

Contribution to the knowledge of Araneae (Arachnida) in Skopje valley, North Macedonia

Dragan Matevski^{1,2}, Christo Deltshev³, Aleksandra Cvetkovska-Gjorgjievska^{1*}, Stoyan Lazarov⁴, Dana Prelic¹

¹Institute of Biology, Faculty of Natural Sciences and Mathematics, Ss. Cyril and Methodius University, Skopje, North Macedonia

²Department of Forest Nature Conservation, Faculty of Forest Science and Ecology, University of Göttingen, Büsgenweg 3, 37077 Göttingen, Germany;

³Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, 1 Tsar Osvoboditel Blvd., 1000 Sofia, Bulgaria

⁴National Museum of Natural History, Bulgarian Academy of Sciences, 1 Tsar Osvoboditel Blvd., 1000 Sofia, Bulgaria

Abstract



A total of 71 species belonging to 14 families (Araneidae - 1; Dysderidae - 3; Gnaphosidae - 21; Linyphiidae - 6; Liocranidae - 2; Lycosidae - 19; Philodromidae - 2; Pisauridae - 1; Salticidae - 3; Tetragnathidae - 2; Theridiidae - 1; Thomisidae - 4; Titanoecidae - 3; Zodariidae - 2) were registered from three sites in Skopje valley, North Macedonia. Of the registered species, 3 are new for the Macedonian fauna: *Hypsosinga sanguinea* (C. L. Koch, 1844), *Marinarozelotes adriaticus* (Caporiaco, 1951) and *Zelotes harmeron* Levy, 2009. They haven't been recorded before due to the lack of faunistic research of spiders in R. North Macedonia. The araneofauna is classified into 17 zoogeographic categories combined in 4 chorological complexes (widely distributed, European, Mediterranean and endemics). Widely distributed species are dominant (60,56%), followed by European (21,13%), Mediterranean (11,27%) and endemics (7,04%).

Key words: Balkan peninsula, New faunistic records, urban fauna, spiders

Introduction

On a national level, the araneofauna of North Macedonia is poorly investigated (Hristovski et al. 2015) with the first checklist being published by Blagoev (2002), listing 558 species. From that point on, several authors have contributed to the knowledge of the Macedonian araneofauna: Komnenov (2002, 2003, 2006, 2014, 2017), Deltshev (2003, 2008), Ćurčić et al. (2004), Fisher & Azarkina (2005), Deltshev et al. (2006, 2007, 2013), Komnenov & Pavičević (2008), Stefanovska et al. (2008), Hristovski et al. (2015), Deltshev & Wang (2016)

and Matevski et al. (2017, 2020). After critically revising all published data, Hristovski et al. (2015) estimated the total number of species in North Macedonia to reach the number of 767, nine of which are local endemics. Since then, Deltshev & Wang (2016) have published one, while Komnenov (2017) has published 29 new species for the North Macedonia fauna for a total of 797 species.

When compared with the neighboring countries, species richness of spiders from North Macedonia is relatively high. According to literature data, the highest number of species is known for Bulgaria - 910 (Deltshev & Blagoev 2001), followed by Greece - 856 (Bosmans & Chatzaki 2005), Serbia - 648 (Deltshev et al. 2003, Grbić et al. 2021), Albania - 335 (Deltshev et al. 2011) and Kosovo - 159 (Geci and Naumova 2021). However, these

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numbers are mainly result of the research interests and degree of the explorations by araneologists.

As far as Skopje region and the knowledge of urban spider fauna from North Macedonia is concern, the research of Stefanovska et al. (2008) remains the only detailed study on the araneofauna of Skopje valley, carried in other parts of the urban zone of the city of Skopje, as well as the surroundings of the settlement Madzari and the village Mralino. This study resulted with a list of 118 species, 31 new for the Macedonian fauna, as well as 7 endemic species, which emphasizes high species richness of this region. This conclusion is supported also by the recent description of a new *Agroecina* species from the area (Deltshev & Wang 2016).

Faunistic researches can increase the awareness of environmental protection by enriching the knowledge about species richness and composition. Although there is an interest in studying the spider fauna in North Macedonia, it is still insufficient. This especially refers to the data on the urban fauna, having in mind the intensified urbanization, especially in the area of Skopje city which is considered one of the largest and fastest growing city in North Macedonia.

It is well known that the intensive human population growth and increased urbanization have profound impact on biodiversity and ecosystem functioning. Therefore, the present study is a contribution to the knowledge of the araneofauna inhabiting suburban part of Skopje valley, including three new records for the fauna of North Macedonia.

