drain | 8,500 00 |
| The meadow from Forked River on the north to Waretown on the south, along the bay shore; soil good for hand or machine ditching | 5,000 00 |
| The meadow from Waretown on the north to Barnegat on the south, along Barnegat bay; soil good for hand or machine ditching | 6,000 00 |
| The point or spit of land from Life-saving Station No. 14 to Barnegat inlet, between ocean and bay; mostly grading and filling | 4,000 00 |
| The meadow on main shore between Barnegat on the north, the Penna. R. R. bridge on the south, Manahawkin on the west and the bay on the east; soil excellent for ditching; cost, including all the islands | 18,000 00 |
| The meadow and depressions on Long beach, between ocean and bay, from the point at the inlet, south to Life-saving Station No. 20; mostly sand filling | 4,500 00 |
| The stretch on the mainland between Manakawkin on the north, West creek on the south and Little Egg Harbor bay on the east; the soil good for either hand or machine ditching | 10,000 00 |
| The area bounded by West creek on the north, Tuckerton creek on the south and Little Egg Harbor bay on the east; soil is all right in every respect for hand and machine ditching | 8,000 00 |
| The meadow bounded by Tuckerton creek on the north, Bass river on the south, Great bay on the east; one of the worst stretches in the State, but with ground good for either hand or machine ditching | 16,000 00 |
| The Bass river marsh, beginning at the mouth and extending to the highland | 2,000 00 |
| Between ocean and bay, from Life-saving Station No. 20 to New inlet, including what is yet to be done at Beach Haven; mostly filling | 6,000 00 |
| On the mainland along the Mullica river, bounded by Bass river on the east and Lower Bank on the west, including both shores: soil is good, several ditches have just been cut by the hay men, and the soil seems to be just the very best for both hand and machine ditching | 10,000 00 |
| The meadow bounded by Nacote creek on the north, Somers' cove on the west, Great bay on the east and Little bay on the south; good ditching | 15,000 00 |
| Island beach, marsh and depressed areas; mostly sand; must be leveled; little ditching possible | 1,000 00 |
| The islands between Great bay on the north, Brigantine channel on the south, Island beach on the east and Little bay on the west, | 2,000 00 |
| The meadow bounded by Somers' cove on the north, Absecon on the south, Red and Absecon bays on the east; soil good for ditching | 4,000 00 |

The meadow bounded by Absecon on the west, Great Thorofare on the east and the Pennsylvania railroad on the south..... $1,000 00

This place is not bad and it is perhaps a question whether mosquitoes breed here at all, except under unusual conditions, but the sum above mentioned will remove all possible danger spots.

The territory bounded by Pleasantville on the north, Somers' Point on the south, Risley's channel on the east and great Egg Harbor bay on the southeast; soil good for ditching..... 12,000 00

The meadow bounded by Somers' Point on the south, May's Landing on the north and Great Egg Harbor river on the west; part ditching, part filling ..... 5,000 00

The area bounded by Tuckahoe creek on the south, May's Landing on the north and Great Egg Harbor river on the east; ditching, filling ..... 10,000 00

Brigantine beach, meadow and depressions, mostly filling, for which there is plenty of material at hand; should not under any circumstances cost more than..... 3,000 00

Absecon island, from the inlet at Atlantic City to the inlet at Longport, west to Lakes bay; soil good in some places, filling necessary in others..... 6,000 00

Ocean City, from the inlet to Fifty-seventh street, meadow and low depressions; mostly filling..... 2,500 00

The meadow bounded by Beasley's Point on the east, Tuckahoe creek on the north, Petersburg on the south, Tuckahoe on the west; soil good for ditching..... 6,000 00

Peck's beach, from Fifty-seventh street to Corson's inlet; meadow bounded by Beasley's Point on the north and Ocean View on south; mostly filling..... 8,000 00

Meadow and depressions from Corson's inlet to Townsend inlet on the south, Seaville on the west; mostly sand, and filling will be mostly required..... 5,000 00

Meadow and depressions from Townsend inlet to Hereford inlet, and from Townsend inlet on the west to Great sound on the south; soil good in some parts; sand in others; ditching and filling ..... 8,000 00

The marsh area bounded by Great sound on the north, Great channel on the east, Pennsylvania railroad to Holly Beach on the south, Cape May Court House on the west..... 4,000 00

Five Mile beach, for its full length to the Thorofare on the west, can be entirely cleaned up for..... 2,500 00

A good portion of the five-mile tract at Wildwood and Holly, Beach has been recently filled in by the dredge and this work is being continued.

The meadow bounded by the Pennsylvania railroad on the north, the county road on the south, Rio Grande on the west, Richards and Grassy sound on the east, will not cost above..... 3,000 00

The meadow between the county road on the north, Cape May City on the south, the highland on the west and the bays and sound on the east, will cost..... 5,000 00

Two Mile beach, meadow and depressions, mostly filling, can be made safe for ..... 1,500 00

| | |
|---|---|
| At Cape May the meadows and depressions from the city to the point, can be cleaned up for..... | $600 00 |
| This does not include clearing the cape marsh, which requires one or more tide gates and may require some ditching; the whole at a cost not to exceed..... | 1,500 00 |
| This would include the meadow at Life-saving Station No. 41. An enormous amount of filling has been done between Sewell's Point and Cape May City, and the whole of that territory is now mosquito safe. | |
| The area between Port Norris and Dennis creek, along the shores of Delaware bay; mostly good ditching, can be drained for..... | 8,000 00 |
| Between Dennis creek and Higbee's Landing, along the west shore of Cape May peninsula, are several detached marshes which may cost ..... | 10,000 00 |
| Between Port Norris, along the shores of the Maurice river, west along the bay to the Cohansey, and along the Cohansey to Bridgeton, drainage would cost..... | 20,000 00 |
| Between Salem creek and the mouth of Cohansey creek is a stretch of meadow about twenty miles in length and from 500 feet to three miles in width, most of which is perfectly safe, and all of it easily drainable; it will cost not over..... | 15,000 00 |
| | $315,550 00 |

It appears, then, that for the sum of $325,000, at the outside, the entire shore line on salt water in the State of New Jersey could be made mosquito safe:—$10,000 being added for expenses of administration and supervision. From three to five years would be required to do the work, depending upon the amounts of money that would be available; but it should take three years for proper supervision.

