PARASITES OF THE LARCH CASEBEARER, *COLEOPHORA LARICELLA* (LEPIDOPTERA: COLEOPHORIDAE). IN THE WEST KOOTENAY AREA, BRITISH COLUMBIA[1]

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ABSTRACT

The parasite complex of the larch casebearer, *Coleophora laricella* (Hbn.), was investigated in the Kootenay area of British Columbia in 1973 and 1974. Forty-one species of hymenopterous parasites were obtained from rearings of almost 153,000 final-instar host larvae and pupae. In 1973 and 1974, 31 and 24 species, respectively, were reared, with 14 common to both years. Twenty-nine of these, in 24 genera, were confirmed as larch casebearer parasites by individual rearings and by reports in the literature. No parasites were obtained from eggs, needle-mining larvae, or third-instar case-bearing larvae. The highest total percentage parasitism was 17.7% in 1973 and 24.5% in 1974, both at Rossland. In Collection II the *Dicladocerus* spp. complex comprised 46.0% of the total parasitism in 1973, and 63.8% of the total in 1974; it was the most abundant at four of the eight collecting sites in 1973 and 13 of the 14 sites in 1974. *Spilochalcis albifrons* (Walsh) comprised 32.8% and 23.5% of the total parasitism in the years 1973 and 1974 respectively; it was most abundant at three collection sites in 1973 and at two in 1974. *Mesopolobus* sp. constituted 4.9% of the total in 1973 and 9.9% in 1974. Larch casebearer densities in the first collection in 1973 were highest at Fruitvale and Shoreacres with 150 and 130 cases per 100 fascicles respectively; in 1974, the highest host densities in the first collection were at Kootenay Bay and Fruitvale with 48 and 41 cases per 100 fascicles respectively.

INTRODUCTION

The larch casebearer, *Coleophora laricella* (Hbn.) (Lepidoptera: Coleophoridae), a European species introduced into western North America, is currently a target of biological control efforts. Releases of exotic parasites have been in progress for about 17 years (Denton 1972; Morris and Monts 1972; Ryan and Denton 1973; Ryan *et al.* 1975, 1977).

Turnbull and Chant (1961) argued that the ecology of a pest being considered for a biological control programme should be studied in the area of proposed release prior to the introduction of natural enemies. To determine the identities of parasites and degree of parasitism of *C. laricella* in British Columbia, surveys were carried out in 1973 and 1974. Results of the 1973 survey were reported by Miller and Finlayson (1974).

METHODS

Procedures in 1974 were similar to those used in the 1973 survey and were described by Miller and Finlayson. Samples were taken in 1973 at eight sites: Anarchist Summit, Arrow Creek, Cascade (=Christina Lake), Fruitvale, Rossland, Sheep's Creek, Shoreacres, and Yahk. In 1974 these eight were again investigated plus the following additional six sites: Cranbrook, Johnstone Creek Park, Kootenay Bay, Roosville, Rykerts and Winlaw (Fig. 1). Collection I on May 14-15, 1974, consisted mainly of final-instar larvae and Collection II on June 12-13, mainly of pupae.

Ten trees were sampled in each collection at 1.5 - 3.0 m (5-10 ft.) and at 6.1 - 7.6 m (20-25 ft.) Five primary branches were taken from the full circumference of each tree at each height. Mass-rearing was done in 30.5x61.0x30.5 cm (1x2x1 ft.) cardboard boxes in which the tops had been replaced by 0.2 mm mesh. Individual rearing of larvae and pupae collected at Cascade, Rossland, Sheep's Creek and Shoreacres in 1974 was done in ½ dram vials to which fresh larch needles were supplied as required by the feeding larvae.

Eggs were collected both years from 10 trees at each site and mass-reared in petri dishes. Early larval instars were collected at Rossland and Shoreacres in August and October, 1973. These were mass-reared in approximately the same way as the later instars.

