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25 let revije *Natura Sloveniae*

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Izvleček. Prispevek predstavi zgodovino in razvoj revije *Natura Sloveniae* v 25 letih izhajanja, od 1999 do 2023. Izpostavljeni so začetki revije, ozadje in namen revije ter kratka analiza števila prispevkov, avtorjev in taksonomskih skupin, ki jih prispevki naslavljajo, vključno s pregledom odmevnosti izbranih prispevkov. V 25-letih je bilo v reviji objavljenih 286 prispevkov, ki jih je pripravilo 320 avtorjev. Prispevki se osredotočajo na območje Slovenije in največkrat predstavljajo razširjenost vrst, objavljeni pa so tudi zapisi za druga območja iz osrednje in jugovzhodne Evrope, ki obravnavajo širše tematike povezane z ekologijo in naravovarstvom. Visoko citiranost in znanstveno odmevnost dosegajo zlasti prispevki, ki predstavljajo nacionalne sezname vrst ali poročajo o novih ali prvih opažanjih vrst v državi. Velika večina prispevkov je osredotočena na posamezne taksone, najpogosteje žuželke z redovoma metuljev in kačjih pastirjev. V 25. letu izhajanja prehaja revija v so-izdajanju Biotehniške fakultete Univerze v Ljubljani in Nacionalnega inštituta za biologijo v okvir Založbe Univerze v Ljubljani in prične uporabljati nov portal za oddajo in obravnavo rokopisov. V tem letu tudi prvič izide tretja, tematska številka revije. Po četrt stoletja rednega izhajanja zaseda *Natura Sloveniae* pomembno mesto v slovenski znanstveni periodiki s področja biologije in nadaljuje svoje poslanstvo objavljanja izvirnih znanstvenih prispevkov s področja favnističnih, floristčnih, biogeografskih, biodiverzitetnih in ekoloških raziskav v osrednji in jugovzhodni Evropi, ter vzpodbujanja mladih piscev k objavi svojih terenskih opažanj.

Ključne besede: Slovenija, floristika, favnistika, biodiverziteta, ekologija, naravovarstvo, terenska biologija, izvirni znanstveni prispevki

Abstract. 25 years of the *Natura Sloveniae* journal – The article presents the history of the journal *Natura Sloveniae* over the 25 years, from 1999–2023, of its publication. The main aim of the journal is highlighted, as well as a brief analysis of the number of contributions and authors, the taxonomic groups covered in the articles, including an overview of the citation success of the articles published in the journal. In 25 years, 286 articles by 320 authors have been published in the journal. Over the years, the geographical scope of published articles has expanded from Slovenia to SE and Central Europe. A brief statistical analysis of the published articles shows the highest popularity of articles presenting species lists or new records for Slovenia. A considerable share of the contributions are focused on individual taxa, mostly insects, including butterflies and dragonflies. In its 25th year of publication, the journal, which is jointly published by the Biotechnical Faculty at University of Ljubljana and the National Institute of Biology, is switching to the digital submission and review system of the University of Ljubljana Press. In this year, a third, thematic issue is being published for the first time. After a quarter of a century of continuous publication, the journal occupies an important niche among Slovenian scientific biological journals and continues its mission to publish original scientific contributions in the field of biogeographical, biodiversity and ecological research in Central and Southeastern Europe and to encourage young authors to publish their field observations.

Key words: Slovenia, floristics, faunistics, biodiversity, ecology, nature conservation, field biology, history, original scientific contributions

Uvod

V letu 2023 revija *Natura Sloveniae* obeležuje 25. obletnico neprekinjenega izhajanja. Revija je bila ustanovljena leta 1999 na pobudo skupine mentorjev Raziskovalnih taborov študentov biologije, katerih prvotni namen je bil vzpodbujanje objav rezultatov biološkega terenskega dela iz terenskih beležnic, predvsem z raziskovalnih taborov (Kostanjšek et al. 1999). V nekaj letih izdajanja je *Natura Sloveniae* postala osrednja nacionalna revija za poročanja o novih odkritjih s področja floristike, favnistike in ekologije. Sprva geografsko sicer osredotočena na območje Slovenije, revija *Natura Sloveniae* danes uspešno zapolnjuje vrzel v znanstveni literaturi s področja terenske biologije, biodiverzitete, naravovarstva in ekoloških raziskav v osrednji in jugovzhodni Evropi, kot je prikazano v analizi prispevkov v nadaljevanju. Poleg znanstvenih vsebin je poslanstvo *Natura Sloveniae* že od njenega začetka tudi podpora mlajšim piscem, predvsem študentom, pri pridobivanju izkušenj s pisanjem recenziranih znanstvenih prispevkov in pridobivanjem znanstvenih referenc, s katerimi prično bogatiti svoje bibliografije in so jim v pomoč na nadaljnji poklicni poti.

Izhajanje revije je v njenem prvem desetletju, natančneje med letoma 1999 in 2011, kot izdajatelj podprla Zveza za tehnično kulturo Slovenije, za kar gredo zasluge predvsem njenemu takratnemu tajniku Branetu Sotošku. Leta 2012 sta izdajanje revije prevzela Biotehniška fakulteta Univerze v Ljubljani (UL) in Nacionalni inštitut za biologijo, ki zagotavljata osnovno finančno podporo izhajanju revije vse do danes. Izdajanje revije je od njenega začetka sofinancirala Javna agencija za raziskovalno dejavnost RS, zdaj Javna agencija za znanstvenoraziskovalno in inovacijsko dejavnost RS, med leti 2010 in 2012 pa je sofinaciranje periodičnih znanstvenih publikacij koordinirala Javna agencija za knjigo RS.