As to the result, all the shore resorts would be free from the clouds of mosquitoes that now infest them for the entire season. The entire pine region, which is now so overrun most of the summer as to be almost uninhabitable, would be freed of its most offensive species. The cities on New York, Newark and Raritan bays would be practically mosquito free, and the first range of the Orange mountains almost entirely so. The influence of the work would extend not only to the immediate vicinity of the shore, but for many miles inland. New Brunswick, for instance, which has no salt marsh, would be made almost entirely free.

Would there not remain many large inland mosquito-breeding areas? Undoubtedly: in the early spring woodland pools would breed great quantities; but they never leave the woods and disappear in June, not to occur again that year. Some of the low, wooded sections of the Great Piece meadow would breed mosquitoes all the summer through;

but these also are species that have a limited range of flight and are rarely found outside the limit of their breeding area:—most of the species have never been found in cities or towns.

There would also remain what may be called the dirty-water mosquitoes:—the species of *Anopheles* and the common rain barrel or house mosquitoes. These offer a problem eminently within the control of local authorities and out of the domain of State interference. They breed in sewer catch basins, puddles, cisterns, rain barrels and in every body of stagnant water no matter how small; but they usually remain pretty close to where they are born, and any active board of health inspector can secure the elimination of 90 per cent. of all the more obvious breeding places in his jurisdiction in a very short time. Complete freedom from the pests will not be secured until every person is educated to recognize the larvæ and the dangers of dirty water; but comfort in streets and parks and in clean sections of the cities can be obtained by the elimination of the salt marsh species.

As to benefits to be derived aside from the comfort of living; the increase in value of shore and suburban property would justify the expenditure over and over again. On Barnegat bay alone millions could be safely invested, while in the suburbs of Newark and along the Orange mountains, property would be available for building sites which is now of little or no value because the swarms of mosquitoes in summer make it impossible to enjoy the natural beauty of the location.

The scientific work of the survey has been continued, but the character of the season was so unfavorable that some of the problems could not be worked out, simply because there were no breeding pools. Mr. Grossbeck was in general charge of the records and the following notes have been prepared by him, though I have added notes and conclusions not in Mr. Grossbeck's records:

## NOTES OF THE SEASON.

During the summer of 1905 little was accomplished in the way of collecting and studying species other than those which were of economic importance, and these only to determine when broods would issue, making it possible to supply information to municipalities that would be directly affected.

Some collecting, however, was done, and two species heretofore unrecorded from New Jersey and two others new to science were secured.

In the report made in 1904 thirty-seven species of mosquitoes were described, all but one, *Culex perturbans,* in both the larval and adult stages. Of these, thirty-six species had actually been taken in the State; the remaining one, *Culex atropalpus,* was believed to occur with us since we are situated intermediate to the States from which it is recorded. At present writing forty-one species are known to occur, and if the prediction that *Culex atropalpus* will be found proves to be correct, forty-two will be credited to New Jersey.

On the pages following only such forms as are new are described, and notes to the species described in the former report are added.

*Anopheles punctipennis* Say. (The Mottled-Wing *Anopheles*).—This species has been taken in its usual numbers, but nothing was added to our knowledge of its life history.

*Anopheles maculipennis* Meig. (The Four-Spotted *Anopheles*).—No specimens of this species were taken in the larval stage, but Mr. J. Turner Brakeley sent in an adult female from Lahaway, where it occurs rarely.

*Anopheles crucians* Wied. (The Day-Light *Anopheles*).—No specimens of this mosquito were collected during the summer in any stage, the drought along shore apparently preventing its occurrence. In early November Mr. Brehme sent in a few larvæ and pupæ taken in pools on the Elizabeth marshes in company with *Culex cantator* and *C. salinarius.* Adults emerged from the pupæ November 4th and gave both the latest record for it and the northernmost locality thus far discovered.

*Anopheles barberi* Coq. (The Tree-Hole *Anopheles*).—This mosquito had not been taken in New Jersey until the present year, and is the smallest of the four species of *Anopheles* occurring with us. It is brownish, with unbanded beak and dark brown, unbanded legs. The wings are entirely without spots and this character serves to distinguish it from all other New Jersey forms.

**Description of the Adult.**

Female (Figure 1).—The length is about 3.5 mm., = .14 of an inch, exclusive of the proboscis. The head is brown, eyes meeting on top, occiput brown, with scales of a yellowish color near the neck; the proboscis is half the length of the body and covered with scales of a

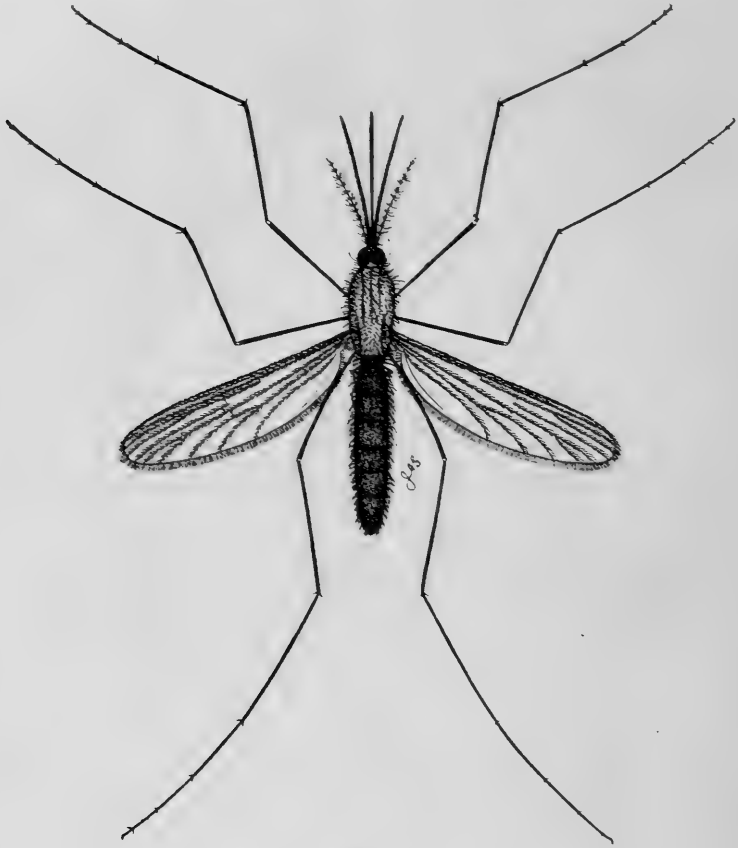

**Fig. 1.**

*Anopheles barberi* Coq : female adult; enlarged. Original.

