

Orijinal araştırma (Original article)

Parasitoids of the Leafminers (Diptera: Agromyzidae) in Malatya, Turkey

Emine ÇIKMAN^{1*}

John LA SALLE²

Summary

The study was carried out to determine parasitoid species attacking leafminers in the family Agromyzidae (Diptera) in Malatya province during 2007-2008. Infested leaves with leafminer larvae were collected from both cultivated and non-cultivated plants twice a month. Adults parasitoids were obtained by rearing them from infested leaves in the laboratory. Two parasitoid species: *Phaedrotoma diversa* (Szépligeti, 1898), *Xynobius (Xynobius) discoidalis* (Fischer, 1957) belonging to the Braconidae (Hymenoptera) and five parasitoid species: *Cirrospilus pictus* (Nees, 1834), *C. talitzkii* Bouček, 1961, *Diglyphus isaea* (Walker, 1838), *Diglyphus pachyneurus* Graham, 1963, *Prigalio soemius* (Walker, 1839) belonging to the Eulophidae (Hymenoptera) were found. Among the parasitoids, *X. (Xynobius) discoidalis* and *C. talitzkii* are new records for the Turkish fauna. Moreover, *P. diversa*, and *C. pictus* were recorded for the first time from species of Agromyzidae in Turkey. *D. isaea* was found the predominant parasitoid species, accounting for 48.55% of presence of parasitoid rate.

Key words: Parasitoid, leafminer, survey, Malatya, Turkey

Anahtar sözcükler: Parazitoit, galerisineği, survey, Malatya, Türkiye

Introduction

Agromyzidae (leafmining flies) is one of the largest fly families, with more than 2742 valid species belonging to 27 genera worldwide (Spencer, 1990). Agromyzids are typically phytophagous, with larvae living in tissues of living plants. Larvae of most leafminers feed within the leaf parenchyma. Some species are serious pests of cultivated plants e.g. *Liriomyza* spp. (Spencer, 1973, 1990; Cerny et al., 2001). *Liriomyza* is a cosmopolitan group of pests that consists of more than 300 species. Larvae of this genus are polyphagous, attacking ornamental and vegetable crops in the families Asteraceae, Brassicaceae, Cucurbitaceae, Fabaceae, Solanaceae, and many other families

¹ Plant Protection Department, Faculty of Agriculture, Harran University, 63300 Şanlıurfa, Turkey

² CSIRO Director Australian National Insect Collection, GPO Box 1700, Canberra, ACT 2601 Australia

* Sorumlu yazar (Corresponding author) e-mail: eminecikman@yahoo.com

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of plants. Infestation by *Liriomyza* spp. can cause both direct and indirect damage. *Liriomyza* spp. are known to have many natural enemies, particularly in their native home in the New World. In Asia 41 species of parasitoids in four different families were found (Chien & Ku, 1998; Lin & Wang, 1992; Murphy & La Salle, 1999). However, in general and under natural conditions, parasitism is usually low early in crop development and gradually increases as the crop matures (Parralle, 1987). At least 23 species of parasitoids have been used in biological control programmes against *Liriomyza trifolii* Burgess and *Liriomyza sativae* Blanchard (Diptera: Agromyzidae) in Senegal, California, Hawaii, Barbados, Marianas, Tonga, Taiwan and Guam (Petcharat et al., 2002).

Parasitoid assemblages of dipteran leafminers are dominated by Eulophidae, Braconidae and Pteromalidae that attack the larval and pupal stages of the flies. Overall, data from agricultural ecosystems suggest that agromyzid leafminers are attacked by a diverse assemblage of hymenopteran parasitoids that often are responsible for significant levels of leafminer mortality (Gratton & Welter, 2001). Parasitoids also have been used successfully to control leafminer infestations in greenhouses (Minkenbergh & Van Lenteren, 1986).