Uredništvo revije sta od leta 1999 do 2005 kot odgovorna urednika vodila Rok Kostanjšek in Aleksandra Lešnik, med letoma 2005 in 2012 je revijo urejal Rok Kostanjšek, z letom 2013 pa je kot glavna urednica nastopila Maja Zagmajster, medtem ko je Rok Kostanjšek prevzel položaj odgovornega urednika. Vlogo tehničnega urednika je v letu 2005 prevzel Jernej Polajnar, ki skrbi tudi za prehod revije v digitalno obliko in oblikovanje njene spletne strani.

Revija je od začetka njenega izdajanja prosto dostopna. Tiskane izdaje revije so iz Biološke knjižnice Oddelka za biologijo Biotehniške fakultete UL in Nacionalnega inštituta za biologijo vrsto let razpošiljane več kot 200 knjižnicam letno po vsem svetu v okviru medknjižnične izmenjave znanstvenih publikacij, s čimer je *Natura Sloveniae* prispevala tudi k dostopnosti tujih znanstvenih revij s področja biologije v Sloveniji. Z letom 2005 je revija začela vzporedno izhajati v spletni obliki, preko spleta pa so bile dostopne tudi vse starejše številke. Leta 2017 je bila sprejeta odločitev, da bo vsebina objavljena pod določili proste licence Creative Commons-priznanje avtorstva 4.0. Ta poleg javne dostopnosti prispevkov bralcem dopušča razširjanje in uporabo vsebin prispevkov v izpeljanih delih, kar povečuje njihovo odmevnost. Kot zanimivost: tako objavljeno fotografijo pisane krtovke (*Xya variegata*) iz članka Matjaža Bedjaniča v prvi letošnji številki (Bedjanič 2023) je že možno najti v sistemu Wikimedia Commons [https://commons.wikimedia.org/wiki/File:Xya_variegata_(Slovenia).jpg], od koder je vključena v seznam kobilic Avstrije na Wikipediji v nemškem jeziku [https://de.wikipedia.org/wiki/Liste_der_Heuschrecken_%C3%96sterreichs].

Revija izhaja dvakrat letno. Z letom 2003 so postali prispevki indeksirani v mednarodnih bibliografskih bazah podatkov Aquatic Sciences and Fisheries Abstracts (ASFA), International System for Agricultural Science and Technology - AGRIS in Zoological Records, z letom 2005 pa še v bazah Biological Abstracts (BA), BIOSIS Previews in CAB Abstracts. Mednarodno odmevnost in znanstveno težo objavljenih prispevkov potrjuje tudi vključitev *Natura Sloveniae* v skupino »Nacionalno pomembnih znanstvenih revij za področje biologije« in »Skupino revij s katerimi je mogoče nadomeščati prispevke indeksirane v SCI, SSCI in AHCI« v habilitacijskih postopkih Univerze v Ljubljani, v kateri je revija uvrščena od leta 2009. Z namenom vzpodbujanja domačih piscev, približevanja znanstvenih besedil širšemu krogu bralcev in v skrbi za slovensko strokovno izrazoslovje, prispevki objavljeni v angleškem jeziku vključujejo povzetek in izvleček v slovenščini in obratno.

Pomemben mejnik za revijo pa prestavlja tudi leto 2023. Revija je prešla pod okrilje Založbe Univerze v Ljubljani in s tem na platformo Open Journal Systems (OJS). Slednja je namenjena manjšim založnikom in podpira sodobne bibliografske standarde, kar omogoča lažjo dostopnost in zanesljivo indeksiranje prispevkov. Na omenjeno platformo zdaj prehaja celoten uredniški proces, s čimer bo omogočana tudi analiza objavljanja ter ogledov, dobrodošla in nujno potrebna novost pa je tudi dodeljevanje digitalnih identifikatorjev DOI objavljenim prispevkom. V tem letu tudi prvič doslej izide tretja, tematska številka revije, v kateri so zbrani prispevki posvečeni rezultatom raziskav biodiverzitete zgornjega toka reke Neretve v Bosni in Hercegovini poleti 2022.

Pregled objav

V 25 letih, od začetka izhajanja v 1999 do vključno prve številke v letu 2023, je v reviji s skupno 286 prispevki na preko 2.800 straneh sodelovalo 320 avtorjev, ki so prispevali 131 znanstvenih člankov, 75 terenskih notic, 75 kratkih vesti ter 5 ostalih prispevkov (Tab. 1). V posamezni številki je prispevke objavilo od dveh do 52 avtorjev, v povprečju pa 14 (Tab. 1). Osem avtorjev je prispevalo od 10 do 23 prispevkov, ostali pa od enega do devet prispevkov. Pregled afiliacij razkrije, da prevladujejo avtorji, zaposleni v bioloških ali sorodnih ustanovah. Takih je polovica, medtem ko je 30 % avtorjev navedlo domači naslov, 12 % pa naslov društva, katerega člani so. Ker so biološka društva v Sloveniji in soseščini skoraj izključno nepoklicna, to pomeni, da je 42 % avtorjev neprofesionalnih biologov ali študentov. Preostalih 8 % je začelo objavljati ljubiteljsko, v kasnejših prispevkih pa so navedli institucionalno pripadnost, iz česar lahko sklepamo, da so našli zaposlitev v stroki.

Poizvedba v spletnem portalu Google Scholar (opravljena dne 1.12.2023) je pokazala, da je bilo 30 člankov, objavljenih v *Natura Sloveniae*, citiranih 10-krat ali večkrat (Tab. 2). Velik del visoko citiranih del so seznami vrst za območje Slovenije ali pa prikazi razširjenosti posameznih taksonomskih skupin v Sloveniji. Visoko citirane so tudi nove najdbe za Slovenijo. Najbolj citirana članka sta *Seznam mravelj Slovenije (Hymenoptera: Formicidae)* (Bračko 2007) in *Seznam metuljčkov (Microlepidoptera) Slovenije* (Lesar & Govedič 2010) in sicer 49-krat in 48-krat.