pale brown color; the antennæ are pilose, brown, with a few whitish scales scattered over the surface, save the basal joint, which is yellowish; the palpi are brown, long and slender, four-jointed, the terminal joint with a few white hairs at the apex; the dorsum of

the thorax is grayish-brown, smooth and without scales; three brown stripes set with black bristles extend from the anterior margin to the middle, and the sides are also brown and well clothed with black bristles, as is the posterior part of the dorsum. The legs are long and slender, dark brown, almost black, with steely-blue reflections; the femora are somewhat paler beneath and there is a small, faint, yel-

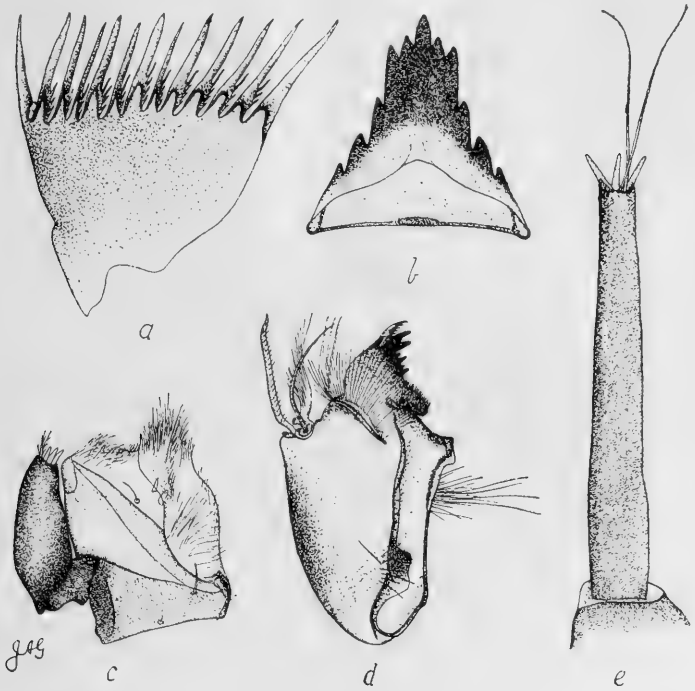


**Fig. 2.**

*Anopheles barberi:* details of larval structure: *a*, one of the scales; *b*, mentum; *c*, maxilla; *d*, mandible; *e*, antenna; all much enlarged. Original.

lowish dot at the knee. The claws are simple on all feet. The wings are hyaline, with brown scales attached with uniform thickness to the veins and margins. The abdomen is brown, in some specimens paler at the base of the segments, and fine brownish hairs are scattered evenly over the entire surface; beneath it is evenly grayish-yellow.

Male.—Differs from the female in the antennæ being plumose and the terminal joint of the palpus swollen and wholly brown, not tipped with white. The claws of the anterior tarsal joint are unequal in size,

the large claw with a median prong and a small, tooth-like process at its base, the small claw very short and simple. The claws of the mid and posterior tarsal joints are equal and simple, the latter somewhat smaller than the median.

**Description of the Larva.**

The larva in general appearance resembles the other species of the genus which occur in New Jersey, but is easily separated from all by the very dark head; it is further separable from *punctipennis* and *maculipennis* by the anal gills, which are even shorter than in *crucians*.

The full-grown larva measures 6 mm., or .24 of an inch in length. The head is dark brown with a single black diffused spot in the center of the vertex and a pale yellow circle around the eyes. The antennæ (Figure 2 *e*) is two-jointed, the first joint broader than long and fixed immovably; the second is much longer and narrower, almost straight, tapering toward the apex, terminated by three pegs of uniform length and two long, simple, flexible bristles; in color it is evenly dark brown with the apical articulations pale yellow. Apparently, there is no tuft or divided hair on the shaft of this second joint and no tubercle or pit in indication of one. The mentum (Figure 2 *b*) is triangular in form, almost as broad as long, with an apical tooth and five others on each side. The mandible (Figure 2 *d*) is elongate, with three large and several small teeth and a comb-like structure at the apex; on the dorsal surface is one long, slender, simple spine, a stouter one with short bristles, and a large, weakly-chitinized, compound spinet. The maxilla (Figure 2 *c*) is a pale yellow, squarish structure, with a thick tuft of short hairs at the apex and patches of hair irregularly distributed over the surface; its palpus is dark brown, almost three times as long as its greatest width, with three yellow, apical pegs and a small tuft of two or three branched hairs arising from a pit near the apex. The triangular plates, one on each side of the respiratory apparatus on the eighth segment, each bear thirteen or fourteen long teeth of almost even length on the posterior margin, and each tooth has three or four minor teeth at the base. The tracheal gills are slightly inflated, pointed and about one-fourth the length of the ninth segment.

**Habits.**

This species, like *Culex triseriatus,* is confined to the water contained in tree-holes. It was described from Plumber's Island, Md. Mr. Dickerson found a few larvæ associated with those of *C. triseriatus* and *C. signifer* in a tree-hole at Chester, Morris county, September 6th. The same day a male *A. barberi* emerged from a pupa, with specimens of its associates. On the 8th, one female emerged and on the 11th,—another, the last in the lot, though *triseriatus* and *signifer* hatched in large numbers. Another visit to the tree was made September 9th, but no larvæ were found and only a single male hatched September 10th, from a collected pupa.

The larvæ rarely descend to the bottom, but like their allies maintain a horizontal position on the surface of the water. This would suggest a diet of floating particles of vegetable matter; but Dr. Dyar says that they are predaceous and the mandibles seem to bear out this statement. He also says that the winter is passed in the larval stage, a point which we have been unable to verify and which is not in accord with the habits of the other species of this genus occurring in the State.

*Psorophora ciliata* Fabr. (The Fringe-Legged Mosquito).—This mosquito has been rare throughout the season, though Mr. Brehme took a number of the larvæ near Newark in the middle of June, the first adults emerging on the 26th of that month.

*Janthinosoma musica* Say. (The Big Wood Mosquito).—This species was not taken in any stages, its breeding places in the Great Piece meadow having dried out completely.

*Culex jamaicensis* Theob. (The Spotted-Legged Mosquito).—This mosquito was taken commonly in the larval stage, breeding in the lot pools at New Brunswick; but curiously enough the adults seemed not to be troublesome at the nearby dwellings.

