FOREST MANAGEMENT NOTE

Note 61 *Northwest Region*

REARING PARASITOIDS OF SPRUCE BUDWORM FROM NORTHERN ALBERTA

Numerous species of parasitic flies and wasps attack spruce budworm (*Choristoneura fumiferana* Clemens) (SBW) throughout its geographic range and at all immature stages (McGugan and Blais 1959; Miller 1963). There is considerable geographic variation in the diversity and impact of SBW parasitoids (McGugan and Blais 1959; Miller and Renault 1976), and little is known about these dynamics in northern Alberta.

Assessment of the diversity and impact of natural enemies in such an area requires an accurate and consistent method of sampling SBW populations and a reliable means of obtaining parasitoid adults. Parasitoids sampled in this study lay eggs on SBW larvae, live as larvae in the host body, and emerge from older larvae or pupae (Maltais et al. 1989). Sampling techniques therefore include examination of the incidence of egg laying, the presence of parasitoid larvae in the host, and the emergence of adult parasitoids. Observation of egg-laying activities and dissection of SBW larvae and pupae are, however, labor intensive. Also, identification of eggs or larvae of most species of parasitoids is rarely possible. Extensive rearing of immature parasitoids and association with adults is therefore required for comprehensive, effective surveys of parasitoid immature stages.

For this study, large numbers of SBW larvae were individually reared to obtain adult parasitoids. Extensive dissection of SBW larvae was avoided, and results were obtained using limited time and materials.

MATERIALS AND METHODS

Spruce budworm larvae were collected from permanent sample plots set up to monitor SBW populations that were sprayed with *Bacillus thuringiensis* var. *kurstaki*. Branches were removed from white spruce trees with pole pruners before and after spray treatments and during the peak of pupation before SBW adults began to emerge. Branches were placed in paper bags marked with appropriate plot and tree data and transported to the laboratory, where larvae were selected for rearing. Three larvae or pupae per branch were selected, if available, with preference given to older and larger larvae because these fed more readily and had higher survival rates than earlier instars.

Larvae were placed individually in 5-dram glass shell vials. Plot and tree number, crown level, and larva number were recorded on a label on each vial. Each vial contained about 5 gm of artificial diet (Robertson 1979) and was plugged with cotton batting. Vials and their contents were assembled in the lab prior to sampling infested trees, so that larval collection only required placement of larvae in vials and recording of appropriate data.

Racks containing rows of vials were stored indoors. No attempt was made to regulate temperature or humidity, although racks were kept out of direct sunlight to avoid overheating.

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Vials were examined daily for the first 2 weeks, every second day for the next month, and weekly thereafter. Records were kept of dates of SBW pupation and emergence, larval and pupal mortality, and parasitoid emergence. Dead larvae, pupae, and adult moths were discarded.

Parasitism in dead larvae and most dead pupae could not be determined because of desiccation of hosts. Parasitoid larvae were found in some pupae, but these could not be identified beyond order. Budworm larvae that did not pupate were given fresh diet when the original diet dehydrated. Very few of these larvae responded by feeding and completing larval development. The remainder eventually died. Uneclosed pupae were retained for three months, then transferred to vials containing damp peat moss and subjected to cold storage to stimulate emergence of parasitoids that might require diapause.

Vials were kept at 5°C for 30 days, transferred to 2°C for 30 days, then to –3°C for 2 months. Most pupae were attacked by fungi during cold storage and were discarded. Those that were not were moved to room temperature, then discarded after 2 weeks if nothing emerged.

Parasitoids that emerged from SBW hosts as larvae immediately spun cocoons (wasps) or formed puparia (flies). These vials were removed to separate racks and sorted by sample date and tentative identification. Puparia and cocoons were monitored for adult emergence and dates of emergence were recorded. Adult parasitoids with associated puparium or cocoon were then identified. Cocoons and puparia from which nothing emerged were given cold-storage treatment. Series of each species were mounted and submitted to experts for confirmation of identification. Voucher specimens of all species were retained.

RESULTS AND DISCUSSION

Over 500 specimens of parasitoids, representing 13 species, were reared from 3511 larvae and pupae of SBW over two seasons in 1990 and 1991 (Table 1). The wasp families Braconidae (three species), Pteromalidae (one species), and Ichneumonidae (five species), and the fly family Tachinidae (three species) are represented in Table 1. The dominant species of the parasitoid complex was *Apanteles fumiferanae* Viereck, comprising 52% of all parasitoids recovered, while *Glypta fumiferanae* Viereck and two species of tachinid flies, *Phryxe pecosensis* (Townsend) and *Eumaea caesar* (Aldritch) were common. Six species, almost half the total fauna, were represented by no more than 5 specimens recovered over 2 years. These six species represent less than 2% of all parasitism. They represent all of the change in species composition between years.

There was considerable overlap in species composition between years, though there were some differences as well. Four species were recovered in the second year that were not observed in the first year; *Apanteles* sp., *Bassus* sp., Pteromalidae sp., and *Tachina* sp. One species—Ichneumonidae sp.—was recovered in the first year only. In each case only single specimens were found, indicating either low population levels or rare transfer from another host species in the area. Results from other studies (McGugan and Blais 1959; Miller and Renault 1976) have shown that rare species are usually not recovered every year. Miller (1963) also showed that parasitoid populations can lag behind SBW populations in abundance during an outbreak, and that species complexes can change successionally between outbreak phases. It is possible that these rare species may represent such phenomena.