Tabela 1. Pregled števila prispevkov in avtorjev v reviji *Natura Sloveniae* v obdobju od začetka izhajanja v letu 1999 do vključno prve številke leta 2023. * – skupno število avtorjev brez ponavljanja.
Table 1. Overview of the number of contributions and authors in the journal *Natura Sloveniae* in the period from the start of publication in 1999 and the first issue of the year 2023. * – summrized number of unique authors.

Leto	Letnik	Številka	Število strani	Število prispevkov	Znanstveni članek	Kratka vest	Terenska notica	Drugo	Število avtorjev
1999	1	1	77	4	4				9
2000	2	1	56	4	4				5
		2	58	5	4			1	6
2001	3	1	43	4	3	1			6
		2	57	4	4				7
2002	4	1	34	4	3	1			7
		2	38	4	3	1			6
2003	5	1	39	4	3	1			5
		2	62	6	4	2			9
2004	6	1	38	6	4	2			9
		2	51	6	3	2	1		7
2005	7	1	40	7	3	3	1		11
		2	124	1	1				2
2006	8	1	37	3	3				13
		2	60	2	2				2
2007	9	1	37	6	3	2	1		14
		2	41	5	3		2		10
2008	10	1	57	5	3	2			9
		2	56	4	3		1		7
2009	11	1	67	6	2	2	2		12
		2	94	4	4				16
2010	12	1	125	5	3		2		6
		2	62	7	3	1	3		11
2011	13	1	59	8	3	1	4		14
		2	56	8	2	4	2		14
2012	14	1	39	7	1	3	3		13
		2	74	8	4	1	3		20
2013	15	1	49	8	2	2	4		19
		2	66	6	4	2			16
2014	16	1	61	6	3	2	1		13
		2	83	3	3				5
2015	17	1	45	6	3	1	2		22
		2	79	6	3	3			16
2016	18	1	64	17	1	3	12	1	52
		2	80	8	4	3	1		29
2017	19	1	47	12	1		10	1	35
		2	68	7	3	3	1		23
2018	20	1	55	5	3	1	1		14
		2	70	14	1	12		1	47
2019	21	1	54	5	2	1	2		11

Leto	Letnik	Številka	Število strani	Število prispevkov	Znanstveni članek	Kratka vest	Terenska notica	Drugo	Število avtorjev
2019	21	2	30	6		2	3	1	14
2020	22	1	33	5	1	1	3		12
		2	82	7	3	1	3		32
2021	23	1	41	6	2	4			18
		2	78	6	5		1		16
2022	24	1	40	5	2	1	2		12
		2	55	6	2	2	2		15
2023	25	1	50	5	1	2	2		12
	Skupaj	**48**	**2811**	**286**	**131**	**75**	**75**	**5**	**320***

Tabela 2. Seznam 30 najbolj citiranih prispevkov iz revije *Natura Sloveniae* v obdobju 1999 do 2023. Okrajšave – »Št. cit.«: število citatov po Google Scholar; »Avtorji«: vodilni avtor oz. avtorja; »Leto«: letnica objave; »Naslov prispevka«: polni naslov prispevka v slovenščini. Vir: Google Scholar, 27.11.23, iskanje po geslih: »natura sloveniae« in »author«.
Table 2. The list of 30 most cited papers from journal *Natura Sloveniae* in the period between 1999 and 2023. Abbreviations – »Št. cit.«: number of citations, »Avtorji«: lead author(s); »Leto«: publication year; »Naslov prispevka«: full article title in Slovene language. Source: Google Scholar, 27.11.23, search terms: »natura sloveniae« and »author«.

Št. cit	Avtorji	Leto	Naslov prispevka
49	Bračko G.	2007	Seznam mravelj Slovenije (Hymenoptera: Formicidae)
48	Lesar T., Govedič M.	2010	Seznam metuljčkov (Microlepidoptera) Slovenije
37	Krofel M. et al.	2009	Razširjenost plazilcev v Sloveniji: pregled podatkov, zbranih do leta 2009.
33	Dudek K., Ekner-Grzyb A.	2014	Najdbi dvorepih osebkov martinčka *Lacerta agilis* Linnaeus, 1758 in živorodne kuščarice *Zootica vivipara* (Jacquin, 1787) na Poljskem
33	Krofel M.	2009	Potrjena prisotnost teritorialnih skupin zlatega šakala (*Canis aureus*) v Sloveniji
29	Mulec J., Kosi G.	2008	Alge v aerofitskem habitatu jame Račiške ponikve (Slovenija)
25	Mihelič M., Krofel M.	2012	Novi podatki o pojavljanju zlatega šakala (*Canis aureus* L.) v zgornji Soški dolini
24	Krofel M., Potočnik H.	2008	Prvi podatek o pojavljanju šakala (*Canis aureus*) v Savinjski dolini (S Slovenija)
19	Kostanjšek R., Celestina A.	2008	Nove najdbe sinantropnih pajkov (Arachnida, Araneae) v Sloveniji
17	Lesar T., Habeler H.	2005	Prispevek k poznavanju metuljčkov (Microlepidoptera) Štajerske in Koroške v Sloveniji
16	Kostanjšek R., Gorjan A.	2013	Prispevek k favni pajkov Slovenije – II
16	Bedjanič M., Šalamun A.	2003	Veliki studenčar *Cordulegaster heros* Theischinger, nova vrsta za favno Italije (Odonata: Cordulegastridae).
15	Zagmajster M.	2003	Svatbeni napev dvobarvnega netopirja *Vespertilio murinus* Linnaeus, 1758 (Chiroptera, Mammalia) v južni Sloveniji in preliminarna študija njegove variabilnosti.
15	Bračko G.	2003	Nove vrste za favno mravelj Slovenije (Hymenoptera: Formicidae)
14	Vamberger M., Trontelj P.	2007	Želvja pijavka *Placobdella costata* (fr. Müller, 1846) (Hirudinea: Glossiphoniidae), nova vrsta pijavke za Slovenijo

