precipitation than it is in Oregon where there is very little rain during the summer months. Here again the washes containing naphthalene show up to best advantage, and have given a satisfactory control.

This uniformity of results from the use of the naphthalene washes is especially pleasing, and we believe warrants further tests of this material. We would be greatly interested in having other workers on this problem test the use of naphthalene as an active agent in washes for the control of either the Eastern or Western Root Borer.

PARASITISM AND NICOTINE IN THE CONTROL OF THE ORIENTAL PEACH MOTH: A SECOND REPORT

By LOUIS A. STEARNS, *Associate Entomologist, Virginia State Crop Pest Commission*

In respect to its distribution in Virginia, the status of the oriental peach moth, at the present time, remains unchanged. The Virginia infestation is still a well defined area within a few miles of Washington city. Here, however, there are indications of the increasing destructiveness of the species.

Collections have shown that within three years the numbers of the insect have been practically doubled. It has established itself with surprising rapidity in isolated plantings of young peach. That the pest has not spread by natural means to the important fruit-growing district of extreme northern Virginia is due possibly to a strip of forested and farming land some thirty miles in width intervening.

The lowest record, in 1920, of average infestation in small home-garden plantings of two-year old peach, based on twig counts, was 37 per cent, while in the case of individual trees, the injury ran as high as 81 per cent. In one instance, injury in a block of budded peach stock was found to exceed 85 per cent of all terminals.

A study made in an established orchard of the comparative growth of 600 uninfested and infested peach twigs of trees distributed among the varieties Belle, Bilyeu, Carmen, Elberta, Heath, Hiley, Salway and Smock produced interesting data. These trees, averaging eight years, had received a moderate winter pruning. The injury was due entirely to infestation by first brood larvae, at the time an average growth of 4.4 inches had been made. Contrary to the accepted idea, the major injury (83 per cent) was to lateral rather than to terminal growth from the year-old wood. Often, this injury was a gouging of

the fruit spurs, while the growth was still tender enough for feeding, and undersized, and in some instances, deformed fruits resulted. It was found, moreover, that fully 41 per cent of the first brood injured twigs grew no more during the season.

In 1920, the injury to late peach fruit was much greater than in preceding years. About mid-September, an examination made in an old infestation of considerable severity, by actual count of between 3000 and 4000 fruits on trees of the varieties Smock, Heath and Salway, showed infestations of 12, 43 and 58 per cent for these respective varieties.

These facts, and others of lesser importance, emphasize the necessity for, and warrant the publication of, increased knowledge concerning the control of the insect either by natural or artificial means.

PARASITISM

In lack of an effective method of orchard control for the oriental peach moth, those who have published notes have commented hopefully on the fact, that this recently imported insect had become subject immediately to the attack of numerous parasites of our native species. Altogether, no less than nineteen hymenopterous and dipterous forms are known now to parasitize the peach moth in its egg, larva and pupa stages. The writer, in 1918, succeeded in rearing eleven species of parasites, the records of which have been published already.¹ Seven of these species had not been known to attack this insect. During 1919 and 1920, while continuing the study of the peach moth in northern Virginia, further attention was given to parasitism. The list of parasites reared each year has been much the same, the only new record being that of a single species of *Apanteles*² taken in 1920. However, in connection with from 1500 to 2000 orchard collected larvae, a number of interesting observations have been made.

Perhaps the most important fact is that parasitism is keeping pace with the increasing numbers of the host. In 1918, parasitism, while attaining and continuing at an average of 35 per cent for small numbers of larvae and pupae during the latter part of the summer, did not exceed 6 per cent in earlier collections. For all three summer broods in 1920, an average of 20 per cent parasitism was recorded, and the averages, 17, 16 and 25, for the first, second and third broods, respectively, show little variation. It has been encouraging, also, to find a uni-

¹Jour. Eco. Ent., Vol. 12, No. 4, August, 1919, pp. 347-348.

²Kindly determined by Mr. S. A. Rohwer, U. S. National Museum.

formity in the extent of parasitism in collections made in the older infestations near the District of Columbia and those more recent and farther removed from the Potomac river.