*Culex discolor* Coq. (The Mottled Mosquito).—Mr. Seal collected full-grown larvæ and pupæ of this species at Delair, Camden county, in company with *C. pipiens,* August 15th,—the latest record of the occurrence of larvæ thus far in hand. The larvæ were attacked by a fungus and placed in alcohol. Adults emerged from pupæ on the three days following the 16th. August 8th was the latest previous record for adults.

Mr. Seal writes that he found larvæ in two temporary pools at Delair, where, like *Psorophora,* they occur only when certain con-

ditions prevail. These two holes usually become stocked with *Sayomyia albipes* larvæ shortly after it rains, and it is only after these disappear that *discolor* can be found. It appears from this that the *discolor* fall prey to the predaceous *Sayomyia.*

*Culex sollicitans* Walk. (The White-Banded Salt Marsh Mosquito).—This species did not begin to breed on the salt marshes of the Newark and Raritan bay districts until well along in summer. On Staten Island, just across the Kill, they swarmed, while on the New Jersey meadow not one developed. This peculiar development made it possible to determine definitely, not only that the species came over from Staten Island; but that it extended along the valley of the Rahway and across the first range of the Watchung mountains. It was not until after midsummer that this species became at all common, and it remained, north of the Raritan bay, less abundant than *C. cantator.* At Barnegat bay and southward, conditions were reversed and *sollicitans* were plentiful—offensively so in early September.

*Culex perturbans* Walk. (The Irritating Mosquito).—The larva of this mosquito still remains undiscovered, though adults have been as common at Lahaway as previously recorded. Some interesting observations, however, were made by Dr. Dyar in the United States and by Dr. Goeldi on a closely allied species in Brazil. The results have been similar, and show that the species must breed naturally under some extremely peculiar conditions, as in neither case were larvæ obtained from eggs brought beyond the first stage of development.

Dr. Dyar secured from captured females eggs which were laid in boat-shaped masses of about 150 each, similar to those of *Culex pipiens.* The young larvæ have very long antennæ, with a single hair representing the tuft at the basal third. The comb of the eighth segment is a single row of short, pointed spines. The anal siphon is constricted at the outer third, the terminal portion linear, and ending in a bunch of stout, recurved hooks, the basal portion is slightly constricted centrally, bearing a long hair on each side, but no pecten.

Concerning their habits, Dr. Dyar says: "The larvæ refused to feed. They did not use the mouth brushes perceptibly, but lay at the bottom of the water absolutely motionless for hours and days together. Some specimens we thought dead: but on transferring them to a slide, they wriggled in a fairly lively manner, pushing the curiously shaped air tube as if to fasten it to some object."

Mr. Brakeley sent in a male from Lahaway, June 4th, the first captured there, and the belief that the species is a migrant therefore

seems less likely. Mr. Brakeley's latest capture in 1905 was September 12th, seventeen days later than any previous record. All sorts of possible breeding places were investigated by Mr. Brehme and some by Mr. Grossbeck, in several parts of the State; but no larvæ were secured.

*Culex tæniorhynchus* Wied. (The Small, Salt Marsh Mosquito).—This was very rare throughout the season. A single female specimen was sent in from Lahaway, and this is not only the farthest point inland where it has been taken; but the first time it was taken there at all.

*Culex sylvicola* Grossb.* (The Scaly-Winged Mosquito).—Larvæ were found in some numbers in swampy woods near New Brunswick, where they were taken the year before. They were rare as compared with their associate, *Culex canadensis*, the ratio being about one *sylvicola* to 1,000 *canadensis*. April 10th ten larvæ and four pupæ were secured, and on May 2d two larvæ and thirty pupæ, showing that the larvæ pupate almost simultaneously. Most of the larvæ were placed in alcohol and from the pupæ adults emerged as follows: Twelve males and one female May 4th, two males and twelve females May 5th, two males and six females May 6th and one male and one female May 7th.

As previously noted there is apparently only a single spring brood. No later collections turned up additional material, and adult captures were more and more worn as the season advanced.

*Culex cantator* Coq. (The Brown, Salt Marsh Mosquito).—The early broods on the New Jersey salt marshes north of the Raritan bay were of this species, almost exclusively, and, while the brood on the Newark marshes was entirely absent and on the Elizabeth marshes not very heavy, the Linden area sent two very respectable swarms a considerable distance inland. At New Brunswick this was the dominant species throughout the season, though the spring migrations were small and even the September swarms not very heavy. All the previous observations were confirmed.

*Culex cantans* Meig. (The Brown Woods Mosquito).—It is strange that where this species bred in great numbers in Newark a few years ago, it should be entirely absent in 1905; and that in the Great Piece meadows, twelve or more miles distant, which had been thoroughly explored previously without finding the species, it should occur commonly. Not a larva was found in Newark, in the pools where it was

* This is the species erroneously identified as the Pacific coast *squamiger* in previous reports.

known to breed in 1904. In the Great Piece meadows large larvæ occurred April 17th, in many pools, some of which were two miles distant from each other. They were very local, large numbers being found in one pool, while others directly adjacent and of precisely the same character, did not contain a single specimen.

In one locality they were associated with larvæ of *C. canadensis, C. abfitchii* and *Corethra cinctipes,* about one third being *cantans;* in another they occurred with *C. pretans, C. aurifer, C. canadensis* and *Aedes fuscus,* only a very small proportion being *cantans.* Adults began to emerge April 26th and continued to issue till May 8th. There is no record to show that there is more than one brood.

*Culex abfitchii* Felt & Young. (=*siphonalis* Gross.) (The Brown-Striped Woods Mosquito).—Nine half-grown larvæ were taken April 17th, in the Great Peace meadows, in company with *C. canadensis, C. cantans* and *Corethra cinctipes.* Another collection, made April 25th, turned out fifty additional larvæ, and on this same day the first pupa appeared. On the whole the larvæ did not do well and only a small proportion reached the adult stage; the first, a male, emerging May 3d; the last, a female, May 12th.

*Culex sylvestris* Theob. (The Swamp Mosquito).—This mosquito was sent in from many localities and in all stages from young larvæ to adults. It has held its own in numbers as compared with previous years. The earliest larvae were found April 14th, when they occurred in comparatively small numbers associated with *C. canadensis* and *Aedes fuscus.* The first adults from this lot began to emerge April 26th and continued to issue until April 30th, when the culture was closed.

*Culex signifer* Coq. (The White-Lined Mosquito).—This species has been sent in from three localities, all of them September collections, and as, in one of the localities, earlier collections had been made in the same situations, the question arose as to whether or not the species bred only in fall.

