they appear to be dead, but usually survive. This may perhaps be owing to some of the larvae being more securely embedded in the roots or crown of the tree than others, or some variation in the temperature and humidity within the fumigating chamber. Although 65° to 70° Fah. is the temperature usually maintained within the fumigating chamber, the humidity may vary owing to outside atmospheric conditions.

Blackberry Root Borer

The blackberry and raspberry root borer **(Bembecia marginata),** is about as immune to the ordinary fumigating process as the peach root borer, and, to insure against distributing either of these pests, all the trees, bushes, vines and canes are thoroughly inspected. Any sign of the castings or borings of the insects condemns the tree, etc., to the bonfire.

Vacuum Fumigation

I have referred to the foregoing treatment of insects as applying to the ordinary fumigating process for the following reason:

We have great expectations regarding the vacuum process, by which we hope to get better results as regards the destruction of certain insect pests without injury to the stock or products they infest.

Vacuum fumigation is not entirely new in connection with the treatment of certain products, such as cotton, etc., but there are still a few problems that require working out to perfection regarding the treatment of certain nursery stock.

Mr. D. B. Mackie, of the California State Department of Agriculture, has already done excellent work solving the problems referred to. I could not do justice to his work were I to try and explain in detail all that he has accomplished. But we may look forward to a greatly improved method of nursery stock fumigation in the near future.

THE PEACH TWIG BORER, (Anarsia lineatella) IN BRITISH COLUMBIA

By R. C. Treherne, Entomological Branch, Ottawa.

In the years just preceding 1915 the peach growing industry of southern British Columbia was somewhat depressed. Prices had not been good and much disheartenment was in evidence. In 1915 the price for No. 1 wrapped peaches varied between 45 cents and 75 cents per 20 pounds. In 1916 the price varied between 60 cents and $1.00. In 1917 the peach industry showed signs of revival, the prices being received in this year varying from 75 cents to $1.25 to the grower. Much concern, however, was shown over the depredations of the Peach Twig Borer or Peach Worm, an insect which had been allowed to increase to such proportions in the

years previous to 1917 that, in that year, fully 50% of the fruit in the orchards was unmarketable, while a heavy loss was apparent with the fruit taken to the packing houses. Peaches, apricots, prunes and cherries were being attacked throughout the Okanagan Valley.

During the winter of 1917-1918 energetic steps were taken at the request of the growers by the Provincial Horticultural Department to institute repressive measures against this insect. A campaign of spraying was inaugurated in the spring of 1918, the measures taken being adapted from recommendations made by the States of Washington and California against this insect. During the course of the campaign of 1918 studies were begun by the writer, as an officer of the Dominion Entomological Branch, at Summerland, Penticton and Kaleden, and efforts were made to harmonize the developing life history of the insect with the spraying campaign then in progress. Similar studies were maintained during 1919. A short circular on this insect, its life history and control, was prepared by the writer and issued and circulated by the Provincial Department of Agriculture. This circular covered the essential features of practical value to the grower. So far as I am aware no effort has been made to present to entomologists the substance from which this circular was written. With this end in view, the following record is presented:

OVER-WINTERING HABITS

The adult of this insect is a minute moth which may be found on the wing in the orchards in considerable numbers during May and June and again in August and September. In a normal year two generations occur, the autumn brood of moths being present from early August until late September, ovipositing freely on the twigs. The eggs hatch, giving rise to larvae which over-winter. So far as our records go, the winter is only passed in this larval stage. Commencing in August and passing through September into October, these larvae, which are of an average length of 2.5 mm., after feeding to a slight extent on leaves, twigs and fruit, form hibernacula. This hibernaculum is a minute gallery made in the wood of the tree by the larvae. It is lined on the inside with silk and a minute column of frass is thrown up on the outside. These columns of frass are very distinctive and are readily seen, particularly when the castings are fresh. They occur in the crotches of 1, 2, 3 and 4-year-old wood of young orchards. When larvae are particularly numerous and in older orchards, these hibernacula are found, as well, in 5- and 6-year-old wood, on the underside of boughs as well as in the crotches. Entrance to the wood is frequently made through the stomata and in the softer cambium growth surrounding pruning scars. As a result of an examination of several hundred hibernacula during 1918 and 1919, in commercial peach and apricot orchards, by far the greatest number of larvae were found in the crotches of 1- and 2-year-old wood, usually on the upper sides and not underneath.

