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First records of two ascomycete fungi (Ascomycota) for Slovenia

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Abstract. In April and May 2019, two ascomycetous species – *Vibrissea filisporia* (Bonord.) Korf & A. Sánchez 1967 and *Cudoniella tenuispora* (Cooke & Massee) Dennis 1974 were observed in Tivoli, Rožnik and Šiška hill Landscape Park in central Slovenia. This is the first evidence of their presence in the country. Despite specific growth condition requirements, there is a reasonable probability that these two species grow also elsewhere in Slovenia, but have simply been overlooked. We recommend further studies of suitable habitats for the species, to complete the knowledge on their distribution within the country.

Key words: fungi, Ascomycota, first records, *Vibrissea filisporia*, *Cudoniella tenuispora*, Mali Rožnik, Ljubljana, Slovenia

Izvleček. Prvi podatki o dveh vrstah gliv zaprtotrosnic (Ascomycota) za Slovenijo – V aprilu in maju 2019 sta bili na območju zavarovanega območja Krajinskega parka Tivoli, Rožnik in Šišenski hrib v osrednji Sloveniji najdeni dve glivi zaprtotrosnici, *Vibrissea filisporia* (Bonord.) Korf & A. Sánchez 1967 in *Cudoniella tenuispora* (Cooke & Massee) Dennis 1974. Kljub specifičnim rastiščnim zahtevam je zelo verjetno, da ti dve vrsti uspevata tudi drugod po državi, a sta bili spregledani. Prihodnje študije primernih habitatov bodo lahko dopolnile poznavanje razširjenosti teh vrst v državi.

Ključne besede: glive, Ascomycota, prvi podatki, *Vibrissea filisporia, Cudoniella tenuispora*, Mali Rožnik, Ljubljana, Slovenija

Introduction

Tivoli, Rožnik and Šiška hill Landscape Park is a nature protected area in central Slovenia. Due to highly preserved natural features of the area, it was declared a Landscape Park in 1984 (Ur. l. SRS 1984; Ur. l. RS 2015). Management office for the park, also in charge of conducting organism inventories within the park, was established in 2017 (Anonymous 2018). Part of the assignments of the management team includes fulfilling the inventories of the species within the park.

So far, more than 1,200 different fungi species have been recorded in the Landscape Park in Ljubljana (Šparl, unpublished data). This number is probably underestimation of the true diversity, as systematic studies on fungi in the area are lacking. Due to various high humidity habitats, as well as due to areas with remains of wood mass (Smrekar et al. 2011), the potential for new findings is high.

During the few days of targeted research within the park in spring 2019, we observed many different fungal species. Here we report on two that were most interesting, as these are first records not only for the park, but for the whole of Slovenia.

Materials and methods

Tivoli, Rožnik and Šiška hill Landscape Park is positioned in central Slovenia, within the capital city Ljubljana (Fig. 1). It covers 4.59 km^2, at about 300–429 m altitude, encompassing different seminatural habitats. Three quarters of this area are covered by forests, in which beech, fir and noble deciduous trees prevail. Natural forest associations are present particularly on the eastern slopes, while other forested areas have been changed owing to planned forestation with spruce, also Douglas firs and even eastern white pine. A smaller part of the Landscape Park is overgrown by regularly maintained grasslands, which stretch from the western edge of the area towards its south (Fig. 1). At the eastern part of the area spreads the urban green area, Tivoli Park, a transition between the urban flat part of the city and its hilly forested area.

During the three days in spring 2019 (20. 4., 25. 4. and 2. 5.2019) we conducted a field work study within different parts of the park: Mali Rožnik Nature Reserve (Gauss-Krüger coordinates of the central point of the area are Y: 459573, X: 101895) and the area near Mostec Nature Reserve (Gauss-Krüger coordinates of the central point of the area are Y: 460036, X: 102173). In both areas, fungi were searched for visually and on foot. We paid special attention to the area of Mali Rožnik Nature Reserve, which is an extensive marshland and as such an exceptionally vulnerable ecosystem.

All observed fungi were photographed at the sites and accurate locations recorded. Specimens were collected by hand and later determined by observing morphological microstructures (ascospores, paraphyses, etc.) under 1000× magnification, using immersion oil and Carl Zeiss Jenaval microscope. All data was transferred to the »Boletus informaticus« database (Koller 2019, Zupan 2019). All fungal material was dried and exsiccates deposited at the »Mycotheca and Herbarium« of the Slovenian Forestry Institute.

Figure 1. The locations where two fungal species, both new for Slovenian mycoflora, were observed. Upper orange circle indicates the locality of Vibrissea filisporia (Bonord.) Korf & A. Sánchez 1967 and lower yellow circle the locality of Cudoniella tenuispora (Cooke & Massee) Dennis 1974. The wider green area denotes »Tivoli, Rožnik and Šiška hill« Landscape Park, while the two inner green areas designate Mostec Nature Reserve (northern area) and Mali Rožnik Nature Reserve (southern area). Source of base map: GURS, 2019.

Slika 1. Lokacije najdb dveh vrst gliv, novih za slovensko mikofloro. Zgornji oranžni krog ponazarja najdbo vrste Vibrissea filisporia (Bonord.) Korf & A. Sánchez 1967, spodnji rumeni krog pa najdbo vrste *Cudoniella tenuispora* (Cooke & Massee) Dennis 1974. Širše zeleno orisano območje ponazarja Krajinski park Tivoli, Rožnik in Šišenski hrib, notranji zeleni območji pa Naravni rezervat Mostec (severno) in Naravni rezervat Mali Rožnik (južno od prvega v osrednjem delu krajinskega parka). Vir osnovne kartografske podlage: SDMS, 2019.

Results and discussion

During our rather short research in the Landscape Park, we discovered two new fungi species for the Park and Slovenia as a whole. The species *Vibrissea filisporia* (Bonord.) Korf & A. Sánchez 1967 (f. Vibrisseaceae, o. Heliotales, cl. Leotiomycetes) (Wang et al. 2006a, Wang et al. 2006b, Hustad & Miller 2011, Sandoval-Leiva et al. 2014) was found in the area close to Mostec on 25. 4. 2019 and 2. 5. 2019 (Fig. 1). The second species *Cudoniella tenuispora* (Cooke & Massee) Dennis 1974 (f. Helotiaceae, o. Helotiales, cl. Leotiomycetes) (Wand et al. 2006a, Wang et al. 2006b, Hustad & Miller 2011) was found in Mali Rožnik Nature Reserve on 20. 4. 2019 and 2. 5. 2019 (Fig. 1).

Both species were found growing on branches of dead wood (Fig. 2).

Figure 2. Two new fungi species for Slovenia, photographed at the sites within Tivoli, Rožnik and Šišenski hrib Landscape Park in 2019. Left: *Vibrissea filisporia* on a fallen branch at Mostec; right: *Cudoniella tenuispora* on a hardwood fallen branch at Mali Rožnik (photo: Luka Šparl).
Slika 2. Dve vrsti gliv, novi za Slovenijo, fotografirani na rastišču v Krajinskem parku Tivoli, Rožnik in Šišenski hrib v letu 2019. Levo: *Vibrissea filisporia* na padli veji v Mostecu; desno: *Cudoniella tenuispora* na padli veji v Malem Rožniku (foto: Luka Šparl).

Determination of the species was done visually on the found individuals in nature (Fig. 2), as well based on measurements of the spores (Fig. 3). Paraphyses of *V. filisporia* are several times branched, often fasciculate, rarely simple, apices 2–5 µm wide; outermost cells of the ectal excipulum round or pyriform, without projections. Disk bluish-grey, yellow or ochraceous. Measurements of the typical structures for determination are given in Tab. 1, and are within measurements given by Medardi (2006). As we observed both living and dead cells and tissues, we could not differentiate between such spores. Apothecia were sessile, receptacle brown to light brown (Fig. 2).

Table 1. Morphological characteristics of the two new fungi species for Slovenia, found in Tivoli, Rožnik and Šiška hill Landscape Park in 2019.
Tabela 1. Morfološke karakteristike dveh vrst gliv, novih za Slovenijo, najdenih leta 2019 v Krajinskem parku Tivoli, Rožnik in Šišenski hrib.

