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Parasitoid and predator species of Coccidae (Hemiptera: Coccoidea) species in fruit orchards of Diyarbakır and Elazığ Provinces, Türkiye

Murat GÜLMEZ^{1*}, Lütfiye GENÇER², Mehmet Rifat ULUSOY³

Diyarbakır ve Elazığ illeri meyve alanlarında Coccidae (Hemiptera: Coccoidea) Türleri Üzerinde tespit edilen parazitoit ve predatör türler

Öz: Bu çalışma koşnil (Hemiptera: Coccidae) türleriyle beslenen predatör ve parazitoit türlerin belirlenmesi amacıyla 2017-2018 yıllarında Diyarbakır ve Elazığ illeri meyve bahçelerinde yürütülmüştür. Çalışmada gözle kontrol ve kültüre alma metotları kullanılmıştır. Çalışma sonucunda, Coccinellidae (4), Cybocephalidae (1) (Coleoptera) , Forficulidae (2) (Dermaptera) ve Chrysopidae (1) (Neuroptera) familyalarına ait 8 predatör tür ile Encyrtidae (14), Aphelenidae (1) ve Pteromalidae (1) (Hymenoptera) familyalarına ait 14 parazitoit ve 2 hiperparazitoit tür tespit edilmiştir. Tespit edilen parazitoit türlerden *Metaphycus ater*, *M. luteolus*, *M. chermis* ve *M. unicolor* (Hymenoptera: Encyrtidae) türleri Türkiye böcek faunası için ilk kayıt niteliğindedir.

Anahtar sözcükler: Koşnil, parazitoit, predatör, Diyarbakır, Elazığ/Türkiye

Abstract: This study was carried out in order to determine the predator and parasitoid species that feed on soft scale insect (Hemiptera: Coccidae) species in orchards of Diyarbakır and Elazığ Provinces in Türkiye in 2017 and 2018. Visual identification and rearing methods were used. Eight predatory species belonging to the families Coccinellidae (4) and Cybocephalidae (1) (Coleoptera), Forficulidae (2) (Dermaptera), and Chrysopidae (1) (Neuroptera), were detected. In addition, 14 parasitoid and 2 hyperparasitoid species from the families Encyrtidae (14), Aphelenidae (1) and 2 Pteromalidae (1) (Hymenoptera) were collected. Among the parasitoid species, *Metaphycus ater*, *M. luteolus*, *M. chermis* and *M. unicolor* (Hymenoptera: Encyrtidae) are first records for the insect fauna of Türkiye.

Key words: Soft scale insect, Parasitoid, Predator, Diyarbakır, Elazığ/Türkiye

¹ Diyarbakır Ziraî Mücadele Araştırma Enstitüsü Müdürlüğü, Diyarbakır, Türkiye

² Sivas Cumhuriyet Üniversitesi, Fen Bilimleri Fakültesi, Biyoloji Bölümü, Sivas, Türkiye

³ Çukurova Üniversitesi, Ziraat Fakültesi, Bitki Koruma Bölümü, Adana, Türkiye

* Corresponding author (Sorumlu yazar): glmzmurat@gmail.com

ORCID ID (Yazar sırasıyla) : 0000-0001-5781-3422; 0000-0002-0314; 8858-0000-0001-6610-1398

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Introduction

Integrated pest management and biological control systems are increasingly being used across the world to reduce the use of pesticides because of the environmental harm they cause. However, to successfully implement these land management systems, comprehensive knowledge of pests and pathogens and their natural enemies are essential.

Türkiye has very different climatic regions with various polycultural agrosystems in them. Therefore, plant pests vary considerably across Türkiye. Many kinds of insect species can be found on plants. Among these, soft scale insects (Hemiptera: Coccoidea) are common and important pests (Japoshvili & Karaca 2002). They can feed on almost any live organ of the host plant, including the roots, although most species develop on the leaves or shoots or the trunk. The actual takeup of nutrients is from the phloem vessels and all species of Coccidae produce honeydew. Some coccid species are noxious crop pests, causing direct injury by depleting the host plant of nutrients and damaging tissues, and indirectly through honeydew secretion which accumulates on crops (Öncüer 1974; Hodgson 1994; Ben-Dov 1997).

