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Parasitoids of Leafminers (Diptera: Agromyzidae) from Southeast Turkey with 3 New Records*

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Abstract: This study was carried out in order to determine parasitoid species of the family Agromyzidae (Diptera) in Diyarbakır and Mardin provinces during 2002-2004. Infested leaves with leafminer larvae were collected from both cultivated and non-cultivated plants twice a month. The adult parasitoids were obtained by rearing from infested leaves in the laboratory. Five parasitoid species belonging to the Braconidae (Hymenoptera) were found. These species, *Bracon kirgisorum* Telenga, 1936, *Opius basalis* Fischer, 1958, *O. monilicornis* Fischer, 1962, *O. quasipulvis* Fischer, 1989, *O. exiguus* Wesmael, 1835. *B. kirgisorum*, *O. basalis* and *O. quasipulvis*, were new records for the Turkish fauna. In this study, *B. kirgisorum* and *O. quasipulvis* were recorded for the first time in species of Agromyzidae. Nine parasitoid species belonging to the Eulophidae (Hymenoptera) were found. These species were *Chrysocharis liriomyzae* Delucchi, 1954, *Cirrospilus vittatus* Walker, 1838, *Diglyphus crassinervis* Erdős, 1958, *D. isaea* (Walker, 1838), *D. minoens* (Walker, 1838), *Hemiptarsenus zilahisebessi* Erdős, 1951, *Neochrysocharis formosa* (Westwood, 1833), *Pediobius metallicus* (Nees, 1834), and *Pnigalio soemius* (Walker, 1839). Two parasitoid species belonging to the Pteromalidae (Hymenoptera) were found. These species were *Cyrtogaster vulgaris* Walker, 1833, and *Sphexgaster brevicornis* (Walker, 1833). In this study, among the species, *D. isaea* was the most predominant parasitoid species found (49.80%).

Key Words: Parasitoid, leafminer, new record, Turkey

3 Yeni Kayıtlı Güneydoğu Türkiye'den Galerisineklerinin (Diptera: Agromyzidae) Parazitoitleri

Özet: Bu çalışma Agromyzidae (Diptera) familyası türlerinin parazitoitlerinin saptanması amacıyla 2002-2004 yıllarında Diyarbakır ve Mardin illerinde gerçekleştirilmiştir. 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 5 tür bulunmuştur. Bu türler, *Bracon kirgisorum* Telenga, 1936, *Opius basalis* Fischer, 1958, *O. monilicornis* Fischer, 1962, *O. quasipulvis* Fischer, 1989, *O. exiguus* Wesmael, 1835 türleridir. Bunlardan, *B. kirgisorum*, *O. basalis* ve *O. quasipulvis* Türkiye faunası için yeni kayıtlardır. Bu çalışmada, *B. kirgisorum* ve *O. quasipulvis*, Agromyzidae türlerinde ilk defa saptanmıştır. Eulophidae (Hymenoptera) familyasına bağlı dokuz parazitoit saptanmıştır. Bunlar; *Chrysocharis liriomyzae* Delucchi, 1954, *Cirrospilus vittatus* Walker, 1838, *Diglyphus crassinervis* Erdős, 1958, *D. isaea* (Walker, 1838), *D. minoens* (Walker, 1838), *Hemiptarsenus zilahisebessi* Erdős, 1951, *Neochrysocharis formosa* (Westwood, 1833), *Pediobius metallicus* (Nees, 1834) ve *Pnigalio soemius* (Walker, 1839) türleridir. Pteromalidae familyasına bağlı iki tür bulunmuştur. Bunlar; *Cyrtogaster vulgaris* Walker, 1833 *Sphexgaster brevicornis* (Walker, 1833) türleridir. Bu çalışmada, türler arasında, *D. isaea* %49,80 lik bir yüzdeyle en baskın parazitoit tür olarak bulunmuştur.

Anahtar Sözcükler: Parazitoit, Galerisineği, Yeni Kayıt, Türkiye

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Introduction

The Southeastern Anatolia Project (GAP) is a large developmental project in Turkey. The GAP region has 3.1 million hectares of cultivated land and 1.7 million hectares of this will be irrigated under the irrigation scheme of the state and private irrigation. Upon the introduction of irrigation, the GAP region's agricultural constitution will undergo complete change.

