Parasitism of Egg-Batches of the Cedar Processionary Moth *Traumatocampa ispartaensis* in Turkey

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Studies were carried out on the egg material of *Traumatocampa ispartaensis* Doğanlar & Avcı (Lep.: Notodontidae) collected on *Cedrus libani* A. Rich. A total of 95 egg-batches were sampled over two annual generations of *Tr. ispartaensis*. The number of eggs in each egg-batch varied between 39 and 245 and the length of the batches varied between 7 and 36 mm. The mean number of eggs per batch was found to be 119 and 122 in 1999 and 2000, respectively. Based on field data the oviposition period continued from mid August to mid September. The mean hatching rate of the host was found to be 85.8% and 88.9%, whereas the impact of egg parasitoids accounted for 11.3% and 7.4%, respectively in the 2 years. *Ooencyrtus pityocampae* (Mercet) was observed as the most abundant egg parasitoid, followed by *Ooencyrtus* sp. near *masii* (Mercet) and *Trichogramma brassicae* Bezdenko. Based on the emergence dynamics of the egg parasitoids in the laboratory, it seems that *O. pityocampae* emerged mainly in June whereas *O.* sp. near *masii* and *T. brassicae* emerged mainly in May.

KEY WORDS: *Traumatocampa ispartaensis*; egg parasitoids; *Ooencyrtus pityocampae; Ooencyrtus* sp. near *masii*; *Trichogramma brassicae*; Turkey.

INTRODUCTION

Three species of processionary moths (Notodontidae: Thaumetopoeinae) can be found in cedar (*Cedrus* spp.), including *Thaumetopoea bonjeani* (Powell) in *C. atlantica* Man. in North Africa, and *T. libanotica* Kiriakoff & Talhouk and *Traumatocampa ispartaensis* Doğanlar & Avcı in *C. libani* A. Rich in the northeast Mediterranean region (3,5,7). *Tr. ispartaensis* can be found in the Isparta region of Asia Minor located in the Lakes District. The only determined host species of *Tr. ispartaensis* is *C. libani* (4).

Traumatocampa ispartaensis, previously, since 1975, known as *Thaumetopoea solitaria* (Freyer) in Turkey, has recently been identified as a new species. To the best of our knowledge, there has been no research on this moth since it was identified. *Tr. ispartaensis* is one of the most dangerous pests of cedar forests in the Isparta region. The caterpillars feed on the needles of cedar trees and produce tiny hairs containing an urticating substance, which causes contact dermatitis (4). The information about the natural enemies of *Tr. ispartaensis* is insufficient. Some information is available on the tachinid flies parasites of the larvae and pupae (2). Knowledge about the egg parasitoids of *Tr. ispartaensis* is practically nil. The objective of this study was to examine the egg parasitoids of *Tr. ispartaensis* in the Isparta region and to evaluate the impact of this group of enemies on

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host mortality. We focused on the structure of egg-batches, the hatching rate, parasitism failure and the emergence dynamics of the parasitoids.

MATERIALS AND METHODS

Egg-batches of *Tr. ispartaensis* were sampled in natural stands of *C. libani* (age: 45–55 years) located on the West Taurus Mountain Chain in Senirkent-Kapıdağ near Isparta at an altitude of 1300–1600 m. The egg-batches were collected in November 1999 and December 2000. All egg-batches were taken from the underside of twigs of *C. libani*. Ninety-five egg-batches, oviposited over two annual generations, were studied. After collection, the batches were put singly in test tubes with cotton stoppers and placed in the laboratory at 21–24°C (mean = 22.2°C±0.11° S.E.), where further investigations were also performed.

The scales covering the egg-batches were removed and the emerging parasitoids were taken out of the tubes and counted daily. The emergents were placed in small vials for identification. This was done throughout the entire period of emergence, which included the spring and summer months in the following year after oviposition of the host. Eventually, all individuals that were alive emerged from the sample. Following the emergence period, all eggs without an emerging or hatching hole were carefully opened and the meconia and remains of the dead insects were determined by means of a stereomicroscope (×40 magnification) (10).

RESULTS

Formation of egg-batches According to field observations during this study, the flight period of the moth ranged from mid-August to mid-September, depending on the temperature and altitude. Egg-laying started soon after emergence and copulation, as in other Notodontidae species. Copulation started a few hours after the adults had emerged and egg deposition took place during the same night. Only one egg-batch was laid by a female during its very short life. The eggs were laid on the underside of twigs of *C. libani*. The larvae hatched during the last week of March and first half of April.

Characterization of the egg batches A total of 23 egg-batches in 1999 and 72 in 2000, containing 11,494 eggs, were collected and analyzed. The results are given in Table 1. Oviposition by the moth in all cases was found to occur from the tip to the base of the twigs. This observation was based on the position of the scales which covered the eggs; the scales were grayish-brown, similar to the color of the bark and therefore inconspicuous. The eggs, which were white in color, were 2–5 mm in diameter (average 3.5 mm). The length of the egg-batches varied from 7 to 36 mm (average 17 mm in both generations). A 1-cm egg-row contained a mean of 10.5 (10.1–10.9) eggs. The number of eggs per batch varied from 39 to 245.

