

Preliminary Results on Predation of Gypsy Moth Egg Masses in Slovakia

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Abstract

Predation of gypsy moth egg masses was studied in Slovakia from 1999–2002. Predation on naturally laid egg masses was recorded and linear regression was used to test the hypothesis that predation follows a type II vs. type III functional response. We also investigated the role of egg mass predation in gypsy moth population dynamics. The relative contribution of invertebrates vs. vertebrates as agents of predation on egg masses was estimated using exclosures. During the study, population densities remained very low and stable. Generally, invertebrata caused 38% and vertebrata 62% of total predation. K-values varied from 0.03 to 0.70 and plots of abundance vs. k-values suggested that total predation is inversely density dependent, characteristic of a “type II” functional response. The ultimate role of predation on gypsy moth egg masses remains unclear, however there are some indications that egg mass predation plays a significant role in the dynamics of gypsy moth populations in Slovakia.

Introduction

The gypsy moth (*Lymantria dispar*) is the most serious pest of broadleaved stands (oak stands mainly) in Slovakia. Outbreaks are repeated in cycles of 6 to 12 years. During the last outbreak of 1992–1994, gypsy moth severely damaged more than 18,000 ha of forest land. In stands exhibiting patterns of long-term oak decline, defoliation can cause increased tree mortality in subsequent years and therefore, infested stands are often treated with biopesticides, mainly *Bacillus thuringiensis*. The key biotic factors influencing population dynamics during the latency phase are not well known in Slovakia. Conversely, the bioregulation complex of gypsy moth is better understood in the U.S.A. (Doane and McManus 1981, Elkinton, Liebhold 1990). The goal of this paper is to present results on a study of gypsy moth egg mass predation during the latency phase. The objectives of this study were to: Determine the relationship between predation and gypsy moth densities (i.g. identify the type of functional response); evaluate the role of egg mass predation in gypsy moth population dynamics; and quantify the relative levels of predation caused by vertebrates vs. invertebrates.

Material and Methods

Survey of Population Density

A series of 12 study plots was established across the outbreak area of gypsy moth in southern Slovakia (Fig. 1). Surveys of population density were conducted using the Modified Turcek method (MTM) (Turčani 1998). MTM consists of counting the number of egg masses on 4 points (every point consists of 30 trees) in the study area. If the average number was over 1.00 egg mass per tree, the survey was terminated. If it was below 1.00 egg mass per tree, counting continued on another 4 points (together 240 trees). If the population density was below 0.3 egg masses, another 8 points were taken. The total arrangement consisted of 480 trees. Egg masses were found on trunks from ground level to the 5–8 m.

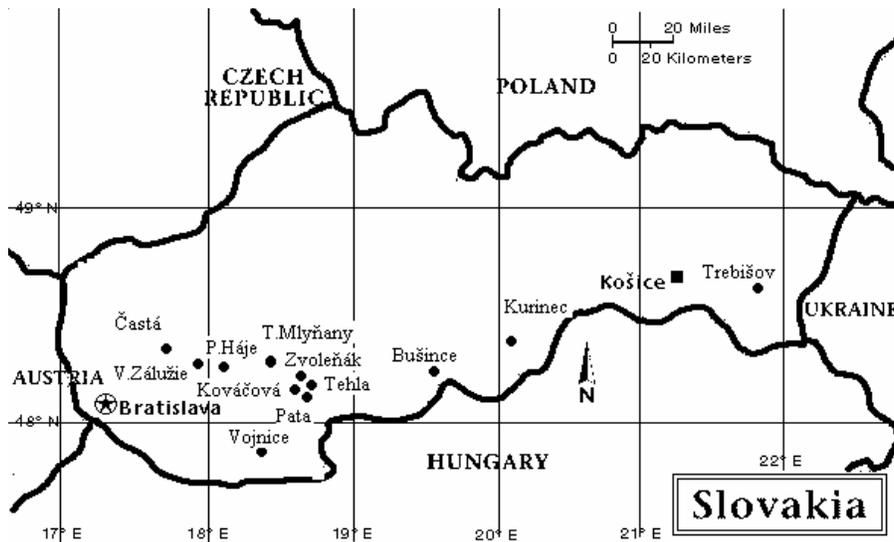


Figure 1.—Placement of study plots (•) in the Slovak Republic

Egg mass predation

Predation on naturally laid egg masses was recorded by inspection of each egg mass found during the annual survey described above. These inspections were conducted at the end of November (around the time of first snowfall) and at the beginning of April (when all snow has melted). At the time of original survey and at each check, the size (length and width) and condition of each egg mass was recorded (we recorded the proportion of each egg mass that was missing).