Irrigating agricultural systems and polycultural cropping have been dominant since 1995 in some provinces in the GAP region (Karlı, 1999). This change in the agricultural constitution of the GAP region has caused some problems. Among these, the increase in agricultural pests may be one of the most important plant protection problems in the near future. Among these pests, leafminers (Diptera: Agromyzidae) feed on cultivated and non-cultivated plants. Both larvae and adults cause damage; larvae primarily mine the palisade mesophyll, which contains chloroplasts, thereby disrupting photosynthesis (Parella et al., 1985). Adults females puncture the upper and lower leaf epidermis with their ovipositor to feed and lay eggs (Spencer, 1990). This behavior results in cosmetic damage to crops and facilitates the spreading of various plant diseases (Civelek and Önder, 1997; Miranda et al., 1998). Damage caused by leafminers is therefore both direct and indirect.

A number of parasitoids of leafminers have been recorded throughout the world (Neder de Roman and Arch de Hamity, 1985; Schuster, 1993; Shepard et al., 1998; Heimpel and Meloche, 2001). Most of the parasitoid species belong to 3 families of Hymenoptera: Braconidae, Eulophidae and Pteromalidae. The species of the Braconidae are endo- and ectoparasitoids on the egg and larval hosts, whereas those of Eulophidae are solitary or gregarious ectoparasitoids on larval and pupal hosts. Growers in Turkey frequently apply large quantities of insecticide, especially in greenhouse environments. Insecticides have a negative impact on beneficial fauna (Weintraub and Horowitz, 1998). To control the leafmining flies by non-chemical means, it is necessary first identify the key parasitoids species. Thirty-nine parasitoid species of leafminers have been identified in Turkey before this study (Civelek and La Salle, 2005). The goal of this study was to contribute to the naturally occurring parasitoids of leafminers in Southeast Turkey. This study will also provide a basis for future research on the biological control of leafminer species.

Materials and Methods

This study was carried out during 2002 and 2004 in Diyarbakır and Mardin provinces, which were divided into 4 sub-areas for the convenience of specimen collection. The leafminer species were collected from both cultivated and non-cultivated plants in different areas twice in a month.

The sample of leaves infested with leafminers were randomly collected from the first week of spring until the end of autumn. Leafminer-infested leaves were taken to the laboratory at 25 ± 2 °C, $70 \pm 5\%$ RH, photoperiod 14:10 (L:D) h 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 Eulophidae that emerged were identified by Prof. Dr. Mikat Doğanlar (Mustafa Kemal University, Agricultural Faculty, Plant Protection Department, Hatay). Representative species were deposited in the laboratory of Harran University, Agricultural Faculty, Plant Protection Department, Şanlıurfa, Turkey.

Results

In this study 16 parasitoid species were identified. Among these species *Bracon kirgisorum*, *Opius basalis* and *O. quasipulvis* are new records for the Turkish fauna. Moreover, *B. kirgisorum* and *O. quasipulvis* were recorded for the first time in species of Agromyzidae.

B. kirgisorum, *D. isaea* and *D. minoeus* were the most common parasitoids. Thus, these species were considered the most important natural enemies of the Agromyzidae in Diyarbakır and Mardin provinces. The morphological, ecological and distribution information of these 16 species are provided below. The taxa are presented alphabetically.

Family 1. Braconidae

Genus 1. *Bracon* Fabricius, 1804

Bracon (Glabrobracon) kirgisorum Telenga, 1936

Material examined: *B. kirgisorum* was found in Savur-Mardin on *Phytomyza orobanchia* Kaltenbach, on

Orobanche spp. on 10.10.2002 (3♀♀, 3♂♂); Mazıdağı-Mardin on *Orobanche* spp. on 23.10.2002 (9♀♀, 6♂♂).

Hosts: Unknown.

General Distribution: Center and south of the European part of the former Soviet Union, Caucasus, Kirgizia (Tobias 1976, 1986a).

Distribution in Turkey: New record for the Turkish fauna.

Genus 2. *Opius* Wesmael, Wesmael, 1853

Opius basalis Fischer, 1958

Material examined: *O. basalis* was found in Viranşehir-Şanlıurfa on *Agromyza albitarsis* Meigen, (*Populus* spp.) on 06.05.2002 (1♀, 1♂); Savur-Mardin on *Liriomyza trifolii* (Burgess) (*Papaver* spp.) on 17.05.2002 (2♀♀, 1♂).

Hosts: Unknown.

General Distribution: Former Czech Republic, Hungary (Fischer, 1972).

Distribution in Turkey: New record for the Turkish fauna.

