Natural Control Agents In Forest Tent Caterpillar Populations

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The forest tent caterpillar, Malacosoma disstria Hübner, is a defoliator of trees and shrubs in forested areas. An outbreak occurred in the Fort Totten, North Dakota area during the period 1969-1970. Several natural control agents in caterpillar populations were found and identified. These included pathogens, parasites, and vertebrate and invertebrate predators.

The forest tent caterpillar, *Malacosoma disstria* Hübner, is a defoliator of trees and shrubs in forested areas. It is a nuisance in most of its habitat, but when present in high numbers in successive years it may cause economic losses.

A severe outbreak in a forested area near Fort Totten, North Dakota, was first noted in 1969. It covered an area of slightly more than 1,000 acres. The major overstory host plant in the area is basswood, *Tilia americana* L., and the major understory host is chokecherry, *Prunus virginiana* L. By the summer of 1971, caterpillar populations had declined sharply.

Severe defoliation destroys most or all of the browse utilized by deer and elk in the area. The pest is a source of irritation to tourists when the caterpillars and their droppings fall on them and their food. At present, applied control is not easily achieved; chemical control is not allowed because the area is a wildlife sanctuary. Other means of controlling *M. disstria* under outbreak conditions are needed. With these problems in mind, an investigation of natural and applied control of the caterpillar was undertaken. The following discussion deals with natural control factors in the Fort Totten area.

Procedures

Diseased forest tent caterpillar larvae were forwarded to the Insect Pathology Laboratory, Entomology Research Divison, ARS, USDA, Beltsville, Maryland in the fall of 1970 for identification of pathogenic microorganisms. In 1971, diseased larvae were sent to the Forest Sciences Laboratory, Forest Service, USDA, Corvallis, Oregon.

Eggs, larvae and pupae were collected to determine the incidence of parasitism and the species of parasites attacking *M. disstria* in North Dakota. One hundred egg masses were collected from the field in the fall in 1970 and 1971. After a three-month cold treatment at 2°C, the egg masses were placed at room temperature for larval and parasite emergence. A total of 790 5th instar larvae were collected in the field during early July, 1971, and placed in the laboratory to determine the incidence of parasitism. One thousand pupae were collected in early July and placed in the laboratory to determine species of pupal parasities and the incidence of pupal parasitism.

Observations were made on other insects and birds seen feeding on *M. disstria.* Predaceous insects and other insect forms found in association with the pupae and rolled up leaves surrounding the pupae were recorded. Predaceous birds were observed by Goeke (1971).

Results and Discussion

A nuclear polyhedrosis virus was the most abundant pathogen infecting *M. disstria* populations at Sully's Hill. The disease accounted for a mortality of over 50 per cent of the population in the spring of 1971. The effect of nuclear polyhedrosis was not as noticeable during the summer of 1970. There is evidence that high populations and high humidity are conducive to transmission of the virus in populations of *M. disstria.* "Mummified" dead and dying larvae were observed on the bases of trees, and were attached to the substrate by their prolegs. An exudate from ruptured larvae often covered parts of the host plant surface. This may provide a source of contamination of healthy larvae. It is interesting to note that the virus appeared to be rather host specific and infected only larvae in the genus *Malacosoma.* Four unidentified geometrid larvae were subjected to the same virus disease. After two weeks there were no viral symptoms in the geometrid larvae. The prairie tent caterpillar *Malacosoma californicum lutescens* (Neumoegen and Dyar) also was subjected to the same virus. Larval death occurred in two weeks.

John Thompson, research entomologist at Beltsville, Maryland, determined the pathogenic microorganisms found during the summer of 1970. Several specimens were infected with the fungus *Beauveria bassiana* (Bals.) Vuill. (Figure 1) and *Entomophthora megasperma* Cohn (Figure 2). Nuclear and cytoplasmic polyhedrosis viruses were

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also identified. The cytoplasmic polyhedrosis disease was associated with a tough, intact integument, and except for the gut, well preserved internal organs.

Kenneth Hughes, research entomologist, Forest Sciences Laboratory, Corvallis, Oregon, made determinations of diseased larvae in 1971, and found resting spores of a fungus in the genus *Entomophthora.* Larvae were also found to be heavily infected internally by a fungus producing a coarse mycelium; possibly a species of *Entomophthora.* Hughes noted that this organism may be a stress factor in populations of *M. disstria.* Fungi in the genera *Beauveria* and *Isaria* (Figure 3) were also found. These can be important pathogens when climatic conditions are favorable, and were observed infrequently during the study.

