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Structure and parasitism of egg-batches of a processionary moth population different from *Thaumetopoea pityocampa* (Den. & Schiff.) (Lep. Thaumetopoeidae) found in Bulgaria (*)

Abstract - A population of a pine processionary moth was studied near Banya in Bulgaria, which differs from *Thaumetopoea pityocampa* (Den. & Schiff.) in its biology. The caterpillars reach the 5th larval instar already in October and hibernate in the soil as prepupae until March. Two generations were studied found on *Pinus nigra* Arnold. In all cases, oviposition occurred from the base to the tip of the needle. The mean number of eggs per batch was found to be 237 and 247. The oviposition period was estimated to range from midth of June to midth of July and the host embryonic development required some 29 days. The hatching rate of the host was found to be 76.9 and 69.2%, where the impact of egg parasitoids accounted 15.8% and 24.5%, respectively. *Ooencyrtus pityocampae* (Mercet) was the most abundant egg parasitoid. Additionally, *Baryscapus servadeii* (Dom.), *Anastatus bifasciatus* (Fonsc.), *Trichogramma embryophagum* (Htg.) and *Macroneura vesicularis* (Retzius) were recorded. Most of the egg parasitoids emerged during the embryonic development of the host. For *O. pityocampae* a developing period of 2-3 weeks was calculated. About 26% of all emerged *O. pityocampae* appeared during the consecutive year, mainly in April-May. Only *T. embryophagum* preferred the eggs on the basal part of the batch for parasitism. Tettigoniids were observed as predators.

Zusammenfassung - *Struktur und Parasitierung der Eigelege einer Population von Pinienprozessionsspinnern aus Bulgarien, die von* Thaumetopoea pityocampa *(Den. & Schiff.) verschieden ist (Lep. Thaumetopoeidae).*

Eine Population von Pinienprozessionsspinnern wurde bei Banya in Bulgarien gefunden, die in ihrer Biologie von *Thaumetopoea pityocampa* (Den. & Schiff.) abweicht. Die Raupen erreichen das 5.Larvenstadium bereits im Oktober und überwintern in der Erde als Vorpuppe bis März. Zwei Generationen wurden an *Pinus nigra* Arnold untersucht. In allen Fällen begann die Eia-

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blage in der Nähe der Nadelbasis zur Nadelspitze hin. Die mittlere Anzahl der Eier pro Gelege war 237 und 247. Die Eiablageperiode wurde zwischen Mitte Juni und Mitte July ermittelt; die Embryonalentwicklung des Wirtes betrug etwa 29 Tage. Die Schlupfrate des Wirtes betrug 76.9 und 69.2% und der Anteil der Eiparasitoiden an der Eimortalität 15.8 bzw. 24.5%. *Ooencyrtus pityocampae* (Mercet) war am häufigsten vertreten. Zusätzlich wurden in kleiner Anzahl *Baryscapus servadeii* (Dom.), *Anastatus bifasciatus* (Fonsc.), *Trichogramma embryophagum* (Htg.) und *Macroneura vesicularis* (Retzius) gefunden. Die meisten Eiparasitoiden schlüpften während der Embryonalentwicklung des Wirtes. Für *O. pityocampae* wurde eine 2-3 wöchige Entwicklungszeit festgestellt. Etwa 26% aller geschlüpften *O. pityocampae* Individuen erschienen im Jahr nach der Eiablage des Wirtes, vorwiegend im April-Mai. Nur *T. embryophagum* bevorzugte die Eier am Basalteil des Geleges zur Parasitierung. Tettigoniiden wurden als Prädatoren beobachtet.

