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ORIGINAL ARTICLE

The predators attacking soft scales (Hemiptera: Coccomorpha: Coccidae) in Serbia

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Abstract. This study aimed to determine the diversity of species of predators attacking scale insects (Hemiptera: Coccidae) in Serbia. Over a four-year period, at 25 locations and on 25 host plants infested with 16 species of Coccidae, a total of 18,050 predators were collected and reared. Among them, were 16 species belonging to 7 families and 5 insect orders (Coleoptera, Dermaptera, Diptera, Hemiptera, and Neuroptera). Six species, *Harmonia axyridis*, *Hippodamia variegata*, *Propylea quatuordecimpunctata*, *Forficula auricularia*, *Deraeocoris ruber* and *Oxycarenus lavaterae*, were recorded for the first time feeding on coccid pests in Serbia and *O. lavaterae* was first recorded being zoophagous. The most common species was *Exochomus quadripustulatus*, which was recorded feeding on all 16 species of soft scale insects, while the dominant species was *Anthribus nebulosus,* with a total of 17,385 individuals collected and reared on five species of soft scale. Considering the potential of the predators as biocontrol agents for suppressing scale insects, the data obtained indicate the need to understand predator diversity, which is one of the prerequisites for using these predators for controlling coccid pests.

INTRODUCTION

Soft scales (Hemiptera: Coccidae) are serious pests of agricultural crops and ornamental plants worldwide. Due to their small body size, limited mobility and relatively low visibility, Coccidae can easily be transported on plant material, thus, due to their pronounced ecological plasticity, they have a worldwide distribution (Ouvrad et al., 2013; Amnoroux et al., 2019). The high fertility of females and poor mobility of individuals lead to colonial life, resulting in the concentration of a large number of individuals, which often completely cover plant organs or even entire plants. They cause damage by feeding on plant sap and injecting salivary toxins into plant tissue (Szklarzewicz et al., 2021). During feeding, scale insects cause the formation of lesions and discoloration of tissues around stylet penetration sites. Such damage is mostly localized on certain parts of plants; however, high infestations of scale insects reduce growth, induce leaf drop and death of individual branches, or even the death of entire plants (Carter, 1973; Raven, 1983; Vranjić, 1997). Plants become weakened and susceptible to attack by other insects and pathogens (Hanson & Miller, 1984; Camacho & Chong, 2015). In addition, Coccidae excrete honeydew, which indirectly damages plants. Honeydew is a suitable substrate for the development of sooty moulds, which can cover parts of plants and so reduce photosynthetic activity, resulting in a decrease in the aesthetic and market value of fruit and ornamental plants (Mibey, 1997; Ülgentürk & Çanakçioğlu, 2004). In addition to the loss of aesthetic value of ornamental trees and shrubs, as well as the quality and quantity of fruit, the costs of controlling scale insects need to be considered. The global economic loss due to scale insects, including control costs, amounts to 5 billion dollars annually (Kosztarab & Kozár, 1988), with probably a quarter of that loss due to damage by species of the family Coccidae (Gill & Kosztarab, 1997). In the territoriy of the former Yugoslavia (including Serbia), fruit production was carastrophical reduced due to an infestation of *P. corni*, in which the number of plum trees decreased by 16 million, or 29%, in the 1930s (Vukasović, 1929).

Control of soft scales requires a combination of different measures, including the use of insecticides along with arthropod biological control agents, such as predators and parasitoids. Soft scales are the prey of numerous predatos belonging to the orders Coleoptera, Dermaptera, Neuroptera and Hemiptera. Particularly significant are species belonging to the families Coccinellidae and Anthribidae, which have been used in biological control programs. For example, *Cryptolaemus montrouzieri* Mulsant (Coleoptera: Coccinellidae) was introduced into at least 64 countries for

the biological control of scale insects (Kairo et al., 2013). *C. montrouzieri* has successfully controlled scale insects in orchards, vineyards, tea and coffee plantations, as well as citrus orchards (Prokopenko, 1982; Longo & Benfatto, 1987; Mani, 1988; Yanosh et al., 2001). Similarly, *Chilocorus nigritus* (F.) is a ladybird beetle that has been successfully used in classical biological control programs. It is an efficient predator of many species of the families Coccidae, Diaspididae and Asterolecaniidae, and has colonized a wide range of tropical and subtropical environments (Ponsonby, 2009). Likewise, *Anthribus nebulosus* (Coleoptera: Anthribidae) was introduced from Hungary to Virginia (USA) in the 1980s for the suppression of *Physokermes hemicryphus* and locally it was very effective (Kosztarab & Kozár, 1983; Hoebeke & Wheeler, 1991).