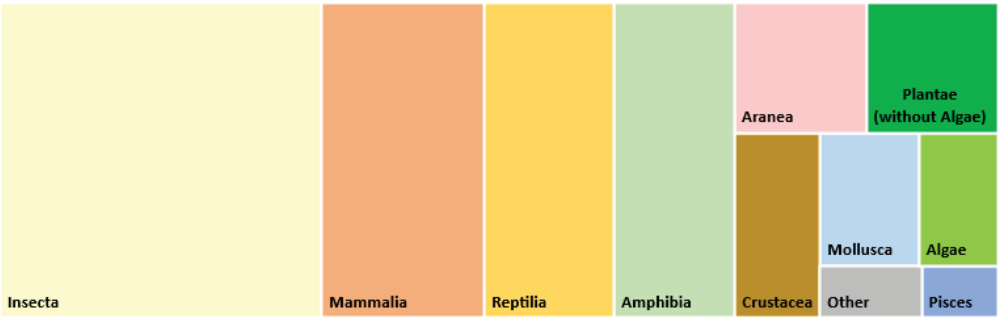
Št. cit	Avtorji	Leto	Naslov prispevka
14	Kalan K. et al.	2011	Pregled razširjenosti tigrastega komarja *Aedes albopictus* (Diptera: Culicidae) v Sloveniji v letih 2007 in 2010
14	Vilisics F., Lapanje A.	2005	Kopenski raki enakonožci (Isopoda: Oniscidea) na območju slovenskega Krasa
14	Presetnik P., Šalamun A.	2019	Prve najdbe dolgorepega netopirja *Tadarida teniotis* (Rafinesque, 1814) v Sloveniji
14	Kuntner M., Kostanjšek R.	2000	Prispevek k poznavanju favne pajkov zahodne Slovenije (Arachnida: Araneae).
13	Bačič T.	2006	Nezadostno znane enokaličnice slovenskega Rdečega seznama.
13	Presetnik P., Knapič T.	2015	Prve potrditve prisotnosti velikega mračnika *Nyctalus lasiopterus* (Schreber, 1780) v Sloveniji po več kot 85 letih
13	Kostanjšek R., Fišer C.	2005	Nove najdbe pajkov skakačev (Araneae: Salticidae) v Sloveniji
12	Mori N., Meisch C.	2012	Prispevek k poznavanju razširjenosti recentnih prostoživečih dvoklopnikov (Podocopida, Ostracoda, Crustacea) v celinskih vodah Slovenije
12	Jelić D.	2014	Pregled dvoživk in plazilcev Hrvaške z bibliografijo 250 let raziskav
12	Presetnik P. et al.	2013	Ali je dvobarvni netopir *Vespertilio murinus* Linnaeus, 1758 pogost v Sloveniji?
11	Krofel M. et al.	2007	Topografske in vegetacijske značilnosti mest, kjer so risi uplenili svoj plen v Dinaridih v Sloveniji
11	Verovnik R., Popović M.	2013	Prva najdba grškega senožetnika *Colias aurorina* Herrich-Schäffer, 1850 (Lepidoptera: Pieridae) v Albaniji
10	Verovnik R.	2012	Prispevek k poznavanju pomladanske favne dnevnih metuljev Republike Makedonije (Lepidoptera: Papilionoidea & Hesperioidea)
10	Trontelj P., Zakšek V.	2016	Genetski monitoring populacij človeških ribic
10	Kulijer D. et al.	2012	Prispevek k poznavanju odonatne favne Bosne in Hercegovine – rezultati ECOO 2012.

Vsebinski pregled objav od leta 1999 do vključno prve številke leta 2023 pokaže, da je velika večina prispevkov osredotočena na posamezne taksone (239 od 286 prispevkov; Sl. 1). Obravnavanih je bilo več kot 26 redov iz več kot 11 razredov in podrazredov. Najpogosteje so bile obravnavane žuželke (32 % vseh prispevkov oz. 77 prispevkov; Sl. 2), med katerimi sta bila najpogosteje obravnavana redova metuljev (48 % oz. 37 od 77 prispevkov) in kačjih pastirjev (18 % oz. 14 od 77 prispevkov; Sl. 3). Med taksonomskimi članki velja izpostaviti objavo opisa nove vrste vrbnice *Perla carantana* (Sivec & Graf 2002).

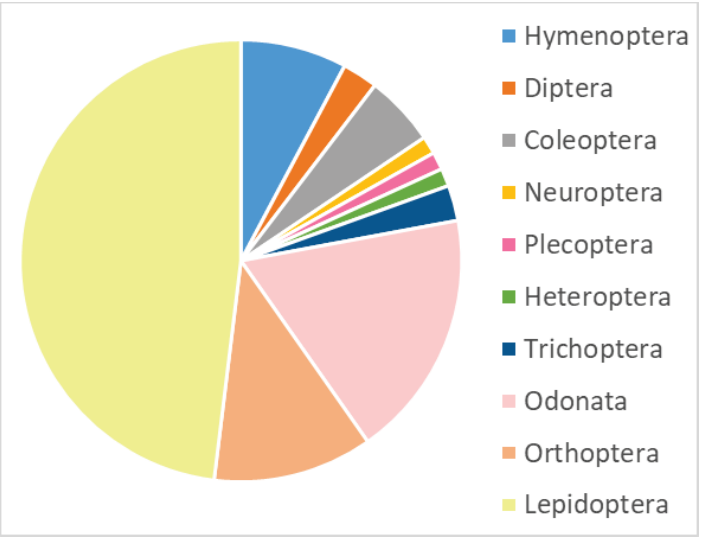
Petnajst prispevkov je bilo vezanih na proučevanje združb. Ti so obravnavali združbe taksonomskih skupin (npr. dvoživke, plazilci, nevretenčarji, …), združbe temelječe na ekoloških razmerah (npr. perifiton, fitobentos, intersticialna favna, …) ter združbe opredeljene glede na ekološko vlogo proučevanih organizmov (npr. opraševalci, zajedavci, …). Petnajst je bilo tudi prispevkov o raziskavah habitatov (npr. tipi jezer, onesnaževanje jam, Kras, …). Revija *Natura Sloveniae* je uspešno izpolnjevala tudi svoje izobraževalno poslanstvo. Poleg vzpodbujanja mlajših in manj izkušenih piscev k objavljanju znanstvenih prispevkov, je bilo v *Natura Sloveniae* objavljenih tudi deset prispevkov s poučnimi vsebinami kot so »Kodeks etike terenskega biologa« (izšel v drugi številki drugega letnika, leta 2000), »Floristika na raziskovalnih taborih