Riassunto - *Struttura e parassitizzazione di ovature di una popolazione di processionaria differente da* Thaumetopoea pityocampa *(Den. & Schiff.) (Lep. Thaumetopoeidae) trovata in Bulgaria.*

Nei dintorni di Banya in Bulgaria è stata trovata una popolazione di processionaria di pino, che nella sua biologia differisce da *Thaumetopoea pityocampa* (Den. & Schiff.). Le larve raggiungono la 5ª età in ottobre e svernano fino a marzo nel suolo come prepupa. Due generazioni su *Pinus nigra* Arnold sono state prese in esame. In ogni caso le uova furono deposte iniziando dalla base all'apice della foglia aghiforme. La media di uova per ovatura è stata rispettivamente di 237 e 247. Il periodo di ovideposizione è stato stimato tra metà giugno e metà luglio. Lo sviluppo embrionale dell'ospite è ammontato a circa 29 giorni. La percentuale di uova schiuse è risultata del 76,9% e del 69,2%. La mortalità dovuta all'attività dei parassitoidi oofagi è del 15,8% e del 24,5%. È stato più frequentemente riscontrato *Ooencyrtus pityocampae* (Mercet). Inoltre sono stati trovati *Baryscarpus servadeii* (Dom.), *Anastatus bifasciatus* (Fonsc.), *Trichogramma embryophagum* (Htg.) e *Macroneura vesicularis* (Retzius), ma in numero minore. La maggior parte dei parassitoidi oofagi è sfarfallata durante il periodo di sviluppo embrionale dell'ospite. Per *O. pityocampae* lo sviluppo embrionale si è completato in 2-3 settimane. Il 26% di *O. pityocampae* è sfarfallato a marzo-aprile dell'anno successivo all'ovideposizione dell'ospite. Per la parassitizzazione soltanto *T. embryophagum* ha preferito le uova situate nella parte basale dell'ovatura.

Key words: *Thaumetopoea* sp., egg parasitoids, *Ooencyrtus pityocampae*, parasitism rate, *Trichogramma embryophagum*, Bulgaria.

INTRODUCTION

In Bulgaria, the processionary moths appear in two different biological cycles of development (Tsankov, 1960). Depending on the climatic conditions, at Banya

and Velingrad the moths emerge from end of June until July and start egg laying immediately after copulation. The caterpillars hatch in the second half of July and the first half of August. They grow very fast and processions of the 5th instar larvae can be observed already in the middle of October migrating into the soil for pupation, although pupation takes place in March-April of the consecutive year. Until this period the caterpillars stay in the prepupal stage. Pupal diapause lasts until July, which can be prolonged up to 1-3 years.

On the other hand, near to the Greek border, at Razlog, Sandanski, Blagoevgrad and Marikostinovo, the processionary moths eclose one month later. The caterpillars hibernate in very tight and insulated nests on the trees, as common in *T. pityocampa.* As governed by winter temperature, the 5th larval instar will be reached only in March-April. Then the mature larvae migrate into the soil for pupation, which starts in about two weeks. A prolonged pupal diapause was found under laboratory conditions as well (Schmidt, 1990a).

