

Literature

- A partial list of references appertaining to taxonomic revisions and to life histories of some of the Vancouver Island species dealt with in this paper is appended here.
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THE APPLE SAWFLY *HOPLOCAMPA TESTUDINEA* KLUG. ON VANCOUVER ISLAND, BRITISH COLUMBIA*

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In June 1940 some small apples damaged by a boring insect were brought to the Entomological Laboratory at Victoria by the owner of a city garden. Each apple had a round hole in the side nearly one-eighth of an inch in diameter; the interior was extensively excavated and contained a black oozy pulp. In some of the apples a whitish sawfly larva was found. This type of injury was something entirely new to us and the apples were forwarded to Mr. W. A. Ross of the Vineland Station, Ontario, laboratory who tentatively identified the insect as the apple sawfly, *Hoplocampa testudinea* Klug. Later this identification was confirmed by Dr. A. M. Masee of

the East Malling Research Station, Kent, England, to whom some of the larvae were sent by the Dominion Entomologist. This is the first known occurrence of this insect in North America. A brief survey showed that the species was present in parts of the city of Victoria and the adjoining municipality of Oak Bay over an area of approximately six square miles.

Distribution and economic importance:

The apple sawfly is distributed over the whole continent of Europe but is more common in the north. It is the most important apple pest in many parts of Germany, Denmark, south-west France and Holland. It is found in most parts of England but appears to be only locally common and seasonal in abundance. Masee (2) states: "This insect is re-

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sponsible for much of the useless fruit grown in the apple orchards of England." The fruit is attacked as soon as it begins to form and by the time the apple is an inch in diameter the larva is full grown and ready to leave through a large hole in the side. The infested fruit falls to the ground either before or after the larva leaves it. In addition to the destruction of young fruit, a secondary injury is caused to many of the apples by surface feeding. The young larva, before it enters a fruitlet, may feed on the exterior of an adjoining one, which results in characteristic ribbonlike scars or deformity. The injury is quite different from that caused by the codling moth. Large cavities are eaten in the centre of the apple and there is always an opening to the exterior even at an early stage. The larva does not always complete its growth within a single fruit and if the first is insufficient for its use before it reaches maturity it passes to the next one and so a succession of young fruits may be destroyed. The cavities are full of black or brown messy frass which often exudes from the hole at the side. Infestation observed at Victoria varied from slight, to possibly 50 or 60 per cent.

Life History: The adults appear on the wing as soon as the apple trees come into bloom. In 1941 early apples were in flower in the neighbourhood of Victoria on April 10. The first sawflies were collected on April 18 but since they were quite numerous it is probable that they had begun to appear a week before that date. The proportion of males to females on April 18 was 4 to 1 and five days later 2 to 1. The adults are active only in bright sunlight and on dull days none could be found. They are swift in flight and not very easy to obtain, since the majority seem to prefer the blossoms on the upper branches of the trees. Only trees in full bloom were visited by them and as soon as the petals began to fall they left those trees for others. None were found on trees from

which the bloom had dropped. According to our observation in 1941 the adults were on the wing for about three weeks.

Oviposition was not observed although the females were frequently watched as they crawled over the blossoms. The egg is inserted from the outside of the calyx just below a sepal, is pushed right through and may be found at the base of the filaments or near the style, the position being indicated by a small rusty-brown spot which is often partly obscured by pubescence. Those seen by us were white, glistening, oval and about 1 mm. in diameter. According to English and German authorities the average number laid is 12 or 13 with a maximum of 20 to 22. The incubation period is about 13 days. Some of the larvae remain within the calyx after hatching, while others leave the egg pocket and feed on the exterior of the young fruit, or on an adjoining one, forming a characteristic lineal scar. These lineal scars were found to be much more frequent on small-sized varieties of apple, such as crabs, with many fruits to a cluster, than on large-sized varieties.

The larva: The larva is creamy-white with a dark brown head and a black or dusky chitinous plate on the upper surface of the anal segment. When mature it is about 12 mm. in length. There are 6 abdominal and one anal pair of prolegs. On the labrum, in the middle of the two muscle attachments, there is a dark brown triangular spot. Like those of many other species of sawflies, the larvae have a most offensive odour which in this case resembles that of a pentatomid bug. They are active and capable of crawling some distance after dropping to the ground, which they do in June when mature. They then enter the soil to a depth of four to eight inches and form compact, oval, brown cocoons, 7 to 8mm. long and 3 to 4 mm. wide, those of females being the larger. During the rest of the season the insect remains as a larva within the cocoon and pupation takes place in the following

spring. Velbinger (6) states that the diapause lasts 9 months where the development is annual and 21 months where it is biennial. The developmental period of the larva in the cocoon is probably dependent upon the moisture of the environment at the time of spinning and upon the temperature during the first hibernation. Moisture is all-important to the welfare of the insect during the diapause. From a considerable number of cocoons collected by us only three adults emerged, which is attributable to an insufficient moisture supply.

