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The distribution of *Microcondylaea bonellii* (Bivalvia: Unionidae) in Slovenia

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Abstract. The freshwater bivalve *Microcondylaea bonellii* is classified as Vulnerable according to the last IUCN Red List assessment and also listed in Annex V of the Habitats Directive. According to more than one hundred years old data, the species was present in Slovenia in a restricted section of the Vipava River and its tributary the Lijak Stream, which is also the species' type location. We surveyed all previously known as well as new potential localities for *M. bonellii*. Live mussels were found only in the lower part of the Vipava River, but not in the Lijak Stream. Nevertheless, the population in Slovenia is isolated from other populations and restricted only to 16 km of the Vipava River. Unfortunately, key sections of the Vipava River have been subjected to habitat destruction in the past and are threatened by ongoing engineering works and developments. Thus the legislation should be taken into strict consideration immediately if we want to preserve this protected species and its habitat.

Key words: *Microcondylaea bonellii*, distribution, type locality, Vipava River, Slovenia, the Habitats Directive

Izvleček. Razširjenost rečne enozobke (*Microcondylaea bonellii*; Bivalvia: Unionidae) v Sloveniji – Rečna enozobka je kot ranljiva vrsta uvrščena na Rdeči seznam IUCN in na Prilogo V Direktive o habitatih. Glede na več kot sto let stare podatke je vrsta živela na omejenem odseku reke Vipave in v njenem pritoku Lijaku, ki je hkrati tudi tipsko najdišče te vrste. Na terenu sva rečno enozobko iskala na vseh predhodno znanih, hkrati pa tudi na novih potencialnih nahajališčih. Žive školjke sva našla le v spodnjem delu reke Vipave, ne pa tudi v potoku Lijaku. Slovenska populacija je izolirana od drugih populacij, njen habitat pa je omejen le na 16 km dolgi odsek reke Vipave. Ta je bila v preteklosti izpostavljena posegom, ki so vodili v preoblikovanje habitata, vodnogospodarska dela pa potekajo še naprej. Zato bi bilo treba nujno začeti upoštevati obstoječo zakonodajo, če želimo ohraniti to zavarovano vrsto in njen habitat.

Ključne besede: *Microcondylaea bonellii*, rečna enozobka, tipsko najdišče, razširjenost, reka Vipava, Slovenija, Direktiva o habitatih

Introduction

Freshwater bivalves of the order Unionida, also known as freshwater mussels, are represented in Europe by at least 16 recognized species with several subspecies grouped into two families Margaritiferidae and Unionidae (Cuttelod et al. 2011, Lopes-Lima et al. 2017). Some species are widely distributed, while others have a relatively limited range. *Microcondylaea bonellii* (A. Ferussac, 1827) (= *M. compressa* Menke, 1828) is restricted to southern Europe and has been recorded from the Italian Peninsula to the Adriatic drainages of the Balkans (Lopes-Lima et al. 2017). Most of the populations of *M. bonellii* are restricted to the Po River Basin in Italy, where it is present in a few tributaries of the Po River (Lopes-Lima et al. 2017), with no more than 30 known locations (Oliverio et al. 2016). Isolated populations have also been recorded in the Soča (= Isonzo) River Basin in Italy (Nagel & Hoffmeister 1986, Cencetti & Castagnolo 1997, Nagel et al. 2007) and in the Mirna River on the Istrian Peninsula in Croatia (Fischer 1999, Fischer & Reischütz 1999, Reischütz & Reischütz 2002, Mrkvicka 2018). In the last ten years new populations have been discovered in Albania (Reischütz et al. 2008, 2014). It is considered to be extinct in Switzerland (Rüetschi et al. 2012).

In Slovenia, *M. bonellii* has been found in the Soča's tributary, the Vipava River (Erjavec 1877, Kobelt 1884, Gallenstein 1889, 1894, Reischütz & Reischütz 2002), and in its tributary, the Lijak Stream (Rossmässler 1835, Erjavec 1877, Kobelt 1884, Gallenstein 1889, 1894, Reischütz & Reischütz 2002), which is also the type location (Rossmässler 1835). The lectotype specimen is housed at the Naturmuseum Senckenberg Frankfurt am Main (Zilch 1967). The Vipava River and Lijak Stream are also mentioned in many recent Slovenian (Bole 1969, 1992, Velkovrh 2003, Slapnik 2013, Govedič 2017) and international papers (Fischer 1999, Fischer & Reischütz 1999, Bössneck 2002, Nagel et al. 2007, Rüetschi et al. 2012, Lapini et al. 2013) without any definitive proof that the species is still present in the year of publication. Only Reischütz & Reischütz (2002) confirmed its presence in the Vipava River and found empty shells in the Lijak Stream.

Freshwater mussels, particularly Unionidae and Margaritiferidae, rank among the most endangered organisms in freshwater ecosystems and have experienced a global decline in species richness, distribution and abundance (Lopes-Lima et al. 2017). *M. bonellii* has undergone a serious decline (Nagel et al. 2007). Until the beginning of the last century it was considered relatively abundant. As in many other freshwater mussel species, the drastic decline of this species is probably due to human impacts, among which habitat destruction and water pollution are the most important factors. Using the last IUCN Red List assessment, *M. bonellii* is recognized as Vulnerable (Albrecht et al. 2011). It has been assessed as Vulnerable in the European Red List of non-marine Molluscs (Cuttelod et al. 2011). *M. bonellii* is also listed under the name *M. compressa* in Annex V of the Habitats Directive (OJ 1992) and protected under the Bern Convention (Appendix III - Protected fauna species). In Slovenia, both the species and their habitats are protected (Ur. l. RS 2004). After adoption of the Habitats Directive in 1992, intensive research activity on species of conservation concern was spurred in many European countries. However, the emphasis was on Annex II and some Annex IV species but unfortunately not for Annex V species. Therefore a knowledge gap has arisen for the ecology and even the basic distribution of many species, also for *M. bonellii.*

Even the host fishes for *M. bonellii* glochidia remain unclear (Nagel et al. 2007, Lopes Lima et al. 2017).

No research and monitoring of most Annex V species in Slovenia has been carried out and, in turn, no new data have been collected so far. The ongoing unknown status (XX) of *M. bonellii* was reported under Article 17 of the Habitats Directive in 2007 and 2013 (ZRSVN 2007, 2013). Article 11 of the Habitats Directive requires Member States to monitor the habitats and species listed in the Annexes (habitats in the Annex I and species in the Annexes II, IV and V), while Article 17 requires a report to be sent to the European Commission every 6 years. As there are no published and up-to-date data on the species in Slovenia and old literature is commonly overlooked, there is also a gap in the distribution maps in the last review of European Unionidae (Lopes-Lima et al. 2017). At the same time, many recent papers about *M. bonellii* just mention its presence in Slovenia (Fischer 1999, Fischer & Reischütz 1999, Bössneck 2002, Nagel et al. 2007, Rüetschi et al. 2012, Lapini et al. 2013), but none of them bring new data or proof that this species is still present in Slovenia.

In this paper we present recent data on the distribution of *M. bonellii* in Slovenia.

Materials and methods

The Vipava River is a 49 km long left tributary of the Soča River, with its mouth in the northern Adriatic Sea. The Vipava River spring system is located at an elevation of 98 m a.s.l. in Vipava town in the western foothills of the Nanos massive. It drains a 598 km^2 catchment (Brenčič 2013, Monegato et al. 2015). In Miren, the Vipava River leaves Slovenia and enters Italy, where it discharges into the Soča River after 5 km, at an elevation of 30 m. The average discharge in Miren is 16.5 m^3/s, the minimum can be less than 2 m^3/s and the maximum 341 m^3/s (Brenčič 2013). At Miren it reaches a width of 30 m. The Vipava River has a Dinaric pluvio-nival regime, in which spring and autumn peaks are fairly similar, while differences between winter highs and summer lows are pronounced (Pavlič & Brenčič 2010). The Vipava River spring is a typical karst, water-rich spring, with a stable average water temperature of 9.5°C which oscillates between 8.5°C and 10°C (Pavlič & Brenčič 2010). In Miren, water temperatures rarely fall below 4°C in the winter and can reach up to 26°C in the summer. Close to Renče, the Lijak Stream flows into the Vipava River. The maximum discharge close to the confluence with the Vipava River is 70 m^3/s and 2 m^3/s on average. Water temperature in the Lijak Stream rises up to 20°C in the summer and falls below 4°C in the winter.

Bivalve surveys were conducted between 2007 and 2018 during low water levels. In total, 23 localities were surveyed. Three of these localities were revisited (Tab. 1). Localities were selected, based on the known and predicted distribution of the species. We surveyed shallow water patches to a maximum water depth of 1 m. We combined methods of hand collection, hand netting and the use of surface bathiscope. To spot mussels or their siphons, especially on the gravel sediment, a surface bathiscope was used, while hand netting was performed only in fine river sediments. We also systematically searched for empty shells at gravel bars. As our focus was only the distribution and not quantitative surveys of *M. bonellii*, we didn't use methods for searching completely buried mussels, especially small ones. Consequently the results are presented as presence-absence only.

Table 1. List of survey locations, where *Microcondylaea bonellii* was searched for in Slovenia in the years 2007–2018. Letters in Sampling refer to: MG (Marijan Govedič), TBG (Teja Bizjak Govedič), PV (Peter Valič). Signs in the column *M. bonellii* refer to: x – live mussels, o – empty shells.

Tabela 1. Seznam lokacij vzorčenja rečne enozobke (*M. bonellii*) v letih 2007–2018 v Sloveniji. Razlaga kratic v stolpcu Vzorčenje: MG (Marijan Govedič), TBG (Teja Bizjak Govedič), PV (Peter Valič). Razlaga kratic v stolpcu *M. bonellii*: x – žive školjke, o – prazne lupine.

ID number /Zap. številka	Locality/Lokacija	Gauss-Krüger coordinates/ Gauss-Krügerjeve koordinate		Date/ Datum	Sampling/ Vzorčenje	Survey method/ Metoda vzorčenja		*M. bonellii*
		X	Y			water/ voda	gravel bar/ prodišče	
1	The Vipava River before national border	391124	83585	12. 8. 2016	MG, TBG, PV	x	x	x, o
2	The Vipava River close to national border East from Rupa village	391224	83978	13. 8. 2018	MG, TBG		x	o
3	The Vipava River downstream the bridge in the town of Miren	392360	84242	27. 5. 2015	MG		x	o
4	The Vipava River 50 m downstream from mouth of the Vrtojbica Stream	392819	84466	13. 8. 2018	MG, TBG	x	x	x, o
5	The Vipava River downstream the weir at village Pod Otokom	392926	84340	22. 7. 2018	MG, TBG	x		x, o
6	The Vipava River 200 m Northeast from Miren Castle downstream the weir Pri Selu	392242	83247	26. 5. 2018 20. 6. 2018	MG, TBG	x		x
7	The Vipava River downstream weir at Dolnji Konec	393857	83787	20. 7. 2018	MG, TBG	x		x
8	The Vipava River 400 m downstream from the bridge of the bypass of Renče town	396505	83799	13. 8. 2018	MG, TBG	x		x, o
9	The Vipava River at the mouth of the Oševljek Stream	397872	83649	20. 6. 2018	MG, TBG	x	x	x
10	The Vipava River under the bridge North from Gradišče above Prvačina	399859	84025	20. 7. 2018	MG, TBG, PV	x	x	x
11	The Vipava River downstream the weir of Gradišče hydropower plant	400851	83032	1. 6. 2015	MG		x	
12	The Vipava River under the bridge on the road Zalošče-Dornberk	402852	83540	30. 8. 2016	MG	x	x	

ID number /Zap. številka	Locality/Lokacija	Gauss-Krüger coordinates/ Gauss-Krügerjeve koordinate		Date/ Datum	Sampling/ Vzorčenje	Survey method/ Metoda vzorčenja		*M. bonellii*
		X	Y			water/ voda	gravel bar/ prodišče	
13	The Vipava River between former weir and railway bridge East from settlement Tabor	402795	82652	13. 8. 2018	MG, TBG	x	x	
14	The Lijak Stream at ARSO water measuring station	398193	84781	4. 6. 2015 20. 6. 2018 13. 8. 2018	MG	x		
15	The Lijak Stream between weir and railway bridge	398261	84887	13. 8. 2018	MG, TBG	x		
16	The Lijak Stream under the highway viaduct	399726	86765	26. 5. 2018	MG, TBG	x		
17	The Lijak Stream at the hunting observatory Northwest from crossroad towards the poultry	399922	88717	26. 5. 2018	MG, TBG	x		
18	The Lijak Stream under the bridge on the road Nova Gorica-Ajdovščina	400125	90102	16. 4. 2015	MG	x	x	
19	SE part of the Vogrščėk reservoir	403349	85271	12. 8. 2016	MG, TBG, PV		x	
20	The Vrtojbica Stream West from the bridge to the house address Vipavska cesta 90 in Rožna dolina settlement	396527	89194	3. 6. 2015 24. 6. 2016	MG	x		
21	The Pevnica Stream close to Podsabotin village	393227	94189	22. 7. 2018	MG, TBG	x		
22	The Briša Stream close to Vipolže village	387557	92684	22. 7. 2018	MG, TBG	x		
23	The Stream Oblenč close to Medana village	386554	94238	22. 7. 2018	MG, TBG	x		

Identification of mussels is unambiguous. *M. bonellii* has a unique shell shape which does not resemble any of the other species present in the Adriatic basin of Slovenia. It has a weakly developed cardinal tooth in each valve compared to the genus *Anodonta*, which is without teeth and *Unio* with well-developed teeth. *M. bonellii* is characterized by its tree-like (»arboriform«) siphonal papillae – all other European Unionidae have undivided papillae (Mrkvicka 2018). This characteristic allows the identification of mussels on underwater photos, especially on web photo forums.

All bivalves were measured (length, height and width) by using vernier caliper which is accurate to the nearest 0.1 mm. Living bivalves were immediately returned to their habitat, whereas empty shells were taken from the spot and are stored in the authors' private collection. Bivalves were surveyed in accordance with a licence (35603-3/2010-4) issued by the Slovenian Environment Agency of the Ministry of the Environment and Spatial Planning of the Republic of Slovenia to the Centre for Cartography of Fauna and Flora (CKFF).

The range of water quality variables are measured by national authorities (Slovenian Environment Agency – ARSO) within a national monitoring program. We gathered data for Miren, town close to the Italian border, for the period 2007 to 2017 (ARSO 2018; Tab. 2).

Results

Live mussels or empty shells were found at all survey sites in the Vipava River downstream from the Gradišče hydropower plant (Tab. 1: ID 1-10, Fig. 1). At all positive sites for *M. bonellii* we also found live *Unio elongatulus* C. Pfeiffer, 1825. In the Lijak Stream, no live mussels or empty shells of *M. bonellii* were found at any of the survey sites (Tab. 1: ID 14–18, Fig. 1). Altogether, 169 live mussels were found and 287 empty shells collected.

The mean length of live bivalves was 79.3 mm (min-max: 57.7–95.1 mm), the mean length of empty shells 75.6 mm (min-max: 31.3–95.1 mm) (Fig. 2).

Table 2. Physical and chemical water quality parameters of the Vipava River at Miren (ARSO 2018).
Tabela 2. Fizikalni in kemijski parametri kvalitete vode reke Vipave na merilnem mestu v naselju Miren (ARSO 2018).

Parameter	Unit / Enota	Mean (min-max) / Povprečje (min-max)	Number of measurements / Št. meritev	Number of measurements above detection limit / Št. meritev nad mejo detekcije	Detection limit / Meja detekcije
pH		8.2 (7.6–8.6)	60	60	
Specific conductance / Električna prevodnost	µS/cm	356 (296–466)	60	60	
Dissolved oxygen / Raztopljeni kisik	mg O_2/l	9.6 (6.2–14.3)	60	60	
Saturation of dissolved oxygen / Nasičenost	%	93 (65–130)	60	60	
Chemical Oxygen Demand (COD) / Kemijska potreba po kisiku (KPK)	mg O_2/l	6.8 (5–9)	52	12	5
Biological Oxygen Demand (BOD) / Biološka potreba po kisiku (BPK)	mg O_2/l	1.3 (0.5–2.9)	52	51	0.5
Dissolved Organic Carbon (DOC) / Celotni raztopljeni organski ogljik	mg C/l	1.3 (0.6–2.8)	28	28	
Total Nitrogen (TN) / Skupni dušik	mg N/l	1.80 (1.01–3.01)	52	52	
Ammonia / Amonijak	mg NH_3/l	0.005 (0.003–0.01)	44	17	0.003
Unionized ammonium / Amonij	mg NH_4^+/l	0.093 (0.014–0.3)	52	49	0.013
Nitrite / Nitrit	mg NO_2/l	0.059 (0.013–0.172)	52	51	0.007
Nitrate / Nitrat	mg NO_3/l	6.6 (4.4–11)	52	52	
Total phosphorus / Celotni fosfor	mg PO_4/l	0.16 (0.04–0.43)	52	52	
Orthophosphates / Ortofosfati	mg PO_4/l	0.062 (0.031–0.132)	52	35	0.031
Calcium / Kalcij	mg/l	60.8 (46–83)	52	52	

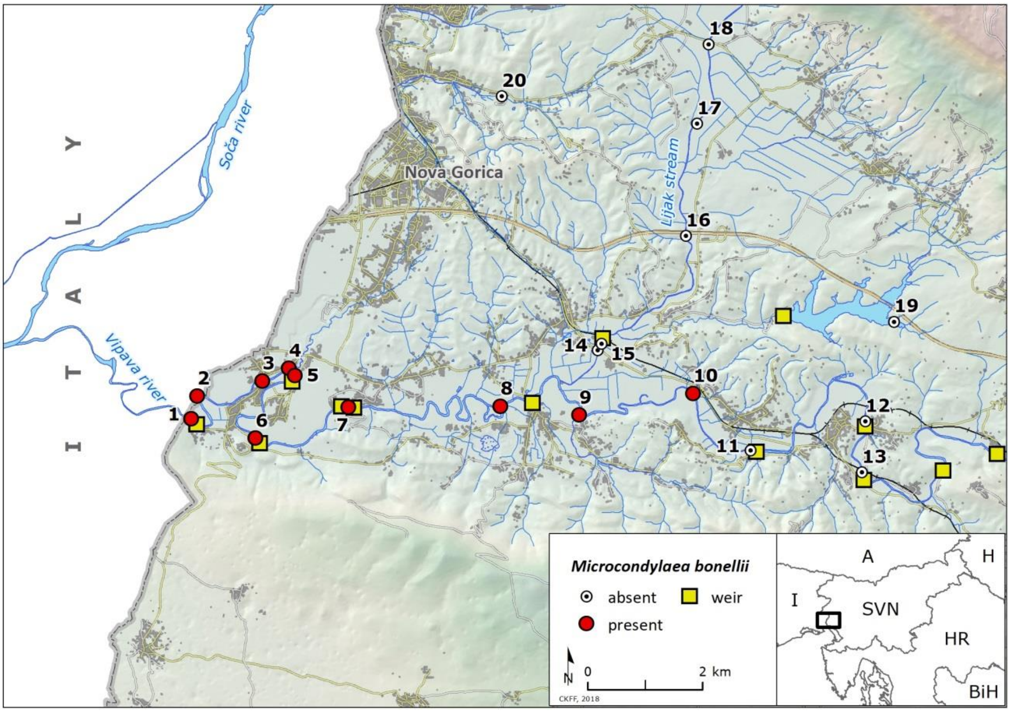

Figure 1. Locations of *M. bonellii* in the Vipava River in Slovenia and higher weirs in this sections (numbers on Fig. 1 correspond to ID Numbers in Tab. 1).