Study area

This study was carried out in Skopje valley (270-290 m a.s.l.) as part of Skopje region, which is the largest urban region in North Macedonia. It comprises of three study sites (Fig. 1.) in Bardovci municipality in the suburban part of Skopje city, exposed to growth of residential buildings over the previous two decades. This trend of increased urbanization leads to continuous

environmental degradation and unavoidable negative impact on the variety of species and habitats.

L1 – Skopje valley, Bardovci municipality (42.030450°N, 21.385170°E, 293 m a.s.l.), dominated by weed communities of recently abandoned rural constructions

L2 – Skopje valley, Bardovci municipality (42.041101°N, 21.370075°E, 285 m a.s.l.), lowland habitats colonized by tall nitrophilous herbs, next to a vineyard plantation

L3 – Skopje valley, Bardovci municipality, (42.034000°N, 21.366670°E; 272 m a.s.l.), moist or wet tall-herb and fern fringes and meadow, near the river Lepenec

Material and methods

The material was collected with the use of pitfall traps. The pitfall traps were constructed out of 300 ml plastic cups with a diameter of 85 mm. Five of them were set in a line, with a distance of 10 m between them. A solution of 4% formalin and vinegar (1:7) was used as a preserving agent (vinegar as attractant and formaldehyde as preserving agent). Vinegar and formalin are among preserving agents used in capturing ground-dwelling arthropods, including spiders (Stefanovska et al. 2008, Komnenov 2020, Matevski et al. 2020). The material was collected monthly in the period 1st. Apr. – 30th. Aug. 2014. Collected spiders were analysed taxonomically with the use of keys by Heimer & Nentwig (1991) and Nentwig et al. (2022), as well as the personal collection of Christo Deltshev. Data on general distribution was taken from World Spider Catalog (2022), while data on zoogeographic classification of spiders are taken from Stefanovska et al. (2008), Deltshev et al. (2011, 2013) and Komnenov (2014, 2017). The material (including reference collection) is deposited in the National Collection of Invertebrates at the Institute of Biology, Faculty of Natural Sciences and Mathematics in Skopje.



Figure 1. Location of the three study sites in Skopje valley

Results

The araneofauna was presented by 716 individuals belonging to 71 species and 14 families. Among them, 676 were adults (220 females and 456 males), 5 sub adults and 35 juveniles. Most of the species belonged to family Gnaphosidae – 21, followed by Lycosidae – 19, Linyphiidae – 7 and Thomisidae – 4. Dysderidae, Salticidae, Titanoecidae each were presented by 3 species. Other families, Philodromidae, Liocranidae, Tetragnathidae and Zodariidae consisted of 2 species, while Araneidae, Pisauridae and Theridiidae were present with only one species. Gnaphosidae (21/29,6%) and Lycosidae (19/26,6%) had highest species richness, while genera *Pardosa* (7) and *Zelotes* (7) were the most diverse (Table 1).

Three species are new for the Macedonian fauna (marked in the faunistic list with an asterisk (*)).

Discussion

New records for the North Macedonian fauna: Of all the species present, three are new for the Macedonian fauna (marked with * in the faunistic list): *Hypsosinga sanguinea* (C. L. Koch, 1844), *Marinarozelotes adriaticus* (Caporiaco, 1951) and *Zelotes harmeron* Levy, 2009.

Hypsosinga sanguinea is widely distributed in Europe as well as the entire Palearctic region, while *Marinarozelotes adriaticus* and *Zelotes harmeron* have a narrower distribution. These species have been previously recorded in one or more neighbouring countries, and in some cases North Macedonia is one of two or three Balkan countries where the species has not been registered yet. This is due to a lack of faunistic research in North Macedonia. Most probably, their distribution is not isolated in the Skopje valley and it is expected that these species are distributed in other Macedonian regions as well.

Hypsosinga sanguinea has been recorded in Europe, North Africa, Turkey, Russia (Europe to Far East),

Iran, Central Asia, China, Korea, Japan (World Spider Catalogue 2022) and it is found on shrubs and trees in deciduous and mixed forests, often on conifers (Le Peru 2011). Knoflach et al. (2009) give mainly bushes and trees as habitats. In this study, it was recorded in an arid scrub in the Skopje valley.