Considering the agricultural significance of scale insects and the rich fauna of natural enemies associated with them, which is in need of further study in Serbia, the aim of this study was to investigate the diversity of predators and their interactions with soft scales as prey in Serbia.

MATERIAL AND METHODS

This study on the predators of Coccidae was done from 2015 to 2018 in Serbia. To determine the presence and distribution of predators, plant material with soft scale colonies was sampled at 25 locations: Ada Ciganlija (44°47′30″N, 20°24′45″E), Altina (44°51′21″N, 20°21′21″E), Bežanijska kosa (44°49′50″N, 20°22′31″E), Blok 45 (44°47′48″N, 20°22′45″E), Borča (44°52′43″N, 20°28′00″E), Crvenka (45°65′85″N, 19°45′60″E), Grabovac (44°60′14″N, 20°10′42″E), Grocka (44°40′27″N, 20°43′30″E), Konjarnik (44°46′54″N, 20°30′31″E), Mirijevo (44°78′54″N, 20°54′62″E), Novi Beograd (44°49′11″N, 20°23′56″E), Pančevo (44°51′53″N, 20°39′23″E), Radmilovac (44°45′15″N, 20°34′59″E), Ribare (44°01′26″N, 21°28′84″E), Svilajnac (44°13′54″N, 21°11′32″E), Umčari (44°34′58″N, 20°44′11″E), Ušće (44°49′36″N, 20°26′13″E), Veliko Gradište (44°46′30″N, 21°31′70″E), Voždovac (44°77′62″N, 20°47′71″E), Vračar (44°47′51″N, 20°28′35″E), Zemun (44°50′26″N, 20°24′31″E), Zemun Polje (44°52′19″N, 20°19′27″E), Zvezdara (44°46′36″N, 20°31′56″E), Žagubica (44°11′51″N, 21°47′18″E) and Žarkovo (44°45′41″N, 20°24′49″E).

Sampling of plant material was conducted throughout the year, in orchards, vineyards, nurseries and parks. Adult predators found feeding on soft scales, were collected using an aspirator and transported to the laboratory for identification. Predator larvae collected from such colonies were individually reared to the adult stage in Petri dishes or cylinders covered with dense mesh to prevent cannibalism. These containers were kept under laboratory conditions of 25°C ± 1°C, 55% ± 5% RH and 16L : 8D. Freshly emerged adults were mounted by sticking them onto cardboard and identified using keys or with the assistance of taxonomic specialists. The determination of ladybird species (Coleoptera: Coccinellidae) was carried out using the key of Bieńkowski (2018) and of the order Dermaptera (Forficulidae) the key of Murányi (2013). The determination of species belonging to the family Anthribidae (Coleoptera) was done by Snežana Pešić (University of Kragujevac, Faculty of Science, Serbia); the determination of true bugs (Hemiptera) was carried out by Ljiljana Protić, curator-entomologist (Natural History Museum, Belgrade, Serbia) and that of predatory flies (Diptera: Chamaemyiidae) by Radoslava Spasić (University of Belgrade, Faculty of Agriculture, Serbia). The mounted specimens are preserved in the laboratory of the Entomology and Agricultural Zoology, Faculty of Agriculture in Belgrade.

For the identification of soft scales, permanent microscopic preparations of females were made according to the method of Kosztarab & Kozár (1988) and their identification to species level was done using keys of Schmutterer (1956), Gill (1988), Kostarab & Kozár (1988) and Stepaniuk & Łagowska (2006).

RESULTS

Feeding on 16 species of scale insects belonging to the family Coccidae, a total of 16 species of predators belonging to 7 families and 5 insect orders were collected and reared (Table 1).

