

## Assessing the gypsy moth (*Lymantria dispar*) population in permanent monitoring plots of the forests of the Mat, Elbasan and Librazhd Districts, Albania

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### Abstract

Gypsy moth (*Lymantria dispar*) is a large European moth, appears almost all over Europe, as well appears and in Albania that is a serious pest in fruit orchards and in particular in deciduous forests. In Albania this species appears over all the country except the mountains and Alps regions, but, so far, it has not been as harmful as the nun moth. However, the economic importance of the gypsy moth (*Lymantria dispar*) at the end of XX century and at the beginning of XXI century became more significant due to the decrease in both the forest areas infested with this species. The biological control by a bacterium that has caused the death in the caterpillar stage has also proved quite successful and it is continuing and for 2 years in some permanent monitoring plots (experimental plots).

**KEYWORDS:** assessing, gypsy moth, *Lymantria dispar*, *Lymantriidae*, *Lepidoptera*, egg, egg-mass, pests, diseases, biological control.

### Introduction

The gypsy moth is classified as (*Lymantria dispar*) belongs to the family *Lymantriidae* of the order *Lepidoptera*.

Gypsy moth (*Lymantria dispar*) is a large European moth, appears almost all over Europe, as well appears and in Albania that is a serious pest in fruit orchards and in particular in forests. It is related to the brown-tail and the tussock moths, both destructive, but less so than the gypsy moth. The adult female is white with dark wing markings. The wingspan is about 6.3 cm. The female has a heavy body and rarely flies, despite having well-developed wings. Throughout her adult lifespan, the female gypsy moth remains near the pupal shell from which she emerged. The adult male is olive-brown with dark wing markings and, although a powerful flier, has much smaller wings than the female.

Eggs are deposited in masses numbering from less than 200 to more than 1,000; they are yellow but are covered with buff-coloured scales from the abdomen of the adult female. The larvae, or caterpillars, occasionally appear within a few weeks, but more often they hatch the following spring. The caterpillars are yellowish-grey with long hairs

and have four longitudinal rows of coloured tubercles (nodules). One tubercle from each row appears on each of the larval segments, those on the front segments being blue and those behind being red. The caterpillars devour the foliage of numerous trees, especially of oaks and birches. Because repeated defoliation kills the trees, authorities in infested areas have instituted intensive control measures.

In Albania this specie appears over all the country except the mountains and Alps regions, but, so far, it has not been as harmful as the nun moth. However, the economic importance of the gypsy moth (*Lymantria dispar*) at the end of XX century and at the beginning of XXI century became more significant due to the decrease in both the forest area infested with this species (Lushaj, 2001 & 2006).

### **Material and methods**

To assess the gypsy moth (*Lymantria dispar*) population and the phase in population dynamics, such parameters can be used as: population density, the number of eggs per egg-mass, the size of an egg-mass (a length), the mass of an egg-mass, the ratio of the old to the new egg masses, the sex ratio, mortality at the different stages of the gypsy moth (*Lymantria dispar*) development, etc. (Wellenstein *et.al.*, 1978; Nealis *et.al.*, 1993; Meshkova, 1993).

For assessing of the gypsy moth (*Lymantria dispar*) population and the phase in population dynamics were used the 75 permanent monitoring plots by 30-90 sample trees of the Forest Monitoring System 2 for principal pests, diseases, and other biotic and abiotic stress factors (Lushaj, 2001). The permanent monitoring plots were set up 50 x 50 m = 2500 m<sup>2</sup>, and they were selected according to 10 x 10 Km grid, based on statistically representative method (Lushaj, 1997, 1999 & 2001).

Surveys and evaluation of the health state of each tree, occurring in the study sites were based on a visual assessment of two parameters, as well defoliation and discoloration and at the same time laboratory works, Table 1 (Lushaj, 1999, 2001 & 2006).

In our studies we took into account the density population, the length of an egg mass, the number of eggs per egg mass and mortality at the larval stage.

### **Estimation of the population density**

The egg stage of the gypsy moth (*Lymantria dispar*) is most suitable for estimating its population density. In the USA, Canada and European countries, different methods of egg-mass counts were used.

The methods of "timed walk" and "fixed-area plots" are common in North America and Canada. The first one is based on simply counting all of the egg-masses seen on a "five minute walk" through an area. This method was used in early gypsy moth programmes and has been assumed to be imprecise. The second method is now used most commonly in the United States. Egg-mass counts are conducted on the trunks of all trees within the fixed-radius plots (5.4-metre radius) of 0.01 ha. Obtained estimates of population density can be used for comparing different stands (Nealis *et.al.*, 1993).