Slika 1. Najdišča rečne enozobke (*M. bonellii*) v reki Vipavi v Sloveniji z označbo večjih jezov (številke na sliki so enake zaporednim številkam v Tab. 1).

In the Prvačina and Renče area we were able to survey the Vipava River from bank to bank (20 m width), as well as its central part, where water was up to 1 m deep at low discharge rates. *M. bonellii* and *U. elongatulus* were present only in a 1.5 m strip from the bank with the low but present water current. Bivalves were buried in fine sand and gravel up to 1 cm diameter. In the central part, where water current was higher and consequently larger fractions of gravel were present, we didn't find any mussel of either species. Compared to *U. elongatulus*, *M. bonellii* was totally buried into the sediment and thus only siphonal openings were visible.

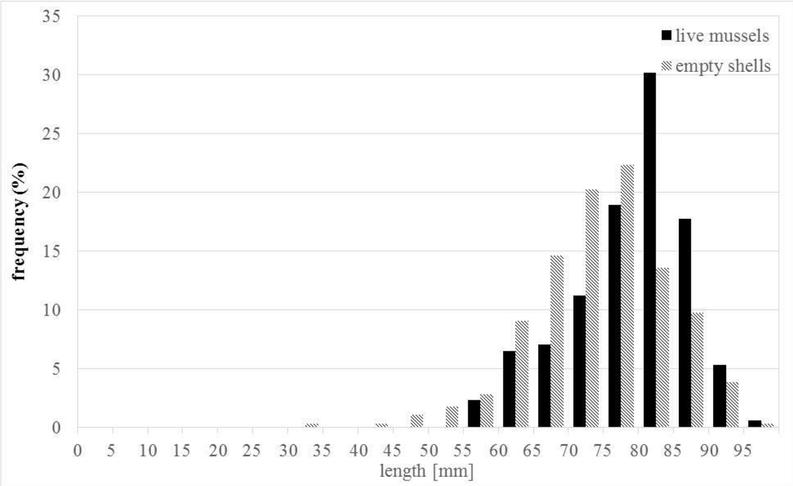

Figure 2. Length frequency distribution of *M. bonellii* in the Vipava River in Slovenia.
Slika 2. Frekvenčna distribucija dolžine lupin pri rečni enozobki (*M. bonellii)* iz reke Vipave v Sloveniji.

In the Miren area, we were only able to survey a 5 m strip from the bank due to deep water in the main river channel. In a patch, where a living *M. bonellii* was found, evident water current was observed. Bivalves were buried between stones of the same size as was their own. Right next to the riverbank in fine sand with low flow, *M. bonellii* was very rarely recorded, while *U. elongatulus* prevailed. This was the opposite of the survey results for the Prvačina and Renče areas.

Discussion

We confirmed the presence of *M. bonellii* in the Vipava River main channel downstream of the Gradišče hydropower plant. 120 years ago, Gallenstein (1894) wondered whether the species really does occur further upstream of the confluence with the Lijak Stream. He concluded that more detailed research was required. We were able to find it close to Prvačina town, 3 km upstream from the confluence of the Lijak Stream, 2 km downstream from the Gradišče hydropower plant. Live mussels were also observed in the Italian part of the Vipava River (Reischütz & Reischütz 2002, Lapini et al. 2013). In the Lijak Stream, dozens of living *U. elongatulus* were found, but no living *M. bonellii*. Neither did we find any empty shells, although they had been found by Reischütz & Reischütz (2002). The downstream section of the Lijak Stream was very difficult to survey due to its steep river banks and deep water. In the Vipava River basin, the species' range is limited to 20 km of the Vipava River from the Gradišče hydropower plant downstream to its confluence with the Soča River, 16 km of those in Slovenia. The hydropower plant was built in 1922 (Brenčič 2013) and is poorly or even totally impassable for upstream fish migration. Thus it has probably been limiting the upstream distribution of *M. bonellii* for already a century. Additionally, small weirs were built on the Vipava River for mills and sawmills. Today at least 4 weirs over 1.5 m in height exist in the Vipava River downstream from Gradišče. All weirs are poorly or even totally impassable for fishes. Consequently the habitat of *M. bonellii* and probably populations are fragmented. Oxbow lakes of the Vipava River, where Erjavec (1877) found the species, weren't surveyed, since most of them don't exist anymore. Although bivalves can be totally buried into the sediment (Nagel et al. 2007), we believe our results of the species range are representative, since we combined the method of surveying both live mussels and empty shells. Correspondingly we also found *U. elongatulus* at some locations where *M. bonellii* was not present. We can conclude that the range of *M. bonellii* in the Vipava River is similar to the previously described situation. The statement by Reischütz & Reischütz (2002) that *M. bonellii* is extinct in the Lijak Stream needs further focused research. In streams where mussels might be present in very low densities, other methods (e.g. sieving sediment) on more patches should be performed.

The population in the Vipava River and the population in the Versa Stream are the only two populations of *M. bonellii* in the Soča River basin, both already mentioned in Gallenstein (1894). Both populations are isolated from each other, since there are no records that *M. bonellii* lives in the Soča River. In the Versa Stream 12 km West from Nova Gorica, *M. bonellii* was rediscovered in 1984 and was then the first live record of this bivalve in Northern Italy since 1930 (Nagel & Hoffmeister 1986). In the upper regulated section of the Birša Stream (Slovenian name for the Versa Stream) in Slovenia, no mussels were found. The Birša Stream partly dries up before the national border and shows signs of excessive nutrient intake. At the bottom of the stream fine sediments are present as a result of runoff from adjacent agriculture areas, with the signs of anoxia. South of Slovenia, the first known population of *M. bonellii* lives in the Mirna River on the Istrian Peninsula in Croatia (Fischer 1999, Fischer & Reischütz 1999, Mrkvicka 2018). The IUCN range map (Albrecht et al. 2011) shows a totally inaccurate range in the region. The Vipava River in Slovenia, the Versa Stream in Italy and the Mirna River in Croatia are excluded, while the Dragonja and Reka River basin are included as an area of distribution (Albrecht et al. 2011). Consequently, references which use IUCN range maps are incorrect (e.g. Darwall et al. 2014). There is no evidence that this species is present in the catchment area of the Dragonja and the Reka Rivers in Slovenia. A record for the Reka River from Slapnik (2005) is doubtful and should be omitted, as Slapnik (2013) mentioned the species' distribution only for the Vipava River basin. In addition, our findings of individual bivalves from the genus *Anodonta* in the Reka River (Govedič, unpublished), which is not mentioned in Slapnik (2005), is another reason to omit the record from the Reka River.

The drastic decline of *M. bonellii* in Europe is probably caused by human impacts, among which habitat destruction and water pollution are the most important factors (Nagel et al. 2007). Nitrogen compounds, particularly ammonia, and temperature are suspected major stressors for these aquatic organisms (Beggel et al. 2017). Studies from Central Europe have shown a relationship between the impaired population status of threatened freshwater mussel species and elevated nitrate (NO_3) concentrations in running waters (Douda 2010). The quality of water in the Vipava River entirely depends on its catchment area. Thus the protection of *M. bonellii* in the Vipava River entirely depends on Slovenia since the complete catchment area is geographically within the country. Most of the flood plain of the Vipava River is used for intensive agricultural purposes. After World War II, the Vipava Valley was subjected to extensive agromeliorations and regulation of tributaries (Brenčič 2013). Before, mostly meadows and pastures existed along the Vipava River, which were regularly flooded. The increasing intensification of agriculture in the Vipava Valley can lead to elevated concentrations of nitrogen in the water and, due to the use of phytopharmaceuticals, also some other chemicals. The Vipava River receives all wastewater from the entire valley. There is a population of at least 65,000 inhabitants in the wider drainage area (Kladnik 2013). The probability of accidental pollution incidents increased after the change of discharge from the waste water treatment plant of the town of Nova Gorica, which had been redirected a few years ago to the Vrtojbica Stream (a tributary of the Vipava River upstream from Miren). There is no information on water quality requirements for *M. bonellii* habitat, so we can't compare the results of water quality of the Vipava River at Miren with others studies. Average concentrations of nitrate (6.6 mg/L NO_3) in the Vipava River that corresponds to 1.5 mg/L of nitrate nitrogen (N-NO_3), is in range of the reported value for high abundance and reproduction of *U. crassus* (Douda 2010, Köhler 2006, Zając et al. 2018, Denic et al. 2014, Zettler & Jueg 2007). There can be some misunderstanding while some research present results as nitrate (NO_3) values (Zając et al. 2018), others (Douda 2010, Denic et al. 2014, Zettler & Jueg 2007) as nitrate nitrogen (N-NO_3). Only Köhler (2006) pays attention to both values. Furthermore, many other chemicals of which impact has not been studied and which are not regularly monitored can have negative effects on bivalves. Knowledge on chemicals that are produced and released to the Lijak Stream from sediments of accumulation in Lake Vogrščesk is also lacking. Also human activity in Goriška Brda in Slovenia in the catchment area of Versa Stream can potentially affect the quality of water at *M. bonellii* populations downstream in Italy. Goriška Brda is an agricultural region with intensive vineyards and orchards. Population density in Goriška Brda is high (69 inhabitants/km^2) as well (Glavan 2011). Due to the intensification of agriculture in Goriška Brda, special attention on water quality should be paid, as well as on quantity. Especially in summer, the stream should be regularly monitored with the purpose to detect early threats to the *M. bonellii* populations downstream in Italy.

In terms of size structure smaller live mussels are missing. The reason for this is most probably the hand-searching surveying method, which is insufficient for identifying the presence of small mussels. Digging in the substratum to detect small specimens was not performed. The biggest live specimen and empty shell measured 95 mm in length. This is comparable with related studies (max. 91 mm in Bössneck (2002), max. 81 mm in Fischer & Reischütz (1999)). The biggest one ever found measured 102 mm in length (Erjavec 1877). *M. bonellii* can live up to ten years, but negative environmental impacts, specifically water pollution, shorten their life expectancy (Fischer & Reischütz 1999). According to the length structure of *M. bonellii* in the Vipava River they still reach the expected length and age. From the size structure of living specimens and from empty shells in the years 2015 and 2018, we can conclude that they still successfully breed in the Vipava River. But the alarming fact is that we found large amounts of empty shells at Miren, where they were smaller than 65 mm. This size corresponds to the age of 4 years (Nagel & Hoffmeister 1986) and indicates the mortality of mussels before they reach their final size. We don't know what is causing this, but the quality of water should be monitored more thoroughly as is provided under the national monitoring program, especially during summer flow minimums.

The number of specimens we found at each locality is related to the surface of shallow habitat, which was accessible for survey and with time spent for searching. Our goal was not to assess the density of the species, but to confirm its presence. It seems that, as in the Versa Stream, *M. bonellii* in Vipava River also prefers sections with a distinctive flow. In the main flow section of the Versa Stream, 25 mussels/m^2 were observed, but higher densities were also observed in pools and among the roots of plants on shallow banks (Nagel et al. 2007). In the Mirna River, mussels were observed in high densities up to 15 mussels/m^2 in shallow waters of eroded banks with coves and sandy substrate or accumulated fine substrate but not in the straight parts of the riverbed with a stronger current and gravel substrate (Mrkvicka 2018). According to Rüetschi et al. (2012), *M. bonellii* can also live in lakes and in slow flowing streams with sandy banks. Erjavec (1877) found it in oxbow lakes of the Vipava River. Thus it is questionable whether the mussel lives also in deep sections of the Vipava River and its oxbow lakes, according to the fact that it wasn't found in fine sediment next to the riverbank with low flows. Most of the lower part of the Vipava River is between weirs, where water is deep and its riverbanks are steep and consequently inaccessible for conventional survey methods. It would only be possible to check deeper sections of the Vipava River with the help of divers or underwater cameras. Thus the overall population size of *M. bonellii* in Slovenia remains unknown. If mussels prefer only shallow parts with a distinctive flow, then the population will be very patchy scattered as a result of the arrangement of a suitable substrate.

We still consider *M. bonellii* in Slovenia to be a poorly known and endangered species. New records give the impression that the overall population has increased in the Vipava River, but they are probably only rediscoveries and a confirmation of the former range of the species. Its presence in deeper parts of the Vipava River between weirs should be surveyed as soon as possible as well as in the Lijak Stream. Distribution and population size of the species in the Vipava River remain unknown. Ongoing unknown status (XX) of *M. bonellii* needs to be reported under Article 17 of the Habitats Directive in the next reporting period in 2019. The Vipava River and Lijak Stream underwent large scale habitat destruction in the previous century, but local construction works are still in progress. In order to maintain high flows within the riverbed and to prevent flooding, the habitat is changing because of higher riverbed shear stress during high water discharges. After adoption of the Habitats Directive in 2004, there were few construction interventions in the Vipava River, without confirmation of the species at the site of intervention. Locally eroded banks are replaced by blocks of stone and small locally shallow parts are destroyed. Many suitable habitats and eventually existing mussels' populations were probably destroyed. At least the exact distribution of protected species should have been studied before. In the future all construction works, which can cause the death of mussels or impair their habitat, shouldn't be carried out in the Vipava River or the Lijak Stream. Further comprehensive studies focusing particularly on the ecology and habitat requirements are warranted to better understand the conservation status of the species. Also weirs should be passable for all fish species and not only for spring spawning migrations, also all year around, especially during the development of glochidia and at the end of the parasitic phase of bivalves. Reischütz & Reischütz (2002) evaluated that the conservation status of *M. bonellii* in Slovenia should be altered to CR (Critically Endangered). We fully agree with this assessment, since the existence of the species is limited to 16 km of the highly fragmented Vipava River in Slovenia and is isolated from other populations.

Povzetek

Rečna enozobka (*Microcondylaea bonellii*) je endemit pritokov Jadranskega morja od porečij Pada in Soče prek Istre do severne Grčije. Njeno tipsko najdišče je potok Lijak, pritok reke Vipave v Sloveniji. V Sloveniji je vrsta zavarovana, uvrščena je v Prilogo V Direktive o habitatih, kot ranljiva vrsta pa na svetovni Rdeči seznam IUCN. Predhodni podatki o razširjenosti vrste v Sloveniji so stari več kot 100 let. Takrat je bila vrsta razširjena v potoku Lijak in spodnjem toku reke Vipave.

Školjke in lupine sva iskala na več lokacijah v reki Vipavi in njenih pritokih ter v potokih v Goriških Brdih. Pregledovala sva plitve odseke in prodišča. Školjke sva našla na več lokacijah v reki Vipavi nizvodno od HE Gradišče pri Prvačini, medtem ko je v potoku Lijak ni bilo. Na vseh lokacijah, kjer sva našla rečno enozobko, je bil prisoten tudi podolgovati škržek (*Unio elongatulus*). Rečne enozobke sva našla v bližini brega na mestih z očitnim tokom, ne pa v srednjem delu struge, kjer so hitrosti vode večje, še posebej ob večjih pretokih. Populacija v Vipavi je omejena na 20 km reke od Gradišča do izliva v Sočo (od tega 16 km v Sloveniji) in je izolirana od edine ostale populacije v porečju Soče v potoku Versa (Birša) v Italiji.

Glede na velikostno strukturo najdenih školjk sklepava, da doživijo pričakovano starost. Koncentracije različnih oblik dušika, izmerjene v reki Vipavi na merilni postaji v Mirnu, za zdaj niso omejujoče za obstoj in razmnoževanje školjk. Sva pa v reki Vipavi pri Mirnu našla številne lupine tudi manjših osebkov, zato bo treba v prihodnje zelo paziti na kemijsko stanje vode v reki Vipavi. Za Vipavsko dolino sta značilna gosta poseljenost in intenzivno kmetijstvo. V reko Vipavo tako s površinskim spiranjem pritečejo onesnažila s kmetijskih površin, hkrati pa se vanjo izlivajo tudi vse odpadne vode, v zadnjih letih prek potoka Vrtojbica tudi iz Centralne čistilne naprave Nova Gorica.

O habitatu školjke v reki Vipavi vemo zelo malo, zato bi bilo treba raziskati, ali je razširjena le v plitvih odsekih, ali morda tudi v globljih, kjer je tok počasen. V Vipavi je habitat rečne enozobke fragmentiran z jezovi, ki so povečini neprehodni za ribe. Ti bi morali biti prehodni tudi v času sproščanja glohidijev iz škrg rib in ne samo v času drstne migracije rib. Varstvo vrste in njenega habitata je pravno že urejeno, le nemudoma je treba začeti upoštevati zakonodajo in se pred vsemi posegi v reko Vipavo prepričati, ali res nimajo vpliva na vrsto.

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A contribution to the Slovenian spider fauna – IV

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Abstract. We provide a list of 171 spider species from 27 families recently recorded in Slovenia. Among them are first records of *Nigma flavescens*, *Walckenaria alticeps*, *Pelecopsis parallela*, *Erigone autumnalis* and *Micaria subopaca* for Slovenia and a second record of *Zodarion rubidum*, a species just recently added to the Slovenian spider fauna.

Key words: first records, *Nigma flavescens*, *Walckenaria alticeps*, *Pelecopsis parallela*, *Erigone autumnalis*, *Micaria subopaca*, *Zodarion rubidum*

Izvleček. Prispevek k favni pajkov Slovenije – IV – V prispevku je predstavljen seznam 171 vrst pajkov iz 27 družin, ki so bile nedavno najdene v Sloveniji. Med temi gre za prve najdbe vrst *Nigma flavescens*, *Walckenaria alticeps*, *Pelecopsis parallela*, *Erigone autumnalis* in *Micaria subopaca* v Sloveniji in drugo najdbo v Sloveniji nedavno najdene vrste *Zodarion rubidum*.