Egg mortality and parasitism rate A total of 2,742 eggs (100%) in 1999 and 8752 eggs (100%) in 2000 were used to study parasitism rate; of these numbers of eggs, 85.8% and 88.9% caterpillars hatched in 1999 and 2000, respectively (overall egg mortality of 14.2% and 11.1%, respectively). Parasitism reached 11.3% and 7.4% in 1999 and 2000, respectively. The total mortality of the eggs was always higher than the rate of parasitism, because not all caterpillars were able to hatch; some of them died in eggs with or without opening the egg shell. Some eggs were completely empty, without any remains (Table 1).

TABLE 1. Structure and parasitism of egg-batches of *Traumatocampa ispartaensis*

Date of collection	21.XI.1999	4.XII.2000
Number of egg-batches	23	72
Length of egg-batches (mm ±S.E.)	17 (±0.9)	17 (±0.7)
Mean diameter of twigs (mm ±S.E.) on which eggs were deposited	3.5(±0.11)	3.5(±0.12)
Oviposition direction (underside of twigs)	tip to base	tip to base
Number of eggs per batch ±S.E.	119 (±9.8)	122 (±5.0)
Total number of eggs studied	2742	8752
Tr. ispartaensis		
caterpillars hatched	2353 (85.8%)	7780 (88.9%)
caterpillars died in eggs without opening	59	280
caterpillars died with opening	17	44
eggs totally empty, without any remains	4	–
total number of eggs from which no caterpillar hatched, without visible influence of parasitoids	80 (2.9%)	322 (3.7%)
Parasitism		
O. pityocampae		
number of emerged adults	210	387
number of dead immatures	17	39
	227 (8.3%)	426 (4.9%)
O. sp. near *masii*		
number of emerged adults	65	113
number of dead immatures	4	11
	69 (2.5%)	124 (1.4%)
T. brassicae		
number of parasitized eggs	11	98
adults died before emergence	2 eggs	–
	13 (0.5%)	98 (1.1%)
Impact of egg parasitoids (%)	11.3	7.4
Total mortality of host (%)	14.2	11.1

Three species of parasitoids were reared from the eggs of *Tr. ispartaensis*: *Ooencyrtus pityocampae* (Mercet) and *Ooencyrtus* sp. near *masii* (Mercet) (Hym.: Encyrtidae), both solitary species, and *Trichogramma brassicae* Bezdenko (Hym.: Trichogrammatidae), a gregarious species. *O. pityocampae* was the most abundant species responsible for egg parasitism. The second most abundant egg parasitoid was *O.* sp. near *masii*, and *T. brassicae* was the least abundant species. Most of the egg parasitoids opened an emergence hole at the top of the egg and emerged through this hole, but a considerable number (approximately 10%) of them found their way out through a hole made on the side of the egg shell. It was possible to record the exact number of *T. brassicae* adults. Sixty-four and 684 individuals (approx. seven per egg) emerged in 1999 and 2000, respectively.

In each of the three parasitoid species, some died inside the eggs at various developmental stages. The rates were 0.5% (*O. pityocampae*), 0.1% (*O.* sp. near *masii*) and 0.02% (*T. brassicae*) (Table 1). The highest level of parasitism of an egg batch by *O. pityocampae, O.* sp. near *masii* and *T. brassicae* was 39.6% (in 1999), 14.0% (in 2000) and 18.6% (in 2000), respectively.

Emergence dynamics of parasitoids The emergence pattern of the egg parasitoids from the collected egg-batches in the laboratory is presented in Figure 1. At room temperature, the emergence of the three parasitoid species started on May 9 in 1999 and on April 26 in 2000. In general, the emergence of *O. pityocampae* started from the beginning of May

and lasted until the third week of July; a single period of emergence was observed for each study year, extending from the end of June to the first week of July in 1999, and from the end of May to the first half of June in 2000 (Fig. 1A). The emergence of *O.* sp. near *masii* started at the end of April, reached a peak in May, and all adults emerged by the third week of June (Fig. 1B). *T. brassicae* emerged mainly in May (Fig. 1C).

