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NOTES ON THE CABBAGE SEEDPOD WEEVIL, *CEUTORHYNCHUS ASSIMILIS* (PAYK.) (COLEOPTERA: CURCULIONIDAE), AND ITS PARASITES¹

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The cabbage seedpod weevil, *Ceutorhynchus assimilis* (Payk.), is an indigenous pest of cruciferous seed crops in Europe. It was first reported in North America by the Division of Entomology (1935, p. 463) from a specimen taken at Vancouver, British Columbia, by Hugh B. Leech in May, 1931. The insect did not become economically important in British Columbia until the importation of turnip, cabbage, and cauliflower seed from Europe was prevented in 1940 by the naval blockade of western Europe. There was then an increase in the acreage planted to cruciferous seed crops on Vancouver Island and the lower mainland of British Columbia, and the weevil became the most important insect pest of these crops. The use of parasites to reduce damage by this pest was undertaken in 1943 as a co-operative project between the Field Crop Insect Laboratory at Agassiz, B.C., and the Dominion Parasite Laboratory, Belleville, Ont.

The weevil became economically important in the western United States about the same time as in British Columbia. It was reported in 1935 in the northwestern part of Washington, where most of the cabbage seed produced in the United States is grown (Baker, 1936). From this area it spread southward through Oregon to California, where it was reported in 1946 (Hagen, 1946).

In Washington it became of increasing importance and a laboratory, now known as the Northwestern Washington Experiment Station, was established at Mount Vernon, to investigate the weevil and other pests of cruciferous seed crops. Its biology, distribution, food plants, and parasites were studied (Hanson *et al.*, 1948).

Mr. R. Glendenning, Officer-in-charge, Field Crop Insect Laboratory, Agassiz, studied the course of the infestation in British Columbia from 1939 to 1945. The infestation on the mainland was severe during the early years of his investigation, but gradually became less severe until 1945, when it had virtually disappeared. During this period the infestation on Vancouver Island remained at a high level.

In 1949 a survey was initiated at the Vancouver laboratory to obtain information concerning parasitism of the weevil in British Columbia with special reference to the value of introduced species. Further information concerning its distribution and the degree to which it infests cruciferous seed crops was necessary. The project was continued in 1950 and 1951 and collections of infested material were obtained from the important seed-growing areas from June to October.

The insect was obtained from seed fields of cabbage, cauliflower, Brussels sprouts, and swede turnip and also from wild turnip, *Brassica campestris* L.; garden radish, *Raphanus sativus* L., growing as an escape; and a wild

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mustard, *Brassica juncea* (L.) Coss. The wild host plants are more widely distributed and it is from weevils infesting these that the cultivated cruciferous seed crops become infested. These wild plants remain green and succulent much later in the season than do the cultivated species. The latter species ripen and become un-

suitable for larval feeding during July, whereas the former remain green until October and provide food for its extended seasonal activity.

The percentage of cruciferous seedpods infested by the weevil varies considerably from year to year (Table I).

TABLE I

Infestation of the cabbage seedpod weevil, *Ceutorhynchus assimilis* (Payk.), in British Columbia, 1949, 1950, and 1951.

Area	Seedpods Examined		Per Cent. Infested
Vancouver Island			
Cabbage	1949	3,830	94.7
"	1950	731	75.6
"	1951	656	55.9
Fraser Valley			
Turnip	1949	1,688	30.7
"	1950	1,210	54.6
"	1951	600	62.3

The percentage of cabbage seed destroyed by the larvae increases disproportionately with the percentage of the seedpods infested. For example, an infestation of 80 per cent reduced the seed yield by about 40 per cent, whereas an infestation of 30 per cent reduced the seed yield by about 10 per cent. The reason for the increased percentage loss of seed in heavily infested fields is the larger proportion of pods in which there are 2 or more larvae.

