

CHARACTERISTICS OF THE FEEDING PROCESS OF THE *Lymantria Dispar* LARVAE REARED WITH BEECH LEAVES

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Abstract. *Lymantria dispar* is one of the most common butterfly which produces important economic and ecological damages in Romania's forests. Usually it appears in oak stands and in stands with oak mixed with other broadleaf species, but, in the past few years it developed significant outbreaks also in poplar, salix and beech stands. The paper presents the characteristics of the feeding process of the *Lymantria dispar* larvae reared in laboratory conditions in order to calculate the critical numbers used for next year population level estimation. Larvae feeding process has been analyzed by larval sex and larval instars, determining the quantity of leaves that larva eats in a time unit. With statistical methods we established the relations between food quantity and larval sex and instars. We also analyzed the excrements resulted in feeding process in order to determine the quantity of food used by larvae in physiological process.

Key words: *Lymantria dispar*, larvae, beech, food, ratio

Rezumat. Caracteristicile procesului de hrănire a larvelor de *Lymantria Dispar* crescute cu frunze de fag. *Lymantria dispar* este una din insectele defoliatoare care produce cele mai importante pagube economice și ecologice în pădurile din țara noastră. De obicei, apare în arborete de cvercinee sau amestec de cvercinee cu diverse foioase, dar fiind un dăunător polifag, în ultimii ani, a dezvoltat gradații semnificative și în arborete de plop, salcie și nu în ultimul rând în fâgete. În lucrarea de față s-a studiat procesul de hrănire al larvelor, în condiții de laborator, ca un prim pas în determinarea numerelor critice pe baza cărora se întocmește prognoza anuală și se stabilesc suprafețele ce trebuie combătute. Procesul de hrănire s-a analizat pe sexe și vârste larvare, determinându-se cantitatea de frunziș consumat de larve în unitatea de timp. Prin aplicarea testelor statistice s-a stabilit modul cum variază cantitatea de hrană consumată de omizi în funcție de sexul și vârsta acestora. De asemenea, s-a analizat și cantitatea de excremente rezultate în urma procesului de hrănire în scopul determinării indicelui de utilizare al hranei, ca un proces fiziologic important al speciei.

Cuvinte cheie: *Lymantria dispar*, larve, fag, rația de hrană

INTRODUCTION

Lymantria dispar is one of the defoliating species of insects which, along the time, has produced numerous gradations in the quercine forests in Romania, sometimes extending itself in the mixed forests of quercine with the beech. It is the case of gradations in the period 1963-1964, when *Lymantria dispar* infested about 100 thousand hectares in the forests mixed with beech in the Danube narrow zone. (Orșova Forest District (F.D.), Berzasca F.D., Moldova Nouă F.D., Mehadia F.D. and Băile Herculane F.D.), without producing significant defoliations in the pure beech stands from the immediate nearness of these. Nevertheless, in the last time, more precisely, beginning with the generation 2004-2005, strong infestations have been also recorded in beech forests, initially, in the forests from Orșova – Berzasca – Herculane zone, and beginning with the generation 2005-2006, in the pure beech or mixed forests from north-west of the country (Ulmeni Forest District and Satu Mare Forest District). Total defoliations were recorded on about 2,500 hectares (NETOIU C., TAUT I., 2006) in some pure beech forests, strongly infested from Orșova – Berzasca – Herculane zone, within Domogled and Portile de Fier National Parks, in their years 2005 and 2006.

Up to the present, researches referring to the activity of the defoliator *Lymantria dispar* in beech forests have not been carried out in Roumania and also abroad, such damages being cited only in the specialized literature (STEFANESCU M., 1980).

For the effectuation of the prognosis works in the years 2004 -2005, in the lack of the critical numbers specific to the beech, there were assimilated critical numbers, previously established for quercine (DISSESCU G, 1966), which, in some cases, have lead to the superestimation or subestimation of the probable percentage of defoliation.

The study of characteristics of the feeding process of larvae of *Lymantria dispar* with leaves of beech has permitted the determination of the food ratio and the quantity of excrements eliminated by caterpillars, depending on sex and larval-stage of the caterpillars, and implicitly, the determination of the food use index by caterpillars. The food ratio, which represents the amount of food consumed by a larva along its entire period of development, beside the foliar biomass of the tree, constitutes the basic parameter in the calculation of critical numbers, on the basis of which the probable percentage of defoliation is determined. The knowledge of the amount of excrements eliminated by caterpillars in the feeding process in a certain period of time (24 hours), may help to the estimation of the population of existing caterpillars, at a given moment, in the stand (WELLENSTEIN G., 1978).