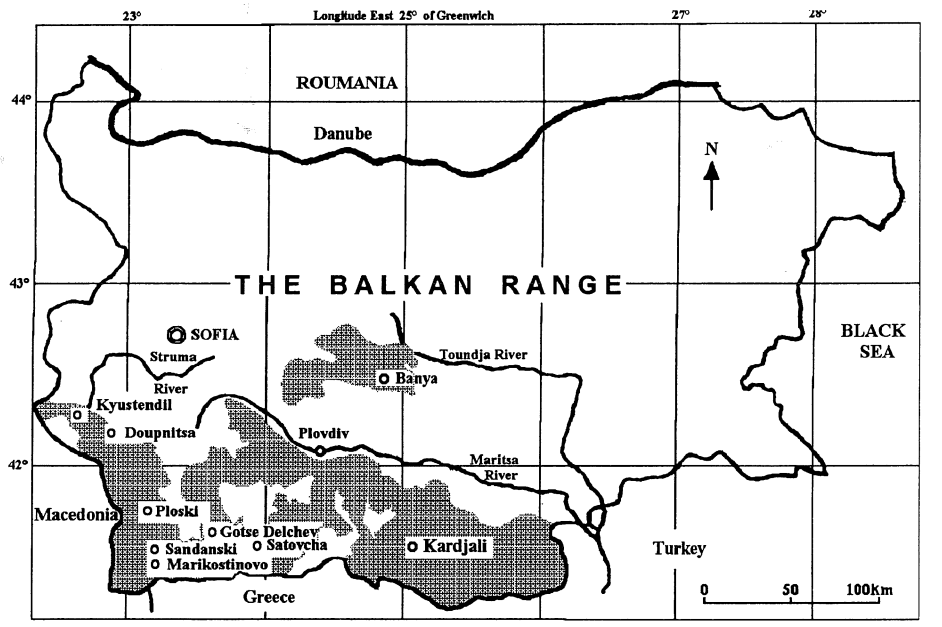

Fig. 1 - Map of Bulgaria showing the forest part as dark area and the localities of research.

For a more precise pest control it is necessary to know the developmental patterns and differences, if any, of various populations. Therefore, we started intensive research on populations from Marikostinovo and Ploski in the South-West of Bulgaria (fig. 1) (Tsankov et al., 1996, 1997), where a developmental cycle was found typical for *T. pityocampa.* Near Banya, located between Toundja and Maritsa Ri-

ver, the population development corresponds to the first type, mentioned above, about which very little is known on structure and parasitism of egg-batches and on the mortality. During last several years the Banya population was compared with that near Marikostinovo and the first results are presented in this paper.

MATERIALS AND METHODS

The studied population is found near Banya (fig. 1) and is observed since about 25 years. Every year the same pattern of life cycle was found, but different from that observed near Marikostinovo. Special studies on egg parasitism and mortality were carried out in the years 1992 and 1993. Egg-batches were sampled in August 1992 and September 1993 after hatching of the caterpillars. All were collected from *Pinus nigra* Arnold. After collection, the batches were singled in test tubes closed with cotton stoppers and transported to the laboratory of the Forest Research Institute at Sofia. All laboratory studies were carried out at room temperature (20-22°C). The emergence of parasitoids was registered almost daily. They were transferred from the test tubes into small plastic capsules for identification, until the end of the consecutive year. Then the scales of the egg-batches were removed. The eggs in which either the caterpillars or the parasitoids had developed and left could be discriminated by different hole sizes (Schmidt, 1988). The last registration was done in October 1995 at the Department of Zoology-Entomology, University of Hannover. Every egg without a hole in its shell was opened carefully and the meconia and the remains of the emerged and dead insects were determined by means of a WILD stereomicroscope (40 x magnification) (Schmidt & Kitt, 1994, Tanzen & Schmidt, 1995).

Additionally, egg batches were sampled during the whole period of host oviposition in 1993, singled in test tubes closed with cotton stoppers and kept at 20-22°C. Hatching of caterpillars was registered and the duration for embryonic development was calculated for either batch. Furthermore, daily observations were carried out and all egg parasitoids emerging during embryonic development of the host were counted and identified. Their developmental period was estimated from the obtained data.

RESULTS

Characterization of the egg-batches

Altogether 92 egg-batches were studied during two generations of female moths. All batches were wrapped around two needles of *P. nigra* in the area of

Banya (Central Bulgaria). Oviposition in all cases was found to occur from the base to the tip of the needles. The length of the egg-batches depended mainly on the number of eggs deposited in 8-11 longitudinal rows. The diameter of the egg-batches varied from 3.0 - 4.3 mm. The length of the needles seemed not deciding for the oviposition behaviour of the females. The number of eggs per batch varied from 166-332 (means 237 and 247) (table 1). On 07.IX.1993 only 11 egg-batches could be found, because 50 were already sampled during June to August for other purposes (see below).

Egg parasitoids and parasitism rate

At Banya, *Ooencyrtus pityocampae* (Mercet) was the most abundant species of egg parasitoids in all egg-batches collected. Most of them had emerged before the collection of the batches (table 1). Many died either as adults, pupae or larvae before leaving the egg-shell. The rate of parasitism was 13.6% in 1992 and 22.4% in 1993 for *O. pityocampae*. *Baryscapus servadeii* (Dom.) was found in very low numbers, only one in 1992 whereas 41 in 1993, all after hibernation. *Anastatus bifasciatus* (Fonsc.) was also rare, which parasitized 11 eggs only in 1992. The parasitization rate of *Trichogramma embryophagum* Htg. was slightly higher, but varied from year to year.