Ključne besede: prve najdbe, *Nigma flavescens*, *Walckenaria alticeps*, *Pelecopsis parallela*, *Erigone autumnalis*, *Micaria subopaca*, *Zodarion rubidum*

Introduction

The Slovenian spider fauna currently comprises 753 species (Kostanjšek & Kuntner 2015). As already noted in earlier contributions (Kostanjšek 2010, Kostanjšek & Gorjan 2013, Kuralt & Kostanjšek 2016), there is still a number of spider species expected to be found in Slovenia.

For instance, comparison of spider species listed in the Slovenian National spider checklist (Kostanjšek & Kuntner 2015) and the species present in the neighbouring countries uncover that most of the expected, yet missing, species in the Slovenian araneofauna most likely belong to the family Linyphiidae (Fig 1). Comprising generally smaller species often associated with colder habitats (e.g. Hagvar 1973, Relys 2000, Wiśniewski et al. 2018), the shortage of Linyphiidae in Slovenia indicates undersampling of spiders in Slovenia in general, as well as a lack of efficient sampling of cryptic habitats and habitats at higher altitudes. Several species with submediterranean distribution are also expected to be found in the south-western part of the country. Furthermore, as previous studies have revealed (e. g. Kostanjšek & Celestina 2008, Mammola et al. 2018), urban environments act as a surrogate habitat for species rarely found in nature and should not be neglected.

The last decade of araneological fieldwork in in Slovenia was mostly concentrated to »Biology Students Research Camps« (herein: biology camps) that traditionally take place in the second half of the July, resulting in sub-optimal conditions for spider research. High temperatures and low precipitation at that time impact spiders' activity and makes sampling, especially during daytime, less effective. Nevertheless, the work done at biology camps provides an unprecedented insight into the Slovenian spider fauna. In the past year, however, araneological fieldwork from biology camp was complemented with two other studies, (1) a short-term sampling at Draga pri Igu, and (2) monthly surveys of spider fauna at Škocjan Caves Park. Additionally, spiders from soil invertebrate sampling at Grebenje were handed over to us for identification.

Here we provide list of spider species collected in Slovenia during aforementioned studies and report on five new species records for the Slovenian fauna. We discuss the implications of these findings and provide recommendations for future araneological work in Slovenia.

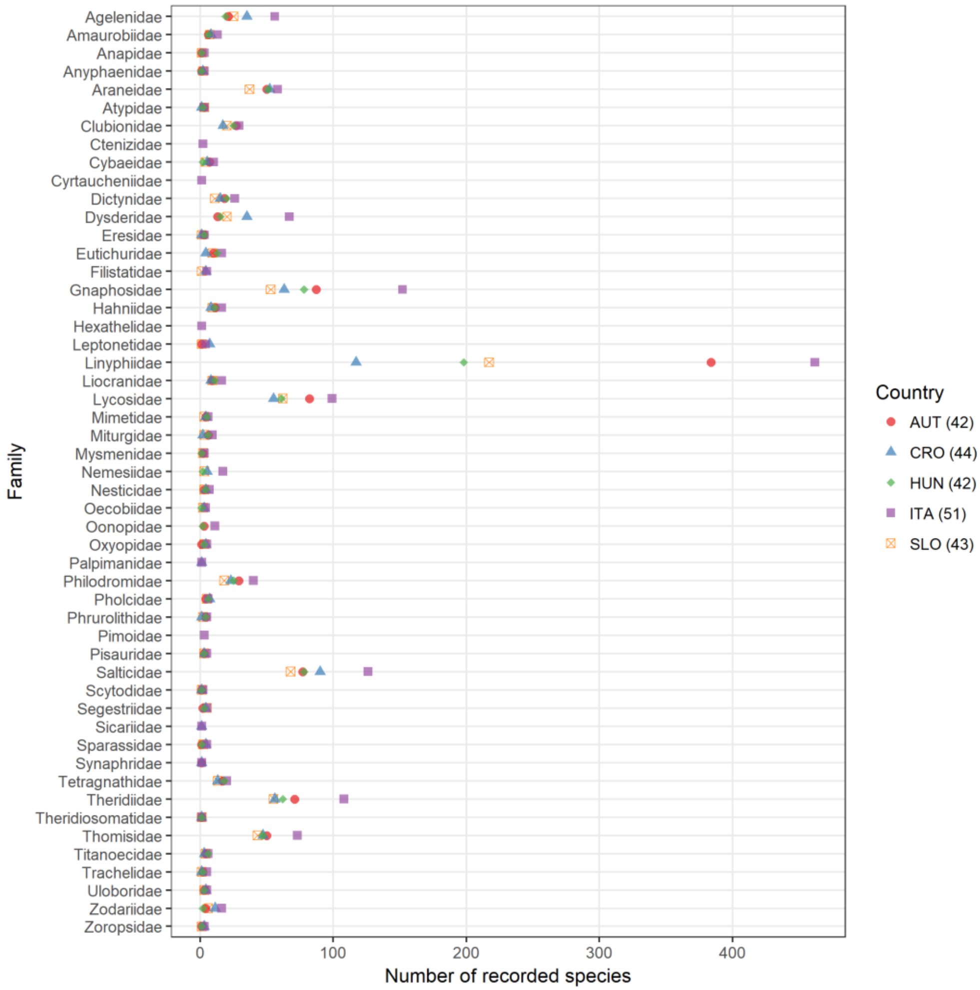

Figure 1. Number of recorded species per family for Slovenia and the neighbouring countries (AUT – Austria, CRO – Croatia, HUN – Hungary, ITA – Italy, SLO – Slovenia). Numbers in the brackets indicate count of families per country. There is a significant difference in the number of species of the Linyphiidae family between the countries. Country species lists were retrieved from Spiders of Europe (Nentwig et al. 2019).

Slika 1. Število zabeleženih vrst iz različnih družin v Sloveniji in sosednjih državah (AUT – Avstrija, CRO – Hrvaška, HUN – Madžarska, ITA – Italija, SLO – Slovenija). V oklepajih je navedeno število družin, zabeleženih v državi. Med državami je opaziti veliko razliko v število vrst iz družine Linyphiidae. Sezname vrst za vse države smo pridobili na spletnem portalu Spiders of Europe (Nentwig et al. 2019).

Materials and methods

Study area

Spiders were collected in different parts of the country (see Tab. 1 for full list of examined localities) in the period from 5. 2. 2016 to 17. 5. 2018. Extensive sampling was carried out on 19. 5. 2017 as a part of »Bioblitz Slovenija 2017« (Jogan et al. 2018), held at Draga pri Igu (Localities BioBlitz-1 to BioBlitz-12), where spiders were collected in various habitats at 12 sampling sites (note that soil samples were collected prior to the event on 17. 5. 2017). Another intensive survey lasted from 19. to 29. 7. 2017, as part of the annual »Biology Students Research Camp« in the Gorenjska region (Localities RTSB17-1 to RTSB17-34). The third survey, consisting of monthly examinations of araneofauna at Škocjan Caves Regional Park, lasted from May to September 2017 (Localities PSJ-1 to PSJ-19). Spiders were also obtained during soil invertebrates sampling near Grebenje village in 2016 and 2017 (Localities Grebenje-1 to Grebenje-24). The specimen of *Micaria subopaca* was coincidentally collected at the Department of Biology building in Ljubljana (Locality BioDept-1).

Table 1. Localities where spiders were collected. Sampling methods' abbreviations are: A – aspirator, F – forceps, RSN – round sweep net, LLS – leaf litter sifter, ILB – inverted leaf blower, SS – soil sampling.
Tabela 1. Lokacije vzorčenja pajkov. Kratice metod vzorčenja so: A – aspirator, F – pinceta, RSN – okrogla lovilna vreča, LLS – sejanje listne stelje, ILB – motorni sesalnik, SS – vzorci tal.

Locality ID	Locality	Lat. Long.	Altitude a.s.l.	Date	Sampling methods	Legator
RTSB17-01	forest edge; Velika gmajna; 1 km NW from Hraše pri Preddvoru	46.30091697°N 14.373234°E	477 m	20. 7. 2017	F, A, LLS, RSN	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt
RTSB17-02	mixed forest; Velika gmajna; 1 km NW from Hraše pri Preddvoru	46.30149499°N 14.37204503°E	489 m	20. 7. 2017	F, A, LLS, RSN	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt
RTSB17-03	mixed forest; Velika gmajna; 1 km NW from Hraše pri Preddvoru	46.30189296°N 14.37050904°E	501 m	20. 7. 2017	F, A, LLS, RSN	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt
RTSB17-04	forest clearing; Velika gmajna; 1 km NW from Hraše pri Preddvoru	46.30229797°N 14.37040301°E	503 m	20. 7. 2017	F, A, RSN	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt
RTSB17-05	forest clearing; Velika gmajna; 1 km NW from Hraše pri Preddvoru	46.30398198°N 14.370301°E	517 m	20. 7. 2017	F, A, RSN	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt
RTSB17-06	mixed forest; Velika gmajna; 1 km NW from Hraše pri Preddvoru	46.303582°N 14.37010403°E	514 m	20. 7. 2017	F, A, LLS, RSN	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt
RTSB17-07	cave; P-1 (Brezovica); Češnjica pri Kropi	46.2916°N 14.2172°E	580 m	20. 7. 2017	PT, A, F	D. Škufca, A. Kos, G. Benko, G. Makovec, A. Podrug
RTSB17-08	cave; P-5 (Brezovica); Češnjica pri Kropi	46.291°N 14.2173°E	560 m	20. 7. 2017	PT, A, F	D. Škufca, A. Kos, G. Benko, G. Makovec, A. Podrug
RTSB17-09	riparian forest; Brdo Estate; 500 m W from Breg ob Kokri	46.29026399°N 14.41165103°E	488 m	21. 7. 2017	F, A, LLS, RSN	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt

Locality ID	Locality	Lat. Long.	Altitude a.s.l.	Date	Sampling methods	Legator
RTSB17-10	riparian zone; Brdo Estate; 1 km W from Hotemaže	46.28653002°N 14.41033498°E	471 m	21. 7. 2017	F, A	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt
RTSB17-11	oak forest; Brdo Estate; 1 km NE from Srakovlje	46.28486998°N 14.379878°E	445 m	21. 7. 2017	F, A, LLS, RSN	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt
RTSB17-12	mixed forest; Udin boršt; 1 km E from Cegelnica	46.27705101°N 14.33570604°E	436 m	22. 7. 2017	F, A, LLS, RSN	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt
RTSB17-13	mixed forest; Udin boršt; 1 km E from Cegelnica	46.27959601°N 14.33398498°E	443 m	22. 7. 2017	F, A, LLS, RSN	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt
RTSB17-14	riparian forest; Udin boršt; 1,5 km E from Cegelnica	46.28601504°N 14.32982999°E	433 m	22. 7. 2017	F, A, LLS, RSN	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt
RTSB17-15	riparian forest; Petrovc; 200 m NE from bridge over the Kokra River at Predoslje	46.264533°N 14.391465°E	411 m	22. 7. 2017	F, A, LLS, RSN	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt
RTSB17-16	meadow; Savski otok; S del Savskega otoka	46.244062°N 14.351125°E	355 m	22. 7. 2017	F, A, RSN	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt
RTSB17-17	construction waste dumpsite; Šenčurska gmajna; 1,5 km S from Šenčur	46.23055°N 14.417874°E	386 m	22. 7. 2017	F	M. Vek, A. Pekolj, L. Fon Mervič, R. Karner, D. Lenarčič, J. Perutka, J. Prevc, K. Prot, L. Recer, L.L. Zamuda
RTSB17-18	mixed forest; Rupa; 350 m N from Rupa	46.259701°N 14.364561°E	406 m	22. 7. 2017	F, A, LLS, RSN	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt, R. Kostanjšek
RTSB17-19	meadow; stream Bela; 1 km SW from Preddvor	46.29678302°N 14.41079498°E	484 m	23. 7. 2017	F, A, RSN	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt
RTSB17-20	riparian forest; stream Bela; 1 km SW from Preddvor	46.29756002°N 14.41024303°E	483 m	23. 7. 2017	F, A, LLS, RSN	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt
RTSB17-21	mixed forest; Možjanca; 900 m E from Možjanca	46.29116303°N 14.46115999°E	680 m	23. 7. 2017	F, A, LLS, RSN, ILB	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt
RTSB17-22	meadow; Štefanja Gora; 1 km W from Štefanja Gora	46.28984397°N 14.46989997°E	685 m	23. 7. 2017	F, A, RSN	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt
RTSB17-23	urban area; OŠ Predoslje; Predoslje	46.266463°N 14.387378°E	420 m	19. - 28. 7. 2017	F, A	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt
RTSB17-24	meadow; Matizovec; 2,5 km NE from Podljubelj	46.415245°N 14.307888°E	1070 m	25. 7. 2017	F, A	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt
RTSB17-25	cave; Jama pri Taboru; Rovte	46.2761°N 14.2411°E	460 m	23. 7. 2017	PT, A, F	D. Škufca, A. Kos, G. Benko, G. Makovec, A. Podrug
RTSB17-26	cave; Lisična jama; Njivica	46.2647°N 14.244°E	480 m	23. 7. 2017	PT, A, F	D. Škufca, A. Kos, G. Benko, G. Makovec, A. Podrug
RTSB17-27	cave; Gipsova jama; Vincarje	46.1626°N 14.2982°E	434 m	22. 7. 2017	PT, A, F	D. Škufca, A. Kos, G. Benko, G. Makovec, A. Podrug
RTSB17-28	mixed forest; Mostec; 700 m NW from Šišenski hrib	46.06168597°N 14.47992104°E	322 m	26. 7. 2017	F, A, LLS, RSN, ILB	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt

Locality ID	Locality	Lat. Long.	Altitude a.s.l.	Date	Sampling methods	Legator
RTSB17-29	meadow; Department of Biology; 200 m SW from Ljubljana ZOO	46.05152501°N 14.47049299°E	297 m	26. 7. 2017	F, A, RSN, ILB	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt
RTSB17-30	meadow; Spodnje Tenetiše; 700 m N from Tenetiše	46.30153899°N 14.34912002°E	434 m	26. 7. 2017	F, A, RSN, ILB	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt
RTSB17-31	riparian forest; Nova vas; 1,2 km NE from Preddvor	46.31152896°N 14.42868096°E	514 m	26. 7. 2017	F, A, LLS, RSN	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt
RTSB17-32	riparian zone; Brdo Estate; 780 m S from Srednja Bela	46.286271°N 14.39456°E	446 m	26. 7. 2017	A, F	D. Vinko, A. Tratnik, A. Janović, D. Kablar, R. Kraševec, K. Mazinjanin
RTSB17-33	urban area; Rupa; 1 km N from Kranj	46.25702°N 14.365558°E	401 m	27. 7. 2017	A, F	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt
RTSB17-34	riparian forest; Rupovščica canyon; 1,5 km N from Kranj	46.262537°N 14.364868°E	400 m	27. 7. 2017	F, A, LLS, RSN	N. Pajek Arambašić, M. Ferle, M. Velkavrh, E. Premate, N. Šramel, N. Štrekelj, Ž. Kuralt
PSJ-1	thermophilic meadow; Betanja; 200 m N from Betanja	45.668327°N 13.994555°E	390 m	13. 5. 2017	F, A, RSN, ILB	R. Kostanjšek, Ž. Kuralt
PSJ-2	thermophilic meadow; Betanja; 200 m N from Betanja	45.668327°N 13.994555°E	390 m	24. 6. 2017	F, A, RSN, ILB	R. Kostanjšek, Ž. Kuralt
PSJ-3	thermophilic meadow; Betanja; 160 m NW from Betanja	45.66721°N 13.991662°E	380 m	13. 5. 2017	F, A, RSN, ILB	R. Kostanjšek, Ž. Kuralt
PSJ-4	thermophilic meadow; Betanja; 160 m NW from Betanja	45.66721°N 13.991662°E	380 m	24. 6. 2017	F, A, RSN, ILB	R. Kostanjšek, Ž. Kuralt
PSJ-5	thermophilic meadow; Betanja; 160 m NW from Betanja	45.66721°N 13.991662°E	380 m	17. 7. 2017	F, A, RSN, ILB	R. Kostanjšek, Ž. Kuralt
PSJ-6	thermophilic meadow; Betanja; 160 m NW from Betanja	45.66721°N 13.991662°E	380 m	30. 8. 2017	F, A, RSN, ILB	R. Kostanjšek, Ž. Kuralt
PSJ-7	thermophilic meadow; Betanja; 160 m NW from Betanja	45.66721°N 13.991662°E	380 m	30. 9. 2017	F, A, RSN, ILB	R. Kostanjšek, Ž. Kuralt
PSJ-8	thermophilic forest; Matavun; 300 m NW from Matavun	45.66548°N 13.988209°E	375 m	13. 5. 2017	F, A, RSN, ILB, LLS	R. Kostanjšek, Ž. Kuralt
PSJ-9	thermophilic forest; Matavun; 300 m NW from Matavun	45.66548°N 13.988209°E	375 m	24. 6. 2017	F, A, RSN, ILB, LLS	R. Kostanjšek, Ž. Kuralt
PSJ-10	thermophilic forest; Matavun; 300 m NW from Matavun	45.66548°N 13.988209°E	375 m	17. 7. 2017	F, A, RSN, ILB, LLS	R. Kostanjšek, Ž. Kuralt
PSJ-11	thermophilic forest; Matavun; 300 m NW from Matavun	45.66548°N 13.988209°E	375 m	30. 8. 2017	F, A, RSN, ILB, LLS	R. Kostanjšek, Ž. Kuralt
PSJ-12	thermophilic forest; Matavun; 300 m NW from Matavun	45.66548°N 13.988209°E	375 m	30. 9. 2017	F, A, RSN, ILB, LLS	R. Kostanjšek, Ž. Kuralt
PSJ-13	under stones and stone wall; Škocjan; 150m S from Škocjan	45.663913°N 13.99365°E	409 m	13. 5. 2017	F, A	R. Kostanjšek, Ž. Kuralt