While the larvae enter their hibernacula in the autumn, 2 mm. to

3 mm. in length, they feed to some extent and undergo at least one moult before they emerge to continue their development. Signs of activity in the spring are evidenced by the production of fresh frass and by an enlargement of the gallery. These larvae may become 5.5 mm. in length before they emerge, although the average length is not more than 3 mm. in the spring.

There is a certain natural mortality of the larvae during winter. An exact record taken in unsprayed orchards in April, 1919, at Penticton, following the winter of 1918, showed that 31.5% of the larvae had died; 66.4% out of the 125 galleries examined in April, 1919, contained live larvae, while 2.1% contained dipterous larval parasites.

Spring Larval Habits

The over-wintering larvae, in the early spring, leave their burrows and move to the buds and blossoms. This migration commenced in 1918, on April 10th, at the time when the apricot and peach blossom buds were well swollen, and on April 21st, 1919, when apricots were nearly in full bloom and peaches were in the "pink." This migration, once started, was rapid. It was at its height on April 16th, in 1918, and on April 27th, in 1919; in the former year when apricots were in full bloom and in the latter year when the apricot petals were commencing to fall and peaches were in full bloom. Larvae were actually found infesting the buds of peaches on April 16th, in 1918, and on April 25th, in 1919. There is, however, as has already been pointed out, certain larval activity within the burrows previous to emergence. In 1919 this activity was apparent in the presence of fresh frass at the entrance of the burrows on April 9th, fully two weeks before any migration took place from the burrows. A period of cold, backward weather in the spring of 1919 checked the development which might have followed rapidly after the first appearance of activity.

Following the migration of the larvae from their over-wintering burrows, much feeding takes place at various points on the tree; buds and twig growth are fed on and mined, blossoms and young fruit are bored into and destroyed. At first there seems to be an inclination for the larvae to move freely over the tree, feeding here and there before settling in one fruit or twig. This is an important point which has its bearing on the value of arsenical sprays. This larval activity of the first generation continued until the middle of June, at which time practically all had pupated. In 1918, full grown larvae, measuring 12-15 mm. in length were found preparing to pupate on May 10th; in 1919 the first pupae were found on May 28th, though they commenced their preparation on May 23rd.

From these habits it may be seen that twig, leaf and fruit development are all attacked by the larvae in the spring and that there is a certain movement of the larvae over the tree, although they seldom move off the original twig on which they passed the winter. On the records

from the examination of a great many larvae during May, it was found that 83% of the larvae attacked twigs and 17% attacked fruit.

The injury to peach twig growth was more apparent than that on apricots. There was a slight wilting of the leaves in the initial attack, resembling the curl caused by aphids, followed by a distinctive withering and a darkening of the green color of the foliage, which becomes discernible by experience. With apricots the twigs grow faster and stronger than peaches and the wilting is offset, thus making determination of infestation difficult.

During June, twigs attacked in May recover and new growth forms to replace the wilted portions. Often a small cluster of dead leaves will be seen, particularly in apricots, with the new twig growth continuing without interruption. Sometimes where marked injury has been caused and the terminal bud destroyed, growth starts at other points on the stem. In a severe attack "twiggy" formation is a characteristic sign of previous infestation.

PUPATION OF FIRST GENERATION

Full grown larvae measuring 12 to 15 mm. in length were found on May 10th, 1919, preparing to pupate. A few days later pupae were formed. These were located, for the most part, in cracks and crevices of the bark in the main trunks and larger limbs. Beneath flakes of loose bark, within the characteristic curls of bark tissue and in the longitudinal cracks in the main trunk, were common locations, particularly on apricots. By the end of May it was almost impossible to find any larvae in the fruit or twigs, those found being full-grown, but pupae were plentiful. A few full-grown larvae were observed within the fruit of apricots on May 17th, but in general almost the entire generation were in the pupal stage by June 1st. In 1919 the first pupae observed were those bred under insectary conditions from larvae 3 to 4 mm. in length taken on May 2nd. These commenced to pupate on May 28th. Under field conditions in this year full-grown larvae were observed in the orchards on June 6th, but all had disappeared and had formed pupae on June 16th. The length of life of individual larvae varied from 38 days to 57 from the spring emergence from hibernacula, and the pupal period in each year lasted 14 days to 3 weeks.

EMERGENCE OF MIDSUMMER MOTHS

In 1918, the last week of May saw the first appearance of adults. Moths at Kaleden were seen on apricots on May 29th, and in the first two weeks of June they were common in the orchards at Penticton, and some were seen in the first week of July. In 1919 moths were observed on June 16th and remained common for a full month.