Opius exiguus Wesmael, 1835

Material examined: *O. exiguus* was found in Derik-Mardin on *P. orobanchia* on *Orobanche* spp. on 06.06.2002 (1♀, 2♂♂); Mazıdağı-Mardin on *Chromatomyia horticola* Goureau on *Raphanus sativus* L. (1♂); Şükürlü-Çınar on *C. horticola* on *Sinapis arvensis* L. on 06.05.2003 (1♀, 1♂).

Hosts: *C. horticola*, *L. trifolii* (Çıkman and Uygun, 2003).

This species has previously been recorded from *C. horticola* and *L. trifolii* from Turkey (Çıkman and Uygun, 2003).

General Distribution: Distribution: Caucasus, North, West and Central Europe, Greece, Israel, Italy, Kazakhstan, Mongolia, North Korea, Russia, Turkey, Egypt, Ethiopia, northern Africa (Tobias, 1986; Fischer, 1990).

Distribution in Turkey: Şanlıurfa (Çıkman and Uygun, 2003).

Opius monilicornis, Fischer, 1962

Material examined: *O. monilicornis* was found in Savur-Mardin on *Liriomyza cicerina* (Rondani) on *Cicer arietinum* L. on 17.05.2002 (7♀♀, 4♂♂).

Hosts: *L. cicerina* (Hincal et al., 1996; Öde and Heinz, 2002).

This parasitoid species has previously been reported from *L. cicerina* in Turkey (Hincal et al., 1996).

General Distribution: Jordan, Moldova, northern Africa, Turkey (Bosphorus) (Fischer, 1972; Tobias, 1986b).

Distribution in Turkey: Aegean Region (Hincal et al., 1996).

Opius quasipulvis Fischer, 1989

Material examined: *O. quasipulvis* was found in Ergani-Diyarbakır on *C. horticola* on *Turgenia latifolia* (L.) on 11.04.2002 (2♀♀, 4♂♂); Ergani-Diyarbakır on *C. horticola* on *S. arvensis* on 05.05.2003 (2♂♂).

Hosts: Unknown.

General Distribution: Hungary (Fischer, 1990).

Distribution in Turkey: New record for the Turkish fauna.

Family 2. Eulophidae

Genus 1. *Chrysocharis* Foerster, 1856

Chrysocharis liriomyzae Delucchi, 1954

Material examined: *C. liriomyzae* was found in Kabala-Mardin on *C. horticola* on *Sonchus* sp. on 19.04.2002 (2♀♀, 3♂♂); Çınar-Diyarbakır on *C. horticola* on *Xanthium* sp. on 24.10.2002 (2♀♀, 1♂); Bismil-Diyarbakır on *C. horticola* on *Papaver* spp. on 06.05.2003 (1♀, 1♂).

Hosts: *Agromyza frontella* (Heimpel and Meloche, 2001); *C. horticola*, *L. trifolii* (Çıkman and Uygun, 2003).

This parasitoid species has previously been recorded from *C. horticola* in Turkey (Çıkman and Uygun, 2003).

General Distribution: Cosmopolitan species. Europe, Asia, North Africa, Canada, USA (Hansson, 1985).

Distribution in Turkey: Şanlıurfa (Çıkman and Uygun, 2003).

Genus 2. *Cirrospilus* Westwood, 1832

***Cirrospilus vittatus* Walker, 1838**

Material examined: *C. vittatus* was found in Nusaybin-Mardin on *A. albitarsis* on *Populus* sp. L. on 22.04.2002 (1♀, 2♂).

Hosts: *Liriomyza* spp. (Cabello et al., 1994), *C. horticola* (Çikman and Uygun, 2003).

This parasitoid species has previously been recorded from *C. horticola* in Turkey (Çikman and Uygun, 2003).

General Distribution: Cosmopolitan species. Europe, Asia, North Africa, Canada, USA (Hansson, 1985).

Distribution in Turkey: Şanlıurfa (Çikman and Uygun, 2003).

Genus 3. *Diglyphus* Walker, 1848

***Diglyphus crassinervis* Erdős, 1958**

Material examined: *D. crassinervis* was found in Derik-Mardin on *L. trifolii* on *Lycopersicum esculentum* Mill. on 11.10.2002 (3♀♀, 1♂); Dicle-Diyarbakır on *L. trifolii* on *Phaseolus vulgaris* L. on 22.09.2003 (2♀♀, 3♂).