Locality ID	Locality	Lat. Long.	Altitude a.s.l.	Date	Sampling methods	Legator
PSJ-14	under stones and stone wall; Škocjan; 150m S from Škocjan	45.663913°N 13.99365°E	409 m	17. 7. 2017	F, A	R. Kostanjšek, Ž. Kuralt
PSJ-15	under stones and stone wall; Škocjan; 150m S from Škocjan	45.663913°N 13.99365°E	409 m	30. 8. 2017	F, A	R. Kostanjšek, Ž. Kuralt
PSJ-16	under stones and stone wall; Škocjan; 150m S from Škocjan	45.663913°N 13.99365°E	409 m	30. 9. 2017	F, A	R. Kostanjšek, Ž. Kuralt
PSJ-17	thermophilic meadow; Betanja; 200 m N from Betanja	45.669157°N 13.994193°E	395 m	17. 7. 2017	F, A, RSN, ILB	R. Kostanjšek, Ž. Kuralt
PSJ-18	thermophilic meadow; Betanja; 200 m N from Betanja	45.669157°N 13.994193°E	395 m	30. 8. 2017	F, A, RSN, ILB	R. Kostanjšek, Ž. Kuralt
PSJ-19	thermophilic meadow; Betanja; 200 m N from Betanja	45.669157°N 13.994193°E	395 m	30. 9. 2017	F, A, RSN, ILB	R. Kostanjšek, Ž. Kuralt
BioBlitz-1	meadow; meadow at hunter's lodge; 740 m S from Draga	45.940594°N 14.546413°E	300 m	19. 5. 2017	F, A, RSN, ILB	A. Celestina, R. Kostanjšek, S. Kralj Fišer, Ž. Kuralt
BioBlitz-2	mixed forest; Draška reber; 1 km S from Draga	45.938115°N 14.547604°E	300 m	19. 5. 2017	F, A, LLS	A. Celestina, R. Kostanjšek, T. Knapič, Ž. Kuralt, M. Gregorič
BioBlitz-3	meadow; meadow at middle pond; 1.2 km S from Draga	45.93693°N 14.548203°E	300 m	19. 5. 2017	F, A, RSN, ILB	A. Celestina, R. Kostanjšek, S. Kralj Fišer, Ž. Kuralt, M. Gregorič
BioBlitz-4	mixed forest; Šviglov gozd; 550 m S from Draga	45.941536°N 14.546578°E	300 m	19. 5. 2017	F, A	A. Celestina, R. Kostanjšek, T. Knapič, Ž. Kuralt, M. Gregorič
BioBlitz-5	mixed forest; Gmajna; 650 m S from Draga	45.941532°N 14.551181°E	300 m	19. 5. 2017	F, A, LLS	A. Celestina, R. Kostanjšek, T. Knapič, Ž. Kuralt, M. Gregorič, N. Sivec, M. Velkavrh
BioBlitz-6	riparian forest; riparian forest at Veliki ribnik; 950 m S from Draga	45.938527°N 14.551°E	300 m	19. 5. 2017	F, A	A. Celestina, R. Kostanjšek, T. Knapič, Ž. Kuralt, M. Gregorič
BioBlitz-7	riparian zone; embankement between first and second pond; 600 m S from Draga	45.941478°N 14.5487°E	300 m	19. 5. 2017	F, A	A. Celestina, R. Kostanjšek, T. Knapič, Ž. Kuralt, M. Gregorič
BioBlitz-8	meadow; meadow E of Veliki ribnik; 600 m S from Draga	45.938648°N 14.551909°E	300 m	19. 5. 2017	F, A, RSN	A. Celestina, R. Kostanjšek, T. Knapič, Ž. Kuralt, M. Gregorič
BioBlitz-9	mixed forest soil; Šviglov gozd; 550 m S from Draga	45.941388°N 14.546148°E	300 m	17. 5. 2017	SS	F. Kljun
BioBlitz-10	riparian forest soil; riparian forest at Veliki ribnik; 950 m S from Draga	45.938484°N 14.550005°E	300 m	17. 5. 2017	SS	F. Kljun
BioBlitz-11	mixed forest soil; NW forest slope; 1.6 km S from Draga	45.933555°N 14.551714°E	300 m	17. 5. 2017	SS	F. Kljun
BioBlitz-12	mixed forest soil; SE forest slope; 1.6 km S from Draga	45.934036°N 14.549683°E	300 m	17. 5. 2017	SS	F. Kljun

Locality ID	Locality	Lat. Long.	Altitude a.s.l.	Date	Sampling methods	Legator
Grebenje-1	mixed forest soil; Grebenje; 150 m E from Grebenje	45.799391°N 14.632649°E	620 m	5. 2. 2016	SS	F. Kljun
Grebenje-2	mixed forest soil; Grebenje; 150 m E from Grebenje	45.799391°N 14.632649°E	620 m	23. 3. 2016	SS	F. Kljun
Grebenje-3	mixed forest soil; Grebenje; 150 m E from Grebenje	45.799391°N 14.632649°E	620 m	13. 5. 2016	SS	F. Kljun
Grebenje-4	mixed forest soil; Grebenje; 150 m E from Grebenje	45.799391°N 14.632649°E	620 m	30. 6. 2016	SS	F. Kljun
Grebenje-5	mixed forest soil; Grebenje; 150 m E from Grebenje	45.799391°N 14.632649°E	620 m	12. 8. 2016	SS	F. Kljun
Grebenje-6	mixed forest soil; Grebenje; 150 m E from Grebenje	45.799391°N 14.632649°E	620 m	30. 9. 2016	SS	F. Kljun
Grebenje-7	mixed forest soil; Grebenje; 150 m E from Grebenje	45.799391°N 14.632649°E	620 m	25. 11. 2016	SS	F. Kljun
Grebenje-8	mixed forest soil; Grebenje; 150 m E from Grebenje	45.799391°N 14.632649°E	620 m	15. 2. 2017	SS	F. Kljun
Grebenje-9	xerophillic meadow soil; Grebenje; 150 m NE from Grebenje	45.799708°N 14.632331°E	630 m	5. 2. 2016	SS	F. Kljun
Grebenje-10	xerophillic meadow soil; Grebenje; 150 m NE from Grebenje	45.799708°N 14.632331°E	630 m	23. 3. 2016	SS	F. Kljun
Grebenje-11	xerophillic meadow soil; Grebenje; 150 m NE from Grebenje	45.799708°N 14.632331°E	630 m	13. 5. 2016	SS	F. Kljun
Grebenje-12	xerophillic meadow soil; Grebenje; 150 m NE from Grebenje	45.799708°N 14.632331°E	630 m	30. 6. 2016	SS	F. Kljun
Grebenje-13	xerophillic meadow soil; Grebenje; 150 m NE from Grebenje	45.799708°N 14.632331°E	630 m	12. 8. 2016	SS	F. Kljun
Grebenje-14	xerophillic meadow soil; Grebenje; 150 m NE from Grebenje	45.799708°N 14.632331°E	630 m	30. 9. 2016	SS	F. Kljun
Grebenje-15	xerophillic meadow soil; Grebenje; 150 m NE from Grebenje	45.799708°N 14.632331°E	630 m	25. 11. 2016	SS	F. Kljun
Grebenje-16	xerophillic meadow soil; Grebenje; 150 m NE from Grebenje	45.799708°N 14.632331°E	630 m	15. 2. 2017	SS	F. Kljun
Grebenje-17	mulched meadow soil; Grebenje; 150 m NE from Grebenje	45.799689°N 14.632271°E	630 m	5. 2. 2016	SS	F. Kljun
Grebenje-18	mulched meadow soil; Grebenje; 150 m NE from Grebenje	45.799689°N 14.632271°E	630 m	23. 3. 2016	SS	F. Kljun
Grebenje-19	mulched meadow soil; Grebenje; 150 m NE from Grebenje	45.799689°N 14.632271°E	630 m	13. 5. 2016	SS	F. Kljun

Locality ID	Locality	Lat. Long.	Altitude a.s.l.	Date	Sampling methods	Legator
Grebenje-20	mulched meadow soil; Grebenje; 150 m NE from Grebenje	45.799689°N 14.632271°E	630 m	30. 6. 2016	SS	F. Kljun
Grebenje-21	mulched meadow soil; Grebenje; 150 m NE from Grebenje	45.799689°N 14.632271°E	630 m	12. 8. 2016	SS	F. Kljun
Grebenje-22	mulched meadow soil; Grebenje; 150 m NE from Grebenje	45.799689°N 14.632271°E	630 m	30. 9. 2016	SS	F. Kljun
Grebenje-23	mulched meadow soil; Grebenje; 150 m NE from Grebenje	45.799689°N 14.632271°E	630 m	25. 11. 2016	SS	F. Kljun
Grebenje-24	mulched meadow soil; Grebenje; 150 m NE from Grebenje	45.799689°N 14.632271°E	630 m	15. 2. 2017	SS	F. Kljun
BioDept-1	inside a building; Department of Biology; 200 m SW from ZOO Ljubljana	46.051281°N 14.47038°E	296 m	17. 5. 2018	A	Ž. Kuralt

Sampling methods, identification and specimen preparation

To cover as many microhabitats as possible, a variety of sampling methods (forceps, aspirator, round sweep net, inverted leaf blower, leaf litter sifter, soil sampling) were used in targeted spider sampling. Specimens were preserved in denatured 70% ethanol. Soil samples were acquired using soil sampling probe with diameter of 21 cm and later extracted using modified Tullgren-Berlese funnels. The specimens were identified by commonly used determination keys (Roberts 1995, Oger 2016, Nentwig et al. 2019,). The identity of *E. autumnalis* was additionally supported by recent paper by Bellvert et al. (2018). Extraction, identification, preparation and observation of the specimens were performed at the Department of Biology of the Biotechnical Faculty, University of Ljubljana.

The epigyne of female specimens was observed with Olympus SZX7 stereomicroscope and photographed with Olympus XC30 camera.

For electron microscopic observation, the male pedipalps were briefly sonicated in ultrasonic bath PIO Sonis 2 T, air-dried, mounted on aluminium stubs and sputter-coated with platinum. The prepared samples were observed with a Jeol JSM-7500F field emission scanning electron microscope.

Specimens are deposited in the Department of Biology, Biotechnical Faculty, University of Ljubljana.

Results

Altogether, 716 adult spider specimens (204 males, 511 females) belonging to 171 species from 27 families were identified (see Tab. 2 for the list of species).

Table 2. Species list of the examined spiders. New records for the Slovenian fauna are marked with an asterisk. For abbreviations of localities see Tab. 1. Numbers next to gender symbol refer to number of collected individuals.
Tabela 2. Seznam zabeleženih vrst pajkov. Prve najdbe za Slovenijo so označene z zvezdico. Natančen opis lokalitet je v Tab. 1. V oklepajih je navedeno število in spol ujetih in določenih pajkov.

	Family / Species	**Localities**
	AGELENIDAE	
1	*Agelena labyrinthica*	RTSB17-11 (1 ♀); RTSB17-24 (1 ♀); RTSB17-31 (1 ♀); PSJ-14 (2 ♀)
2	*Allagelena gracilens*	RTSB17-10 (2 ♀ 2 ♂); RTSB17-28 (1 ♀)
3	*Coelotes terrestris*	Grebenje-6 (1 ♂)
4	*Histopona torpida*	RTSB17-02 (1 ♀); RTSB17-03 (1 ♀); RTSB17-21 (1 ♀); PSJ-9 (1 ♀)
5	*Tegenaria silvestris*	RTSB17-03 (1 ♀); RTSB17-13 (1 ♀); RTSB17-20 (1 ♀); RTSB17-21 (1 ♀); PSJ-6 (1 ♀)
	AMAUROBIIDAE	
6	*Amaurobius fenestralis*	PSJ-9 (2 ♀)
	ANAPIDAE	
7	*Comaroma simoni*	BioBlitz-5 (1 ♀ 2 ♂)
	ANYPHAENIDAE	
8	*Anyphaena accentuata*	BioBlitz-3 (1 ♂); BioBlitz-5 (1 ♀)
	ARANEIDAE	
9	*Aculepeira ceropegia*	BioBlitz-3 (1 ♂)
10	*Araneus alsine*	RTSB17-10 (1 ♂)
11	*Araneus angulatus*	RTSB17-17 (1 ♀); RTSB17-17 (1 ♀); BioBlitz-4 (1 ♀)
12	*Araneus diadematus*	RTSB17-05 (1 ♂); RTSB17-09 (1 ♀); RTSB17-23 (1 ♀)
13	*Araneus marmoreus*	RTSB17-14 (1 ♀)
14	*Araneus triguttatus*	PSJ-9 (1 ♂)
15	*Araniella cucurbitina*	PSJ-4 (1 ♀); Bioblitz-8 (1 ♂)
16	*Argiope bruennichi*	RTSB17-10 (1 ♀ 1 ♂); RTSB17-19 (1 ♀); RTSB17-22 (1 ♂); RTSB17-29 (3 ♀); RTSB17-30 (2 ♀ 1 ♂); PSJ-18 (1 ♂)
17	*Cercidia prominens*	PSJ-18 (1 ♀); PSJ-1 (1 ♀)
18	*Cyclosa conica*	RTSB17-02 (1 ♀)
19	*Cyclosa oculata*	Bioblitz-8 (1 ♀)
20	*Hypsosinga pygmaea*	Bioblitz-8 (1 ♂); RTSB17-19 (1 ♀ 1 ♂)
21	*Hypsosinga sanguinea*	PSJ-3 (1 ♂); BioBlitz-3 (2 ♂)
22	*Larinioides sclopetarius*	BioBlitz-7 (1 ♀)
23	*Larinioides suspicax*	BioBlitz-7 (1 ♀)
24	*Leviellus thorelli*	BioBlitz-7 (1 ♀)
25	*Mangora acalypha*	RTSB17-11 (2 ♀); PSJ-9 (3 ♀); PSJ-2 (1 ♀ 1 ♂); PSJ-4 (1 ♀); BioBlitz-3 (2 ♂)

	Family / Species	Localities
26	*Nuctenea umbratica*	RTSB17-01 (2 ♀); RTSB17-10 (1 ♀); RTSB17-18 (1 ♂); RTSB17-23 (3 ♀ 3 ♂); BioBlitz-7 (1 ♀)
27	*Singa hamata*	BioBlitz-3 (2 ♂)
28	*Zilla diodia*	BioBlitz-5 (3 ♀)
	CLUBIONIDAE	
29	*Clubiona neglecta*	RTSB17-30 (1 ♀); PSJ-5 (1 ♀)
30	*Clubiona phrahmitis*	BioBlitz-6 (1 ♂)
31	*Clubiona pseudoneglecta*	RTSB17-18 (1 ♀); PSJ-2 (1 ♀); PSJ-4 (1 ♀)
32	*Clubiona terrestris*	RTSB17-18 (1 ♂); PSJ-2 (1 ♂)
	CYBAEIDAE	
33	*Cybaeus raymondi*	RTSB17-03 (1 ♀)
	DICTYNIDAE	
34	*Argenna subnigra*	Grebenje-11 (2 ♂); Grebenje-12 (1 ♀); Grebenje-15 (1 ♂); Grebenje-17 (1 ♀ 1 ♂); Grebenje-19 (1 ♀); Grebenje-9 (1 ♀)
35	**Nigma flavescens*	BioBlitz-1 (2 ♂)
	DYSDERIDAE	
36	*Dysdera crocata*	RTSB17-18 (1 ♀)
37	*Dysdera ninni*	RTSB17-14 (1 ♂)
38	*Harpactea hombergi*	RTSB17-20 (1 ♀)
	GNAPHOSIDAE	
39	*Drassodes lapidosus*	PSJ-14 (1 ♀)
40	*Echemus angustifrons*	PSJ-9 (1 ♀)
41	*Haplodrassus kulczynskii*	Grebenje-11 (1 ♀ 1 ♂); Grebenje-15 (1 ♂); Grebenje-16 (1 ♂)
42	**Micaria subopaca*	BioDept-1 (1 ♂)
43	*Trachyzelotes pedestris*	PSJ-13 (1 ♀)
	HAHNIIDAE	
44	*Hahnia pusilla*	Grebenje-14 (1 ♂); Grebenje-8 (1 ♀); BioBlitz-11 (4 ♀ 2 ♂); BioBlitz-12 (5 ♀ 1 ♂); BioBlitz-9 (5 ♀)
	LINYPHIIDAE	
45	*Agyneta saxatilis*	PSJ-6 (1 ♀)
46	*Agyneta fuscipalpa*	RTSB17-16 (1 ♀)
47	*Agyneta rurestris*	RTSB17-29 (1 ♂)
48	*Centromerus cavernarum*	Grebenje-22 (1 ♀)
49	*Centromerus silvicola*	BioBlitz-2 (1 ♀)
50	*Centromerus sylvaticus*	Grebenje-23 (1 ♀)
51	*Diplocephalus helleri*	RTSB17-24 (1 ♂)
52	*Diplocephalus latifrons*	Grebenje-9 (1 ♀)
53	*Diplostyla concolor*	RTSB17-09 (1 ♀); RTSB17-29 (1 ♀); Grebenje-21 (1 ♀)
54	*Entelecara acuminata*	BioBlitz-1 (2 ♀); BioBlitz-2 (1 ♂)
55	*Erigone atra*	Grebenje-19 (1 ♀)
56	**Erigone autumnalis*	Grebenje-11 (1 ♂); Grebenje-9 (2 ♂)
57	*Erigone dentipalpis*	RTSB17-29 (1 ♂)
58	*Erigone longipalpis*	BioBlitz-1 (1 ♂)

