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CONTRIBUTION TO THE KNOWLEDGE OF THE CHALCID PARASITOID COMPLEX (*HYMENOPTERA: CHALCIDOIDEA*) OF AGROMYZID LEAFMINERS (*DIPTERA: AGROMYZIDAE*) FROM TURKEY, WITH NEW HOSTS AND RECORDS

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Abstract: A total of nineteen parasitoid species were recorded from agromyzid leafminers in some sites of Middle Anatolia. These species were: *Diglyphus iseae* (Walker), *D. pachyneurus* Graham, *D. crassinervis* Erdös, *D. pusztenzis* (Erdös&Novicky), *D. begini* (Ashmead), *Baryscapus* sp., *Hemiptarsenus zilahisebessi* Erdös, *Pnigalio soemius* (Walker), *Neochrysocharis formosa* (Westwood), *N. clara* Szelenyi, *N. arvensis* Graham, *N. chlorogaster* (Erdös), *Chrysocharis pentheus* (Walker), *C. phyrne* (Walker), *C. pubicornis* (Zetterstedt), *C. viridis* (Nees), *Pediobius metallicus* (Walker) (Eulophidae), *Epiclerus panyas* (Walker) (Tetracampidae), and *Merismus* sp. (Pteromalidae). Among the parasitoids reared, *Diglyphus begini* and *Chrysocharis viridis* have been for the first time found in Turkey, *D. crassinervis, H. zilahisebessi, N. clara* and *E. panyas* were recorded from *Chromatomyia horticola* and *P. soemius* was recorded from *Liriomyza strigata* were recorded for the first time.

Key words: *Chalcidoidea*, leafminers, parasitoids, Turkey

INTRODUCTION

Leafminers are among the most serious polyphytophagus insect pests of vegetable and ornamental plants in the world (Spencer 1973). The adults are commonly found on vegetation, whereas the most larvae are leafminers. Considerable damage is caused by larvae. The larvae feed within the leaves of the host plant and this feeding can severely reduce yields and/or kill the plants at high fly density (Spencer and Steyskal 1986). Many factors induce leafminer outbreaks, but the loss of natural enemies due to widespread use of insecticides is one of the most important. Agromyzid leafminers are known to have rich natural enemy communities. Parasitoids are the major group of natural enemies of leafminer and they have played a very important role in leafminer suppression in natural ecosystems or cultivated areas with reduced insecticide use (Johnson *et al*. 1980). Leafminers parasitoids have been intensively and extensively investigated and evaluated in many countries with more than 100 species reported, and several, such as *Diglyphus begini* and *Dacnusa sibirica*, were succesfully used as biological control agents in commercial greenhouses planted with vegetables and ornamental plants, especially tomato and chrysanthemum in Europe and North America (Chen *et al*. 2003). Leafminers have also become a serious problem in vegetable production in Turkey in recent years (Uygun *et al*. 1995). Few surveys for leafminers' parasitoids have been conducted in Turkey (Civelek and Önder 1999; Civelek *et al*. 2002; Civelek and La Salle 2005; Çıkman and Uygun 2003; Çıkman *et al*. 2006; Uygun *et al*.1995; Gençer 2004, 2005). However, no systematic or comprehensive field investigation has been carried out in sites around Sivas to assess the occurrence of leafminers and their parasitoids in cultivated vegetable and uncultivated plants. Thus, the objective of this study was to identify species of agromyzid parasitoids and their host plants in the Middle Anatolia.

MATERIALS AND METHODS

Leafminer-infested leaves from Sivas, Kayseri, Tokat, Malatya and Giresun were collected from March 2004 to October 2005. Leafminer-infested leaves were taken to the laboratory for the emergence of pests and parasitoids. The laboratory temperature was approximately 25–30°C and the relative humidity was between 60 and 70%. Samples (leafminer-infested) were cleared of other insects and residues and categorized according to plant species. All leaves were carefully examined under microscope to count the number of mines where leafminer larvae were present. Samples were placed in a small glass vials and then closed with a cotton ball covered with muslin. They were daily checked for the emergence of leafminers and parasitoids and relevant notes were made. After the completion of emergence, all reared pest and parasitoid specimens were identified.