During this research, six species of predators, *Harmonia axyridis*, *Hippodamia variegata*, *Propylea quatuordecimpunctata*, *Forficula auricularia*, *Oxycarenus lavaterae* and *Deraeocoris ruber*, were recorded for the first time feeding on scale insects of the family Coccidae in Serbia and *O. lavaterae* as a predator for the first time in the world.

The family Coccinellidae was the most specious with 8 species, for the families Anthribidae and Miridae it was two species each and the families Chamaemyiidae, Forficulidae, Lygaeidae and Chrysopidae, one species each.

For each species of predator, the soft scale prey, the type of plant on which it develops, the locality and the number of individuals that completed their development were determined (Table 2).

A total of 16 species of predators feeding on 16 species of soft scales, on 25 host plant species, at 25 localities in Serbia were collected and reared. Among the predators, the most abundant was *E. quadripustulatus*, which was collected and reared from colonies of all 16 species of soft scales. *H. axyridis* was recorded feeding on nine species, *A. nebulosus* and *Ch. carnea* on five species each, *L. silesiaca* on four species and *Ch. bipustulatus* on three species. The remaining 10 species of predators were collected and reared from colonies of one or two species of soft scales.

During this four-year study, a total of 18,050 predators was reared. In terms of the number of individuals reared, the Anthribidae dominate, with 17,385 individuals of *A.*

Table 1. Predators of soft scales in Serbia.

Order	Family	Species
Coleoptera	Anthribidae	*Anthribus fasciatus* Forster
		Anthribus nebulosus Forster
	Coccinellidae	*Chilocorus bipustulatus* (L.)
		Chilocorus renipustulatus (Scriba)
		Coccinella septempunctata (L.)
		Exochomus quadripustulatus (L.)
		Harmonia axyridis (Pallas)*
		Hippodamia variegata (Goeze)*
		Propylea quatuordecimpunctata (L.)*
		Scymnus abietis (Paykull)
Dermaptera	Forficulidae	*Forficula auricularia* (L.)*
Diptera	Chamaemyiidae	*Leucopomyia silesiaca* (Egger)
Hemiptera	Lygaeidae	*Oxycarenus lavaterae* (Fabricius)**
	Miridae	*Atractotomus mali* (Meyer-Dür)
		Deraeocoris ruber (L.)*
Neuroptera	Chrysopidae	*Chrysoperla carnea* (Stephens)

*Newly confirmed predator of Coccidae in Serbia. **Newly confirmed predator of Coccidae worldwide.

Table 2. Qualitative and quantitative details of the predators of Coccidae recorded during the period 2015–2018 in Serbia.