	Family / Species	Localities
59	*Frontinellina frutetorum*	RTSB17-04 (2 ♀); RTSB17-13 (1 ♀); PSJ-9 (1 ♀); Bioblitz-8 (1 ♀ 2 ♂)
60	*Gonatium hilare*	RTSB17-11 (1 ♀)
61	*Gonatium rubens*	BioBlitz-12 (2 ♀); BioBlitz-9 (7 ♀)
62	*Leptyphantes obscurus*	RTSB17-10 (1 ♂)
63	*Linyphia hortensis*	PSJ-9 (1 ♀); BioBlitz-2 (1 ♂); BioBlitz-5 (2 ♀); BioBlitz-6 (1 ♀)
64	*Linyphia triangularis*	RTSB17-09 (2 ♀ 6 ♂); RTSB17-11 (2 ♀ 1 ♂); RTSB17-12 (2 ♀ 1 ♂); RTSB17-14 (1 ♀ 2 ♂); RTSB17-18 (4 ♂); RTSB17-21 (1 ♀); RTSB17-34 (1 ♂); PSJ-12 (1 ♀)
65	*Maso sundevalli*	BioBlitz-1 (1 ♀); BioBlitz-2 (2 ♀)
66	*Mermessus trilobatus*	Grebenje-1 (4 ♀ 1 ♂); Grebenje-11 (1 ♀); Grebenje-12 (2 ♀ 1 ♂); Grebenje-13 (1 ♀); Grebenje-14 (4 ♀ 1 ♂); Grebenje-15 (1 ♀ 1 ♂); Grebenje-16 (2 ♀); Grebenje-17 (2 ♀ 1 ♂); Grebenje-18 (2 ♀); Grebenje-19 (2 ♀ 3 ♂); Grebenje-2 (1 ♀); Grebenje-20 (6 ♀); Grebenje-21 (8 ♀ 4 ♂); Grebenje-22 (5 ♀ 1 ♂); Grebenje-23 (1 ♀ 3 ♂); Grebenje-24 (3 ♀ 2 ♂); Grebenje-5 (1 ♀); Grebenje-6 (2 ♀); Grebenje-9 (4 ♀ 1 ♂)
67	*Micrargus herbigradus*	Grebenje-13 (2 ♀); Grebenje-3 (1 ♀); Grebenje-5 (1 ♂); Grebenje-6 (1 ♀); Grebenje-7 (2 ♀ 1 ♂); Grebenje-8 (2 ♀ 3 ♂); BioBlitz-12 (1 ♂)
68	*Micrargus subaequalis*	Grebenje-12 (2 ♀); Grebenje-19 (1 ♀ 1 ♂); Grebenje-20 (1 ♀)
69	*Microlinyphia pusilla*	RTSB17-29 (1 ♀)
70	*Microneta viaria*	BioBlitz-5 (7 ♀)
71	*Nematogmus sanguinolentus*	RTSB17-29 (1 ♂); RTSB17-30 (1 ♂); BioBlitz-1 (2 ♀); BioBlitz-6 (1 ♀)
72	*Neriene clathrata*	RTSB17-28 (1 ♀); RTSB17-29 (1 ♀); RTSB17-29 (1 ♀)
73	*Neriene emphana*	BioBlitz-2 (1 ♀)
74	*Neriene peltata*	BioBlitz-5 (2 ♀ 1 ♂)
75	*Neriene radiata*	RTSB17-05 (1 ♀); PSJ-8 (1 ♂)
76	*Oedothorax agrestis*	BioBlitz-10 (1 ♀); BioBlitz-11 (6 ♀); BioBlitz-12 (6 ♀); BioBlitz-2 (2 ♀); BioBlitz-6 (4 ♀ 1 ♂)
77	*Oedothorax apicatus*	RTSB17-34 (1 ♀)
78	*Palliduphantes pallidus*	Grebenje-8 (1 ♀)
79	*Panamomops affinis*	BioBlitz-2 (1 ♂)
80	**Pelecopsis parallela*	PSJ-6 (1 ♀)
81	*Pocadicnemis pumila*	BioBlitz-1 (7 ♀); BioBlitz-2 (1 ♀)
82	*Porrhoma pallidum*	RTSB17-27 (1 ♀)
83	*Stemonyphantes lineatus*	Grebenje-8 (1 ♀)
84	*Tapinocyba insecta*	Grebenje-19 (1 ♀); Grebenje-22 (6 ♀ 5 ♂); Grebenje-23 (2 ♀ 3 ♂); Grebenje-24 (1 ♀)
85	*Tapinocyba pallens*	Grebenje-24 (1 ♂)
86	*Tenuiphantes alacris*	BioBlitz-2 (4 ♀); BioBlitz-5 (1 ♀)
87	*Tenuiphantes cristatus*	BioBlitz-5 (1 ♀)
88	*Tenuiphantes flavipes*	RTSB17-18 (1 ♀); RTSB17-20 (1 ♀); RTSB17-28 (2 ♀ 4 ♂); RTSB17-29 (1 ♀); RTSB17-23 (1 ♀); Grebenje-6 (1 ♀); BioBlitz-5 (2 ♀)
89	*Tenuiphantes mengei*	RTSB17-29 (1 ♀); RTSB17-31 (1 ♀)

	Family / Species	Localities
90	*Tenuiphantes tenebricola*	RTSB17-31 (1 ♀); BioBlitz-2 (1 ♀)
91	*Tenuiphantes tenuis*	RTSB17-23 (1 ♀)
92	*Tiso vagans*	Grebenje-21 (1 ♀); Grebenje-22 (1 ♂); Grebenje-24 (1 ♀)
93	*Troglohyphantes cf. sordellii*	RTSB17-08 (1 ♀)
94	**Walckenaria alticeps*	BioBlitz-2 (1 ♂)
	LIOCRANIDAE	
95	*Apostenus fuscus*	RTSB17-02 (1 ♀)
96	*Liocranum rupicola*	PSJ-16 (1 ♀)
97	*Phrurolitus festivus*	RTSB17-13 (1 ♀)
	LYCOSIDAE	
98	*Arctosa lutetiana*	RTSB17-09 (1 ♀); Grebenje-10 (1 ♀); Grebenje-17 (1 ♀)
99	*Aulonia albimana*	RTSB17-13 (2 ♀); BioBlitz-1 (1 ♂); Bioblitz-8 (1 ♂)
100	*Hogna radiata*	PSJ-6 (1 ♀); PSJ-19 (1 ♀)
101	*Pardosa alacris*	BioBlitz-5 (2 ♂)
102	*Pardosa amentata*	RTSB17-10 (3 ♀); RTSB17-11 (1 ♀); RTSB17-14 (1 ♀)
103	*Pardosa hortensis*	PSJ-14 (1 ♀)
104	*Pardosa lugubris*	RTSB17-02 (4 ♀); RTSB17-03 (1 ♀); RTSB17-04 (3 ♀); RTSB17-10 (1 ♀); RTSB17-21 (3 ♀); RTSB17-22 (1 ♀); RTSB17-31 (1 ♀); Grebenje-3 (1 ♂); PSJ-9 (4 ♀); PSJ-13 (1 ♀); PSJ-14 (1 ♀); BioBlitz-1 (3 ♀); BioBlitz-2 (3 ♀ 1 ♂); BioBlitz-3 (6 ♀); BioBlitz-4 (2 ♀); BioBlitz-5 (11 ♀)
105	*Piratula hygrophila*	BioBlitz-6 (1 ♀)
106	*Piratula knorri*	RTSB17-14 (2 ♀); RTSB17-15 (1 ♀); RTSB17-20 (2 ♀); RTSB17-34 (6 ♀); BioBlitz-6 (2 ♀ 1 ♂)
107	*Trochosa terricola*	RTSB17-18 (2 ♀); Grebenje-6 (1 ♀); BioBlitz-3 (1 ♀)
	MITURGIDAE	
108	*Zora armillata*	RTSB17-12 (1 ♀); PSJ-12 (1 ♀)
109	*Zora spinimana*	RTSB17-30 (2 ♀); PSJ-6 (1 ♀); PSJ-8 (1 ♀); BioBlitz-4 (1 ♂); BioBlitz-5 (4 ♀ 2 ♂); BioBlitz-9 (1 ♀)
	NESTICIDAE	
110	*Nesticus cellulanus*	RTSB17-26 (1 ♀)
	OXYOPIDAE	
111	*Oxyopes lineatus*	PSJ-4 (2 ♀ 1 ♂)
	PHILODROMIDAE	
112	*Philodromus albidus*	RTSB17-23 (1 ♀)
113	*Philodromus collinus*	RTSB17-10 (1 ♀)
	PHOLCIDAE	
114	*Holocnemus pluchei*	RTSB17-33 (1 ♀)
115	*Pholcus opilionides*	RTSB17-01 (1 ♂); RTSB17-23 (3 ♀); PSJ-16 (1 ♂)
116	*Pholcus phalangoides*	RTSB17-23 (2 ♀ 1 ♂)
	PISAURIDAE	
117	*Dolomedes fimbriatus*	RTSB17-32 (1 ♀)
118	*Pisaura mirabilis*	RTSB17-10 (1 ♀); RTSB17-11 (1 ♀); RTSB17-22 (1 ♀); RTSB17-29 (1 ♀); PSJ-3 (1 ♀ 2 ♂); PSJ-1 (1 ♀); BioBlitz-3 (1 ♂)

	Family / Species	Localities
	SALTICIDAE	
119	*Ballus chalybeius*	PSJ-9 (2 ♀)
120	*Evarcha arcuata*	RTSB17-05 (1 ♀); RTSB17-10 (1 ♀); RTSB17-30 (1 ♀ 3 ♂); PSJ-6 (1 ♀); PSJ-18 (2 ♀); PSJ-18 (1 ♀); Bioblitz-8 (1 ♂)
121	*Evarcha falcata*	RTSB17-04 (1 ♀); RTSB17-18 (1 ♀); PSJ-1 (1 ♂); PSJ-14 (1 ♂); BioBlitz-1 (2 ♂); BioBlitz-3 (1 ♂)
122	*Evarcha laetabunda*	PSJ-7 (1 ♂)
123	*Heliophanus cupreus*	PSJ-9 (1 ♂); BioBlitz-1 (1 ♂)
124	*Heliophanus flavipes*	PSJ-6 (1 ♀); PSJ-18 (1 ♀); PSJ-1 (1 ♀)
125	*Marpissa muscosa*	RTSB17-23 (1 ♀); PSJ-16 (1 ♀); PSJ-13 (1 ♂)
126	*Neon reticulatus*	RTSB17-28 (2 ♀); BioBlitz-11 (1 ♀); BioBlitz-2 (1 ♂)
127	*Pellenes tripunctatus*	PSJ-1 (1 ♀)
128	*Phlegra fasciata*	RTSB17-15 (1 ♀); BioBlitz-1 (1 ♀)
	SPARASSIDAE	
129	*Micrommata virescens*	BioBlitz-1 (1 ♂); BioBlitz-2 (1 ♀)
	TETRAGNATHIDAE	
130	*Meta menardi*	RTSB17-07 (1 ♀); RTSB17-25 (1 ♀)
131	*Metellina mengei*	PSJ-9 (1 ♀); BioBlitz-6 (1 ♀)
132	*Metellina merianae*	RTSB17-01 (1 ♀); RTSB17-18 (1 ♀)
133	*Metellina segmentata*	RTSB17-09 (1 ♀); RTSB17-18 (1 ♀); RTSB17-31 (1 ♀); PSJ-8 (1 ♂); Bioblitz-8 (2 ♀)
134	*Pachygnatha degeeri*	RTSB17-29 (2 ♂); Grebenje-19 (1 ♂); Grebenje-22 (1 ♂); Grebenje-23 (1 ♂); BioBlitz-1 (1 ♂)
135	*Pachygnatha listeri*	RTSB17-29 (1 ♂)
136	*Tetragnatha montana*	RTSB17-20 (1 ♀)
137	*Tetragnatha extensa*	RTSB17-11 (2 ♀); BioBlitz-2 (2 ♂); BioBlitz-7 (1 ♂)
138	*Tetragnatha pinicola*	RTSB17-05 (1 ♂); RTSB17-10 (2 ♂)
	THERIDIIDAE	
139	*Crustulina guttata*	BioBlitz-1 (2 ♀)
140	*Cryptachea riparia*	RTSB17-23 (1 ♂)
141	*Dipoena melanogaster*	BioBlitz-4 (1 ♀)
142	*Enoplognatha ovata*	RTSB17-09 (1 ♀); RTSB17-11 (1 ♀); RTSB17-12 (2 ♀); RTSB17-14 (1 ♀); RTSB17-21 (2 ♀); RTSB17-22 (2 ♀); PSJ-2 (5 ♀); PSJ-4 (1 ♀)
143	*Enoplognatha thoracica*	Grebenje-10 (2 ♂)
144	*Episinus truncatus*	RTSB17-10 (1 ♀); RTSB17-11 (1 ♀)
145	*Neottiura bimaculata*	RTSB17-12 (1 ♀); RTSB17-29 (1 ♀); Grebenje-13 (1 ♀); Bioblitz-8 (1 ♂)
146	*Parasteatoda lunata*	RTSB17-01 (2 ♀); RTSB17-31 (6 ♀)
147	*Parasteatoda simulans*	RTSB17-18 (1 ♀)
148	*Parasteatoda tepidariorum*	RTSB17-01 (2 ♀); RTSB17-23 (9 ♀); RTSB17-33 (1 ♀); RTSB17-23 (2 ♀)
149	*Platnickina tinta*	RTSB17-23 (1 ♀)
150	*Robertus lividus*	RTSB17-09 (1 ♀)
151	*Steatoda bipunctata*	RTSB17-23 (4 ♀)

	Family / Species	Localities
152	*Steatoda paykulliana*	PSJ-14 (1 ♀)
153	*Steatoda triangulosa*	RTSB17-23 (1 ♂)
154	*Theridion melanurum*	RTSB17-12 (1 ♀)
155	*Theridion varians*	RTSB17-09 (1 ♀)
	THOMISIDAE	
156	*Diaea dorsata*	RTSB17-11 (1 ♀); RTSB17-21 (1 ♀); PSJ-1 (1 ♂)
157	*Misumena vatia*	RTSB17-11 (1 ♀ 1 ♂); RTSB17-19 (1 ♂); RTSB17-22 (1 ♂); RTSB17-18 (1 ♀); BioBlitz-2 (1 ♂); BioBlitz-3 (2 ♂)
158	*Ozyptila claveata*	Grebenje-10 (1 ♀); Grebenje-11 (1 ♂); Grebenje-12 (1 ♀); Grebenje-15 (1 ♀ 1 ♂); Grebenje-17 (1 ♂); Grebenje-9 (1 ♀ 1 ♂)
159	*Ozyptilla praticola*	RTSB17-23 (2 ♀)
160	*Ozyptilla simplex*	Bioblitz-8 (1 ♀ 2 ♂)
161	*Synaema globosum*	BioBlitz-3 (1 ♂); Bioblitz-8 (2 ♀ 1 ♂)
162	*Tmarus piger*	RTSB17-34 (1 ♀); PSJ-1 (1 ♀); BioBlitz-3 (3 ♂)
163	*Xysticus bifasciatus*	RTSB17-22 (1 ♀); Grebenje-24 (1 ♀)
164	*Xysticus cor*	PSJ-6 (1 ♂)
165	*Xysticus cristatus*	PSJ-3 (1 ♀ 1 ♂); BioBlitz-1 (1 ♀); BioBlitz-3 (4 ♀ 1 ♂); BioBlitz-7 (1 ♀)
166	*Xysticus erraticus*	Grebenje-22 (1 ♀); Grebenje-9 (1 ♀); PSJ-1 (3 ♀)
167	*Xysticus kochi*	BioBlitz-3 (4 ♀ 5 ♂); BioBlitz-6 (1 ♀); Bioblitz-8 (2 ♀)
168	*Xysticus lanio*	PSJ-3 (1 ♀); BioBlitz-3 (1 ♂)
169	*Xysticus ulmi*	BioBlitz-2 (1 ♀); Bioblitz-8 (1 ♂)
	ULOBORIDAE	
170	*Hyptiotes paradoxus*	RTSB17-18 (4 ♀ 4 ♂); PSJ-16 (1 ♀)
	ZODARIIDAE	
171	*Zodarion rubidum*	RTSB17-23 (1 ♂)

Photographic material of new and interesting records

Erigone autumnalis Emerton, 1882 (Linyphiidae)

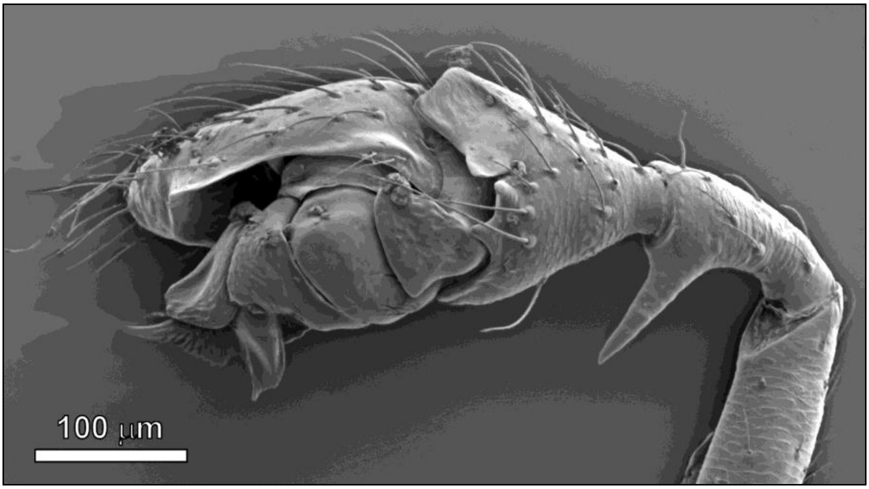

Figure 2. Lateral view of *Erigone autumnalis* left male pedipalp with specific shape of patellar apophysis and distinctive structure of bulbar sclerites. Specimen was collected in soil samples from xerophilic meadow in Grebenje village on 13. 5. 2016.

Slika 2. Stranski pogled na značilne oblike skleritov bulba in apofize na pateli levega pedipalpa samca vrste *Erigone autumnalis*. Osebek je bil najden v talnih vzorcih z dne 13. 5. 2016, odvzetih na termofilnem travniku v Grebenjah.

Pelecopsis parallela (Wider, 1834) (Linyphiidae)

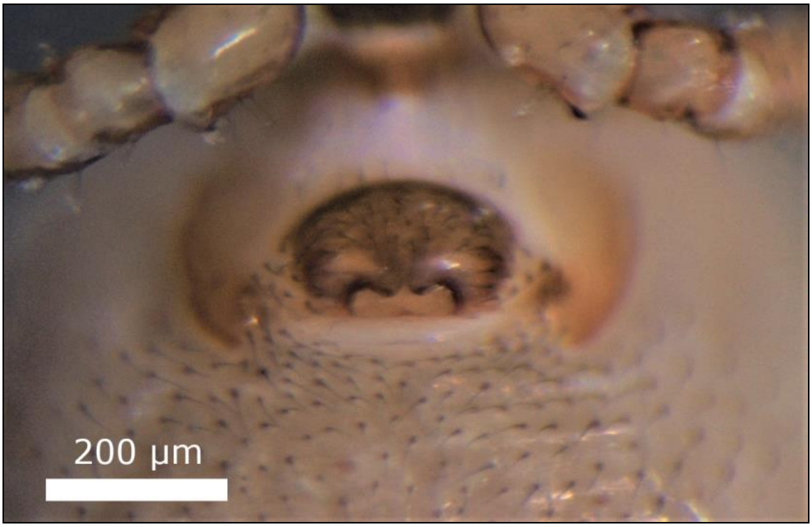

Figure 3. Ventral side of *Pelecopsis parallela* showing the distinctive epigynal morphology. Specimen was collected in a thermophilic meadow near Betanja Village on 30. 8. 2017.

Slika 3. Trebušna stran *Pelecopsis parallela* z značilno oblikovano epigino. Osebek je bil ujet 30. 8. 2017 na termofilnem travniku v bližini vasi Betanja.

Figure 4. Dorsal view of *Pelecopsis parallela*.
Slika 4. *Pelecopsis parallela* s hrbtne strani.