The effect of density on predation levels was studied by comparing predation levels at different sites in different years. Predation was expressed as k-values at each site in each year. Density dependence was tested by regressing predation vs. log egg mass density. Linear regression was used to test the hypothesis that predation follows a type II vs. type III functional response (Holling 1965).

The impact of egg mass predation on population growth was evaluated by plotting $R(N_{t+1}/N_t)$ vs. k-values from the same year during the entire study period.

The relative contribution of invertebrates vs. vertebrates as agents of predation on egg masses was estimated using exclosures (Grushecky et al. 1998). These experiments were conducted at Zvolenak and Pata during the winters of 2000/2001 and 2001/2002. At each site, 150 laboratory reared egg masses were placed on the stem of individual trees.

Exclosures were placed around 75 of these egg masses. Exclosures consisted of a ~1.5 cm steel mesh (“hardware cloth”) cage stapled to the bark surface around each egg mass. The proportion of each mass was recorded in November (around the 1st snowfall) and in the middle of April (prior to the approximate time of egg hatch). We assumed that the exclosure excluded all vertebrate predators but did not impede invertebrates and the relative contribution of invertebrate predators will thus be estimated by the k-values computed from predation of egg masses inside exclosures. K-values for predation by vertebrates was estimated as the difference between k-values computed from predation of egg masses without exclosures and k-values computed from predation of egg masses inside exclosures (Grushecky et al. 1998).

Results

Population Density Survey

Relatively little change in population density occurred during the period of 1999 – 2001. The range of population density varied from 0 to 0.056 egg masses per tree (0 to 28 egg masses/ha). The values indicate a period of latency on all of the plots. Examples of changes in abundance are provided in Figures 2, 3 and 4.

Table 1.—Predation of naturally laid eggs in study period.

Site	Abund 1999	k-values 1999/2000	Abundance 2000	k-values 2000/2001	Abundance 2001	k-values 2001/2002
Trebišov	1	0.699	0	No egg masses	0	No egg masses
Kurinec	4	0.143	1	0.699	1	0.022
Bušince	2	0.046	0	No egg masses	4	0.097
Pata	6	0.125	26	0.076	1	0.046
Tehla	12	0.131	3	0.456	0	No egg masses
Kováčová	29	0.046	14	0.469	3	0.036
Zvoleňák	13	0.046	19	0.051	0	No egg masses
Vojnice	0	No egg masses	1	0.097	0	No egg masses
T.Mlýňany	12	0.119	4	0.046	0	No egg masses
P. Háje	6	0.097	16	0.056	4	0.027
V. Zalužie	1	0.284	4	0.276	2	0.081
Castá	3	0.187	24	0.081	27	0.051

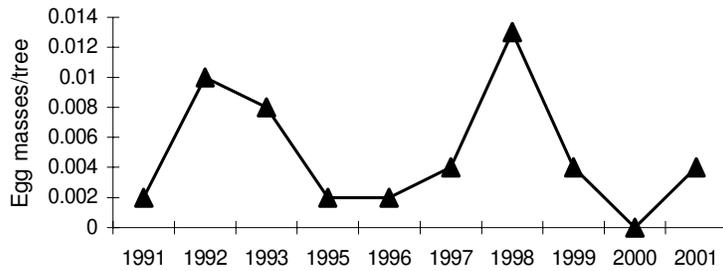


Figure 2.—Trend of egg masses at Bušince.

