

## The presence and the activity of egg-parasitoids of pine processionary moth (*Thaumetopea pityocampa* Den & Schiff) in new forests of Austrian pine (*Pinus nigra* Arn.) in Korça, Kolonja e Pogradec districts, Albania

<sup>a</sup>Ilirian Myteberi, <sup>b</sup>Bashkim Lushaj, <sup>a</sup>Fatmir Laçeja, <sup>a</sup>Ramiz Metaliaj, <sup>c</sup>Vera Malsia, <sup>a</sup>Vasillaq Mine, <sup>a</sup>Ervin Toromani, <sup>d</sup>Arben Petto

<sup>a</sup>Faculty of Forest Sciences, Agricultural University, Koder Kamez, Kamez, Tirana, Albania

<sup>b</sup>Department of Environmental Engineering (DEE), Faculty of Civil Engineering (FCE), Polytechnic University of Tirana (PUT) (part time). Str. of "Muhamet Gjollësia", No. 56; P.O. Box No: 244/1, Tirana, Albania

<sup>c</sup>Environmental Impact Assessment Centre, Street "Kongresi i Lushnjës" 33/1/5. P.O.Box 244/1 Tirana, Albania

<sup>d</sup>Instituti i Studimeve e Projektmeve Pyjore, Rruga " Sami Frasheri", Tirane, Shqiperi

### Abstract

The pine processionary moth (*Thaumetopea pityocampa* Den & Schiff) is without doubt one of the most dangerous insects (pests) of pine forests in Albania. The observations regarding the presence and the activity of egg-parasitoids of the pine processionary moth (*Thaumetopea pityocampa* Den & Schiff) in the new stands of Austrian (black) pine (*Pinus nigra* Arn.) in the districts of Korça, Kolonja e Pogradec, Albania, clarify the role of the egg-parasitoids in restriction of processionary population in these zones. From egg-batches collected in three Austrian (black) pine stands were taken into consideration, and were observed *Ocencyrtus pityocampae* (Mercet), *Baryscapus servadeii* (Dom), and *Trichogramma embryophagum* (Htg.). *Baryscapus servadeii* (Dom) has been the most efficacious on egg-batches, collected in Austrian (black) pine (*Pinus nigra*) stands in the districts of Kolonja and Pogradec, while *Ocencyrtus pityocampae* (Mercet) has been the most efficacious on egg-batches, collected in Austrian (black) pine (*Pinus nigra* Arn.) stands in the district of Korça. *Trichogramma embryophagum* (Htg.) on the contrary, even that was observed in three Austrian (black) pine (*Pinus nigra* Arn.) stands, and it has a modest activity. In complex the mortality from several causes of examined eggs has moved from 24.3 % in the district of the Pogradec to 35.72 % in the district of the Korça, and 32.42 % in the district of the Kolonja.

**KEYWORDS:** assessing, Austrian (black) pine (*Pinus nigra* Arn.), pine processionary moth (*Thaumetopea pityocampa* Den & Schiff), egg, egg-batches, egg-parasitoids, *Ocencyrtus pityocampae* (Mercet), *Baryscapus servadeii* (Dom), and *Trichogramma embryophagum* (Htg.).

### Introduction

In Albania, before and actually there is a specie of *Thaumetopea* gender, that is the pine processionary moth (*Thaumetopea pityocampa* Den & Schiff). It is without doubt one of the most dangerous insects (pests) of Albanian pine forests.

As a principal insect (pest) and at the same the most spreaded insect on coniferous forest during last years the processionary moth (*Thaumetopea pityocampa* Den & Schiff) has attacked over 50000 ha in every year in coniferous species and in particular in Austrian (black) pine (*Pinus nigra* Arn.). As a principle skeleton and at the same time harmful insect is spreaded in the most of coniferous forest in Albania, in particular in the Austrian (black) pine (*Pinus nigra* Arn.).