Structure	***Vibrissea filisporia***	***Cudoniella tenuispora***
Apothecium [mm]	0.7–2.0 (n = 10)	27.0–32.0 (n = 4)
Ascospores size [µm]	100–210 × 1–1.3 (n = 10)	9.4–14.8 × 4.2–4.9 (n = 20)
Asci size [µm]	120–305 (–325) × 6–8 (n = 5)	83–102 × 8.3–10.1 (n = 5)

In *C. tenuispora*, asci and ascospores were smaller (Tab. 1; Fig. 3). We observed negative iodine reaction on ascus apex. Macroscopically, this species is highly reminiscent of the similar *Cudoniella clavus* which has smaller apothecium, rarely bigger than 15 mm (Breitenbach & Kränzlin 1984, Handsen & Knudsen 2000).

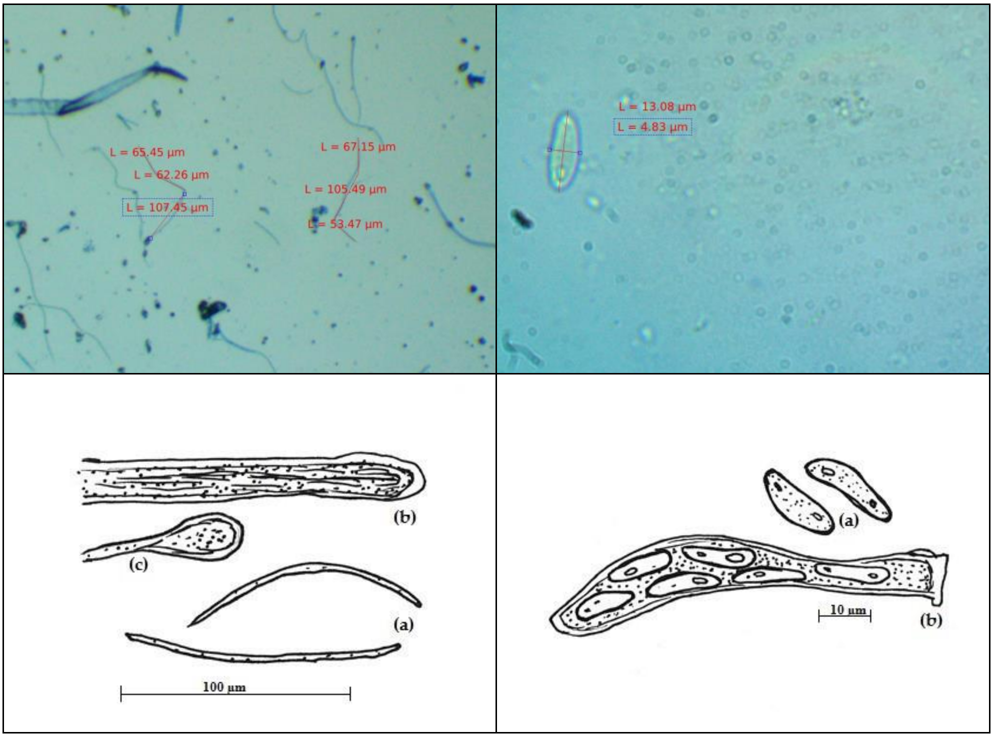

Figure 3. Microphotographs of ascospores of *Vibrissea filisporia* (upper left) and *Cudoniella tenuispora* (upper right) and sketches of ascospores (a), asci (b) and paraphyses (c) of *V. filisporia* (lower left) and *C. tenuispora* (lower right) found in 2019 in central Slovenia. Dimension rates on sketches are approximated; accurate dimensions are included in Tab. 1. Abbreviations: L – length (photo: Eva Zupan).

Slika 3. Mikrofotografije askospor vrste *Vibrissea filisporia* (zgoraj levo) in *Cudoniella tenuispora* (zgoraj desno) ter skice askospor (a), askov (b) in parafiz (c) vrst *V. filisporia* (spodaj levo) in *C. tenuispora* (spodaj desno), najdenih v letu 2019 na območju osrednje Slovenije. Razmerja dimenzij na skicah so ocenjena, natančne dimenzije so podane v Tab. 1. Okrajšave: L – dolžina.

The exsiccates of both species were given identification numbers, and are stored in the »Mycotheca and Herbarium« of the Slovenian Forestry Institute (*V. filisporia* with ID number 7008 and *C. tenuispora* with ID number 7013).

Vibrissea filisporia was described as *Sarea filisporia* Bonord. for the first time in 1853 by German mycologist H. F. Bonorden. The current combination was proposed by A. Sánchez in 1967 (Sänchez, 1967). According to Sanchez (1967), this aquatic species grows isolated or in small groups in woods or marshes and streams, on dead branches, especially on *Salix sp.* or. *Alnus* immersed in ditches. It grows from spring to autumn, and is considered rare in Europe.

Cudoniella tenuispora (Cooke & Massee) Dennis 1974 was described as *Sarcoscypha tenuispora* Cooke & Massee for the first time in 1893 by Cooke and Massee. The current combination was proposed by British mycologist R. W. G. Dennis in 1974 (Dennis 1974). This aquatic species grows isolated, rarely gregarious in forest streams, on little wet branches of hardwoods. The apothecia are white to cream, diameter from 5 to 15 mm, pileus convex, white and brownish small squamules on top. Small squamules on white-cream stipe (Dennis 1974, Beyer 2004, Wang et al. 2015, Gierczyk et al. 2019).

As the two species are confirmed for Slovenia, we suggest Slovenian vernacular names for both. Name »temnoroba potočka« is suggested for *V. filisporia* and name »ozkotrosna žebljarka« for *C. tenuispora*.

Both species require marshy ecosystems with pure and chemically unpolluted slow water flow, without any pesticide content (Sanchez 1967, Schefer 1986, Medardi 2006, Shearer et al. 2007). These findings in Landscape Park indicate good conservation status of these parts of the Park. Due to exceptional rarity of the species, and sensitivity of suitable habitats which are in decline across Europe (Silva et al. 2007, Čižková-Končalová et al. 2013), additional observations on both species are needed to improve knowledge on their biology, ecology and conservation status. We recommend additional field research of suitable habitats throughout Slovenia, as there is a great probability that both species are present in other parts of the country as well.

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Interstitial fauna of the Sava River in Eastern Slovenia

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Abstract. Interstitial water that occupies the pore spaces within unconsolidated sediments is a unique habitat, inhabited by surface as well as exclusively subterranean species (stygobionts). The best studied of all interstitial habitats is the hyporheic zone, an interface between surface water and groundwater (phreatic zone) environments. The Sava River in central Slovenia (i.e., at the Ljubljana alluvial plain) readily qualifies as one of the global hotspots of interstitial biodiversity, while data from other river sections are lacking. In 2015, we sampled two gravel bars on the final Slovenian section of the river (Eastern Slovenia), and collected nine samples per site using the Bou-Rouch pumping method. At »Čatež ob Savi« and »Obrežje« sites, at least 26 invertebrate species with 14 stygobionts and 25 invertebrate species with 13 stygobionts were identified, respectively. Altogether, 33 invertebrate taxa with 16 stygobionts were recorded, which increased the previously known interstitial stygobiotic richness of the Sava River in Slovenia by eight species (to 37 species). Three species of the stygobiotic amphipod genus *Niphargus* were recorded in Slovenia for the first time, one of which is even a new species to science. We discuss the novel results in the context of current national conservation practices.