The total rate of parasitism was 15.8% in 1992 and 24.5% in 1993, the hatching rate of caterpillars 78.9% and 69.2%, respectively. Based on these data mortality rates of eggs could be calculated as 21.1% for 1992 and 30.8% for 1993. These data include the number of caterpillars which died during embryonic development, unfertile eggs and totally empty eggs. The parasitoids were found to be responsible for these mortalities.

All *O. pityocampae* and *B. servadeii* specimens were females, whereas all emerged *A. bifasciatus* were males.

Most of the egg parasitoids emerged through holes made on the top of the eggs, but a considerable number of *O. pityocampae* found their way out through the holes made on the sides of the egg-shells.

The rate of parasitism can be observed as the impact of egg parasitoids, because the collection of the egg-batches took place after hatching of the caterpillars, and the egg parasitoids could use the whole developing period of the host for parasitism. It was higher in 1993 than in 1992.

Emergence dynamics of Ooencyrtus pityocampae

The observations were carried out during 1992-1993 on the egg-batches collected on 12.VIII.1992. Some 399 individuals were found already emerged which could be identified by their meconia. Other 30 specimens emerged until October of the same year, wheras 151 during the consecutive year until August 1993. Most

Table 1 - Structure and parasitism of egg-batches of Thaumetopoea *sp. near Banya.*

Date of collection	**12.VIII.1992**	**07.IX.1993**		
Number of egg-batches	31	11		
Length of needles (*P. nigra*)	55-125 mm	55-87 mm		
Length of egg-batches	20-40 mm	25-36 mm		
Diameter of egg-batches	3.0 - 4.3 mm	4.0 mm		
Number of egg length rows/batch	8-11	8-10		
Distance of egg-batch to needles'base	0-12 mm	0-12 mm		
Number of needles used	2	2		
Oviposition direction	base to tip	base to tip		
Range number of eggs/batch	166-332	198-277		
Total number of eggs studied	7647	2610		
Mean number of eggs/batch	247	237		
Caterpillars hatched before collection				
Parasitism				
O. pityocampae emerged				
before collection	399	333	238	with flat yellow and
after collection	181	86	181	with dark meconium
with hole on top	484	291		
with hole on side	96	128		
adults died in eggs	194	76 from these	15	with yellow and
			61	with dark meconium
pupae died in eggs	60	36		
larvae died in eggs	185	54		
Total	1039 (13.6%)	585 (22.4%)		
B. servadeii				
emerged after collection as adults	1	35	32 emerged at top	4 early parasitised
			3 emerged at side	31 late parasitized
pupae		5	(2 of them alive)	
larvae		1	(dead)	
A. bifasciatus				
males emerged after collection	11	-		
Trichogramma embryophagum				
emerged before collection from	29 eggs	-		
adults died in	130 eggs	14 eggs		
Thaumetopoea pityocampa				
caterpillars died without opening	196	37		
caterpillars died with opening	48	7		
undeveloped eggs with dried-up yolk	83	94		
caterpillars hatched	6031 (78.9%)	1806 (69.2%)		
eggs destroyed by predators	-	7		
eggs totally empty, without any remains	79	16		
Impact of egg parasitoids	15.8 %	24.5 %		
Total mortality of host	21.1 %	30.8 %		

Remarks:	O.p.: from 54 larvae, 23 were alive up to 20.06.'94, 31 were dead	from 36 pupae, 12 were alive up to 20.06.'94, 24n died before, in 10 empty eggs of the host, eggs of O.p. were found (in 2 egg-batches)

of them appeared in April-May after hibernation (table 2). More individuals emerged in the year of host oviposition than in the following year.

