

It should be noted that the percentage of infestation recorded here is probably less than the true flea populations of the living animals, as the bulk of the collecting was done by means of traps and, while these were visited as frequently as possible, the rats were often left dead in the traps for hours before they could be examined. As ectoparasites usually tend to leave soon after the death of the host, it is likely that many fleas were lost in this manner. Also, the fact should be considered that the greater part of the survey was conducted during the autumn. C. Y. Wu (4) points out that in China, flea populations were high during May, June, July and August, and that during other months the animals were not so heavily infested. This probably holds true here also, especially in view of the fact that the same species of fleas are being considered. Thus the figures presented here may not be representative of the percentage infestation during the season of principal activity, i.e. the summer, and in the case of infestation, the ideal season for the dissemination of plague.

#### References

1. **Holland, G. P.**, 1940. New records of Siphonaptera for British Columbia. Proc. Ent. Soc. British Columbia, No. 36:11-12.
2. **Poole, J. B.** Unpublished Report—"A rat and rat flea survey of the city of Vancouver and the Port of New Westminster." (Files of the Laboratory of Hygiene, Kamloops, B.C.)
3. **Spencer, G. J.**, 1937. The menace of rat parasites in Vancouver in 1936. Proc. Ent. Soc. British Columbia, No. 33: 44-45.
4. **Wu, Chun, Pollitzer and Wu**, 1936. "Plague" Weishengushu, National Quarantine Service, Shanghai Station.

---

### NOTES ON THE LIFE HISTORY OF THE JUNE BEETLE *POLYPHYLLA PERVERSA* CASEY\*

by W. DOWNES and H. ANDISON,  
Dominion Entomological Division, Victoria, B.C.

The June beetle, *Polyphylla perversa* Csy., has long been a major pest of small fruits grown on light sandy soil in most parts of southern Vancouver Island, where there is scarcely a fruit farmer who is not familiar with the fat three-year-old grubs known as "June bugs", which take such a heavy toll in the strawberry fields. Within recent years losses occurring through the attacks of this species have become general rather than sporadic, making it imperative that a study of the habits of the insect be made with a view to devising, if possible, some means of control.

#### Crops Attacked:

Formerly the June beetle was considered mainly a pest in strawberry fields but evidence recently accumulated shows that the larvae, through the greater part of their three-year life cycle, can do much injury to other crops on light soil. Nursery stock planted on sandy land has suffered greatly, the roots of roses, apples, pears, plums and cherries being completely destroyed;

\* Formerly referred to as *P. ruficollis* Csy. See Brown, 1940, Canadian Ent., 72: 186

so much damage was caused in one case that the growing of nursery stock had to be abandoned. Loganberries and raspberries are also attacked and there are instances of whole rows of loganberries being destroyed in the first season after planting. Unthriftiness in young cherry trees has been traced to destruction of the feeding roots by June beetle larvae. Potatoes are often seriously injured when planted on infested land, the larvae scooping out large cavities in the tubers. Corn is also attacked, a single larva often moving from plant to plant cutting off the roots of each in succession. We have one record of injury to broccoli by *Polyphylla* grubs. Complaint has been received of damage to tulip and crocus bulbs in one instance only, and in general it may be said that bulbs are not attacked. However, should the larvae be deprived of their preferred food by the planting of some other crop they may feed on the latter just as readily, although an exception must be made in the case of legumes, which usually do not seem attractive to them.

Most of the damage appears to be done by the large two- and three-year-old larvae. In strawberry fields, the main root of a plant may be severed from two to four inches below the surface of the soil, or the main fibrous roots eaten away, the grub then moving on to the next one. Quite commonly, in some of the worst localities, a grower may lose one-third of his strawberry plants in a single season.

#### The Larva:

The grubs are found only in light sandy or gravelly lands with a permeable subsoil. Digging up the first six or eight inches of topsoil generally results in the discovery of only large mature or nearly mature grubs. Since it is fairly certain that in common with related species of Scarabaeidae, the larval period lasts for three or even four years, the smaller larvae of the first and second years apparently must occur at greater depth in the soil, where the finer and more tender roots extend, while the older larvae which are able to feed on larger and more woody roots may be found in the upper levels. To some extent the observations made during the present season confirm this supposition, as numbers of one-year-old larvae have been found at a depth of more than a foot, especially among the small roots of Japanese plum and other trees; and, as will be shown later, the newly-hatched and one-year-old larvae are likely to be found below plough level, since the eggs are deposited at depths of from eight to fifteen inches.

In common with related species of white grubs, the *P. perversa* larvae descend deeper in the soil for a short period in December and January and in the course of population studies have been found as deep as thirty inches. This would seem to be an inherited trait rather than a matter of necessity, for in the mild climate of the Pacific Coast frost seldom enters the ground very far. Apart from these seasonal movements, some large larvae may be found at considerable depths at any time of the year, their movements being influenced by the presence of suitable food such as tree roots; but from February, until pupation takes place in May, and throughout the summer, they are generally near the surface. Thus the grubs are most noticeable during the spring ploughing and prodigious numbers are sometimes turned up. From one acre of a strawberry patch in Saanich four gallons of grubs were gathered in 1938.