Repetition by harmful insect of the processionary moth (*Thaumetopea pityocampa* Den & Schiff) in full cycle for every year has the negative impact in pine forest with damages, as the reducing of annual increment of infected pine trees, the physiological weakening of them and these pine trees are disposed to be attacked by other biotic and abiotic stress factors.

Entomologists recognize two basic forms of metamorphosis: complete and incomplete. In complete metamorphosis, the insect egg hatches to produce a larva, an active immature form typified by the caterpillar; then changes to a pupa, a more or less dormant form, often enclosed in a cocoon; and finally emerges as the adult insect, or imago. A form of complete metamorphosis in which the insect larva undergoes one or more changes in form (usually to adapt it to a change in food supply) before becoming a pupa is called hyper metamorphosis.

In our country the butterflies of the processionary moth (*Thaumetopea pityocampa* Den & Schiff) get out during of July and after their copulation, females lay their eggs in batches, as egg pods on needles of Austrian pine (*Pinus nigra* Arn.) or other pine species, in generally to couple 2 needles together. Deposition of eggs make under of pine crowns, in South and South-East expositions. These eggs laid in batches, as egg pods cover with of same lumps, that produced by females for cover-uping and protection. In the end of August the insect eggs hatched to produce the larvae of the processionary moth (*Thaumetopea pityocampa* Den & Schiff) and start to feed by needles of pine around of them.

Exactly, the level of parasitism of eggs, parasitoids and presence and affectivity of them has been the final objective of our study. It was the first study in this kind for the processionary moth (*Thaumetopea pityocampa* Den & Schiff) in our country, because in all of time were studied for the processionary moth (*Thaumetopea pityocampa* Den & Schiff), spreading and biology of it and chemical and physic-mechanical control.

## **Material and methods**

### **Study sites**

The presence of the pine processionary moth (*Thaumetopea pityocampa* Den & Schiff) specie was investigated for our part during the years 1997-2006, in new forest of Austrian (black) pine (*Pinus nigra*) stands in the Korça, Kolonja e Pogradec districts, Albania. Surveys were made in all main districts of the country. Before 1995 were carried out the studies in a non-systematic way in areas of most attacked by pine processionary moth (*Thaumetopea pityocampa* Den & Schiff) . Later, a systematic study was carried out in both, in a non-systematic way, in areas of most attacked by pine processionary moth (*Thaumetopea pityocampa* Den & Schiff) and on permanent monitoring plots of the National Assessment and Monitoring System in Albania. The monitoring plots were 50 x 50 m in size and they were laid out on a grid 10 x 10-km, based on a statistically representative method (Lushaj *et al.* 1996; Lushaj 1997-2001). On each monitoring plot,

30-90 forest trees were examined for the presence of presence of the pine processionary moth (*Thaumetopea pityocampa* Den & Schiff), and the degree of damage caused by the pest to trees was classified in four classes (Lushaj *et al.* 1996).

The setting up of National Assessment and Monitoring System 1 (full or extensive system) by permanent monitoring plots for forest condition. The permanent monitoring plots (50 m x 50 m = 2500 m<sup>2</sup>) were selected according to 10x10 Km grid, on the basis of a statistically representative method. In each permanent monitoring plot, 30-90 sample trees were selected, assessed and monitored, for each tree type found, in the basis of classification of Kraft (crown canopy classes) (Lushaj *et al.* 1996; Lushaj 1997-2001).

The setting up of National Assessment and Monitoring System 2 (additional system) by 75 permanent monitoring plots for pests, diseases and other abiotic and biotic stress factors. Setting up was performed in most attacked forest stands, selecting 30-90 sample trees for each plot (Lushaj *et al.* 1996; Lushaj *et al.* 1997). In this additional system were chosen some of the permanent monitoring plots by new forest of Austrian pine (*Pinus nigra* Arn.) in the Korça, Kolonja e Pogradec districts, Albania. For our study is used National Assessment and Monitoring System 2 (additional system) for the Korça, Kolonja e Pogradec districts. The situational characteristics of studied stands in permanent monitoring plots are showed in Table 1(Laçej & Lushaj, 2000; Lushaj, 2001 & Lushaj, 2006).