Table 2 - Ooencyrtus pityocampae *emergence dynamics from Banya 12.VIII.1992.*

Before 12.VIII.1992 399n + autumn flight 30n Total: 429n																																	
After 12.VIII.1992 181n - 30n Total: 151n																																	
n	1	4	5	18	2	1	1	-	1	3	4	5	16	27	20	19	10	3	21	12	2	3	-	-	-	-	-	3					
week	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1					
	August			October		February		March				April				May				June				July				August					
	19 92															1993																	

Distribution of egg parasitoids in different parts of the egg-batches

Normally unscaled eggs were attacked more by egg parasitoids than scaled one. The majority of unscaled eggs is located at the base and on the top of the batch. Therefore, parasitism on base and top of the egg-batch should be higher than in the other parts. Based on this, each batch of 42 egg-batches was divided into five equal parts and parasitized eggs were counted (table 3).

Table 3 - Distribution of egg parasitoids on the egg-batches.

Parts of batches		1/5 base	2/5	3/5	4/5	5/5 top
Ooencyrtus pityocampae						
	n:	208	160	211	268	192
	%:	20.0	15.4	20.3	25.8	18.5
Trichogramma embryophagum						
	n:	72	31	15	21	20
	%:	45.3	19.5	9.4	13.2	12.6

In Banya many eggs were parasitized by *O. pityocampae* irrespective of the preference to any part of the egg-batch, whereas *T. embryophagum* parasitized eggs mainly at the base of the batches.

Host oviposition and caterpillars' hatching

During the flying period of the host in 1993 the first egg-batch was noticed on 22.VI, which indicated the onset of eclosion of moths. In every one or two weeks collections were carried out until 18.VIII.1993. During the two months time 50 egg-batches were found (table 4).

Oviposition took place mainly at night and in the morning hours. During the

Table 4 - Date of collection, number of egg-batches and hatching date of the caterpillars of the Thaumetoopoea *sp. population near Banya; roman numbers compare in table 5.*

Collecting date	22.VI.1993	28.VI.1993	02.VII.1993	16.VII.1993	27.VII.1993	06.VIII.1993	18VIII.1993
Number of batches	1	3	12	7	8	17	2
Hatching date of caterpillars	I: 11.VII.'93	III: 22.VII.'93 II: 26.VII.'93 I: 26.VII.'93	I: 22.VII.'93 III: 22.VII.'93 IX: 22.VII.'93 X: 22.VII.'93 XII: 22.VII.'93 VIII: 23.VII.'93 V: 25.VII.'93 II: 26.VII.'93 IV: 26.VII.'93 VI: 26.VII.'93 VII: 26.VII.'93 XI: 29.VII.'93	I: hatched II: 23.VII.'93 III: 29.VII.'93 IV: 29.VII.'93 VI: 05.VIII.'93 VII: 06.VIII.'93 V: 13.VIII.'93	III: 29.VII.'93 VIII: 29.VII.'93 V: 02.VIII.'93 I: 06.VIII.'93 IV: 11.VIII.'93 VII: 12.VIII.'93 II: hatched VI: hatched	II: 17.VIII.'93 I: hatched III-XVII:hatched	I: hatched II: hatched
Period of development studied (days)	21	25 - 29	20 - 27	7 - 29	2 - 16	11	--

Table 5 - Estimation of developmental periods of Ooencyrtus pityocampae *(Mercet) in eggs of* Thaumetopoea *sp. near Banya; oviposition period: 14.VI - 17.VII.1993; embryonic development of caterpillars: 29 days.*

Collection date of egg-batches	22.VI.1993	28.VI.1993	02.VII.1993	16.VII.1993	27.VII.1993
Developmental period (days)	17	8 12 19	2 x 14 3 x 15 3 x 16 2 x 17 2 x 19 20 22 2 x 24 25	14 16 25 41 43	13 19 21 33 2 x 34

period of observation it was not possible to find a depositing female which would have helped to determine the exact date of egg-laying. From table 4 it is obvious that most of the egg-batches were found some days after deposition, in which the embryonic development had already started. The longest duration for host development was found to last for 29 days (3 cases), which helped to calculate the average duration for the embryonic development to be slightly more than four weeks.