Many factors induce leafminer outbreaks, but the loss of natural enemies due to widespread use of insecticides is one of the most important. Parasitoids are the major group of natural enemies of leafminers, and they have played a very important role in leafminer suppression in natural ecosystems or cultivated areas with reduced insecticide use. Leafminer parasitoids have been intensively and extensively investigated and evaluated in many countries with more than 100 species reported, and several species, such as *Diglyphus begini* (Ashmead) (Hymenoptera: Eulophidae), and *Dacnusa sibirica* Telenga (Hymenoptera: Braconidae), have been successfully used as biological control agents in commercial greenhouses planted with vegetables and ornamentals, especially tomato and chrysanthemum in Europe and North America (Johnson, 1993; Murphy & La Salle, 1999; Chen et al., 2003). *Diglyphus isaea* (Walker) (Hymenoptera: Eulophidae), and its congener, *D. begini*, are effective augmentative biological control agents against *Liriomyza* leafminers infesting a wide range of greenhouse and field-grown crops and ornamentals (Oncuer, 1991).

To date 60 parasitoid species of leafminers have been identified in Turkey (Oncuer, 1991; Uygun et al., 1995; Campobasso et al., 1999; Civelek & Onder, 1999; Civelek, 2002; Civelek et al. 2002; Cıkman & Uygun, 2003; Civelek & La Salle, 2005; Cıkman et al., 2006; Cıkman & Doganlar, 2006; Cıkman et al., 2008; Gencer, 2004, 2005). The aim of this study is to contribute to presence of parasitoid level of leafminers in East of Turkey. Also the study will provide a base for future research regarding the biological control of leafminer species. Depositories of specimens Representative species were deposited in the laboratories of the Harran University, Agricultural Faculty, Plant Protection Department; Şanlıurfa, Turkey.

Materials and Methods

The study was carried out during 2007 and 2008 in Malatya province, which was divided into four subareas for convenience of the collection of the specimens. The leafminer species were collected from both cultivated and non-cultivated plants in different areas twice in a month. Samples of leaves infested with leafminers were randomly collected from the first week of spring (March) until the end of the autumn (November). Leafminer-infested leaves were taken to the laboratory at 25 ± 2 °C, 70 ± 5 %RH, photoperiod 14:10 (L:D). for the emergence of pests and parasitoids. A small piece of leaf containing the larvae was cut and placed in a small glass vial and then closed with a cotton ball covered with muslin. They were checked for the emergence of leafminers and parasitoids and relevant notes were recorded. After the completion of emergence, all reared pest and parasitoids specimens were identified.

The emerged Braconidae were identified by Prof. Dr. Ahmet Beyarslan (Trakya University, Art and Science Faculty, Biology Department, Edirne), Eulophidae were identified by Prof. Dr. Mikdat Doganlar (Mustafa Kemal University, Agricultural Faculty, Plant Protection Department, Hatay) and Dr. John La Salle (CSIRO Entomology, Australia). The species of Agromyzidae were identified by Dr. Emine Cıkman (Harran University, Agricultural Faculty, Plant Protection Department, Sanliurfa, Turkey). Representative species were deposited in the laboratory of Harran University, Agricultural Faculty, Plant Protection Department, Sanliurfa, Turkey.

The study was carried out during 2007 and 2008 in Malatya province, which was divided into four subareas for convenience of the collection of the specimens. Subareas of Malatya Province are Table 1. The leafminer species were collected from both cultivated and non-cultivated plants in different areas twice in a month.

Table 1. Subareas of Malatya Province for collection of the specimens

Subareas number	Counties
1	Malatya center, Battalgazi, Doganyol, Kale and Puturge
2	Akçadag, Darende and Kuluncak
3	Dogansehir and Yesilyurt
4	Arapgir, Arguvan, Hekimhan and Yazihan

Results

In the study 7 parasitoid species were identified. Among these species *Xynobius (Xynobius) discoidalis* (Fischer) and *Cirrospilus talitzkii* Bouček are new records for the Turkish fauna. Moreover, *Phaedrotoma diversa* (Szépligeti), and *Cirrospilus pictus* (Nees) were recorded for the first time in species of Agromyzidae in Turkey.