Scale insects have many natural enemies and the identification and utilization of successful natural enemies would greatly improve biological control. In addition, recent studies suggest that the relationships between natural enemies and host scale insects are important (Ülgentürk et al. 2004). However, studies on natural enemies of coccid species found in fruit orchards in Türkiye has been not been systematic. Nevertheless, through the studies carried out in fruit orchards, many parasitoid species belonging to the families Aphelinidae, Encyrtidae, Eulophidae, Signiphoridae and Pteromalidae (Hymenoptera), as well as many predator species from the families Anthribidae, Cybocephalidae, Coccinellidae (Coleoptera), Chamaemyiidae (Diptera), Chopteraoptera (Hymenoptera) and Miridae (Hemiptera) have been recorded (Altay et al. 1972; Öncüer 1974; Soylu 1976; Gökmen & Seçkin 1979; Kozár et al. 1982; Kılıç & Aykaç 1989; Erol & Yaşar 1996; Kumral & Kovancı 2004; Ülgentürk et al. 2004; Japoshvili et al. 2008a; Özgen & Bolu 2009; Bolu 2012; Kaplan & Turanlı 2016; Bolu 2019).

This paper deals with parasitoids and predators of species of Coccidae collected from fruit orchards in Diyarbakır and Elazığ Provinces in Türkiye.

Materials and Methods

This study was carried out in fruit orchards in Diyarbakır (Çermik, Çüngüş, Eğil, Ergani, Çınar) and Elazığ (Center district, Baskil, Keban, Sivrice) in April to September, at least every two weeks, in 2017-2018. The number of trees examined in the sampled orchards was determined according to Lazarov & Grigorov (1961).

While examining the fruit trees infested with Coccidae species during the surveys, adult predators found to be feeding on them were directly collected with a mouth aspirator. In addition, predatory species seen on branches infested with coccids, but whose feeding could not be observed, were brought to the laboratory together with the coccid species they were found on, and it was determined

whether they fed on the pest. Larvae of the predators were also taken to the laboratory to rear them on their prey until adulthood.

The shoots infested with coccid species that were found to be parasitized were taken to the laboratory. After being cleared of other harmful species, they were placed into parasitoid emergence containers. The containers, which were placed in climate rooms adjusted to 26 ± 1 °C, $65\pm 5\%$ humidity and 16:8 hours light/dark period, were checked daily and the emerged parasitoids were collected with an oral aspirator. After the parasitoids were examined and counted under a stereomicroscope, they were placed in 70% alcohol, labeled and stored for identification

Results and Discussion

Parasitoid species

A total of 14 parasitoids and 2 hyperparasitoid species belonging to the families Aphelenidae, Encyrtidae and Pteromalidae (Hymenoptera) were obtained from 5 different coccid species in the survey studies carried out to determine their natural enemies in fruit orchards in Diyarbakır and Elazığ Provinces of Türkiye. The determined parasitoid species, their hosts and collection locality information are given in Table 1.

Table 1. Parasitoids of Coccidae in fruit orchards in Diyarbakır and Elazığ Provinces, Türkiye