The highest egg-laying was found at the beginning of July. In a month almost all caterpillars were hatched. The period of embryonic development of the host and the chances of parasitism were calculated to lie between 10.VI and 13.VIII.1993. The oviposition period ranged between 14.VI and 17.VII.1993, with the maximum during 23 to 27.VI.1993.

Parasitism and development of egg parasitoids

Egg parasitoids can start parasitizing right from the day of host oviposition. Sometimes the parasitoids wait near the depositing host female and begin to parasitize the eggs just after termination of oviposition. Almost all the collected egg-batches were parasitized and many of the parasitoids emerged before the caterpillars hatched (table 2). Most of the egg parasitoids belonged to *O. pityocampae,* as mentioned above. From four batches alone, 7 to 14 individuals of *B. servadeii* and 5 to 27 individuals of *O. pityocampae* had emerged on the same egg-batch and date.

From the data presented in table 4 embryonic development of the host could be estimated to be 29 days. The hatching of caterpillars from various egg-batches, and the estimated days for development helped to calculate the date on which oviposition of the host might have taken place. Basing on this date, parasitoid development could also be estimated. The data are presented in table 5.

The minimum developmental period of eight days, from egg deposition to adult emergence, was most surprising in *O. pityocampae*. However, most of the individuals developing in host eggs would require 2-3 weeks. In older host eggs, parasitoid development can be prolonged up to more than 40 days. On the other hand, larvae and pupae of *O. pityocampae* can survive in the host eggs even more than one year. Also in empty eggs laid by the host (without yolk), eggs of the parasitoids were found (table 1).

The few *B. servadeii* individuals needed 19, 20, 23 and 28 days until adult emergence, according to our estimation.

Predators observed

During winter, *Parus major* L. was often observed feeding on the caterpillars wandering on the branches of the tree. At sunny daytime, tettigoniids, *Ephippiger*

ephippiger (Fieb.) and *Rhacocleis germanica* (H.-S.), were also observed feeding on and destroying the egg-batches.

DISCUSSION

Deposition and structure of egg-batch

As found in *T. pityocampa* in Bulgaria near Marikostinovo (Tsankov et al., 1996) only two needles of *P. nigra* were used for preparing an egg-batch at Banya. Oviposition started always from near the base towards the tip of the needles as found in Bulgaria in former studies and in Israel in populations of *T. wilkinsoni* Tams on *P. halepensis* (Kitt & Schmidt, 1993), but not in Greek populations (Bellin et al., 1990; Schmidt, 1990b).

The mean number of eggs per batch found near Banya varied from 237 to 247 and was slightly higher than that counted near the border to Greece (223 - 233 eggs) (Tsankov et al., 1997).

Host development

The Banya population of the processionary moth appears about one month earlier than in other parts of Bulgaria. Our egg-batch collections showed that the embryonic development is relatively short (about 29 days). The embryonic period of *T. pityocampa* in Greece was 5-6 weeks at 20-22°C, and 45 days were reported for *T. wilkinsoni* in Israel (compare Schmidt, 1990a). The shorter embryonic development has enabled the population at Banya to reach the 5th larval instar before the commencement of winter and to migrate into the soil for hibernation as prepupae. After a short pupal period of about three months the adults started emerging, followed by oviposition in the midth of June of the consecutive year, which lasted about one month only. This early and fast development on the tree has the advantage that energy needed for winter nest construction has been saved.

The developing behaviour of the Banya population resembles to the southern *T. pinivora* type, in having a one-year cycle in regions with higher temperatures (Agenjo, 1941). In the latter, oviposition occurs in May-June and the caterpillars are seen from June to August. Pupation takes place already in August-September, and the pupae hibernate in the soil until May (Schmidt, 1990a). The silky nest is weak and not suitable for hibernation. The Banya population also spun the silky nests which looked like winter nests. In warm winters the caterpillars can stay in these nests up to January-February until migration into the soil. In strong winter seasons many caterpillars can not survive in these nests (Tsankov, 1960).