Eleven species of parasites have been reared from the weevil on the Pacific coast. Of these, 7 species

have been found in British Columbia, 8 in Washington (Breakey, *et al.*, 1944, and Hanson *et al.*, 1948), and 5 in California (Carlson, *et al.*, 1951). The parasite species and the state or province from which they have been reported are shown in Table II.

Table II shows that *Trichomalus fasciatus* (Thoms.) is the only parasite species that has been reported from each of the 3 areas; 6 of the species found in British Columbia have been reported from Washington, and 2 species reported from Washington have also been reported from California.

TABLE II

Parasites reared from the cabbage seedpod weevil on the Pacific coast.

	British Columbia	Washington ¹	California ¹
<i>Amblymerus</i> sp.		x	
<i>Amblymerus mayetiolae</i> Gahan			x
<i>Bracon</i> sp.	x		
<i>Eupelmella vesicularis</i> (Retz.)	x	x	
<i>Eurytoma</i> sp.	x	x	
<i>Habrocytus</i> sp.	x	x	
<i>Necremnus duplicatus</i> Gahan	x	x	
<i>Spilochalcis side</i> (Walk.)			x
<i>Trichomalus fasciatus</i> (Thoms.)	x	x	x
<i>Trimeromicrus maculatus</i> Gahan			x
<i>Xenocrepis pura</i> Mayr		x	x
<i>Zatropis</i> sp.	x	x	

¹ Records from Breakey et al., 1944; Hanson et al., 1948; and Carlson et al., 1951.

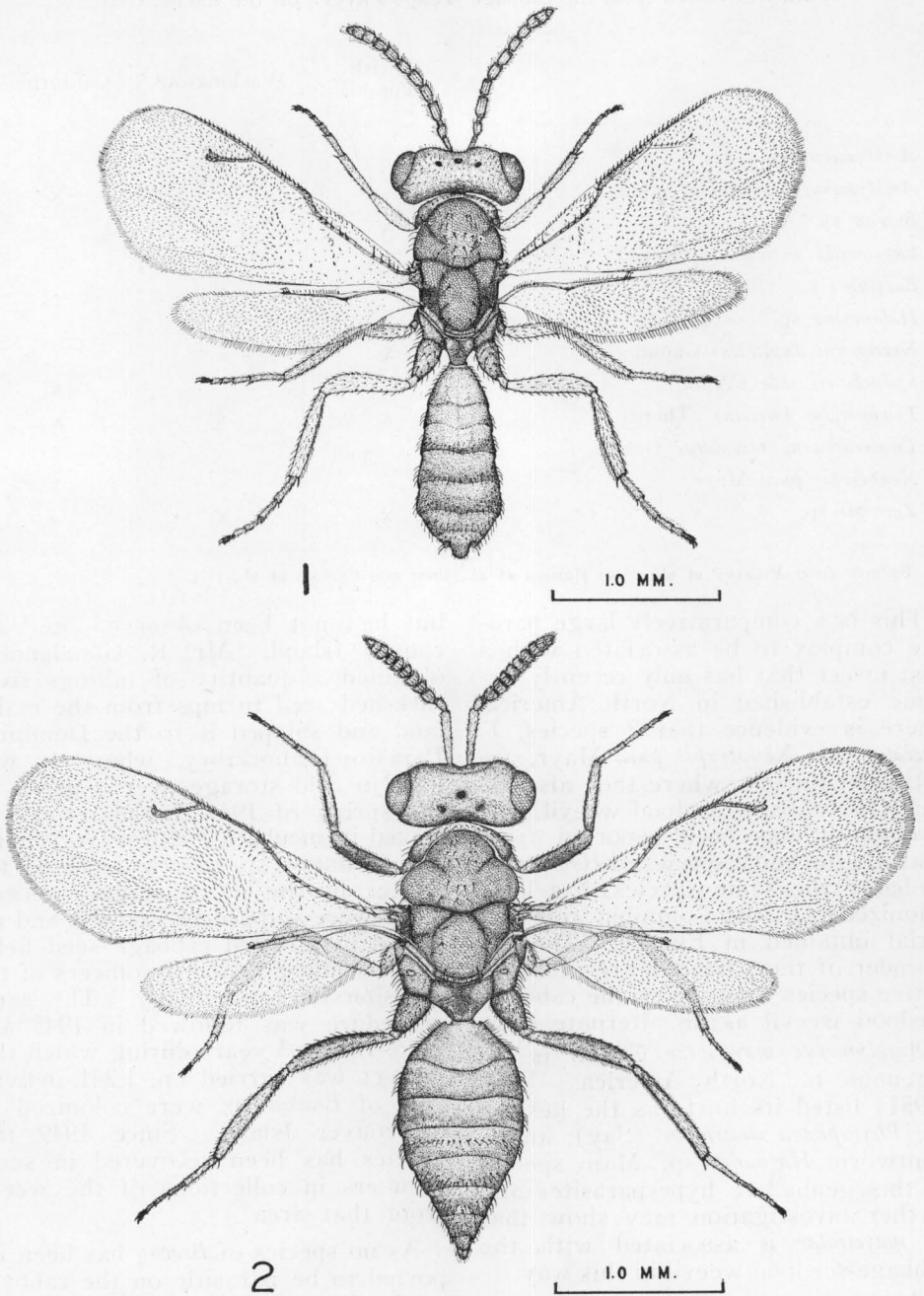
This is a comparatively large parasite complex to be associated with a host insect that has only recently become established in North America. There is evidence that 2 species, *T. fasciatus* and *Xenocrepis pura* Mayr, are native to Europe, where they also attack the cabbage seedpod weevil. *Habrocytus* sp. has been reported from Washington and a species of *Habrocytus*, probably the same species, has been colonized in British Columbia from material obtained in Europe. The remainder of the parasites are probably native species that attack the cabbage seedpod weevil as an alternate host.