Order of the parasitoids	Families of the parasitoids	Parasitoid species	Soft scale insect host	Plant host, locality and date of collection
Hymenoptera	Aphelenidae	<i>Coccophagus lycimnia</i> Walker	<i>Didesmococcus unifasciatus</i> (Archangelskaya)	<i>Prunus persica</i> (L.), Karşiyaka/çüngüş/Diyarbakır, 16.08.2017
			<i>Palaeolecanium bituberculatum</i> (Signoret)	<i>Malus domestica</i> Borkh., Gözeli/Sivrice/Elazığ, 17.05.2018
			<i>Sphaerolecanium prunastri</i> (Boyer de Fonscolombe)	<i>Prunus armeniaca</i> L., Gemici/Baskil/Elazığ, 20.07.2017; <i>Prunus armeniaca</i> , Karaali/Baskil/Elazığ, 10.08.2018
	Encyrtidae	<i>Blastothrix longipennis</i> Howard	<i>Eulecanium tiliae</i> (L.)	<i>Malus domestica</i> , Veran/Center distrikt/Elazığ, 09.04.2018
			<i>Parthenolecanium corni</i> (Bouché)	<i>Pistacia vera</i> L., Öncülü/Çınar/Diyarbakır, 12.04.2022; <i>Prunus Domestica</i> L., Tevekli/Ergani/Diyarbakır, 17.04.2018; <i>Juglans regia</i> L., Yolçatu/Central distrikt/Elazığ, 02.05.2018
		<i>Cerapterocerus mirabilis</i> Westwood	<i>Didesmococcus unifasciatus</i>	<i>Prunus dulcis</i> (Mill.), Cevizdere/Sivrice/Elazığ, 24.04.2018
			<i>Sphaerolecanium prunastri</i>	<i>Prunus armeniaca</i> L., Karaali/Baskil/Elazığ, 02.05.2018; <i>P.</i> <i>armeniaca</i> , Gemici/Baskil/Elazığ, 16.05.2018; <i>P. armeniaca</i> , Kuşsarayı/Baskil/Elazığ, 16.05.2018; <i>P.</i> <i>armeniaca</i> , Sürsürü/Central distrikt/Elazığ, 16.05.2018

Table 1. Continued

	<i>Discodes aeneus</i> (Dalman)	<i>Sphaerolecanium prunastri</i>	<i>P. armeniaca</i> , Pınarlı/Baskil/Elazığ, 16.05.2018; <i>P. armeniaca</i> , Kuşsarayı/Baskil/Elazığ, 16.05.2018; <i>P. domestica</i> , Bahçekaşı/Ergani/Diyarbakır, 17.05.2018; <i>P. armeniaca</i> , Çiğdemli/Baskil/Elazığ, 17.08.2018
	<i>Metaphycus ater</i> (Mercet)	<i>Parthenolecanium corni</i>	<i>P. domestica</i> , Hacımehmetli/Baskil/Elazığ, 20.07.2018
	<i>Metaphycus chermis</i> (Fonscolombe)	<i>Eulecanium tiliae</i>	<i>P. vera</i> , Ekinveren, Öncülü/Çınar/Diyarbakır, 12.04.2018
	<i>Metaphycus flavus</i> Howard	<i>Didesmococcus unifasciatus</i>	<i>P. dulcis</i> , Keleşevler/Çüngüş/Diyarbakır, 10.05.2018
	<i>Metaphycus luteolus</i> Timberlake	<i>Parthenolecanium corni</i>	<i>Malus domestica</i> Borkh., Beşpınar/Çınar/Diyarbakır, 12.04.2018
	<i>Metaphycus petitus</i> Walker	<i>Parthenolecanium corni</i>	<i>M. domestica</i> , Beşpınar/Çınar/Diyarbakır, 12.04.2018
	<i>Metaphycus unicolor</i> Hoffer	<i>Eulecanium tiliae</i>	<i>P. vera</i> , Ekinveren/Çınar/Diyarbakır, 12.04.2018
	<i>Metaphycus zebratus</i> Mercet	<i>Didesmococcus unifasciatus</i>	<i>P. dulcis</i> , Günay/Sivrice/Elazığ, 16.04.2018; <i>P. dulcis</i> , Cevizdere/Sivrice/Elazığ, 24.04.2018
	<i>Metaphycus</i> sp.1	<i>Sphaerolecanium prunastri</i>	<i>P. armeniaca</i> , Kuşsarayı/Baskil/Malatya, 16.05.2018
	<i>Metaphycus</i> sp.2	<i>Eulecanium tiliae</i>	<i>P. domestica</i> , Hacımehmetli/Baskil/Elazığ, 20.07.2018
	<i>Microterys hortulanus</i> Erdos	<i>Didesmococcus unifasciatus</i>	<i>P. dulcis</i> , Günay/Sivrice/Elazığ, 16.04.2018;
	<i>Microterys masii</i> Silvestri	<i>Didesmococcus unifasciatus</i>	<i>P. dulcis</i> , Keleşevler/Çüngüş/Diyarbakır, 10.05.2018
Pteromalidae	<i>Pachyneuron muscarum</i> (L.)	<i>Didesmococcus unifasciatus</i>	<i>P. dulcis</i> , Keleşevler/Çüngüş/Diyarbakır, 10.05.2018
		<i>Sphaerolecanium prunastri</i>	<i>P. domestica</i> , Bahçekaşı/Erganil/Diyarbakır, 17.05.2018; <i>P. armeniaca</i> , Alibaba/Baskil/Elazığ, 20.07.2018; <i>P. armeniaca</i> , Yalındamlar/Central district/Elazığ, 10.08.2018