Mr. H. O. Marsh, of Chester, and Mr. Dickerson jointly tested this point and the results indicate, rather conclusively, a single fall brood. Mr. Marsh found full-grown larvæ and pupæ September 5th, 1904, in a hollow tree, associated with those of *C. triseriatus,* and October 3d of the same year, a single, fully-developed larva was taken; apparently a belated example. In 1905 he visited the tree again, May 21st, and though *triseriatus* larvæ in various stages were found,

no *signifer* were present. June 25th and July 22d, periods of one month apart, other visits were made, but no larvæ other than *triseriatus* were taken.

It may be mentioned that the pool in this tree hole never dries up, no matter how long the drought. It is frequently twelve inches in depth and has never yet been observed with less than six inches of water.

Mr. Marsh was absent from Chester later in the season, so Mr. Dickerson continued the observations. He visited the tree September 6th and found full-grown larvæ and pupæ of *signifer* in company with *triseriatus* as usual, and *Anopheles barberi*. Several adult *signifer* were also seen resting on the sides of the tree hole. From the pupæ thirty-five adults issued during the seven days following; all but the three first emerging were females, the males having already hatched.

*Culex atropalpus* Coq. (The Rock Pool Mosquito).—No effort has been made to find this species along the rocky banks of the Delaware river in Warren county, where it is supposed to breed; so it still remains as only a probable inhabitant of the State.

*Culex canadensis* Theob. (The Woodland Pool Mosquito).—The earliest adults hatched April 22d, from pupæ collected at Newark, April 8th, and the latest adults emerged September 11th. Larvæ were found at Arlington, April 14th, in company with *Anopheles punctipennis, C. territans* and *C. sylvestris*. It has never before been found by us in pools with the first named species.

*Culex niveitarsis* Coq. (The Snowy Foot Mosquito).—This species, which is known only by the types, was searched for in its habitat in rocky pools at Paterson, but no specimens in any stage were secured. It is apparently very rare, since it has not as yet been found by any of the other collectors in the United States.

*Culex pallidohirta* Grossb. (The Pale-Haired Mosquito).—A light-colored, medium-sized mosquito, with cream-colored, unbanded legs, brownish, unbanded beak, and silvery gray, unbanded abdomen. The wings are unspotted and the thorax is pale brown, marked with darker scales on the sides of a narrow median groove, and inclosed in a semicircular lateral line on the posterior half. The latter character can be seen only in bred specimens.

**Description of the Adult.**

Female (Figure 3).—Measures 4.5—5 mm.,=.18—.20 of an inch in length, excluding the proboscis, which is about half the length of the body. The occiput is clothed with yellowish scales and a few dark brown ones intermixed; the antennæ are brown, the basal joint

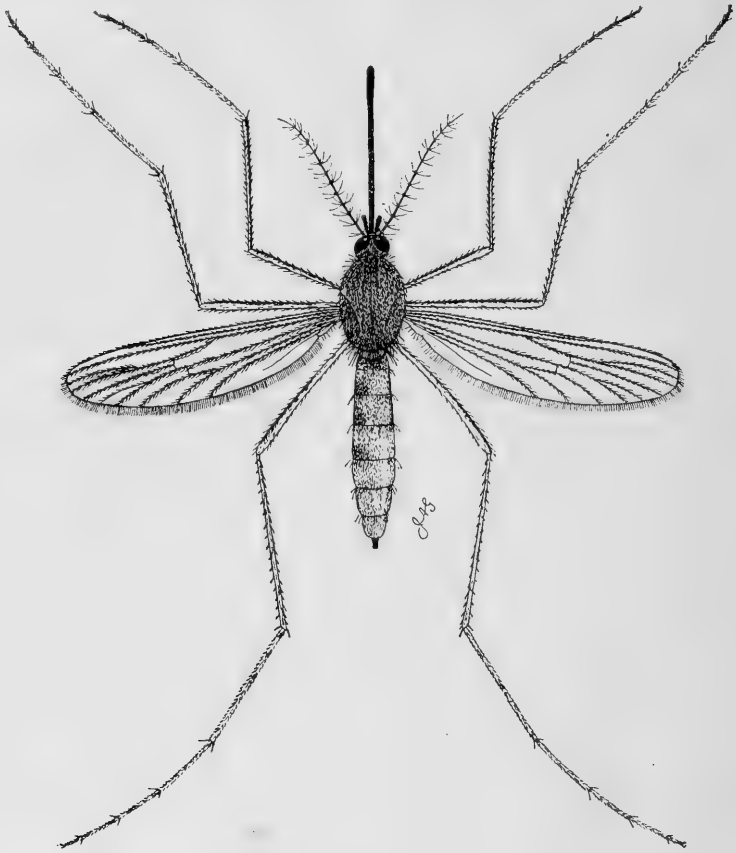

**Fig. 3.**
*Culex pallidohirta* Grossb.: female adult; enlarged. Original.

and basal half of following one dirty yellow; the proboscis is brown with whitish scales scattered over the surface, save at the apical fourth; the palpi are four-jointed, brown, tipped with silvery-white, the apical joint minute, flattened and slightly spiny. The dorsum of

the thorax is covered with pale brown scales and has a narrow median furrow, obsolete on posterior portion, bounded on each side by scales of a slightly darker color: a lateral line of pale yellow scales beginning near the posterior margin and extending to the middle of the lateral margin, also encloses these darked scales. The pleura are yellowish-brown, with patches of whitish scales. The legs are cream colored, the anterior part of all femora and also anterior part of tibia of fore-leg brownish; the apical two or three joints of fore and mid tarsi are also brownish. The claws are equal in size on all feet, each with a single tooth at the middle. The abdomen is unbanded, creamy, with metallic, silvery-gray lustre in living specimens, but darker with grayish shadings when pinned; the *genitalia* are dark brown.

**Habits.**

This species was taken only in the pupal stage with *C. canadensis* larvæ and pupæ and *Corethra cinctipes,* collected by Mr. Brehme in the Orange mountains, May 19th and May 22d. From the first lot a female emerged May 25th, and out of the second another female issued on the 26th. All remaining larvæ were put into alcohol at once, and though numbering hundreds, none could be differentiated from *C. canadensis.* Another collection was made May 27th, and its entire mosquito contents taken; but all larvæ proved to be *canadensis,* and none other than that species hatched from the pupæ. It is probably one of the early spring forms with but a single brood, since it was not taken in any of the collections later in the season.

