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The Parasitoid Complex of Forest Tent Caterpillar, *Malacosoma Disstria* (Lepidoptera: Lasiocampidae), in Eastern Wyoming Shelterbelts

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THE PARASITOID COMPLEX OF FOREST TENT CATERPILLAR, *MALACOSOMA DISSTRIA* (LEPIDOPTERA: LASIOCAMPIDAE), IN EASTERN WYOMING SHELTERBELTS[1]

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ABSTRACT

A parasitoid complex affecting the forest tent caterpillar, *Malacosoma disstria*, was investigated during 1978–79 in shelterbelts in eastern Wyoming. Egg parasitoids included five species: *Ablerus clisiocampae*, *Ooencyrtus clisiocampae*, *Telenomus clisiocampae*, *Tetrastichus* sp. 1 and *Telenomus* sp. Thirteen hymenopterous species and five dipterous species were reared from larvae and pupae of the forest tent caterpillar. The most common 5th-instar larval parasitoids were the tachinid flies, *Lespesia archippivora* and *Archytas lateralis*. Of the pupal parasitoids reared, 64% were Diptera and 36% were Hymenoptera. Four previously unrecorded parasitoids of *M. disstria* were reared: *Cotesia atalantae*, *Macrocentrus irridescens*, *Pimpla sanguinipes erythropus*, and *Lespesia flavifrons*.

As a defoliator of deciduous trees, the forest tent caterpillar, *Malacosoma disstria* Hübner is one of the most destructive forest pests in North America (Addy et al. 1971). Due to a wide host range and relatively frequent outbreaks, it has been the focus of much comprehensive research. Recently, Witter and Kulman (1979) completed a six-year study of an outbreak in northern Minnesota, which compared fluctuations in percent parasitism and relative abundance of each parasitoid species. This study implicated the pupal parasitoid, *Sarcophaga aldrichi* Parker, as an important contributor to the collapse of the outbreak. In other populations (Batzer 1955, Kulman 1965), parasitoids reportedly played an important role in preventing unrestricted increases in caterpillar populations and in the ultimate collapse of the outbreaks, although as Witter and Kulman (1972) point out, few quantitative studies have been done. An outbreak in Minnesota during 1936–38 was terminated by a combination of factors, primarily late frost and parasitoids (Hodson 1941).

Under Wyoming conditions, populations of *M. disstria* periodically reach sufficiently high population levels to cause considerable defoliation of key shelterbelt trees, such as cottonwood (*Populus deltoides*), golden willow (*Salix alba*, var. *vitellina*), western choke cherry (*Prunus virginiana demissa*) and wild plum (*Prunus americana*). A 1977 survey suggests that *M. disstria* was one of the most significant

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pests afflicting shelterbelt (windbreak) trees in Platte County, Wyoming (Knight et al. 1985).

In view of the reported benefits provided by parasitoids in forest tent caterpillar control in other areas of the U.S. (Baker 1972, Witter and Kulman 1979), we thought it important to investigate their potential in Wyoming. The prospect of controlling *M. disstria* without total reliance on broad spectrum insecticides, that have potential to contaminate local environments and that most likely provide only temporary relief, and would be advantageous.

Objectives were to collect and identify the parasitoid, predator, and pathogen complex of *M. disstria* in the area of Wheatland, Wyoming, and to determine the incidence of parasitism for each life stage. This complex was then to be compared with that of *M. disstria* in other parts of the United States to ascertain if key parasitoids were missing in the Wyoming fauna.

MATERIALS AND METHODS

Five shelterbelts in the vicinity of Wheatland, Wyoming, where populations of the pest had been consistently high during the previous two years (1976–1977), were selected as sampling sites.

Sampling of the egg stage was initiated in May, three weeks prior to larval emergence. Sixty-six egg masses collected from five shelterbelts were placed in separate 946 ml mason jars. After larval emergence, the parasitoids present were removed, killed, and pinned for subsequent identification.