Eggs were seen, on occasion, shortly after the appearance of adults in each year, on new twig growth. Difficulties in rearing moths in cap-

tivity prevented the taking of more ample notes on the places chosen for oviposition, and the size of the egg precluded extended obsravtions in the field.

Appearance of Second Generation Larvae

In 1918 the first small larvae of the second generation were observed first, at Kaleden, on apricots on June 19th. The terminal leaf cluster was attacked much in the same way as the earlier spring damage was accomplished. In this same orchard larvae 4 mm. long were taken on June 27th. They had burrowed down two inches into the central pith of the stem and had caused the terminal growth to wilt. Other larvae, entering the stems at leaf axils, burrowed in, but frequently withdrew to attack the tips of the growing twigs, where surface tissue is fed on to some extent before entering and burrowing down the central pith, where they were commonly found. On July 10th, larvae 5 mm. in length were found, and on July 16th some 10 mm. long. In August larvae in all stages of growth, from 3 mm. to 12 mm., were common. Fruit was attacked much in the same way as formerly noticed, the larvae frequently gaining entrance near the stalk. Clustered peaches were often found attacked. Fruit thus entered would be completely hollowed out, showing a large cavity within and a minute entrance hole. The attack on mature fruit is probably the only really serious form of injury caused, as it renders it unmarketable.

In 1919 all larvae seen between June 6th and 16th were full grown. There was then a lapse of fully five weeks, in which period it was practically impossible to find any larvae of any kind and none at all on the particular trees which were under continuous and careful surveillance. On July 14 minute larvae 3 to 5 mm. in length were common. Hence field data supports our laboratory rearing that the larvae found during July and August arose from moths which had developed from overwintering larvae. On August 30th, in 1919, nearly all the larvae found in the orchards were full grown. During the first two weeks of September, minute larvae were again apparent, which, from our laboratory rearing notes, were the progeny from the autumn generation of moths. These small larvae formed hibernacula. The field notes of injury show no material variation in habits to that already evidenced by the spring larvae. It was noticed, however, that the percentage of larval injury to fruit was greater than the injury to twigs.

Second Generation and Moth Emergence

Collections of larvae taken between August 1st, and 27th, 1918, varied in size from 3 mm. to 10 mm. These were bred through under normal insectary conditions, using a small cage over a young peach tree. Pupation followed, and moth emergence took place between August 19th and October 1st. The height of the flight season occurred in the middle of August. The length of the pupal period again lasted about 14 days,

and 75% of the pupal cases were formed on the main trunk and crotches two feet from the soil surface. An unusual record was obtained from a pupa formed on July 13th, from a larva which had possibly been starved, and which formed its moth on July 21st.

In 1919 second generation larvae formed pupae on July 23rd, and moths emerged on August 4th. On August 5th, field observations showed 25% pupation; on August 19th 75%. Full-grown larvae were taken on September 4th. Moths were commonly observed in the orchards on August 19th and throughout the month. Laboratory material yielded moths until the close of September.

The second oviposition period of the year followed shortly after the appearance of moths, and eggs, although only seen at various times, must have been freely laid in both years, from the middle of August until October.

The larvae arising from these eggs enter the bark, form hibernacula and pass the winter with an average length of 2.5 mm., although some may be 4 mm. and a few as much as 5 mm. in length.

These young larvae undoubtedly feed to some extent before entering winter quarters, as they may be quite commonly seen feeding on mature peach fruit or on leaves during the latter part of August and in September. Hibernacula were formed and inhabited on August 20th and at all periods between this and autumn.

There is no doubt that two generations occur in a year, although it is true, in certain seasons, the second generation may not be quite complete.

THE CONTROL BY SPRAYING

The matter of control by lime sulphur and lead arsenate applications before and after blossoming have been laid down already in the circular previously mentioned. The following notes are supplementary to the circular:

On April 10th, 1918, at Kaleden, when the apricot buds were well swollen and purple, lime sulphur (1-9) spraying was in full operation. Triplex power machines with "gun" nozzles were employed, and certain sections of an orchard were personally thoroughly sprayed at 200 lbs. pressure, with particular spray direction into the crotches of the finer twigs, the work being done from the machine and not from the ground. On April 16th, and on succeeding days, it was found that a larger percentage of larvae survived than was expected. Some larvae were unquestionably destroyed in their burrows, for between April 10th and 16th the majority of the larvae in 1918 were still in winter quarters, though signs of activity were noticed in the presence of fresh frass and some larvae had migrated to the buds. Other larvae freshly destroyed were found in the terminal buds, indicating either that the solution penetrated

these burrows or that the lime sulphur had acted as a slow stomach poison following larval feeding on surface tissue. In the laboratory the value of lime sulphur as a stomach insecticide gave both positive and negative results. The caustic action would appear to be the main controlling factor, but it was not as great as anticipated, judging from the number of live larvae found a week after the applications in hibernacula and in buds. A careful record made in sprayed and unsprayed plots showed that no more than a 50% degree of control had been effected; a ratio from 8.1 to 3.8.

