PERSISTENCE OF MICROSPORIDIA IN POPULATIONS OF THE SPRUCE BUDWORM AND FOREST TENT CATERPILLAR

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ABSTRACT

The microsporidian pathogens, *Nosema fumiferanae* and *Pleistophora schubergi* were tested against the spruce budworm, (*Choristoneura fumiferana*) and a combination of *Nosema disstriae* and *P. schubergi* against the forest tent caterpillar, (*Malacosoma disstria*) during the years 1975 to 1977. A packsack-type mist blower was used to apply suspensions of microsporidian spores on individual white spruce, balsam fir and trembling aspen trees. Levels of *N. fumiferanae* were significantly higher in spruce budworm in the treated areas as compared to the checks. This higher level of infection persisted for about three years. Although infection by *P. schubergi* was higher than that of *N. fumiferanae*, there was no carry-over of *P. schubergi* to the next year. The application of mixtures of *P. schubergi* and *N. disstriae* significantly increased the levels of *P. schubergi*, but not *N. disstriae* in forest tent caterpillars. Here again there was no carry-over of *P. schubergi*.

RÉSUMÉ

De 1975 à 1977, on a éprouvé *Nosema fumiferanae* et *Pleistophora schubergi*, agents microsporidiens d'infection, contre la tordeuse des bourgeons de l'épinette (*Choristoneura fumiferana*) et une combination du dernier et de *N. disstriae* contre la livrée des forêts (*Malacosoma disstria*), en les projettant sur des épinettes blanches, des sapins baumiers et des peupliers faux-trembles, au moyen d'un pulvérisateur pneumatique porté sur le dos. La tordeuse a été notablement plus infectée par *N. fumiferanae* que les témoins, et ce, pendant trois ans. L'infection causée par *P. schubergi* était plus forte, mais elle ne s'est pas maintenue jusqu'à l'année suivante. Chez la livrée, l'infection causée par *P. schubergi* a été accrue par le traitement, mais non pas celle qui était causée par *N. disstriae*; de plus, l'infection due à *P. schubergi* ne s'est pas maintenue.

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INTRODUCTION

During the years 1975 to 1977, infectivity of microsporidian species was determined in field trials against the spruce budworm, *Choristoneura fumiferana* (Clem.) and the forest tent caterpillar, *Malacosoma disstria* Hbn. at various locations in Ontario. The microsporidian parasites, *Nosema fumiferanae* (Thom.) and *Pleistophora schubergi* Zwolfer were tested against the spruce budworm and *Nosema disstriae* (Thom.) and *P. schubergi* against the forest tent caterpillar. Aqueous suspensions of the microsporidia were sprayed on individual trees (white spruce, *Picea glauca* Voss.; balsam fir, *Abies balsamea* Mill. and trembling aspen, *Populus tremuloides* Michx.), using a packsack-type mist blower.

These studies were carried out in order to determine whether or not the microsporidia could be introduced into a budworm or forest tent caterpillar population and also study their persistence over the following years. Detailed information on methods of application and sampling were published earlier (Wilson and Kaupp 1975, 1976, and 1977). Information on the persistence of these parasites to the year 1979 is presented in this report.

MATERIALS AND METHODS

Experimental plots

The plot in which only *N. fumiferanae* was tested against the spruce budworm was located 1.1 km south of the town of Burpee in Burpee Township on Manitoulin Island. This plot was treated in 1975. During 1976 individual white spruce and balsam fir trees,

in plots located 15 km north of Thessalon, Ontario in Rose Township were treated with *N. fumiferanae* and *P. schubergi* in separate experiments. Experimental plots for tests using microsporidia against the forest tent caterpillar were located 4 km south of Echo Bay, Ontario in the corporate Township of MacDonald, Meredith and Aberdeen Additional. In all of the above plots, check trees were selected in a suitable site in close proximity to the treatment area to ensure similar levels of natural microsporidian infection.

