

Parasitoid Complex and New Host Plants of the Gypsy Moth, *Lymantria dispar* L. in the Lakes District, Turkey

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Abstract: The present study determined egg, larval and pupal parasitoids of the gypsy moth *Lymantria dispar* L. (Lepidoptera: Lymantriidae), which is an important forest pest in Turkey. High populations of the gypsy moth have been observed recently in oak forests and coniferous forests in the Lakes District of Turkey. *Pinus brutia* Ten and *Cedrus libani* A. Rich are reported for the 1st time in the world as host plants of *L. dispar*. Its parasitoid complex and impact were analyzed in a 2-years study. In larval and pupal stages of the pest, the tachinids *Exorista segregata* (Rond.), *Compsilura concinnata* Meigen, *Drino inconspicua* Meigen and *Pales pavidus* Meigen, the chalcid *Brachymeria intermedia* (Nees), the torymid *Monodontomerus aereus* Walk. The braconid *Apanteles xanthostigma* (Haliday) and the egg parasitoids *Ooencyrtus kuvanae* (Howard) (Hym. Encyrtidae), *Anastatus disparis* Rusch and *Anastatus bifasciatus* (Fonsc.) (Hym: Eupelmidae) were recorded. *O. kuvanae* had the greatest impact on *L. dispar* populations. *A. xanthostigma* is a new record for Turkey and also a new record for the world as a parasitoid of *L. dispar*.

Key words: *Lymantria dispar*, parasitoid, host plant, Lakes District, Turkey

INTRODUCTION

The gypsy moth, *Lymantria dispar* L. (Lep., Lymantriidae) is one of the most important defoliators of oak forest and is widely disturbed in Europe, Asia and America. Typically, outbreaks are in South and South west Europe and they can almost completely defoliate forests. It is known to be polyphagous on approximately 500 species in orchards and forest stands (Ozdemir, 1993). It feeds on 270 species in Romania, 300 species in Russia and 450 species in the USA. *L. dispar* is the main defoliator of *Quercus*, *Carpinus*, *Fagus* and *Castanea* trees in forests stands in Turkey (Oymen, 1982). It becomes a very important pest during outbreaks in the Lakes District Region of Turkey, especially on forest and fruit trees.

L. dispar is univoltine and overwinters in the egg stage. The female lays clusters of eggs in the lower parts of trees in July, they hatch at the end of April and larvae feed from that time to mid-June. Pupation takes place among leaves and the adults appear at the end of June in the Marmara region of Turkey (Oymen, 1982).

Predators and parasitoids are known to play an important role in reducing the population density of *L. dispar*. However, there is limited information about natural enemies of *L. dispar* in the forest ecosystem, especially for the Mediterranean region of Turkey.

Therefore, the objectives of the current study were to report on host plants and to determine parasitoids and quantify their impact on different stages of *L. dispar* in the Lakes District of Turkey.

MATERIALS AND METHODS

Host plants and parasitoids were determined in 2005 and 2006 at 9 forested localities in the Lakes District of south-west Turkey (Table 1).

The parasitoids were reared from *L. dispar* eggs, larvae and pupae. The eggs were collected from the stems and the larvae and pupae were taken from shoots and leaves of host plants. A total of 8,178 eggs from 144 egg clusters (mean 59.8) and 3,968 mature larvae and pupae were brought to the laboratory in 2005 and 2006. To explore parasitism qualitatively and quantitatively, *L. dispar* were collected in a stage-specific manner from the study plots. For evaluation of egg parasitism, *L. dispar* egg masses were collected several weeks before hatching and kept in glass petri dishes at room temperature (22-25°C) in the laboratory. They were checked daily; emerging gypsy moth neonates were removed and parasitoids were collected. Parasitoids were preserved in 80% alcohol prior to identification.