On May 9th, at Kaleden, when 60%-70% of the apricot husks had fallen and the fruit was three-quarters of an inch long, when the larvae were half to full-grown, an application of 2 gallons of concentrated lime sulphur to 100 gallons of water, to which was added 2½ lbs. of lead arsenate paste, the results proved that many larvae died from arsenical poisoning. Here, again, only 50% efficiency was apparent; a ratio being obtained of 7.2 to 4.5.

Owing to the extensive spraying campaign that was conducted in 1918, an opportunity offered itself to check the general results over a large acreage of peaches and apricots. The notes taken presented themselves without comparison to control blocks, hence are only judged on their relative commercial value, supported by observations of larvae in situ.

It was felt that both sprays individually applied did not accomplish more than 50% results, though the results obtained, supported by the natural larval mortality during winter and a certain natural loss in the pupae during May, were commercial and pronounced satisfactory. Those growers with extra zeal who applied two sprays, one before and the other after blossoming, obtained practically 100% results, for their orchards hardly yielded any worms at time of picking. This proved the desirability of making two sprays in heavy infestation, the practicability of rendering an orchard commercially clean in a single season, and lastly that moths do not move on the wing from one orchard to another to any appreciable extent.

In 1919, further notes on spraying were obtained. It was shown that a power machine, with a 200-gallon tank, actually carrying about 150 gallons, with a pressure of 250 lbs., using a "gun," one man and a driver, would spray two acres of 9-year-old apricots in bud to a filling. The trees were planted 170 to the acre, and about 15 trees were sprayed in 15 minutes.

A Pontiac machine, a favored lower powered machine, used for hillside work, carrying a 120 Imperial gallon tank, handled 5 acres of apricots a day during April. Two nozzle men and a driver were required, and 150-175 lbs. pressure was employed. Both machines did excellent work, the coating of lime sulphur being thorough.

Here, again, as in 1918, the hibernacula were not always penetrated. Some crotches containing hibernacula, encrusted with a heavy deposit of lime sulphur in the April spraying, yielded healthy larvae a week after application, but, on the whole, results were satisfactory. In this year, lead arsenate applications applied as soon after blossoming as possible gave better results than the lime sulphur sprays applied just before blossoming.

In consideration of the whole matter of spraying, growers have the choice of lime sulphur or lead arsenate, used separately or in association in two sprays, one just before and the other just after blossoming. In a heavy degree of attack, both applications may be made. The lime sulphur application has a slight preference over the later lead arsenate sprays owing to its possible effect against the fungous disease, "leaf curl." The spray for "leaf curl" is an early lime sulphur spray applied even before the buds break. A grower with a light attack of fungous and peach worm has the opportunity of economizing by combining this peach leaf curl spray with the spray for the peach worm.

FOREST ENTOMOLOGY

BY RALPH HOPPING.

If I were to ask you what was the most important crop of British Columbia, many of you would probably answer "apples" or "strawberries," for instance. The forests, however, produce the most valuable crop and turn in the most revenue to the Provincial Government. I understand the revenue is greater than all the other industries combined.

Although the Government is doing a great deal at the present time to preserve the forests, we are not properly or adequately taking care of this, the most valuable crop in the province; principally because the public does not realize that it is so valuable or so necessary, and we must have the support of the public when public money is expended.

The forests of B. C. have been subject to great losses from year to year, through two chief agencies: FIRE and DESTRUCTIVE INSECTS. Fire is the more spectacular, but the depredations of insects are at present of much greater importance in the open stands of yellow pine in the dry southern interior of the province. During the past eight years the loss from insects in and around Princeton and Merritt has amounted to over 200 million feet of lumber, worth at least 6 million dollars to the province.

The fires are being taken care of more and more effectively as the years go on by the protective force of the Forest Branch. Through close co-operation with this same Forest Branch, we are gradually beginning to take care of the insect depredations. This work, however, is a specialized department, as the insects attacking trees are of many species, each species of tree often having its own special group of insects.