Formulation and application rate

Each sample tree on the Manitoulin Island plot was sprayed with 1500 ml of a formulation consisting of 12% microsporidian suspension and 88% distilled water by volume. Approximately 1.8 x 10" spores were applied to each tree. In the remaining studies sample trees were sprayed with 1500 ml of an aqueous formulation containing 25% (v/v) molasses and 30 g/ℓ of IMC 90-001 sunlight protectant. Application rates are indicated in Tables 1 to 4. All formulations were prepared in the field immediately prior to spraying.

Spray operation and larval development

The suspension of microsporidia was applied to sample trees with a packsack-type mist sprayer (KWH 2677 Kem San Ltd.). Larval development of spruce budworm at the time of application was primarily fourth and fifth instar. Most forest tent caterpillars were in the third instar at the time of spraying.

Sampling and microscopic examination

The procedures for sampling and microscopic examination were reported earlier (Wilson and Kaupp 1975 and 1977) with sampling dates indicated in the tables of this report (Tables 1-4).

RESULTS AND DISCUSSION

The incidence of *N. fumiferanae* in living spruce budworm larvae collected from white spruce on Manitoulin Island, the year of spraying and subsequent years is given in Table 1. The pre-spray sample indicated that 13.5% of the larvae were naturally infected with the microsporidia. Budworm larvae from sprayed trees taken 25 days after spraying had significantly higher levels of infection than budworm from the check area. Over the next three years there was a progressive increase of *N. fumiferanae* in the check area eventually reaching that of the treated area.

Table 2 shows the levels of *N. fumiferanae* in spruce budworm larvae collected from treated white spruce and balsam fir from plots located north of Thessalon, Ontario. As was the case for the Manitoulin Island plots there was a significantly higher level of *N. fumiferanae* in the treated areas as compared to the checks. Samples taken 19 days after spraying showed higher levels of infection in budworm taken from balsam fir. This is probably due to the more open nature of buds at time of spraying. Again there was a progressive increase of *N. fumiferanae*, infection in spruce budworm in the check areas, from both white spruce and balsam fir, reaching levels of the treated area in three years.

Treatment with *P. schubergi* in the Thessalon area resulted in higher levels of infection as compared to *N. fumiferanae* and again levels were higher in insects collected from treated balsam fir. There was little carry-over of *P. schubergi* the year after spraying and subsequently disappeared by the second year (Table 3). This may have been due, in part, to mortality of infected insects. Population reduction studies were not performed, as our main purpose was to determine if these protozoans could be successfully introduced into a population of the spruce budworm.

An application rate of 1.8 x 10" spores per tree consisting of mixtures of *P. schubergi* and *N. disstriae* significantly increased the incidence of *P. schubergi*, but not *N. disstriae* in forest tent caterpillars, the year of treatment. However, as with the spruce budworm there was no carry-over of *P. schubergi* (Table 4). Insects had disappeared from the area by the third year, therefore, no levels of infection could be reported.

The results of these preliminary field trials indicate that *N. fumiferanae* can be successfully introduced into a population of spruce budworm and advance the infection levels by two to three years. Since the parasite is transmitted transovarially, most offspring of infected adults are also infected. In these studies only a few individual trees among a large number were sprayed, thus the influx of microsporidia-free adults would dampen the effects of the treatment with time. The adverse effect

of this parasite on adult longevity and fecundity, as well as on larval and pupal development could be important in a program to control levels of spruce budworm. It is possible that *P. schubergi* could be used as a control agent against both forest tent caterpillars and the spruce budworms. However, extensive laboratory studies, to determine proper dosage rates, host range, etc., followed by field trials would have to be carried out.

REFERENCES

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Table 1.