Diglyphus isaea (Walker) and *D. pachyneurus* Graham were recorded as the most common parasitoids. Thus, these species were considered to be the most important natural enemies of the Agromyzidae in Adiyaman province.

The ecological and distribution information of these seven species are provided below. The taxa are presented alphabetically.

Braconidae

Phaedrotoma Förster, 1862

Phaedrotoma diversa (Szépligeti, 1898)

Material examined: *P. diversa* was found in Gurun (Center), 38° 33' 06.3"N, 37° 26' 17.8" E, 776 m on *Phytomyza plantaginis* Robineau-Desvoidy, on *Plantago* spp., 05.IX.2007 (2♀♀, 2♂♂); Battalgazi (Boran) 38° 27' 53.0"N, 38° 22' 35.11" E, 1324 m on *Chromatomyia horticola* (Goureau) on *Portulaca oleracea* L., on 05.IX.2007 (1♀, 1♂).

Host: *Calycomyza solidaginis* (Kaltenbach), *Chromatomyia succisae* (Hering), *C. scabiosae* (Hendel), *C. syngenesiae* (Hardy), *Liriomyza centaureae* Hering, *Phytomyza gentianae* Hendel, *P. plantaginis*, (Dip.: Agromyzidae) (Yu et al., 2006).

P. diversa is a new record from Agromyzidae in Turkey.

General distribution: Palaearctic region (Yu et al., 2006).

Distribution in Turkey: Elazığ Adana, Antalya, Aydın, Bolu, Burdur, Bursa, Denizli, Edirne, Isparta, Izmir, Karabuk, Kastamonu, Kirklareli, Mugla, Sanliurfa, Tekirdag, Van, Zonguldak (Fischer & Beyarslan, 2005; Cıkman et al., 2009).

Xynobius Förster, 1862

Xynobius (Xynobius) discoidalis (Fischer, 1957)

Material examined: *X. discoidalis* was found in Battalgazi (Haniminciftligi), 38° 26' 42.5"N, 38° 21' 33.1" E, 776 m on *Japanagromyza salicifolii* (Collin), on *Populus* L., 29.IV.2008. (3♀♀, 5♂♂).

Host: Unknown (Yu et al., 2006)

P. diversa is a new record from Agromyzidae in Turkey.

General distribution: Western Palaearctic (Yu et al., 2006).

Distribution in Turkey: New record for the Turkish fauna.

Eulophidae

Cirrospilus Westwood, 1832

Cirrospilus pictus (Nees, 1834)

Material examined: *C. pictus* was found in Alacakaya (Merkez) on 38° 27' 10.1"N, 38° 22' 33.11,9" E, 776 m on *J. salicifolii*, on *Populus*, 05.IX.2007. (2♀♀, 2♂♂). Battalgazi (Boran) 38° 27' 53.0"N, 38° 22' 35.11" E, 1324 m on *J. salicifolii*, on *Populus*, 05.IX.2007 (1♀, 2♂♂).

Hosts: Mainly leafmining Agromyzidae (Diptera), Coleoptera and Lepidoptera; this species can act as a facultative hyperparasitoid (Noyes, 2003).

This parasitoid species has previously been recorded from *Micrurapteryx sophorivora* Kuznetsov & Tristan (Lepidoptera: Gracillariidae) and *Phyllocnistis citrella* Stainton (Lepidoptera: Gracillariidae: Phyllocnistinae) in Turkey (Gencer & Seven, 2005; Elekçioğlu & Uygun, 2006).

C. pictus is a new record from Agromyzidae in Turkey.

General distribution: Widespread throughout the Holarctic region, including North Africa (Noyes, 2003).

Distribution in Turkey: Kuluncak (Gencer & Seven, 2005).