No.	Predator	Scale insect	Host plant	Locality	No. of individuals
	Order Coleoptera				
1.	*Anthribus fasciatus*	*Eulecanium tiliae* (L.)	*Tilia tomentosa*	Zemun	213
		Parthenolecanium corni (Bouché)	*Tilia tomentosa*	Zemun	126
2.	*Anthribus nebulosus*	*Eulecanium tiliae*	*Acer pseudoplatanus*	Zemun	540
				Zemun Polje	563
			Carpinus betulus	Zemun	258
			Corylus colurna	Novi Beograd	471
			Malus pumila	Radmilovac	788
			Tilia tomentosa	Ada Ciganlija	653
				Borča	536
				Crvenka	547
				Voždovac	234
				Zemun	1,131
			Ulmus glabra	Radmilovac	809
		Parthenolecanium corni	*Acer pseudoplatanus*	Ada Ciganlija	124
				Zemun	190
			Corylus avellana	Zemun Polje	271
			Sophora japonica	Novi Beograd	225
			Tilia tomentosa	Borča	231
			Ulmus minor	Radmilovac	374
		Parthenolecanium rufulum (Cockerell)	*Quercus robur*	Ada Ciganlija	224
				Novi Beograd	120
				Voždovac	68
				Vračar	92
				Zemun	72
		Physokermes hemicryphus (Dalman)	*Picea abies*	Grocka	396
				Konjarnik	751
				Novi Beograd	599
				Voždovac	610
				Zemun	594
				Zemun Polje	568
		Physokermes piceae (Schrank)	*Picea abies*	Grabovac	893
				Grocka	514
				Mirjevo	526
				Novi Beograd	1,011
				Voždovac	846
				Vračar	764
				Zemun Polje	792
3.	*Chilocorus bipustulatus*	*Parthenolecanium corni*	*Tilia tomentosa*	Borča	1
				Novi Beograd	1
		Parthenolecanium fletcheri (Cockerell)	*Thuja occidentalis*	Pančevo	1
		Pulvinaria hydrangeae (Steinweden)	*Hydrangea macrophylla*	Zemun Polje	1
				Žarkovo	1
4.	*Chilocorus renipustulatus*	*Parthenolecanium corni*	*Tilia tomentosa*	Zemun	2
		Pulvinaria floccifera (Westwood)	*Acer negundo*	Bežanijska kosa	7
5.	*Coccinella septempunctata*	*Coccus hesperidum* L.	*Citrus limon*	Žagubica	2
		Pulvinaria hydrangeae	*Hydrangea macrophylla*	Zemun Polje	1
6.	*Exochomus quadripustulatus*	*Ceroplastes rusci* (L.)	*Ficus carica*	Altina	1
		Coccus hesperidum	*Citrus limon*	Žagubica	3
		Coccus pseudomagnoliarum (Kuwana)	*Celtis occidentalis*	Novi Beograd	2
				Ušće	1
		Eulecanium tiliae	*Malus pumila*	Radmilovac	7
			Tilia tomentosa	Ada Ciganlija	2
				Zemun	1
			Ulmus minor	Radmilovac	1
		Neopulvinaria innumerabilis (Rathvon)	*Cornus sanguinea*	Radmilovac	1
		Parthenolecanium corni	*Fraxinus excelsior*	Zemun	1
			Tilia tomentosa	Novi Beograd	3
			Vitis vinifera	Radmilovac	3
		Parthenolecanium fletcheri	*Thuja occidentalis*	Pančevo	1
		Parthenolecanium persicae (Fabricius)	*Vitis vinifera*	Radmilovac	2
		Parthenolecanium pomeranicum (Kawecki)	*Taxus baccata*	Svilajnac	1
		Parthenolecanium rufulum	*Quercus robur*	Ada Ciganlija	3
		Physokermes hemicryphus	*Picea abies*	Borča	2
				Grocka	5
				Konjarnik	3
				Mirjevo	11
				Novi Beograd	5
				Ribare	4
				Vračar	1
				Zemun	1
				Zemun Polje	4
				Zvezdara	1

Table 2 (continued).