**The Pupa:**

Pupation commences about the middle of May the duration of the pupal period has not yet been determined exactly but appears to be about five weeks. On May 10 the larvae were found to be forming their pupal cells but none had at that time pupated. The majority of the cells examined were about four inches below the surface, with a few a little deeper. The cell is large, oblong, and measures about two inches long by three-quarters of an inch wide.

**The Adult:**

Usually the beetles begin to emerge from the soil during the first week in July, but in early seasons emergence may start in the third week of June. In 1939 the first beetles obtained, two males, were taken on July 6. The males seem to emerge before the females as none of the latter were obtained before July 10. The emergence holes, about three-fifths of an inch in diameter, are bored directly upwards from the pupal cells; often they may be found in groups, especially on hard-trodden ground such as pathways, as if firm soil was preferred for the construction of pupal cells. After boring the emergence hole the beetle does not necessarily take flight, but may remain in the cell until a favorable evening, flight probably depending on the evening temperature. It was found that if the temperature was lower than 54° F. at 8.30 p.m. there was little or no flight of beetles, but above that temperature and especially at 60° or over there was great activity. The flight commences at about 8.30 p.m. and continues for half an hour, after which few beetles are seen, though some continue to be attracted to lights until 10 p.m.

To test the efficiency of a light trap, one was constructed of a white board three feet square with a 60 watt electric bulb in the centre. This was fastened vertically on posts at a height of about seven feet, above a large washtub containing water. The beetles, on striking the white board, fell into the washtub where they were perfectly helpless even in water half an inch deep. The trap, however, was a failure as a means of collecting beetles, as comparatively few would strike the white reflector and fall. The majority would circle around the light and then zoom up in ever widening circles until lost to sight. Moreover, nearly all the beetles caught at light were males. As only a few females were captured this light trap had no value as a method of control.

Females were not obtained until the males had been in flight for several days. Some females were found in their emergence holes waiting for an evening suitable for flight. By poking a straw down these holes, the presence of an occupant could be detected by the intermittent hissing or wheezing sound. The disturbed beetle makes this noise as it raises and lowers the elytra; it is seemingly caused by friction between the edges of the elytra and the sides of the abdomen. In sandy ground the soil falls in at the mouth of the emergence hole forming a slight pit similar to that made by an antlion, and at the base of the pit the beetle will be found waiting until night-fall when it takes flight.

The adult beetles feed on the foliage of conifers. In captivity they were fed on Douglas fir, Norway spruce and western hemlock, and showed an especial liking for the last. Lodgepole pine was offered, but the beetles took

it only under stress of hunger. Elytra of the beetles were found in considerable numbers under Douglas fir and hemlock trees on the edges of clearings, where screech owls and bats had caught them as they fed. Adults kept in captivity lived for about three weeks. The beetles were still in flight during the first week of August and nine males were captured at light on the 2nd. As the flights diminished after that date, the adult life is possibly not longer than four or five weeks.

#### **Oviposition:**

It was observed in 1939 that the females were most active on warm evenings. The eggs are laid at a depth of from eight to twelve inches or even deeper if the soil is easily penetrated, eggs having been recovered from a depth of fourteen inches where the soil is very sandy. On alighting, the female rapidly descends in a vertical direction to the desired depth and then burrows horizontally depositing eggs as she goes. Not more than fifteen eggs have as yet been found by us in one spot, the usual number being from eight to twelve. Dissections of gravid females have indicated a laying capacity of sixty to seventy eggs.

#### **The Egg:**

The eggs are large and slightly oval; when first deposited they measure 3.4 mm. long by 2 mm. wide, but after several days, increase considerably in size, the largest measuring 4.5 by 4 mm. They are dull creamy white in color, and are not enclosed in an earth ball as are those of some species of white grubs. The incubation period has been found to be about fifty-four days. Eggs collected in the field and kept in the laboratory hatched on September 2nd; others placed in soil boxes in the open hatched during the third week in September.

#### **Parasites and Predators:**

As mentioned before, the adult beetles are destroyed in some numbers by screech owls (*Otus asio kennicotti*), and bats have been seen to attack them in flight. Many of the adult beetles caught by us were parasitized by a large sarcophagid, *Sarcophaga misera* var. *exuberans* Pandelle. Two other species of flies, *Muscina assimilis* (Fallén), and *Muscina stabulans* (Fallén) also were reared from the adults, but are probably scavengers. The larvae are parasitized to a considerable extent by a large hymenopteron, *Tiphia* sp. Numerous cocoons of this wasp have been discovered when digging for June beetle larvae. When ploughing is in progress gulls and crows destroy great numbers of larvae. Hogs and chickens also feed on them greedily; owing to the large size of the grubs, chickens are soon satisfied; if the hogs are kept in infested fields, they will root up the soil and find most of the larvae not too deeply buried.