### **Field observation**

#### **Survey and evaluation of pine forest trees**

Survey and evaluation of the health of all pine trees were carried out on the base on the visual assessment of two parameters, as defoliation and discoloration, and at the same time were carried out and survey and evaluation of the health of all pine trees for attack incidence caused by pest; damage incidence in % and in the classes and distribution in the classes damage, and are showed in Table 2. So, the phytosanitary characteristics of studied stands in permanent monitoring plots by attack; damage incidence and the distribution to the classes of the pine processionary moth (*Thaumetopea pityocampa* Den & Schiff) are showed in Table 2. (Lushaj, 2001)

#### **Sampling and isolation**

To carry out the study for every year, mentioned above were collected 43-52 egg-batches of the pine processionary moth (*Thaumetopea pityocampa* Den & Schiff) in the new stands of Austrian (black) pine (*Pinus nigra*) in the permanent monitoring plots, mentioned above in Korça, Kolonja e Pogradec districts, Albania. These collections were carried out during the period from January to February of all years mentined above (Lushaj *et al.* 1996; Lushaj1997-2001; Laçej & Lushaj, 2000; Lushaj, 2001 & Lushaj, 2006).

After the collection of the egg-batches, immediately were isolated in laboratory conditions into test-tubes, closed by cotton stoppers. Keeping was carried out in laboratory conditions by temperature from 20 to 22 ° C.

In continuing these test-tubes were observed in every period between of 2-3 days until June, for determination and numbering of imagoes of developed parasitoids. In the end of June and at beginning of July were opened test-tubes, and were carried out cleaning of scales for every of egg-batches and at the same is done the analysing of undeveloped eggs

by help of stereomicroscope. Analysing of eggs was filled the formulary for every egg. For them were carried out classification as sterile eggs, eggs by caterpillar died and eggs by parasitoids died (Lacej & Lushaj 2000 & Lushaj, 2006).

#### *Control of the pine processionary moth (Thaumetopea pityocampa Den & Schiff)*

The pine processionary moth (*Thaumetopea pityocampa* Den & Schiff) has long been a pest in coniferous forests. The caterpillar stage feeds on the foliage of coniferous trees, as Austrain pine (*Pinus nigra* Arn.), and other types of commercially important plants. The fosphororganic insecticides were used to control the moth the pine processionary moth (*Thaumetopea pityocampa* Den & Schiff), in combination of physico-mecanical control, but resulats were bad from it. We have conclude that the fosphororganic insecticidae have had no good rezults by low impact on it and at the same time have damaged the parasitoids in the new stands of Austrain pine (*Pinus nigra*).

Control-by bacterium of the *Bacillus thuringiensis* were carried out in the permenet monitoring plots, mentoned above, and were a good rezults. Control-by bacterium of the *Bacillus thuringiensis* causes death in the caterpillar stage-has also proved quite successful without damage in usefull parasitoids the and it is continuing and for 2 years in three permanent monitoring plots (Laçej & Lushaj, 2000; Lushaj, 2001 & Lushaj, 2006).

### **Results and discussion**

By analysing of eggs of the pine processionary moth (*Thaumetopea pityocampa* Den & Schiff) have three principal parasitoids. From egg-batches collected in three Austrian (black) pine stands were taken into consideration, and were observed the principal parasitoids, as *Ocencyrtus pityocampae* (Mercet), *Baryscapus servadeii* (Dom), and *Trichogramma embryophagum* (Htg.) (Battisti *et al.* 1998; Tiberi *et al.* 1991 & 1994; Tsankov *et al.* 1995 & 1996 & Laçej & Lushaj, 2000).

In all of egg-batches analyzed there were by the principal parasitoids, but between permanent monitoring plots has differences between of the parasitiods, mentioned above, as show in Table 3 (Laçej & Lushaj, 2000).