Amblymerus mayetiolae Gahan is indigenous to North America. Peck (1951) listed its hosts as the hessian fly, *Phytophaga destructor* (Say), and a jointworm, *Harmolita* sp. Many species of this genus are hyperparasites and further investigation may show that *A. mayetiolae* is associated with the cabbage seedpod weevil in this way.

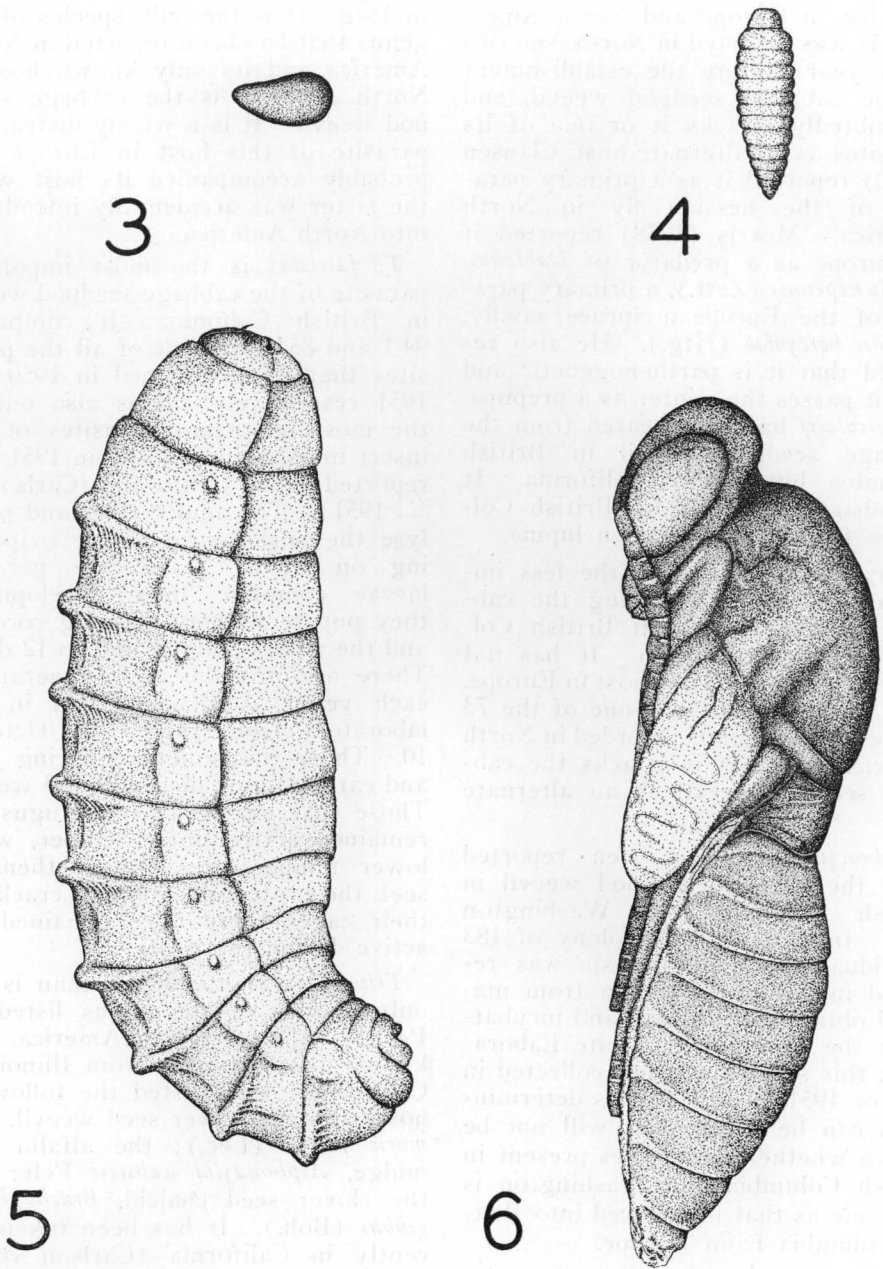
Bracon sp. has been reported from British Columbia only. In 1943 on Vancouver Island the cabbage seedpod weevil was more abundant and less heavily parasitized than on the mainland. At that time *Bracon* sp. was relatively abundant on the mainland

but had not been observed on Vancouver Island. Mr. R. Glendenning obtained a quantity of tailings from threshed seed turnips from the mainland and shipped it to the Dominion Parasite Laboratory, where it was kept in cold storage over winter. In the spring of 1944 the material was placed in incubation and a large number of *Bracon* sp. that had passed the winter in the pupal stage emerged. They were shipped to Victoria and released in infested cabbage seed fields on Vancouver Island by officers of the Division of Entomology. The same procedure was followed in 1945 and 1946. In the 3 years during which this project was carried on, 1,241 individuals of *Bracon* sp. were colonized on Vancouver Island. Since 1949 this species has been recovered in small numbers in collections of the weevil from that area.

As no species of *Bracon* has been reported to be parasitic on the cabbage seedpod weevil in Europe, it is assumed that this species is a native of North America that attacks the cabbage seedpod weevil as an alternate host. Until the species is identified it will not be possible to determine whether it has any other hosts.



Figs. 1-2. *Trichomalus fasciatus* (Thoms.). 1, male. 2, female.



Figs. 3-6. *Trichomalus fasciatus* (Thoms.). 3, egg. 4, early larva. 5, late larva. 6, pupa.

Eupelmella vesicularis (Retz.) is widely distributed and has an extensive host list in Europe and North America. It was reported in North America many years before the establishment of the cabbage seedpod weevil, and undoubtedly attacks it or one of its parasites as an alternate host. Clausen (1940) reported it as a primary parasite of the hessian fly in North America. Morris (1938) reported it in Europe as a predator of *Dablomimus fuscipennis* (Zett.), a primary parasite of the European spruce sawfly, *Diprion hercyniae* (Htg.). He also reported that it is parthenogenetic and that it passes the winter as a prepupa. *E. vesicularis* has been reared from the cabbage seedpod weevil in British Columbia but not in California. It has also been reared in British Columbia from *Hylemya* sp. on lupine.

