parasitism obtained by dissection (Table I) and by the proportion of *M. aulicus* adults that emerged from the random collection of 1,181 cocoons of *P. erichsonii* collected in 1949 and reared in 1950 (Fig. 1). Further evidence of the effectiveness of *M. aulicus* was obtained when the diapause *P. erichsonii* larvae were dissected in August, 1950; 89.8 per cent. of them contained living *M. aulicus* larvae. This showed that the parasite had synchronized its development with that of the host, thus ensuring the continued effectiveness of the parasite.

References

Hopping, G. R., H. B. Leech, and C. V. G. Morgan. 1943. The larch sawfly, *Pristiphora erichsonii* (Hartig), in British Columbia, with special reference to the cocoon parasites *Mesoleius tenthredinis* Morley and *Tritneptis klugii* (Ratzeburg). Sci. Agr. 24: 53-63.

BIOLOGY AND CONTROL OF THE CHERRY CASEBEARER, COLEOPHORA PRUNIELLA CLEMENS, IN BRITISH COLUMBIA[1]

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An outbreak of the cherry casebearer, *Coleophora pruniella* Clem., occurred in two adjacent apple orchards at Creston in the Kootenay Valley in 1947. This is the first record of this species for the Province of British Columbia. The insect was reported causing serious damage to apple at Salem, Oregon, in 1937, by Hsiao and Mote (1939), marking the most westerly record for this species. Known since 1861, when it was described, the cherry casebearer has been a serious pest of both cherry and apple in the United States and Canada during the past 25 years. Petch and Armstrong (1926) recorded that apple orchards in the Lake St. Louis area of Quebec had been heavily infested for several years. These authors were the first to give adequate descriptions of all stages of the insect and an adequate account of the life-history. Petch and Maheux (1930) reported little damage to apple in Quebec from this species, whereas 5 per cent. injury was caused by the cigar casebearer, *Coleophora occidentis* Zell. The latter species, the only casebearer hitherto recorded as having caused damage to orchards in British Columbia, was reported by Treherne (1914, p. 25) to be present in every orchard of the Lower Fraser Valley in 1912-13. Later Glendenning (1923) noted its presence in that valley but not as a serious pest. Hutson (1931, '32) reported the cherry casebearer to be a spectacular pest of cherry in Michigan. Its depredations in orchards were first noted in 1929, although known on wild black cherry from the time of its description.

LOCALITY, VARIETIES OF FRUIT ATTACKED, AND SEVERITY OF INFESTATION

The coleophorid infestation was confined to two adjacent orchards one mile southeast of Creston, at the southern end of the Kootenay Valley. One orchard contained only mature McIntosh apple trees, the other a mixed planting with McIntosh predominating but including Delicious, Jonathan, Winter Banana, and scattered pears and cherries. All fruit varieties were attacked, McIntosh most severely; the heaviest infestation and damage occurred in the orchard with the mixed planting. The difference in severity of damage between the two orchards was due to an application of dormant oil-dinitro orthocresol to the McIntosh planting but not to the mixed planting.

The infestation was first noted in the fall of 1947, when the twigs and fruit spurs were literally covered with overwintering cases. Evidently some damage had occurred in 1947 but had not been reported by the growers. In

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1948 the injury to the developing foliage was severe, approximately 60 per cent. of the leaves on some trees being almost completely skeletonized. Set, size, and colour of fruit were markedly affected. Late summer damage by young larvae was noticeable but not severe. Injury in 1949 was light, because of the application of a dormant spray in each orchard.

LIFE-HISTORY

The life-history of *C. pruniella* in the the Kootenays follows in general that related for Quebec (Petch and Armstrong, 1926), Michigan (Hutson, 1931), and Oregon (Hsiao and Mote, 1939). Dates noted in the developmental period refer to 1948 records.

Egg.—The eggs are light yellow, convoluted, and conoid; they are laid singly, usually on lower leaf surfaces in mid-July (July 12-23). As many as 60 eggs were observed on one leaf. Thirty leaves taken at random from lower portions of trees averaged 20 eggs per leaf. The incubation period was approximately 10 days. Petch and Armstrong (1926) reported 18 days as the average period of incubation for Quebec, whereas Hsiao and Mote (1939) reported 14 days for Oregon. All eggs hatched by August 10.