študentov biologije« (Jogan 2001), različni metodološki pristopi in naravovarstveni ukrepi ter vsebinsko usmerjene strokovne vsebine (npr. Delavnice SOS Proteus). Čeprav je bila revija sprva omejena na slovenski prostor, so s prepoznavnostjo revije prispevki pričeli pokrivati geografsko območje osrednje Evrope (Sl. 4).

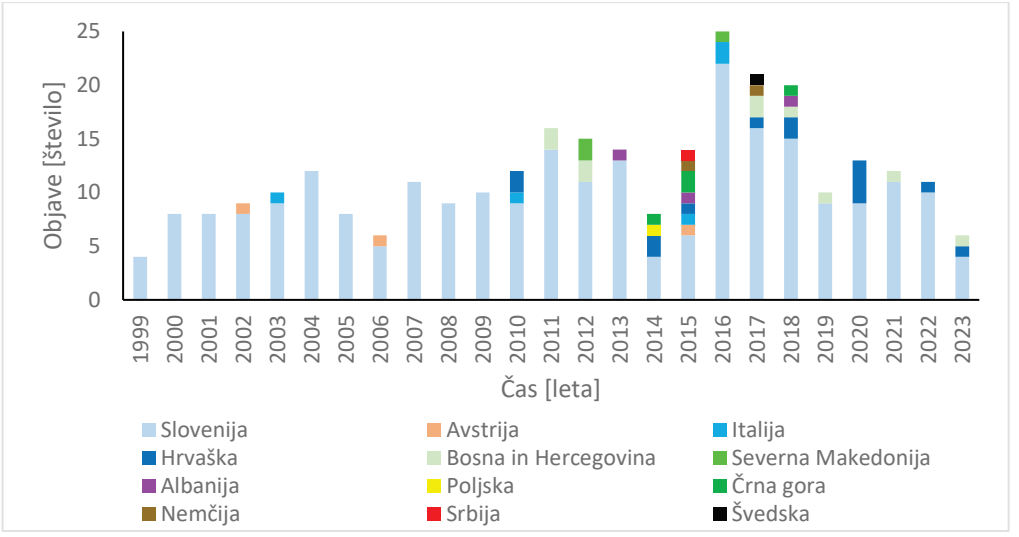
Slika 1. Oblak besed, ki prikazuje pogostost pojavljanja ključnih besed posameznih prispevkov v reviji *Natura Sloveniae* med letoma 1999 in 2023). Slika je izdelana v programskem okolju R, z analizo ključnih besed v angleščini.
Figure 1. Word cloud, presenting the frequency of appearance in key words of the contributions to the journal *Natura Sloveniae* between years 1999 and 2023. The figure is prepared by using the program R and key words in English.



Slika 2. Delež posameznih taksonomskih skupin v 239 prispevkih, ki obravnavajo taksone, objavljenih v reviji *Natura Sloveniae* od leta 1999 do vključno prve številke v letu 2023.
Figure 2. The proportion of taxonomic groups in 239 taxa-related contributions in the journal *Natura Sloveniae* in the period from 1999 to the first issue of the year 2023.



Slika 3. Zastopanost redov v 77 prispevkih, ki obravnavajo žuželke, objavljenih v reviji *Natura Sloveniae* od leta 1999 do vključno prve številke v letu 2023.
Figure 3. The proportion of orders that appeared in 77 insect-related contributions in the journal *Natura Sloveniae* from 1999 to the first issue of the year 2023.



Slika 4. Število objav in geografska pokritost prispevkov v reviji *Natura Sloveniae* od leta 1999 do vključno prve številke v letu 2023.
Figure 4. Number of contributions and their geographical coverage in the journal *Natura Sloveniae* in the period between 1999 to the first issue of the year 2023.

Namesto zaključka

Razvoj revije *Natura Sloveniae* od začetnih, na raziskovalnih taborih študentov biologije identificiranih potreb po vzpostavitvi znanstvene publikacije za objavljanje terenskih opažanj, ki prepogosto ostajajo skrita v terenskih beležnicah in s tem nedostopna strokovni in naravovarstveni javnosti, do mednarodno uveljavljane revije za objavljanje podatkov bioloških terenskih opažanj v osrednji Evropi, nas utrjuje v prepričanju, da je bila začrtana pot pravilna. Glede na delež mlajših in manj izkušenih avtorjev prispevkov v *Natura Sloveniae* lahko enako trdimo tudi za njeno edukativno poslanstvo. Zelo zgovorna sta tudi četrt stoletja obstoja in rednega izhajanja *Natura Sloveniae*, zato osnovno poslanstvo in cilji revije tudi v prihodnje ostajajo nespremenjeni. Tudi vključenost dveh močnih javnih raziskovalnih inštitucij s področja biologije v izdajanje revije *Natura Sloveniae*, podaja močno sporočilo – da je *Natura Sloveniae* pomemben vir terenskih bioloških podatkov, ki niso le zanimivi sami po sebi, temveč so nujna osnova za ohranjanje biodiverzitete in načrtovanju posegov v prostor.