Macrocentrus sp. has been at all times the most abundant parasite taken. In 1920, 132, or 92 per cent of the 143 specimens reared, were of this species. Apparently, it is becoming equally brooded with the peach moth, specimens emerging from the first brood between the dates June 24 and July 8, from the second brood between the dates July 24 and August 7 and from the third brood between the dates August 22, and September 21.

According to Rohwer³ "the various species of *Macrocentrus* are internal parasites of microlepidoptera, and the overwintering habit will depend on the habits of the host. In most cases, they will overwinter in their cocoons as prepupal larvae."

Under normal conditions, the wintering, cocooned larvae of the peach moth include small numbers of the third brood, and the fourth brood in its entirety. A high degree of parasitism of the third brood affects indirectly, therefore, the number of wintering larvae and the size of the spring brood of moths, upon which the severity of twig infestation is subsequently dependent. However, up to the present time, no parasites of overwintering larvae have been reared, and it seems certain that *Macrocentrus*, and the other parasites as well, have failed to establish themselves as yet in this section of the seasonal life history of the peach moth, and that they still continue overwintering on their native hosts. It may be that this lack of parasitism of the fourth brood is due to its distinctly fruit-feeding habit, as compared with other broods, which may render oviposition by the parasites more difficult. Whatever the cause assigned, this fact, coupled with the low mortality of the insect for the dormant season (about 85 percent of the cocooned larvae have been found to overwinter successfully) accounts probably for its greater abundance in the orchard and the increasing destructiveness noted during the summer of 1920.

LABORATORY TESTS WITH NICOTINE

Preliminary laboratory tests, involving 2877 eggs of the oriental peach moth, were conducted by the writer in 1919 to determine the ovicidal value of nicotine sulphate in respect to this species. The results were promising, and have been reported.⁴

³Correspondence.

⁴Jour. Eco. Ent., Vol. 13, No. 4, August, 1920, pp. 364-367.

During the summer of 1920, these tests were continued, and on a sufficiently larger scale to give results that would eliminate the chance element present in tests in which only small numbers of eggs are employed. In this study, twenty-six experiments, comprising thirty-eight tests with eighteen insecticides and involving 9894 selected eggs were conducted at the Leesburg Field Laboratory. The results substantiate those obtained in the earlier tests. In addition, interesting data were secured on the relative toxicity of different strengths of nicotine sulphate, when used alone, and also, when used in combination with certain spreaders (caseinate and sea moss) and with an arsenical (powdered lead arsenate).

The method of procedure in these tests was similar to that described in the previous report. The eggs deposited on the foliage of one-year-old peach trees were always examined carefully with a hand lens, so that only well-rounded and apparently viable ones entered into the experiments. In applications, the atomizer was held at a sufficient distance to prevent any drenching of the leaves; only a spray mist hit them. Following applications, eggs were given daily binocular examinations up to hatching, and then, the young larvae were continued under observation for 36 hours.

Three series of tests were conducted, in all of which nicotine sulphate (40 per cent) was employed at the varying dilutions 1-1600, 1-800 and 1-500. In the first series, it was used alone; in the second series, a spreader was added; and in the third series, both an arsenical and a spreader were combined with it. Of the 9894 selected eggs, 4585 were sprayed, and 5309 were reserved as a check. Although an endeavor was made to distribute the eggs uniformly, a greater number were employed in those tests, in which applications were made at the more common 1-800 dilution of nicotine sulphate.

The efficiency, or killing power, of an insecticide is computed here, by deducting the per cent of check eggs not hatching from the percent of sprayed eggs not hatching, and in arsenical combinations, larvae dead 36 hours after hatching.

In the first series of tests, in which nicotine sulphate was used alone, 8.7, 70.3 and 80.5 per cent of the sprayed eggs did not hatch. At no time did more than 10 per cent of the check eggs fail to hatch. The actual percentages of efficiency for the varying dilutions 1-1600, 1-800 and 1-500 were 3.8, 60.4 and 73.5, respectively. The greater dilution gave practically no control, while the 1-800 dilution gave a little less than two-thirds, and the 1-500 dilution an approximately three-fourths control.