(*): Hyperparasitoid species

Coccophagus lycimnia was obtained from *P. bituberculatum*, *D. unifasciatus* and *S. prunastri*. This species was reported previously as a parasitoid of *P. bituberculatum* by Schmutterer (1972). Bolu (2012) also recorded *C. lycimnia* as a parasitoid of *D. unifasciatus*. In addition, a lot of studies carried out in Türkiye and in many regions of world has reported that *C. lycimnia* is a parasitoid of *S. prunastri* (Ben-Dov 1968; Santas 1985; Potaeva 1992; Moglan & Moglan 1989;

Japoshvili 1999; Karaca et al. 2003; Demirözer et al. 2004; Japoshvili et al. 2008a; Özgen & Bolu 2009).

Blastothrix longipennis was collected from *E. tiliae* and *P. corni*. In Türkiye, Ülgentürk (2001), Ülgentürk et al. (2004), and in Iran, Fallahzade and Japoshvili (2017), reported that *B. longipennis* parasitizes *E. tilae*. Some studies conducted in Türkiye and abroad have shown that *B. longipennis* is a parasitoid of *P. corni* (Blahutiak 1972; Japoshvili & Karaca 2002; Japoshvili et al. 2008b; Basheer et al. 2014).

Cerapterocerus mirabilis was obtained from *S. prunastri* and *D. unifasciatus*. Although Japoshvili & Karaca (2002), Karaca et al. (2003) reported *C. miribalis* as a parasitoid of *S. prunastri*, Ben-Dov (1968), Öncüer (1991), Japoshvili (1999), Ülgentürk (2001), Ülgentürk et al. (2004), Japoshvili et al. (2008a) and Fallahzadeh & Japoshvili (2017), reported *C. miribalis* as a hyperparasitoid of *S. prunastri*. It has been also reported that *D. unifasciatus* is the primary host of *C. miribalis* (Anonymous 2021).

Discodes aeneus was collected from *S. prunastri*. Many studies in Türkiye and around the world have shown that this chalcidoid wasp is a parasitoid of *S. prunastri* (Balachowsky 1930; Ben-Dov 1968; Soydanbay 1976; Öncüer 1977; Kılıç & Aykaç, 1989).

Metaphycus ater was obtained from *P. corni*. This is the first record of *M. ater* for the insect fauna of Türkiye. In addition, although it has been stated that *M. ater* is a parasitoid of *Anophococcus inermis* (Green) and *Rhizococcus greeni* (Newstead) belonging to Eriococcidae (Hemiptera: Coccoidea) family (Anonymous 2021), no record has been found that *M. ater* is associated with *P. corni*.

In this study, it was also determined that *Metaphycus chermis* parasitizes *E. tiliae*. This is the first record of *M. chermis* for the fauna of Türkiye. From abroad, it has been noted that *M. chermis* is a parasitoid of *E. tiliae* (Anonymous 2021).

In addition, *Metaphycus flavus* was found to parasitize *D. unifasciatus*. Although some studies in Türkiye have reported that *M. flavus* parasitizes coccid species such as *Coccus pseudomagnoliarum* (Kuwana), *Saissetia oleae* Olivier, and *Coccus hesperidum* L. (Öncüer 1974; Soydanbay 1976; Japoshvili & Karaca 2002), no records have been found from Türkiye and other parts of the world that *D. unifasciatus* is a host of *M. flavus*. However, some species of *Metaphycus* such as *Metaphycus babajani* Sugonjaev and *Metaphycus claviger* (Timberlake) (Hymenoptera: Encyrtidae) have been reported to parasitize *D. unifasciatus* (García Morales et al. 2016).