Key words: interrstitial fauna, hyporheic, stygobionts, endemic species, Bou-Rouch pumping method, Sava River, Slovenia

Izvleček. Intersticijska favna reke Save v vzhodni Sloveniji – Intersticijska voda – voda med zrni nesprijetega sedimenta, je edinstven življenjski prostor tako za površinske kot tudi izključno podzemne vrste (stigobionte). Najbolje raziskan med plitvimi intersticijskimi habitati je hiporeik, prehodni pas med površinsko vodo in globoko podtalnico (freatikom). Odsek reke Save na območju Ljubljanskega polja (osrednja Slovenija) sodi med svetovne vroče točke intersticijske vrstne pestrosti, medtem ko podatkov iz drugih odsekov reke skoraj ni. Leta 2015 smo z metodo Bou-Rouch pridobili po devet vzorcev iz vsakega od dveh prodišč v končnem odseku Save (vzhodna Slovenija). Na prodiščih »Čatež ob Savi« in »Obrežje« smo zabeležili najmanj 26 oz. 25 nevretenčarskih vrst, od tega 14 oz. 13 stigobiotskih. Skupno število najdenih taksonov, t.j. 33 nevretenčarskih, od tega 16 stigobiotskih vrst, je zvišalo pestrost savskih stigobiontov za osem vrst (na 37 vrst). Tri vrste iz rodu slepih postranic (*Niphargus*) smo v Sloveniji zabeležili prvič, od tega je ena nova za znanost. V prispevku izsledke obravnavamo v luči trenutne naravovarstvene prakse.

Ključne besede: intersticijska favna, hiporeik, stigobionti, endemiti, Bou-Rouch metoda črpanja, Sava, Slovenija

Introduction

Water in voids between grains of unconsolidated sediments constitutes a unique subterranean habitat, the so-called aquatic interstitial (Angelier 1962, Danielopol 1976, Culver and Pipan 2014). The best studied of all shallow interstitial habitats is the hyporheic zone beneath and alongside the stream and river beds (Orghidan 1955): »a temporally and spatially dynamic saturated transition zone between surface- and groundwater bodies that derives its specific physical (e.g., water temperature) and biogeochemical (e.g., steep chemical gradients) characteristics from mixing of surface- and groundwater to provide a dynamic habitat and potential refugia for obligate and facultative species« (Krause et al. 2011). Its exact limit towards permanent groundwater (phreatic water) is difficult to define, due to its variability in space and time (Fraser and Williams 1998). The importance of the hyporheic zone as an essential component of river and stream ecosystems was widely recognized by the 1980s (Hancock et al. 2005), but major research gaps remain (Boulton et al. 2010).

This dynamic lotic ecotone is inhabited by a diverse array of surface (i.e., benthic) species that temporarily inhabit the substrate, and by specialized subterranean (i.e., aquatic troglobiotic or stygobiotic) species, which rarely if ever occur in the surficial water channel (Gibert et al. 1994, Mori and Brancelj 2011). The somewhat reduced dispersal capacity of stygobionts in comparison to their surface counterparts usually results in small distribution ranges of the former (Trontelj et al. 2009, Zagmajster et al. 2014). Many stygobionts are narrowly distributed, which makes them especially prone to extinction (Sket 1999). Dependence and interconnection of hyporheic and permanent groundwater (i.e., phreatic water) with surface water, combined with limited self-purification capability of aquatic interstitial habitat, is the reason for the negative effects of above-ground human threats on interstitial aquifers and their specialized and sensitive fauna.

One of the most interesting European rivers according to richness of the interstitial fauna is the Sava River (hereinafter referred to as the Sava). With its 219 km stretch from the spring to the Croatian border, it is the longest river in Slovenia. It starts as an alpine river, which then flows through the sub-Alpine hills in central Slovenia, to the plain in the eastern part of the country, where it gradually changes into a typical lowland river. After running through the Posavina region (Croatia and Bosnia and Herzegovina), it discharges into the Danube River in Serbia. The hyporheic and phreatic interstitial fauna along its 990 km long course was mainly studied in the mid-twentieth century. Most of the faunistic studies were carried out around Zagreb (Croatia) and Ljubljana (Slovenia) (Karaman 1954, 1983, Meštrov 1957, 1960, 1961, Meštrov et al. 1978, 1983, Sket & Velkovrh 1981, Rogulj et al. 1994). Nearly three decades have passed before the study focusing on microcrustacean assemblages (i.e., Copepoda, Ostracoda and Cladocera) in the Sava gravel bar near Ljubljana was carried out (Mori et al. 2012).

Based on literature review and some unpublished records, as many as 29 stygobiotic species were known from the interstitial habitats of the Sava in Slovenia till the end of 2014 (SubBioDB 2014). Although this confirmed its ranking among the global hotspots of interstitial fauna biodiversity (Sket & Velkovrh 1981), current data are almost exclusively based on samples collected from the alluvial plain north of Ljubljana (i.e., Ljubljansko polje aquifer, central Slovenia). The lack of new studies and data from other sections of the river and its tributaries is hindering any attempt to evaluate the comparative importance of different river sections for interstitial species and their importance for conservation.

In order to fill this gap, a study of the interstitial fauna in the Slovenian lowermost section of the Sava (Eastern Slovenia) was conducted in 2015, which enabled the provision of invertebrate species list for this section. We paid special attention to stygobionts. Here, we discuss their contribution to the biodiversity of the Sava interstitial fauna in general. Also, we comment on the conservation status of the sampled taxa and the current national habitat management.

Materials and Methods

The two gravel bars are situated on the right bank of the lowland Sava, in the eastern part of Slovenia (Fig. 1). The site »Obrežje« (45°50'56'' N, 15°42'24'' E) is located immediately along the national border with Croatia. The site »Čatež ob Savi« (45°53'37'' N, 15°37'55'' E) is situated about 8 km upstream from the gravel bar »Obrežje«, north from the thermal spa »Terme Čatež« near Čatež (Fig. 1).

We sampled the hyporheic zone using the Bou-Rouch pumping method (Bou & Rouch 1967). At both sites, sampling was done at two depths in the river: 30–60 cm and 60–90 cm, while in the exposed gravel bar next to the river, only sampling at 60–90 cm was carried out. We repeated the sampling procedure three times at each site, within a distance of approx. 10 m along the gravel bar, resulting in nine samples per gravel bar. For each sample, we pumped 30 litres of a mixture of water, sediments and particulate organic matter. In the first 10 litres of collected mixture, the *in situ* dissolved oxygen, oxygen saturation, temperature, conductivity, and pH were measured with a portable multimeter CyberScan 600 (Eutech Instruments). The mixtures were then filtered to collect invertebrates, using hand nets of 0.5 mm and 0.1 mm mesh size. Invertebrates from the two hand nets were preserved separately in 96% ethanol and stored in the collection of the Department of Biology (Biotechnical Faculty, University of Ljubljana).

In the laboratory, only invertebrates from the 0.5 mm mesh size fraction were sorted and either morphologically or molecularly identified to the lowest taxonomic level possible. To present the interstitial diversity of each gravel bar, we pooled the data from all nine samples. Some taxa from the 0.5 mm mesh size fraction (e.g. Oligochaeta and Chironomidae) and all invertebrates from the 0.1 mm mesh size fraction remained unidentified due to the lack of taxonomists or/and methodological obstacles (e.g., immaturity, small body size and the need to implement molecular approaches).