Marinarozelotes adriaticus is distributed in Italy, Croatia, Albania, Greece, South Urals, North Caucasus and NW China near streamside fields, rocks (Tuneva & Eyunin 2001, Song et al. 2004, Chatzaki 2010, Kúrka et al., 2020). In this study, it was recorded next to a vineyard plantation near a stream in the Skopje valley. Its presence in Croatia, Greece and now North Macedonia suggests that this species has a wider distribution in the Balkan Peninsula.

Zelotes harmeron has distribution in Greece and Israel. The species was described in Israel, by Levy (2009), and it has also been recorded in Turkey, in Kahramanmaras province (Seyar et al. 2010). In this study, it was recorded in an arid scrub and next to a vineyard plantation near stream, both located in the Skopje valley. Due to the recent description of this species and the general lack of faunistic research in the Balkan Peninsula, it is probable that this species has a wider distribution in the Balkan region.

Zoogeographical analysis: According to their current distribution the established 71 species can be classified into 17 zoogeographic categories, grouped into 4 chorological complexes (Fig 2):

1. Widely distributed: Cosmopolitan (COS) + Holarctic (HOL) + Palearctic (PAL) + Euro-Asian (EUR) + Europe to Central Asia (ECA) + Europe-Middle Asian (EMA) + Mediterranean-Central Asia (MCA) + Mediterranean-Middle Asiatic (MMA) + Euro-Siberian (EURS);
2. European (EUR): European (EUR) + Euro-Caucasian (EURC) + S-European (SEUR);
3. Mediterranean: Mediterranean (MED) + Ponto-E-Mediterranean (PEM);
4. Endemics: Carpatho-Balcanic (CBAL) + Balkan endemic (BP) + Macedonian (local) endemic (MK).

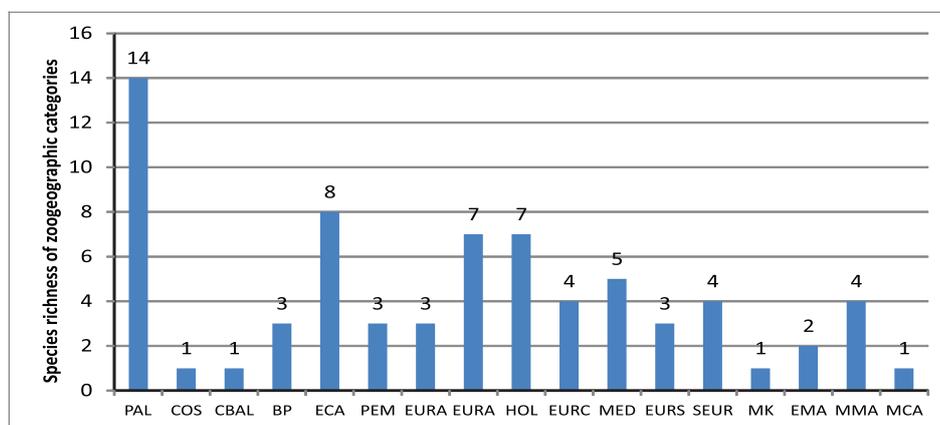


Figure 2. Zoogeographic distribution of the araneofauna of Skopje valley

Table 1: Species composition and zoogeographic classification of the recorded spiders; Legend: Asterisk (*) in the first column indicates new records for the spider fauna of N.M. Zoogeographic categories listed on the table follow Stefanovska et al. (2008), Deltshv et al. (2011, 2013), Komnenov (2014, 2017): Cosmopolitan (COS), Holarctic (HOL), Palearctic (PAL), Euro-Asian (EUR), Europe-Central Asia (ECA), Euro-Middle Asian (EMA), Mediterranean-Central Asia (MCA), Mediterranean-Middle Asiatic (MMA), Euro-Siberian (EURS), European (EUR), Euro-Caucasian (EURC), S-European (SEUR), Mediterranean (MED), Ponto-E-Mediterranean (PEM), Carpatho-Balcanic (CBAL), Balkan endemic (BP), endemic to North Macedonia (MK)