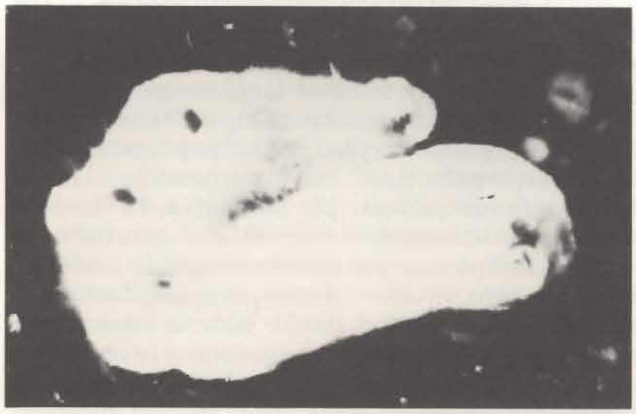

Figure 1. Malacosoma disstria larvae infected with a fungus, Beauveria sp., 1971.

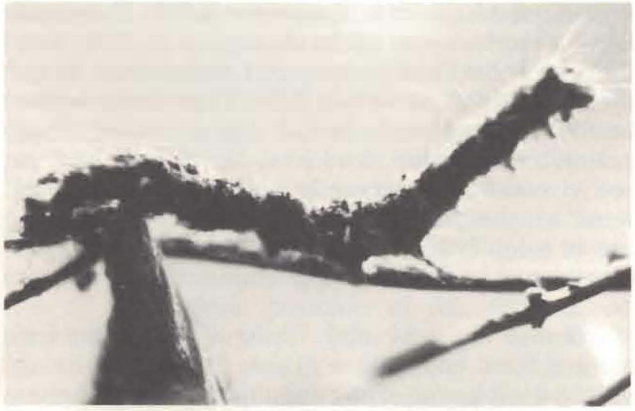

Figure 2. Malacosoma disstria larvae infected with a fungus, Entomophthora sp., 1971.

Figure 3. Malacosoma disstria larvae infected with a fungus, Isaria sp., 1971.

A bacterium, *Bacillus sp.,* was also identified but it is not known if it was a pathogen or a saprophyte. A protozoan (a microsporidian) was also found in diseased larvae. Hughes noted that this infection probably was not a significant factor in reducing populations of *M. disstria.* However, he suggested it could assume importance as a stress on future populations in the area.

Information relative to parasitism of *M. disstria* eggs is summarized in Table 1. Four hundred sixty-five parasites emerged from 100 egg masses in 1970, an average of 4.65 parasites per mass. The average number of eggs per mass was calculated to be 188.7, and the incidence of egg parasitism was 2.46 per cent. The largest number of parasites which emerged from a single mass was 39. In this case, the incidence was 20.7 per cent. From 100 egg masses collected in 1971, 615 parasites emerged (6.15 parasites per egg mass), an incidence of 4.13 per cent. The largest number of parasites from a single mass was 40 (an incidence of 21.2 per cent). Incidence of parasitism was higher in 1971; populations of *M. disstria* were lower in 1971.

Table 1. Parasitism of Malacosoma disstria eggs, Fort Totten, North Dakota.

	1970	1971
Eggs per mass	188.7	148.9
Parasites	465	615
Parasites per mass, average	4.65	6.15
Range in parasites per mass	0-39	0-40
Percent incidence of parasites	2.46	4.13
Range in per cent incidence of parasites	0-20.7	0-21.2

Egg masses collected in 1971 appeared to be smaller than in 1970. The average number of eggs in 10 masses was 148.9, or 39.8 less than in 1970. Actual incidence of parasitism almost doubled the parasitism in 1970. Most parasites emerged about a month after larval emergence. Some egg parasites emerged on the same day as 1st instar larvae, while others did not emerge for over a month. Egg parasites were determined by USDA scientists at Beltsville, Maryland. *Telenomus clisiocampae* Riley (Hymenoptera: Scelionidae) determined by P.M. Marsh, *Tetrastichus silvaticus* Gahan (Hymenoptera: Eulophidae) and *Ooencyrtus clisiocampae* (Ashm.) (Hymenoptera: Encyrtidae)

Figure 4. Ooencyrtus clisiocampae, a hymenopterous egg parasite of Malacosoma disstria.