Larva. — Eclosion occurs through the base of the egg, so that the larva never exposes itself as it commences to mine the area between the upper and lower epidermal layers. The egg shell serves as a protection for the larva and for the storage of frass, while the larva gradually bores its way through the leaf tissues, forming a blotch mine around the egg shell. It continues to feed in the original mine for 3 to 3.5 weeks before forming a case and becoming mobile. The earliest cases were observed on August 16; forming of cases was complete by September 2. The larva moves frequently once the case is formed, tunnelling out a small, almost circular mine at each feeding site, so that the leaves become "peppered" with mines. After continuing to feed for 4 to 6 weeks the larva moves to a twig or spur, there to overwinter. Although feeding is prolonged over a 7-week period, mining is slow and larvae do not increase greatly in size. The original case is enlarged at least once. The overwintering cases are about 3.5 mm. long and 1.0 mm. in diameter. The majority of the larvae had moved to overwintering quarters by October 15. The larvae move from winter quarters at the end of April, when they attack the opening leaves. They feed for approximately 7 weeks, during which two additions are made to the cases. Mining is extensive during this period, and leaf injury may be severe, appearing as skeletonized dead and brown areas varying in shape and size. There was no yellowing or leaf drop as reported by Hutson (1931) in Michigan.

Pupation:—When mature, the larvae usually move to the twigs to pupate; some, however, remain attached to leaves and others lower themselves to the ground by silken threads and move to the tree trunks. The pupation period is about 10 days. Hsiao and Mote (1939) reported a pupation period of 3 weeks, but this record may refer to the period between cessation of feeding and moth emergence. About 2 weeks after the larvae cease feeding (about June 7) the moths emerge.

Adult.—In 1948, moths commenced to emerge on June 25 and continued until July 12, with the peak of flight about July 11. At this time hundreds of moths were noted in the cover crop and on the lower limbs of each tree. The moth population then gradually declined toward the end of the month. The first eggs were noted on July 12, the majority being laid by July 23.

CHEMICAL CONTROL

The normal spray schedule for apple scab and the codling moth, consisting of 4 to 5 sprays of lime-sulphur and calcium arsenate commencing in the pink stage of apple development, was of no value in controlling this pest. Additional sprays of lead arsenate and cryolite also failed to have any effect. Petch and Armstrong (1926)

and Hutson (1932) reported similar results with these materials. Treherne (1914), however, noted that lead arsenate applied before or after blossoming would control the cigar casebearer. Also, Gould (1936) reported control of the pistol casebearer, *C. malivorella* Riley, with lead arsenate. Hutson (1932) in Michigan, and Lilly and Fluke (1933, '34) in Wisconsin, reported effective control of the cherry casebearer with dormant oil 6 to 10 per cent. concentration. The latter authors found that a dormant lime-sulphur spray (1:8) in a fall application gave satisfactory control. The cigar casebearer, *Coleophora occidentis* Zell., in Norfolk County, Ontario, was not controlled with arsenicals, but dormant sprays of 1 per cent. "Elgetol" (20% dinitrocresol) or 0.5 per cent. "Elgetol" in 3 per cent. dormant oil emulsion gave excellent control (Hall, J. A., in litt., 1948). Of the chemical treatments applied at Creston, by far the most satisfactory was dormant oil, 2 gallons, and 40 per cent. dinitrocresol, 1.5 pounds, per 100 gallons of spray mixture.

NATURAL CONTROL

The egg, larval, and pupal stages of *C. pruniella* are known to be heavily parasitized. Petch and Armstrong (1926) reported 17 species of hymenopterous parasites in Quebec. Doner (1934) reared 32 species of parasites in Wisconsin; *Bracon pygmaeus* Prov., obtained from 70 per cent. of all parasitized larvae, was the most abundant. The same author (1936) recorded a long list of parasites, of which *B. pygmaeus* was again the most important. Total parasitism of mature larvae in Wisconsin ranged from 5 to 59 per cent. *Eurydinota lividicorpus* Gir. was the most common chalcidoid. Hsiao and Mote (1939) noted that these two parasites were important factors in the control of the pest in Oregon. Gould (1936) reared 36 species of parasitic Hymenoptera from the pistol casebearer, *C. malivorella* Riley; and later, Gould and Geissler (1940) reported a total of 40 species reared from the same host in West Virginia. Beacher (1947) recorded 15 species of parasites of *C. malivorella* in Pennsylvania and Delaware.