RESULTS

A total of 134,511 *C. laricella* were mass-reared: 102,947 in 1973 and 31,564 in 1974; and 18,300 were reared individually in 1974. In 1974 there were 20,168 casebearers in Collection I and 11,396 in Collection II, whereas

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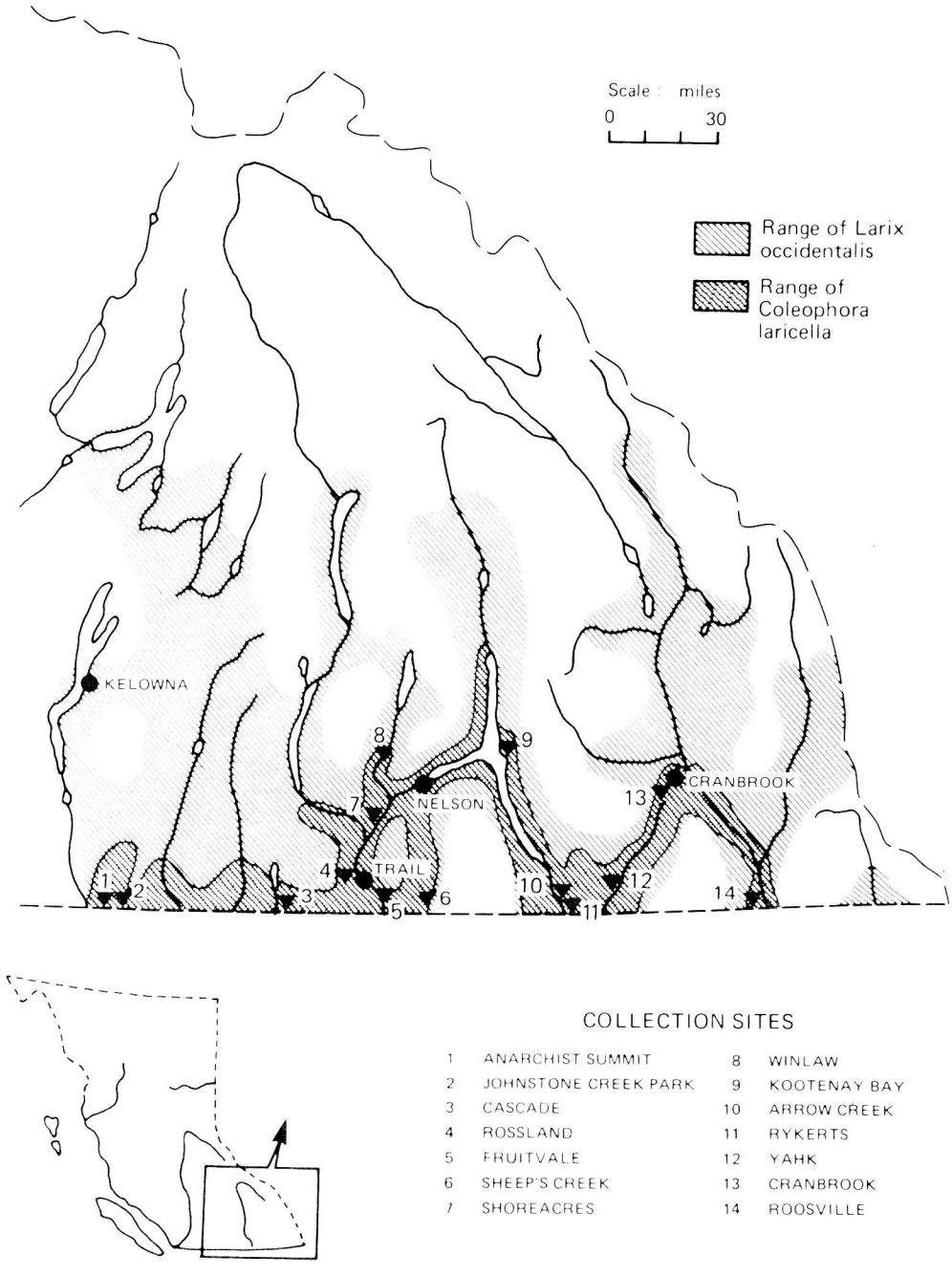

Fig. 1. Distribution of **Coleophora laricella** in British Columbia in 1972 and location of the collection sites in 1973 and 1974. (Adapted from R. F. Shepherd and D. A. Ross, "Problem analysis: larch casebearer in B.C." Unpublished Internal Report BC-37, Pac. For. Res. Cent., Victoria, B.C. 1973).

the comparable collections in 1973 amounted to 40,695 and 62,242. As more samples were taken in 1974 than in 1973, the figures indicate a considerable reduction in populations over the range of this species in British Columbia between the two years.

In 1974, a total of 1,989 specimens of 24 species of hymenopterous parasites and hyperparasites were reared as compared with 4,459 specimens of 31 species in 1973 (Miller and Finlayson 1974). The total number of species obtained in the two years was 41, with 14 common to both.