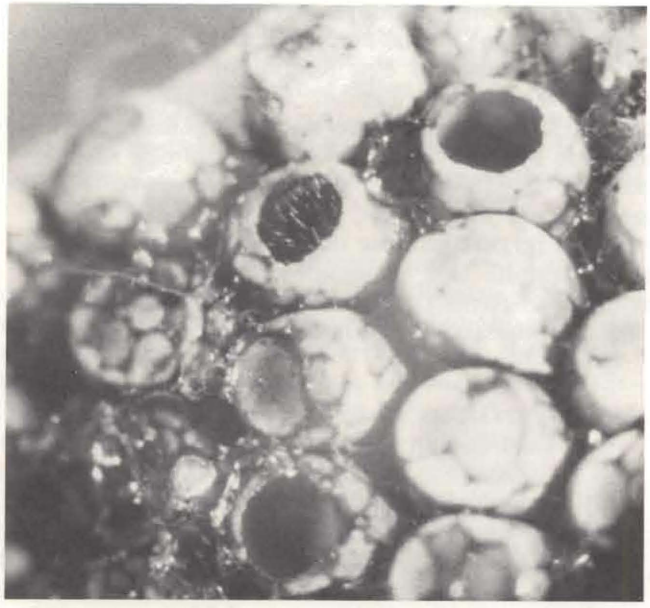

Figure 5. Eggs of Malacosoma disstria showing exit holes of larvae and egg parasites.

determined by B.D. Burks, all emerged from eggs of *M. disstria*. According to Hodson (1939), *Ooencyrtus clisiocampae* (Figure 4) does not require an exposure to low temperatures to break diapause. This was confirmed in the insectary. Microscopic examinations showed that most parasitized eggs were around the edges of the masses and where the spumaline was the thinnest (Figure 5).

The incidence of larval and pupal parasitism in 1971 is summarized in Table 2. Most of the forest tent caterpillar larvae entered the pupal stage in the laboratory. Counts were made 76 days after collection. Fifty-six adult dipterous parasites emerged, and one living and 17 dead larvae were recorded. The majority of the parasites (190) were in the pupal stage. Most parasites died in the pupal stage, and others were parasitzed by hyperparasites. There usually was one parasite per host larva. In the case of hyperparasitism, there were several parasites per host. Some dipterous parasites emerged as adults at the same time as *M. disstria* adults. Fifteen and seven-tenths per cent of the *M. disstria* adults were normal. Four hundred two specimens were unaccounted for (some of the parasite larvae escaped through the cotton stoppers in the rearing vials and were lost; some succumbed to disease; some were the victims of hyperparasites). The majority of parasitized *M. disstria* larvae went into the pupal stage; therefore, parasites emerging at that time might be considered to be pupal rather than larval parasites. Many parasites killed their hosts before the host completed larval development. The parasites live within dead host larvae and feed on host viscera. Host larvae in an advanced stage of parasitism had a putrid odor, and were unusually dark in color. If the host was still alive, it was very sluggish and had a sickly appearance.

After 76 days, 24 adult dipterous parasites had emerged from host pupae (Table 2). Sixteen living and 433 dead larvae of several unidentified parasites were found. One hundred eighty-eight parasite pupae were recovered. Two living adult hyperparasites and 80 dead hyperparasite larvae were observed. Parasitism of pupae (66.1 %) was

Table 2. Incidence of parasitism in larvae and pupae of Malacosoma disstria collected at Fort Totten, North Dakota, 1971.

	Forest tent caterpillar adults emerged		Larvae and pupae unaccounted for		Parasites					
	Total No.	%	Total No.	%	Adults	Larvae	Pupae	Dead larvae	Total parasites	% incidence of parasites
Larvae (790)	124	15.7	402	50.9	56	1	190	17	264	33.4
Pupae[a]	203	20.3	134	13.4	24	16	188	433	661	66.1

[a]*NOTE:* Two live adult hyperparasites, and 80 dead hyperparasites larvae were found.

twice as great as that observed in larval collections (33.4%). Normal *M. disstria* adults emerged from 20.3 per cent of the pupae. Only 13.4 per cent of the pupal specimens were unaccounted for.