The species of hymenopterous parasites reared from the pistol casebearer are the same as those attacking the cherry casebearer. Indeed, some of these parasites, e.g., *E. lividicorpus*, attack only members of the genus *Coleophora*. The occurrence of this particular parasite in Creston indicates that the insect may have been present in that area for some time.

In 1948, some 500 encased larvae were collected from the infested Creston orchards in May and June. Five species of parasites were reared, including three chalcidoids and two ichneumonoids. The most abundant was the chalcid *Spilochalcis albifrons* (Walsh), which constituted 49 per cent. of the total. In 1949, 2,770 encased larvae were collected in May and July. Parasitism of larvae and pupae totalled approximately 15 per cent. and included 22 species, of which 16 were chalcidoids and the remainder ichneumonoids.

It was not possible to demonstrate the presence of egg parasites, although one such species, *Closterocerus* sp. near *tricinctus* (Ashm.). was reared from a mature coleophorid larva. The parasites reared may not all be primary parasites. Possible hyperparasitic species include *Gelis tenellus* (Say) and *Hypopteromalus percussor* Gir., although the former has been noted elsewhere as a primary parasite of *C. pruniella*. The limited number of individuals of some parasitic species suggests that their role as coleophorid parasites may have been accidental. The encyrtid *Copidosoma truncatellum* (Dalm.) is one of these. Three species, *G. tenellus*, *Closterocerus* sp. near *tricinctus*, and *Tetrastichus* sp., were found to have as alternate hosts two unidentified willow leaf miners. Examination of the figures for the relative abundance of the parasite species (Table I) indicates that the braconid wasp *Bracon pygmaeus* Prov. is the most important parasite of the cherry casebearer in Creston. *Tetrastichus* spp. and the chalcid *Spilochalcis albifrons* (Walsh) are next in importance.

TABLE I

Relative abundance of parasites of COLEOPHORA PRUNIELLA Clem. at Creston, B.C.

Species	Per cent. of total reared	
	1948	1949
Bracon pygmaeus Prov.	24.0	39.6
Tetrastichus sp.		12.6
Sympiesis sp. near *ancylae* Gir.		9.8
Spilochalcis albifrons (Walsh)	49.0	8.8
Hypopteromalus percussor Gir.		7.6
Gelis tenellus (Say)		7.1
Itoplectis obesus Cush.	14.0	5.5
Habrocytus thyridopterigis How.		3.5
Elachertus proteoteratis How.		1.3
Eurydinota lividicorpus Gir.		1.0
Closterocerus sp. near *tricinctus* (Ashm.)		0.5
Tetrastichus xanthops (Ratz.)	12.0	
Habrocytus phycidis Ashm.	1.0	
Other species (11)		2.7

A large number of the parasitic Hymenoptera reared from coleophorids at Creston are new records as casebearer parasites. However, the most important parasites, including *B. pygmaeus, S. albifrons, Tetrastichus* spp., *G. tenellus* and *E. lividicorpus,* are continentally widespread as parasites not only of *C. pruniella* but also of other coleophorids (Table 2).

LONGEVITY OF PARASITES

Studies were carried out on the longevities of some species of parasites reared from coleophorid larvae and pupae. Upon emergence from host cocoons, the parasites were transferred to shell vials, 5.5 inches in length and 1 inch in diameter, stoppered with corks. Dried raisins, pinned to the corks and wetted periodically, were supplied as food. Table 3 records the results.

TABLE II

Parasites of the Cherry Casebearer, COLEOPHORA PRUNIELLA Clemens, in British Columbia, and Records of Some of these Species from Quebec, Oregon, and the Pistol Casebearer, C. MALIVORELLA Riley

Species	Locality: British Columbia 1948	British Columbia 1949	Quebec*	Oregon**	Host: *C. malivorella****
HYMENOPTERA					
CHALCIDOIDEA					
CHALCIDIDAE					
Spilochalcis albifrons (Walsh)	X	X			X
ENCYRTIDAE					
Copidosoma truncatellum (Dalm.)		X			
EULOPHIDAE					
Horismenus sp. near *fraternus* (Fitch)		X			
Elachertus proteoteratis How.		X			
Chrysocharis sp.		X			
Closterocerus sp. near *tricinctus* (Ashm.)		X			
Sympiesis sp. near *ancylae* Gir.		X			
Pnigalio sp. near *tischeriae* Ashm.		X			
Sympiesis sp.		X			X
Tetrastichus sp.		X			X
Tetrastichus xanthops (Ratz.)	X				
PTEROMALIDAE					
Catolaccus aeneoviridis (Gir.)		X			X
Eurydinota lividicorpus Gir.		X	X	X	X
Habrocytus phycidis Ashm.	X				X
Habrocytus thyridopterigis How.		X			X
Habrocytus sp.		X			
?*Habrocytus* sp.		X			
Hypopteromalus percussor Gir.		X			
ICHNEUMONOIDEA					
BRACONIDAE					
Bracon pygmaeus Prov.	X	X	X	X	X
ICHNEUMONIDAE					
Gelis tenellus (Say)		X			X
Itoplectis obesus Cush.	X	X			
Itoplectis quadricingulatus (Prov.)		X			
Scambus hispae (Harr.)		X			