*Culex triseriatus* Coq. (The Tree-Hole Mosquito).—This mosquito was taken continuously throughout the season wherever tree-holes containing water were found. The earliest record of larvæ thus far is April 18th, when examples in the first and second stages of development were found on Garret mountain, Paterson.

*Culex serratus* Theob. (The Silver-Striped Mosquito).—This species was not taken in any stage.

*Culex punctor* Kirby. (The Unbanded-Legged Woods Mosquito). —This is a rather large mosquito with brown, unbanded legs and beak. The thorax is evenly clothed with golden brown hair and the abdomen is broadly banded with white at the base of the segments. In calling this species *punctor* we are following Dr. Dyar, who says that *abserratus* F. & Y. is a synonym. Dr. Felt does not admit this, and the description given by Theobald does not cover this species. At all events the form here called *punctor* is the form described as *abserratus,* —so Dr. Felt says.

**Description of the Adult.**

Female (Figure 4).—Large, rather robust, averaging 5—5.5 mm., = .20—.22 of an inch in length, exclusive of the proboscis. The occiput is clothed with golden brown and some yellowish scales on top, whitish scales on the sides; the antennæ are brown, with the basal

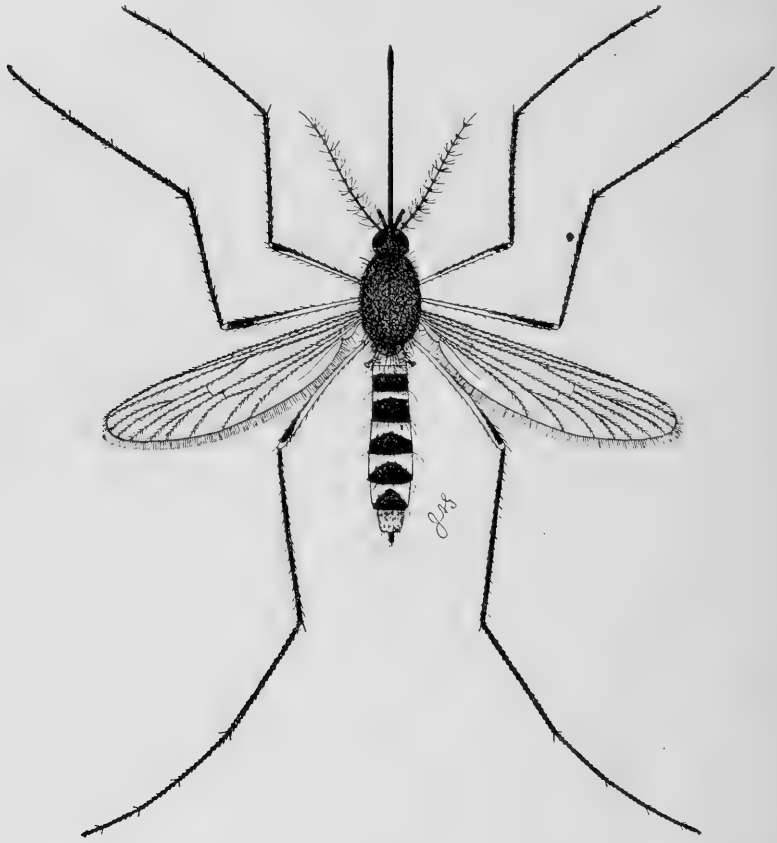

**Fig. 4.**
*Culex punctor* Kirby: female adult; enlarged. Original.

segment yellowish; the proboscis is perceptibly longer than half the length of the body; the palpi are wholly brown, four-jointed, with apical joint minute, rounded and spiny. The thorax is evenly clothed with golden brown scales; there is a very narrow median groove and

a lateral, semicircular one on the posterior half; but this is seen only in very fresh specimens. The pleura are almost wholly covered with white scales. The femora are cream colored, becoming brown toward the apex on the upper surface, then with a sharply defined creamy spot at the knee; the tibia and tarsi are uniformly dark brown, save that the former has yellowish bristles. The claws are equal in size on all feet, each claw with a single median tooth. The abdomen is very dark brown, with broad, clean-cut white bands at the base of the segments, which become wide laterally; beneath it is whitish with intermixed brown scales and a narrow, median brown stripe.

Male.—The male is like the female in general appearance. The antennæ are brown with paler plumes, and the palpi are brown without rings or marks. The claws of the anterior and mid tarsal joints are unequal in size, the larger with a single median tooth, the smaller with a single tooth near the base. The posterior claws are equal, each with a single tooth near the middle as in the female.

**Description of the Larva.**

Dr. Dyar differentiates the larva from *C. sollicitans* (Proc. Ent. Soc. Wash., vol. VI., p. 39), and figures it with some of the details (Jour. N. Y. Ent. Soc., vol. XII.), but here gives no description. His figures agree with those given subsequently by Dr. Felt (Bull. 79, N. Y. Sta. Mus.) under the name *Culex abserratus,* which is a synonym of what Dr. Dyar calls *C. punctor.*

As Dr. Felt says, the larva bears a general resemblance to *C. serratus.* The antennæ are rather stout, with the tuft at the basal third. The mentum is rather broadly triangular, bearing twenty-seven fine triangular teeth. The comb or scale patch on the sides of the eighth abdominal segment consists of six or seven scales arranged in a curve. The anal siphon is about three times as long as wide, with a double posterior pecten or row of spines, each row consisting of twelve to fifteen closely set spines. The anal gills are long, slender and uniformly tapered.

**Habits.**

From a lot of larvæ and pupæ collected in the woodland near New Brunswick, April 28th, a male and four females emerged May 1st. No others hatched from this lot, but from another collection made May 2d, two more females were secured from the pupæ on the

same day. These were the last emergences of this species, though hundreds of *canadensis* issued in the few days following. Adult captures were made May 25th, and seven more or less worn specimens were taken either upon the clothing or in the act of biting. A single female was sent in by Mr. Brakeley, who bred it May 2d, out of a lot of mostly *canadensis.*

*Culex dupreei* Coq. (Dupree's Mosquito).—The species occur with *C. serratus,* and like it, has not been taken during the past season. None of the pools where it occurred previously contained water at its proper time.

