spruce and balsam fir at various periods throughout the summer. A sample consisted of 12–15 branch tips cut from the host tree, which were examined in the laboratory and the spruce budworm removed. A final sample was taken in the field with a beating mat after 80-90% of the budworm had pupated.

It was found that there is a general build-up in the incidence of the microsporidian parasite as the budworm infestation persists. This was also demonsrtated by Thomson (Can. Dep. Agric. Bi-Mon. Prog. Rept., 16(4):1, 1960) for *N. fumiferanae* in a population of spruce budworm in the Uxbridge Municipal Forest, Ontario. The incidence of microsporida also increases with age of the larvae during the summer; a higher percentage of the sixth-instar were infected with *N. fumiferanae* when compared to the other instars (Table 1). This probably resulted from a natural spread of the pathogen during the summer; however it is also possible that some light infection may have been overlooked in the younger larvae. Viable spores are present in regurgitated fluids and frass of infected insects. Larvae killed by the parasite contain millions of spores (Thomson, Can. J. Zool. 36: 309-316, 1958; Wilson, Ph.D. Thesis, Cornell University, Ithaca, New York, 1973). Spores from these sources may be dispersed by various abiotic and biotic factors to other budworm larvae in the population.

TABLE 1
Percentage microsporidian infection in spruce budworm larvae collected in Parkinson township during 1971, 1972, and 1973

Year	Collection date	Predominate instars	Percent larval infection[a]
1971	May 27	2–3	32.6
	June 3	4–5	22.4
	June 10	6	50.6
	June 17	6	40.0
1972	May 24	3–4	37.0
	May 31	4	33.3
	June 7	5	33.3
	June 14	6	40.7
	June 22	6	41.6
1973	May 10	3–4	67.0
	May 23	4	66.8
	June 20	6	82.0

[a] Each percentage based on 80–200 examinations.

As indicated in Table 2, those larvae remaining after 80-90% of the budworms have pupated have a high incidence of microsporida. It is possible that most of these larvae are stragglers due to infection by *N. fumiferanae*. The results from the examination of the insects in these collections were a further indication of the increasing levels of microsporida toward the end of the budworm season.

TABLE 2
Percentage of spruce budworms infected with microsporida based on a beating mat sample taken after 80-90% of the budworms had pupated in Parkinton Township

	1972	1973
Larvae infected	66.6% (18)[a]	87.5% (40)
Prepupae and pupae infected	46.6% (75)	81.4% (70)

(—)[a]: number of insects examined.

An examination of the budworm population in 1974 should indicate whether this high level of microsporidian infection has any effect on reducing the level of the infestation.—G. G. Wilson, Insect Pathology Research Institute, Sault Ste. Marie, Ont.

Ambrosia Beetle Attacks Delayed by Turpentine Oil.—Because certain monoterpens have a repellent effect on the ambrosia beetle [*Trypodendron lineatum* (Oliv.)] (Moeck, Can. Entomol. 102:985-995, 1970) a test was conducted in a forested area at Lake Cowichan, B.C. during mid-June 1970 to determine whether such naturally occurring volatiles could retard beetle attack.

Four Douglas-fir bolts (.75 m long) were cut from each of two trees and placed on end in a row 2 m apart, alternating control and treated bolts. Two bolts from each tree were used as controls. The other bolts were brush-wetted with commercial turpentine oil (distillate of a mixture of mainly mono- and diterpenes).

After 3 days, the beetles were crawling on and burrowing into the control bolts; none were seen on the treated bolts until the fifth day. The bark was stripped from all the bolts on the sixth day. Table 1 shows the numbers of *T. lineatum* attack holes.

TABLE 1
Numbers of attack holes of *Trypodendron lineatum* on bolts 5 days after treatment with turpentine oil

Bolt No.	No. of *T. lineatum* Attack Holes	
	Treated	Untreated
1	30	625
2	0	697
3	91	650
4	22	720

Treatment with turpentine retarded the attack. As the terpenes evaporated, the bolts again became susceptible. The extent of retardation is apparently related to the rate of evaporation of the effective terpenes. Treated bolt No. 2 was in a shaded area where evaporation was slower than in direct sunshine.

Trees cut shortly before the flight season are less heavily attacked than those cut during fall and early winter (Dyer and Chapman, Can. Entomol. 97:42-57, 1965). Whether this is due to masking, lack of primary attraction or other mechanism is not clear.

Further experiments with selected terpenes may identify naturally occurring retardants. The use of such retardants, probably in combination with stickers, along with water misting (Richmond and Nijholt, Can. For. Serv. Inf. Rep. BC-P-4, 1972), and a male-produced pheromone mask (Nijholt, Can. Entomol. 102:894-897, 1970; 105:583-590, 1973; J. H. Borden, personal communication) could provide effective means of log protection.—W. W. Nijholt, Pacific Forest Research Centre, Victoria, B.C.

Toxicological Studies of Some Insecticides upon Adult Spruce Budworm.—The extension of the aerial spray program to include the spraying of adult insects has necessitated an evaluation of the relative toxicides of various insecticides on adult budworm. Preliminary tests, using fenitrothion, phosphamidon, lannate, and pyrethrins, have been made in the laboratory. Diapause-free budworm were reared on synthetic diet to pupation, then pupae were isolated in shell vials until emergence. The sexed adults (2 days old) were anaesthetized with CO_2 and tested in replicates of 8 to 12 insects with two replicates per dose. Control replicates were dosed with pure cyclohexanone solvent. The insecticide was applied between the front coxae using a 0.2-μl capillary tube. Mortality was assessed after 24 hours. The probit regression lines were calculated by program on a Wang 700 calculator and were corrected for natural mortality.

Phosphamidon was the most effective insecticide at both LD50 and LD95 values (Table 1), which agrees with preliminary studies under field conditions (E. G. Kettela, personal communication). The slopes of the probit lines for the three synthetic compounds are very similar, being almost parallel. However, the slope of the pyrethrin line is much steeper (Fig. 1) giving an LD95 value comparable with the other three, even though its LD50 is 3.5 times less than that for phosphamidon. This may prove to be of considerable importance in the assessment of the pyrethrin group as potential field compounds. The efficacy of pyrethroids can be greatly improved by mixing them with synergists like sesame oil and iperonyl butoxide.