NOTE

Low Incidence of Viral and Fungal Entomopathogens in Gypsy Moth (Lepidoptera: Lymantriidae) Populations in Northern Virginia[1]

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The gypsy moth *Lymantria dispar* L., population collapsed in northern and northwestern Virginia in 1996 due to epizootics of *Entomophaga maimaiga* Humber, Shimazu & Soper (Webb et al., 1999, J. Entomol. Sci. 34: 84-100). We report here the levels of *E. maimaiga* and the gypsy moth nucleopolyhedrosis virus (LdMNPV) in the remnant, low-density populations following that population collapse.

Three areas were monitored from 1997 through 1999. One site was located near Lexington, VA. A second area was established in cooperation with the gypsy moth coordinators for Fairfax, Fauquier, Orange, Prince William, Rockbridge, and Stafford counties. The third area was established near Goshen, VA, in 1998.

In each study area burlap bands (0.3 m wide) were wrapped around the trunks of dominant host trees (oak, *Quercus* spp.) at a height of 1.5 m (Liebhold et al. 1986, Environ. Entomol. 15: 373-379). These were used to monitor gypsy moth life stages throughout the study. The bands were searched at regular intervals for each area. For each observation, all living larvae and pupae were recorded and left under the bands. Any dead larvae were removed and returned to the laboratory for necropsy using methods of Webb et al. (1999). Dead pupae were removed and discarded.

Relative population density was calculated as per Webb et al. (1999). Disease indices were computed for both LdMNPV and *E. maimaiga* in each of the three study areas (Webb et al., 1993, J. Econ. Entomol. 86: 1185-1190). Data for the northern Virginia plots for 1998 were analyzed by correlation analysis using SAS Version 7.0 for Windows (SAS Institute 1998).

Gypsy moth populations remained at low but detectable levels averaging 1.8, 4.6, and 0.9 life stages per 100 burlap bands (number of burlap bands per plot = 150) in

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the Lexington plots during 1997, 1998, and 1999, respectively. However, despite the high levels of viral and fungal inoculum produced in 1995 (Webb et al. 1999), both *E. maimaiga* and LdMNPV remained below detectable levels during this study. Onstad (1993, Biol. Contr. 3: 353-356) indicated that disease transmission is a function of the density of both the free-living pathogen propagules and the susceptible host. In these 10 plots for the years 1997-1999, the density of susceptible hosts (gypsy moth larvae) was apparently below the threshold needed to induce detectable levels of either disease despite a heavy presence of propagules.

In Northern Virginia, we sought to test for density dependence for *E. maimaiga* by monitoring plots with a range of gypsy moth population levels. All plots were within the generally infested area and were assumed to have had populations of gypsy moth at some point during the northern Virginia outbreak of 1990 to 1995. None of the plots were near large, current gypsy moth outbreaks so that disease incidence probably resulted from propagules resident in the plots. All plots received 50 burlap bands in 1997 and 1999, and 25 burlap bands in 1998.

Gypsy moth populations were difficult to detect in the northern Virginia plots in 1997 with the exception of one population in Fairfax Co. and one population in Orange Co. These 2 sites were remnants of the collapsed 1990-1995 northern Virginia outbreak, and it is interesting that these two plots had significant LdMNPV loads (Table 1). This suggests that such remnant populations may be important reservoirs of virus between gypsy moth outbreak cycles.

In 1998, populations were higher, especially on Bull Run Mountain and on the border between Prince William and Fauquier counties. This allowed us to establish 8 plots with a range of populations ranging from 0.3 to 66.4 life stages per burlap band (=8 to 1660 life stages per 25 bands). Levels of fungal-induced mortality increased as gypsy moth populations under the burlap bands increased ($n = 10$; $r = 0.85$; $P = 0.007$), indicating density dependence for the fungus.

The higher-density plots used in 1998 were treated for gypsy moth in 1999, forcing us to find new, lower-density evaluation sites that year. Gypsy moth populations as well as disease levels were low and/or below detectable levels in 1999 (Table 1). In all 3 yrs, mortality due to *E. maimaiga* was detected in plots with quite low gypsy moth populations, indicating that the fungus can maintain itself even at low gypsy moth densities.

The 16 study plots near Goshen were situated on the far leading edge of the expanding gypsy moth population. The populations were newly, lightly infested in 1998. We counted 395 life stages under the 1600 burlap bands in these plots. Levels of *E. maimaiga* were below detectable levels in all plots except for the two highest density plots. Mortality due to the fungus was 22% in a plot with 177 larvae per 100 burlap bands and 3% in a plot with 67 larvae per 100 burlap bands, indicating that the fungus is expanding its range along with the gypsy moth and appears as gypsy moth infestations rise. Levels of LdMNPV were below detection in all plots.

Our results suggest that both LdMNPV and *E. maimaiga* remain at undetectable levels in very low gypsy moth populations (less than 1 larva per burlap band). Such low populations are characteristic for the latency phase in the generally-infested areas and in the newly-infested sites of the Slow-The-Spread transition zone (Leonard and Sharov, 1995, USDA For. Serv. Gen. Tech. Rep. NE-213: 82-85). However, *E. maimaiga* soon appears as gypsy moth populations increase, possibly due to the aerial transport of conidia from higher-density areas. However, LdMNPV appearance lags, probably due to the slower spread of its propagules in the environment.

Table 1. Peak burlap numbers (n = 50 in 1997, 1999; n = 25 in 1998) and % mortality due to *E. maimaiga* and LdMNPV in northern Virginia study plots, 1997, 1998, and 1999

Plot (county)	Life stages per burlap	% *E. m.*	% NPV
1997			
Fairfax-1	67.2	2	9
Orange-1	26.4	8	32
Pr. William-1	1.2	0	0
Fauquier-1	0.6	0	0
1998			
Fauquier-2	66.4	28	0
Fairfax-1	50.9	15	8
Pr. William-2	34.5	7	0
Pr. William-3	23.8	2	0
Pr. William-6	16.1	0	0
Pr. William-4	3.1	9	0
Stafford-2	0.7	0	0
Pr. William-5	0.3	0	0
1999			
Fairfax-2	7.9	1	0
Rockbr. 99-3	4.2	1	0
Rockbr. 99-1	0.8	0	0
Stafford-3	0.7	0	0
Rockbr. 99-2	0.5	0	0

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