Hosts: *L. huidobrensis*, *L. trifolii* (Civelek et al., 2002).

This parasitoid species has previously been recorded from *L. huidobrensis* and *L. trifolii* in Turkey (Civelek et al., 2002).

General Distribution: Hungary (Erdős, 1958).

Distribution in Turkey: Muğla (Civelek et al., 2002).

***Diglyphus isaea* (Walker, 1838)**

Material examined: *D. isaea* was found in Nusaybin-Mardin on *A. albitarsis* on *Populus* sp. on 06.05.2002 (15♀♀, 12♂); Kabala-Mardin on *C. horticola* on *Sonchus* sp. on 19.04.2002 (10♀♀, 7♂); Çınar-Diyarbakır on *C. horticola* on *Xanthium* sp. on 24.10.2002 (8♀♀, 11♂); Bismil-Diyarbakır on *C. horticola* on *Papaver* spp. on 06.05.2003 (12♀♀, 11♂); Savur-Mardin on *Papaver* sp. on 17.05.2002 (3♀♀, 5♂); Derik-Mardin on *L. trifolii* on *Solanum melongena* L. on 22.09.2003 (4♀♀, 5♂); Dicle-Diyarbakır on *L. trifolii* on *P. vulgaris* on 22.09.2003 (13♀♀, 11♂).

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

General Distribution: Widespread in Palearctic regions, and also Afrotropical, Australian, Pacific, Nearctic, and Oriental regions (Boucek, 1965).

Distribution in Turkey: This species has previously been reported to be parasitoid on some species of Agromyzidae in Turkey (Doğanlar, 1985a; Uygun et al., 1995; Civelek and Önder, 1999; Çikman and Uygun, 2003; Gençer, 2004).

***Diglyphus minoëus* (Walker, 1838)**

Material examined: *D. minoëus* was found in Bismil-Diyarbakır on *C. horticola* on *Papaver* spp. on 06.05.2003 (9♀♀, 6♂).

Hosts: *L. huidobrensis* (Ganiev et al., 1993). *L. congesta* (Çikman and Uygun, 2003).

This species has previously been reared from *Liriomyza congesta* (Becker, 1903) (Çikman and Uygun, 2003).

General Distribution: Widespread in Palearctic region, and also Afrotropical, Australian, Pacific, Nearctic, and Oriental regions (Hansson, 1991).

Distribution in Turkey: Şanlıurfa (Çikman and Uygun, 2003).

Genus 4. *Hemiptarsenus* Westwood, 1833

***Hemiptarsenus zilahisebessi* Erdős, 1951**

Material examined: *H. zilahisebessi* was found in Dicle-Diyarbakır on 11.10.2002 on *L. trifolii* on *P. vulgaris* on 22.09.2003 (3♀♀, 4♂).

Hosts: *Liriomyza* spp. (Cabello et al., 1994; Yaşarakıncı and Hıncal, 1997).

This species has previously been reared from *L. trifolii* and *L. bryonia* (Kaltenbach) (Yaşarakıncı and Hıncal, 1997).

General Distribution: Widespread and common in Palearctic region (Yefremova, 2002).

Distribution in Turkey: İzmir (Yaşarakıncı and Hıncal, 1997).

Genus 5. *Neochrysocharis* Kurdjumov, 1912

Neochrysocharis formosa (Westwood, 1833)

Material examined: *N. formosa* was found in Yeşilli-Mardin on *C. horticola* on *Sonchus* sp. on 16.05.2002 (2♀, 1♂); Dicle-Diyarbakır on *L. trifolii* (*P. vulgaris*) on 22.09.2003 (4♀, 4♂).

Hosts: Several species of Lepidoptera, Diptera, Hymenoptera and Coleoptera. This species mostly prefers Agromyzidae species as hosts. In particular, it is thought of as an important control agent for populations of *L. trifolii* and *L. sativa* (Lema and Poe, 1978; Hansson, 1990; Murphy and La Salle, 1999; Sivapragasam et al., 1999).

This species has previously been recorded from *C. horticola*, *L. huidobrensis*, *L. trifolii*, and *Phytomyza chelonei* (Uygun et al., 1995; Civelek et al., 2002; Çıkman and Uygun, 2003).

General Distribution: Widespread and common in West Palearctic, also in Nearctic region, Africa and Europe (Gençer, 2004).

Distribution in Turkey: Adana, İzmir, Şanlıurfa (Uygun et al., 1995; Civelek et al., 2002; Çıkman and Uygun, 2003).