Metaphycus luteolus was collected from *P. corni*. This is also the first record for the fauna of Türkiye. Trjapitzin (1989) and Guerrieri & Noyes (2000) stated that *M. luteolus* is a parasitoid of *P. corni*.

In the present study, it was determined that *Metaphycus petitus* parasitizes *P. corni*. The presence of *M. petitus* in Türkiye was reported by Japoshvili & Çelik (2010) and Japoshvili (2012), but there were no host records since the parasitoid was obtained with traps. It has been stated that species belonging to *Metaphycus*, such as *Metaphycus insidiosus* (Mercet), *Metaphycus melanostomatus* (Timberlake), *Metaphycus parthenolecanii* Japoshvili, *Metaphycus punctipes*

(Dalman) and *Metaphycus Stanleyi* Compere (Hymenoptera: Encyrtidae), are parasitoids of *P. corni* (Schmutterer 1972; Fallahzadeh & Japoshvili 2017; Stathas et al. 2021), but such a record has not been found with regard to *M. petitus*.

The present study also reports that *Metaphycus unicolor* parasitizes *E. tiliae*. This is the first record for the insect of Türkiye. Although it is known that *M. unicolor* is a parasitoid of the coccids, *Physokermes hemicryphus* (Dalman), *Physokermes piceae* (Schrank) and *Physokermes sugonjaevi* Danzig (Anonymous 2021), no record has been found that this natural enemy parasitizes *E. tiliae*.

Metaphycus zebratus is a parasitoid of *D. unifasciatus*. Japoshvili & Çelik (2010) and Japoshvili (2012) reported *M. zebratus* in Türkiye. Bolu (2012) also reported that *Metaficus* sp. near *zebratus* was obtained from *D. unifasciatus*. Many harmful coccid species belonging to the Coccidae, Diaspididae, Eriococcidae and Pseudococcidae families are hosts of *M. zebratus* (Anonymous 2021).

In this study, *Metaphycus* sp.1 and *Metaphycus* sp.2 were obtained from *S. prunastri* and *E. tiliae*, respectively. It has been reported that many species of *Metaphycus* parasitize *S. prunastri* and *E. tiliae* (Anonymous 2021).

Also, *Microterys hortulanus* was obtained from *D. unifasciatus*. In previous studies conducted in Türkiye and different of regions of the world, it has been reported that this natural enemy parasitizes *D. unifasciatus* (Sugonjaev 1976; Bolu 2012; Japoshvili & Noyes 2006; Fallahzadeh & Japoshvili, 2010,2017).

Additionally, *Microterys masii* was found to parasitize *D. unifasciatus*. Although *M. masii* is known to be a parasitoid of many coccid species, such as *C. hesperidum*, *E. tiliae*, *Filippia follicularis* (Targioni Tozzetti), *Lichtensia viburni* Signoret, *P. corni*, *Pulvinaria floccifera* (Westwood) and *S. prunastri* (Anonymous, 2021), no study could be found that has reported *M. masii* to be a parasitoid of *D. unifasciatus*.

Also in this study, *Pachyneuron muscarum* was obtained from *S. prunastri* and *D. unifasciatus*. Although Japoshvili & Karaca (2002), Hoffmann & Schmutterer (2003), Karaca et al (2003), Andriesku & Mitroiu (2004) and Özgen & Bolu (2009) reported *P. muscarum* as a parasitoid of *S. prunastri*, Podsiadlo (1981), Japoshvili (1999), Ülgentürk (2001), Ülgentürk et al (2004) and Japoshvili et al. (2008a) reported *P. muscarum* as a hyperparasitoid of *S. prunastri*. Bolu (2012) collected *P. muscarum* while determining the parasitoids of *D. unifasciatus* and determined that it is a hyperparasitoid

Predator species

In this study carried out to determine the predator species that feed on soft scale insects in the orchards of Diyarbakır and Elazığ Provinces in Türkiye, 8 predator species belonging to the families of Coccinellidae (4), Cybocephalidae (1) Forficulidae (2) and Chrysopidae (1) were detected. The predators species, their hosts and collection locality information are given in Table 2.