Cirrospilus talitzkii Bouček, 1961

Material examined: *C. talitzkii* was found in Merkez (Hanevleri) on 38° 25' 01.2"N, 39° 34' 58.5" E, 1334 m on *Liriomyza congesta* (Becker), on *Medicago sativa* L., 17.V.2007 (2♂♂, 2♀♀); Battalgazi (Boran) 38° 27' 53.0"N, 38° 22' 35.11" E, 1324 m on *L. trifolii* on *Solanum melongena* L. on 05.IX.2007 (4♀♀, 3♂♂); Surgu (Surmelipinar) 38° 00' 39.1"N, 30° 55' 12.0" E, 1324 m on *L. trifolii* on *Lycopersicum esculentum* Mill. on 05.IX.2008 (1♂, 2♀♀).

Hosts: Mainly leafmining Lepidoptera, but also Agromyzidae (Diptera) (Noyes, 2003).

C. talitzkii is a new record from Agromyzidae in Turkey.

General distribution: Palaearctic region (Noyes, 2003).

Distribution in Turkey: New record for the Turkish fauna.

Diglyphus Walker, 1848

Diglyphus isaea (Walker, 1838)

Material examined: *D. isaea* was found in Gurun (Merkez) 38° 33' 06.3"N, 37° 26' 17.8" E, 948 m on *C. horticola* on *Zinnia* spp., on 17.V.2007 (8♀♀, 5♂♂); Surgu (Surmelipinar) 39.1"N, 30° 55' 12.00" E, 1324 m on *L. trifolii* on *L. esculentum* on 05.IX.2008 (12♀♀, 14♂♂); Battalgazi (Merkez) 38° 27' 53.0"N, 38° 22' 35.11" E, 1324 m on *L. trifolii* on *S. melongena*, on 05.IX.2007 (5♀♀, 7♂♂); Battalgazi (Sahil) 38° 28' 39.1"N, 38° 23' 22.5" E, 692 m on *C. horticola* on *Xanthium* spp., on 05.IX.2007 (3♀♀, 2♂♂); Malatya (Alacakaya) 38° 27' 10.1"N, 38° 22' 11.9" E, 776 m *C. horticola* on *P. oleracea*, on 05.V.2008 (5♀♀, 3♂♂); Darende (Merkez) 38° 30' 18.2"N, 37°32' 48.6" E, 980 m on *L. trifolii* on *Centaurea* sp., on 20.IV.2007 (9♀♀, 8♂♂); Battalgazi (Haniminciftligi), 38° 26' 42.5"N, 38° 21' 33.1" E, 776 m on on *C. horticola* on *Lactuca sativa* L., 29.IV.2008. (1♀, 1♂); Surgu (Surmelipinar), 38° 00' 39.1"N, 30° 55' 12.0" E, 1324 m on *L. trifolii* on *Cucurbita* sp., on 05.IX.2008 (2♀♀).

Hosts: Many species of Agromyzidae and also Lyonetiidae and Tephritidae (Lepidoptera) (Ciampolini, 1952; Gordh & Hendrickson, 1979; Minkenberg & van Lenteren, 1986; Zhu et al., 2000; Noyes, 2003).

This species has previously been recorded from *Agromyza albitarsis* Meigen, *C. horticola*, *L. congesta*, *L. huidobrensis* (Blanchard), *L. strigata* (Meigen), *L. trifolii*, *Phytomyza petoei* Hering, *P. tetrasticha* Hendel, in Turkey (Uygun et al., 1995; Civelek & Onder, 1999; Cıkman & Uygun, 2003; Cıkman, 2006; Cıkman et al., 2006).

General distribution: Widespread in Palearctic regions, and also Afrotropical, Australian, Pacific, Nearctic, and Oriental regions (Bouček, 1965; Noyes, 2003).

Distribution in Turkey: Adana, Ankara, Izmir, Sivas, Southeast Anatolian regions of Turkey (Uygun et al., 1995; Civelek & Onder, 1999; Cıkman & Uygun, 2003; Gencer, 2004; Gencer, 2005; Cıkman, 2006; Cıkman et al., 2006).