Family	Species	L1		L2		L3		Total			Zoogeographic distribution
		male	female	male	female	male	female	male	female	total	
Araneidae	<i>Hypsosinga sanguinea</i> (C. L. Koch, 1844)*	1						1	1	2	PAL
Araneidae Total		1						1		1	
Dysderidae	<i>Dysdera crocata</i> C. L. Koch, 1838				2				2	2	COS
	<i>Harpactea saeva</i> (Herman, 1879)			2				2		2	CBAL
	<i>Harpactea samuili</i> Lazarov, 2006			2	1			2	1	3	BP
Dysderidae Total				4	3			4	3	7	
Gnaphosidae	<i>Civizelotes caucasicus</i> (L. Koch, 1866)	16	12	5	17			21	29	50	ECA
	<i>Civizelotes gracilis</i> (Canestrini, 1868)				1				1	1	PEM
	<i>Drassodes pubescens</i> (Thorell, 1856)			1				1		1	EUR
	<i>Drassyllus praeficus</i> (L. Koch, 1866)		1	2				2	1	3	ECA
	<i>Drassyllus pusillus</i> (C. L. Koch, 1833)	7				1		8		8	EUR
	<i>Gnaphosa lucifuga</i> (Walckenaer, 1802)				1	1	1	1	2	3	PAL
	<i>Haplodrassus bohemicus</i> Miller & Buchar, 1977			3				3		3	PEM
	<i>Haplodrassus dalmatensis</i> (L. Koch, 1866)	2		1				3		3	PAL
	<i>Haplodrassus minor</i> (O. Pickard-Cambridge, 1879)		7		7				14	14	EUR
	<i>Haplodrassus signifer</i> (C. L. Koch, 1839)	2		7	8		1	9	9	18	HOL
	<i>Micaria guttulata</i> (C. L. Koch, 1839)		1						1	1	EUR
	<i>Micaria pulicaria</i> (Sundevall, 1831)						2		2	2	HOL
	<i>Marinarozelotes adriaticus</i> (Caporiaco, 1951)*			1				1		1	ECA
	<i>Trachyzelotes pedestris</i> (C.L. Koch, 1837)					3		3		3	EURC
	<i>Zelotes atrocaeruleus</i> (Simon, 1878)	1	3					1	3	4	PAL
	<i>Zelotes babunaensis</i> (Drenski, 1929)	1		1				2		2	BP
	<i>Zelotes clivicola</i> (L. Koch, 1870)	1		3	1			4	1	5	PAL
	<i>Zelotes harmeron</i> Levy, 2009*	1	5		1			1	6	7	MED
	<i>Zelotes hermani</i> (Chyzer, 1897)		2		1				3	3	PEM
	<i>Zelotes latreillei</i> (Simon, 1878)					1		1		1	EURS
	<i>Zelotes longipes</i> (L. Koch, 1866)	1		3				4		4	ECA
Gnaphosidae Total		32	31	27	37	6	4	65	72	137	
Linyphiidae	<i>Diplocephalus graecus</i> (O. Pickard-Cambridge, 1873)	1						1		1	MED
	<i>Diplostyla concolor</i> (Wider, 1834)						1		1	1	HOL
	<i>Neriere clathrata</i> (Sundevall, 1830)					1	1	1	1	2	HOL
	<i>Oedothorax apicatus</i> (Blackwall, 1850)						9		9	9	PAL
	<i>Palliduphantes byzantinus</i> (Fage, 1931)	1						1		1	SEUR
	<i>Prinerigone vagans</i> (Audouin, 1826)					2		2		2	PAL
	<i>Trichoncus hackmani</i> Millidge, 1955		1						1	1	EUR
Linyphiidae Total		2	1			3	11	5	12	17	
Liocranidae	<i>Agraecina scupiensis</i> Deltshv, 2016			2				2		2	MK
	<i>Agroeca cuprea</i> Menge, 1873				1				1	1	ECA