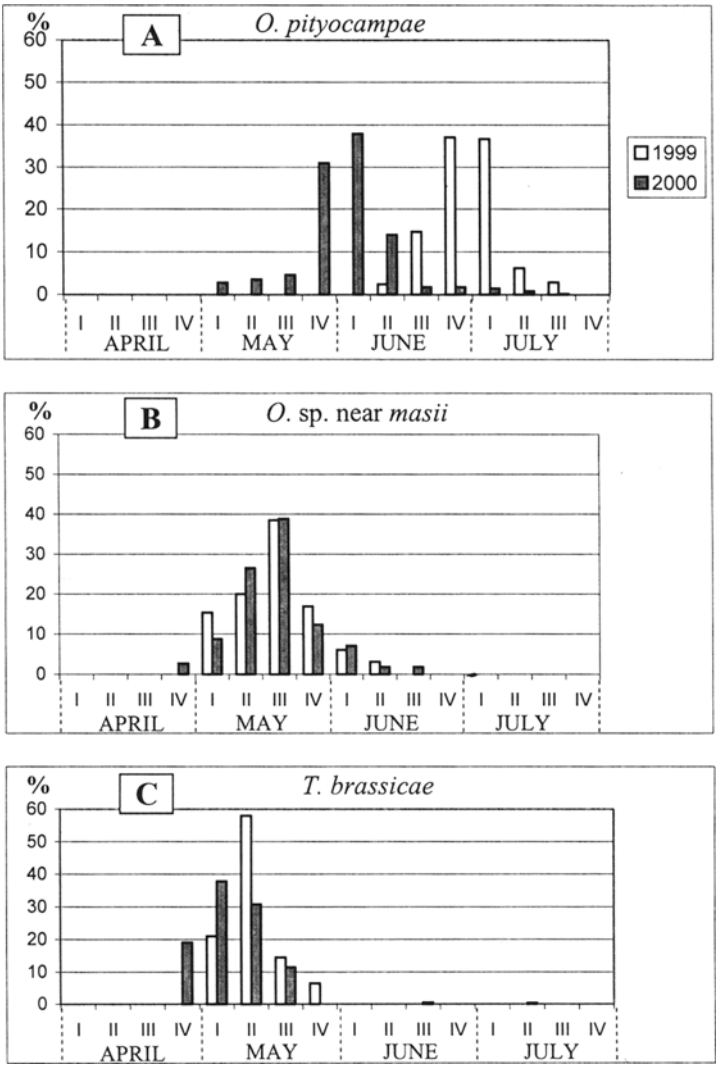

Fig. 1. The pattern of emergence at room temperature (21–24°C) of three egg parasitoids from the egg-batches of *Traumatocampa ispartaensis* (collected in Nov. 1999 and Dec. 2000).

DISCUSSION

Traumatocampa ispartaensis displays a phenology similar to that of *Thaumetopoea bonjeani* in *Cedrus atlantica* forests in the Atlas Mts. of North Africa (3). Oviposition of *T. bonjeani* takes place in August–September on small twigs and the eggs are also covered with scales. The eggs hibernate and hatch in the spring (March–April) of the following year.

The egg rows of *Tr. ispartaensis* were generally not tidy, but more random than those of *T. pityocampa*, *T. wilkinsoni* or *T. solitaria*. The eggs of *T. solitaria* are white on top and grayish-yellow below, hexagonal, and deposited in a flat, one-layered, symmetrical, hexagonal cluster. The eggs of *T. pityocampa* and *T. wilkinsoni* are deposited around one or more pine needles or small twigs, in a one-layered cylindrical cluster. The color of the *Tr. ispartaensis* eggs is white.

The overall impact of the parasitoids was small with a high rate of hatching of *Tr. ispartaensis* neonates in the 2 years. The low rate of parasitization was caused by high hatching rates of the host caterpillars: 85.8% and 88.9%. In comparison, the hatching rate of *T. pityocampa* was found to be 70.3% in Turkey (1).

Three species of primary egg parasitoids emerged from the eggs of *Tr. ispartaensis* in the Isparta region: *O. pityocampae*, which was the most frequent, followed by *O.* sp. near *masii* and *T. brassicae*. The emergence waves of the three species were found to overlap. *O. pityocampae* and *O.* sp. near *masii* were more abundant in 1999 than 2000, whereas *T. brassicae* occurred in high numbers in the second study year.

Thaumetopoea bonjeani eggs are attacked by *O. pityocampae* and *B. servadeii* (3,5). The same species attack *T. pityocampae* in North Africa and the Mediterranean Basin. In Turkey, egg parasitoids of *T. pityocampa*, *O. pityocampae*, *Baryscapus servadei*, *Anastatus bifasciatus* and *Trichogramma embryophagum* have been found. Their impact accounted for 25.8% in another study (1). *T. embryophagum* frequently emerges from eggs of *Thaumetopoea* spp. in the central and east Mediterranean region (1,11,14). *O. pityocampae* can be found as an egg parasitoid in many species including *T. pityocampa*, *T. wilkinsoni*, *T. solitaria* and *T. bonjeani* (5,6,8,9,12,13). In Israel, *O.* sp. near *masii* is known as an egg parasitoid of *T. jordana*, the rate of parasitism being 0.8%. The adults of *O.* sp. near *masii* emerged from egg masses between May 8 and 25 in Israel (6). The emergence of *T. brassicae* started much earlier than the other parasitoids, appearing as early as late April. A few individuals of *T. brassicae* emerged 30–60 days after the main wave of emergence.

In the present study, *T. brassicae* was found for the first time as an egg parasitoid of the processionary moth. Previously, it was known as a significant egg parasitoid of *Ostrinia nubilalis* (Hbn.) (Lep.: Pyralidae) (8).

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