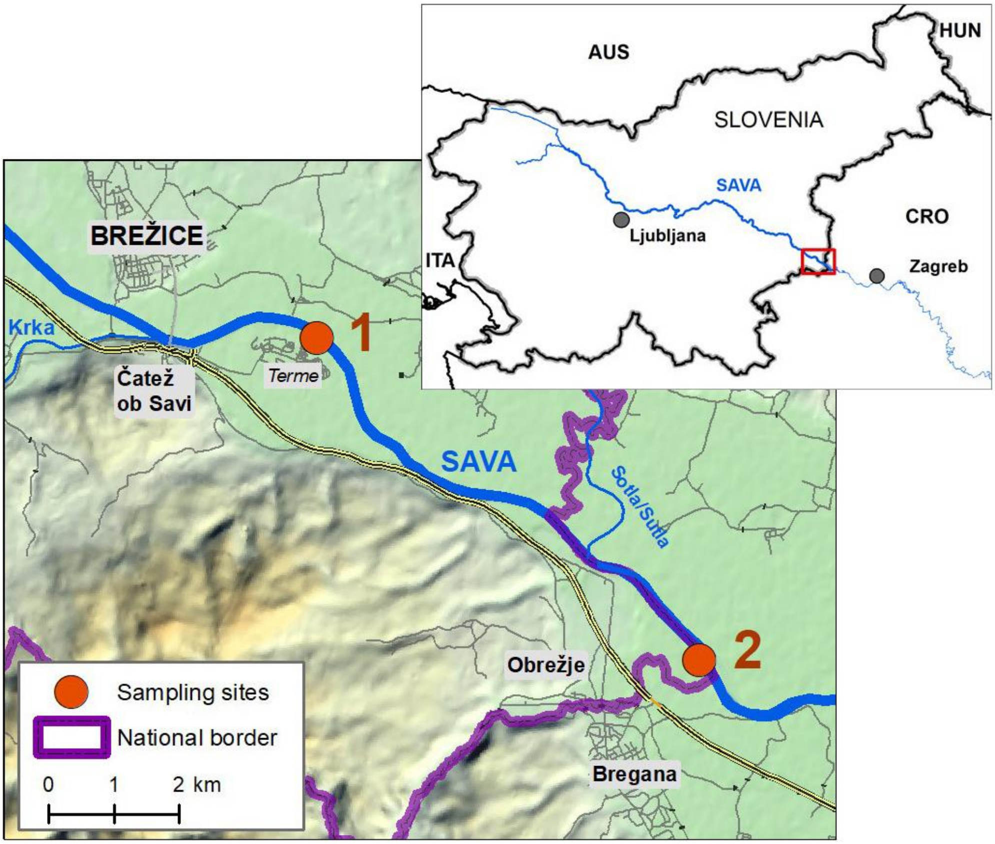

Figure 1. Map of the lower reach of the Sava River in Slovenia. The two sampling sites for interstitial fauna »Čatež ob Savi« (1) and »Obrežje« (2) are marked with red dots.
Slika 1. Zemljevid območja vzorčenja intersticijske favne na prodiščih Save v Sloveniji. Označeni sta mesti vzorčenja »Čatež ob Savi« (1) in »Obrežje« (2).

Results and Discussion

Observations on the species richness and species conservation status

Using the same sampling procedure at both gravel bars enabled comparisons between the sites, even though with some prudence (Malard et al. 2002). The species richness at »Čatež ob Savi« and »Obrežje« gravel bars is almost the same: 14 and 13 stygobiotic species out of 26 and 25 sampled taxa were identified, respectively (Tab. 1). As some invertebrates remained unidentified (discussed above in Materials and methods), these numbers represent the minimum number of taxa.

Table 1. List of invertebrates from gravel bars of the Sava River at Čatež ob Savi and Obrežje. The national (RS; Ur. l. RS 2002) and IUCN (IR; IUCN 2019) Red list statuses are given: LC = least concern, K = not evaluated, R = rare, V and VU = vulnerable. The names of taxa the identification of which might be questionable are marked »cf.« (similar to). The underlined names indicate the first confirmation of the species presence in interstitial habitats of the Sava River. Annotations: D – species included in the Decree on protected wild animal species (Ur. l. RS 2004a), En – Slovenian endemic species, juv. – juvenile, s – only shells found, T – species with the type locality in Slovenia, »*« – stygobiont, »+« – present, »!« – conservation status candidate.

Tabela 1. Seznam nevretenčarjev s prodišč reke Save v Čatežu ob Savi in Obrežju. Navedena sta nacionalni (RS; Ur. l. RS 2002) in IUCN (IR; IUCN 2019) status ogroženosti; LC = najmanj ogrožen, K = neocenjen, R = redek, V in VU = ranljiv. Vprašljiva identifikacija je označena s »cf.« (podoben kot). Podčrtana imena označujejo prvo najdbo v savskem intersticiju. Oznake: D – vrsta iz Uredbe o zavarovanih prosto živečih živalskih vrstah (Ur. l. RS 2004a), En – slovenski endemit, juv. – mladi, s – prazne hišice, T – vrste s tipsko lokacijo v Sloveniji, »*« – stigobiont, »+« – prisoten, »!« – kandidat za pridobitev statusa ogroženosti.

Higher taxa	**Family**	**Genus/species**	**Čatež**	**Obrežje**	**RS/IR**	**Remarks**
CNIDARIA:	Hydridae:	*Hydra* sp.		+		
TURBELLARIA:	Dendrocoelidae:	*Dendrocoelum* sp.	+			
GASTROPODA:	Acroloxidae:	*Acroloxus lacustris*		s	V/VU	
	Planorbidae:	*Gyraulus* cf. *albus*		s		
	Hydrobiidae:	*Iglica gracilis**	+	+	V/VU	T
		Bythinella cf. *austriaca*	+		-/LC	
		*Hauffenia media**	+		V/VU	
	Valvatidae:	*Valvata cristata*	s		K/-	
OLIGOCHAETA			+	+		
ACARINA:	Hygrobatidae:	*Hygrobates* sp.	+			
CRUSTACEA:						
Copepoda:	Cyclopidae:	*Acanthocyclops venustus**	+	+		
		*Diacyclops slovenicus**	+	+		
Ostracoda:	Candonidae:	*Typhlocypris cavicola**	+	+	R/VU	T, En
Amphipoda:	Niphargidae:	*Niphargus serbicus**	+	+		
		*Niphargus longidactylus**	+	+		
		Niphargus cf. *kenki**	+	+		T
		*Niphargus minor**		+		NT
		*Niphargus parapupetta**		+	!	first record
		*Niphargus labacensis**	+	+		T
		*Niphargus multipennatus**	+	+		NT
		*Niphargus lattingerae**	+		!	first record
		Niphargus sp. nov.*	+		!	new
	Gammaridae:	*Gammarus* sp. (juv.)	+	+		
	Crangonictidae:	*Synurella* cf. *ambulans*	+	+		
	Bogidiellidae:	*Bogidiella albertimagni**	+	+		
Isopoda:	Asellidae:	*Proasellus deminutus deminutus**	+	+		T
HEXAPODA (juv.):						
Diptera	Chironomidae		+	+		
	Ceratopogonidae		+			
Ephemeroptera:	Ephemerellidae:	*Ephemerella ignita*		+		
	Baetidae:	*Baetis fuscatus*	+	+		
	Potamanthidae:	*Potamanthus luteus*	+	+	R/-	
Coleoptera:	Elmidae:	*Macronychus quadrituberculatus*	+	+		D
Trichoptera:	Glossosomatidae:	*Glossosoma boltoni*		+		
	Number of all taxa / stygobiotic taxa		**26/14**	**25/13**		

Most stygobiotic species are snails (Gastropoda) and crustaceans (Crustacea), the latter especially from the amphipod genus *Niphargus* (9 species). Five of the collected species are listed in the Slovenian Red list of endangered plant and animal species (Ur. l. RS 2002) or/and in the IUCN Red list of threatened species (IUCN 2019; Tab. 1). Two of them are surface species: a mayfly nymph *Potamanthus luteus* (Linnaeus, 1767) and a snail *Acroloxus lacustris* (Linnaeus, 1758). Actual presence of the latter species at »Obrežje« could not have been confirmed as only empty shells were found. The other three species are stygobiotic, two snails: *Iglica gracilis* (Clessin, 1882) (Fig. 2A) and *Hauffenia media* Bole, 1961 (Fig. 2B) and one ostracod crustacean, *Typhlocypris cavicola* (Klie, 1935) (Fig. 2C). *Iglica gracilis*, sampled at both gravel bars (Hofman et al. 2018), is endemic to Slovenia where it is known from caves and springs in the basin of the Krka River to the junction with the Sava (De Mattia 2007). *Hauffenia media*, sampled at »Čatež ob Savi« (Rysiewska et al. 2017), is restricted to southern and southeastern Slovenia (i.e. caves and springs in the Dolenjska Region and Bela krajina) and Croatia (known from a single locality at the border with Slovenia) (Bole 1992). *Typhlocypris cavicola*, sampled at both gravel bars, has long been known only from the cave Krška jama (Klie 1935). During the last 17 years, however, it has been recorded from several locations in the Dinaric Karst of Slovenia, mostly from caves, springs and hyporheic zones (Mori and Brancelj 2011, Mori et al. 2011, Mori and Meisch 2012). In both the Slovenian and IUCN Red lists, *T. cavicola* is still listed under currently invalid name *Pseudocandona cavicola* (Klie, 1935).