All the parasitoids were identified by the author using the relevant literature (Hansson 1985, 1990; Graham 1959,

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Table1. Parasitoid species, agromyzid species and host plants

Parasitoid species	Agromyzidae species	Host plants
Baryscapus sp.	*Chromatomyia horticola* (Goureau, 1851)	Cerinthe minor
Chrysocharis pentheus (Walker 1839)	*Chromatomyia horticola* (Goureau, 1851) *Phytomyza lappae* (Goureau, 1851)	*Cirsium* sp. *Papaver somniferum* *Brassica* sp. *Cardaria draba* *Reichardia* sp. *Brassica oleracea* *Pisum sativum* *Arctium* sp.
Chrysocharis pubicornis (Zetterstedt 1838)	*Chromatomyia horticola* (Goureau, 1851)	*Helianthus annuus* *Cardaria draba* *Pisum sativum* *Phaseolus vulgaris* *Lactuca sativa*
Chrysocharis phyrne (Walker 1839)	*Chromatomyia horticola* (Goureau, 1851)	not identified
Chrysocharis viridis (Nees 1834)	*Chromatomyia horticola* (Goureau, 1851)	*Cirsium* sp.
Diglyphus begini (Ashmead 1904)	not identified	*Populus* sp.
Diglyphus crassinervis Erdös 1958	*Chromatomyia horticola* (Goureau, 1851)	*Papaver somniferum* *Reichardia* sp. *Brassica* sp.
Diglyphus iseae (Walker 1838)	*Chromatomyia horticola* (Goureau, 1851) *Liriomyza trifolii* (Burgess, 1880)	*Cardaria draba* *Pisum sativum* *Phaseolus vulgaris* *Pisum sativum* *Antirrhinum majus* *Cucumis sativus* *Cardaria draba* *Eruca sativa* *Cirsium lappaceum* *Brassica* sp. *Melilotus officinalis* *Helianthus annuus* *Cardaria draba*
Diglyphus pachyneurus Graham 1963	*Chromatomyia horticola* (Goureau, 1851)	*Cardaria draba*
Diglyphus pusztensis (Erdös&Novicky 1951)	*Chromatomyia horticola* (Goureau, 1851)	*Cardaria draba*
Epiclerus panyas (Walker 1839)	*Chromatomyia horticola* (Goureau, 1851)	*Cucumis sativus*
Hemiptarsenus zilahisebessi Erdös 1951	*Chromatomyia horticola* (Goureau, 1851)	*Beta vulgaris* *Pisum sativum*
Merismus sp.	*Liriomyza* sp.	*Cucumis sativus*
Neochrysocharis arvensis Graham 1963	*Chromatomyia horticola* (Goureau, 1851)	*Helianthus annuus*
Neochrysocharis chlorogaster (Erdös 1966)	*Chromatoyia horticola* (Goureau, 1851)	*Brassica oleracea*
Neochrysocharis clara Szelenyi 1977	*Chromatoyia horticola* (Goureau, 1851)	*Helianthus annuus* *Cucumis sativus* *Lactuca sativus* *Brassica oleracea* *Cardaria draba* *Lapsane communis*
Neochrysocharis formosa (Westwood 1833)	*Chromatomyia horticola* (Goureau, 1851) *Liriomyza* sp.	*Pisum sativum* *Brassica oleracea* *Reichardia* sp. *Melilotus officinalis*
Pediobius metallicus (Walker 1839)	*Chromatomyia horticola* (Goureau, 1851)	*Helianthus annuus* *Cirsium* sp. *Pisum sativum* *Brassica oleracea,* *Brassica* sp. *Cardaria draba* *Cucumis sativus* *Cerinthe minor* *Reichardia* sp. *Pisum sativum* *Heracleum* sp. *Papaver somniferum* *Antirrhinum majus* *Raphanus sativus*
Pnigalio soemius (Walker 1839)	*Liriomyza strigata* (Meigen, 1830)	*Cerinthe minor*
not found	*Liriomyza cicerina* (Rondani, 1875)	*Cicer arietinum*

1991; Boucek 1959, 1965; Gordh and Hendrickson 1979; Efremova *et al*. 1996; La Salle and Parrella 1991; Noyes 2002, 2003; Zhu *et al.* 2000; Zhu and Huang 2003). The emerged leafminers were identified by Dr. H.S. Civelek (Muğla University, Department of Biology) and the plants were identified by Dr. E. Dönmez (Cumhuriyet University, Department of Biology). The specimens were kept in the collection of Department of Biology, Cumhuriyet University, Sivas, Turkey.

RESULTS

Host species composition

Six leafminers species; *L. cicerina*, *L. strigata*, *L. trifolii*, *Liriomyza* sp., *Phytomyza lappae* and *Chromatomyia horticola* were reared from the collected leaves. The most common agromyzid species was *Chromatomyia horticola* reared from nearly every plant. The reared leafminer species and their host plants are given in table 1. *Chromatomyia horticola* and *L. cicerina* were present mostly from May to August, the other species from June to July. Although both *C. horticola* and *L. cicerina* appeared on host plants initially in May, in general *C. horticola* occurred earlier than *L. cicerina*.