By analyzing of our data showed in the Table 3 in the permanent monitoring plots in the Korça, Kolonja e Pogradec districts there are eggs-parasitiods, as *Ocencyrtus pityocampae* (Mercet), *Baryscapus servadeii* (Dom), and *Trichogramma embryophagum* (Htg.) (Battisti *et al.* 1998; Tiberi *et al.* 1991 & 1994; Tsankov *et al.* 1995 & 1996 & Laçej & Lushaj, 2000), but in the Korça district is missing egg-parasitoid of *Baryscapus servadeii* (Dom). Egg-parasitoid of *Ocencyrtus pityocampae* (Mercet) there is in 100 % of all egg-batches analysed (Laçej & Lushaj, 2000).

In relation with the *Trichogramma embryophagum* (Htg.) there is present in all permanent monitoring plots of the Korça, Kolonja & Pogradec districts. There is in equal level the *Trichogramma embryophagum* (Htg.), respectively by 30.77 % and 30 % in the Kolonja & Pogradec districts and lower in the Korça district by 25 %. Always, based on the data of Table 3 egg-parasitoid of *Baryscapus servadeii* (Dom) is more actively in the new forest pine stands in the permanent monitoring plots of the Kolonja & Pogradec districts, meantime the *Ocencyrtus pityocampae* (Mercet) is more actively in the new forest pine stands in the permanent monitoring plots of the Korça district (Laçej & Lushaj, 2000).

*Mortality of the eggs of the pine processionary moth (Thaumetopea pityocampa Den & Schiff)*

In continuation, based in our data there are the different causes of the mortality about the total of analyzed eggs, and in these cause one important role play the *Ocencyrtus pityocampae* (Mercet), *Baryscapus servadeii* (Dom), and *Trichogramma embryophagum* (Htg.).

The data in relation of the different causes on mortality of the eggs of the pine processionary moth (*Thaumetopea pityocampa* Den & Schiff) were showed in the Table 4.

As we see the percentage of the different causes of the mortality about the total of analysed eggs, in new forest pine studied stands in permanent monitoring plots, the parasitoids of the *Ocencyrtus pityocampae* (Mercet), *Baryscapus servadeii* (Dom), and *Trichogramma embryophagum* (Htg.) have the crucial role and importance that play determinant role in the mortality of the pine processionary moth (*Thaumetopea pityocampa* Den & Schiff) (Laçaj & Lushaj, 2000). Concretely the % of eggs parasitized (died) is respectively by 23.77, 32.42 & 19.12 for Korça, Kolonja & Pogradec districts.

At the same time we have a phenomenon, in new pine forest stands of permanent monitoring plots, over there where there is the *Baryscapus servadeii* (Dom), respectively by 29.57 % for Kolonja district and 18.32 % for Pogradec district it is missing in the Korça district. There is by dominance the *Ocencyrtus pityocampae* (Mercet) in the Korça district, meantime in the Kolonja & Pogradec the *Ocencyrtus pityocampae* (Mercet) is in minority. On other hand the *Trichogramma embryophagum* (Htg.) is in lower percentage, respectively by 0.29, 0.73 & 0.39 for Korça, Kolonja & Pogradec districts.

Analysing the data in relation of the causes on mortality of the eggs of the pine processionary moth (*Thaumetopea pityocampa* Den & Schiff) result that the parasitoids of the *Ocencyrtus pityocampae* (Mercet), *Baryscapus servadeii* (Dom), and *Trichogramma embryophagum* (Htg.) are between the first causes, and a need to continue the studies.

*Results of the chimacal in combination with physic-mecanical control of the pine processionary moth (Thaumetopea pityocampa Den & Schiff)*

As we know, the pine processionary moth (*Thaumetopea pityocampa* Den & Schiff) has long been a pest in coniferous forests, which attack them by big negative impact. The caterpillar stage feeds on the foliage of coniferous trees, as Austrain pine (*Pinus nigra*), and other types of commercially important plants. Fospororganic insecticides were used to control the pine processionary moth (*Thaumetopea pityocampa* Den & Schiff), these in the combination of physico-mecanical control, but were bad results from it. Results of control were in non a good level, and at the same time the fospororganic insecticides have damaged the parasitoids in the new stands of Austrain pine (*Pinus nigra* Arn.). Control-by bacterium of the *Bacillus thuringiensis* were carried out in the permanent plots, mentioned above, and have had the good results. Control-by bacterium of the *Bacillus thuringiensis* has impact causing the death in the caterpillar stage-has also proved quite successful without damage in usefull parasitoids. Biological

control will be in continuing and for 2 years in the permanent monitoring plots (experimental plots).