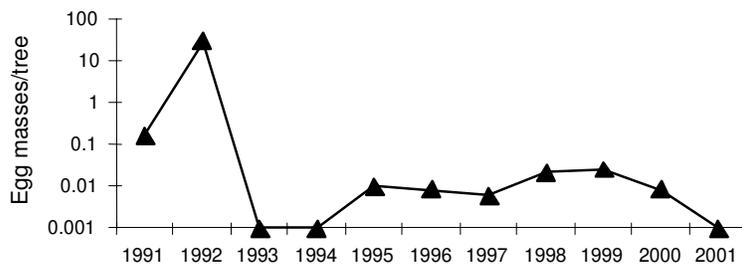


Figure 3.—Trend of egg masses at T. Mlýňany

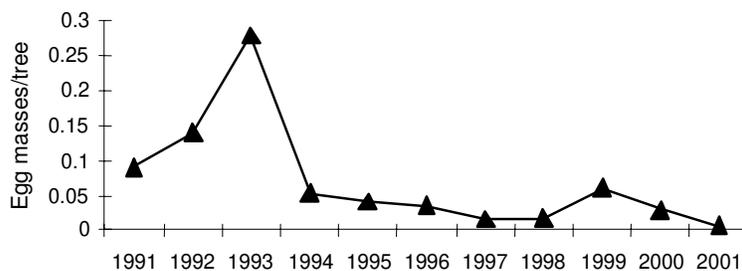


Figure 4.—Trend of egg masses at Kováčová

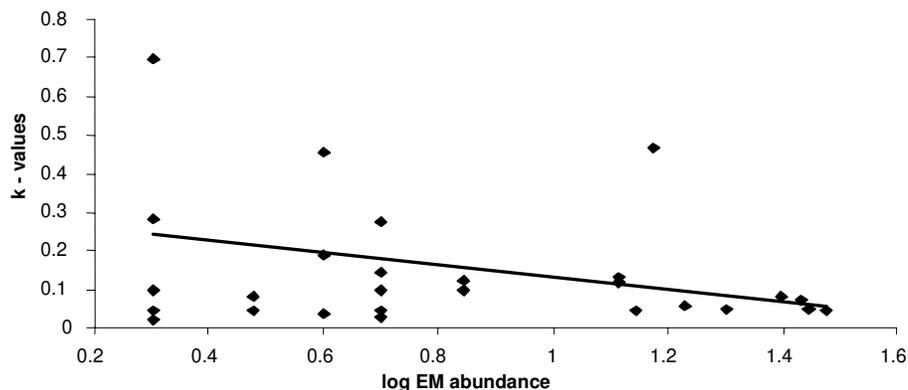


Figure 5.—Comparison of log EM abundance and k-values at the same year (n=28, Cc= -0.34).

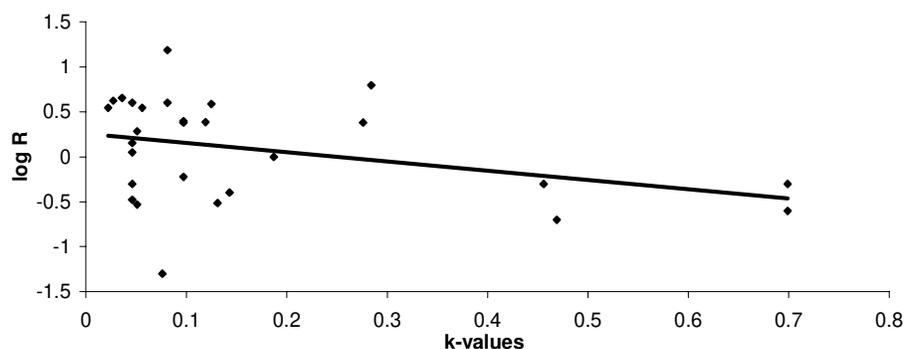


Figure 6.—Relationship between log R (N_{t+1}/N_t) and k-values (N=28, Cc= -0.35).

Predation of Naturally Laid Egg Masses

Egg mass predation was generally low and was variable among different sites (Table 1).

Dependence of predation was estimated based on the relationship between k-values and abundance in the same year. Though there was an apparent negative correlation, this was not statistically significant (Fig. 5). Nevertheless these data suggest that total predation is inversely density dependent - “type II” functional response (Holling 1965).