Specimens were also collected from each study plot during the mature larval and pupal stages. Field-collected

Table 1: Study areas and their characteristics

Plot number	Location	Tree species	Coordinates	Altitude (m)
1	Isparta-Egirdir-Yukarigokdere	<i>Quercus cerris-Q. libani</i>	37°40'57"N 30°51'42"E	940
2	Isparta-Egirdir-Akpinar	<i>Q. coccifera</i>	37°50'35"N 30°51'04"E	1205
3	Isparta-Gonen	<i>Q. coccifera - Pinus brutia</i>	37°58'00"N 30°31'18"E	1110
4	Isparta-Sav	<i>Q. coccifera -Cedrus libani</i>	37°41'25"N 30°39'27"E	770
5	Isparta-Egirdir-Beydere	<i>Q. coccifera</i>	37°55'17"N 30°44'48"E	1175
6	Afyonkarahisar-Dinar-Bademli	<i>Q. coccifera</i>	37°57'50"N 30°08'47"E	1405
7	Burdur-Aglasun	<i>Q. coccifera-Q. trojana</i>	37°38'18"N 30°39'17"E	1040
8	Burdur-Dirmil-Ballik	<i>Q. pubescens-Q. cerris</i>	36°52'20"N 29°25'37"E	1430
9	Burdur-Bucak-Seydikoy	<i>Q. coccifera-Q. infectoria</i>	37°30'29"N 30°32'56"E	930

larvae were reared in groups of 50 in containers (50×50×75 cm) on oak foliage. The larvae were checked daily and deceased larvae and larvae from which parasitoids had emerged were removed. Pupae were kept in containers and examined daily throughout the whole emergence period of parasitoids.

RESULTS AND DISCUSSION

New and preferred host plants of *L. dispar*: *L. dispar* was determined the most important pest of broad leaf forests in the Lakes District. In all stands, *Quercus* species were the main host. *Pinus brutia* Ten and *Cedrus libani* A. Rich were also host plants, especially in outbreak years and are reported as host plants of *L. dispar* for the 1st time.

All natural oak species of the region were hosts of the pest (Table 1). The greatest damage occurred in *Q. coccifera* stands. In these forests, outbreaks of *L. dispar* occur periodically. In addition to the experimental areas, larval damage was observed on *Q. vulcanica* in Kasnak Oak Nature Protected area in the Lakes District.

Larvae were observed feeding at high densities on *P. brutia* in Isparta-Gonen and on *C. libani* in Isparta Sav. Some trees had lost many of their needles. Eggs, larval and pupal samples were collected from those trees.

The parasitoid complex of *L. dispar*: Ten species were determined to be parasitoids of *L. dispar*. *Ooencyrtus kuvanae* (Howard) (Hym.: Encyrtidae), *Anastatus disparis* Rusch and *A. bifasciatus* (Fonsc.) (Hym.: Eupelmidae) were the egg parasitoids and the larval-pupal parasitoids were *Compsilura concinnata* Meigen, *Exorista segregata* (Rond.), *Drino inconspicua* Meigen, *Pales pavidata* Meigen (Dip. Tachinidae); *Brachymeria intermedia*

Table 2: Egg parasitoids of *Lymantria dispar* in Lakes District

Plants	Species	Parasitism (%)
Hymenoptera	Encyrtidae	
	<i>Ooencyrtus kuvanae</i> (Howard)	64.6
	Eupelmidae	
	<i>Anastatus disparis</i> (Rusch.)	0.9
	<i>Anastatus bifasciatus</i> (Fonsc.)	0.8
	Total	66.3

Table 3: Larval and pupal parasitoids of *Lymantria dispar* in the Lakes District, Turkey

Plants	Species	Parasitism (%)
Diptera	Tachinidae	
	<i>Exorista segregata</i> (Rond.)	9.0
	<i>Drino inconspicua</i> (Meigen)	0.5
	<i>Compsilura concinnata</i> (Meigen)	0.4
	<i>Pales pavidata</i> (Meigen)	0.1
Hymenoptera	Chalcididae	
	<i>Brachymeria intermedia</i> (Nees)	4.5
	Torymidae	
	<i>Monodontomerus aereus</i> (Walk.)	5.8
	Braconidae	
<i>Apanteles xanthostigma</i> (Haliday)	0.1	
	Total	20.4

(Nees) (Hym.: Chalcididae); *Monodontomerus aereus* Walk. (Hym.: Torymidae) and *Apanteles xanthostigma* (Haliday) (Hym.: Braconidae). Table 2 shows the egg parasitoids came from 2 hymenopteran families and Table 3 shows that larval-pupal parasitoids came from 4 dipteran and hymenopteran families.