Eurytoma sp. is one of the less important parasites attacking the cabbage seedpod weevil in British Columbia and Washington. It has not been reported from this host in Europe. It is assumed that it is one of the 73 species of that genus recorded in North America and that it attacks the cabbage seedpod weevil as an alternate host.

Habrocytus sp. has been reported from the cabbage seedpod weevil in British Columbia and Washington only. In July, 1949, a colony of 183 individuals of *Habrocytus* sp. was released in British Columbia from material obtained in Europe and incubated at the Dominion Parasite Laboratory; this species was not collected in 1950 or 1951. Until species determination can be obtained it will not be known whether the species present in British Columbia and Washington is the same as that introduced into British Columbia from Europe.

Necremnus duplicatus Gahan, described from specimens taken in Washington, is one of the most important parasites of the cabbage seedpod weevil in Washington and British Columbia. It is not known in Europe and no other host record is listed by Peck (1951) for North America.

Trichomalus fasciatus (Thoms.) is a European species that was described in 1878. It is the only species of the genus that has been reported in North America and its only known host in North America is the cabbage seedpod weevil. It is a widely distributed parasite of this host in Europe and probably accompanied its host when the latter was accidentally introduced into North America.

T. fasciatus is the most important parasite of the cabbage seedpod weevil in British Columbia: it comprised 94.1 and 85.9 per cent of all the parasites that were obtained in 1950 and 1951 respectively. It is also one of the most important parasites of the insect in Washington and in 1951 was reported from California (Carlson *et al.*, 1951). The adults sting and paralyze the host larvae before ovipositing on them. After the parasite larvae complete their development they pupate without forming cocoons and the adults emerge in 8 to 12 days. There are probably two generations each year. Adults emerged in the laboratory from July 11 to October 10. Those that emerged during July and early August died within 3 weeks. Those that emerged after August 15 remained active until October, when lower temperatures caused them to seek the protection of small cracks in their cage; there they remained inactive during the winter.

Trimeromicrus maculatus Gahan is the only species of the genus listed by Peck (1951) for North America. Its known distribution is from Illinois to California. Peck listed the following hosts: the sunflower seed weevil, *Desmoris fulvus* (Lec.); the alfalfa gall midge, *Asphondylia websteri* Felt; and the clover seed chalcid, *Bruchophagus gibbus* (Boh.). It has been taken recently in California (Carlson *et al.*, 1951) from the cabbage seedpod weevil, but it has not been reported in Washington or British Columbia. Whether it is a primary parasite or a hyperparasite is not known.

Xenocrepis pura Mayr has been reared from this host in California and Washington, but not in British Columbia.

Three colonies comprised of 1,269 individuals of this species were released in British Columbia in 1949 from material obtained in Europe and incubated at the Dominion Parasite Laboratory.

X. pura is reported to be the most important parasite of the cabbage seedpod weevil in California (Carlson *et al.*, 1951). It is less effective in Washington; and in British Columbia, the northern limit of the host insect's distribution, it has not yet been recovered even where colonized. The range of *X. pura* is the reverse of that of *T. fasciatus*: the latter is the most important parasite at the northern limit of its host's range.

Zatropis sp. is of minor importance in British Columbia and Washington and has not been reported from California. It is a North American species, but its other hosts are not known.

Although the present parasite complex does not prevent injury to cruciferous seed crops by the cabbage seedpod weevil, it reduces the amount of seed loss in two ways. The parasite adults sting and paralyse the host larvae; these larvae are often in the later instars before they are parasitized, but the feeding period of even the more mature larvae is shortened considerably. This reduces the number of seeds destroyed by each larva with the result that there is an immediate reduction in the amount of seed loss. There is a further reduction the following year caused by the reduction in weevil population due to the parasitism and resulting mortality of the weevil larvae.