MATERIAL AND METHODS

With a view to elaboration of some methods and technologies of prognosis of the defoliator in the beech stands or beech mixed with quercine, there were effectuated, in laboratory conditions, individual rearings of caterpillars to establish the food ratio, which, afterwards, will be the basis for the determination of the critical numbers for *Lymantria dispar* in the beech forests.

To establish the food ratio of the caterpillars, as a main element in the calculation of critical numbers, we have made rearings of caterpillars in laboratory, in special vessels, and the caterpillars were given fresh food, daily. There were measured the amount of leaf consumed daily, using measurements before and after the consumption, the time (in days) necessary from one stage to the other, the amount of excrements for each caterpillar and the sex ratio (TOMESCU R, 1994).

In this sense, there were collected egg-masses from the infested beech forests, which were kept in laboratory, until the caterpillars hatched. Then, each caterpillar was set in a vessel and the fresh food (leaves of beech) was given, daily; From 110 caterpillars, thus reared in vessels, 46 reached the stage of pupation, the sex ratio being 1:1. In the course of the development of caterpillars, there was observed that, at the passing from the first-stage to the second-stage, and from the second-stage to the third-stage, approximately 60% of caterpillars died, the probable cause being later adaptation to the conditions of light, temperature and humidity in which they were reared. Data referring to the food ratio were statically processed, by the variance analysis, in order to point out the influence of sex of caterpillars and the larval - stage on the amount of food consumed. (ANOVA-MANOVA Test).

RESULTS AND DISCUSSIONS

The individual rearing of the caterpillars in laboratory with fresh leaves of beech (daily changed) has offered the possibility of observing the daily feeding rhythm, on larval stages and sexes, at the passing from one larval-stage into the other, a pause in feeding of 1- 2 days was observed Fig. 1A and 1B).

The female larvae need about 35-45 days to reach the maturity, with a foliage consumption of 600-850 square cm (approximately 25-30 mature leaves of beech), and the males reach the maturity in 28-35 days, fter they have consumed 50-200 square cm of foliage (approximately 5-7 mature leaves of beech). As concerns the maximum feeding period, from the above shown figures, one is observed that the male larvae begin the ignificant consumption of foliage after 12-15 days from the eclosion, at a time when the larvae pass into the third-stage larva and the females after 15-20 days, when they, too, pass into the third-stage larva.

On the whole, there can be find that the female caterpillars consume a bigger amount of foliage in a longer time, unlike the males which consume less food in a shorter time.

Data referring to the food ratio were processed according to the double analysis of variance (ANOVA-MANOVA), taking into account, as factors of influence on feeding, the sex and the instar of the caterpillars, and as a dependent variable, the food consumed, expressed in the surface of foliage (square cm of leaf (Table 1).

Table 1. The results of the variance analysis concerning the food ratio of the caterpillars reared with beech leaves

Tabel 1. Rezultatele analizei variantei privind ratia de hrana a omizilor crescute cu frunze de fag

Efect	SS	f	M.S	F	P
Sex	343100	1	343100	125.128	0.0000***
instar	1769404	1	353881	129.060	0.0000***
Sex x instar	1821237	5	364247	132.841	0.0000***
Error	690979	5	2742	-	-

From the above table, one may observe that the sex and the larval-stages of the caterpillars influence significantly the food ratio of the caterpillars.

In the first five - larval stages of the caterpillars no significant differences were found in the feeding of the caterpillars in those two sexes, however, due to the fact that the female caterpilalrs pass, too, through the sixth-stage larva, on the whole, there are very significant differences between sexes. (Fig. 2).