Either caseinate or sea moss, as spreaders, were added to the varying dilutions of nicotine sulphate, in the second series of tests. Caseinate, as referred to here, was in all cases powdered casein 1 part and hydrated lime 3 parts thoroughly mixed. The preparation of the sea moss spreader has been described previously. Caseinate was employed at the rate of 1 pound, and sea moss at the rate of 2 pounds, to 50 gallons of water. Inasmuch as there was no appreciable difference in the merits of these respective spreaders, the results are reported as one. The addition of a spreader influenced the effectiveness of the nicotine sulphate, especially in the case of the greater dilution. In the tests of this series, 44.4, 75.4 and 84.5 per cent of the sprayed eggs did not hatch, whereas, an average of 87 per cent of all check eggs were hatching, and in the case of the 1-500 dilution tests, only 4.7 per cent of the check eggs failed to hatch. This increased killing power due to the addition of a spreader is shown by the higher percentages of efficiency, 29.8, 61.4 and 79.7, as compared with the results in the first series of tests, in which nicotine sulphate was used alone.

Nicotine-arsenical combinations (nicotine sulphate at the same varying dilutions and powdered lead arsenate always at the rate of 1 pound to 50 gallons of water), with the addition of a spreader (employed as discussed in the preceding paragraph), constituted the third series of tests. Briefly, the combination of nicotine sulphate with an arsenical, in the hope of killing the young larvae immediately after hatching, did not give satisfactory results. The highest per cent of unhatched eggs in this series was 71.9 in the case of a 1-800 nicotine-lead arsenate-sea moss mixture, and in these tests, as high as 17.8 per cent of the check eggs failed to hatch. The highest percentage of efficiency, 54.1, was, therefore, considerably lower than that recorded in either the first or the second series of tests. Failure, here, is due probably to the commonly observed larval habit of rejecting the first few mouthfuls of food material, when entering twigs or fruit.

Extensive studies of the seasonal life history of the peach moth were conducted in connection with this experimental control work to determine the varying abundance of eggs present on the foliage during the egg-laying periods of the successive broods. The records of the deposition of 12678 eggs, in 1920, show that the dates for the heaviest deposits of eggs on the foliage in northern Virginia, as given in the previous report, are correct within seasonal variations. The dates of heaviest deposition, May 10 to 28 and June 27 to July 9, for the first and second broods, respectively, are quite distinct. The last two broods overlap to such a degree, however, that eggs are present on the foliage

from mid-July until late September. The setting of a date for a single application against either the third or fourth brood eggs would be impossible, therefore.

The experimental studies, as reported here, are intended to form the basis of orchard spraying operations, during 1921.

SOME INSECT PROBLEMS CONFRONTING THE AVOCADO GROWER¹

By G. F. MOZNETTE, *Assistant Entomologist, Tropical and Subtropical Fruit Insect Investigations, U. S. Department of Agriculture*

In the present day development of horticulture in the Tropics, there is no new fruit that is coming into prominence more rapidly or with greater assurance of becoming the basis of a profitable industry than the avocado, often erroneously called the "alligator pear." To many this fruit is still unknown, but its reputation is being more widely established each year. At the present time one may find avocados in many of the fresh-fruit markets in our northern and western cities and the fruit is fast becoming as well known as the grapefruit and pineapple. Its unique character reduces to a minimum its competition with other fruits, while its rich, nutlike flavor is almost universally enjoyed among those who have known it long enough to become familiar with its peculiar charm.

At the present time there are probably several thousand acres of bearing avocado groves in Florida and as many more acres in young groves coming into bearing. Avocado growing also is coming into prominence in southern California as well, where many choice varieties are being planted in orchards. Avocado growing in Florida, however, was established a number of years prior to its introduction into California, so that considerable more is known regarding the different phases of the industry in Florida.

With the growth of the avocado industry various problems have confronted the grower. Knowledge of the best methods of propagation, varieties and location best suited to culture to insure success are only successive steps in the production of a satisfactory crop of fruit. There are still other phases and one of the important ones in connection with successful avocado growing is the insect problem. Like citrus, the avocado is an evergreen and hence is subject to the continual attacks

¹By permission of the Sec. of Agriculture.