The reported differences in biology and behaviour , thus justify the considera-

tion that the Banya population to be mentioned as *T. pityocampa bulgarica* Tsankov ssp. n..

Parasitoid impact

In the region of Banya, *O. pityocampae* was the only egg parasitoid having a significant impact (13.6 and 22.4%) on the mortality of the host, as reported for other Bulgarian regions (Tsankov et al., 1996). The total impact was 15.8 and 24.5 %, respectively. The small differences are mainly due to *T. embryophagum*, which seems more active near Banya than in other regions investigated in Bulgaria. *B. servadeii* and *A. bifasciatus* were observed in very low numbers.

The low rate of parasitoid impact resulted in a high hatching rate of 69.2 and 78.9% of the host caterpillars.

The egg parasitoids were able to hibernate and emerge in the consecutive year, a variable percentage of mortality of them was recorded.

No hyperparasitism was observed as found in other regions (Tsankov et al., 1996).

Phenology of egg parasitoids

It is well known that egg parasitoids can be present during the whole vegetation period (from February to October) (Bellin et al., 1990), because of the variable periods of diapause. At Banya, the emergence dynamics of egg parasitoids could be demonstrated only for *O. pityocampae* as the most abundant parasitoid. In 1992 two third of the parasitoids emerged before sampling of the egg-batches (12.VIII.1992). Only some of these might have a bivoltine development. Many hibernate as mature larvae until April-May of the consecutive year. The period of emergence lasted until August 1993; no hyperparasitism was found. The data indicate that only about one quarter of the total emerged parasitoids of the former generation can have the possibility to reach the next host generation for parasitism. There is no indication that many parasitoids could complete a second cycle in eggs of the same batch, most of them have to find another one for multiplication. If parasitoid development lasts 2-3 weeks and the oviposition period of the host about one month, some parasitoids may have the chances to be at least trivoltine. On the other hand, there are individuals which infested the egg-batch as soon as after host oviposition being univoltine. Till date, there is no consolidation for such very wide parasitism behaviour; it seems that *O. pityocampae* is not well adapted to the host and a large number of individuals has no chance of multiplication.

As in the present study, *Trichogramma* parasitoids in Spain also emerged before winter (Schmidt et al., 1997).

Sites of egg-masses attacked by parasitoids

Tiberi (1978) reported that the main obligatory egg parasitoids of *T. pityocampa* tend to attack the basal and apical sectors of the batch. *O. pityocampae* was found more frequently in the basal sector, while *B. servadeii* preferred the apical sector. At Banya, this could not be observed in *O. pityocampae*. In contrast, *T. embryophagum* preferred exclusively the basal part. According to Biliotti (1958) the presence of the scales implies an obstacle for the parasitoids. Kitt & Schmidt (1993) found that *O. pityocampa* parasitized predominantely the apical part of the egg-batch, which does not agree with the present findings and observations in other regions of Bulgaria (Tsankov et al., 1996). For the very small *Trichogramma* parasitoids, it is more obvious that parasitism takes place in parts of the egg-batch in which the scale cover is not so tight, and the females need not spend so much energy for piercing the scales for egg laying.

In Spain, *Trichogramma* preferred both the basal and apical parts of the egg batch and *A. bifasciatus* only the apical (Schmidt et al., 1997). *O. pityocampae* and *B. servadeii* were almost equally distributed. The different results found in various countries indicate that there are other factors than scale cover influencing the search of eggs for parasitism.

Predators

In populations of pine processionary moths the enemy pressure can be relatively high. Besides parasitoids several predator species are well known (Schmidt et al., 1990a,b). During winter, birds (*Parus* species) were observed feeding on young caterpillars and egg-batches. In early spring, when the processions of the caterpillars start for pupation, carabid beetles preyed on them. Near Banya, tettigoniids could be observed feeding on the eggs and destroying the egg-batches in the summer months. In these cases, not only developing caterpillars but also developing parasitoids would be exterminated.

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