		Physokermes piceae	*Picea abies*	Borča	14
				Blok 45	4
				Novi Beograd	3
				Voždovac	1
				Vračar	1
				Zemun	5
			Picea pungens	Borča	4
				Mirjevo	3
		Pulvinaria floccifera	*Acer negundo*	Bežanijska kosa	2
			Acer pseudoplatanus	Zemun Polje	3
		Pulvinaria hydrangeae	*Hydrangea macrophylla*	Zemun Polje	2
		Pulvinaria vitis (L.)	*Vitis vinifera*	Radmilovac	2
		Sphaerolecanium prunastri (Fonsc.)	*Prunus persica*	Veliko Gradište	3
		Eulecanium tiliae	*Malus pumila*	Radmilovac	7
		Parthenolecanium corni	*Prunus domestica*	Žagubica	1
			Tilia tomentosa	Novi Beograd	2
		Parthenolecanium fletcheri	*Thuja occidentalis*	Pančevo	1
7.	*Harmonia axyridis*	*Parthenolecanium rufulum*	*Quercus robur*	Ada Ciganlija	1
				Vračar	1
		Physokermes hemicryphus	*Picea abies*	Novi Beograd	1
		Physokermes piceae	*Picea abies*	Zemun Polje	2
		Pulvinaria floccifera	*Acer pseudoplatanus*	Zemun Polje	3
		Pulvinaria hydrangeae	*Hydrangea macrophylla*	Zemun Polje	2
		Sphaerolecanium prunastri	*Prunus armeniaca*	Umčari	1
8.	*Hippodamia variegata*	*Pulvinaria hydrangeae*	*Hydrangea macrophylla*	Zemun Polje	2
9.	*Propylea quatuordecimpunctata*	*Eulecanium tiliae*	*Corylus colurna*	Novi Beograd	2
10.	*Scymnus abietis*	*Physokermes hemicryphus*	*Picea abies*	Novi Beograd	1
		Physokermes piceae	*Picea abies*	Novi Beograd	2
	Order Dermaptera				
11.	*Forficula auricularia*	*Eulecanium tiliae*	*Corylus colurna*	Novi Beograd	1
		Physokermes piceae	*Picea abies*	Grabovac	2
	Order Diptera				
12.	*Leucopomyia silesiaca*	*Neopulvinaria innumerabilis*	*Ulmus minor*	Radmilovac	25
		Pulvinaria floccifera	*Acer negundo*	Bežanijska kosa	15
			Acer pseudoplatanus	Zemun Polje	62
		Pulvinaria hydrangeae	*Hydrangea macrophylla*	Zemun Polje	5
		Pulvinaria vitis	*Vitis vinifera*	Radmilovac	37
	Order Hemiptera				
13.	*Oxycarenus lavaterae*	*Coccus hesperidum*	*Citrus limon*	Žagubica	4
14.	*Atractotomus mali*	*Physokermes piceae*	*Picea abies*	Novi Beograd	2
15.	*Deraeocoris ruber*	*Eulecanium tiliae*	*Corylus colurna*	Novi Beograd	2
	Order Neuroptera				
16.	*Chrysoperla carnea*	*Coccus hesperidum*	*Citrus limon*	Žagubica	1
		Parthenolecanium corni	*Fraxinus excelsior*	Zemun	1
		Parthenolecanium rufulum	*Quercus robur*	Ada Ciganlija	1
		Physokermes hemicryphus	*Picea abies*	Borča	1
				Grocka	1
				Mirjevo	1
				Zemun Polje	1
		Pulvinaria floccifera	*Acer negundo*	Bežanijska kosa	1
Σ	16	16	25	25	18,050

nebulosus and 339 of *A. fasciatus*. The overall abundance of these predators during the four-year study varied depending on the species of soft scales and locality. The highest abundance of *A. nebulosus*, with 1,131 individuals, which were collected in colonies of *E. tiliae* on *T. tomentosa* at Zemun and the lowest, with 68 individuals in colonies of *P. rufulum* on *Q. robur* at Voždovac. Species of the genus *Anthribus* synchronized their life cycle with that of their prey and the larvae feed on the eggs of soft scales. Pupae developed during May and adult emergence was recorded from mid-May to mid-June.

Third in abundance, with a total of 144 individuals reared, is the predatory fly *L. silesiaca*, with the highest number of 62 individuals recorded in colonies of *P. floccifera* on *Acer pseudoplatanus* at Zemun Polje. A smaller number of individuals were collected and reared on the other three species of soft scale. Larvae of *L. silesiaca* were found in the ovisacs of soft scale, where they fed on the eggs. Larve were present in nature during the month of May, pupae developed at the end of May and adult emergence was recorded in the first decade of June. In one ovisac, the number of larvae of *N. innumerabilis* and *P. vitis* ranged from one to four, whereas only one larva developed in the ovisacs of *P. floccifera* and *P. hydrangeae*.

Eight species of ladybirds were identified. The most numerous were *E. quadripustulatus*, with a total of 117 in-

dividuals reared and *H. axyridis* with 22 individuals. For the other species, *Ch. bipustulatus*, *Ch. renipustulatus*, *C. septempunctata*, *H. variegata*, *P. quatuordecimpunctata*, and *S. abietis*, only one individual was recorded in soft scale colonies. Ladybirds were present in Coccid colonies throughout the year, with young larvae feeding on eggs or nymphs and older larvae and adults on all of the developmental stages of the prey.

Individual specimens of the Chrysopid, *Ch. carnea* were recorded in colonies of five species of Coccidae, which is the first record of it as a predator of *C. hesperidum*, *P. rufulum*, *Ph. hemicryphus* and *P. floccifera* in Serbia. Its larvae fed on all developmental stages of soft scales and were recorded in their colonies in May and June.

Individual earwigs of the species *F. auricularia* were recorded in colonies of two species of Coccidae in May and June, where both larvae and adults fed on all developmental stages of the prey.