Genus 6. *Pediobius* Walker, 1846

Pediobius metallicus (Nees, 1834)

Material examined: *P. metallicus* was found in Yeşilli-Mardin on *C. horticola* on *Sonchus* sp. on 16.05.2002 (1♀, 3♂); Derik-Mardin on *L. strigata* on *Cucurbita* sp. on 11.10.2002 (2♀, 1♂).

Hosts: Primary sometimes secondary, solitary endoparasites of larvae and pupae of mining forms of Lepidoptera and Diptera. Particularly agromyzid genus *Phytomyza*, *Liriomyza* and *Dizgomyza* (Boucek, 1965; Boucek and Askew, 1968).

This species has previously been reported from *C. horticola*, *L. strigata*, *L. cicerina*, and *L. trifolii* (Doğanlar, 1985a; Uygun et al., 1995; Civelek and Önder, 1999; Civelek, 2002; Çıkman and Uygun, 2003).

General Distribution: Europe, Asia, North America (Civelek and Önder, 1999).

Distribution in Turkey: Adana, Ankara, İzmir and Şanlıurfa. (Doğanlar, 1985a; Uygun et al., 1995; Civelek

and Önder, 1999; Çıkman and Uygun, 2003; Gençer, 2004).

Genus 7. *Pnigalio* Schrank, 1802

Pnigalio soemius (Walker, 1839)

Material examined: *P. soemius* was found in Beyazsu-Nusaybin-Mardin on *A. albitarsis* on *Populus* sp. on 06.05.2002 (2♀, 3♂).

Hosts: Agromyzidae (Öncüer, 1991).

This species has previously been reported from the family Agromyzidae (Öncüer, 1991).

General Distribution: Widespread in Palearctic region (Trjapitzin, 1978).

Distribution in Turkey: İzmir (Öncüer, 1991).

Family 3: Pteromalidae

Genus 1. *Cyrtogaster* Walker, 1833

Cyrtogaster vulgaris Walker, 1833

Material examined: *C. vulgaris* was found in Derik-Mardin on *L. trifolii* on *L. esculentum* on 11.10.2002 (1♀, 1♂).

Hosts: *Liriomyza* spp. (Nedstam, 1986).

General Distribution: Cosmopolitan species. Holarctic, Palearctic, Nearctic regions (Dzhanokmen, 1978).

Distribution in Turkey: Erzincan (Doğanlar, 1985b).

Genus 2. *Sphegigaster* Spinola, 1811

Sphegigaster brevicornis (Walker, 1833)

Material examined: *S. brevicornis* was found in Derik-Mardin on *L. trifolii* on *S. melongena* on 22.09.2003 (3♀, 1♂).

Hosts: Unknown.

General Distribution: England, Ireland, Italy, Spain (Garrido and Nieves, 1999; Burgio et al., 2000).

Distribution in Turkey: Erzincan (Doğanlar, 1985b).

Conclusion

In this study the proportions of *B. kirgissorum*, *O. basalis*, *O. exiguus*, *O. monilicornis*, *O. ouaspulvis*, *C.*

vittatus, *C. liriomyzae*, *D. crassinervis*, *H. zilahisebessi*, *N. formosa*, *P. metallicus*, *P. soemius*, *C. vulgaris*, and *S. brevicornis* were low. However, several species of *Chrysocharis* and *Hemiptarsenus* have been reported as important agromyzid parasitoids and the rates of these parasitoids belonging to *Chrysocharis* and *Hemiptarsenus* have been reported to be up to 60% in some regions (Uygun et al., 1995; Civelek and Önder, 1999; Murphy and La Salle, 1999; Sivapragsam et al., 1999).

D. isaea has been recorded as the most common species (49.80%) and this finding is in accord with the report by Uygun et al. (1995) and Çıkman and Uygun (2003) in the East Mediterranean and the Southeast of Turkey.

D. isaea is considered an important parasitoid of agromyzid flies. A rate of emergence higher than 10% among all parasitoids is reported to be significant and it is considered a potential biological control agent (Murphy and La Salle, 1999). The relatively high parasitism level may suggest that parasitoids could be an important

mortality factor in the population dynamics of leafminers 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 programs.

Among the species, *B. kirgisorum*, *O. basalis* and *O. quasipulvis* were new records for the Turkish fauna and *B. kirgisorum* and *O. quasipulvis* were recorded for the first time in species of Agromyzidae.

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