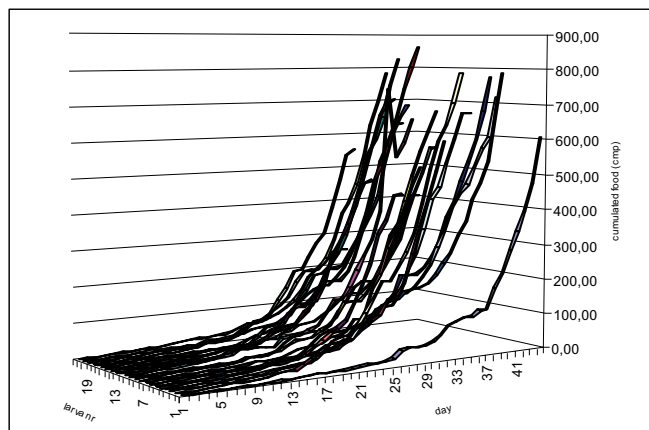


Figure 1A. The daily cumulative consumption of food of the caterpillars from which female butterflies eclosed.

Figura 1A. Consumul zilnic, cumulativ de hrana al larvelor din care au eclozat fluturi femeli

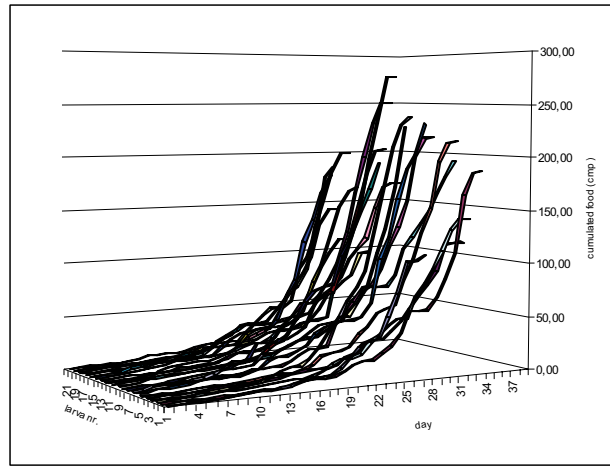


Figure 1B. The daily cumulative consumption of food of the caterpillars from which male butterflies eclosed.
Figura 1 B. Consumul zilnic, cumulativ de hrană al larvelor din care au eclozat fluturi masculi

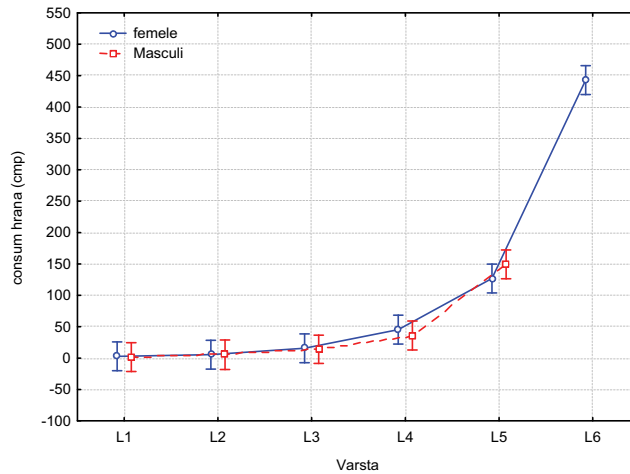


Figure 2. The variation of the average food consumption of the caterpillars on sexes and larval –stages
Figura 2. Variația consumului mediu de hrană al omizilor pe sexe și vârste larvare.

Table 2. The analysis of the limit differences between the average food consumption of the caterpillars depending on the sex and the larval – stage of the caterpillars

Tabel 2. Analiza diferențelor limită dintre consumul mediu de hrană al omizilor în funcție de sexul și vârsta larvelor

Efect	Average (cmp)	FL1	FL2	FL3	FL4	FL5	FL6	ML1	ML2	ML3	ML4	ML5
FL1	2.80		0.86543	0.41627	0.00751	0.00000	0.000	0.94215	0.87188	0.47456	0.03649	0.00000
FL2	5.48			0.51976	0.01217	0.00000	0.000	0.80877	0.99504	0.58648	0.05436	0.00000
FL3	15.66				0.06118	0.00000	0.000	0.37599	0.52062	0.91480	0.19880	0.00000
FL4	45.35					0.00000	0.000	0.00606	0.01299	0.04566	0.55424	0.00000
FL5	126.86						0.000	0.00000	0.00000	0.00000	0.00000	0.15511
FL6	442.96							0.0000	0.00000	0.00000	0.00000	0.00000
ML1	1.66								0.81577	0.43051	0.03054	0.00000
ML2	5.38									0.58664	0.05642	0.00000
ML3	13.99										0.15986	0.00000
ML4	36.00											0.00000
ML5	149.37											

FL1 – female larval instar 1, ML1 – male larval instar 1

In the first three - stage larva, both in the larvae from which male butterflies eclosed, and those from which female butterflies resulted, the food consumed by the caterpillars does not significantly differ among them, the marked difference is observed, beginning with the fourth-stage larva. The weight of the consumption realized by the male larvae until the fourth-stage larva is sensibly equal with that realized by the female larvae until the fifth-stage larva (about 20% from the total ratio of each category of larvae: males-females).