Liocranidae Total				2	1			2	1	3	
Lycosidae	<i>Alopecosa accentuata</i> (Latreille, 1817)	1		1				2		2	EMA
	<i>Alopecosa albofasciata</i> (Brullé, 1832)	1	3	4				5	3	8	PAL
	<i>Alopecosa pentheri</i> (Nosek, 1905)	1		6				7		7	MED
	<i>Alopecosa pulverulenta</i> (Clerck, 1757)			1				1		1	PAL
	<i>Arctosa leopardus</i> (Sundevall, 1833)					45	21	45	21	66	PAL
	<i>Arctosa stigmosa</i> (Thorell, 1875)						2		2	2	EURS
	<i>Hogna radiata</i> (Latreille, 1817)				1				1	1	MMA
	<i>Lycosa praegrans</i> C.L. Koch, 1836	1						1		1	MMA
	<i>Pardosa agrestis</i> (Westring, 1861)					2		2		2	EUR
	<i>Pardosa agricola</i> (Thorell, 1856)			10	1	28	9	38	10	48	EUR
	<i>Pardosa alacris</i> (C.L. Koch, 1833)	5						5		5	EUR
	<i>Pardosa atomaria</i> (C.L. Koch, 1847)				1	4	1	4	2	6	SEUR
	<i>Pardosa bifasciata</i> (C.L. Koch, 1834)	1	1		3	1	2	2	6	8	EURS
	<i>Pardosa hortensis</i> (Thorell, 1872)			13	7	5	2	18	9	27	EURC
	<i>Pardosa proxima</i> (C.L. Koch, 1847)	6		9	1	108	27	123	28	151	PAL
	<i>Piratula hygrophila</i> (Thorell, 1872)					1	1	1	1	2	ECA
	<i>Piratula latitans</i> (Blackwall, 1841)					34	8	34	8	42	EURC
	<i>Trochosa hispanica</i> Simon, 1870			3	1	5	7	8	8	16	MCA
<i>Trochosa terricola</i> Thorell, 1856					2	2	2	2	4	HOL	
Lycosidae Total		16	4	47	15	235	82	298	101	399	
Philodromidae	<i>Philodromus cespitum</i> (Walckenaer, 1802)						1		1	1	HOL
	<i>Thanatus atratus</i> Simon, 1875	30	3	1	1			31	4	35	EMA
Philodromidae Total		30	3	1	1		1	31	5	36	
Pisauridae	<i>Pisaura mirabilis</i> (Clerck, 1757)			1		1		2		2	PAL
Pisauridae Total				1		1		2		2	
Salticidae	<i>Pellenes brevis</i> (Simon, 1868)			1				1		1	SEUR
	<i>Pellenes seriatus</i> (Thorell, 1875)						1		1	1	ECA
	<i>Phlegra fasciata</i> (Hahn, 1826)	3	2			1		4	2	6	EURA
Salticidae Total		3	2	1		1	1	5	3	8	
Tetragnathidae	<i>Pachygnatha clercki</i> Sundevall, 1823					2	1	2	1	3	HOL
	<i>Pachygnatha degeeri</i> Sundevall, 1930					8	4	8	4	12	PAL
Tetragnathidae Total						10	5	10	5	15	
Theridiidae	<i>Enoplognatha thoracica</i> (Hahn, 1833)		1						1	1	EUR
Theridiidae Total			1						1	1	
Thomisidae	<i>Bassaniodes caperatus</i> (Simon, 1875)	2						2		2	MED
	<i>Ozyptila confluens</i> (C.L. Koch, 1845)	9	4		1			9	5	14	SEUR
	<i>Xysticus acerbus</i> Thorell, 1872	4		1				5		5	EURC
	<i>Xysticus kochi</i> Thorell, 1872	2	3	7	4			9	7	16	MMA
Thomisidae Total		17	7	8	5			25	12	37	
Titanoeidae	<i>Nurscia albomaculata</i> (Lucas, 1846)	3		3				6		6	MMA
	<i>Titanoeca tristis</i> L. Koch, 1872			1				1		1	ECA
Titanoeidae Total		3		4				7		7	
Zodariidae	<i>Zodarion frenatum</i> Simon, 1885		1		3				4	4	SEUR
	<i>Zodarion ohridense</i> Wunderlich, 1973				1	1		1	1	2	BP
Zodariidae Total			1		4	1		1	5	6	
Grand Total		104	50	95	66	257	104	456	220	676	

Widely distributed complex is best represented and is comprised of 43 species (60,56%). Palearctic species are dominant (14/19,72%), followed by European-Central Asian (8/11,27%) and Holarctic species (7/9,86%).

European chorological complex includes 15 species (21,13%) inhabiting Europe. Species with a wide distribution in Europe dominate with 7 species (9,86%).

Mediterranean complex is represented by the MED and PEM zoogeographic categories, which are present with 5 (7,04%) and 3 (4,23%) species respectively.

Balkan endemics are represented by the Carpatho-Balkan species *Harpactea saeva*, the Balkanic endemics *Zelotes babunaensis*, *Zodarion ohridense* and *Harpactea samuili*, and the Macedonian endemic species *Agroecina scupiensis*, found only in Skopje.

The zoogeography of the Balkan fauna as well as large areas important for the genesis of the Balkan fauna, such as the Mediterranean, Asia Minor, Caucasus, Central Asia and Siberia, are insufficiently studied (Komnenov 2014). Because of this, the distribution range of many species cannot be reliably presented. This makes it almost impossible to clearly identify and properly characterize faunal relationships between these regions (Komnenov 2013). As a result, all zoogeographical analysis of the Balkan spider fauna, especially endemics cannot be considered conclusive.