Table 1. Confirmed parasites from mass-rearings of **Coleophora laricella** in British Columbia in 1973 and 1974

	Abundance							
	1973				1974			
	May 8-9		May 23-25		May 14-15		June 12-13	
Hymenopterous Parasites	No. Obtained	No. Sites[a]	No. Obtained	No. Sites[a]	No. Obtained	No. Sites[b]	No. Obtained	No. Sites[b]
Braconidae								
Bracon pygmaeus Prov.[1,2,3]	32	5	273	8	9	5	6	4
Ichneumonidae								
Campoplex rufipes Prov.[3]							2	1
Diadegma sp.[1,3]					3	2	1	1
Gelis tenellus (Say)[1, 2, 3]			2	2			2	2
Gelis sp. [1, 2, 3]			9	4			3	2
Itoplectis vesca Townes [1]			1	1			2	1
Pristomerus sp. [1, 2]			2	1	4	4	4	3
Scambus decorus Walley [1]			10	2	4	2	2	1
Eulophidae								
Achrysocharella sp. [1, 2]			30	3	7	2	3	1
Chrysocharis laricinellae (Ratz.) [1, 3]			5	2			1	1
Cirrospilus pictus (Nees)[3]			1	1				
Dicladocerus spp. (2) [1, 2, 3]	325	8	1,480	8	693	14	669	14
Elachertus proteoteratis (How.) [3]			1	1				
Euderus cushmani (Crawford) [3]			2	1				
Eulophus sp. [3]*	2	1	2	1				
Tetrastichus dolosus (Gahan) [2]			9	2				
Tetrastichus ecus Wlkr. [1, 2]			142	5			1	1
Zagrammosoma americanum Gir. [2]			10	1			2	1
Encyrtidae								
Copidosoma sp.[3]					1	1		
Pteromalidae								
Catolaccus aeneoviridis (Gir.) [2, 3]			2	1				
Habrocytus phycidis Ashm. [2, 3]	1	1	5	2				
Mesopolobus sp. [1, 2]	15	2	158	6	111	9	104	9
Chalcididae								
Spilochalcis albifrons (Walsh) [1, 2, 3]			1,054	6			247	7
Eurytomidae								
Eurytoma sp. [3]*					1	1		
Diapriidae								
Telenomus spp. (3) [3]*			6	2				
Trissolcus sp. [3]*			10	2				

a-out of 8 b-out of 14
1 confirmed by individual rearings in this study
2 confirmed by Bousfield and Lood (1973)
3 confirmed by Webb (1953)
* confirmed to genus only.

Table 2. Relative abundance of the confirmed **Coleophora laricella** parasite species obtained from mass-rearings of **C. laricella** in British Columbia in 1973 and 1974 (in per cent)

Species	1973		1974	
	May 8-9	May 23-25	May 14-15	June 12-13
Dicladocerus spp.	86.7	46.0	83.2	63.8
Spilochalcis albifrons		32.8		23.5
Bracon pygmaeus	8.5	8.5		0.6
Mesopolobus sp.		4.9	13.3	9.9
Tetrastichus ecus		4.4		0.1
Other (no. of species)	4.8 (3)	3.3 (19)	3.5 (7)	2.1 (12)

Some of the parasites that emerged from mass-reared samples could have come from hosts other than *C. laricella* that were accidentally included in the collections. A mass-reared parasite was considered to have come from *C. laricella* only if it had been obtained from the individual rearings in this work, or had been verified previously (Bousfield and Lood 1973; Denton 1972; Sloan 1965; Webb 1953).

Twenty-nine species have been confirmed as parasites of *C. laricella* (Table 1). The 12 species not considered to be casebearer parasites are: *Aphidius* sp. (Aphidiidae); *Acrolyta* sp., *Hyposoter* sp. (Ichneumonidae); *Aprostocetus* spp. (2), *Diglyphus* sp., *Melittobia* sp. (Eulophidae); *Thysanus* sp. (Thysanidae); *Cyrtogaster vulgaris* Wlkr. (Pteromalidae); *Aphanogmus* sp. (Ceraphronidae); and *Aclista* sp. (Diapriidae).

Most of the confirmed species represent new host records for British Columbia. *Gelis tenellus* (Say), *Scambus decorus* Wly., *Tetrastichus ecus* Wlkr. [=*xanthops* (Ratz.)] and *Spilochalcis albifrons* (Walsh) were previously recorded by Andrews and Geistlinger (1969). These workers also obtained *Bracon* sp. which may well have been *B. pygmaeus* Prov; *Amblymerus* sp. which probably is the same as the *Mesopolobus* sp. found in this study; and a species reported as *Dicladocerus westwoodii* Westw. which may be either of the two new species found in this study, *D. nearcticus* Yosh. or *D. pacificus* Yosh. (Yoshimoto 1976). Two species not taken in the study but which have been reported previously as parasites of *C. laricella* in British Columbia are *Scambus transgressus* (Holmg.) and *Sceptrothelys deione* (Wlkr.) (Andrews and Geistlinger 1969).