Larval-pupal parasites and hyperparasites determined by Marius Wasbauer of the California Department of Agriculture were all ichneumonids with the exception of a braconid hyperparasite, *Aphaereta pallipes* (Say). Wasbauer noted that this is a parasite of muscoid Diptera; in this case probably secondary on tachinids. The most abundant ichneumonid obtained in collections at Fort Totten was *Theronia atalantae fulvescens* (Cress.) (Figure 6). Wasbauer noted that this is a species which is widespread on the eastern and western seaboards but had not been reported previously from the Dakotas. Hosts include *Malacosoma fragile, M. californicum* and *M. americanum.* A few specimens of *Hyposoter fugitivus fugitivus* (Say) were recovered. It is a common parasite of *M. disstria* east of the Continental Divide. *Gelis tenellus* (Say) also was collected. It was probably a hyperparasite of *Hyposoter fugitivus fugitivus.* A common parasite with a wide host range was *Scambus (Scambus) tecumseh* Viereck (Figure 7). *Coccygomimus pedalis* (Cress.), a common transcontinental species, also was found. Wasbauer noted this has been reared from *Malacosoma pluviale, M. americanum* and *M. fragile.* Ichneumonid parasites determined by R.W. Carlson of the USDA at Beltsville, Maryland were *Gambrus canadensis canadensis* (Prov.), a pupal parasite, and *Phobocampe clisiocampae* (Weed), a larval parasite. All the above parasites and hyperparasites had not been recorded previously in North Dakota. *Itoplectis conquisitor* (Say) (Figure 8) was common in the study area. Wasbauer noted that this is a common parasite of *M. disstria, M. americanum* and *M. fragile* east of the Rocky Mountains. In one case, *I. conquisitor* emerged as a secondary or hyperparasite from a pupal case of an unidentified parasite. Langston (1957) noted *I. conquisitor* as a hyperparasite on *Hyposoter fugitivus.* A small, commonly found hyperparasite at Fort Totten was determined by B.D. Burks of the USDA at Beltsville, Maryland, to be *Dibrachys cavus* (Walk.) (Hymenoptera: Pteromalidae).

Dipterous parasites (Figure 9) determined by C.W. Sabrosky at Beltsville, Maryland included the tachinids, *Lespesia archippivora* (Riley), *Lespesia frenchii* (Will.), *Carcelia* sp. and *Patelloa* sp. An unidentified sarcophagid was also found. A listing of determined parasites and hyperparasites is presented in Table 3.

Invertebrate predators and forms associated with *M. disstria* are shown in Table 4. A large stink bug, *Brochymena quadripustulata* Fabricius (Hemiptera: Pentatomidae), was observed feeding on a *M. disstria* larva. It removed internal body

Figure 6. Theronia atalantae fulvescens (Hymenoptera: Ichneumonidae), a larval-pupal parasite of M. disstria.

Figure 7. Scambus (Scambus) tecumseh (Hymenoptera: Ichneumonidae), a larval-pupal parasite of M. disstria.

Figure 8. Itoplectis conquisitor (Hymenoptera: Ichneumonidae),, a pupal parasite of Malacosoma disstria. It also emerged as a hyperparasite.

Figure 9. A dipterous parasite of Malacosoma disstria, undetermined.

material from its host with its sucking mouthparts. After the predator had finished feeding, the host larva was about one-half its original size. On another occasion, a small stink bug, *Banasa dimidiata* (Say), was seen sucking fluid from *M. disstria.* The latter was a smaller predator, but was equally effective in killing its host. The above predators were determined by R.C. Froeschner of the USDA, Beltsville, Maryland.

Rove beetles (Coleoptera: Staphylinidae) were observed attacking *M. disstria* larvae which had fallen on buffalo droppings. The caterpillar larvae were attacked behind the head by the beetles, and larvae were usually dead within a few seconds. On occasion the rove beetles were observed eating their prey. On other occasions they failed to feed on the larvae after attacking and killing them.

Bird predation was also observed as a natural control factor in *M. disstria* populations. Goeke (1971) observed that many *M. disstria* larvae were devoured by birds at Sully's Hill Game Preserve. He reported that bird populations had increased during

Table 3. Determined parasites and hyperparasites of Malacosoma disstria, Fort Totten, North Dakota, 1971.

	Parasite	Hyper-parasite
Hymenoptera		
Encyrtidae		
Ooencyrtus clisiocampae (Ashm.)	X	
Eulophidae		
Tetrastichus silvaticus Gahan	X	
Scelionidae		
Telenomus clisiocampae Riley	X	
Pteromalidae		
Dibrachys cavus (Walk.)		X
Ichneumonidae		
Theronia atalantae fulvescens (Cress.)	X	
Hyposoter fugitivus fugitivus (Say)	X	
Coccygomimus pedalis (Cress.)	X	
Scambus (Scambus) tecumseh Viereck	X	
Itoplectis conquisitor (Say)	X	X
Gelis tenellis (Say)		X
Gambrus canadensis canadensis (Prov.)	X	
Phobocampe clisiocampae (Weed)	X	
Braconidae		
Aphaereta pallipes (Say)		X
Diptera		
Tachinidae		
Lespesia archippivora (Riley)	X	
Lespesia frenchii (Will.)	X	
Carcelia sp.	X	
Patelloa sp.	X	
Sarcophagidae	X	

the previous two years of the *M. disstria* infestation, and attributed the bird buildup to the increase in caterpillar numbers. Goeke concluded that bird predation accounted for a sizeable reduction in *M. disstria* populations. A listing of the birds observed in the infestation area is presented in Table 4.