The predatory bugs *A. mali*, *D. ruber* and *O. lavaterae* were present in small numbers in soft scale colonies. They fed by sucking body fluids from soft scale larvae and females. *A. mali* and *D. ruber* were present in soft scale colonies in May and *O. lavaterae* was recorded from May to July feeding on *C. hesperidum*. This is the first world record of this species being zoophagous.

The largest number of species of predator (7 each) were collected and reared from three species of soft scales (*E. tiliae*, *P. corni* and *Ph. piceae*) and the smallest number (only one each) from *C. rusci*, *P. persicae* and *P. pomeranicum*.

DISCUSSION

Predators of coccids were collected at 25 locations throughout Serbia from 2015 to 2018 from colonies of 16 species of Coccidae on 25 species of plants, including fruit trees, grapevines, and various forest and ornamental trees. A total of 18,050 predators were reared, among which 16 species were identified as members of the orders Coleoptera, Dermaptera, Diptera, Hemiptera and Neuroptera. In terms of species abundance, the order Coleoptera was dominant with 10 species, followed by Hemiptera with three, Dermaptera with two and the orders Diptera and Neuroptera with one species each.

Coleopteran predators

Within the order Coleoptera, species of the family Anthribidae, *A. nebulosus* and *A. fasciatus*, were most numerous in terms of the number of individuals. *A. nebulosus* was collected from colonies of 5 species of soft scale and *A. fasciatus* from colonies of two species of soft scale (Table 2). *A. nebulosus* is recorded as a predator of 15 species of Coccidae and one species of Kermesidae (Kosztarab & Kozár, 1983; Ülgentürk, 2016). The efficacy of this predator in regulating populations of scale insects has been studied in several countries (Danzig, 1959; Arnaoudov et al., 2006, Rainato & Pellizzari, 2009). In Serbia, it is reported that *A. nebulosus* can reduce the abundance of five species of Coccidae by up to 80% (Graora et al., 2012; Dervišević, 2019). *A. fasciatus* was collected from colonies of *E. tiliae* and *P. corni*. This predator is reported in Europe feeding on *Pulvinaria vitis* (Pellizzari, 1997), *Eulecanium kunoense* and *Rhodococcus perornatus* (Ponsonby & Copland, 1997) and *Eulecanium ciliatum* (Ülgentürk, 2001). In Turkey, *A. fasciatus* is more dominant and significant compared to *A. nebulosus*, in that it is reported reducing the population of *E. ciliatum* by up to 73% (Ülgentürk, 2001).

Eight species of ladybirds were collected, of which *H. axyridis*, *H. variegata* and *P. quatuordecimpunctata* were recorded for the first time as predators of Coccidae in Serbia. *H. axyridis* was collected from colonies of 9 species of soft scale. This species is polyphagous and feeds on aphids, leafhoppers, scale insects and mites (Koch, 2003; Staverløkk et al., 2007; Michaud, 2012). *H. variegata* was collected for the first time in Serbia feeding on *P. hydrangeae*. This is a Palearctic species reported feeding on S. *prunastri* in Iran (Biranvand et al., 2017), a significant predator of aphids on crops (Koul, 2003) and on psyllids (Sarkar et al., 2023). *P. quatuordecimpunctata* was collected feeding on *E. tiliae*, which has not previously been reported in Serbian literature. Of the scale insects, it is reported feeding on *Ceroplastes floridensis* in Iran (Ostovan & Modaresi, 2006), but in Serbia, it is reported to be a predator of psyllids (Jerinić-Prodanović, 2010) and aphids (Jovičić, 2016).

The most prevalent species, *E. quadripustulatus*, was collected feeding on all 16 species of coccids. This Palearctic species is polyphagous and reported feeding on 36 species of scale insects from the families Coccidae, Diaspididae, Eriococcidae and Kermesidae (García-Morales et al., 2016). It is known as a significant predator of scale insects of the superfamily Coccoidea in Croatia (Masten-Milek et al., 2009) and Turkey (Kaydan et al., 2012). In Serbia, it is reported to be a predator of *P. corni* (Mitić-Mužina, 1964), *Ph. piceae* (Graora et al., 2012), *Ph. hemicryphus* (Simonović et al., 2018) and species of the family Diaspididae (Mihjalović & Kozarževskaja, 1983).