Walckenaria alticeps (Denis, 1952) (Linyphiidae)

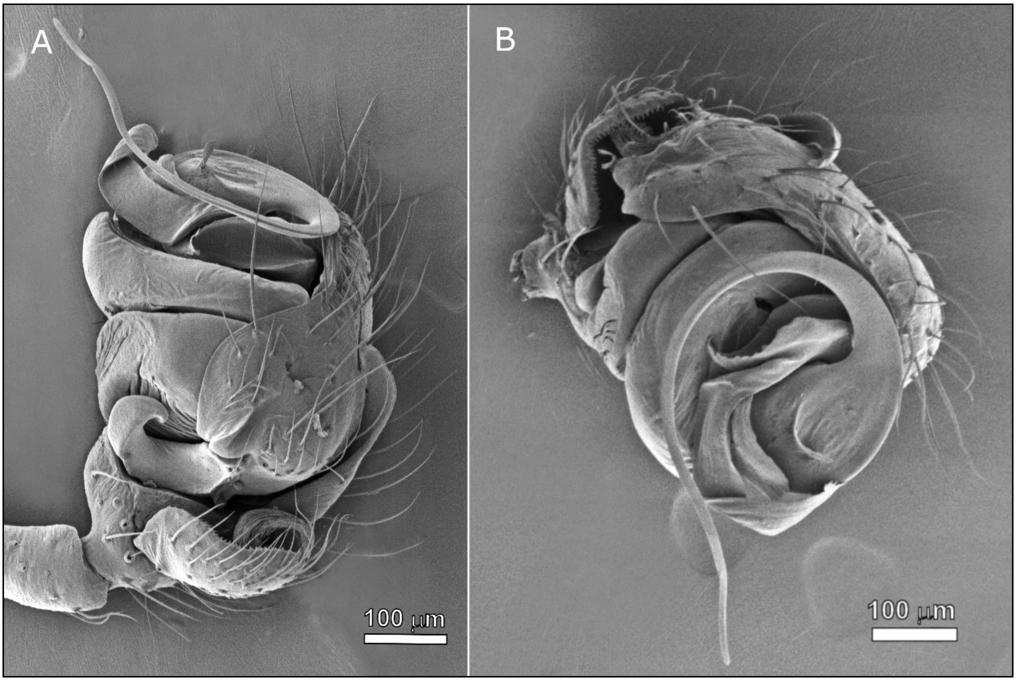

Figure 5. A – Lateral view of *Walckenaria alticeps* left male pedipalp with distinctive structure of bulbal sclerites and shape of embolus. B – Frontal view of *Walckenaria alticeps* right male pedipalp. Widely twisted embolus is ~0.3 mm in diameter. Specimen was collected on 19. 5. 2017 in mixed forest leaf litter at Draška reber.

Slika 5. A – Stranski pogled na značilne sklerotizirane strukture bulba (glave puščic) in embola (puščica) levega pedipalpa samca vrste *Walckenaria alticeps.* B – Frontalni pogled na značilno oblikovani embol desnega pedipalpa samca vrste *Walckenaria alticeps* premera ~0.3 mm. Osebek je bil ujet 19. 5. 2017 v listnem opadu mešanega gozda na Draški rebri.

Nigma flavescens (Walckenaer, 1830) (Dictynidae)

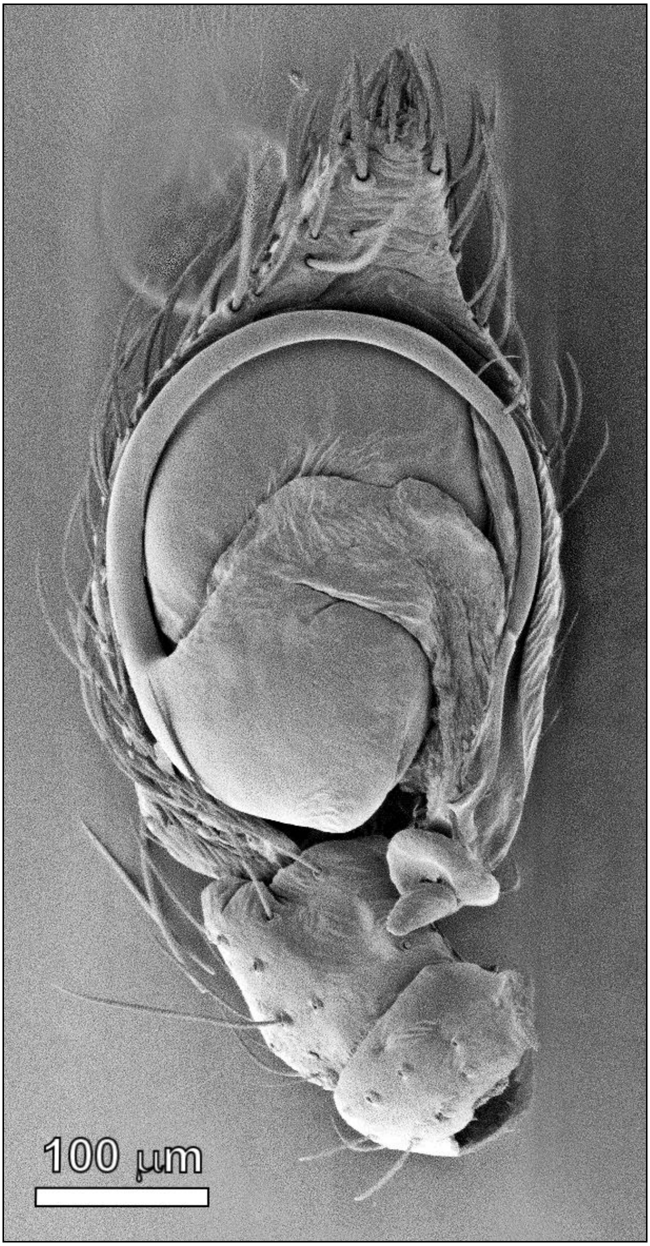

Figure 6. Ventral view of *Nigma flavescens* left male pedipalp depicting its distinctive structure. Specimen was collected on 19. 5. 2017 on forest edge near hunter's lodge at Draga.

Slika 6. Značilna struktura spodnje strani levega pedipalpa samca vrste *Nigma flavescens*. Osebek je bil ujet na gozdnem robu dne 19. 5. 2017 v bližini lovske koče Draga.

Zodarion rubidum Simon, 1914 (Zodariidae)

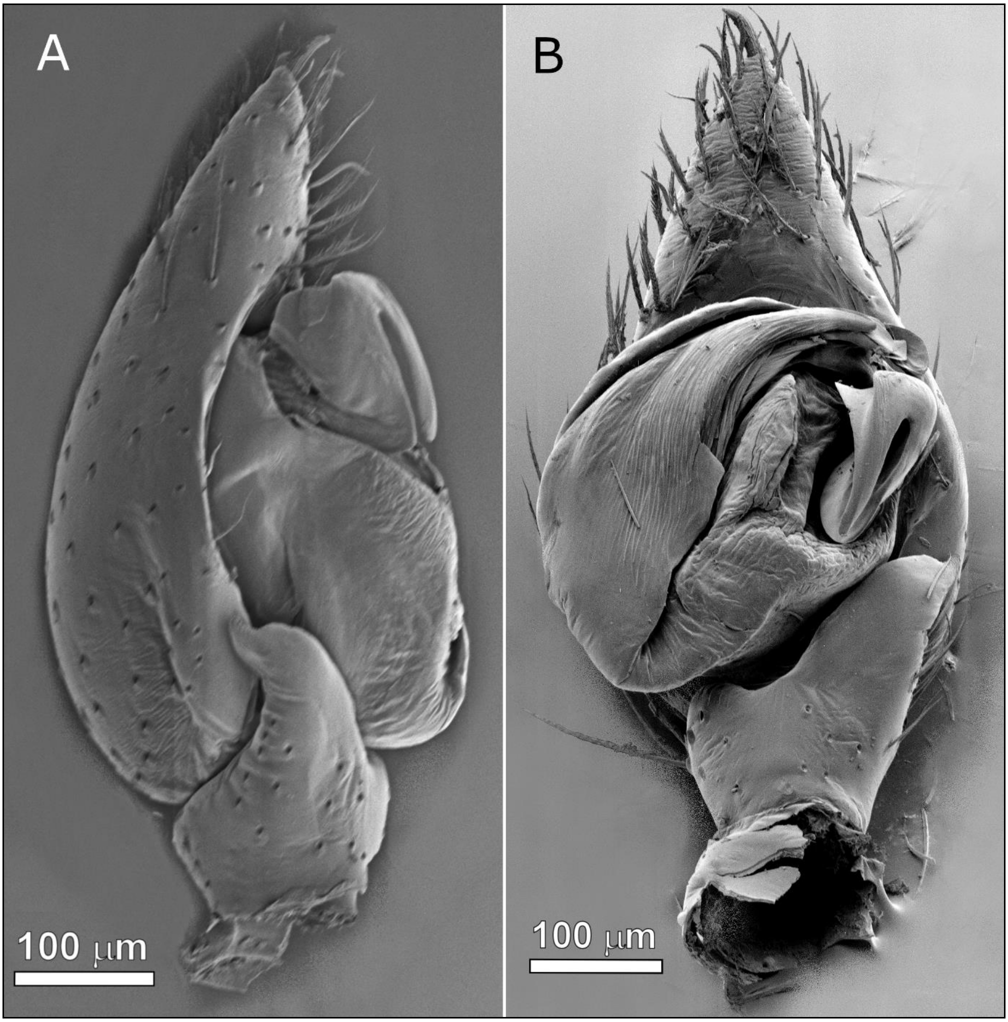

Figure 8. A – Lateral view of *Zodarion rubidum* right male pedipalp with distinctively shaped tibial apophysis. B – Ventral view at recognizable structure of *Zodarion rubidum* left male pedipalp. Specimen was collected in the vicinity od Predoslje Primary school during nighttime on 25. 7. 2017.

Slika 8. A – Stranski pogled na desni pedipalp samca vrste *Zodarion rubidum* z značilno oblikovano tibialno apofizo. B – Značilna struktura spodnje strani levega pedipalpa samca vrste *Zodarion rubidum*. Osebek je bil ujet ponoči v bližini osnovne šole Predoslje dne 25. 7. 2017.

Discussion

With 171 species and 27 families, the spider taxa presented in this paper covers 23% and 63% of currently known spider species and families in Slovenia, respectively. Approximately one third of the listed species belong to family Linyphiidae, which is consistent with the proportion of this family in the national spider checklist (Kostanjšek & Kuntner 2015).

Since its publication in 2015, the list of 738 species given in the national spider checklist (Kostanjšek & Kuntner 2015) has already seen additions. These include two new additions by Kuralt & Kostanjšek (2016) and 13 species from the existing literature, which were overlooked in the initially published checklist. These include *Clubiona diversa*, *Centromerus persimilis*, *Microlinyphia impigra, Trichoncus auritus*, *Agroeca lusatica*, *Hygrolycosa rubrofasciata*, *Zora parallela*, *Z. pardalis*, *Z. silvestris* and *Ozyptila sanctuaria* previously listed in Gregorič & Kuntner (2009), *Stalita pretneri* and *Palliduphantes spelaeorum* listed by Deltshev (2008) and *Alopecosa solitaria* reported in Slovenia by Giltay (1932). Updated version of Slovenian spider checklist comprising 753 species is available on-line (http://www.bioportal.si/katalog/araneae.php).

Additions to the Slovenian spider fauna, including five species in the present work, confirm the proverbial 'never-finished work with the checklists' and confirm predictions on undersampled spider fauna (Kostanjšek & Kuntner 2015, Kuralt & Kostanjšek 2016) as well as need of long-term systematic surveys of the spider fauna in Slovenia.

During the sampling at Škocjan Caves Regional Park, we collected *Pelecopsis parallela*, a first record of this species in Slovenia. Nevertheless, finding the species in Slovenia was somehow expected as it has a wide European distribution and is also present in all neighbouring countries (Lüscher et al. 2016, Nentwig et al. 2019).

In comparison to commonly used and accessible sampling techniques for spiders inhabiting the soil surface, like pitfall traps and leaf litter sifting, the sampling of soil-dwelling spiders inhabiting cryptic habitats in lower soil horizons are much more demanding and consequently less commonly used. In these techniques, the sampling of the soil by probe is followed by time consuming extraction of animals on Tullgren-Berlese funnels, which commonly require a dedicated extraction room for efficient extraction. To diminish the deficiency in soil-dwelling spiders we recently established a collaboration with the Research Group for Animal Ecology at the Biotechnical Faculty in Ljubljana, led by dr. Ivan Kos. Since the colleagues in the group are focused in other soil invertebrates, mainly centipedes (Chilopoda), they generously donated us the spiders from the already extracted material and provided us with access to their soil sampling probes and extraction equipment. Retrieving *Erigone autumnalis*, a new species for Slovenian spider fauna, from soil samples, the collaboration has already proved fruitful. Considering the poor sampling of deeper soil horizons for spiders in the past, further additions to the Slovenian spider fauna can be expected from this cryptic, yet faunistically rich habitat in the future.

Finding *Nigma flavescens* and *Walckenaria alticeps* during an intensive short-term (24 hour) survey at BioBlitz 2017 event (Jogan et al. 2018) emphasizes the importance of thorough samplings in our quest to fully describe the Slovenian spider fauna. Additionally, collecting *Walckenaria alticeps* in leaf litter and the discovery of *E. autumnalis* in soil samples support the claims of soil environment being one of the last frontiers in biodiversity research (Schmidt & Keith 2010, Menta 2012, Cameron et al. 2019).

The find of *Micaria subopaca* in an urban environment is surprising, as Nentwig et al. (2019) note that the species is mostly found on bark of coniferous trees where it preys on ants (Svenja 2015). We thus suspect the animal was accidentally brought to the building of Department of Biology from the field.

Most of the newly recorded species were expected to be found in Slovenia, as their presence has already been confirmed in the neighbouring countries (Nentwig et al. 2019), whereas *Erigone autumnalis* has only been confirmed in Spain, France, Switzerland (only in Tessin), Austria, Italy and Georgia. Nentwig et al. (2019) note that *E. autumnalis* is an alien species originating from North America and has been introduced to Europe on several occasions. Finding multiple animals in soil samples from a relatively small sampling area in Grebenje village suggest that the species has probably been overlooked.

Apart from being an important faunistic contribution as the second record of the species for the Slovenian fauna, the collection of *Zodarion rubidum* in the urban environment of the village Predoslje in NW Slovenia itself carries some implications that warrant discussion. The first record of *Z. rubidum* in Slovenia was recently reported by Kuralt & Kostanjšek (2016) from the Bela krajina region where a single female was collected in an urban environment during night-time sampling. Such isolated localities of the species were previously reported from Poland (Rozwałka & Gosik 2006), where collection site lay more than 400 km from other known localities. Nentwig et al. (2019) report that the species has been showing some spreading tendencies over the last decades, presumably facilitated by human activity (Rozwałka & Gosik 2006 and references therein), which could partially explain recent findings of the species in the country. At the same time, we should bear in mind that *Z. rubidum* is a nocturnal species (Pekár & Křál 2002), and that it might have been simply overlooked in previous, predominantly daytime sampling routine.

Survey of spider samplings in Slovenia quickly reveals a considerable bias towards day-time sampling of relatively accessible natural environments and little sampling effort. Considering the facts that (1) the majority of spider species are nocturnal (Foelix 2011), (2) semi-natural and urban habitats often act as surrogate habitats for species that are rarely found in natural environments (Kostanjšek & Celestina 2008, Mammola et al. 2018) and (3) cryptic and hardly accessible habitats provide niches for rarely found species, the future samplings in Slovenia should focus on temporally and spatially more evenly distributed samplings and application of sampling techniques, covering various cryptic or undersampled habitats, to ensure further additions to the Slovenian spider fauna.

Povzetek

Prispevek obravnava rezultate nedavnih favnističnih raziskav pajkov v Sloveniji. Predstavljen je seznam 171 vrst pajkov iz 27 družin, zabeleženih v Sloveniji v obdobju od 5. 2. 2016 do 30. 9. 2017. V tem obdobju je potekalo vzorčenje talnih nevretenčarjev v okolici vasi Grebenje, mesečna vzorčenja v Parku Škocjanske jame, vzorčenje v okviru dogodka BioBlitz Slovenija 2017 v Dragi pri Igu ter vzorčenje v okviru Raziskovalnega tabora študentov biologije 2017 v Predosljah pri Kranju. V prostorih Oddelka za biologijo Biotehniške fakultete Univerze v Ljubljani je bila naključno najdena vrsta *Micaria subopaca* (Gnaphosidae), ki pa je bila najverjetneje tja zanešena s terena.

Omenjenih 171 vrst iz 27 družin pokriva 23 % znanih vrst ter 63 % znanih družin pajkov vrst v Sloveniji. Med temi je tudi pet vrst, ki so bile v Sloveniji najdene prvič – *Erigone autumnalis* (Linyphiidae), *Pelecopsis parallela* (Linyphiidae), *Walckenaria alticeps* (Linyphiidae), *Micaria subopaca* (Gnaphosidae) ter *Nigma flavescens* (Dictynidae). Vrsta *Zodarion rubidum* (Zodariidae), ki je bil nedavno prvič najdena v jugovzhodnem delu države, je bil ponovno najdena v okolici Kranja.

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We thank Vanja Debevec of Škocjan Caves Park, who enabled and supported the sampling at the Park. The work was supported by the Slovenian Research Agency research program P1-0148. We thank and congratulate the BioBlitz 2017 organising team for a successful event that yielded an impressive number of 1588 (81 spider) species in one day. Ivan Kos, Franc Kljun and Katarina Tušar generously provided spiders from their soil samples. The work carried out by the araneological group at the »29th Biology Summer Research Camp - Predoslje 2017« would not be possible without highly motivated members - Neža Pajek Arambašić, Maja Ferle, Manca Velkavrh, Nina Šramel, Ester Premate and Nina Štrekelj - who worked tirelessly in the field and in the lab. Finally, we would like to express our gratitude to Matej Křižnar for proofreading the manuscript, and to three anonymous reviewers for their constructive comments.

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SHORT COMMUNICATION

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First records of the European free-tailed bat *Tadarida teniotis* (Rafinesque, 1814) in Slovenia

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Abstract. An acoustic survey of bats was conducted throughout 2016 on the slopes of the hill Črna griža near Kozina, and from the end of August 2016 to the end of October 2017 on a small Griško polje plateau close to the village of Dolenja vas near Senožeče — both sites are located in the south-west of Slovenia. Echolocation calls of *Tadarida teniotis* were recorded at both sites. *T. teniotis* was recorded near Kozina during 11 nights from April to October 2016, but it was rare, with its 38 passes constituting just 0.53% of all bat passes. It was even rarer near Dolenja vas where it was recorded twice only on the hill Veliki Ognjivec — in April and October 2017 — where constituting only 0.0001% of all bat passes. Both sites are located on the northern border of *T. teniotis* Submediterranean range. *T. teniotis* is the 31st bat species recorded in Slovenia and the 30th bat species currently living in the country.