Čeprav je napovedovanje razvoja revije nehvaležno, lahko s precejšnjo gotovostjo predvidevamo, da bo, ob vse številčnejšim grožnjam izgube naravnih habitatov, pestrosti vrst in vplivih globalnih klimatskih sprememb, dosledno beleženje in objavljanje bioloških podatkov s terena v prihodnje le še pridobivalo na pomenu. Večji izziv je predvidevanje bodočega znanstvenega dometa revije. Dosedanje težnje *Natura Sloveniae* in drugih slovenskih bioloških znanstvenih revij po vključitvi v seznam revij indeksiranih v SCI (Science Citation Index) so pokazale, da trenutni potencial revij ne omogoča pridobitev omenjenega indeksa, čeprav so nekatere revije, vključno z *Natura Sloveniae* že bile vključene v pogovore za vključitev v razširjene sezname SCI indeksiranih revij. Ali bo tovrstni preboj v bodoče uspel kateri od slovenskih znanstvenih revij s področja biologije, ali bo za ta korak morda potrebno združevanje revij ali preoblikovanje slovenske biološke publicistične krajine z namenom vzpostavitve osrednje stanovske revije, ki jo slovenska biologija zagotovo zasluži in potrebuje, bo pokazal čas. Dotlej pa bo *Natura Sloveniae* nadaljevala svoje utrjeno poslanstvo osrednje slovenske revije za terensko biologijo, saj misel - *litera scripta manet* (pisana beseda ostane), zapisana v uvodniku prve *Natura Sloveniae* pred četrt stoletja (Kostanjšek et al. 1999) z digitalizacijo pridobiva dodaten pomen in težo.

Summary

The article begins by introducing the 25th-anniversary celebration of the journal *Natura Sloveniae*, founded in 1999. Initially focused on publishing results from biological fieldwork, the journal evolved into a prominent platform for reporting new discoveries in floristics, faunistics, and ecology in Slovenia and broader Central and Southeastern Europe. Throughout its history, the journal published 286 contributions from 320 authors, with a focus on Slovenia's region. The contributions primarily addressed individual taxa, particularly insects, with butterflies and dragonflies prevailing. Notably, impactful contributions often presented species lists or reported new observations of species in the country. One of the most cited papers is the »Checklist of the ants of Slovenia (Hymenoptera: Formicidae)« published by Bračko (2007).

In 2023, the journal underwent significant changes, transitioning to the University of Ljubljana Publishing House, maintaining co-publishing partnerships with the Biotechnical Faculty of the University of Ljubljana and the National Institute of Biology. The journal adopted a new manuscript submission portal and released its first thematic issue dedicated to the biodiversity research of the Neretva River in Bosnia and Herzegovina 2022.

The article provides an overview of the editorial history, affiliations, and financial support. It also mentions the transition to the Open Journal Systems platform, making the content more accessible and reliable, with articles now receiving unique DOI identifiers. The analysis of contributions revealed a diverse range, including scientific articles, field notices, short communications, and other formats. The article concludes with a review of the most cited contributions, and emphasizing the journal's impact on scientific literature.

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A new checklist of Slovenian leeches (Hirudinea: Euhirudinea): In memory of Boris Sket (1936–2023)

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Abstract. The new (as of 2023) checklist of Slovenian leeches (Euhirudinea) contains 33 species, which is a 44% increase since the last published inventory in 2003. Notable new entries include *Placobdella costata* found parasitizing on the European pond turtle, the marine fish leech *Trachelobdella lubrica* from the Slovenian Adriatic coast, the semi-terrestrial *Haemopis elegans*, the terrestrial *Xerobdella praealpina* – making Slovenia possibly the only country with confirmed occurrence of all three European land leeches – and a new, still undescribed highly troglomorphic cave leech from a deep Dinaric cave. The number of freshwater fish leeches (Piscicolidae) is underwhelmingly low: two. This, and several unresolved taxonomic questions in the family Erpobdellidae suggest that more faunistic and taxonomic work is needed and that the list of Slovenian leech species is far from concluded. The authors dedicate this contribution to their teacher, Prof. Boris Sket (1936–2023), a leading figure in biodiversity research in the Dinaric Karst, including leeches and cave life.

Key words: leeches, Hirudinea, cave, diversity, species number, new species, Slovenia

Izvleček. Pregled pijavk Slovenije (Hirudinea: Euhirudinea): V spomin Borisu Sketu (1936–2023) – Posodobljeni (stanje 2023) seznam slovenskih pijavk (Euhirudinea) ima 33 vrst in za 44 % presega prejšnji pregled, objavljen leta 2003. Izmed novosti velja omeniti želvjo pijavko *Placobdella costata*, najdeno na močvirski sklednici, morsko ribjo pijavko *Trachelobdella lubrica* iz obrežnega pasu slovenske Obale, pretežno kopensko sorodnico konjske pijavke *Haemopis elegans*, popolnoma kopensko pijavko *Xerobdella praealpina* – s katero je Slovenija postala domnevno edina država s potrjenimi najdbami vseh treh evropskih kopenskih pijavk iz rodu *Xerobdella* – in pa novo, še neopisano močno troglomorfno jamsko pijavko iz globokega brezna na Kočevskem. Z le dvema vrstama je zastopanost sladkovodnih ribjih pijavk (Piscicolidae) pod vsemi pričakovanji. Ta ugotovitev skupaj z nerešenimi taksonomskimi problemi v družini Erpobdellidae kaže, da bo potrebnega še precej favnističnega in taksonomskega dela ter da je seznam slovenskih pijavk vse prej kot zaključena zgodba. Avtorja posvečava pričujoči prispevek spominu na učitelja in mentorja profesorja Borisa Sketa (1936–2023), vodilnega raziskovalca biodiverzitete Dinarskega krasa, predvsem pijavk in podzemeljskega živalstva.