At least three more species would be eligible for the national and global conservation assessment:

- two stygobiotic amphipods, *Niphargus parapupetta* G. Karaman, 1984 (Fig. 2D) and *N. lattingerae* G. Karaman, 1983, were recorded in Slovenia for the first time. They should be considered endangered under the Slovenian Red list (Ur. l. RS 2002), as is the case in *N. valachicus* Dobreanu & Manolache, 1933, with similar distribution range. Specifically, they all have extensive range in other countries, while in Slovenia they are narrowly distributed.
- a new stygobiotic *Niphargus* species was found at the »Čatež ob Savi« gravel bar. In addition to morphology, the uniqueness of this extremely small amphipod was confirmed by DNA analysis and its description is in preparation. It should be listed in one of the highest levels of threats under both Red lists.

Of all the species collected, only a small riffle beetle *Macronychus quadrituberculatus* is included in the Decree on protected wild animal species (Ur. l. RS 2004a, Appendices 1 and 2), which protects the species and its habitat.

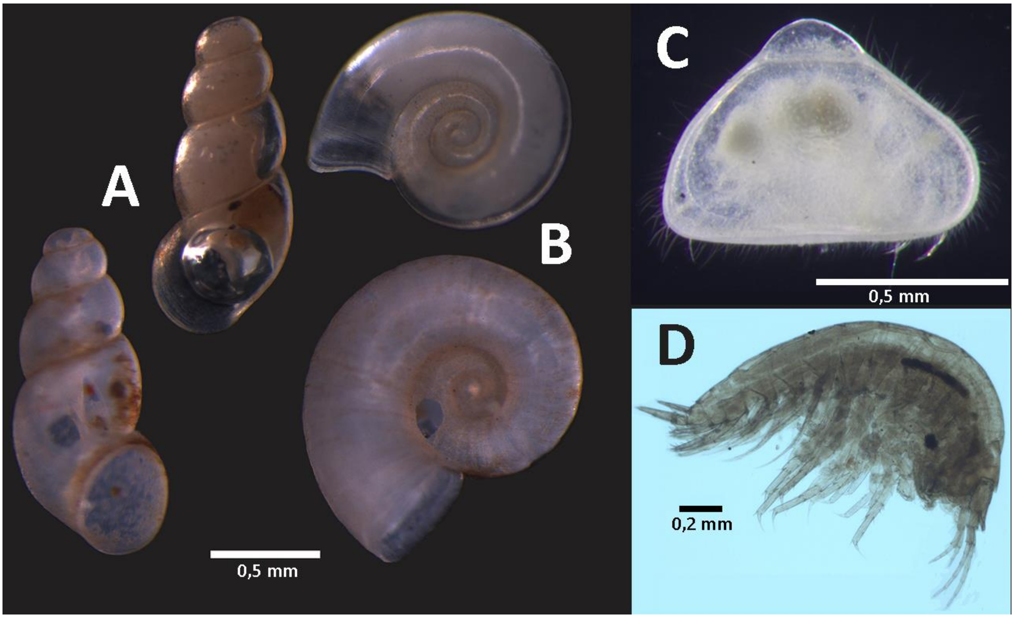

Figure 2. Interstitial stygobionts: snails (A) *Iglica gracilis* and (B) *Hauffenia media* and crustaceans (C) ostracod *Typhlocypris cavicola* and (D) amphipod *Niphargus parapupetta* (photos A, B, D: S. Prevorčnik, photo C: N. Mori).
Slika 2. Intersticijski stigobionti: polža (A) *Iglica gracilis* in (B) *Hauffenia media* ter raka (C) dvoklopnik *Typhlocypris cavicola* in (D) slepa postranica *Niphargus parapupetta* (fotografije A, B, D: S. Prevorčnik, fotografija C: N. Mori).

The need for further studies and conservation of the interstitial fauna

Although the number of taxa collected during sampling of two gravel bars is not final due to incomplete species identification, our preliminary results clearly indicate that the lower section of the Sava River in Slovenia hosts a high number of stygobiotic taxa as well. The data obtained from this study increased the known diversity of the interstitial stygobiotic fauna of the Slovenian Sava from at least 29 species known in 2014 (SubBioDB 2014) to at least 37 species. The identification of yet unidentified taxa is likely to increase the number.

The lack of studies over the last few decades, coupled with the new discoveries of our short-term and narrowly localized survey, unambiguously indicate the need for intensive and targeted sampling and exploration of understudied fauna of interstitial habitats in general. Unfortunately, this fauna often remains »invisible« in procedures related to assessing the potential impacts of various construction plans on the environment. In Slovenia, the interstitial fauna is not protected *per se*. Its protection often comes as a side effect of protecting the habitat for some other reason. For instance, gravel bars achieve some conservation concern as important habitats of protected terrestrial (mainly birds) and surface aquatic species (mainly fish) (Ur. l. EU 1992, 2010). Also measures established to safeguard groundwater as the source of drinking water have a positive effect on the hyporheic and phreatic as a habitat (Ur. l. RS 2009). But, these measures only cover aspects of chemical quality and quantity, omitting other aspects relevant to stygobiotic inhabitants. Meanwhile, the high potential for endemism in these species, which would provide their direct protection according to Article 14 of the national Nature Conservation Act (Ur. l. RS 2004b), remains unduly overlooked. This article explicitly states that no actions are allowed that would result in endangering or extinction of any animal or plant species. Active protection of interstitial species under the Slovenian Red List of Endangered Animal and Plant Species (Ur. l. RS 2002) is generally deficient, due to the outdated list. The update would likely include several additional interstitial species.

The interstitial fauna is theoretically protected also via binding international legislative frameworks. For example, the Convention on Biological Diversity ratified also by Slovenia (Ur. l. RS 1996), reminds decision-makers that natural resources are not infinite and sets out a philosophy of their sustainable use. The EU Groundwater Directive (OJ EU 2006) contains a direct reference to interstitial habitats as ecosystems. The same is stated in EU Water Framework Directive (Ur. l. EU 2000). Both directives recognise the importance of groundwater also in relation to the »groundwater dependent« surface ecosystems (aquatic or terrestrial). Nevertheless, they only state the need for chemical and quantitative monitoring, ignoring biota.

It is well known that any human-induced watercourse degradation (e.g., building of dams, removal of gravel, etc.), as well as changing the natural water level regimes (e.g., due to over-exploitation of interstitial groundwater), can have significant and irreversible negative effects on interstitial fauna (Culver and Pipan 2014). Given that interstitial habitats and their fauna are severely understudied, with a great potential for new discoveries and high endemicity, they are undisputed candidates for further studies, as well as for the implementation of appropriate conservation measures.

Acknowledgements

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FIELD NOTE

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Two invasive ant species, *Lasius neglectus* Van Loon et al., 1990 and *Tapinoma magnum* Mayr, 1861 (Hymenoptera: Formicidae), living in close proximity in coastal Slovenia

Dve invazivni vrsti mravelj, *Lasius neglectus* Van Loon et al., 1990 in *Tapinoma magnum* Mayr, 1861 (Hymenoptera: Formicidae), živeči v neposredni bližini v obalni Sloveniji

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Invasive species have been given much attention in the last decades and ants are no exception (e.g., McGlynn 1999, Holway et al. 2002, Lach & Hooper-Bùi 2009, Rabitsch 2011, Wittman 2014, Hoffmann et al. 2016). One of the most notorious ant species invading the European territory is *Lasius neglectus* Van Loon et al., 1990 (Fig. 1A). This species, probably originating from Asia Minor (Seifert 2000), was described from Budapest, Hungary (Van Loon et al. 1990), and is now reported from 16 European countries (Espadaler & Bernal 2018). Here it is mostly found in human-modified habitats, ranging from purely urban habitats (e.g. in streets with heavy traffic) to city gardens, urban woods and semi-urban areas (Espadaler & Bernal 2018). It is reported on its negative effects on native arthropod fauna (Nagy et al. 2009). Less is known about *Tapinoma magnum* Mayr, 1861 (Fig. 2A). This species, previously also known under the name *T. nigerrimum*, is distributed in the Mediterranean area from NW Africa to Italy and is particularly abundant in open unstable or degraded areas with anthropogenic influence and a weakly developed tree layer (Seifert et al. 2017). Recently, it was reported to be artificially introduced to several cities in Germany, Belgium and the Netherlands, where it established permanent supercolonies and acts as a pest species with strong local impacts (Dekoninck et al. 2015, Noordijk 2016, Seifert et al. 2017). It shows the strongest invasive potential of all species of *T. nigerrimum* complex (Seifert et al. 2017).