In this study, 66.3% of the pest eggs were parasitized by 3 solitary parasitoid species. *O. kuvanae* was by far the most important egg parasitoid, reducing egg numbers by 64.6%. Its highest percentage emergence occurred in September. The other egg parasitoids were *A. disparis* which achieved parasitism of 0.9% and *A. bifasciatus* (8%) (Table 2). The strikingly high levels of parasitism by *O. kuvanae* indicate its singular importance in regulating larval numbers.

The mortality of *L. dispar* caused by larval and pupal parasitoids was 20.4%. The dipteran Tachinidae family

had the largest representation of species (4) in larval and pupal parasitoids. The most important species was *E. segregata*, which reduced pest numbers by 9.0%, followed by *M. aereus* (5.8%), *B. intermedia* (4.5%), *D. inconspicua* (0.5%), *C. concinnata* (0.4%), *P. pavidata* (0.1%) and *A. xanthostigma* (0.1%) (Table 3). *A. xanthostigma* is reported as a new parasitoid of *L. dispar* and also as a new record for the Turkish fauna.

In addition, *Calosoma* sp., particularly *Calosoma sycophanta* (L.) (Col.: Carabidae), destroyed many *L. dispar* larvae and pupae. *C. sycophanta* was abundant at both the larval and adult stages in the study plots.

During the current study at 9 localities in the Lakes District forests of South-West Turkey, 10 species were determined to be parasitoids of *L. dispar*. In an earlier study in Turkey, *C. concinnata*, *P. pavidata*, *E. segregata*, *D. inconspicua* and *B. intermedia* were determined as parasitoids of *L. dispar*. In addition, *C. sycophanta* was mentioned as a predator. Parasitism rates of *L. dispar* larvae by *C. concinnata* were 5-14%, by *P. pavidata* 2-3%, by *E. segregata* 2-7%, by *D. inconspicua* 1% and by *B. intermedia* 1-5% (Oymen, 1982).

Ozdemir (1993) reported *O. kuvanae*, *A. disparis* and *A. bifasciatus* as egg parasitoids. In that study, the hymenopterans *Apanteles liparidis* (Bouche), *A. solitarius* Ratz. (Braconidae), *M. aereus* Walk. (Torymidae) and *B. intermedia* (Nees) (Chalcididae) and the dipterans *D. inconspicua*, *Zenillia libatrix* (Panzer), *C. concinnata*, *P. pavidata*, *Exorista larvarum* (L.) and *Senometapia separata* (Rondani) (Tachinidae), were determined as larval and pupal parasitoids. Also, *C. sycophanta*, *Xylocoris flavipes* Reuter, *Cardiastethus nazarenus* Reuter and *Orius alpidipennis* Reuter (Hem. Anthocoridae) were noted as predators of *L. dispar*.

The study of Ozkan (1988) recorded *O. kuvanae* for the 1st time in Turkey. Parasitism of *L. dispar* eggs by this species varied between 80 and 96%, compared to 64.6% in the current study. Kara and Tschorsnig (2003) reported *C. concinnata*, *E. larvarum*, *E. segregata*, *D. inconspicua*, *S. separata*, *Z. libatrix*, *P. pavidata* and *P. processioneae* as tachinid parasitoids of *L. dispar*. Four of those species were recorded in the current study (Table 3).