The adult: The adult sawfly is black on the dorsal surface except the head, which is orange yellow with a black patch between the eyes. The eyes are black. The antennae are yellow with a dusky or black mark at the base of segments 3, 4 and 5 on the upper side. The tip of the abdomen in both sexes is yellow but this is more apparent in the males. The ventral side of the abdomen and the legs are orange yellow. The wings are transparent, somewhat iridescent, with brownish or black veins and costal margin with the stigma dark except at the apical end which is yellow. The females are about 6 mm. long, the males slightly smaller.

H. testudinea reproduces both bisexually and parthenogenetically. According to Theobald (1) a second generation has been observed occasionally in England. This was not confirmed by Velbinger (6) in Germany. The second generation is said to attack large apples in July and August. It is possible that a second generation could occur where higher summer temperatures are general.

The apple sawfly was undoubtedly introduced in balled nursery stock. Even with the most careful examination of the soil it is difficult to detect the cocoons, for being covered with grains of earth they cannot be distinguished except by their symmetrical outline, from a small piece of soil. To collect many of them, even where they are known to

be numerous, has been found quite a difficult matter and the most feasible method is to float them out of the soil in a tub of water.

Impracticability of extermination :

The short survey carried out in 1940 showed that the sawfly had already spread over a very considerable area of city and suburban lots in which apple trees were extensively planted. The question of extermination before the pest could spread further was immediately considered, but the actual limits of the infected area were not then known nor were the means available for carrying out a campaign. It was decided at a conference of Dominion and Provincial officers that scouting should be continued in the spring of 1941. The limit of the infested area in 1941 was found at a point six miles north of the city, including the whole of the municipality of Oak Bay, the Gordon Head and Cadboro Bay districts and the greater part of the city of Victoria, an area of approximately 16 square miles. The sawfly was not found in Victoria West nor in Esquimalt, but appeared to have spread in a northerly and northeasterly direction, possibly following the general trend of the prevailing winds. It was seen at once that an extermination campaign involving the destruction of all apples over a period of 2 years would be a colossal undertaking. A census of apple trees within the affected area, including a two mile zone outside the actual limit of infestation, showed that more than 23,000 trees would have to be dealt with. The time limit during which the fruit must be stripped being only fourteen days at the most, probably 400 or 500 men would be needed for the work and the impossibility of obtaining such a force under the difficult labour conditions created by the war will readily be appreciated. Therefore, extermination of the sawfly cannot now be regarded as a possibility and recourse must be had to spraying to keep it in control.

Control by spraying: Fortunately, one spray applied at the proper time will usually give good control of this species. In England a spray of free nicotine (98%) at the strength of 8 oz. to 100 gallons, with or without lime-sulphur, applied within a week after petal-fall, is recommended (2, 3, 4). As the object is to destroy the eggs, a coarse driving spray directed at the calyces should be used. The addition of a spreader is desirable, but not essential. Lead arsenate will not control the sawfly but may be added to sprays for the purpose of controlling other pests. Velbinger (6) states that the best control of *H. testudinea* in Germany was obtained by spraying with a strong solution of quassia; or with quassia in combination with arsenic, copper, and lime, at petal-fall. Contrary to English data, he states that nicotine with lime sulphur and lead arsenate was ineffective.

At Victoria in 1941 experiments with nicotine sulphate in a 1½ per cent summer oil spray gave control equal to that obtained in England with free (98%) nicotine. The nicotine sulphate was used at a strength of 1 to 600, and lead arsenate was added at the rate of 2 lbs. to 40 gallons. As this trial was conducted in city gardens where no satisfactory check trees could be used owing to the number of different varieties of apple in the gardens, the result must be taken only as an indication. Infestation was kept down to 3.9 per cent in the case of one series of trees and to 5.2 per cent in another, while unsprayed trees in a nearby garden showed as high as 80 per cent attack. The addition of lead arsenate had a good effect in clearing the foliage of sundry other pests such as apple and thorn skeletonizer and other caterpillars.

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THE ADVANCE OF THE CODLING MOTH IN BRITISH COLUMBIA

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The codling moth, *Carpocapsa pomonella* (L.), has increased to such an extent during the last fifteen years that it has now become the chief limiting factor in apple production throughout the apple producing areas of the southern Interior of British Columbia. Until about 1915 the codling moth was practically unknown in the Interior. Although infestations were reported at Victoria in 1900 and at Kamloops and Kaslo in 1905, these infestations evidently covered

only small areas. They were believed to have resulted from the importation of wormy pears from California and wormy apples from Ontario.

In 1912 codling moth was reported from Armstrong and Rutland. At Armstrong worms had evidently been imported in nursery cases from Oregon, and at Rutland in settlers' effects. Prompt eradication measures were carried out. Weather conditions were helpful for in the spring of 1913 a heavy frost prac-