Parasitoids and predators of Coccidae species in Diyarbakır and Elazığ

Table 2. Predators of Coccidae in fruit orchards in Diyarbakır and Elazığ Provinces, Türkiye

Order of the predators	Families of the predators	Predators species	Soft scale insect host	Plant host, locality and date of collection
Coleoptera	Coccinellidae	<i>Adalia fasciatopunctata revelierei</i>	<i>Didesmococcus unifasciatus</i> (Archangelskaya)	<i>Prunus persica</i> (L.), Karşıyaka/Çüngüş/Diyarbakır, 16.08.2017; <i>Prunus dulcis</i> (Mill.), Günay/Sivrice/Elazığ, 16.04.2018
			<i>Sphaerolecanium prunastri</i> (Boyer de Fonscolombe)	<i>P. dulcis</i> , Karaali/Baskil/Elazığ, 16.04.2018
		<i>Brumus quadripustulatus</i> (L.)	<i>Parthenolecanium corni</i> (Bouché)	<i>Malus domestica</i> Borkh., Sinanköy/Central district/Elazığ, 14.07.2017; <i>P. dulcis</i> , Dere/Eğil/Diyarbakır, 14.07.2017; <i>Prunus domestica</i> L., Höyükdibi/Çınar/Diyarbakır, 30.05.2018
			<i>Sphaerolecanium prunastri</i>	<i>Prunus armeniaca</i> L., Gemici/Baskil/Elazığ, 20.07.2018; <i>P. armeniaca</i> , Karaali/Baskil/Elazığ, 02.08.2018
		<i>Chilocorus bipustulatus</i> (L.)	<i>Parthenolecanium corni</i>	<i>P. domestica</i> , Hacimehmetli/Baskil/Elazığ, 20.07.2017; <i>M. domestica</i> , Sinek/Çermik/Diyarbakır, 01.08.2017/ <i>M. domestica</i> , Beşpınar/Çınar/Diyarbakır, 12.04.2018
	<i>Coccinella septempunctata</i> L.	<i>Didesmococcus unifasciatus</i>	<i>P. dulcis</i> , Altınakar/Çınar/Diyarbakır, 20.09.2017; <i>P. dulcis</i> , Cevizdere/Sivrice/Elazığ, 24.04.2018	
	Cybocephalidae	<i>Cybocephalus fodori</i> Endrödy-Younga	<i>Sphaerolecanium prunastri</i>	<i>P. armeniaca</i> , Alangören/Baskil/Elazığ, 14.07.2017, 08.06.2018; <i>P. domestica</i> , Bahçekeşi/Ergani/Diyarbakır, 17.05.2018; <i>P. armeniaca</i> , Alibaba/Baskil/Elazığ, 20.07.2018; <i>P. armeniaca</i> , Karaali/Baskil/Elazığ, 20.07.2018; <i>P. armeniaca</i> , Ortaçalı/Central district/Elazığ, 26.07.2018; <i>P. armeniaca</i> , Yalındamlar/Central district/Elazığ, 17.08.2018
Dermaptera	Forficulidae	<i>Forficula auricularia</i> L.	<i>Sphaerolecanium prunastri</i>	<i>P. armeniaca</i> , Alangören/Baskil/Elazığ, 08.06.2018,
		<i>Forficula smyrnensis</i> Audinet-Serville	<i>Sphaerolecanium prunastri</i>	<i>P. armeniaca</i> , Alangören/Baskil/Elazığ, 08.06.2018,
Neuroptera	Chrysopidae	<i>Chrysopa viridana</i> Schneider	<i>Sphaerolecanium prunastri</i>	<i>P. armeniaca</i> , Deliktaş/Baskil/Elazığ, 08.06.2018,

In this study, larvae and adults of *Brumus quadripustulatus* were observed to feed on nymphs of *P. corni* and *S. prunastri*. Soydanbay (1976), Ülgentürk (2001), Ülgentürk et al. (2004), Özgen & Bolu (2009) and Develioğlu (2017) recorded *B. quadripustulatus* as a predator of *S. prunastri*. Demirözer et al. (2004), Arnaoudov et al. (2006), Develioğlu (2017) and Dervişević (2019) stated that the predator in question feeds on *P. corni*.