**Table 1. The situational characteristics of studied stands in permanent monitoring plots**

District	Host Specie	Age from 1997 to 2006	Altitude (m)	Exposition	Attack incidence from 1997 to 2006 (%)
Korça	Austrian pine ( <i>Pinus nigra</i> Arn.)	18-28	800	West	25-80
Kolonja	Austrian pine ( <i>Pinus nigra</i> Arn.)	25-35	1000	South-West	25-70
Pogradec	Austrian (black) pine ( <i>Pinus nigra</i> Arn.)	20-30	650	East	25-85

**Table 2. The phytosanitary characteristics of studied stands in permanent monitoring plots**

District	Host Specie	Attack incidence from 1997 to 2006 (%)	Damage incidence (%)	Damage incidence in classes	Distribution to the classes of damage (%)				
					0	1	2	3	4
Korça	Austrian pine ( <i>Pinus nigra</i> Arn.)	25-80	35	3	20	55	19	5	1
Kolonja	Austrian pine ( <i>Pinus nigra</i> Arn.)	25-70	31	3	21	50	24	4	1
Pogradec	Austrian (black) pine ( <i>Pinus nigra</i> Arn.)	25-85	42	3	17	52	21	7	3

**Table 3. The percentage of the egg-batches parazitized and the part of each parasitoid**

District	Host Specie	Egg-batches parazitized	<i>Baryscapus servadeii</i> (Dom)	<i>Ocencyrtus pityocampae</i> (Mercet)	<i>Trichogramma embryophagum</i> (Htg.)	Attack incidence of parasitoids

						<i>on eggs of pine process. moth</i>
Korça	Austrian pine ( <i>Pinus nigra</i> Arn.)	100	0	100	25	High
Kolonja	Austrian pine ( <i>Pinus nigra</i> Arn.)	100	92.31	7.69	30.77	High
Pogradec	Austrian pine ( <i>Pinus nigra</i> Arn.)	100	100	10	30	High

**Table 4. The percentage of the different causes of the mortality about the total of analysed eggs, in new forest pine studied stands in permanent monitoring plots**

District	% of eggs unhatched	% of eggs parasitized (Died)	% of eggs parasitized by <i>Baryscapus servadeii</i> (Dom)	% of eggs parasitized by <i>Ocencyrtus pityocampae</i> (Mercet)	% of eggs parasitized by <i>Trichogramma embryophagum</i> (Htg.)	% of eggs died by other causes
Korça	35.72	23.77	0	23.48	0.29	11.95
Kolonja	46.20	32.42	29.57	2.12	0.73	13.78
Pogradec	24.93	19.12	18.32	0.41	0.39	5.81

### Conclusions

From the collected eggs in the new stands of Austrian pine (*Pinus nigra* Arn.) of the permanent monitoring plots of the Korça, Kolonja e Pogradec districts, Albania, based in our works in the field and in laboratory conditions by sampling and isolation have determined the presence and affectivity of the parasitoids of *Ocencyrtus pityocampae* (Mercet), *Baryscapus servadeii* (Dom), and *Trichogramma embryophagum* (Htg.) on the eggs of the pine processionary moth (*Thaumetopea pityocampa* Den & Schiff),

It seems clearly that between the causes of the mortality of eggs of the pine processionary moth (*Thaumetopea pityocampa* Den & Schiff) there are parasitoids, mentioned above, and these natural antagonists play one determinant role by positive

impact in the mortality of eggs of the pine processionary moth (*Thaumetopea pityocampa* Den & Schiff).