Key words: *Tadarida teniotis*, distribution, echolocation, acoustic survey, Slovenia

Izvleček. Prve najdbe dolgorepega netopirja *Tadarida teniotis* (Rafinesque, 1814) v Sloveniji – Leta 2016 smo napravili celoletni zvočni popis netopirjev na območju hriba Črna griža pri Kozini, podobno študijo pa tudi med avgustom 2016 in oktobrom 2017 na Griškem polju pri Dolenji vasi pri Senožečah (oboje v jugozahodni Sloveniji). Na obeh mestih smo posneli tudi eholokacijske klice dolgorepega netopirja *Tadarida teniotis.* Pri Kozini smo dolgorepega netopirja zabeležili v 11 nočeh od aprila do oktobra 2016, vendar je bil redek in njegovih 38 posnetih mimoletov je sestavljalo le 0,53 % vseh mimoletov netopirjev. Pri Dolenji vasi je bil še redkejši, saj smo ga na hribu Veliki Ognjivec zaznali le enkrat v aprilu in enkrat v oktobru 2017, kar je bilo le 0,0001 % vseh mimoletov netopirjev. Obe mesti najdb ležita na severnem robu submediteranske razširjenosti te vrste. Dolgorepi netopir je 31. vrsta netopirjev, najdena v Sloveniji, in 30. vrsta netopirjev, trenutno živeča pri nas.

Ključne besede: *Tadarida teniotis*, razširjenost, eholokacija, zvočni popis, Slovenija

Introduction

In Europe, the European free-tailed bat *Tadarida teniotis* (Rafinesque, 1814) has a predominantly circum-Mediterranean distributional range, although it reaches as far as southern Switzerland, and has even been recorded further north (Dietz & Kiefer 2014). It is common along the Adriatic shores in Italy and Croatia (Lanza 2012, Tvrtković 2017) and was recently found in Italy, very close to the Slovenian border (Lapini et al. 2014, Zagmajster et al. 2015). Considering its known distribution, the species was long presumed to be present in Slovenia as well (Kryštufek 1991, Presetnik at al. 2009). Researchers have tried to confirm the presence of *T. teniotis* in southeast Slovenia (e.g. Kryštufek 1991, Presetnik 2005) a number of times by conducting surveys near rocky cliffs with fissures, which are generally its typical roosts (Dietz & Kiefer 2014), but all their attempts were unsuccessful. Although Lanza (2012) reported the species' existence near the village of Osp in Slovenia citing Kryštufek (1991), this is erroneous, as Kryštufek (1991) merely reported on an unsuccessful survey for *T. teniotis*. However, the results of our present studies finally confirm the presence of *T. teniotis* in Slovenia.

Materials and methods

During 2016, we carried out an acoustic inventory of bats on the hill Črna griža and its vicinity (lat. 45.6064°N, long. 13.9238°E, approximately 520 m a.s.l.), close to the town of Kozina in the south west of Slovenia. The hill is partly covered by forest stands of *Pinus nigra* of medium age, partly by overgrown meadows and partly by regularly mown meadows separated by lines of trees. The valley of the Glinščica River begins on the southwestern side of the hill, and approximately 9 km to the west the river flows into the Adriatic Sea, near the city of Trieste. On the Črna griža hill we recorded, on 17 evenings from 12 May 2016 to 13 November 2016, bat calls in 10× time-expansion mode with manually operated ultrasound detectors (Pettersson D240x, Pettersson Elektronik, Sweden) and a digital recorder (Marantz PMD 670, Marantz Professional, USA). The audio settings were: a) detector: maximum storage time – 1.5 s, b) recorder: 16 bit rate, 48 kHz sampling frequency. We also carried out 51 all-night surveys (March: 6, April: 6, May: 3, June: 3, July: 6, August: 7, September: 9, October: 8, November: 3) with three automatic acoustic recorders, Song Meter SM4BAT FS with SMM-U1 ultrasonic microphones protected by windscreens (Wildlife Acoustics Inc., Maynard, USA) placed at ground level. The audio settings used were: gain – 12 dB, 16k High Filter – off, sample rate – 256 kHz, minimum duration of signal for scrubber – 1.5 ms, maximum duration of signal for scrubber – none, min minimum trigger frequency – 11 kHz, trigger level – 12 dB, trigger window – 3 s, maximum length of recording – 15 s, compression – none. The automatic acoustic recorders also recorded the ambient temperature with a precision of 0.25°C for each minute.

A similar study was conducted on a small plateau – commonly known as Griško polje, located approximately 2 km west of the village of Dolenja vas near Senožeče. On the plateau, there are pastures for cattle, horses, donkeys and sheep, meadows, as well as small forest islands. Most of the continuous forest is concentrated on the slopes descending to the west of the plateau towards the valley of the small river Raša. The area is situated approximately 20 km NE of the Adriatic Sea. There we also carried out an inventory using manually operated detectors (26 evenings), and 80 all-night surveys with three automatic recorders (2016: August: 4, September: 13, October: 8, November: 3; 2017: March: 9, April 4, May: 7, June: 4, July: 4, August: 7, September: 7, October: 10).

In this paper, each separate recording made by automatic recorders is referred to as a »bat pass«, and we define a »bat visit« as a group of bat passes made sequentially with pauses of less than 3 minutes. We regard such bat visits as an indication of the number of separate visits *T. teniotis* made to the area. All recordings were later analysed with the program BatSound 4.0 (Pettersson Elektronik, Sweden). On the spectrogram we manually measured the duration of bat calls, the frequency of maximum energy, the start and end frequencies, as well as intercall intervals. The program settings for the analysis of *T. teniotis* calls were: FFT size – 1024 samples, threshold – 15, window type – Hanning, segment duration – 250-2000 ms per plot. We used echolocation call characteristics described by Haquart & Disca (2007) and Barataud (2015) to discriminate *T. teniotis* calls from the calls of other bat species. Specifically, short call duration (e.g. < 20 ms) in combination with low end frequency (e.g. < 14 kHz) are, according to the above mentioned authors, characteristic enough to separate *T. teniotis* from observations of *Nyctalus lasiopterus* which also uses low echolocation calls. Characteristically, the echolocation calls of the latter species are usually of much longer duration (>20 ms) at the frequencies of maximum energy and end frequencies below 14 kHz.

To investigate whether *T. teniotis* had been more active at certain times of the night, we divided each night into ten equal time periods (deciles) and made a visual comparison of the number of passes in each particular time period. Our interest was only in the deciles where *T. teniotis* was present, regardless of the fact that the deciles differentiated in absolute time length (from 49 minutes to 1 hour and 27 minutes) as the nights differed in length throughout the season.

Results and discussion

Surveys with manually operated detectors on the hill, Črna griža, and at the plateau, Griško polje, failed to reveal the presence of *T. teniotis*. Nevertheless, we identified its calls on the recordings made with the automatic acoustic recorders. We counted 38 bat passes of the species (grouped in 17 bat visits) on 11 nights (Tab. 1) at Črna griža, and 2 bat passes (2 visits) on separate nights close to the hill, Veliki Ognjivec, which is above the Raša valley at Griško polje. The terminal buzzes of the species were also present on some of the recordings at Črna griža. The measured parameters of selected echolocation calls, excluding terminal buzzes, were: frequency of maximum energy ranged from 10.6–12.7 kHz, start frequency from 11.0–15.0 kHz, end frequency from 10.0–11.6 kHz, call duration from 13–24 ms and the intercall interval ranged from 361–1240 ms (N = 14). The combination of the low frequency of maximum energy and the low end frequency of the echolocation calls, with the relatively short call duration clearly discriminated *T. teniotis* echolocation calls (Fig. 1) from observations of *N. lasiopterus*, which was also recorded at both areas investigated. We recorded the latter species more frequently than *T. teniotis*, but still very sporadically, on 27 nights (129 passes) at Črna griža, and on 32 nights (88 passes) at Griško polje. These sites are the second and third locations of recent sighting of *N. lasiopterus* in Slovenia (Presetnik & Knapič 2015).

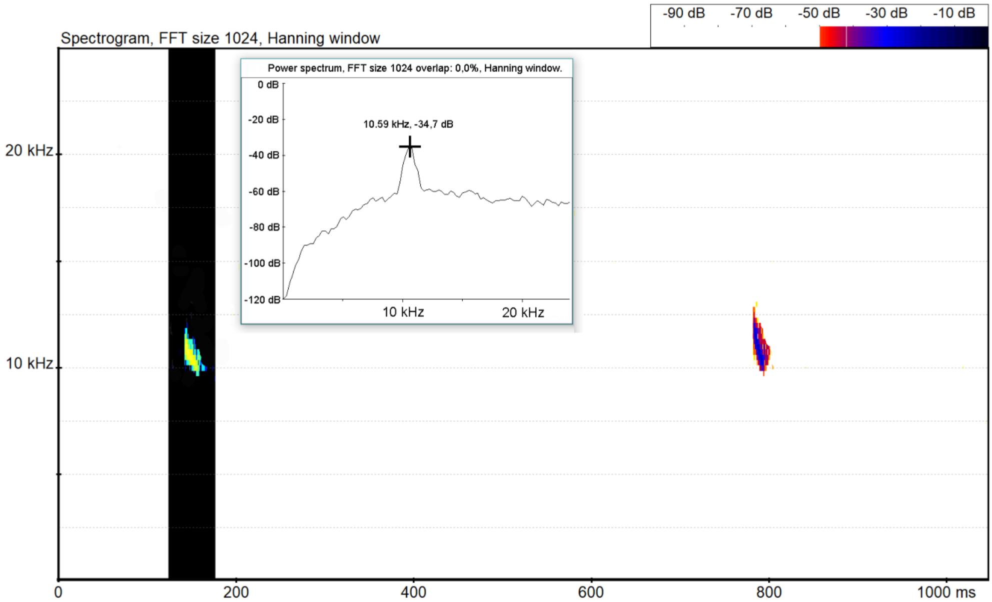

Figure 1. Spectrogram of an exemplary echolocation call sequence and power spectrum of the marked *Tadarida teniotis* call recorded on the hill Črna griža near Kozina in Slovenia.
Slika 1. Spektrogram primera zaporedja eholokacijskih klicev in jakostni spekter označenega eholokacijskega klica dolgorepega netopirja, posnetega na hribu Črna griža pri Kozini v Sloveniji.

Table 1. Dates and number of European free-tailed bat *Tadarida teniotis* passes on the Črna griža hill in 2016.
Tabela 1. Datumi in število mimoletov dolgorepega netopirja na hribu Črna griža v letu 2016.

Night / Noč	Duration of one decile / Trajanje ene desetine noči [h:min]	Sum of bat visits (no. of bat passes) / Število netopirskih obiskov (št. mimoletov)	Decile of the night (no. of bat passes) / Desetina noči (št. mimoletov)
5.4./6.4.2016	1:05	1 (3)	9 (3)
15.4./16.4.2016	1:02	1 (1)	6 (1)
16.4./17.4.2016	1:02	4 (5)	1 (1), 4 (2), 7 (2)
3.5./4.5.2016	0:57	1 (1)	1 (1)
13.8./14.8.2016	0:59	1 (1)	5 (1)
14.8./15.8.2016	0:59	1 (3)	8 (3)
25.8./26.8.2016	1:02	1 (5)	7 (5)
10.9./11.9.2016	1:07	3 (13)	3 (6), 4 (2), 5 (5)
11.9./12.9.2016	1:07	1 (2)	8 (2)
30.9./1.10.2016	1:13	1 (2)	3 (1), 5 (1)
1.10./2.10.2016	1:14	1 (2)	2 (2)
Median / Mediana	-	1 (2)	5

The presence of *T. teniotis* on the hill, Črna griža, was not a surprise as this site (in UTM square VL 15) is a mere 9 km ENE from the recent observations recorded by Zagmajster et al. (2015) just across the border in Italy (UTM square VL 04). The hill, Veliki Ognjivec at Griško Polje (in UTM square VL 26) is approximately 20 km NE from the site in Italy, but still in the expected distribution range of the species.

T. teniotis very rarely made an appearance on the hill, Črna griža, because we could attribute only 0.53 % of all bat passes (out of 7231) to this species. We recorded 17 separate bat visits of the species on 11 nights or 21% out of 51 possible nights. However, it was recorded from early April until early October 2016 (Tab. 1) at air temperatures ranging from 10 to 23 °C. On each recording, the echolocation calls of only one *T. teniotis* were observed. In most cases, *T. teniotis* visited the area under investigation only once per night, with two exceptions. On the nights of 16 April and 10 September 2016, *T. teniotis* visited the area 4 and 3 times respectively (Tab. 1). The median number of bat passes per bat visit was 1 (maximum 6) and the bat visits lasted 4 minutes at most, with the median being 1 minute. In general, the median was 2 bat passes by *T. teniotis* per night, and usually no more than 5 passes were recorded each night, the exception being the night of 10 September 2016 (13 passes). At Veliki Ognjivec (Griško polje), one bat pass by *T. teniotis* was recorded on 8 April 2017, and one on 7 October 2017, amounting to just 0.0001 % of all the bat passes (out of 16759), or on only two nights (i.e. 0.025 %) out of 80 possible nights.

We attribute the lack of *T. teniotis* records for the months of June and July (Tab. 1) at Črna griža, and from May to September at Griško polje, more to its rarity in the areas than to less intensive summer samplings. Zagmajster et al. (2015) also reported on the rarity of the species in the neighbouring Italian region of Friuli Venezia Giulia (4 out of 820 ultrasound detector sites or 0.49%), though they reported the presence of *T. teniotis* in the vicinity of the Slovenian border also from mid-July. Therefore, a possible seasonal variation of the presence of *T. teniotis* in Slovenia and adjacent areas requires further investigation.

Why had this species not been recorded in Slovenia earlier, despite a number of focused surveys carried out to ascertain its presence? One explanation may be its rarity, and/or the time of night when *T. teniotis* is active in the area. In the case of Črna griža, most of the *T. teniotis* passes occurred after the first fifth of the night, and over 60% of passes were recorded after the second fifth of the night (Fig. 2). Similarly, at Veliki Ognjivec (Griško polje) one bat pass was recorded in third and one in forth fifth of the night. Therefore, *T. teniotis* occurred at the times of night when surveys with manually operated detectors had been less intensive or not conducted in the past.

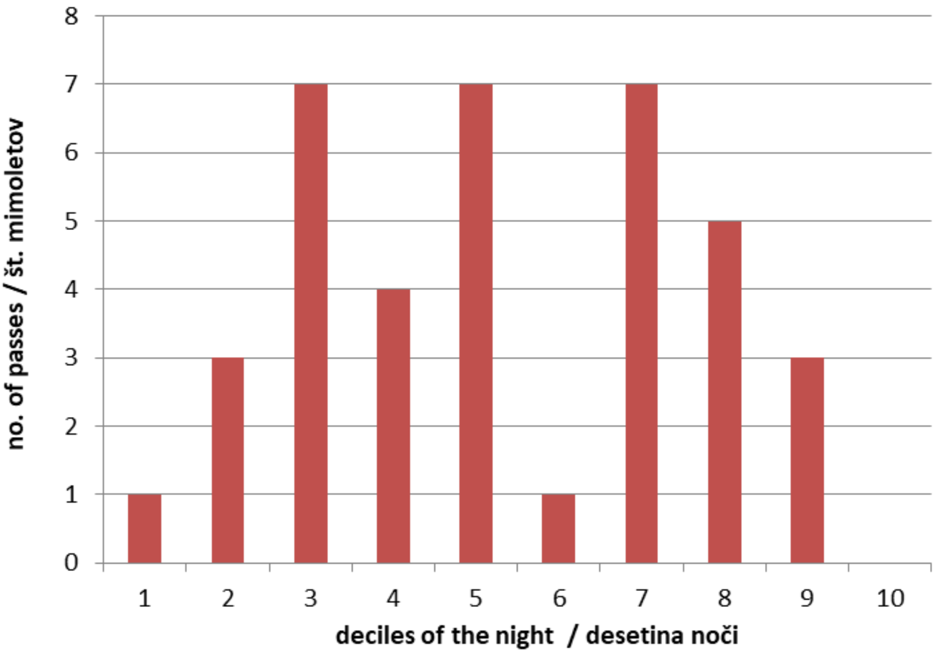

Figure 2. Number of *Tadarida teniotis* passes in each of the ten time periods (deciles) of the night in the year 2016 on the hill Črna griža (for the duration of each decile of the night see Tab. 1).
Slika 2. Število mimoletov dolgorepega netopirja v desetinah noči v letu 2016 na hribu Črna griža (za dolžino trajanja desetine noči glej Tab. 1).

Conclusions

Tadarida teniotis was recorded in areas close to the seashore in the western part of Slovenia. The species seems to occur there throughout the year, and therefore should be considered a permanent part of Slovenian bat fauna. It is the 31st bat species recorded for our country, and is considered the 30th bat species currently living in Slovenia (Presetnik et al. 2009, Presetnik 2012, Presetnik & Knapič 2015). However, because Slovenia is at the edge of its current areal, it is only to be expected that observations of it would be rare, which might explain the late confirmation of its presence in the country. We are confident that further acoustic surveys, especially using automatic recorders, will shortly reveal more sites containing this species in Slovenia.

Acknowledgements

We are grateful to ENERCOM d.o.o. and AAE Gamit d.o.o. who sponsored our research. We appreciate all the time we spent with our colleagues in search of *Tadarida teniotis* in Slovenia, even when it was in vain, and especially acknowledge Klemen Koselj as the *spiritus movens* for our research, and thank him for keeping his promise to throw a big party after the species was finally found in the Slovenian territory. Finally, we would like to express our sincere thanks to two anonymous reviewers for their in depth advice on text improvement.

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FIELD NOTE

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The first documented finds of *Calliostoma laugieri* (Payraudeau, 1826) (Gastropoda: Calliostomatidae) on the coastal mollusc shell deposit at Ankaran

Prvi dokumentirani najdbi *Calliostoma laugieri* (Payraudeau, 1826) (Gastropoda: Calliostomatidae) na školjčni sipini pri Ankaranu

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The snail *Calliostoma laugieri* (Payraudeau, 1826) is an intertidal and infralittoral dwelling species that feeds on animals of the order Actiniaria (Simič 2014). It can be found among the sea grass Posidonia oceanica (Albano & Sabelli 2012) and *Cystoseira* algal associations (Pitacco et al. 2014). The animal is uniformly brown, while the shell varies greatly, from olive green with brown speckles to beige or brown and even to solid purple. The shell is conically shaped with a natural shine, completely smooth or with spiral ribs, the body whorl is rounded and oftentimes the bottom edge of each whorl is thickened. It lacks an umbilicus and has a rounded aperture with mother-of-pearl on the inside (Simič 2014).