Two shelterbelts (Lenhart and Sinnard), that had cottonwoods with high densities of forest tent caterpillars, were sampled for parasitism rates when caterpillars were in fourth and fifth instars. Samples taken from the lower and upper stories of each tree were mixed to help unify the sample in the event that the incidence of parasitism varied with height. Access to crowns was facilitated by a 12.2 m (40 ft.) extension ladder. At one site (Lenhart shelterbelt) all 15 trees in the shelterbelt were sampled on two dates, five days apart, and a total of 600 larvae was collected. On each date, 20 larvae were taken from each tree each day; one-half from the lower story and one-half from the upper story. Due to variation in tree heights, a lower story sample was taken between the base of the tree to 6.1 m above the ground, and an upper story sample was taken within the 6.1 m to 12.2 m stratum. At the other site (Sinnard shelterbelt) 20 sampled trees for each date provided a total of 400 larvae, two samples of 10 larvae each, collected from the upper and lower strata.

Larvae were reared in groups of 10 within cylindrical 946 ml ice cream containers. The bottom of each container was replaced with one-half of a plastic petri dish, which facilitated disposal of fecal material and food replacement. Ventilation was provided by replacing the top lid with a piece of nylon mesh hose. Fresh cottonwood leaves were replaced every other day or as needed. Dead and diseased larvae were removed at the time this food was added. Records were kept daily on the fate of each larva. Rearing containers were held in a field laboratory, consisting of a tent with nylon mesh sides; consequently no attempt was made to control or monitor light, temperature or humidity.

During the pupal stage the incidence of parasitism and the presence of parasitic species were determined from a sample of 2017 pupae. The same five shelterbelts were sampled shortly after larvae began to pupate and sampling was continued for nine days. Samples were taken at ground level, shrub level, and crown level. Groups of cocoons were held for parasitoid emergence in 3.8 l jars with nylon mesh tops. Parasitoids were removed shortly after emergence, killed, pinned and labelled.

Determinations of parasitoids and predators were made by systematists at the USDA, ARS, Systematic Entomology Laboratory and the Department of Entomology, Smithsonian Institution, Washington, D.C.

RESULTS AND DISCUSSION

A list of parasitoids, predators, and pathogens reared from and associated with the forest tent caterpillar, along with biological data, are presented in Table 1. For the most frequently observed parasitoids, information is provided on stage attacked and incidence of parasitism.

Egg parasitoids. Forty-eight parasitoids emerged from 66 egg masses, an average of 0.7 parasitoids per mass. The average number of eggs/egg mass was 182.7, with a resultant incidence of egg parasitism of 0.004%. This figure is considerably lower than the figures of 7.7 to 9.2% reported by Witter and Kulman (1979) in Minnesota. In North Dakota, Frye and Ramse (1975) reported an incidence of 2.5% in 1970 and 4.1% in 1971.

The three most abundant egg parasitoids collected in our study were *Ooencyrtus clisiocampae* (Ashm.) (Lenhart – 41.7%, Sinnard – 42%), *Ablerus clisiocampae* (Ashm.) (Lenhart – 22.9%, Sinnard – 23%) and *Telenomus clisiocampae* (Riley) (Lenhart – 29.1%, Sinnard – 25%). The percentages above represent per cent parasitism/species recovered from all egg masses, calculated for each sampling site. These egg parasitoids have been reported previously as attacking *M. disstria*; *O. clisiocampae* and *T. clisiocampae* also were the most common parasitoids found by Hodson (1941) and Witter & Kulman (1979).

Witter and Kulman (1979) pointed out, that in all studies of North American *Malacosoma* spp., egg parasitism has been less than 10%. They attributed this low rate to the spumuline covering which acts to protect the eggs. Hodson (1939) suggested several additional reasons for this low rate of parasitism despite a favorable host supply and a general distribution of parasitoids. The following may have an effect: a) a high rate of mortality of the parasitoids; b) poor synchronization of host and parasitoid life cycles; and c) physical characteristics of the egg which may hinder oviposition by the female parasitoid.

Based on this low incidence of parasitism, it is clear that these parasitoids are probably not important in the natural control of *M. disstria* in southeast Wyoming.

Larval parasitoids. Four hundred eleven tent caterpillars, that hatched from eggs, reached the adult stage in 1978, while 101 others were unaccounted for. Presumably, the latter escaped from the containers.

Of the 1000 larvae sampled, 21.5% (n = 215) were parasitized. Of this percentage, 11.5% (n = 25) of the parasitoids reached the adult stage, 7.7% (n = 17) died in the larval and pupal stages, and 2.3% (n = 17) died within caterpillars which succumbed to polyhedrosus virus. All larval parasitoids reared were tachinids, except for one hymenopteran. The most common parasitoid was *Lespesia archippivora* (Riley), which accounted for 6.4% (n = 14) of the larvae parasitized.