In some countries in Europe and the republics of the former Soviet Union, egg mass densities are more often expressed as the number of egg-masses per tree. Egg-masses are counted along one or two (perpendicular crossing) transects on 50-90 trees on

each. Then it is translated into an estimate of the number of egg-masses per tree (Turček, 1956; Bogenschutz *et. al.*, 1989; Vorontsov *et. al.*, 1991; Meshkova, 1993).

In permanent monitoring plots by 30-90 sample trees the gypsy moth (*Lymantria dispar*) population is located in the “open” mixed birch-oak-alder-willow forest, where most of trees originated from offshoots. Thus, after analyses of all known methods, the method of fixed-radius plots was chosen as the most reliable and universal in such conditions.

#### ***Mortality at larval stage of the gypsy moth (Lymantria dispar) development***

To estimate the mortality at larval stage of the gypsy moth (*Lymantria dispar*), nine samples by 80-100 larvae were collected from natural population, in the forests of the Mat District, North of Albania, Elbasan District, Center of Albania and Librazhd District, South of Albania – on 20-22 May (samples I); 3-5 June (samples II) and 24-26 June (samples III). Collected larvae were reared separately on the natural diet of oak lewaves in to the laboratory until they died with parasitoid emergence or due to other causes, or reached imago stage. All dead larvae were dissected and analysed under microscope.

#### ***Biological control of the gypsy moth (Lymantria dispar)***

The gypsy moth (*Lymantria dispar*) has long been a pest in deciduous forests. The caterpillar stage feeds on the foliage of deciduous trees, as oaks, birches, and other types of commercially important plants. Although insecticides are used to control the moth, but biological control-by a bacterium that causes death in the caterpillar stage-has also proved quite successful and it is continuing and for 2 years in some permanent monitoring plots.

### **Results and discussion**

#### ***Population density of the gypsy moth (Lymantria dispar)***

In 2001 the density of the gypsy moth (*Lymantria dispar*) population was estimated as 80 egg- masses per ha. Wallner *et.al.*, 1991 determined that “...the gypsy moth (*Lymantria dispar*) was in an outbreak mode once densities exceeded 100 egg - masses per ha. The outbreak was triggered when densities were from 10 to 25 egg- masses per ha...”. Fuester *et.al.*, 1997 assumed for their studies the following limits:

- Low density population – less than 100 egg - masses per ha
- Medium density population from more than 100 to less than 1000 egg - masses per ha
- High density population – more than 1000 egg - masses per ha

#### ***Length of egg mass and the number of eggs per egg-mass***

The mean size of the gypsy moth (*Lymantria dispar*) was  $2.89 \pm 0.31$  cm ( $\pm 95$  % C.L.), (Table 2)

The number of eggs per one egg-mass was counted in five egg-masses only. It varied between 95-366 eggs (Table 3). It can not be used as a statistic because it is a small sample, but it may give additional information for assessing the state of the population.

The value of the egg mass density shows us that, in 2006 the gypsy moth (*Lymantria dispar*) population was in the post – outbreak phase in the forests of the Mat

District, North of Albania, Elbasan District, Center of Albania and Librazhd District, South of Albania. It could be confirmed by mean size of the egg-masses (2.89 cm), as well as by the mean number of egg per egg-masses (247). Larger egg-masses (more than 500 eggs per mass) indicated a healthy, increasing population according to Nealis *et.al.*, 1993. The critical number of eggs per egg-mass can be understood into the critical length of the egg-mass, using antilog of the Moore *et.al.*, 1997 and 1992 fecundity regression:  $f_c = 2.15 (L)^{1.58}$ , where  $L$  (mm) is the mean egg-mass length for a population. So, 500 eggs per mass will be equal to the length of 32 mm.

Wellenstein *et.al.*, 1978 state that the mean number of eggs per egg-mass in the phase of retrogradation (post-outbreak) was less 150, within 250-350 in culmination (outbreak) phase and 500-800 – in the progradation (increase) phase. According to such as a vital statistic we can say that the gypsy moth (*Lymantria dispar*) in forests of the forests of the Mat District, North of Albania, Elbasan District, Center of Albania and Librazhd District, South of Albania.

From our point of view, the size (length) of the egg-masses may be taken in account as a vital statistic for gypsy moth population only in the stands where the diameter of the trees at the breast height is more than 2 cm. If it is less, the females of the gypsy moth (*Lymantria dispar*) lay longer, but more narrow egg-masses. In this case the length of the egg-mass can not be used for assessing the gypsy moth (*Lymantria dispar*) population.

#### ***Mortality at larval stage of the gypsy moth (Lymantria dispar) development***

Cumulative mortality of larvae collected from natural population in the forest of the forests of the Mat District, North of Albania, Elbasan District, Center of Albania and Librazhd District, South of Albania is high in each sample and varied between 77.6-79.6 (samples III) and 83.6- 85.6 (samples II) during 1997-2006.