Invertebrates found associated with *M. disstria* pupae included ants (determined by D.R. Smith), weevils (determined by R.E. Warner), true bugs (determined by J.L. Herring), and dipterons (determined by G.C. Steyskal). Four species of spiders were determined by M.J. Moody of the California Department of Agriculture.

Table 4. Predators and associates of Malacosoma disstria, Fort Totten, North Dakota, 1971.

Predators

Birds observed feeding:

Black-billed cuckoo — *Coccyzus erythropthalmus* Wilson.

Black-and-white warbler — *Mniotilta varia* L.

Northern oriole — *Icterus galbula* L.

Birds known to feed:

Grey catbird — *Dumetella carolinensis* L.

Veery — *Catherus fuscescens* Stephens

Red-eyed vireo — *Vireo olivaceus* L.

Yellow warbler — *Dendroica petechia* L.

Insects:

(Coleoptera: Pentatomidae)

Brochymena quadripustulata Fabricius

Banasa dimidiata (Say)

(Coleoptera: Staphylinidae)

Associates

Insects:

Brachyrhinus ovatus (L.) (Coleoptera: Curculionidae)

Seioptera vibrans (L.) (Diptera: Otitidae)

Hemiptera

Miridae, Lygaeidae and *Pentatomidae*

Camponotus nearcticus Emery (Hymenoptera: Formicidae)

Spiders:

Clubiona moesta (Banks) (Araneida: Clubionidae)

Sergiolus decoratus (Kaston) (Araneida: Gnaphosidae)

Paraphidippus marginatus (Walck) (Araneida: Salticidae)

Araneus cornutus (McCook) (Araneida: Argiopidae)

(Araneida: Micryphantidae)

Summary and Conclusions

Outbreak populations of *Malacosoma disstria* Hübner occurred during the summers of 1969 thru 1971 in the Sully's Hill National Game Preserve and surrounding Indian land near Fort Totten, North Dakota.

The major hosts in the area are basswood and chokecherry. Observations showed that naturally occurring nuclear polyhedrosis viruses were the most important pathogens infecting *M. disstria* populations in the field. Other pathogens found were a cytoplasmic polyhedrosis virus; the fungi *Beauveria bassiana, Entomophthora megasperma* and *Isaria* sp.; a bacterium (*Bacillus* sp.); and a protozoan (*Microsporidia*).

Parasites appeared to be an important natural control. Incidence of egg parasitism was 2.46 per cent in 1970 and 4.13 per cent in 1971. The egg parasites *Ooencyrtus clisiocampae, Tetrastichus silvaticus* and *Telenomus clisiocampae* have been determined. The 1971 incidence of larval parasitism was 33.4 per cent; pupal parasitism was 66.3 per cent. Dipterous parasites were the most abundant. Many larval-pupal hymenopterous parasites were also noted. These included *Theronia atalantae fulvescens, Hyposoter fugitivus fugitivus, Coccygomimus pedalis, Itoplectis conquisitor, Scambus (Scambus) tecumseh, Gambrus canadensis canadensis* and *Phobocampe clisiocampae. T. a. fulvescens* was found in North Dakota for the first time. Hyperparasites determined were *Gelis tenellus, Dibrachys cavus, Aphaereta pallipes; Itoplectis conquisitor* also emerged as a hyperparasite. Dipterous parasites determined were primarily the tachinids *Lespesia archippivora, Lespesia frenchii, Carcelia* sp. and *Patelloa* sp.; undetermined sarcophagids were also found.

Two insect predators were observed feeding on *M. disstria* larvae. One was a pentatomid *Brochymena quadripustulata* and the other an unidentified staphylinid. Several birds, including the black-billed cuckoo, black-and-white warbler and Baltimore oriole were observed feeding on larvae of the forest tent caterpillar. Insects found associated with *M. disstria* pupae included ants, weevils, true bugs and dipterons. Five species of spiders also were found.

References

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