* Petch and Armstrong (1926)
** Hsiao and Mote (1939)
*** Beacher (1947), Pennsylvania and Delaware; Gould and Geissler (1940), West Virginia.

TABLE III

Longevities of parasites of the cherry casebearer

Species	No. of individuals	Length of life in days		
		Maximum	Minimum	Mean
Bracon pygmaeus Prov.	20	77	5	36.9
Sympiesis sp. near *ancylae* Gir.	23	61	5	23.0
Spilochalcis albifrons (Walsh)	18	177	8	78.0
Gelis tenellus (Say)	8	81	8	50.4
Itoplectis obesus Cush.	10	33	1	16.8

The longest-lived of the parasites was *S. albifrons,* one specimen surviving for 177 days. The mean of 78.0 days is considerably higher than that of the next longest-lived species, *G. tenellus* (50.4 days). The maximum and mean longevities of *B. pygmaeus* (77 and 36.9 days) and *S. albifrons* (177 and 78.0 days) show a marked difference from the results found by Beacher (1947), who recorded 58.0 and 22.1 days for the former, and 10.0 and 8.0 days for the latter. Beacher used raisins for the food supply, but did not record supplying water, which may account for the differences.

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References

Beacher, J. H. 1947. Studies of pistol casebearer parasites. Ann. Ent. Soc. Am. 40:530-544.

Doner, M. H. 1934. Observations on the biology of *Microbracon pygmaeus* (Prov.), an important parasite of *Coleophora pruniella* Cl. Ann. Ent. Soc. Am. 27:435-442.

—1936. Hymenopterous parasites of *Coleophora pruniella* Cl., and parasites recorded from other species of Coleophora. Ann. Ent. Soc. Am. 29:224-244.

Glendenning, R. 1923. Insects of economic importance in the Fraser Valley in 1921. Proc. Ent. Soc. B.C., 17 and 19:167-172.

Gould, E. 1936. Notes and observations on the pistol case-bearer. J. Econ. Ent. 29:573-575.

Gould, E., and G. H. Geissler. 1940. Parasites of the pistol case-bearer. J. Econ. Ent. 33:814-815.

Hsiao, Tsai Yu, and D. C. Mote. 1939. The cherry case-bearer, *Coleophora pruniella* Clem., in Oregon. J. Econ. Ent. 32:363-365.

Hutson, R. 1931. The cherry case-bearer, *Coleophora pruniella* Clemens, in Michigan. J. Econ. Ent. 24:54-56.

—1932. The control of cherry case-bearer (*Coleophora pruniella*) by dormant and other sprays. J. Econ. Ent. 25:116-120.

Lilly, J. H., and C. L. Fluke. 1933. New developments in the control of the cherry case-bearer (*Coleophora pruniella,* Clem.) in Wisconsin. J. Econ. Ent. 26:805-812.

---1934. A progress report on the control of the cherry case-bearer (*Coleophora pruniella* Clem.) in Wisconsin. J. Econ. Ent. 27:1142-1147.

Petch, C. E., and T. Armstrong. 1926. *Coleophora pruniella* Clemens; a new pest of apple in Quebec. 18th Rept. Quebec Soc. Prot. Plants, 1925-26, pp. 93-95.

Petch, C. E., and G. Maheux. 1931. Insects of the season of 1930 in Quebec. 61st Ann. Rept. Ent. Soc. Ontario, 1930, p. 19.

Petit, R. H., and R. Hutson. 1931. The insect situation in Michigan. 61st Ann. Rept. Ent. Soc. Ontario, 1930, p. 33.

Treherne, R. C. 1914. Report from Vancouver district: insects economically important in the Lower Fraser Valley. Proc. Ent. Soc. B.C., 4:19-33.