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Chalcidoid Parasitoids of Chromatomyia horticola (Gouraiu) (Diptera: Agromyzidae) on Field Sunflower in Turkey

Abstract
Chromatomyia horticola (Goureau, 1851) (Diptera: Agromyzidae) is a polyphagous species and very common worldwide. In this study, parasitoids of *Chromatomyia horticola* were investigated on sunflower (*Hellianthus annuus*) during 2017-2018 in the Kayseri province. Infested leaves were sampled weekly and kept in the laboratory to observe and count emerging leafminers and parasitoids. Ten species were identified from Chalcidoidea superfamily. Among these parasitoids: 1 species belonging to Eupelmidae family, 6 species belonging to Eulophidae family, 1 species belonging to Mymaridae family and 2 species belonging to Pteromalidae family were identified. These species; *Eupelmus urozonus* (Dalman, 1820), *Neochrysocharis chlorogaster* (Erdös, 1966), *Neochrysocharis clara* (Szelenyi, 1977), *Neochrysocharis formosa* (Westwood, 1833), *Pediobius metallicus* (Nees, 1834), *Diglyphus iseae* (Walkerotal, 1838), *Pronotalia* sp. (Gradwell, 1957), *Cyrtogaster vulgaris* (Walker, 1833), *Sphegigaster brevicornis* (Walker, 1833), Mymaridae sp.(Haliday,1833) . Among these species, *Diglyphus iseae*, *Pediobius metallicus* and *Neochrysocharis formosa* were identified as having the highest densities. When evaluated in both years, *Diglyphus iseae* was identified as the important parasitoid of agromyzides in Kayseri. In addition, *Eupelmus urozonus* and *Pronotalia* sp. have been identified as a new parasitoid species for *Chromatomyia horticola.*

INTRODUCTION

Chromatomyia horticola (Goureau, 1851) is more common in the Mediterranean area than in northern Europe and occurs widely throughout Asia including Japan. In Turkey, it was first found in 1958 on chrysanthemum (Spencer, 1973). It subsequently spread within Turkey. It causes economic damage to ornamentals and various vegetables in greenhouses from time to time. It is bivoltine and lays approximately 50 eggs in a single day; its generation time is 6 weeks under natural conditions (Spencer, 1973; Civelek, 2002). This species has economic importance for some cultivated plants and is also a commom species on wild plants in Turkey. Numerous parasitoids of *C. horticola* have been recorded Turkey and worldwide (Spencer, 1973; del Bene 1989; Uygun et al., 1995; Rauf et al., 2000; Chen et al., 2001, 2003; Civelek 2002; Çıkman and Uygun, 2003; Gençer, 2005; Çıkman, 2006; Çıkman and Doğanlar, 2006; Mahendran and Agnihotri, 2013; Yefremova et al., 2015 ; Bayhan et al., 2016; Kumar and Sharma, 2016). Thus, the objective of this study is to determine parasitoids of *C. horticola* occuring in Turkey.

MATERIAL and METHODS

The study was carried out during 2017-2018 in Kayseri province located between 34^0 56′ and 36^0 59′ E and 37^0 45′ and 38^0 18 N′. Leafminer-infested leaves of sunflower were brougth to the laboratory and were kept in plastic culture containers at approximately 25 ^{0}C and 70% relative humidity in the laboratory. All parasitoids were preserved in 70% ethanol, and flies were preserved as dry material. Parasitoids were sorted and identified, and the number of specimens for each species was counted. Specimens belonging to Chalcidoidea superfamily were identified especially using diagnostic keys from the Palearctic region (Boucek, 1965; Gordh and Hendrickson, 1979; Hansson, 1985; La Salle et al., 1991).

RESULTS and DISCUSSION

A total of ten species of parasitoids were reared from *C. horticola*. These parasitoid species, their relative abundance are given in Table 1. Of these, Among these species, *Diglyphus iseae*, *Pediobius metallicus* and *Neochrysocharis formosa* were recorded as the most common parasitoids. When evaluated in both year, *Diglyphus iseae* to be important parasitoid of *Chromatomyia horticola* for the province of Kayseri. In addition, *Eupelmus urozonus* and *Pronotalia* sp. were recorded new parasitoid species for *Chromatomyia horticola*. For 2017, the rate of general parazitization and the ratio of parasitoids with the highest density among all parasitoids has been determined. The parazitisation [(Emerged Parasitoid number /Emerged Parasitoid number + Fly number) X 100)], this ratio was found to be 85.55 for 2017. In addition, the ratio of the species identified as the dominant parasitoid species among all was determined as 36.36 and the most dominat parasitoid species was *D. iseae* for 2017. For 2018, the rate of general parazitization and the ratio of parasitoids with the highest density among all parasitoids has been determined. The parazitisation [(Emerged Parasitoid/Emerged Parasitoid+ Fly) X 100)], this ratio was found to be 88.31 for 2018. In addition, the ratio of the species identified as the dominant parasitoid species among all was determined as 27.9 and the most dominat parasitoid species was *Pediobius metallicus* for 2018. Among these species, *Diglyphus iseae*, *Pediobius metallicus* and *Neochrysocharis formosa* were recorded as the most common parasitoids. When evaluated in both year, of these species, *Diglyphus iseae* is found to be most common parasitoid (30,83%) and is followed by *Pediobius metallicus* (21,66%) and *Neochrysocharis formosa* (15%). The other parasitoids were less abundant. In addition , *Eupelmus urozonus* , *Pronotalia* sp. and *Mymaridae sp.* were recorded fort he first time from *Chromatomyia horticola*.