Parasitoid species complex

A total of 611 parasitoid adults were reared from collected leafminer and 19 parasitoid species of three families were identified. (Table 1). Distribution of quantitative data of identifications of 611 reared parasitoid were as follows; *Diglyphus iseae* 367, *D. pachyneurus* 14, *D. crassinervis* 9, *D. pusztenzis* 1, *D. begini* 1, *Baryscapus* sp. 1, *Hemiptarsenus zilahisebessi* 2, *Pnigalio soemius* 1, *Neochrysocharis formosa* 8, *N. clara* 27, *N. arvensis* 5, *N. chlorogaster* 2, *Chrysocharis pentheus* 38, *C. phyrne* 2, *C. pubicornis* 39, *C. viridis* 1, *Pediobius metallicus* 89, *Epiclerus panyas* 3, and *Merismus* sp. 1. Among them *Diglyphus iseae*, *Pediobius metallicus*, *Chrysocharis pubicornis* and *C. pentheus* were recorded as the most common parasitoids. In addition, *Diglyphus begini* and *Chrysocharis viridis* have been newly recorded in Turkey. *Diglyphus crassinervis, Hemiptarsenus zilahisebessi*, *Neochrysocharis clara, Epiclerus panyas* from *C. horticola* and *Pnigalio soemius* from *L. strigata* were recorded for the first time.

Host-parasitoid relationship

Parasitoid complex of the 6 host species were remarkably similar. A total of sixteen parasitoid species were reared from the leaves infested by *C. horticola.* Among them *D. iseae* was the most abundant species accounting for 26.19–68.86% of all reared parasitoid adults.

DISCUSSION

In recent years, the population size of pest species has increased dramatically and have been recognized as a very important pest group in Turkey (Uygun *et al*. 1995). The occurrence and relative abundance of leafminers associated with seasons and host plants may reflect the impact of climate and their distinct preferences for host plants (Parella 1987). Just the same, parasitoid species composition and proportionate contribution to overall parasitoid abundance vary in different areas and seasons (Darvas *et al*. 1999; Chen *et al.* 2003). This study showed that under natural conditions the leafminers in Middle Anatolia were attacked by a diverse parasitoid complex. However, most of species found were not specific to these leafminers. In addition, parasitoids *D. crassinervis, H. zilahisebessi, N. clara, E. panyas* from *C. horticola* and *P. soemius* from *L. strigata* were recorded for the first time.

Diglyphus iseae, P. metallicus, C. pubicornis and *C. pentheus* are considered to be important parasitoids of agromyzid flies. A rate of emergence higher than 10% among all parasitoids is reported to be significant and they are considered to be potential biological control agents (Murphy and LaSalle 1999). These parasitoids deserve further study with respect to their biology and ecology. A relative parasitism level in the field as indicated in this study may suggest that parasitoids could be an important mortality factor in the population dynamics of leafminer population. However, in addition to high parasitoids' levels, several important factors have to be take into account in order to increase success rates in biological control programs. These factors include distribution, climate and host specifity. These results suggest that the biodiversity of both parasitoids and host plants of leafminer contribute to balance of leafminer population on crops.

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POLISH SUMMARY

PRZYCZYNEK DO WIEDZY O KOMPLEKSIE PARAZYTOIDÓW (*HYMENOPTERA: CHALCIDOIDEA*) MINIAREK (*DIPTERA: AGROMYZIDAE*) W TURCJI, NOWE ROŚLINY ŻYWICIELSKIE ORAZ NOWE DONIESIENIA

W niektórych rejonach Anatolii wykryto 19 gatunków miniarek liściowych zaliczanych do *Agromyzidae*. Były to: *Diglyphus iseae* (Walker), *D. pachyneurus* Graham, *D. crassinervis* Erdös, *D. pusztenzis* (Erdös&Novicky), *D. begini* (Ashmead), *Baryscapus* sp., *Hemiptarsenus zilahisebessi* Erdös, *Pnigalio soemius* (Walker), *Neochrysocharis formosa* (Westwood), *N. clara* Szelenyi, *N. arvensis* Graham, *N. chlorogaster* (Erdös), *Chrysocharis pentheus* (Walker), *C. phyrne* (Walker), *C. pubicornis* (Zetterstedt), *C. viridis* (Nees), *Pediobius metallicus* (Walker) (Eulophidae), *Epiclerus panyas* (Walker) (Tetracampidae), and *Merismus* sp. (Pteromalidae). Wśród wyhodowanych parazytoidów *Diglyphus begini* i *Chrysocharis viridis* były znalezione w Turcji po raz pierwszy. Z kolei *D. crassinervis, H. zilahisebessi, N. clara* i *E. panyas* stwierdzone na *Chromatoyia horticco* i *P. soemius* na *Liriomyza strigata* wykryto po raz pierwszy.