In the fifth-stage larva, before pupation, the male larvae reach to consume more than the female larvae of the same instar (Fig. 3), but, unlike the male larvae, those female ones continue the feeding also in the sixth-stage larva, so that, per total, the female

larvae consume more food than the male ones. Also, in the last - stage larva of each of those two categories of larvae (fifth-stage larva for males and sixth-stage larva for females), the larvae consume about 70% from the total ratio of food, which, on average, reach to be about 200 square cm for the male larvae and about 600 square cm for the female larvae (Fig. 4).

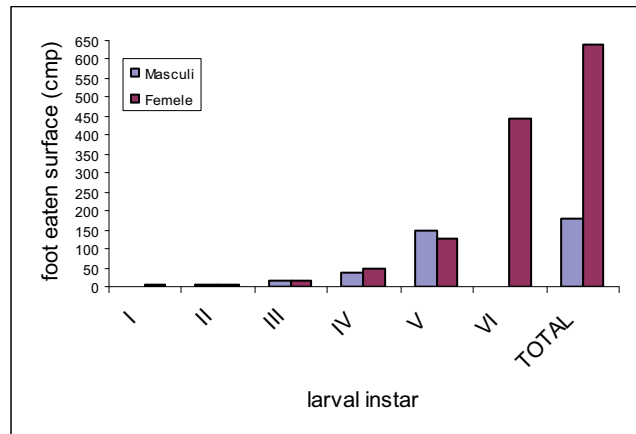


Figure 3. Food average ratio of the caterpillars, on larval - stages and sexes
Figura 3. Rația medie de hrană a omizilor pe vârste și sexe.

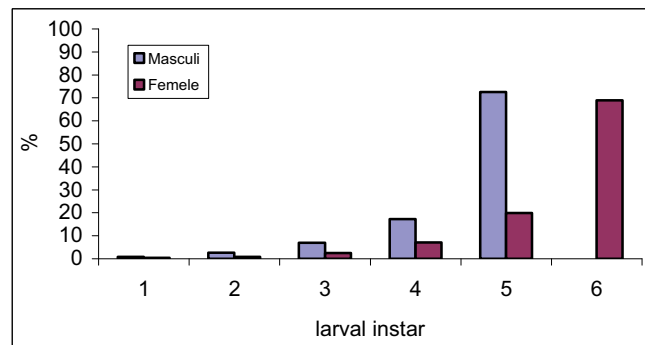


Figure 4. The food ratio percentage of the caterpillars on sexes and larval-stages
Figura 4. Procentajul rației de hrană a omizilor pe sexe și vârste.

Data concerning the excrements eliminated, as a result of the feeding of larvae in laboratory, have lied in calculating the correlation between the amount of food consumed and the amount of excrements eliminated. (Fig. 5).

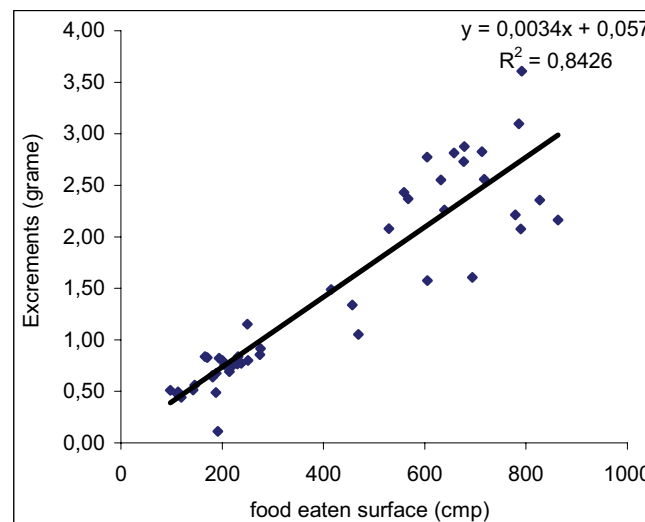


Figure 5. The relation between the amount of consumed food and the amount of excrements eliminated by caterpillars
Figura 5. Relația dintre cantitatea de hrană consumată și cantitatea de excremente eliminată de omizi.