Another commonly collected larval parasitoid was *Archytas lateralis* (Macquart), which parasitized 4.8% of the larvae. The adult parasitoid emerged from the pupal case of the tent caterpillar. In a separate study in southeast Wyoming (Knight 1984), *A. lateralis* was the primary parasitoid of the western tent caterpillar, *Malacosoma californicum* (Packard), infesting mountain mahogany, *Cercocarpus montanus* Raf.

One unidentified hymenopteran, probably an ichneumonid or a braconid, parasitized 2.4% of the sample. This parasitoid had a distinctive pupal case allowing for its identification as a single species. Cold treatment of these pupae did not induce emergence. The pupae were found in the tent caterpillar's cocoon with the host's larval cuticle pressed to one end.

Adult parasitoid emergence was well synchronized with that of *Malacosoma* adults. *Archytas lateralis* and *Exorista mella* (Walker) attacked the larval stage and emerged as adults from the host's pupal stage and are, by definition, considered as larval parasitoids.

Table 1. — Parasites, predators, and associates reared from *Malacosoma disstria* Hbn. in eastern Wyoming in 1978.

Classification	Reared from egg (E) larvae (L), or pupa (P)	Primary (P) or Hyper (H) parasite, pathogen (PN) or predator (PR)	Common (C), uncommon (U), rare (R)
Hymenoptera			
Eulophidae			
Tetrastichus sp.	E	P	R
Encyrtidae			
Ooencyrtus clisiocampae (Ashmead)	E	P	U
Scelionidae			
Telenomus clisiocampae Riley	E	P	U
Telenomus sp.	E	P	R
Braconidae			
Bracon xanthonotus Ashmead	P	P	U
Macrocentrus iridescens French	*P*	*P?*	*R*
Cotesia atalantae (Pack.)	P	P?	R
Aphelinidae			
Ablerus clisiocampae (Ashmead)	E	P	U
Ichneumonidae			
Coccygomimus pedalis (Cresson)	P	P	C
Coccygomimus sanguinipes erythropus (Viereck)	P	P	R
Itoplectis conquisitor (Say)	P	P	R
Itoplectis vidulata (Gravenhorst)	P	P	R
Theronia atalantae fulvescens (Cresson)	P	P & H	R
Pteromalidae			
Dibrachys cavus (Walker)	P	H	U
Pteromalus sp.	P	?	R
Habrocytus sp.	P	H?	U
Diptera			
Tachinidae			
Archytas lateralis (Macquart)	L & P	P	C
Exorista mella (Walker)	L & P	P	U
Lespesia archippivora (Riley)	L & P	P	C
Lespesia flavifrons Bens.	L & P	P	R
Spoggossia sp.	P	P	C
Hemiptera			
Pentatomidae			
Podisus placidus Uhler	L & P	PR	R
Reduviidae			
Zelus exsanguis (Stål)	L	PR	R
Nuclear Polyhedrosus Virus	L	PN	C

Table 2.—Percent of total parasitism of *M. disstria* by shelterbelt, 1978 season.

	Lenhart	Sinnard	Sherlund	Total
% Larval Parasitism	17.8	27.3	—	21.6
% Pupal Parasitism	26.7	32.3	50.0	33.8

Larval pathogens. In the reared sample, 27.3% of the caterpillars died of nuclear polyhedrosis virus, and of these, an undetectable number may have been parasitized prior to infection. Close contact between caterpillars in the rearing containers probably allowed the virus to spread which resulted in more viral deaths than would occur in wild populations. Nuclear polyhedrosis virus was the only pathogen found infecting *M. disstria.* In the field, diseased larvae were only infrequently observed. Dead and dying diseased larvae were recognizable as such, because they hung from the host tree by their prolegs and often had a reddish-brown exudate oozing from their ruptured cuticles.

Larval predators. Two predators fed upon late instars: *Zelus exsanguis* (Stål) and *Podisus placidus* Uhler. *Zelus exsanguis* has not been previously recorded attacking *M. disstria.*

Pupal parasitoids. The incidence of pupal parasitism was 33.8% in a sample of 2167 cocoons. Of the 733 parasitoids, 64% were Diptera and 36% were Hymenoptera. Hyperparasitoids were found in 19 cases and many were apparent multiple parasitisms.