Eggs of the pine processionary moth (*Thaumetopea pityocampa* Den & Schiff) collected in the new stands of Austrian (black) pine (*Pinus nigra* Arn.) of the permanent monitoring plots, in the Korça, Kolonja e Pogradec districts, Albania were attacked by parasitoids, but these in different kind, % etc.

Our conclusion in relation with the *Trichogramma embryophagum* (Htg.) there is present in all permanent monitoring plots of the Korça, Kolonja & Pogradec districts. There is in equal level the *Trichogramma embryophagum* (Htg.), respectively by 30.77 % and 30 % in the Kolonja & Pogradec districts and lower in the Korça district by 25 %. Always, based on the data the egg-parasitoid of *Baryscapus servadeii* (Dom) is more active in the new forest pine stands in the permanent monitoring plots of the Kolonja & Pogradec districts, meantime the *Ocencyrtus pityocampae* (Mercet) is more active in the new forest pine stands in the permanent monitoring plots of the Korça district.

The percentage of the different causes of the mortality about the total of analysed eggs, in new forest pine studied stands of the permanent monitoring plots, the parasitoids of the *Ocencyrtus pityocampae* (Mercet), *Baryscapus servadeii* (Dom), and *Trichogramma embryophagum* (Htg.) have the crucial role and importance that play determinant role in the mortality of the pine processionary moth (*Thaumetopea pityocampa* Den & Schiff) (Laçaj & Lushaj, 2000). Concretely the % of eggs parasitized (died) is respectively by 23.77, 32.42 & 19.12 for Korça, Kolonja & Pogradec districts. At the same is that the *Baryscapus servadeii* (Dom) there is respectively by 29.57 % for Kolonja district and 18.32 % for Pogradec district, and it is missing in the Korça district. There is by dominance the *Ocencyrtus pityocampae* (Mercet) in the Korça district, meantime in the Kolonja & Pogradec the *Ocencyrtus pityocampae* (Mercet) is in minority. On other hand the *Trichogramma embryophagum* (Htg.) is in lower percentage, respectively by 0.29, 0.73 & 0.39 for Korça, Kolonja & Pogradec districts.

% of eggs unhatched has a variance from 24.93, in Pogradec, 35.72 in Korça and 46.20 in Kolonja districts.

Analysing the data in relation of the causes on mortality of the eggs of the pine processionary moth (*Thaumetopea pityocampa* Den & Schiff) result that the parasitoids of the *Ocencyrtus pityocampae* (Mercet), *Baryscapus servadeii* (Dom), and *Trichogramma embryophagum* (Htg.) are between the first causes, and play an important role in mortality of eggs, in particular the *Baryscapus servadeii* (Dom), and it is a need to continue the studies.

In the end we concluded that the parasitoids carried out one biological control in natural conditions, that it is necessary to value it for the future.

#### *The future of biological control by bacterium of the Bacillus thuringiensis*

As mentioned above, the chemical control by the fosphororganic insecticides in combination of physico-mecanical control were used to control the pine processionary moth (*Thaumetopea pityocampa* Den & Schiff) for long of time in our country, but the results were in non a good level and at thew same time by negative impact on parasitoids. We have concluded that the fosphororganic insecticidae have had not a good results by low impact of control on the pine processionary moth (*Thaumetopea pityocampa* Den &

Schiff) and at the same time have damaged the parasitoids, mentioned above and others in the new forest stands of Austrian pine (*Pinus nigra*), in permanent monitoring plots.

Based in our experiments and in others out of our country we concluded that control-by bacterium of the *Bacillus thuringiensis* were carried out in the permanent monitoring plots, and it was by a good results. Control-by bacterium of the *Bacillus thuringiensis* causes death in the caterpillar stage-has also proved quite successful without damage in useful parasitoids the and it is continuing and for 2 years in new pine forest of the permanent monitoring plots (Laçeç & Lushaj, 2000; Lushaj, 2001 & Lushaj, 2006).

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