Faunistically important species: Special attention is paid to endemic species as faunistically important species, because they are highly adapted to their home range, have narrow or restricted distribution and are considered as one of the most important components in conservation processes.

Agroecina scupiensis was recently described from North Macedonia (Deltshev & Wang 2016) and has been recorded from Greece (Chatzaki & Van Keer 2019) since then. It was previously registered from grass vegetation in the Skopje valley. In this study, it was registered next to a vineyard near a stream in the Skopje valley.

Harpactea saeva is a Carpatho-Balkan species distributed in Slovakia, Hungary, Romania, S-Ukraine, Moldova, Serbia, Bulgaria, North Macedonia, Albania and Greece (Komnenov 2014). It inhabits the litter layer, preferably of oak forests (Nentwig et al. 2022). In this study, it was registered next to a vineyard near a stream in the Skopje valley. The oak trees in the surrounding area explain the presence of this species in the vineyard.

Harpactea samuili is described from Bulgaria (Lazarov 2006), and known only from Bulgaria and North Macedonia (Stefanovska et al. 2008) inhabiting screes and dry stony areas covered with bushes. In this study, it was registered next to a vineyard near a stream in the Skopje valley.

Zelotes babunaensis is a species endemic to North Macedonia, Greece. It is reported also from Turkey (Coşar & Danişman 2019) and Iran (Hosseinpour et al., 2019, Zamani et al. 2020).

In this study, it was registered in an arid scrub and next to a vineyard near a stream, both in the Skopje valley.

Among Balkan endemics also, is the species *Zodarion ohridense* registered in Skopje valley, near the river Lepenec in a habitat of tall-herbs, and in lowland habitats colonized by tall nitrophilous herbs, next to a vineyard plantation.

Conclusions

A total of 71 species from 14 families were registered in this study, three of which are new for the Macedonian fauna: *Hypsosinga sanguinea*, *Marinarozelotes adriaticus* and *Zelotes harmeron*. The newly registered species haven't been recorded before due to the lack of research on the Macedonian araneofauna. Among the 4 recorded chorotypes the widely distributed species dominate, representing 60,56% of all species.

The fact that the limited sampling campaign in this study resulted in three new records for the Macedonian fauna emphasizes the need for further faunistic research in order to fully understand the composition and distribution not only of spiders inhabiting urban areas, but in general for the overall Macedonian araneofauna.

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References

- Blagoev, G. (2002). Check list of Macedonian spiders (Araneae). *Acta Zoologica Bulgarica*, **54** (3): 9–34.
- Bosmans, R. & Chatzaki, M. (2005). A catalogue of the spiders of Greece. *Arachnological Contributions*. Newsletter of the Belgian Arachnological Society, 20 (2, suppl.).
- Chatzaki, M. (2010). New data on the least known zelotines (Araneae, Gnaphosidae) of Greece and adjacent regions. *Zootaxa*, 2564 (1).
- Chatzaki, M. & Van Keer, J. (2019). Ground spiders (Araneae: Gnaphosidae, Liocranidae, Prodidomidae) from the Greek islands Rodos, Symi and Karpathos, with the description of new species. *Zootaxa*, **4646**: 434–460.
- Coşar, I. & Danişman, T. (2019). A new *Zelotes* record from Turkey (Araneae: Gnaphosidae). *Serket* **17**: 58–60.