The existing significant correlation between those two characteristics will be used in the future to the determination of the existing population of caterpillars, at a given moment on trees, and to the amount of foliage consumed until that moment by the respective population.

Effectuating the ratio between the amount of excrements produced by each larva and the amount of foliar mass consumed, expressed in dry weight (g), has resulted the index of food dissipation in the process of catabolism of larvae. This index calculated for those two categories of larvae (males and females) does not differ significantly in the male larvae (0.686) to those female ones (0.678), though, the total amount of food consumed is much bigger in the case of the female larvae (Fig 6).

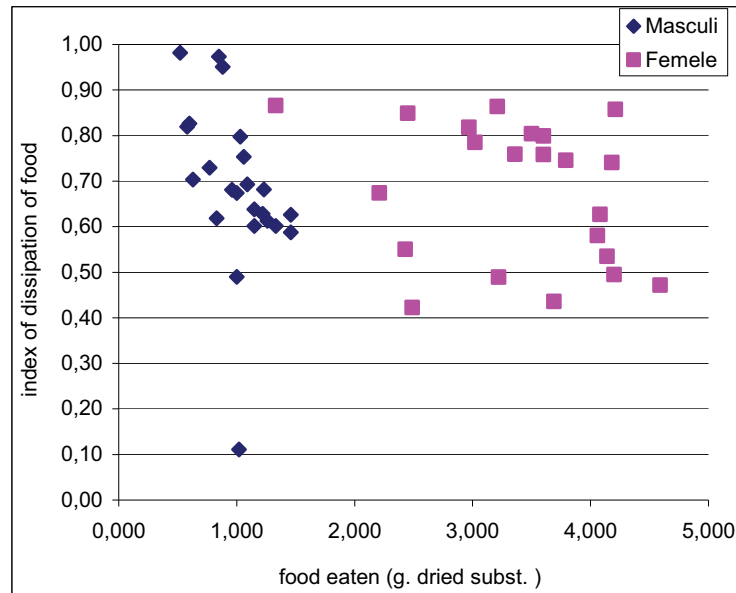


Figure 6. The dissipation index of the consumed food by caterpillars
Figura. 6. Indicele de risipire al hranei consumate de omizi.

individual rearing of the caterpillars in laboratory with fresh foliage of beech has offered the possibility of observing the daily rhythm of feeding, on larval-stages and on sexes. As a result of the data obtained, there was found that the female caterpillars consume a bigger amount of foliage in a longer time, unlike the male ones, which consume less food in a shorter time. From the statistical processing of our data has resulted the fact that, in the first fifth-stages of the caterpillars, there were not found significant differences in the feeding of larvae, on those two sexes, but, due to the fact that the female caterpillars also pass through the sixth-stage larva, on the whole, there are very significant differences between sexes. The female larvae need about 35-45 days to reach the maturity, with a consumption of foliage of 600-850 square cm (approximately 25-30 mature leaves of beech), and the male ones reach the maturity in 28-35 days, after they consumed 150-200 square cm foliage (approximately 5-7 mature leaves of beech).

The proportion of the food consumption, on larval-stages, for those two categories of larvae, thus vary:

	<i>Male larvae,</i>	<i>female larvae</i>
<i>Larvae of 1 -3 th stage</i>	10%	4%
<i>Larvae of 4th stage</i>	17%	7%
<i>Larvae of 5th stage</i>	73%	19%
<i>Larvae of 6th stager</i>	-	70%

At the same time, the average food consumption of those two categories of caterpillars, on the whole cycle of development, expressed in surface and dry mass grames, thus is shown :

	<i>Square cm of leaf dry mass grams</i>	
<i>Males</i>	201	1,068
<i>Females</i>	639	3,395

The study of the feeding process of the larvae of *Lymantria dispar*, represents a first step with the purpose of determining the critical numbers on the basis of which, the works of prognosis are effectuated. A prognosis of the defoliation as exactly as possible leads to the elimination or the reduction of important economic and ecological damages that can be caused by the attacks of the defoliator *Lymantria dispar* in the beech forests.

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