***Diglyphus pachyneurus* Graham, 1963**

Material examined: *D. pachyneurus* was found in Darende (Merkez) 38° 30' 18.2"N, 37° 32' 48.6" E, 980 m on *J. salicifolii* on *Populus* on 20.IV.2007 (1♀, 1♂); Gurun (Merkez) 38° 33' 06.3"N, 37° 26' 17.8" E, 948 m on *J. salicifolii* on *Populus* on 17.V.2007 (1♀, 1♂); Kozluk (Merkez) 38° 24' 46.7"N, 38° 45' 52.2" E, 738 m on *J. salicifolii* on *Populus* on 17.V.2007 (3♀♀, 3♂♂); Battalgazi (Sahil) 38° 28' 39.1"N, 38° 23' 22.5" E, 692 m on *C. horticola* on *Xanthium* spp., on 05.IX.2007 (3♂♂, 5♀♀); Darende (Balaban) 38° 28' 40.1"N, 37° 35' 42.1" E, 688 m on *J. salicifolii* on *Populus* on 21.V.2007 (2♀♀, 1♂); Battalgazi (Ziraat meslek lisesi) 38° 26' 42.1"N, 38° 21' 30.9" E, 744 m on *J. salicifolii* on *Populus* on 29.IV.2008 (3♀♀, 2♂♂); Malatya (Tatlıburnu) 38° 16' 42.5"N, 38° 14' 22.2" E, 1014 m on *J. salicifolii* on *Populus* on 05.V.2008. (5♂♂); Battalgazi (Tacan) 38° 27' 53.5"N, 38° 21' 14.8" E, 716 m on *J. salicifolii* on *Populus* on 30.IV.2008. (6♂♂, 4♀♀). Malatya (Alacakaya) 38° 27' 10.1"N, 38° 22' 11.9" E, 776 m on *J. salicifolii* on *Populus* on 05.V.2008 (6♀♀); Kale (Merkez) 38° 25' 36.5"N, 38° 46' 45.4" E, 720 m on *J. salicifolii* on *Populus* on 17.V.2008 (1♀, 2♂♂).

Hosts: It has been from *J. salicifolii*, although it may have a wider host range as most species of this genus attack a variety of leaf-mining Agromyzidae (Bouček & Askew, 1968; Noyes, 2003).

This species has previously been reared from *C. horticola* and *L. trifolii* (Gencer, 2005; Cıkman, 2006).

General distribution: *D. pachyneurus* is known from Europe (Britain, Sweden, Italy, Moldavia) (Bouček & Askew, 1968; Noyes, 2003).

Distribution in Turkey: Erzurum (Doganlar, 1985), Sivas (Gencer, 2005), Adiyaman (Cıkman, 2006).

Pnigalio Schrank, 1802

Pnigalio soemius (Walker, 1839)

Material examined: *P. soemius* was found in Kozluk (Merkez) 38° 24' 46.7"N, 38°45' 52.2" E, 738 m on *J. salicifolii* on *Populus* on 17.V.2007 (1♀, 3♂♂).

Hosts: Mainly Agromyzidae, although also some leafmining Lepidoptera and Coleoptera (Noyes, 2003).

This species has previously been reared from *A. albitarsis* (Cıkman et al., 2006).

General distribution: Widespread in Palearctic region (Noyes, 2003).

Distribution in Turkey: Izmir (Oncuer, 1991), Mardin (Cıkman et al., 2006).

Conclusion

Seven parasitoid species were obtained from infested leaves in the laboratory. The identified parasitoid species with their percentages and agromyzid species are given in Table 2.

In the study, the percentage of *P. diversa*, *X. (Xynobius) discoidalis*, *C. pictus*, and *P. soemius* was generally low.