C. laugieri is distributed along the European Mediterranean coast and the Atlantic coast of Portugal and Spain (MolluscaBase 2019). It has also been found in Morocco along the Strait of Gibraltar (Conchology 2015a, 2015b). Its presence along the Slovenian coast is known and it is considered to be frequent (De Min & Vio 1997), however, *C. laugieri* was not observed during previous field work on the coastal mollusc shell deposit at Ankaran (De Min et al. 1997), nor are there any more recent publications to suggest so. The coastal mollusc shell deposit was created due to dredging of deposits at the time the Port of Koper deepened the sea floor close to their docks (Geister 2014). Through time, rain and the tides washed away the silt and a pile of shells was left.

Figure 1. The snail *Calliostoma laugieri*, collected on 22. 7. 2018 in coastal mollusc shell deposits at Ankaran in Southwestern Slovenia (photo: Sonja Huč).
Slika 1. Polž *Calliostoma laugieri*, najden 22. 7. 2018 na školjčni sipini v Ankaranu v jugozahodni Sloveniji (foto: Sonja Huč).

During field work done as part of the Biology Students Research Camp »Slovenska Istra«, the marine molluscs group found a single specimen of *C. laugieri* (Fig. 1) at the coastal mollusc shell deposit at Ankaran on 22. 7. 2018. This is an interesting find, as despite the wide distribution of the species and the amount of previous field work done at that location, this is the first documented specimen from this particular locality. The specimen, with a width of 10.28 mm and a height of 8.66 mm, has a missing apex and faded colours due to sun exposure. The presence of this species on the coastal mollusc shell deposit at Ankaran was further confirmed by a second find of a single specimen during field work carried out on 11. 4. 2019. This shell has a width of 13.26 mm and a height of 13.79 mm, also with a missing apex. Most of the outer calcareous layer has been chipped off, exposing the inner mother-of-pearl.

It is unknown whether these shells belonged to more recently deceased snails and were washed ashore or if they were part of the dredged deposits and only now became exposed. They still, however, expand the known diversity of the malacological fauna of this mollusc shell deposit.

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The fieldwork was carried out as part of the Biology Students Research Camp, organized by the Biological Student's Society, Ljubljana, Slovenia. We wish to thank Jan Simič for his support, providing literature, and for confirming the species identification. Thanks also to Simona Prevorčnik for her guidance and support.

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FIELD NOTE

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Discovery of subterranean amphipod *Niphargus stygius* (Schiødte, 1847) (Amphipoda: Niphargidae) in a cave drip pool with increased salinity

Najdba slepe postranice *Niphargus stygius* (Schiødte, 1847) (Amphipoda: Niphargidae) v jamski luži prenikle vode s povečano slanostjo

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With more than 430 species currently described, the subterranean genus *Niphargus* is the species richest genus of amphipods (Fišer 2019). Most of the species live in subterranean freshwaters (groundwaters) with rare cases of species that seem to have recolonized surface waters (Copilaş-Ciocianu et al. 2018). The genus is found in a wide range of habitats, yet the actual data on individual species tolerances to different abiotic parameters are few (Fišer 2019). Here we report on the finding of an individual of the species *Niphargus stygius* (Schiødte, 1847) in cave waters with increased salinity.

In winter 2012, we visited the cave Logarček (Cad. No. 28; Slovenian Cave Register 2019) near Laze pri Planini, close to Postojna (cave entrance coordinates and altitude: 14.26832 E, 45.86493 N, 498 m a.s.l.; Slovenian Cave Register 2019). The cave has a vertical extent of approximately 120 m, and the cumulative length of cave passages reaching nearly 5 km (Slovenian Cave Register 2019). The entrance of the cave is approx. 20 m deep shaft, leading to a fossil channel, which splits into two branches. Both the Northern and the Southern branches contain water lakes and siphons at the deepest parts (see Ilič 2003 for the cave map).

On 23. 2. 2012, upon our first visit to the cave, we found an active water drip, forming a water current and a series of small water puddles on the cave floor in a cave chamber opening from the Northern branch of the cave called »Podorna dvorana«. As the second author tried to drink the water from the water puddles, he noticed its unusually sour and salty taste. We found and collected one amphipod in one of the puddles filled with dripping water, and a sample of water was taken directly from the drip. We measured abiotic parameters of the water in the lab on the same day, when returning to the lab of the Department of Biology in Ljubljana, using portable multimeter CyberScan PCD650 (Eutech Instruments). The specific electric conductivity and salinity level were increased (Tab. 1) compared to normal values for freshwater, having salinity less than 0.5 ‰ (Venice system 1958).

We repeated the visit two weeks later, on 9. 3. 2012, when we checked only the Northern branch up to app. 600 m from the entrance, to the lake in »Skalni rov«. This time, there was no active water drip in »Podorna dvorana«, but the water remained in puddles on the cave floor. We collected the water from two different puddles, and measured abiotic parameters three days later (on 12. 3. 2012) in the lab. The salinity of the water in the puddles was lower than during our February sampling, but much higher than in the water taken from a cave lake in »Skalni rov«, about 250 m deeper in the cave (Tab. 1). At the time of the visit, there were no additional amphipods observed in any of the water puddles on the floor.

The animal collected during the February visit was kept alive in the same drip pool water in the laboratory, in the Speleobiological chamber at Department of Biology (Biotechnical Faculty, University of Ljubljana), at an approximate temperature of 10 °C. It remained alive in this water for about a month, and died between 26. and 30. 3. 2012.

Our accidental observations are interesting in two aspects. First, the water drip in »Podorna dvorana«, active for only a limited interval, appears to be occasionally salty. The chamber is positioned underneath the Vrhnika–Postojna motorway, with the ceiling only 13 m thick (Šebela 2000; Ilič 2003). During our first visit, the snow cover on the surface was melting due to sunny weather, and it is very likely that the increased salinity in the cave was caused by highly salted waste waters from the motorway above the cave. Similarly, increased levels of chlorides and specific electric conductivity in karst waters were observed in a study of road waste waters from a section of the motorway near Postojna (Kogovšek 1993). Both parameters were directly connected to salting of roads. On our second visit, the snow was no longer present on the surface, and the water was no longer dripping into the puddles in »Podorna dvorana«. Noteworthy, in the deeper lake of »Skalni rov« of the Northern channel, a morphologically unusual form of cave hydrozoan *Velkovrhia enigmatica* was found during the same cave visits in 2012 (Zagmajster et al. 2013). The individuals had increased number of tentacles, which could be the effect of the increased salinity (Zagmajster et al. 2013, with references therein), although the lake with *V. enigmatica* showed normal freshwater salinity (Tab. 1). We suggest that waste waters from the motorway are neglected, yet temporary important pollutants of subterranean environments. The extent of this pollution and its impact on subterranean animals remain to be established.

Second, it is interesting to see that a freshwater *Niphargus* species was able to survive in the increased salinity in a cave nearly 50 km away from the sea coast. Some *Niphargus* species tolerate increased water salinity, but they were all found in anchialine (brackish) waters close to the sea (Sket 1977; Gottstein et al. 2012, Delić et al. 2017). Our discovery of *N. stygius* confirms its ability to survive in waters with increased salinity for a short time, but whether it survives in such conditions for a long time, remains unanswered. It is a species found in diverse groundwater freshwater habitats: cave streams and lakes, pools of dripping water, but also at springs and, consequently, in surface streams in the vicinity of springs (Delić 2017). Our observation suggests that the species may survive on a short term in suboptimal conditions (the individual was not fed during captivity), and that at least some individuals of this species are able to survive such increased salinity for a few weeks. However, we cannot rule out a possibility that other *Niphargus* individuals did not survive local pollution, and had been washed away from the cave puddles prior to the first visit. A controlled laboratory experiment is needed to resolve the species' tolerance to increased salinity in waters.

Table 1. Measurements of some abiotic water parameters from the cave Logarček near Laze in central Slovenia, taken in the »Podorna dvorana« chamber, and from the lake in »Skalni rov«, during two samplings in winter 2012. See Ilič (2003) for spatial positions of the chambers.

Tabela 1. Meritve nekaj abiotskih parametrov vode iz jame Logarček pri Lazah v osrednji Sloveniji, ki je bila vzeta v »Podorni dvorani« in v jezeru v »Skalnem rovu«, v dveh vzorčenjih pozimi 2012. Glej Ilič (2003) za prostorski položaj dvoran.

Date	Part of the cave	Conductivity (mS)	Salinity (NaCl ppt)	pH
23. 2. 2012	»Podorna dvorana« - dripping water	12.000	13.810	/
9. 3. 2012	»Podorna dvorana« - puddle 1 on the floor	7.031	7.527	7.50
	»Podorna dvorana« - puddle 2 on the floor	5.596	5.822	7.45
	Lake in »Skalni rov«	0.315	0.283	7.67

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NAVODILA AVTORJEM

NATURA SLOVENIAE objavlja izvirne prispevke, ki imajo za ozadje terensko delo s področja biologije in/ali prispevajo k poznavanju favne in flore osrednje in jugovzhodne Evrope. Prispevki so lahko v obliki znanstvenih člankov, kratkih vesti ali terenskih notic.

Znanstveni članek je celovit opis izvirne raziskave in vključuje teoretično ozadje tematike, območje raziskav in metode uporabljene pri delu, podrobno predstavljene rezultate in diskusijo, sklepe ter pregled literature. Dolžina naj ne presega 20 strani.
Kratka znanstvena vest je izvirni prispevek, ki ne vsebuje podrobnega teoretičnega pregleda. Njen namen je seznaniti bralca z delnimi ali preliminarnimi rezultati raziskave. Dolžina naj ne presega petih strani.
Terenska notica je krajši prispevek o zanimivih favnističnih ali florističnih opažanjih in najdbah na področju Slovenije. Dolžina naj ne presega treh strani.

Vsi prispevki bodo recenzirani. Avtorji lahko v spremnem dopisu sami predlagajo recenzente, kljub temu pa urednik lahko izbere tudi kakšnega drugega recenzenta. Recenziran članek popravi avtor oz. avtorji sami. V primeru zavrnitve se originalne materiale skupaj z obrazložitvijo glavnega urednika vrne odgovornemu avtorju.

Prispevki, objavljeni v reviji Natura Sloveniae, ne smejo biti predhodno objavljeni ali sočasno predloženi in objavljeni v drugih revijah ali kongresnih publikacijah. Avtorji se s predložitvijo prispevkov strinjajo, da ob njihovi potrditvi, ti postanejo last revije.

Prispevke lahko oddate na naslov Natura Sloveniae, Večna pot 111, SI-1111 Ljubljana, Slovenija (telefon: (01) 423 33 70, fax: 273 390, E-mail: maja.zagmajster@bf.uni-lj.si).

FORMAT IN OBLIKA PRISPEVKA
Prispevki naj bodo napisani v programu Word for Windows, v pisavi "Times New Roman CE 12", z levo poravnavo in 3 cm robovi na A4 formatu. Med vrsticami naj bo dvojni razmak, med odstavki pa prazna vrstica. Naslov prispevka in naslovi posameznih poglavij naj bodo natisnjeni krepko v velikosti pisave 14. Latinska imena rodov in vrst morajo biti pisana ležeče. Uredniku je potrebno prispevek oddati v primerni elektronski obliki (disketa, CD, elektronska pošta) v Rich text (.rtf) ali Word document (.doc) formatu.

Naslov prispevka (v slovenskem in angleškem jeziku) mora biti informativen, jasen in kratek. Naslovu naj sledijo celotna imena avtorjev in njihovi naslovi (vključno z naslovi elektronske pošte).

Izvleček v slovenskem jeziku mora na kratko predstaviti namen, metode, rezultate in zaključke. Dolžina izvlečka naj ne presega 200 besed za znanstveni članek oziroma 100 besed za kratko znanstveno vest. Pod izvlečkom naj bodo ključne besede, ki predstavljajo področje raziskave. Njihovo število naj ne bo večje od 10. Sledi abstract in key words v angleškem jeziku, za katere velja enako kot za izvleček in ključne besede.

Glavnina prispevka znanstvenega članka in kratke znanstvene vesti je lahko pisana v slovenskem jeziku čeprav je bolj zaželjen angleški jezik. Prispevek, ki je pisan v slovenskem jeziku mora vsebovati obširnejši angleški povzetek - summary, prispevek pisan v angleškem jeziku pa obširnejši slovenski povzetek (200-500 besed). Terenska notica je v celoti napisana v angleškem jeziku, brez izvlečka, ključnih besed in povzetka. Pri oblikovanju besedil naj se avtorji zgledujejo po zadnjih številkah revije.

SLIKE IN TABELE
Skupno število slik in tabel v prispevku naj ne bo večje od 10, njihovo mesto naj bo v članku nedvoumno označeno. Posamezne tabele z legendami naj bodo na ločenih listih. Naslovi tabel naj bodo nad njimi, naslovi slik in fotografij pa pod njimi. Naslovi in legenda slik in tabel naj bodo v slovenskem in angleškem jeziku. Pri navajanju slik in tabel v tekstu uporabljajte okrajšave (npr. angl: Tab. 1 ali Tabs. 1-2, Fig. 1 ali Figs. 1-2 in slo.: Tab. 1 in Sl. 1).

NAVAJANJE LITERATURE
Navajanje literature v besedilu mora biti na ustreznem mestu. Kadar citiramo enega avtorja, pišemo Schultz (1987) ali (Schultz 1987), če sta avtorja dva (Parry & Brown 1959) in če je avtorjev več (Lubin et al. 1978). Kadar navajamo citat večih del hkrati, pišemo (Ward 1991, Pace 1992, Amman 1998). V primeru, ko citiramo več del istega avtorja objavljenih v istem letu, posamezno delo označimo s črkami (Lucas 1988a, b). Literatura naj bo urejena po abecednem redu.

Primeri:

- članke iz revij citiramo:

Schultz J.W. (1987): The origin of the spinning aparatures in spiders. Biol. Rev. 62: 123-134.
Parry D.A., Brown R.H.J. (1959): The hydraulic mechanism of the spider leg. J. Exp. Biol. 36: 654-657.
Lubin Y.D., Eberhard W.G., Montgomery G.G. (1978): Webs of Miagrammopes (Araneae: Araneaidae) in the neotropics. Psyche 85: 1-13.
Lucas S. (1988a): Spiders in Brasil. Toxicon 26: 759-766.
Lucas S. (1988b): Spiders and their silks. Discovery 25: 1-4.

- knjige, poglavja iz knjig, poročila, kongresne povzetke citiramo:

Foelix R.F. (1996): Biology of spiders, 2. edition. Harvard University Press, London, pp. 155-162.
Nentwig W., Heimer S. (1987): Ecological aspects of spider webs. In: Nentwig W. (Ed.), Ecophysiology of Spiders. Springer Verlag, Berlin, 211 pp.
Edmonds D.T. (1997): The contribution of atmospheric water vapour to the formation of a spider's capture web. In: Heimer S. (Ed.), Proceedings of the 17th European Colloquium of Arachnology. Oxford Press, London, pp. 35-46.

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Short Communication is an original paper without detailed theoretical review. Its purpose is to introduce partial or preliminary results of the research. The length of the Short Communication may not exceed five pages.
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All papers will be subject to peer review by one referee. Authors are invited to suggest the names of referees, although the editor reserves the right to elect an alternative referee to those suggested. The reviewed paper should be corrected by author or authors themselves. In the case of the rejection, the original materials will be sent back to the corresponding author with the editors explanation.

The submitted papers should not have been previously published and should not be simulatenously submiteed or published elsewhere (in other journals, bulletins or congress publications). By submitting a paper, the authors agree that the copyright for their article is transferred to the publisher if and when the article is accepted for publication.

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FORMAT AND FORM OF ARTICLES
Papers should be written with Word for Windows using "Times New Roman CE" size 12 font, align left and margins of 3 cm on A4 pages. Double spacing should be used between lines and paragraphs should be separated with a single empty line. The title and chapters should be written bold in font size 14. The latin names of all genera and species must be written italic. All submissions should be sent to the editor in the appropriate electronic version on diskette, CD or via e-mail in Rich text format (.rtf) or Word document (.doc) format.

Title of paper should be informative, understandable, and concise. The title should be followed by the name(s) and full adress(es) of the author(s), including E-mail adresse(s).

Abstract must give concize information about the objectives, methods used, results and the conclusions. The abstract length should not exceed 200 words for »Scientific Papers« and 100 words for »Short Communications«. There should be no more than ten keywords which must accurately reflect the field of research covered in the paper. Field notice does not include abstract and keywords. Author(s) should check the last issue of Natura Sloveniae when preparing the manuscript.

ILLUSTRATIONS AND TABLES
Papers should not exceed a total of ten illustrations and/or tables, with their positon amongst the text clearly indicated by the author(s). Tables with their legends should be submitted on separate pages. Titles of tables should appear above them, and titles of illustrations and photographs below. Illustrations and tables should be cited shortly in the text (Tab. 1 or Tabs. 1-2, Fig. 1 or Figs. 1-2).

LITERATURE
References should be cited in the text as follows: a single author is cited, as Schultz (1987) or (Schultz 1987); two authors would be (Parry & Brown 1959); if a work of three or more authors is cited, (Lubin et al. 1978); and if the reference appears in several works, (Ward 1991, Pace 1992, Amman 1998). If several works by the same author published in the same year are cited, the individual works are indicated with the added letters a, b, c, etc. (Lucas 1988a, b). The literature should be arranged in alphabetical order.

Examples (use the the following forms):

- articles from journals:

Schultz J.W. (1987): The origin of the spinning aparatures in spiders. Biol. Rev. 62: 123-134.
Parry D.A., Brown R.H.J. (1959): The hydraulic mechanism of the spider leg. J. Exp. Biol. 36: 654-657.
Lubin Y.D., Eberhard W.G., Montgomery G.G. (1978): Webs of Miagrammopes (Araneae: Araneaidae) in the neotropics. Psyche 85: 1-13.
Lucas S. (1988a): Spiders in Brasil. Toxicon 26: 759-766.
Lucas S. (1988b): Spiders and their silks. Discovery 25: 1-4.

- for books, chapters from books, reports, and congress anthologies:

Foelix R.F. (1996): Biology of spiders, 2. edition. Harvard University Press, London, pp. 155-162.
Nentwig W., Heimer S. (1987): Ecological aspects of spider webs. In: Nentwig W. (Ed.), Ecophysiology of Spiders. Springer Verlag, Berlin, 211 pp.
Edmonds D.T. (1997): The contribution of atmospheric water vapour to the formation of a spider's capture web. In: Heimer S. (Ed.), Proceedings of the 17th European Colloquium of Arachnology. Oxford Press, London, pp. 35-46.