We also found an inverse, but insignificant correlation between predation (K) and change in population density. These results suggest that predation on egg masses explains some of the variation in change of population density (Fig. 6).

Determination of the Relative Levels of Predation Caused by Vertebrates vs Invertebrates

Predation in experiments with artificially deployed egg masses was slightly higher than in the case of naturally laid egg masses. This may have been caused by our deployment of egg masses on transects, where the abundance of egg masses is higher than normal, and which might attract predatory birds. Vertebrates caused almost two-thirds of the predation. It is possible, that in several cases, predation by vertebrates could have occurred in exclosures (by birds with long beaks like *Sitta europaea*). In that case, predation caused by vertebrates may have been underestimated in this study.

Discussion

During the length of the study, the quantity of direct damage was low on all sites; k-values only rarely exceeded 0.4. Until now, the importance of damage on egg masses was not well described. Capek et al. (1999) published data on the predation of masses during outbreaks when totally damaged egg masses were found quite often. These data vary from the results of our experiments, in which the occurrence of totally damaged masses was rare. Randík (1967) also mentioned additional information about egg mass predation, but no relationship was found between abundance and

Table 2.—Relative levels of predation in two winters.

Locality	Total K	%	Invertebrata K	%	Vertebrata K	%
Pata 2000/2001	0.102	100	0.046	45	0.057	55
Zvolenak 2000/2001	0.046	100	0.027	59	0.019	41
Pata 2001/2002	0.050	100	0.021	42	0.029	58
Zvolenak 2001/2002	0.132	100	0.030	23	0.102	77
TOTAL	0.330	100	0.124	38	0.206	62

predation. Only frequency of egg mass damage and not the proportion of predation was measured in these experiments.

Turček (1949) observed the following bird species as feeding on gypsy moth egg masses: *Certhia familiaris*, *Sitta europaea*, *Parus major*, *Parus caeruleus*, *Parus major* and *Aegithalos caudatus*. During our experiments, we did not make direct observations of the bird species that were active in the study area.

Various aspects of egg mass predation (e.g., dependence between size of masses and predation; location of masses on trees; and predation and dependence between abundance and predation) were studied by Higasiura (1989). Abundance during his experiments varied between 27 to 230 masses per ha (0.05 to 0.5 EM/T). Percentage of predation varied with abundance and among years. Predation of masses by birds was not usually closely related with abundance. However, when the range of abundances was high, he found a significant inverse correlation dependence between abundance and predation. Higasiura (1980) reported that when abundance varied from 6 to 231 masses per 1 ha (0.01 to 0.5 masses per 1 tree), the predation by birds was almost density independent, but an inverse density dependent trend was observed in 1 year. As a whole, the correlation between egg mass density and percent predation was not apparent. Comparison of abundance and k-values during our experiment suggested an inversely density dependent relationship, but this correlation was not significant.

These results indicate that bird populations are not tightly linked ecologically to populations of gypsy moth and feeding on egg masses is mostly accidental. Predation during individual years may depend on the availability of alternate sources of food to birds and not on the abundance of gypsy moths. An important fact during our experiments was that we used naturally laid eggs except in the vertebrates-invertebrates experiments. In this case it was possible to exclude effect of bird concentrations on areas containing higher egg mass densities.

However, it may be that predation of egg masses is not insignificant in the population dynamics of gypsy moth in Slovakia during the latency phase. Despite the fact that the correlation between log R and k-values was not significant, it is still possible that predation on egg masses plays a relatively important role in gypsy moth population dynamics in Slovakia. The narrow range of egg mass densities encountered along with the sampling methods that were utilized in this study may have limited our ability to detect these relationships.

Conclusions

- Population densities were very low and relatively stable during the study period.
- K-values varied from 0.03 to 0.70 and total predation was slightly inversely density dependent - “type II” of functional response.
- The ultimate role of predation on gypsy moth egg masses is not clear, however there are some indications that predation of egg masses plays some role in the dynamics of gypsy moth populations in Slovakia.
- These experiments indicate that invertebrates caused 38% and vertebrates 62% of egg mass predation.

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