

MR. C. GORDON HEWITT: As Professor Titus has raised the question of the flight of the house-fly, I should like to give my own experience in the matter; as important results were published in a report by the British Local Government Board, on the carriage of infection by flies. Two or three years ago I had some experiments carried out in the city of Ottawa to study the flight of flies under city conditions. Flies were bred out and then marked with rosolic acid. They were liberated at a given point in a fairly well-inhabited region, throughout which Tanglefoot papers were distributed in the houses. These Tanglefoot papers were collected from day to day. Out of the 13,500 flies that were liberated, 172 marked flies were recovered at varying distances from the point of liberation, the farthest being 700 yards. In a further report of the British Local Government Board, experiments carried out by Copeman, Howlett and Merriman in Norfolk, England, demonstrated that under rural conditions flies travel from three hundred to seventeen hundred yards from the refuse in which they are bred; their flight depending largely on the prevailing winds. Experiments are recorded by Nuttall, Merriman and Hindle who carried on experiments under urban conditions in Cambridge, England, which bear out on the whole the limited range of flight of flies under city conditions. I think those interested would do well to consult these reports, which I think could be easily obtained.

PRESIDENT H. T. FERNALD: The next paper will be read by Glenn W. Herrick.

ADDITIONAL DATA CONCERNING THE CONTROL OF THE FRUIT-TREE LEAF-ROLLER IN NEW YORK

By GLENN W. HERRICK

During the past three years the fruit-tree leaf-roller, *Archips argyrospila*, has been exceedingly abundant in parts of New York State and has caused serious losses to fruit-growers. In the spring of 1912 an extensive series of experiments in an orchard in Genesee County was conducted in an attempt to control the leaf-roller by destroying the larvæ with poison and contact sprays. In all, over seventeen combinations of materials were tried on different groups of trees in the orchard. Most of the applications were made before the cluster of flower buds had separated. At this time, however, a large part of the eggs had hatched and many larvæ had already worked their way down among the cluster buds and were feeding on the buds and bud stems.

The results of the whole series of experiments were really very discouraging so far as prevention of injury to the fruit was concerned.

There was so little difference between the sprayed and unsprayed portions that it did not seem worth while to make a count of the fruit. The orchard produced only about two hundred and fifty barrels of apples out of a normal eight hundred barrels and these were mostly in the tops of the trees and in portions of the orchard not so badly infested. In this connection, the work of one of the better and more intelligent fruit-growers in New York is of interest.

The large orchards in question were sprayed five times and sprayed thoroughly and intelligently. The orchards were sprayed first, in the dormant condition, just before the buds burst, with lime-sulphur, 1 gallon to $6\frac{1}{2}$ gallons of water with 1 pint of black-leaf-40 to every 100 gallons for the aphids. The second spraying was made just before the blossoms opened with lime-sulphur 1 to 50 and 3 pounds of arsenate of lead. The third application was made just as the petals had fallen and consisted of lime-sulphur 1 to 50, arsenate of lead 3 pounds and black-leaf-40, $\frac{3}{4}$ pint to 100 gallons. A fourth spraying was made about 10 days to two weeks after the third with lime-sulphur 1 to 50 and 3 pounds of arsenate of lead. At about this time the owners became much worried about the roller and sprayed a fifth time with arsenate of lead alone, 4 pounds to 50 gallons. In spite of this extraordinary amount of careful and thorough spraying, the trees and cover crop under the trees were alive with larvæ and 40 per cent of the crop was ruined.

Gillette and Weldon performed a series of experiments in Colorado in 1912 in an attempt to control the leaf-roller by the use of poison sprays.¹ The first spray was applied May 5. The cluster buds had separated but the buds had not begun to open up. At this time "practically every blossom bud picked had from three to five larvæ feeding in it." They estimated that 75 per cent of the larvæ were killed by this and succeeding applications. Unfortunately 25 per cent, where the larvæ are multitudinous, is quite sufficient to cause disastrous results. The question, of course, arises as to whether the remaining 25 per cent can be caught before they enter the buds or get out of the way of the poison. Mr. J. B. Gill, in his thorough work in New Mexico and Canon City, Colo., found that "applications of arsenicals alone and in combination with 40 per cent nicotine solution have greatly reduced the amount of injury to the fruit and foliage, but these sprays have not been so effective as desirable." On account of the long period of egg-hatching it is almost impossible to poison the larvæ before they become safely hidden. Especially is this true in case of late varieties of apples.

¹ 1912, Circular 5, Colorado Experiment Station.

In conclusion of this brief consideration of the poison sprays it should be said that in every case much benefit was derived from them in protecting the foliage and enabling the trees to develop fruit buds for the subsequent season. Nor is this to be considered of little moment or of slight importance. At the same time, fruit buds are of little value if they are so eaten by insects that they cannot develop into fruit.