The natural enemies of *L. dispar* have been studied throughout its known range. Among these studies, Hoch *et al.* (2006) recorded *Glyptapanteles liparidis*, *G. porthetriae* (Hym. Braconidae), *B. intermedia* (Hym. Chalcididae); *Parasetigena silvestris*, *Z. libatrix*, *Blepharipa* sp. (Dip. Tachinidae) and *C. sycophanta* as natural enemies of *L. dispar* in Austria. Zubrik and

Novotny (1997) reported *A. disparis* and *O. kuvanae* as egg parasitoids of *L. dispar* in Slovakia. The total parasitization was 0.34% and *A. disparis* had 79.5% and *O. kuvanae* had 20.5% of that total. In contrast to Slovakia, the current study showed total parasitization by both species was much higher.

Among 28 species determined as egg, larval and pupal parasitoids by Hoch *et al.* (2001) in Austria, *O. kuvanae*, *A. disparis*, *B. intermedia*, *D. inconspicua*, *C. concinnata* and *P. pavidata* were recorded in the current study. The much higher parasitoid diversity in the Austrian study may reflect more benign climatic conditions and greater ecological diversity generally in their study area. In a study conducted in the USA, Fuester *et al.* (2001) recorded *Aphantorhaphopsis samarensis* (Dip. Tachinidae) among the larval parasitoids. Brown and Cameron (1982) reported *O. kuvanae*, *Dibrachys cavus* (Walker) (Hym. Pteromalidae) and *Pediobius* sp. (Hym. Eulophidae) as egg parasitoids of *L. dispar* in Pennsylvania. In the same study, primarily ants (Hym. Formicidae); larvae of Cantharidae, Dermestidae and Trogositidae (Coleoptera), Chrysopidae (Neuroptera) species and Pentatomidae (Hemiptera) species, were reported as predators, with an average predation of 11%.

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REFERENCES

- Brown, M.W. and E.A. Cameron, 1982. Natural enemies of *Lymantria dispar* (Lep. Lymantriidae) eggs in Central Pennsylvania, USA and a review of the world literature on natural enemies of *L. dispar* eggs. *Biol. Control*, 27: 311-321. DOI: 10.1007/BF02374814. <http://www.springerlink.com/content/bl09738501101477>.
- Fuester, R.W., M. Kenis, K.S. Swan, P.C. Kingsley, C.L. Vaamonde and F. Herard, 2001. Host Range of *Aphantorhaphopsis samarensis* (Diptera: Tachinidae), a Larval Parasite of the Gypsy Moth (Lepidoptera: Lymantriidae). *Environ. Entomol.*, 30: 605-611.

- Hoch, G., M. Zubrik, J. Novotny and A. Schopf, 2001. The natural enemy complex of the gypsy moth, *Lymantria dispar* (Lep., Lymantriidae) in different phases of its population dynamics in eastern Austria and Slovakia a comparative study. *J. Applied Ent.*, 125: 217-227.
- Hoch, G., G. Kalbacher and A. Schopf, 2006. Gypsy moth revisited: Studies on the natural enemy complex of *Lymantria dispar* L. (Lep., Lymantriidae) during an outbreak in a well known gypsy moth area. *Mitt. Dtsch. Ges. Allg. Angew. Ent.*, 15: 201-204. DOI: 10.1046/j.1439-0418.2001.00540.
- Kara, K. and H.P. Tschorsnig, 2003. Host catalogue for the Turkish Tachinidae (Diptera). *J. Applied Ent.*, 127: 465-476.
- Oymen, T., 1982. The Biology and Natural Enemies of *Lymantria dispar* (L.) (Lepidoptera, Lymantriidae) in Marmara Region. Istanbul University J. Fac. For., Seri. A, 32: 65-83.
- Ozdemir, Y., 1993. The Natural Enemies of *Lymantria dispar* L. (Lep. Lymantriidae). 1. Forestry Meeting, 3: 250-253.
- Ozkan, A., 1988. The Outbreak of *Lymantria dispar* L. and Some Investigations on A New Egg Parasitoid for Turkey. *Derim*, 5: 85-86.
- Zubrik, M. and J. Novotny, 1997. Egg parasitization of *Lymantria dispar* (Lep., Lymantriidae) in Slovakia. *Biologia.*, 52: 343-350.