Ključne besede: pijavke, Hirudinea, jame, raznovrstnost, število vrst, nove vrste, Slovenija

Introduction

It is safe to say that without the pioneering work on the leech fauna of former Yugoslavia by Boris Sket much of the exceptional biodiversity of this area would have remained unknown till the present day. He established taxonomic standards that enabled reliable descriptions of these very morphologically plastic and variable animals, developed new sampling methods that opened a window into the depths of ancient Lake Ohrid and caves of the Dinaric Karst, and was the first to apply molecular taxonomic approaches to leeches. His landmark monograph was published fifty-five years ago (Sket 1968). Since then, many new species have been described and discovered, and the big Balkan country fell apart. Some of its constituent republics have become EU member states and need to update their faunistic inventories for legal and other reasons. In Slovenia, the northernmost of the former Yugoslavian republics, research on leeches continued after the disintegration. Some of these new additions to leech taxonomy and fauna have not yet been published at all and others are scattered in different kinds of publications, so the time seems right for a succinct overview. With this contribution we wish to honour the memory of Boris Sket, who taught and raised many of the currently active Slovenian zoologists, taxonomists and speleobiologists. He passed away on 7. 5. 2023.

This contribution is dealing with leeches in the narrow sense, referred to as the order Euhirudinea Lukin, 1956, or Hirudinida Siddall et al., 2001 (junior synonym, not valid). Newer phylogenies (e.g. Tessler et al. 2018) suggest that leeches as traditionally perceived and known under the name Hirudinea Lamarck, 1818 include two additional order-level lineages, the Acanthobdellida Livanow, 1905 and the Branchiobdellida Holt, 1965. Only the latter group has representatives living in Slovenian fresh waters as epibionts on crayfish. It will be the subject of a separate contribution.

The current Euhirudinea species count is at about 830 nominal species globally (Grosser et al. 2024). Biogeographically, the diversity is relatively evenly distributed with an apparent slight bias toward the Palearctic region (Sket & Trontelj 2008). Leeches inhabit a variety of habitats from marine via freshwater to terrestrial, and display a range of lifestyles from predatory via ecto- and endoparasitic to scavenger (Sawyer 1986). All these ecologies and lifestyles are represented within the small fraction of the global diversity of leeches inhabiting Slovenia.

The first comprehensive list of Slovenian leech species can be extracted from Sket's (1968) Yugoslavian overview – it counted 22 species, of which three were treated as form or subspecies. Three decades later, the list was augmented by merely a single marine species, *Pontobdella muricata*, and the number 23 seemed to be final (Sket 1996; 2003). Intentionally or not, our teacher and mentor offered the greatest possible motivation to carry on with the faunistic work by declaring that the work is finished (Sket 2003): »Iz Slovenije pa je znanih trenutno 23 vrst in ta številka se kaj bistveno ne more več spremeniti. – *There are currently 23 species known from Slovenia and this number cannot change substantially anymore.*«

Materials and methods

To compile the checklist, we updated data from Sket (1968; 1996) with data from literature published up to the present day (Trontelj et al. 1999; Trontelj 2000; Trontelj et al. 2004; Vamberger & Trontelj 2007; Jueg 2015; Kvist et al. 2023). In addition, readily available non-literature sources of documented biodiversity data were screened for new records, such as collections, molecular databases and photographic fora. No dedicated taxonomic work, neither on collections nor in the field, was performed as basis for the present checklist. Any taxonomic identifications that are not part of peer-reviewed publications were made by the first author on previous occasions.

The taxonomy is based on Nesemann & Neubert (1999) and incorporates subsequent additions and rearrangements as explained in the Comments to the checklist. The taxonomic sequence used follows Sket (1968) in order to ease comparison between the two checklists.

Results

The newly compiled checklist of leeches of Slovenia (Tab. 1) includes 33 species belonging to six families and 16 genera. It includes one new undescribed species and two species whose potential identity with an existing name-bearing type remains to be clarified.

Table 1. Leech (Euhirudinea) species recorded in Slovenia.
Tabela 1. V Sloveniji ugotovljene vrste pijavk (Euhirudinea).

Classification	Species	Source
Subclass Hirudinea Lamarck, 1818		
Order Euhirudinea Lukin, 1956		
Fam. Glossiphoniidae Vaillant, 1890		
Alboglossiphonia Lukin, 1976	*Alboglossiphonia heteroclita* (Linnaeus, 1761)	Sket (1968); listed as *Glossiphonia heteroclita* (Linnaeus, 1761)
	Alboglossiphonia hyalina (O.F. Müller, 1774)	Sket (1968); listed as *Glossiphonia heteroclita* forma hyalina (O.F. Müller, 1774)
	Alboglossiphonia striata (Apáthy, 1888)	Sket (1968); listed as *Glossiphonia heteroclita* forma striata (Apáthy, 1888)
Glossiphonia Johnson, 1816	*Glossiphonia complanata* (Linanaeus, 1758)	Sket (1968)
	Glossiphonia concolor (Apáthy, 1888)	Sket (1968); listed as *Glossiphonia complanata complanata* (Linnaeus, 1758) forma concolor
	Glossiphonia nebulosa (Kalbe, 1964)	Sket (1968); listed as *Glossiphonia complanata complanata* (Linnaeus, 1758) forma nebulosa

