STATUS OF NEW INSECT PATHOGENS AS METHYL BROMIDE ALTERNATIVES

Joel P. Siegel, USDA/ARS, Horticultural Crops Research Laboratory, Fresno, California

The codling moth, *Cydia pomonella*, a serious pest of apples and pears, originated in Eurasia and occurs on every continent where apples are grown. It is also a quarantine pest. Entomopathogens from several phyla have been reported from codling moth collected around the world. Some of these, most notably a granulosis virus and nematodes, have been developed as microbial control agents and evaluated in orchards in Europe and North America. The effects of naturally occurring pathogens that do not cause acute mortality but caused delayed mortality have received considerably less attention. In 1938 Paillot described the microsporidium *Nosema carpocapsae,* in codling moth larvae collected in a French orchard. This microsporidium was subsequently collected in Eastern Europe and New Zealand but has not been reported in the United States until now. There are contradictory reports on the impact of *N. carpocapsae* on the codling moth. Eastern European researchers reported that heavily infected larvae died while New Zealand researchers reported that infection caused little mortality and had the greatest effect on reproduction, by reducing the fecundity and fertility of infected moths.

I investigated the impact of *N. carpocapsae* using infected codling moths from a colony established from the state of Washington. Dr. Lawrence Lacey, Yakima Agricultural Research Laboratory, USDA/ARS, Wapato, Washington provided the insects. Larvae that acquired an infection transovarially experienced greater mortality than their uninfected counterparts and there was also a difference in adult emergence from infected pupae. For example, at a density of 1 larva per cup, if we started with two groups, one infected and the other uninfected, containing equal numbers of larvae, there would be a 42% reduction in the amount of adults emerging from the infected group. Follow-up studies are necessary to determine the impact of *N. carpocapsae* on overwintering populations of the codling moth and to determine the distribution of this pathogen in North America. The following table summarizes some differences between infected and uninfected codling moths:

Comparison between uninfected and infected codling moth colonies reared at 28°C

	Uninfected	Infected
Generation Time (Days ± S.D.)	32.6 ± 1.8* (9 cohorts)	39.3 ± 3.3* (7 cohorts)
Male Pupal Mortality	7.6% (N = 930)*	20.1% (N = 899)*
Female Pupal Mortality	6.8% (N = 837)*	19.2% (N = 698)*

*P<0.001, comparisons are across rows

Dr. Charles Vossbrinck of the Connecticut Agricultural Experiment Station, New Haven, Connecticut, compared the small subunit ribosomal RNA (ssRNA) sequences of our *N. carpocapsae* isolate to isolates from New Zealand and Bulgaria. The sequences for all isolates were identical for the small subunit rRNA, indicating that these isolates are probably the same species. The internal transcribed spacer region (ITS) was also identical but there were three uncertain positions in the sequence. The data indicate that the distribution of *N. carpocapsae* is cosmopolitan.

One of the goals of my research is the discovery and evaluation of entomopathogens that target several stored product pests. In collaboration with Dr. Patrick A. Vail, USDA/ARS, Horticultural Crops Research Laboratory, Fresno, California, I have been investigating the host range and impact of a cytoplasmic polyhedrosis virus (CPV) of the cabbage looper, *Trichoplusia ni*, against the stored product pests Indianmeal moth (*Plodia interpunctella*), Almond moth (*Ephestia cautella*) and Raisin moth (*Ephestia figulilella*). Preliminary studies indicate that this virus has no activity against the Indianmeal moth but is active against the Almond and Raisin moth. Raisin moth larvae exposed to the CPV were 3.4 times as likely to die as the unexposed larvae and Almond moth larvae exposed to the CPV were 2.9 times as likely to die as the controls. CPV exposed larvae of both species took longer to emerge as adults than the controls, 2.9 days and 5.2 days for the Almond and Raisin moth, respectively. CPV-exposed female Almond moths weighed significantly less than the controls, ($P=0.0004$). This indicates that infected females are less fit than their uninfected counterparts, and as a consequence they probably lay fewer eggs. Currently, I am evaluating the efficacy of this CPV grown in tissue culture compared to CPV obtained from infected cabbage loopers. I plan to evaluate whether higher doses of the virus can produce the level of mortality necessary for control and I am also investigating the sublethal effects of this virus on surviving adults. I am especially interested in assessing whether the greatest impact of infection is on the succeeding generation, due to a combination of reduced adult fecundity and increased larval mortality in transovarially infected larvae. In a preliminary study, this virus also had activity against the codling moth, but this needs to be further quantified.