Although many parasite species were obtained, only a few predominated, with *Dicladocerus* spp. and *S. albifrons* being by far the most abundant (Table 2). The most abundant species were also the most widespread (Table 1). *Dicladocerus* spp. and *Mesopolobus* sp. increased in relative abundance in 1974 when compared with 1973, while the other species that were relatively abundant in 1973

Table 3. Summary of confirmed parasites from mass-rearings of **Coleophora laricella** collected at 14 locations in British Columbia on May 14-15, 1974

Location	**C. laricella**		Parasitism								
			Dicladocerus spp.		**Mesopolobus** sp.		Other		Total		
	No. of Cases	Cases/100 Fascicles	No. Emerged	%	No. Emerged	%	No. Reared	%	No. Reared	No. of Taxa	%
Anarchist Summit	95	1.2	1	1.1					1	1	1.1
Arrow Creek	2,126	29.8	36	1.7	9	0.4	3	0.1	48	2	2.3
Cascade	1,488	17.7	61	4.1	9	0.6	8	0.5	78	7	5.2
Cranbrook	53	0.6	3	5.7					3	1	5.7
Fruitvale	2,774	40.8	86	3.1	11	0.4	11	0.4	108	5	3.9
Johnstone Creek Park	169	8.5	2	1.2					2	1	1.2
Kootenay Bay	4,275	47.8	9	0.2	4	0.1	5	0.1	18	2	0.4
Roosville	61	0.7	3	4.9					3	1	4.9
Rossland	832	8.0	54	6.5	3	0.4	9	1.1	66	4	7.9
Rykerts	4,619	27.5	162	3.5	27	0.6	3	0.1	192	2	4.2
Sheep's Creek	1,873	19.7	121	6.5	31	1.7	19	1.0	171	5	9.1
Shoreacres	1,604	25.4	150	9.4	18	1.2	13	0.8	181	6	11.3
Winlaw	94	1.2	4	4.3	1	1.1			5	2	5.3
Yahk	105	0.8	1	1.0			1	1.0	2	1	1.9

Table 4. Summary of confirmed parasites from mass-rearings of **Coleophora laricella** collected at 14 locations in British Columbia on June 12-13, 1974

Location	C. laricella		Parasitism										
			Dicladocerus spp.		Mesopolobus sp.		Spilochalcis albifrons		Other		Total		
	No. of Cases	Cases/100 Fascicles	No. Emerged	%	No. Emerged	%	No. Emerged	%	No. Reared	%	No. Reared	No. of Taxa	%
Anarchist Summit	94	0.9	5	5.3					1	1.1	6	2	6.4
Arrow Creek	1,546	18.1	97	6.3	11	0.7	12	0.8	8	0.5	128	3	8.3
Cascade	1,199	10.5	53	4.4	9	0.8	60	5.0	5	0.4	127	8	10.6
Cranbrook	38	0.4	2	5.3							2	1	5.3
Fruitvale	1,615	26.1	71	4.4	11	0.7	12	0.7	5	0.3	98	6	6.1
Johnstone Creek Park	115	5.0	4	3.5							4	1	3.5
Kootenay Bay	2,024	36.0	62	3.1					3	0.1	65	2	3.2
Roosville	56	0.7	1	1.8							1	1	1.8
Rossland	147	3.9	23	15.6	2	1.4	6	4.1	5	3.4	36	2	24.5
Rykerts	1,720	18.1	123	7.2	24	1.4	14	0.8	6	0.3	167	3	9.7
Sheep's Creek	1,001	9.4	97	9.7	18	1.8	19	1.9	17	1.7	151	6	15.1
Shoreacres	1,724	15.1	124	7.2	27	1.6	124	7.2	12	0.7	287	8	16.6
Winlaw	75	0.8	5	6.7	1	1.3					6	1	8.0
Yahk	42	0.3	2	4.8	1	2.4					3	1	7.1

decreased, relatively. In 1974, *Dicladocerus* spp. were the most abundant at all locations in the first collection (Table 3) and at 13 in the second (Table 4). In 1973, *Dicladocerus* spp. were the most abundant at six of the eight locations in the first collection and at five in the second collection; *B. pygmaeus* was the most abundant at two in the first collection and one in the second; and *S. albifrons* was the most abundant at two in the second (Miller and Finlayson 1974).