- Ćurčić, B.P.M., Deltshev, C.C., Blagoev G.A., Ćurčić S.B., Makarov S.E., Mitic B.M., Stojkoska E.A., Stankovic S.V. (2004). On some leaf-litter and cave-dwelling spiders (Araneae: Arachnida) from the Republic of Macedonia. *Archives of Biological Science*, **56** (3-4): 23-24.
- Deltshev C., Komnenov M., Blagoev G., Naumova M. (2013). Faunistic diversity of spiders (Araneae) in Galichitsa mountain (FYR Macedonia). *Biodiversity data journal*, **1**.
- Deltshev, C. & Blagoev, G. (2001). A critical check list of Bulgarian spiders (Araneae). *Bulletin of the British Arachnological Society*, **12** (3): 110-138, Loughborough.
- Deltshev, C. & Wang, C. (2016). A new Agraecina spider species from the Balkan Peninsula (FYR Macedonia) (Araneae: Liocranidae). *Zootaxa*, **4117** (1): 135-140.
- Deltshev, C. (2003). A critical review of the spider species (Araneae) described by P. Drensky in the period 1915-1942 from the Balkans. *Berichte des Naturwissenschaftlich-Medizinischen Vereins in Innsbruck*. Bd., **90**: 135-150.
- Deltshev, C. (2008). Faunistic diversity and zoogeography of cave-dwelling spiders on the Balkan Peninsula. S.E., Dimitrijević, R.N. (eds.). *Advances in arachnology and developmental biology. Papers dedicated to Prof. Dr. Božidar Ćurčić*. Institute of Zoology, Belgrade. Bulgarian Academy of Sciences, Sofia. Faculty of Life Sciences, Vienna. SASA, Belgrade; UNESCO MAB Committee, Serbia. *Monographs*, **12**: 327-348.
- Deltshev, C., Bosmans, R., De Spiegelaere, W. Provoost, L. (2006). *Zelotes balcanicus sp. n.*, a new and widespread species from the Balkan Peninsula (Araneae, Gnaphosidae). *Revue Suisse de Zoologie*, **113**: 711-716.
- Deltshev, C., Ćurčić, B., Blagoev, G. (2003). The spiders of Serbia. Committee for Karst and Speleology - Serbian Academy of Sciences and Arts; Institute of Zoology - Bulgarian Academy of Sciences; Institute of Zoology - Faculty of Biology - University of Belgrade; Institute for Biological Research „Siniša Stanković“ (co-publishers), Belgrade - Sofia. 833 pp.
- Deltshev, C., Lazarov, S., Stojkoska, E. (2007). A contribution to the study of spiders (Araneae) from the caves of the Republic of Macedonia. *Acta Zoologica Bulgarica*, **59** (3): 337-340.
- Deltshev, C., Vrenosi, B., Blagoev, G., Lazarov, S. (2011). Spiders of Albania - Faunistic and Zoogeographical Review (Arachnida: Araneae). *Acta Zoologica Bulgarica*, **63** (2): 125-144.
- Fisher, C. & Azarkina, G. (2005). A Contribution to the Knowledge of the Jumping Spiders (Salticidae: Araneae) of the Republic of Macedonia. *Acta Zoologica Bulgarica*, **57** (3): 299-304.
- Geci, D. & Naumova, M. (2021). A Preliminary Checklist of the Spiders of Kosovo (Arachnida: Araneae). *Ecologia Balkanica, Special Edition* **4**: 11-28
- Grbić, G., Hänggi, A., Krnjajić, S. (2021). Spiders (Araneae) of Subotica sandland (Serbia): Additional arguments in environmental protection. *Acta Zoologica Academiae Scientiarum Hungaricae*, **67** (1): 15-61
- Heimer, S. & Nentwig, W. (1991). *Spinnen Mitteleuropas: Ein Bestimmungsbuch*. 543 p. Verlag Paul Parey, Berlin.
- Hosseinpour, A., Zamani, A., Azizi, K., Moemenbellah-Fard, M. D., Soltani, A. (2019). Survey of spiders (Arachnida: Araneae) in southwestern Iran, with new records. *Ecologica Montenegrina*, **22**: 204-213.
- Hristovski, S., Slavevska-Stamenković, V., Hristovski, N., Arsovski, K., Bekchiev, R., Chobanov, D., Dedov, I., Devetak, D., Karaman, I., Kitanova, D. and Komnenov, M. (2015). Diversity of invertebrates in the Republic of Macedonia. *Macedonian Journal of Ecology and Environment*, **17** (1): 5-44.
- Knoflach, B., Rollard, C. & Thaler, K. (2009). Notes on Mediterranean Theridiidae (Araneae) - II. In: Stoev P, Dunlop J, Lavarov, S (eds.). *A life caught in a spider's web. Papers in arachnology in honour of Christo Deltshev*. *Zookeys*, **16**: 227-264
- Komnenov, M. (2013). Spider fauna of the Osogovo Mt. Range, Northeastern Macedonia. Pavičević D., Perreau, M. (Eds.). *Fauna Balkana*, **2**: 1-267.
- Komnenov, M. & Pavičević, D. (2008). First record of the spider *Segestria florentina* (Rossi, 1790) (Araneae, Segestriidae) from Serbia. *Protection of Nature*, **58** (1-2): 169-173.
- Komnenov, M. (2002). Contribution to the Study of Spiders (Araneae) on Šar Planina Mountain, North-West Macedonia. *Bulletin of the Biology Students Research Society*, **2**: 103-110.
- Komnenov, M. (2003). Contribution to the Study of Spiders (Araneae) on Jakupica Mountain, Macedonia. *Bulletin of the Biology Students Research Society*, **3**: 45-49.
- Komnenov, M. (2006). New data on jumping spiders in the Republic of Macedonia with a complete checklist (Araneae: Salticidae). *Acta Zoologica Bulgarica, Supplements*, **1** (1): 301-314.
- Komnenov, M. (2014). Spider fauna of the Osogovo Mt. Range, Northeastern Macedonia. *Fauna Balkana*, **2**: 1-267.
- Komnenov, M. (2017). New data on spider fauna (Araneae) of Shar Mountain, North-Western Macedonia. *Proceedings of the 5th Congress of the Ecologists of Macedonia, with international participation (Ohrid, 19th-22nd October 2016). Special issues of the Macedonian Ecological Society*, **13**: 44-61.
- Komnenov, M. (2020). First data on the spider fauna (Araneae) of Maleshevski Mountains in the Republic of Macedonia. *Bulletin of the Biology Students' Research Society*, **5**: 33-43
- Kûrka, A, Naumova, M, Indzhov, S, Deltshev, C. (2020). New faunistic and taxonomic data on the spider fauna of Albania (Arachnida: Araneae). *Arachnologische Mitteilungen*, **59**: 8-21