Also, *Chilocorus bipustulatus* was recorded as a predator of *P. corni*. It feeds on *P. corni* nymphs and young females. In previous studies in Türkiye, it was determined that *C. bipustulatus* feeds on Coccidae species that include *Parthenolecanium rufulum* (Cockerell), *C. hesperidum*, *C. pseudomagnoliarum*, *Eulecanium ciliatum* (Douglas), *P. piceae* and *S. prunastri* (Öncüer 1974; Ülgentürk & Toros 1999; Ülgentürk 2001; Kaplan & Turan 2016), but there is no Turkish record that *C. bipustulatus* feeds on *P. corni*. On the other hand, in studies conducted in different regions of the world, *C. bipustulatus* was reported to feed on *P. corni* (Herting & Simmonds 1972; Schmutterer 1972; Arnaoudov et al. 2006; Dervişević 2019).

In the present survey studies, *Coccinella septempunctata* individuals were found on shoots of trees which were excessively infested with *D. unifasciatus*, and it was observed that the predator was feeding on nymphs and young females of *D. unifasciatus*. In many studies, it has been stated that it feeds on many species in the Coccoidea superfamily, such as *Marchalina hellenica* (Gennadius) (Hemiptera: Marchalinidae), *Planococcus vovae* (Nasanov) (Hemiptera: Pseudococcidae), *Quadraspidiotus perniciosus* (Comstock) (Hemiptera: Diaspididae), *P. corni*, *Saissetia coffeae*, *S. oleae*, *C. hesperidum* and *Pulvinaria kuwacola* Kuwana (Hemiptera: Coccidae) (Selmi 1979; Thakur et al. 1989; Arnaoudov et al. 2006; Badary 2010; Develioğlu 2017; Dervişević 2019), but it has not been recorded that this predator feeds on *D. unifasciatus*.

In this study, adults of *Adalia fasciatopunctata revelierei* fed on *D. unifasciatus* and *S. prunastri* nymphs. It has been reported that *A. fasciatopunctata* can feed on many coccoid species such as *E. ciliatum*, *P. corni*, *P. rufulum*, *P. bituberculatum* (Hemiptera: Coccidae), *Mercetaspis halli* (Green) (Hemiptera: Diaspididae), *Phenacoccus aceris* (Signoret) and *Planococcus vovae* (Nasonov) (Hemiptera: Pseudococcidae) (Ülgentürk & Toros 1999; Ülgentürk 2001; Kaydan 2004; Kaplan & Turanlı 2016; Develioğlu 2017). However, no record has been found of this predator feeding on *D. unifasciatus* and *S. Prunastri* in Turkey.

Also, during this survey study, *Cybocephalus fodori* individuals were found on trees excessively infested with *S. prunastri*, and it was observed that *C. fodori* fed on its nymphs. Earlier, Bakoyannis (1984), Ülgentürk (2001), Ülgentürk et al. (2004), Özgen & Bolu (2009) and Yiğit (2013) had reported that *C. fodori* is a predator of *S. prunastri* in Türkiye.

In this study, *Forficula auricularia* and *F. smyrnensis* species were observed feeding on crawlers of *S. prunastri*. In earlier studies, there were no records of these species feeding on *S. prunastri*. However, Ülgentürk (2001) reported that *Forficula* sp. feeds on *P. piceae*. Also, Dervişević (2019) reported that *F. auricularia* feeds on the Coccidae species, *E. tiliae* and *P. piceae*. In addition, Logan et al. (2007) and Mather & Logan (2007) stated that *F. auricularia* is an important predator of

species of Diaspididae (Hemiptera: Coccoidea) found in kiwi fruit orchards in New Zealand.

Also, *Chrysopa viridana* was observed feeding on crawlers of *S. prunastri*. Although there is no direct record of *C. viridana* feeding on *S. prunastri*, Argyriou & Paloukis (1976) and Özgen & Bolu (2009) reported that *Chrysopa* sp. could feed on *S. prunastri*. In addition, Yiğit & Telli (2013) stated in a study on mealybugs that *C. viridana* is a predator of *Pseudococcus cryptus* Hempel (Coccoidea: Pseudococcidae).

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