According to Wellenstein *et.al.*, 1978, in the phase of progradation in population dynamics, the larval mortality of the gypsy moth (*Lymantria dispar*) is from 1 to 5 %, in culmination phase from 20 to 30 % and more than 60 % in the phase of retrogradation.

The causes of mortality were divided into the following groups: parasitoids, nuclear polyhedrosis virus (NPV), microsporidia (*Nosema sp.*), mixed infection (NPV + *Nosema sp.*), nematode and undetermined causes.

The larval mortality by about 80 % confirms our previous statement that gypsy moth (*Lymantria dispar*) in forests of the forests of the Mat District, North of Albania, Elbasan District, Center of Albania and Librazhd District, South of Albania in 2006 was in the phase of post-outbreak. We could also draw the similar conclusion from the fact that the percentage of larvae, which died due to the nucleopolyhedrosis virus was rather low, (up to 7.3 % of larvae were infected by NPV and 18.4 % of larvae were infected by NPV + *Nosema sp.*), but, due to parasitoids, rather high (56.8 % in III samples). It is known that the highest mortality caused by NPV in gypsy moth (*Lymantria dispar*) population occurs in the culmination phase, as well as that parasitoids follow their host with a 2-3 year delay and maximum parasitism is the phase of post-gradation.

In 2006 the gypsy moth (*Lymantria dispar*) population density in the same permanent monitoring plots is estimated as 63 egg-masses/ha and is lower than 1997.

#### ***Impact of biological control-by a bacterium on gypsy moth (Lymantria dispar)***

The biological control-by a bacterium that has caused the death in the caterpillar stage-has also proved quite successful and it is continuing and for 2 years in some permanent monitoring plots (experimental plots).

**Figure 1. Gypsy moth (*Lymantria dispar*)**



**Table 1. Forest Damage by Gypsy moth (*Lymantria dispar*)**

Pest (Insect)	Host	Attack incidence from 1997-2006	Distribution to the classes of damage						
			0-10 (%)	>10 <20 (%)	>20 <50 (%)	>50 <90 (%)	> 90-100 (%)	I.D. (%)	I.D. (classes)
gypsy moth ( <i>Lymantria dispar</i> )	mixed birch-oak-alder-willow forest, etc.	5-10	72-78	20-24	2-4	-	-	7	0

**Table 2. Length of the gypsy moth (*Lymantria dispar*) egg-masses in the forests of the forests of the Mat District, North of Albania, Elbasan District, Center of Albania and Librazhd District, South of Albania**

Length of egg masses, cm	Mean, cm	S	Minimum	Maximum	N
	2.89	1.009	1.1	4.6	35

**Table 3 Number of eggs per egg-mass of the gypsy moth (*Lymantria dispar*) in the forests of the forests of the Mat District, North of Albania, Elbasan District, Center of Albania and Librazhd District, South of Albania**

Length of egg masses, cm	Number of eggs per egg-mass
2.6	167
2.8	103
3.3	298
3.7	334

4.5	333
Mean number of eggs per egg-mass	247

### Conclusions

The population density of the gypsy moth (*Lymantria dispar*) in forests of the forests of the Mat District, North of Albania, Elbasan District, Center of Albania and Librazhd District, South of Albania in 1997 was estimated 80 eggs-masses per ha. It was assumed to be a low density (Lushaj, 2001).

The number of eggs per one egg-mass was counted in five egg-masses only. It varied between 95-366 eggs with the mean number 247.

The mean length of size of the egg-masses was 2.89 cm (min. – 1.1 cm and max. 4.6 cm).

The mortality of the gypsy moth (*Lymantria dispar*) larvae in forests of the forests of the Mat District, North of Albania, Elbasan District, Center of Albania and Librazhd District, South of Albania, collected from natural population was high, up to 85 %. Larvae were infected by nucleopolyhedrosis virus (5.5-7.3 %), microsporidia (*Nosema sp.*) (15.1-31.3 %), mixed infection (NPV + *Nosema sp.*) (7.3-18.4 %) of larvae. The percentage of parasitism was the highest and it reached up to 56.8 %.

Obtain results allow us to state that the gypsy moth (*Lymantria dispar*) population in forests of the forests of the Mat District, North of Albania, Elbasan District, Center of Albania and Librazhd District, South of Albania was in the post –outbreak phase and was decreasing. It was confirmed by value of the population density estimated in 2006 as 63 egg-masses per ha.

The method of fixed-radius plots of 0.25 ha was assumed to be the most important to estimate the gypsy moth (*Lymantria dispar*) population density in different types of stands.

The size of the egg-mass can be used as a vital statistics to assess the gypsy moth (*Lymantria dispar*) population only in the stands where the diameter of the trees at the breast height is more 2 cm.

The biological control-by a bacterium that has caused the death in the caterpillar stage-has also proved quite successful and it is continuing more and for 2 years in some permanent monitoring plots (experimental plots).

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