EXPERIMENTS WITH MISCIBLE OILS TO DESTROY THE EGGS

In the spring of 1913 we planned and carried out a series of experiments in a badly infested orchard with the miscible oils, using Scalecide and the Orchard brand manufactured by the Thompson Chemical Company. In all, thirty large russet trees were included in the experiment and carefully sprayed with the oils at the proportions of 1 to 15. In addition to these trees included in the actual experiment many more were sprayed by the owner with Scalecide at the rate of 1 gallon to 15 gallons of water.

The oils were applied April 2 and 3, of course, before the buds had started, although they had begun to swell. Unfortunately, it rained hard in the afternoon of April 3 and the oil applied that morning had been on only four hours, while the oil applied the day before only about twenty-four hours. Undoubtedly this influenced the final results.

On May 13, I made a rather extensive and tedious count of the eggs killed by the oil in different masses. In the experimental rows the masses were taken mostly from the row that was sprayed in the forenoon of the day on which it rained in the afternoon. We were not aware of this until we consulted our notes later. The results of the count showed that a fraction over 76 per cent of the eggs had been destroyed and did not hatch. In that part of the orchard sprayed by the owner a more extensive count of egg masses showed that practically 79 per cent of the eggs had been killed.

The general effect of the spraying with the miscible oils was better than we hardly dared hope. In the first place, there is no appearance in the orchard of injury caused by the oils. We were careful to make the applications just as near the active growing period of the trees as possible. Moreover, the spraying was done in moderately warm weather. The orchard bore a fair crop of fruit and the owner is much encouraged.

Gill, in his work in Colorado with the miscible oils killed a much higher percentage of the eggs. Gillette and Weldon in Colorado succeeded in killing 95 per cent of the eggs. From their accounts it appears that the trees were more thoroughly drenched than were the

trees we sprayed in the New York orchard. If it had not been for the fact that we feared the effect of the miscible oil sprays we should have insisted on a more thorough drenching.

Again, in 1914, a still more extensive series of experiments based on knowledge gained in the previous seasons was planned and carried out in coöperation with two growers at Hilton, N. Y. Mr. R. W. Leiby was placed in charge of these field experiments and to his thorough and careful work we are greatly indebted for our results.

Briefly, three brands of miscible oils were used in a preliminary way on small areas in which the results could be accurately checked by careful counts of eggs, hatched and unhatched. In cage experiments carried out indoors Target brand killed 94.7 per cent of the eggs while Scalecide killed 96.2 per cent. In the check, 95.75 per cent of the eggs hatched.

In outdoor experiments confined to a few plum trees on which the egg masses were located and marked by tying strips of white cloth about the branches, Target brand at 1 to 20 killed 92.6 per cent of the eggs, Scalecide, at 1 to 15 killed 91.2 per cent and Orchard brand 87.4 per cent. The average for the three oils was 90.4 per cent. Very likely these egg masses being so conspicuously marked were more thoroughly treated than would be the case in ordinary orchard spraying. The results in the main orchard would indicate this.

In the main orchard, sprayed by the owner in the ordinary way, yet thoroughly, an extended count of egg masses showed that an average of 85+ per cent of the eggs were destroyed. In general orchard spraying it is an exceedingly difficult matter to hit all of the egg masses or to thoroughly wet all that are touched with the mixture. It is doubtful if the average grower will be able to kill over 85 per cent of the eggs on large apple trees for the simple reason that some of the masses will not be actually hit with the liquid. If, on the average, 85 per cent of the eggs can be destroyed with the miscible oils they will constitute a most efficient check against serious infestations of the leaf-roller.

We did not, however, rely on the miscible oils for the complete control of this insect in the orchards under consideration. We planned to supplement the oils with arsenate of lead and on May 7, the next day after the eggs began to hatch, the orchards were sprayed with the poison at the rate of 3 pounds to 50 gallons of water. The buds had just begun to burst and two or three leaves had separated.

A second application of lead in the same proportions was made on May 14 just before the blossom buds had separated. Finally on May 26 the first codling moth spray was applied. The results were very satisfactory and the owners feel that they can control the leaf-roller.

Their feeling of great discouragement produced by the conditions in 1913 has changed to a hopeful and confident assurance that the problem has been solved.

In some field experiments which cannot be detailed here we were unable to control the leaf-roller to any degree of satisfaction by omitting the application of oils.

Finally, in our treatment of hundreds of apple, pear, plum, and cherry trees not a single case of injury has been found from the effects of the oils. In addition, many barrels of oil were applied last spring throughout western New York and so far as we have personally examined the treated orchards or have been able to talk with the owners of treated orchards we have not found any injury. It should be noted, however, that the oils were applied in the spring and only after the trees had become more or less active or very near the time of the beginning of activity. Moreover, we were afraid of the oils and constantly warned the owner in his general orchard spraying to be careful and not drench the trees. Had the oils been applied more liberally and had the trees been more thoroughly drenched, probably a higher per cent of eggs would have been killed. The owner declares that next year he is going to apply the oils at the rate of 1-12 and that he is going to soak his trees. We have assured him that he will do so on his own responsibility. Undoubtedly Dr. Felt has given us abundant proof that these oils do, under certain conditions, produce an injurious effect. Unfortunately, we do not know just what those conditions are.