Dipteran parasitoids obtained from pupae were the same as those listed for the larval stage, with the addition of *Spoggossia* sp. Most of the Hymenoptera were ichneumonids. *Coccygomimus pedalis* (Cresson) was reared commonly, but it made up only 8.3% of the Hymenopterans. The majority of the hymenopteran sample (47.3%) comprised an unknown species, also reported in the larval sample as unemerged pupae.

Other reared ichneumonids were *Itoplectis conquisitor* (Say), a common parasitoid found in other studies conducted east of the Rocky Mountains (Witter and Kulman 1979); *I. viduata* (Gravenhorst), *Coccygomimus sanguinipes erythropus* (Viereck), which has not been previously recorded as attacking *M. disstria*; and *Theronia atalantae fluvescens* (Cresson), which has been recorded as both a primary and hyperparasitoid (Witter and Kulman 1979).

The most commonly found braconid was *Bracon xanthonotus* Ashmead. This multiple parasitoid accounted for 11% of hymenopteran parasitism.

Two pteromalids, *Habrocytus* sp. and *Dibrachys cavus* (Walker), were recorded as hyperparasitoids. *Dibrachys cavus* has been reported in most parasitoid studies of *M. disstria* (Witter and Kulman 1979).

The highest rate (50%) of pupal parasitism was recorded at the Sherlund shelterbelt. At the Lenhart and Sinnard shelterbelts, the incidence of parasitism was 26.7% and 32.3%, respectively, similar to the incidence of larval parasitism (Table 2).

Control potential. In Minnesota during 1937, *Compsilura concinnata* (Meigen) and *Pimpla turionellae* (L.) were released during forest tent caterpillar infestations (Hodson 1941). *Pimpla turionellae* was originally imported to control European pine shoot moth, [*Rhyacionia buoliana* (Denis & Schiff.)], but was used against *Malacosoma* sp., because it was known to attack many lepidopterous pests. Since their release in Minnesota, no recoveries have been made; however, *C. cońcinnata* is well established in the northeastern states (Baker 1972). In a control program designed to anticipate the movement of gypsy moths in Quebec and Ontario during

1914–18, a carabid and a tachinid were released into areas with forest tent caterpillar populations (Sippel 1957). Though both species were natural enemies of *M. disstria*, neither became established.

Of the adult parasitoids commonly found in our study, based on numerical incidence, only three showed potential for reduction of forest tent caterpillar populations: the unidentified Hymenopteran, *A. lateralis* and *L. archippivora*. However, since it is difficult to increase the effectiveness of the parasitoid complex of native species, it is recommended that these parasitoids not be used in a mass rearing and release program in the shelterbelts of Wyoming.

Comparing the parasitoid complex of Wyoming to that of other areas of the U.S. indicates that a key pupal parasitoid, *Sarcophaga aldrichi* Parker, is absent from the Wyoming parasitoid complex. This parasitoid has been implicated repeatedly in studies as an important natural control factor in forest tent caterpillar populations (Hodson 1939, Sippell 1957, Turnock 1961, Witter & Kulman 1979), where parasitism may approach 90% (Hodson 1941). The introduction of this dipteran into Wyoming shelterbelts to aid in the control of the forest tent caterpillar is feasible for several reasons: (a) it requires no other hosts during the year; (b) mass rearing is simplified because the species can be bred readily in carrion; (c) large numbers of adults are obtained easily in the field using a baited fly trap; (d) it is held easily in diapause for timed release; (e) its scavenger habits make it possible for the fly population to be maintained once introduced, even when caterpillar populations are low; and (f) the species attacks normal pupae as well as parasitized and diseased hosts.

One disadvantage of *S. aldrichi* is that it is so dominating it replaces other parasitoid species (Turnock 1961). Sippell (1957) also noted that *S. aldrichi* was "intrinsically superior" to most of the other parasitoids of the late larval and pupal stage.

Efforts for a potentially successful biocontrol program for *M. disstria* in Wyoming could be based on the introduction of *S. aldrichi* from established populations in other areas of the U.S. A niche apparently exists for this species if it can adapt to the Wyoming climate. However, in light of the failure of parasitoid introduction programs for the forest tent caterpillar in the past, control might better be acheived by the use of the bacterial insecticide, *Bacillus thuriengensis*.

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