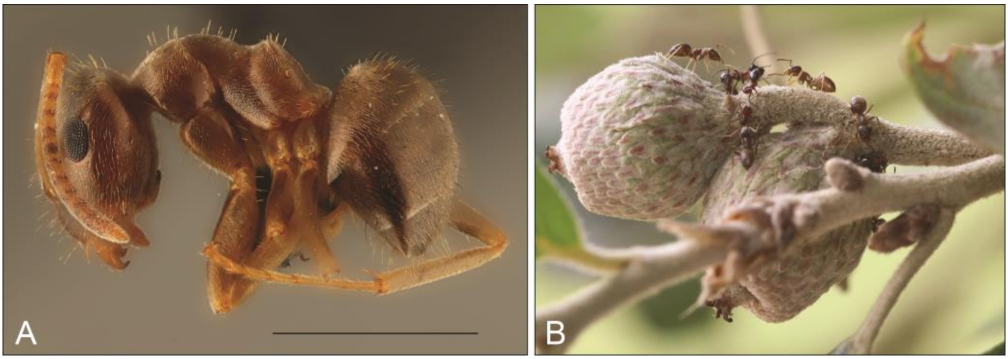

Figure 1. *Lasius neglectus* from Izola, Slovenia. A – Worker, lateral view (scale bar = 1 mm), B – *L. neglectus* workers tending aphids on *Quercus ilex* in Izola park (photo: T. Delić – A, G. Bračko – B).
Slika 1. *Lasius neglectus* iz Izole, Slovenija. A – Delavka, stranski pogled (merilce = 1 mm), B – Delavke *L. neglectus* negujejo listne uši na *Quercus ilex* v parku v Izoli (foto: T. Delić – A, G. Bračko – B).

Figure 2. *Tapinoma magnum* from Izola, Slovenia. A – Worker, lateral view (scale bar = 1 mm), B – One of the many nests of *T. magnum* at Izola cemetery (with the open part of the nest pointed by the arrow) (photo: T. Delić – A, G. Bračko – B).
Slika 2. *Tapinoma magnum* iz Izole, Slovenija. A – Delavka, stranski pogled (merilce = 1 mm), B – Eno izmed številnih mravljišč *T. magnum* na izolskem pokopališču (odprti del mravljišča je označen s puščico) (foto: T. Delić – A, G. Bračko – B).

In 2008 and 2011, we found a colony of *Tapinoma* cf. *nigerrimum* next to the cemetery in the coastal town of Izola (SW Slovenia) (Bračko & Česnik 2016). Applying the latest taxonomic revision of *T. nigerrimum* complex (Seifert et al. 2017), the colony was subsequently identified as *T. magnum*. The more detailed inspection of this part of the town in spring 2018 and 2019 revealed that *T. magnum* was spread over a much larger area. A big supercolony of this species was discovered, occupying the entire Izola cemetery (ca. two hectares) in NE part of the town (45°32.3'N, 13°40.0'E, 3 m a.s.l.) and some smaller patches in its close vicinity (Fig. 3). During the inspection of the site, we discovered another invasive species, *Lasius neglectus*, which was spread over the urban park (ca. 1.5 hectare), situated just north of the cemetery (Fig. 3). The records of the two species from Izola are the only known for Slovenia.

It looks that *Tapinoma magnum* found favourable habitat at Izola cemetery (Fig. 2B). The combination of stony ground and graveyard stones, some vegetation (grass, plants on graves, individual trees), and frequent watering of the plants could represent optimal conditions for this species. *Tapinoma magnum* acts very aggressively when its nests are disturbed. The visitors of the cemetery report on nuisances when in contact with these ants. In the vicinity of the cemetery, *T. magnum* nests can be found on lawns, along the paths and walls, but also on less disturbed sites, e.g. in the park west of the cemetery covered with some trees and shrubs. We assume that the species probably arrived to the cemetery area with the transport of plant and soil material for the needs of the cemetery. This way of transport is also responsible for the occurrence of *T. magnum* in the cities north of the Mediterranean area (Seifert et al. 2017).

The urban park in Izola, colonised by *L. neglectus*, is covered with regularly cut lawn and individual pine and oak trees. The nest openings are concentrated mostly around trees and on the edges of lawn along the paths. The species is known for extensively tending honeydew producing aphids on trees and below ground (Paris & Espadaler 2009, Espadaler & Bernal 2018). In Izola, large columns of *L. neglectus* foraging workers, leading to/from their aphid colonies (Fig. 1B), can be spotted on every tree in the park. The human-mediated transport is the main way of spreading this species between sites (Espadaler et al. 2007). As in the case of *T. magnum*, *L. neglectus* probably established itself in Izola after being brought here with various plant and soil material.

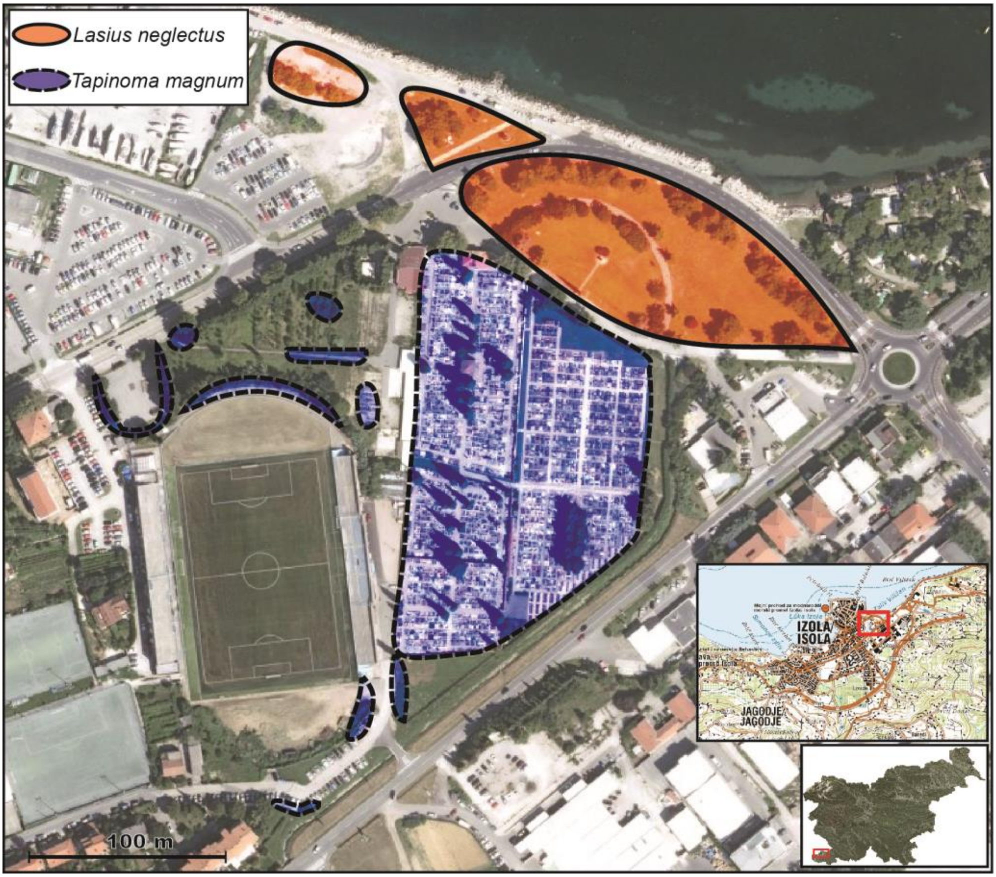

Figure 3. Izola map showing sites inhabited by the invasive ant species *Lasius neglectus* and *Tapinoma magnum* (base maps taken from www.geopedia.si and Atlas okolja, http://gis.arso.gov.si/atlasokolja).
Slika 3. Karta Izole s prikazanimi mesti, poseljenimi z invazivnima vrstama mravelj *Lasius neglectus* in *Tapinoma magnum* (osnovne karte vzete iz www.geopedia.si in Atlasa okolja, http://gis.arso.gov.si/atlasokolja).