To sum up then, our experiments seem to show that the leaf-roller can be satisfactorily controlled by an application of miscible oil to destroy the eggs, supplemented by thorough sprayings with arsenate of lead.

MR. E. P. FELT: I am very glad to have this data, and particularly that in relation to the miscible oils, because the results as noted by Professor Herrick agree quite closely with what I think those oils will do when we make careful application.

MR. W. W. YOTHERS: This subject has been quite thoroughly worked out in Florida during the past five years. The results in Florida show that the injury which follows the use of several miscible oils can be attributed to the chemicals which these insecticides contain and not to the oil itself. Dr. A. W. Morrill found that Orchard brand was very injurious to citrus trees. The present investigation experimented with this insecticide extensively and found independently that it was exceedingly injurious and that it could not be used on citrus at any time of the year. The Bureau of Chemistry analyzed this

insecticide and found that it contained $2\frac{1}{2}$ per cent of sulphuric acid and I inferred that this chemical was the cause of the injury. I regret to state that I found it impossible to introduce sulphuric acid in any of the formula with which I experimented and therefore I was not able to test any formula with and without sulphuric acid.

In regard to Scalecide, it is not so injurious to citrus fruits as Orchard brand but it does so much damage to young fruits that it is inadvisable to use it at any time of the year. The Bureau of Chemistry found that this insecticide contained much rosin or rosin oil. In other experiments with the use of rosin and rosin oil, in every instance the same formula made up with rosin oil caused much damage while the same formula with rosin oil omitted was absolutely harmless. I have concluded that an insecticide for use on citrus trees should not contain rosin oil.

Target brand is fairly efficient. It contains quite a large percentage of phenol which my experiments show is worthless as an insecticide and is more or less injurious to the trees and the fruits. It is much less injurious than either of the former articles and is used quite extensively throughout the state.

Schnarr's Insecticide is also a proprietary article and does not contain any of the above injurious chemicals and as a general proposition it does no injury to fruit or trees. Neither does the Government formula which contains none of these chemicals cause any damage to the trees or fruits if used conservatively. Thousands of gallons of these paraffin oil emulsions have been used with little or no damage.

It is my contention that if oils containing these injurious chemicals cause injury to citrus then there is also great liability that they will cause injury to deciduous trees. I think it would be a matter worth while to experiment with some of the cheap paraffin oil emulsions on deciduous trees to determine if any injury or liability to injury would follow their use. I suppose it is generally understood that miscible oils can be made from cheap lubricating oils which can be found almost everywhere and cost about fifteen cents a gallon in barrel lots.

MR. E. G. TITUS: Only in the last three years have we had any damage from this particular insect. At the present time, it has seriously infested some of the fruit orchards in two of our valleys.

This year I carried on some spraying experiments and my results are not as good as I expected them to be.

The leaf-roller injures from 50 to 60 per cent; this injury was reduced to 24, 11 and 7 per cent, roughly speaking, but even 7 per cent injury is too great to allow the leaf-roller and we wish to improve. If

anyone has been successful with miscible oils and not injured trees, I would like to hear from them.

MR. C. P. GILLETTE: I am very much interested in the paper just read, because the results seem almost identical with those we had in Colorado, especially with the arsenical sprays. We came to the conclusion that it was almost useless to expect the ordinary fruit-grower to control the leaf-roller by means of arsenical sprays. It is necessary to make so many applications in order to keep the young leaves well covered with poison that we seldom find the grower thorough enough to get good results. For that reason, in the Canon City district, where the insect had become very destructive, we insisted upon the use of the oil sprays. We used "Target brand" almost entirely, and got excellent results. Where the growers failed, it was because the orchards were not well treated with the oil.

VICE-PRESIDENT GLENN W. HERRICK: Aren't your trees generally smaller than ours in New York State?

MR. C. P. GILLETTE: I think not. We sometimes gather 40 or 45 bushels of apples from one tree. I believe in Colorado, we have one advantage over the east and the south in our dry climate; it is nearly always bright and clear so that the oil evaporates quickly. In a moist climate the danger of injury from the use of oils is probably greater.

PRESIDENT H. T. FERNALD: The next paper on the program will be by E. N. Cory.

PRELIMINARY REPORT ON THE WOOLLY APHIS¹

By E. N. CORY, *College Park, Md.*

The results herein set forth, as the title indicates, are wholly preliminary. To the author they are in no sense conclusive, but the facts seem to warrant the belief that other experiments along similar lines may lead to a method for the control of the woolly aphid.

Because the nursery injury was the most apparent, the control of this pest was confined for a time, chiefly to nursery stock. This experimentation was begun in 1908, and has been continued as time and circumstances allowed.

This work has never been pursued thoroughly and continuously to a definite conclusion because other, apparently more important, work has always intervened. For the most part we have been content

¹*Schizoneura lanigera* Hausm.