Table 1. Parasitoid species of *Chromatomyia horticola* and their relative abundance.

Parasitoids	Number of specimen (for 2017)	Number of specimen (for 2018)	Relative abundance for 2017 (%)	Relative abundance for 2018 (%)
Diglyphus iseae (Walker 1838)	28	9	36.36	20.93
Neochrysocharis clara (Szelenyi 1977)	8	3	10.38	6.97
Neochrysocharis chlorogaster (Erdos 1966)	4	7	5.19	16.27
Neochrysocharis formosa (Westwood 1833)	15	3	19.48	6.97
Pediobius metallicus (Walker 1839)	14	12	18.18	27.9
Pronotalia sp. (Gradwell 1957)	2	-	2.59	
Sphegigaster brevicornis (Walker 1833)	3	5	3.89	11.6
Cyrtogaster vulgaris (Walker. 1833)	2	3	2.59	6.97
Eupelmus urozonus (Dalman 1820)	1	-	1.29	
Mymaridae sp. (Haliday 1833)	-	1		2.32

Hymenopterous parasitoid species have various life styles (Gauld and Bolton, 1988). In this study, *D. iseae* were recorded to be larval ectoparasitoids and also displayed superparasitism. *Pediobius metallicus* and *N. formosa* were observed to be an ectoparasitoid. Life styles of the other parasitoid species were not determined. Many previous studies have identified parasitoids of *C. horticola* (Al Azawi, 1967, 1971; Spencer, 1973; del Bene 1989; Uygun et al., 1995; Rauf et al., 2000; Chen et al., 2001, 2003; Civelek 2002; Gençe, 2005; Mahendran and Agnihotri, 2013; Yefremova et al., 2015; Bayhan et al., 2016; Kumar and Sharma, 2016, 2017), but the complexes of parasitoids were different from found in this study. One of the differences observed was the presence of new parasitoids species recorded from *C. horticola*, the other was the absence of species belonging to Braconidae, which are important parasitoids of *C. horticola* in some region. Members of the family Braconidae are more commonly recorded parasitoids of *C. horticola* than the other families (Megaspilidae, Pteromalidae). Previous studies on parasitoids of *C. horticola* revealed that these parasitoid species mostly belong to Braconidae. The species are mostly members of the *Opius, Pseudopozomachus, Aphidius, Dacnus* and *Symphya* genera (Spencer 1973; del Bene 1989; Uygun et al., 1995; Chen et al., 2001, 2003; Bayhan et al., 2016; Kumar and Sharma, 2016). Some species of these genera are found to be important in terms of parasitoid density. However, in some studies, no parasitoid braconids were recorded from *C. horticola* (Rauf et al., 2000, Yefremova et al., 2015). A generalist leafminer parasitoid always searches for different hosts at the same time. Parasitoid species composition and proportionate contribution to overall parasitoid abundance vary in different areas and seasons (Chen et al,. 2003). As was pointed out above, no braconid species were obtained in the present study. However, lack of braconids from *C. horticola* does not mean that braconids were absent in the region. There may be several for lack of braconid species. There was moulding and drying of specimens during the rearing process.

There are records of braconids on *C. horticola* in other regions of Turkey (Uygun et al., 1995; Civelek and Önder,1999). New species recorded from *C. horticola* have been reported on various hosts belonging to other agromyzid species. These hosts are summarized below. *Eupelmus urozonus* has been reported to be a parasitoid on *Melanagromyza phaseoli* and *Hexomyza schineri* (Gibson and Fusu 2016, Noyes 2021). Some species belonging to the genus *Pronotalia* have been reported to be parasitoid on *Melanagromyza heracleana* and *Phytomyza orabanchiae* (Doğanlar, 1985; Çıkman and Doğanlar, 2006; Koçak and Özdemir, 2012). This study shows that deatiled investigation is needed on parasitois of *C. horticola.*

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