There were three types of parasitoids present in this species complex. Several species, typified by small-bodied adults (3–4 mm) such as *A. fumiferanae* and *Mesochorus tachypus* Holmgren, preferred to emerge from smaller hosts. Most specimens of these species emerged from fourth-instar and some from fifth-instar SBW, and were most numerous in the prespray sample. Some species, usually with larger body size (about 1 cm), such as *G. fumiferanae* and both common species of tachinid flies, preferred to emerge from larger larvae or pupae. These species were most numerous in the postspray sample. Other species, such as *Phaeogenes m. hariolus* (Cresson), emerged only from pupae. Wasps tended to be either larval or pupal parasitoids, whereas most flies parasitized both. The data reflects this successional change in parasitoid species through the summer.

A comparison of this survey to other surveys of *Choristoneura* species (McGugan and Blais 1959; Dixon and Benjamin 1963; Doganlar and Beirne 1978) shows that the number of parasitoid species obtained in northern Alberta was comparatively low. Other studies report complexes of 20–30 species, including families not recovered in this

Table 1. Parasitoid species and percent parasitism of spruce budworm larvae and pupae

Species	Larvae				Pupae no. (%)	
	Prespray no. (%)[a]		Postspray no. (%)			
	Year one	Year two	Year one	Year two	Year one	Year two
Total sampled[b]	750	719	678	577	490	297
Braconidae						
Apanteles fumiferanae Viereck	72 (9.6)	33 (4.7)	33 (4.9)	4 (0.7)	0	0
Apanteles sp.	0	1 (0.1)	0	0	0	0
Bassus sp.	0	1 (0.1)	0	0	0	0
Ichneumonidae						
Mesochorus tachypus Holmgren	6 (0.8)	6 (0.8)	1 (0.1)	3 (0.5)	0	0
Glypta fumiferanae Viereck	18 (2.4)	32 (4.5)	27 (4.0)	39 (6.8)	0	0
Exochus nigripalpus Thompson	0	1 (0.1)	2 (0.3)	0	0	0
Phaeogenes m. hariolus (Cresson)	0	0	0	0	16 (3.3)	16 (5.4)
Apechthis ontario (Cresson)	0	0	0	0	6 (1.2)	4 (1.3)
Ichneumonidae sp.	0	0	0	0	1 (0.2)	0
Pteromalidae						
Pteromalidae sp.	0	0	0	0	0	1 (0.3)
Tachinidae						
Two species[c]	1 (0.2)	2 (0.3)	8 (1.2)	51 (8.8)	40 (8.2)	21 (7.1)
Tachina sp.	0	0	0	0	0	1 (0.3)
Unknown[d]	7 (0.9)	22 (3.0)	17 (2.5)	12 (2.1)	0	0
Total parasitism	104 (13.9)	98 (13.6)	88 (13.0)	109 (18.9)	63 (12.9)	45 (15.1)

[a] Percentage figures are not absolute parasitism rates.

[b] Numbers given for these species indicate total specimens obtained for each species at each sampling date, but are pooled for all branches, trees, and plots. These numbers do not include potential parasitoids in SBW larvae and pupae that died, and are therefore probably underestimates.

[c] *Eumaea caesar* (Aldritch) and *Phryxe pecosensis* (Townsend) mixed.

[d] Small, white cocoons, probably *Apanteles fumiferanae* Viereck and *Mesochorus tachypus* Holmgren mixed.

study. All of the identified parasitoid species recovered have also been found in other studies (Miller 1963; Miller and Renault 1976).

The absence of *Meteorus trachynotus* (Viereck) in this study is noteworthy. This species is very widespread in North America (Maltais et al. 1989), in many cases comprising a major element of the parasitoid species complex. Differences might be due to geographic variation in species complexes, age and successional stage of the outbreak, or method and intensity of sampling.

CONCLUSION

Although numerous species and specimens were obtained with this mass rearing method, there were several consistent problems encountered. The majority of larval mortality, especially in early instars, was caused by the failure of SBW larvae to feed on the artificial diet. This diet was developed for rearing larvae of the western spruce budworm (Robertson 1979). A diet designed specifically for SBW (Grisdale and Wilson 1991) is required. As well, larvae that failed or ceased to feed degenerated

and dried out so rapidly that identification of parasitoids inside dead SBW bodies proved impossible.

It is unknown whether the parasitism rate of larvae that died prematurely was the same as in those that pupated or emerged as adults, or if parasitoids affected larval feeding. Loss of adult parasitoid specimens occurred when the specimens attempted to push out through the cotton batting plugs. Though these plugs are convenient for admitting oxygen into the vial, an alternate method is required to prevent escape.

Changes to sampling methods are likely required to obtain a comprehensive inventory of parasitoid species present. Sequential sampling of host populations from egg to adult will allow for detection of parasitoids attacking all stages, and provide information on the attack phenology of different parasite species. Also, sampling throughout the duration of the SBW outbreak is critical to assess year-to-year fluctuations in SBW and parasitoid populations as the outbreak cycles and potential long-term successional changes in the parasitoid species complex occur. This information is available for other regions, but preliminary data indicate that it might not be easily extrapolated to the ecologically unique forests of northern Alberta.

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