Ch. bipustulatus and *Ch. renipustulatus* are reported as predators of *P. corni* and *Pulvinaria floccifera*, with *Ch. renipustulatus* also feeding on *P. fletcheri*. Species of the genus *Chilocorus* have a cosmopolitan distribution and feed on scale insects belonging to the families Coccidae and Diaspididae (Ponsonby & Copland, 1997; Masten-Milek, 2007; Masten-Milek, 2009). In Serbia, they are reported as predators of scale insects belonging to the family Diaspididae (Graora, 1994; Graora et al., 2009).

C. septempunctata was collected from colonies of *C. hesperidum* and *P. hydrangeae*. This species is polyphagous feeding primarily on aphids, with scale insects, mites, honeydew, pollen, and nectar listed as secondary food sources (Ali & Rizvi, 2007). It is reported feeding on *P. corni* (Mitić-Mužina, 1964), psyllids (Jerinić-Prodanović, 2010) and aphids in Serbia (Jovičić, 2016).

S. abietis is reported feeding on *Ph. hemicryphus* and *Ph. piceae*. Species of the genus *Scymnus* are known predators of scale insects of the family Coccidae (Ponosby & Copland, 1997).

Dermapteran predators

One species, *F. auricularia*, was collected feeding on *E. tiliae* and *Ph. piceae*, and is also reported as a predator of *Physokermes inopinatu*s (Stathas & Kozár, 2010), and scale insects in the family Diaspididae (Henderson, 2011).

Dipteran predator

The predatory fly, *L. silesiaca*, was recorded feeding on four species of Coccidae (*N. innumerabilis*, *P. floccifera*, *P. hydrangeae* and *P. vitis*), whose females produce white ovisacs in which this predator lays its eggs. In Serbia, it is previously reported feeding on *Pulvinaria vitis* and *P. floccifera* (Mihjalović & Kozarževskaja, 1983; Graora et al., 2016), and in this study, it was first recorded feeding on *N. innumerabilis* and *P. hydrangeae*. In Europe, *L. silesiaca* is mentioned as a predator of numerous species of Coccidae (Kosztarab & Kozar, 1988; Pellizari, 1997; Ülgentürk, 1999), Pseudooccidae (Bei-Bienko,1989) and Eriococcidae (Hoffmann, 2002).

Hemipteran predators

The lime seed bug, *O. lavaterae*, was collected from colonies of *C. hesperidum*, which is the first record of this species being zoophagous, both in Serbia and worldwide. Previously, it was recorded as phytophagous, feeding on herbaceous and shrubby plants of the family Malvaceae (Nedvěd et al., 2014).

D. ruber was collected from colonies of *E. tiliae*, which is a new finding for Serbia. According to Ülgentürk & Toros (1999) this species is a predator of *Eulecanium ciliatum* (Douglas) in Turkey, whereas in Serbia, it is reported as a predator of aphids, mites, larvae of butterflies and other true bugs (Protić, 1993), as well as Diaspid scales (Graora et al., 2009).

Neuropteran predator

During this research, *Ch. carnea* was collected from colonies of five species of soft scale. In Serbia, it is previously reported only feeding on *P. corni* and species of the family Diaspididae (Graora et al., 2009). *Ch. carnea* is a significant biological control agent of aphids and other soft-bodied phytophagous insects (Pappas et al., 2011; Rashid et al., 2012). Due to its wide geographical distribution, ease with which it can be reared in the laboratory and voracity it is an important component of IPM programs (Tolstova, 1986; Khuhro et al., 2012). Lacewing larvae feed on a wide range of pests, whereas adults feed on nectar, pollen and honeydew (Coppel & Mertins, 1977).

CONCLUSIONS

This research recorded the presence of predators belonging to different families and orders, whose role in reducing the abundance of coccid pests can be significant, especially in urban environments and organic agricultural production systems. It is important to note that several species were identified for the first time as predators of Coccidae in Serbia and in the case of *O. lavaterae,* worldwide. Future research should focus on the study of the behaviour, ecology and the role of predators in the control of soft scale in different ecosystems.

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