Greater parasitism, in terms of both number of taxa and percentage parasitism, occurred in the second collection than in the first in both 1973 (Miller and Finlayson) and 1974 (Tables 1, 3, 4).

The greatest casebearer densities per 100 fascicles in 1974 were at Kootenay Bay and Fruitvale where there were, respectively, 47.8 and 40.8 in the first collection and 36.0 and 26.1 in the second (Tables 3, 4). The greatest total percentage parasitism of 24.5% occurred at Rossland where host density was 3.9 casebearers per 100 fascicles. Percentages of parasitism at the various locations were not related to host densities, as was also the case in 1973 (Miller and Finlayson 1974).

Achrysocharella sp. was the only gregarious parasite species indicated by individual rearings. The mean number of adults produced from four cases was 3.25. Bousfield and Lood (1971) also found a very low incidence of gregariousness. However, they found three species, *Achrysocharella silvia* Gir., *T. ecus* and *Mesopolobus* sp., that occasionally produced more than one adult per case.

No parasites emerged from mass-rearings of 2,427 eggs, 19,279 needlemining larvae, or 6,890 fall-collected, casebearing, third-instar larvae.

DISCUSSION

The parasite complex and incidence of parasitism on *C. laricella* in British Columbia were comparable to those in other areas of North America (Bousfield and Lood 1971, 1973; Denton 1972; Sloan 1965; Webb 1953). The parasite complex also resembles the complexes in the Alps region of Europe (Jasch 1973), although more major species, in terms of relative abundance and constancy, occurred in the Alps. There was a low incidence of three species of parasites in needle-mining larvae and casebearing, third-instar larvae in the Alps, whereas no parasites were taken from these stages in British Columbia. There are no reports of parasites that emerge from *C. laricella* eggs.

Miller and Finlayson (1974) reported two European species that had been released against *C. laricella* in eastern North America in the 1930's: *Chrysocharis laricinellae* (Ratz.) and *Cirrospilus pictus* (Nees). *C. laricinellae* was found again in 1974. Ryan *et al.* (1974) give possible explanations for the presence of these species.

Agathis pumila (Ratz.) (Braconidae) is conspicuous by its absence in this survey. It was released against *C. laricella* in British Columbia in 1969 and has since become established (Morris and Monts 1972). One of the release sites was less than one mile from the Arrow Creek location in this study.

The increase in parasitism between the two collections in both 1973 and 1974 indicates that adult parasites are active during this period and/or that *C. laricella* reaches a more susceptible stage. Sweep-net collections of adults of *B. pygmaeus*, *I. vesca*, *Dicladocerus* spp. and *Mesopolobus* sp. during the first 1974 collection confirmed their presence in the field during this period. The increase in parasitism by *S. albifrons* between collections was probably correlated with the increase in host pupal populations between collections, as pupae are thought to be the stage attacked by this species (Bousfield and Lood 1971). Similar increases in parasitism of *C. laricella* and other coleophorids during the spring-feeding period have been reported (Beacher 1947; Bousfield and Lood 1971; Doner 1934).

Mortality of *C. laricella* caused by the native parasites may be limited by the number of alternate hosts available to the parasites in the absence of suitable instars of *C. laricella* as these, or related species, are known to have more than one generation per year (Clausen 1962; Dowden 1941; Jasch 1973) and not all of them can be spent on *C. laricella*. *S. albifrons* is more dependent on alternate hosts than other species as very few females (2.5% of the species total in 1973 and 0.0% in 1974) emerged from *C. laricella* in this study.

A positive trend was noted between total percentage parasitism and the total number of lepidopteran and sawfly larvae (which may or may not be alternate hosts of the parasites taken) at five of the sites. In eastern Canada the introduced species *C. laricinellae*, is much more effective against *C. laricella* in the presence of *A. pumila* or in the presence of alternate hosts due to improved synchronization (Quednau 1970). The lack of alternate hosts has been suggested as a limiting factor of parasitism in other coleophorids (Beacher 1947; Doner 1934, 1936).

Species of exotic parasites that have been recently released, or that are contemplated for release, against *C. laricella* in western North America are taxonomically related to the native species reared in this study. They also are non-specific and non-synchronized with *C. laricella* (with the exception of *A. pumila*) and have a minor role in reducing larch casebearer populations in Europe (Jasch 1973). For these

reasons, the probability that they will be effective biological control agents in western North America is questionable.

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