In Izola, we can observe two supercolonies of two invasive ant species living in close proximity to each other, which is something relatively rare in the field (see Fig. 3). So far, *L. neglectus* and *T. magnum* have never been reported to come into close contact. There are some cases of encountering *T. magnum* and the notorious Argentine ant *Linepithema humile* (Mayr, 1868), where *T. magnum* was reported to limit the spread of *L. humile* (Seifert et al. 2017). In general, invasive ants are often highly aggressive, dominant competitors, trying to exclude other dominant colonies from their territory (Cerdá et al. 2013, Bertelsmeier et al. 2015). Currently, both species from Izola seem to occupy their optimal habitat (*T. magnum* the cemetery and *L. neglectus* the park) and prevent the other invasive species to spread into their territory. Along the path between the park and the cemetery, workers of both supercolonies can be observed, running away from each other when coming into contact.

It would be interesting to monitor the situation in the area of the two invasive species in Izola in the next years, especially if their territories expand, and what the situation is to be like in the contact zone of both supercolonies.

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FIELD NOTE

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Potrditev razmnoževanja plavčka *Rana arvalis* na Goričkem (SV Slovenija)

First confirmed breeding of the moor frog *Rana arvalis* at Goričko (NE Slovenia)

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Dne 31. 3. 2003 je bil ob začasni obcestni ograji, ki preprečuje dvoživkam prosto prečkanje ceste med pomladnimi selitvami do mrestišč, pri vasi Ropoča na zahodni strani Ledavskega jezera najden samec plavčka (*Rana arvalis*). 22. 3. 2014 je bilo v daljavi v gozdu nad Ledavskim jezerom slišati oglašanje rjavih žab, ki je spominjalo na oglašanje plavčka. Iz daljave je bilo opaženih nekaj modrikastih žab. Vendar se v času razmnoževanja lahko modrikasto obarvajo tudi samci sekulje (*Rana temporaria*). V naslednjih pomladih (2015–2018) je bilo na začasni ograji ob cesti na vzhodni in zahodni strani Ledavskega jezera vsako leto najdenih nekaj osebkov plavčka. 3. 4. 2018 je bilo v gozdu nad Ledavskim jezerom ponovno zaznano oglašanje rjavih žab, ki je spominjalo na plavčkovo. Še isti dan smo v močvirnem gozdu na SZ delu Ledavskega jezera (Gauss-Krügerjeve koordinate: X: 579650, Y: 180060) potrdili ter fotodokumentirali nekaj samcev plavčka v modri svatovski preobleki ter odložene sveže mreste (Sl. 1). To je prva potrditev razmnoževanja plavčka na Goričkem. Zaradi neprehodnosti območja (debeli nanosi sedimentov) ocena velikosti populacije z metodo štetja samcev na mrestišču ali kasnejše štetje odloženih mrestov ni bila izvedljiva. Glede na slišano oglašanje je bilo število samcev ocenjeno na sto do več sto osebkov. Že leta 1999 pa so bili plavčki najdeni tudi v okolici Bukovniškega jezera na JV delu Goričkega (France 2000). Tam so bili v kasnejših letih posamezni plavčki opaženi večkrat, nazadnje leta 2014 med spomladanskim prečkanjem ceste (Gorički & Năpăruş 2014). Razmnoževanje pa še ni bilo potrjeno.

Slika 1. Skupina svežih mrestov plavčka (Foto: K. Malačič, 3. 4. 2018).
Figure 1. Freshly deposited egg clutches of *Rana arvalis* (Photo: K. Malačič, 3. 4. 2018).

Ledavsko jezero je umeten zadrževalnik na reki Ledavi. Na severnem delu jezera je kot zadnja sukcesijska faza nastal belovrbov poplavni gozd na površini 28,9 ha (22 % prvotne površine jezera) (Ignjatovič et al. 2013). Mrestišče plavčka v Ledavskem jezeru je podobno – svetel poplavni gozd – mrestiščem plavčka ob Muri, v Polanskem logu in na Ljubljanskem barju (Poboljšaj et al. 2008, Stanković & Cipot 2014). Glede na oceno gostote (48 os/ha) plavčka v gozdu na S delu Ljubljanskega barja (Stankovič & Cipot 2014) bi lahko populacija plavčka nad Ledavskim jezerom štela tudi več kot tisoč osebkov. Dejansko velikost populacije bo treba še določiti, pri tem pa tudi ugotoviti, ali plavčki uporabljajo širše območje Ledavskega jezera kot poletni kopenski habitat ali le kot prezimovališča, saj ravno pomladanske najdbe na cesti potrjujejo daljše premike plavčkov.

V Sloveniji je do nedavnega veljalo, da plavček živi zgolj na severovzhodu Slovenije v nižinah reke Mure in njenih pritokov, na Dravskem polju ter v jugovzhodni Sloveniji v Krakovskem gozdu (Poboljšaj et al. 2008). Leta 2010 so plavčka odkrili tudi na Ljubljanskem barju, v kasnejših raziskavah pa ugotovili, da tam živi zelo velika populacija, verjetno ena največjih v Sloveniji (Stanković & Cipot 2014). Najdeno mrestišče na Goričkem je primer, da je treba vsako posamezno najdbo osebka te vrste raziskati. Tudi ko je opažen le en osebek, je treba preveriti, ali v bližini morda ni kakega mrestišča. Zadnje najdbe na Goričkem pričajo, da o tej vrsti še ne vemo dosti in da tudi poznavanje njene razširjenosti še ni končno. Poleg tega so nekatere populacije v Sloveniji, še posebej v delu Pomurja, že zelo zmanjšane. Posamezni osebki oziroma njihove manjše skupine zagotovo niso več del viabilnih populacij, zato brez resnih in takojšnjih ukrepov plavček na teh območjih ne bo obstal (Cipot et al. 2016). Nujno je, da se čim prej ugotovi velikost populacije ob Ledavskem jezeru, prav tako tudi ob Bukovniškem jezeru, in temu primerno še pravočasno sprejmejo ukrepi varstva. Plavček in njegov habitat sta v Sloveniji zavarovana (Ur. l. RS 2004), prav tako je vrsta uvrščena v Prilogo IV Direktive o Habitatih (Ur. l. EU 1992). Glede na slabo poznavanje lokacij mrestišč v večjem delu Slovenije (Poboljšaj et al. 2006) bi morali odgovorni organi pred izdajo dovoljenja za kakršnokoli spremembo rabe ali poseg v območje voda na območju celotnega areala plavčka, predvsem to velja za gramoznice in ribnike, ne glede na znane podatke, preveriti, ali le-te niso tudi plavčkov razmnoževalni habitat. Njegova razmnoževališča (mrestišča) so namreč tudi predmet okoljske odgovornosti (Ur. l. RS 2009).

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FIELD NOTE

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Albinism of Aesculapian snake *Zamenis longissimus* (Laurenti, 1768) *in situ*: first record for Bosnia and Herzegovina

Albinizem navadnega goža *Zamenis longissimus* (Laurenti, 1768) *in situ:* prvi podatek za Bosno in Hercegovino

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Albinism is a genetic anomaly caused by the lack of activity of the enzyme tyrosinase, which converts to melanin through a stepwise biochemical pathway that results in a lack of pigment in the skin, iris and choroid. More than 100 mutations have been discovered so far associated with albinism (Oetting & King 1999). The red colour of eyes results as the reflection from the choroid capillaries behind the retina, which is visible due to the lack of the pigment melanin in the iris in albinos (Dyrkacz 1981, Boulenger 2000). In snakes, partial amelanism (leucism) is rare, and total amelanism (albinism) is even rarer (Boulenger 2000).