*Culex trivittatus* Coq. (The Three-Striped Mosquito).—Larvæ of this species, full grown, were taken at Madison, Morris county, May 8th, and again in the cedar swamps near Manahawken, June 15th. Both times they were associated with *C. sylvestris.* The early appearance of large larvæ with *sylvestris* of the same size would indicate that eggs are laid in fall and that the winter is passed in that stage. Adult captures in a very fresh condition were sent in from Madison September 1st.

*Culex pretans* Grossb. (The Brown-Striped Mosquito).—This mosquito, prior to 1905, was classed among the rare forms. It had been taken at various points in the State as an adult, but only once were larvæ found, and then only a few among a lot of *canadensis* and *sylvestris* in the Great Piece meadows.

In the season just passed it was again sought in spring, in the Great Piece meadows, and to our surprise was found in swarms with equal numbers of *canadensis.* This state of affairs occurred only on the north side of the Passaic river; on the opposite side *canadensis* was the dominant form, and not a single larva or adult of *pretans* could be found. (The meadow on the south side is a mile or so further up the river.)

Larvæ, full grown, were taken April 19th, in company with *canadensis,* a few *cantans* and a still smaller number of *aurifer, sylvestris* and *Aedes fuscus.* On the 21st pupæ began to form rapidly, and on the 23d the first adults, ten males and one female, emerged. April 24th, thirty-five males and eleven females emerged, and on the 25th, six males and eight females. Another collection, made April 24th, principally for specimens, turned up a lot of pupæ, and on the 26th, sixty-six males and three females emerged; the following day fifty-two males and fifty-two females, and on the 28th, six males and twenty-six females. Two or three specimens issued on the 29th, and

that proved to be the last of the brood. After *pretans* ceased issuing, *canadensis* began to emerge in large numbers. The eggs, it appears, hibernate and hatch simultaneously the following spring, the adults appearing a little before *canadensis*.

In Hartford, Conn., the species was reported equally abundant in the woodland pools, and the adults caused considerable annoyance in the southeastern portion of the city.

*Culex inconspicuus* Grossb. (The Inconspicuous Mosquito).—This mosquito, though sought where it has previously been taken, could not be found during the season.

*Culex aurifer* Coq. (The Golden-Scaled Mosquito).—Two specimens of the larvæ, the only ones sent in, came from the Great Piece meadows, April 24th, in company, as usual, with *canadensis* and with *pretans, sylvestris, cantans* and *Aedes fuscus*.

*Culex pipiens* Linn. (The House or Rain-Barrel Mosquito).—This was found breeding in all places suitable for its development. Young larvæ were found as early as May 8th, and from then continually to the end of the season.

*Culex restuans* Theob. (The White-Dotted Mosquito).—This was found with the preceding, and occasionally an entire brood would be *restuans*.

*Culex salinarius* Coq. (The Unbanded Salt Marsh Mosquito).—This heretofore common species was searched for again and again on the salt marsh, where it was known to breed, but not a single specimen in any stage was secured until early in November, when Mr. Brehme found it in some pools on the Elizabeth marshes, in company with *C. cantator* and *Anopheles crucians*.

*Culex melanurus* Coq. (The Black-Tailed Mosquito).—No specimens of this species were sent in or collected.

*Culex territans* Walk. (The Little Black Mosquito).—Some larvæ of this species were found in many fresh water collections. Mr. Brehme found them in considerable numbers at Arlington, August 12th.

*Culex saxatilis* Grossb. (The Rock Pool Dweller).—A medium-sized, black mosquito, with unbanded legs and beak. The thorax is marked with two pale, yellowish spots and the abdomen is banded with white at the apex of the segments.

**Description of the Adult.**

Female (Figure 5).—Measures 4. 7—5 mm.,=.19—.20 of an inch in length, not including the proboscis. The head is brown, with the occiput covered with yellowish-white scales and some dark brown ones; the antennæ and proboscis are dark brown, the former with

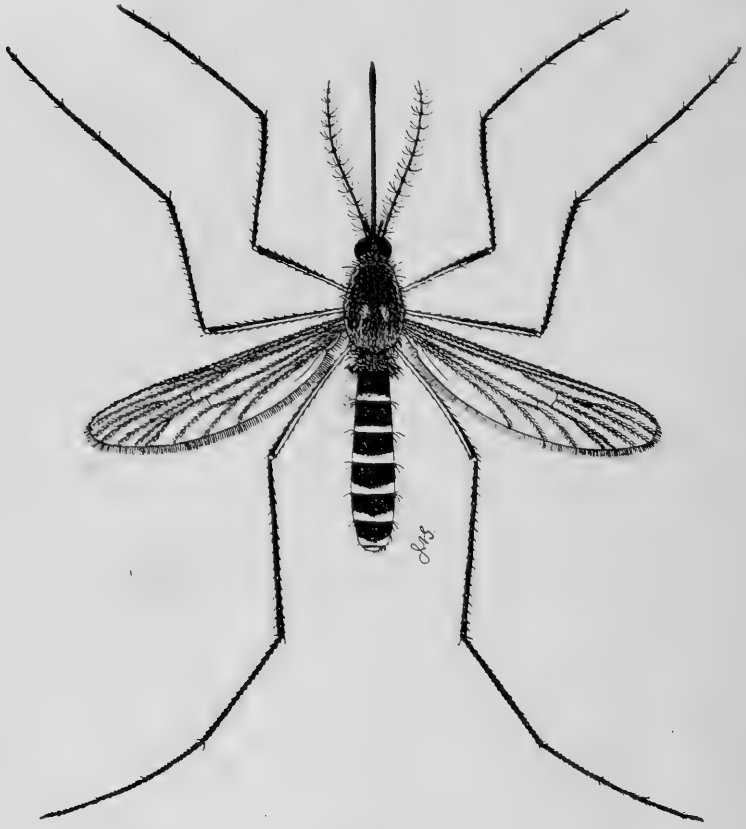

**Fig. 5.**
*Culex saxatilis* Grossb.: female adult; enlarged. Original.

scattered whitish scales: the palpi are brown, apparently three-jointed, the fourth being minute, pointed and wholly retracted within the third joint. The thorax is clothed with rich brown scales and pale, yellowish ones at the margins; two naked lines extend down the anterior part and two pale, yellowish spots, which become more or less

diffuse posteriorly, are on the center of the dorsum. The pleura are light brown with small patches of dirty, white scales. The legs are black, with the under sides and bases of the femora and a small dot at the knee creamy. The claws are equal and simple on all feet. The abdomen is dark brown, all segments with apical white bands, which widen out laterally, till, beneath, it is white with dark brown basal corners.