- Lazarov, S. (2006). A new spider species, *Harpactea samuili* sp. n., from Bulgaria (Araneae: Dysderidae). In: Deltshev C & Stoev P. (eds.). European Arachnology 2005. Acta Zoologica Bulgarica, Supplement, **1**: 81-85
- Le Peru, B. (2011). The Spiders of Europe, a synthesis of data: Atypidae to Theridiidae. Mémoires de la Société Linnéenne de Lyon, **2**: 1-522.
- Levy, G. (2009). New ground-spider genera and species with annexed checklist of the Gnaphosidae (Araneae) of Israel. Zootaxa, **2066**: 1-49
- Matevski, D., Cvetkovska-Gjorgjievska, A., Prelič, D., Hristovski, S., Naumova, M., Deltshev, C. (2020). Efficacy of trapping techniques (pitfall, ramp and arboreal traps) for capturing spiders. Biologia **75**: 2315-2319
- Matevski, D., Cvetkovska-Gjorgjievska, A., Prelič, D., Hristovski, S., Naumova, M., & Deltshev, C. (2020). Distribution and community structure of araneocoenoses (Araneae) along an altitudinal gradient on Kozuf Mountain (North Macedonia). Biologia, Springer: 1-14
- Matevski, D., Prelič, D., Cvetkovska-Gjorgjievska, A., Deltshev, C. (2017). Ecology and distribution of the araneocoenosis in the Skopje and Malesh valleys in the Republic of Macedonia. Macedonian Journal of Ecology and Environment, **19** (1): 15-21
- Nentwig, W., Blick, T., Bosmans, R., Gloor, D., Hänggi, A., Kropf, C. (2022). Spiders of Europe. Version 03.2022
- Seyar, O., Hakan, D., Metin, A. (2010). A new species and two new records of the genus *Zelotes* Gistel, 1848 (Araneae: Gnaphosidae) from Turkey. Archives of Biological Sciences, Belgrade, **62** (2): 449-453, DOI:10.2298/ABS1002449S
- Song, D.X., Zhu, M.S., Zhang, F. (2004). Fauna Sinica: Invertebrata Vol. 39: Arachnida: Araneae: Gnaphosidae. Science Press, Beijing. 362 pp.
- Stefanovska, D., Naumova, M., Prelik, D., Deltshev, C., Lazarov, S. (2008). Spiders from the Skopje Region: a faunistic and zoogeographical analysis. Historia naturalis bulgarica, **19**: 35-49
- Tuneva, T.K. & Esyunin, S.L. (2001). A review of the family Gnaphosidae in the fauna of the Urals (Aranei), 2. New and rare genera. Arthropoda Selecta, **10** (3): 217-224
- World Spider Catalog (2022). World Spider Catalog. Version 23.0. Natural History Museum Bern
- Zamani, A., Mirshamsi, O., Marusik, Y. M., Moradmand, M. (2022). The Checklist of the Spiders of Iran. Version 2022