Evidence of the effect of parasitism in reducing the number of seeds destroyed per larvae was obtained in 1950. A random collection of infested pods was taken from a swede turnip seed field in which the infestation was 39.7 per cent and the aggregate parasitism 79.8 per cent. There were 749 seedpods in the collection and 8,662 seeds, of which 872 were destroyed by larvae. The weevil larval population was 332. Therefore the number

of seeds destroyed by each larva was 2.6. A random collection was taken from another field in which the infestation was 87.9 per cent and the aggregate parasitism 9.4 per cent. There was 348 seedpods in the collection and 4,389 seeds, of which 1,859 were destroyed by larvae. The weevil larval population was 394. Therefore the number of seeds destroyed per larva was 4.7. The difference in the numbers of seeds destroyed per weevil larva was highly significant. Insecticides had not been used on either of the plots from which the collections were taken.

Summary

The cabbage seedpod weevil is a European species that has become a major pest of cruciferous seed crops in western North America. Its spread has been facilitated by widely distributed wild host plants. The degree of infestation varies considerably from district to district and from year to year.

Eleven species of parasites are known to be associated with the cabbage seedpod weevil. The 2 most important species in North America, *Trichomalus fasciatus* and *Xenocrepis pura*, are of European origin. The remainder are probably native species that have accepted the cabbage seedpod weevil as an alternate host.

Parasitism of the cabbage seedpod weevil reduces the amount of seed loss in 2 ways:—

1. When the adult parasites sting and paralyse the weevil larvae, thus preventing further feeding, there is an immediate and significant reduction in the number of seeds destroyed by each cabbage seedpod weevil larva.

2. Parasitized larvae are killed, so that the infestation and seed loss the following year are reduced.

The adult male and female and the egg, early larva, late larva, and pupa are illustrated in Figs. 1-6. The original drawings were prepared by George Yamanaka, formerly of the Vancouver laboratory.

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**NOTE ON THE OCCURRENCE OF RHAGOLETIS FAUSTA (O.S.)
(DIPTERA: TRYPETIDAE) IN THE OKANAGAN VALLEY**

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In the winter of 1950, a sample of frozen sour cherries infested with dipterous larvae was received from the Canada Experimental Station at Summerland. The larvae were partially decomposed when they reached the Fruit Insect Laboratory, Summerland, so that positive identification was impossible. However, it was believed that the larvae were of one of the cherry fruit flies common to many fruit-growing areas of North America.

Neither *Rhagoletis fausta* (O.S.) nor *R. cingulata* (Loew) has previously been recorded from the Okanagan Valley. In British Columbia *R. fausta* has been a pest in the Kootenay district for many years. It was also reported from the north shore of the Shuswap Lake, opposite Canoe, in 1936, and at Salmon Arm in 1937. *R. fausta* is the only species recorded from the Flathead Valley of Montana, whereas *R. cingulata* is the only species found in the lower mainland of British Columbia. Both *R. fausta* and *R. cingulata* are pests on Vancouver Island and as far north as Wenatchee in the State of Washington.

The source of the infested cherries was traced to an orchard in the Bear Creek district, about three miles from

the Westbank ferry landing. In the spring of 1951, traps were set out in this orchard to determine what species of fruit fly was present. On May 31, soil sifted from under the sour-cherry trees yielded five puparia and two empty pupal cases. The latter were in good condition, suggesting that flies had recently emerged from them, although no adults were seen in the orchard at this time. Seven days later one fly was caught in a soil emergence cage and two on a sticky board. These flies were subsequently identified as *Rhagoletis fausta* (O.S.) by Mr. J. F. McAlpine, Division of Entomology, Ottawa.

Fly emergence reached its peak in the third week of June. By the end of the month almost every sour cherry (largely Montmorency) contained one or more maggots, and an occasional sweet cherry (Bing and Lambert) was also infested. A few flies were still found alive on the sticky boards when trapping was discontinued on July 10.

Orchard and packing-house surveys conducted in the Westbank and Kelowna districts by officers of the Provincial government did not reveal any further orchards infested with the cherry fruit fly.