Table 2. Parasitoid species, their host, and presence of parasitoids from host species

Parasitoids	Number of parasitoid species	Presence of parasitoids(%)	Agromyzidae species (Host)
Family: Braconidae			
<i>Phaerotoma diversa</i> (Szépligeti)	6	3.44	<i>Chromatomyia horticola</i> Goureau and <i>Phytomyza plantaginis</i> Robineau- Desvoidy
<i>Xynobius (Xynobius) discoidalis</i> (Fischer)	8	4.59	<i>Japanagromyza salicifolii</i> (Collin)
Family: Eulophidae			
<i>Cirrospilus pictus</i> (Nees)	7	4.02	<i>J. salicifolii</i>
<i>C. talitzkii</i> Bouček	14	8.04	<i>Liriomyza congesta</i> (Becker) and <i>L. trifolii</i> Burgess
<i>Diglyphus isaea</i> (Walker)	85	48.55	<i>C. horticola</i> , and <i>L. trifolii</i>
<i>D. pachyneurus</i> Graham	50	28.73	<i>C. horticola</i> , and <i>J. salicifolii</i>
<i>Pnigalio soemius</i> (Walker)	4	2.29	<i>J. salicifolii</i>

D. isaea, was found to be the most common species, accounting for 48.55% of presence of parasitoid rate, and this finding agrees with reports by Uygun et al. (1995), Cıkman & Uygun (2003), Cıkman et al. (2006), and Cıkman, 2006 in the East Mediterranean and the South East of Turkey.

D. isaea, is considered to be an important parasitoid of agromyzid flies. Presence of parasitoid rate higher than 10% among all parasitoids is reported to

be significant, and such parasitoids are to be considered as potential biological control agents (Murphy & La Salle, 1999). The relatively higher presence of parasitoid level may suggest that parasitoids could be an important mortality factor in the population dynamics of leafminer populations. However, in addition to high parasitoid levels, several important factors have to be taken into account in order to increase success rates in biological control programs. These factors include distribution, climate and host specificity. More detailed studies considering these factors are required in order to explore the potential use of agromyzid parasitoids for biological control program.

Among the species, *Xynobius (Xynobius) discoidalis* and *C. talitzkii* are new records for the Turkish fauna. Moreover, *P. diversa*, and *C. pictus* were recorded for the first time in species of Agromyzidae.

Özet

Malatya ilinde Galerisinekleri (Diptera: Agromyzidae)'nde saptanan parazitoitler

Bu çalışma Agromyzidae (Diptera) familyası türlerinin parazitoitlerinin saptanması amacıyla 2007-2008 yıllarında Malatya ilinde yürütülmüştür. Galerisineği larvalarıyla bulaşık yapraklar kültürü yapılan ve yapılmayan bitkilerden ayda 2 kez toplanmıştır. Ergin parazitoitler laboratuvarında bulaşık yapraklardan yetiştirilmek suretiyle elde edilmiştir. Braconidae (Hymenoptera) familyasına bağlı 2 tür bulunmuştur. Bu türler, *Phaerotoma diversa* (Szépligeti, 1898), *Xynobius (Xynobius) discoidalis* (Fischer, 1957). Eulophidae (Hymenoptera) familyasına bağlı 5 parazitoit saptanmıştır. Bunlar; *Cirrospilus pictus* (Nees, 1834), *C. talitzkii* Bouček, 1961, *Diglyphus isaea* (Walker, 1838), *Diglyphus pachyneurus* Graham, 1963, *Pnigalio soemius* (Walker, 1839) türleridir. Elde edilen parazitoit türlerden, *X. (Xynobius) discoidalis* ve *C. talitzkii* Türkiye faunası için yeni kayıtlardır. *P. diversa* ve *C. pictus* Türkiye'de Agromyzidae familyasında ilk defa saptanmıştır. Tespit edilen, türler arasında, *D. isaea* %48.55'lik bir yüzdeyle baskın parazitoit tür olarak bulunmuştur.

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