In Europe, there have been several cases of albino snakes of six different species: Aesculapian snake (*Zamenis longissimus* (Laurenti, 1768)), Balkan whip snake (*Hierophis viridiflavus* (Lacépède, 1789)), smooth snake (*Coronella austriaca* Linnaeus, 1758), common European adder (*Vipera berus* (Linnaeus, 1758)), nose-horn viper (*Vipera ammodytes* (Linnaeus, 1758)) and aspic viper (*Vipera aspis* (Linnaeus, 1758)) (Ferri & Bettiga 1992, Happ 1994, Krofel 2004, Gezova et al. 2018).

Since 1879, only nine albino Aesculapian snakes have been reported: three cases from Austria (Erber 1879, Sochurek 1955, Happ 1994), two from Slovakia (Balthasar 1935, Gezova et al. 2018), and one each from Serbia (Radovanović 1941), Switzerland (Bruno & Maugeri 1990), Italy (Ferri & Bettiga 1992) and Slovenia (Krofel 2004).

This paper reports on the first finding of an albino Aesculapian snake and the only albino record among reptiles (class Reptilia) in Bosnia and Herzegovina. The adult albino Aesculapian snake was found on 24. 6. 2014 (leg. I. Bošnjak, det. A. Ćurić) near the town of Teslić, Bosnia and Herzegovina (lat. 44.600674 long. 17.820065, elevation 220 m a.s.l.) (Fig. 1a). The locality is populated and with obvious anthropogenic impact on the local nature, but also there are residues of deciduous forest, brushwood and meadows that correspond to the Aesculapian snake natural habitat. The individual was around 900 mm long (Fig. 1b). From the tail region to the head region, this albino was whitish with visible pale pattern along the body, while the head was much more yellowish. The eye colour was red (Fig. 1a). The gender was not determined. Categorisation into adult individual was done according to Kurek et al. 2019. After determination and measurements, the individual was released back to nature.

Figure 1. Albino Aesculapian snake found in Bosnia and Herzegovina, a – closer view, b – full size of the animal (photo: I. Bošnjak).
Slika 1. Albino navadni gož, ki smo ga našli v Bosni in Hercegovini, a – bližnji pogled, b – celotna dolžina živali (foto: I. Bošnjak).

Most albino snake individuals do not reach adult size due to their vulnerability and exposure to predators (Gezova et al. 2018). Albinos have low survival rates and are rapidly removed from the populations as they are conspicuous to predators (birds and mammals) and even to their prey (small rodents, voles, mice, rats, squirrels, birds) (Arnold 2002). They are also exposed to increased skin and eye sensitivity (lowered vision) to sunlight and with the absence of melanophores exposed to high levels of UV radiation, which may have fatal consequences on juveniles survival rate (Krecsák 2008, Kirkwood 2009, Fellows 2018). With peak hunting activity in the early mornings and between early mornings and late afternoons (Beshkov 1976), albino Aesculapian snakes are extremely noticeable which affects their hunting success and surviving rate (Kirkwood 2009).

So far, this is the third record of an albino Aesculapian snake found on the Balkan Peninsula and 10th record in Europe (Erber 1879, Balthasar 1935, Radovanović 1941, Sochurek 1955, Bruno & Maugeri 1990, Ferri & Bettiga 1992, Happ 1994, Krofel 2004, Gezova et al. 2018). Unlike mammals, besides melanophores, reptiles have two other pigment cells: xanthophores and iridophores. For that reason, disruption of melanin production does not affect the production of these pigments and the animals are seldom white, eye-red and with visible patterns (Bechtel 1978, Boulenger 2000, Krecsák 2008).

These findings are rare cases, not only for the albino Aesculapian snakes, but also for wild adult individuals that have survived despite their greater vulnerability.

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Popravki

Erratum: **»A contribution to the Slovenian spider fauna – IV«**
Kuralt Ž. & Kostanjšek R., Natura Sloveniae 21(1), 2019, str. 21-45.

Str. 40: sliki 6 bi morala na tem mestu slediti slika 7:
Page 40: figure 7 should follow figure 6 on this page:

Micaria subopaca Westring, 1861 (Gnaphosidae)

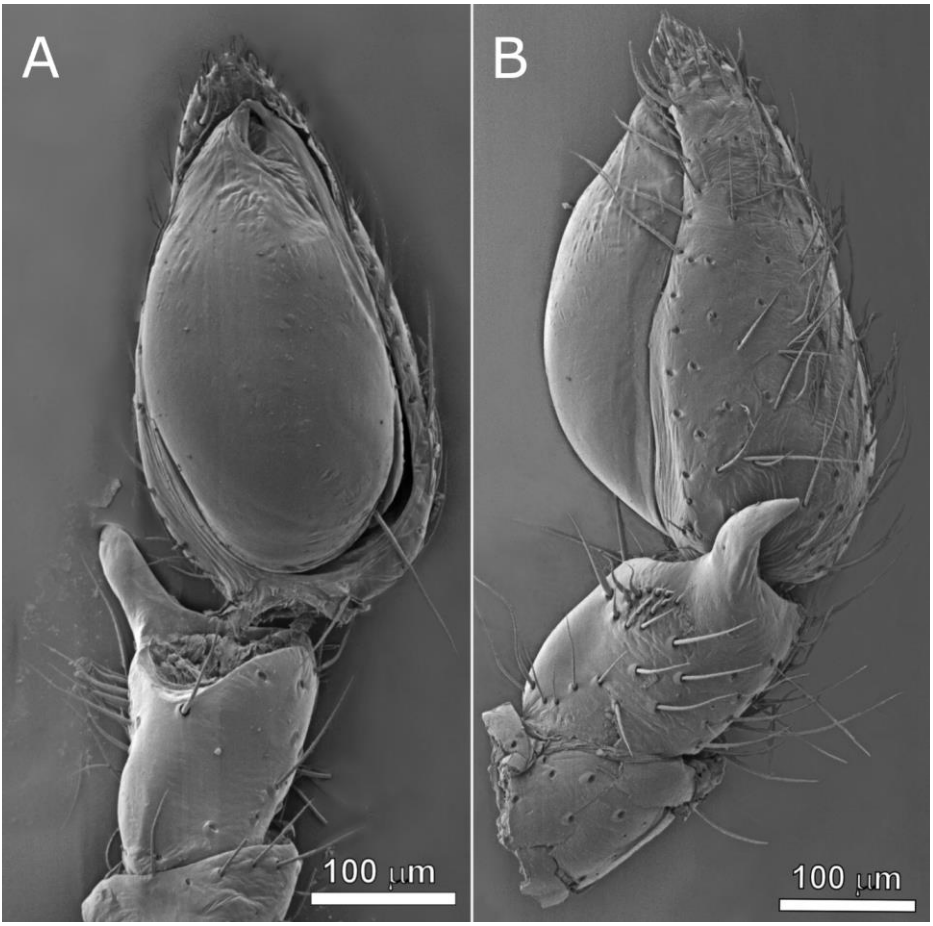

Figure 7. A – Ventral view of *Micaria subopaca* right male pedipalp. B – Clearly visible tibial apophysis with bent branch of *Micaria subopaca* left male pedipalp in lateral view. Specimen was collected on 17. 5. 2018 at Department of Biology.
Slika 7. A – Spodnja stran desnega pedipalpa samca vrste *Micaria subopaca*. B – Značilno oblikovana tibialna apofiza levega pedipalpa samca vrste *Micaria subopaca*. Osebek je bil ujet 17. 5. 2018 na Oddelku za biologijo.

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.

INSTRUCTIONS TO AUTHORS

NATURA SLOVENIAE publishes original papers in Slovene and English which contribute to the understanding of the natural history of Central and Southeast Europe. Papers may be submitted as Scientific Papers, Short Communications or Field Notes.

Scientific Paper is a complete description of the original research including theoretical review, research area, methods, detailed presentation of the results obtained and discussion, conclusions and references. The length of the Scientific Paper may not exceed twenty pages.
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.
Field Note is a short report on interesting faunistical or botanical findings or observations in Slovenia. The lehgth of the Field Note may not exceed three pages.

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.

Papers should be submitted to NATURA SLOVENIAE, Večna pot 111, SI-1111 Ljubljana, Slovenia (telephone: +386 (0) 1 423 33 70, fax: +386 (0) 1 273 390, E-mail: maja.zagmajster@bf.uni-lj.si).

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.