Incidence of *Nosema fumiferanae* in living spruce budworm larvae collected from white spruce trees sprayed June 2, 1975 with 1.8 x 10" spores/tree[a]

Plot	Sample date	No. insects examined	% Incidence of *N. fumiferanae*
Treatment area	May 26, 1975 (prespray)	613	13.5
Treated	June 27, 1975	568	53.0
Check	June 27, 1975	174	23.0
Treated	June 6, 1976	311	52.4
Check	June 6, 1976	141	39.0
Treated	June 11, 1977	416	51.2
Check	June 11, 1977	239	48.9
Treated	June 12, 1978	808	56.0
Check	June 12, 1978	136	56.6
Treated	June 6, 1979	1002	65.3
Check	June 6, 1979	230	60.0

[a]Plot located on Manitoulin Island

Table 2.

Incidence of *Nosema fumiferanae* in spruce budworm larvae collected from white spruce (wS) and balsam fir (bF) trees sprayed June 4, 1976 with 5.0×10^{10} spores/tree[a]

Plot	Sample date	No. insects examined	Percent incident of *N. fumiferanae*
Treatment (wS) area	June 2, 1976 (prespray)	33	24.2
Treatment (bF) area	June 2, 1976 (prespray)	28	39.2
Treated (wS)	June 21, 1976	101	44.5
Check (wS)	June 21, 1976	64	26.6
Treated (bF)	June 21, 1976	80	66.2
Check (bF)	June 21, 1976	67	38.8
Treated (wS)	June 10, 1977	112	53.6
Check (wS)	June 10, 1977	72	40.0
Treated (bF)	June 10, 1977	54	53.7
Check (bF)	June 10, 1977	50	32.0
Treated (wS)	June 14, 1978	233	64.3
Check (wS)	June 14, 1978	218	39.9
Treated (bF)	June 14, 1978	149	55.7
Check (bF)	June 14, 1978	190	27.3
Treated (wS)	June 21, 1979	263	73.8
Check (wS)	June 21, 1979	78	65.4
Treated (bF)	June 21, 1979	38	65.8
Check (bF)	June 21, 1979	219	65.7

[a]Plots located 15 km north of Thessalon, Ontario

Table 3.

Incidence of *Pleistophora schubergi* in spruce budworm larvae collected from white spruce (wS) and balsam fir (bF) trees sprayed June 3, 1976 with 5.0×10^{10} spores/tree[a]

Plot	Sample date	No. insects examined	Percent incidence of *P. schubergi*
Treatment (wS) area	June 2, 1976 (prespray)	28	0
Treatment (bF) area	June 2, 1976 (prespray)	35	0
Treated (wS)	June 21, 1976	74	64.8
Check (wS)	June 21, 1976	64	0
Treated (bF)	June 21, 1976	55	96.3
Check (bF)	June 21, 1976	67	1.4
Treated (wS)	June 10, 1977	31	3.2
Check (wS)	June 10, 1977	72	0
Treated (bF)	June 10, 1977	24	0
Check (bF)	June 10, 1977	50	0
Treated (wS)	June 14, 1978	40	0
Check (wS)	June 14, 1978	218	0
Treated (bF)	June 14, 1978	64	0
Check (bF)	June 14, 1978	190	0
Treated (wS)	June 21, 1979	45	0
Check (wS)	June 21, 1979	78	0
Treated (bF)	June 21, 1979	104	0
Check (bF)	June 21, 1979	219	0

[a]Plot located 15 km north of Thessalon, Ontario

Table 4.

Incidence of *Nosema disstriae* and *Pleistophora schubergi* in forest tent caterpillar collected from trembling aspen trees sprayed with 1.8 x 10" spores/tree consisting of a mixture of 50% *N. disstriae* and 50% *P. schubergi* spores

Treatment	Collection date	No. larvae examined	Percent incidence of *N. disstriae*	Percent incidence of *P. schubergi*
Prespray	May 19, 1977	794	2.6	0
spray area	May 26, 1977[a]	196	19.6	76.1
check	May 26, 1977[a]	36	22.5	0
Spray area	June 7, 1978	757	48.5	0
check	June 7, 1978	200	34.5	0

[a] = Spraying occurred May 20, 1977, larvae collected May 26 reared in the laboratory until June 6, then frozen until examined.