**Habits.**

This species was met with August 31st, in a rock-bottomed pool, on the Garret mountain, Paterson, in the pupal stage only. Some larvæ and pupæ of *C. pipiens* were in the pool at the same time, so it was not known that a new species had been taken until adults began to issue. Two females emerged on the same day of collecting, and September 1st, five others, all females, emerged, each time with *pipiens,* which, excepting one, were also all females. The last of the brood had been secured, the males having already hatched.

*Uranotænia sapphirina* Osten-Sacken. (The Sapphire-Lined Mosquito).—No specimens were taken in any stage during the past season.

*Wyeomyia smithii* Coq. (The Pitcher Plant Mosquito).—No effort was made to collect specimens of this species, though it undoubtedly bred in its usual numbers in the southern portion of the State.

NOTE.—The *Corethini,* formerly a division of the family *Culicidæ,* and embracing the New Jersey genera *Sayomyia, Corethra* and *Corethrella,* is now given family rank and is called *Corethridæ.*

They are distinguished from the *Culicidæ,* or true mosquitoes, by the comparatively short proboscis.

*Sayomyia albipes* Johann. (The White-Legged Corethra).—In the last report a belief was expressed that this species passed the winter in the larval stage. The evidence upon which this belief was based was the collection of a lot of almost full-grown larvæ at Paterson, October 3d, none of which showed any further development up to October 16th, when all were placed in alcohol. In the season of 1905 a few full-grown larvæ and pupæ were taken from a pool on Garret mountain, Paterson, April 18th, and a female emerged April 21st, thus removing all reasonable doubt as to its method of hibernation. It is also probable that they breed continuously throughout the season, as larvæ were taken again July and September, and adults bred from them the same year.

*Sayomyia punctipennis* Say. (The Little Spotted Corethra).—Two females of this species, one from Chester, August 1st, and the other from Delair, September 17th, were found among a lot of miscellaneous

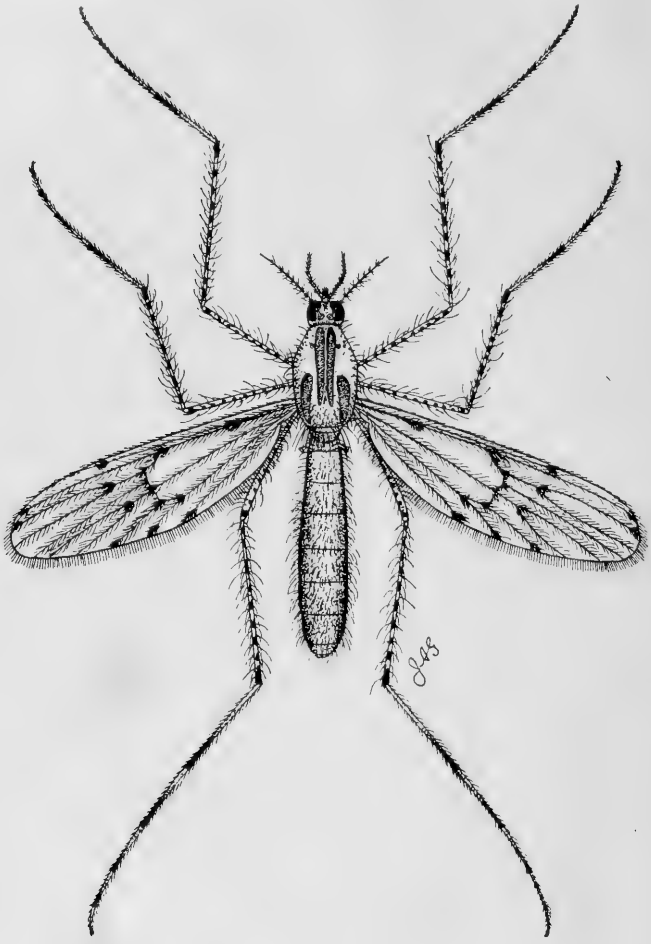

**Fig. 6.**
*Sayomyia punctipennis* Say.: female adult; enlarged. Original.

material in the Experiment Station collection. The only other record of its occurrence in this State is in the list of "Insects of New Jersey," by Professor Smith, where it is noted as occurring June 19th, at Riverton.

It is a small insect with three buff-colored stripes on the thorax, the median abbreviated posteriorly, the lateral abbreviated anteriorly. The wings are marked with about a dozen brown spots. The legs are whitish; the femora and tibiæ spotted with brown and the tarsi ringed with brown at the apex of the joints. The abdomen is yellowish-brown.

**Description of the Adult.**

Female (Figure 6).—Measures 3.5 mm.,=.14 of an inch in length. The head is yellowish, the eyes black and widely separated; the proboscis and palpi brown, the latter five-jointed and clothed with long, concolorous hair; the antennæ are yellowish, annulated with brown, and cream-colored hairs are at the base of the joints. The dorsum of the thorax is whitish with three longitudinal stripes, the median divided longitudinally by a narrow line which begins near the anterior margin and extends posteriorly for two-thirds the length of the thorax. The lateral stripes begin near the posterior margin and extend anteriorly to about the middle. The legs are creamy white, the femora and tibiæ each marked with about a dozen brown spots; the tarsi ringed with brown at the apex of the joints. The claws are simple on all feet. The wing veins are clothed with long, creamy scales, with brown ones collected in small spots as follows: at the cross-veins; at the point where the sub-costa joins the costa; on the radius midway between the point of origin and the junction with radius 2, where they touch the wing margin, and at the fork with radius 2 and 3; at the fork of media 1 and 2 and media 3; at the fork of cubitus 1 and cubitus 2, and also where they join the wing margin; on the first anal vein where it joins the wing margin. The abdomen is yellowish-brown, with black speckles laterally, scantily covered with concolorous hair on top, rather thickly at the sides.

*Corethra cinctipes* Coq. (The Ring-Legged Corethra).—Larvæ were taken occasionally in the early spring, always with the early stages of other species of mosquitoes. The fact that it has never been taken in fall by any of the collectors seems to show that it does not hibernate in the larval stage as does *Sayomyia albipes*.

*Corethrella brakeleyi* Coq. (Brakeley's Corethra).—Mr. Brakeley sent in hibernating larvæ and pupæ from Lahaway, where he collected them May 15th. Adults from this lot issued June 7th, when the culture was closed and the few remaining larvæ were placed in alcohol.