Classification	Species	Source
	Glossiphonia paludosa (Carena, 1824)	Sket (1992)
	Glossiphonia slovaca (Košel, 1973)	Trontelj (2000)
Helobdella R. Blanchard, 1896	*Helobdella stagnalis* (Linnaeus, 1758)	Sket (1968)
Theromyzon Philippi, 1867	*Theromyzon tessulatum* (O.F. Müller, 1774)	Sket (1968)
Hemiclepsis Vejdovsky, 1884	*Hemiclepsis marginata* (O.F. Müller, 1774)	Sket (1968)
Placobdella R. Blanchard, 1893	*Placobdella costata* (Fr. Müller, 1846)	Vamberger & Trontelj (2007)
Fam. Piscicolidae Johnston, 1865		
Pontobdella Leach, 1815	*Pontobdella muricata* (Linnaeus, 1758)	Trontelj et al. (1999)
Trachelobdella Diesing, 1850	*Trachelobdella lubrica* (Grube, 1840)	This work: Piran, Fiesa (45.5259 lat, 13.5835 lon), littoral zone few meters from shore; 21. 9. 2001
Cystobranchus Diesing, 1859	*Cystobranchus respirans* (Troschel, 1850)	Sket (1968)
Piscicola Blainville, 1818	*Piscicola geometra* (Linnaeus, 1758)	Sket (1968)
Fam. Hirudinidae Whiteman, 1868		
Hirudo Linnaeus, 1758	*Hirudo medicinalis* Linnaeus, 1758	Sket (1968)
	Hirudo verbana Carena, 1820	Trontelj et al. (2004)
Fam. Haemopidae Richardson, 1969		
Haemopis Savigny, 1822	*Haemopis sanguisuga* (Linnaeus, 1758)	Sket (1968)
	Haemopis elegans Moquin-Tandon, 1846	Kvist et al. (2023)
Fam. Xerobdellidae Moore, 1946		
Xerobdella Frauenfeld, 1868	*Xerobdella lecomtei* Frauenfeld, 1868	Sket (1968)
	Xerobdella anulata Autrum, 1958	Sket (1968)
	Xerobdella praealpina Minelli, 1971	Jueg (2015)
Fam. Erpobdellidae Moore, 1908		
Erpobdella Blainville, 1918	*Erpobdella octoculata* (Linnaeus, 1758)	Sket (1968)
	Erpobdella verrucosa (Örley, 1886)	Sket (1968); listed as *Erpobdella monostriata* (Gedroyć, 1916)
	Erpobdella testacea (Savigny, 1822)	Sket (1968)
	Erpobdella nigricollis (Brandes, 1900)	Sket (1968)
Dina R. Blanchard, 1892	*Dina lineata* (O. F. Müller, 1774)	(Ur. l. RS 2002); listed as *Dina lineata lineata*
	Dina krasensis (Sket, 1968)	Sket (1968); listed as *Trocheta bykowskii krasense* ssp. n
	Dina A cf. *punctata*	Sket (1968); listed as *Dina apathyi* (Gedroyć, 1916)

Classification	Species	Source
	Dina B cf. *punctata*	This work: Ljubjana, Sava River (46.0773 lat, 14.6512 lon), collected by P.T. on gravel bank; 30. 6. 2021
	Dina sp.n.	This work: Črnomelj, Čaganka Cave (45.5499 lat, 15.0822 lon, -400 m), on photo taken by Anže Tomšič, a caver from Caving Club Novo mesto; 12. 1. 2014
Trocheta Dutrochet, 1817	*Trocheta cylindrica* Örley, 1886	Sket (1968); listed as *Trocheta bykowskii* (?) *bykowskii* Gedroyć, 1913

Comments

Alboglossiphonia

The genus was established only after the work by Sket (1968). All three taxa from Central Europe that have thereafter been recognized as separate species (Trontelj 1997; Nesemann & Neubert 1999) had been reported by Sket (1968) for the territory of Slovenia.

Glossiphonia paludosa

The original mention (Sket 1992) is without locality and date but includes habitat – eutrophic ponds. On a second occasion, Sket (1996) lists presumably the same find under the obsolete generic assignment *Batracobdella paludosa* and includes 'NE Slovenia' as geographic descriptor. Only later it became known that under the name *G. paludosa* a second species with similar habitat and distribution, *Batracobdelloides moogi*, had been frequently addressed (Nesemann & Csanyi 1995). A third species, *Glossiphonia slovaca,* closely resembles *G. paludosa.* Thus the record could refer to any of these three species. However, *G. slovaca* is the least likely candidate as its habitat is in large rivers of the Danube Basin, such as the Sava near Brežice (Trontelj 2000). Until we obtain corroboration in the form of either a corresponding collection item or a field record from a pond in Northeast Slovenia, this will remain the vaguest taxon on the present checklist.

Cystobranchus respirans

This freshwater fish leech is by some contemporary authors referred to by its synonym *Piscicola respirans* Troschel, 1850. However, available molecular phylogenies suggest that a couple of other valid piscicoline genera are more closely related to *Piscicola* sensu stricto, making the original classification non-monophyletic (Utevsky & Trontelj 2004; Cichocka et al. 2018). It therefore makes sense to keep the genus *Cystobranchus* Dissinc, 1859, on the basis of its type species *C. respirans.*

Trachelobdella lubrica

No written sources documenting the occurrence of this globally distributed species in the Slovenian part of the Adriatic Sea are known to the authors. The closest known sites are the coastal waters around Venice (Mizzan 1994). The 2001 find in Slovenian coastal waters can be considered as expected. Two individuals were found in the first few meters of the littoral zone at Fiesa, Piran. The leeches were hidden in dense marine vegetation, detached from hosts. The sampling was carried out within a fieldwork class for Biology students of the Biotechnical Faculty of the University of Ljubljana.

Erpobdella verrucosa

Since the first listing for Slovenia under the name *Erpobdella monostriata* (Gedroyć, 1916) in Sket (1968), the name of this species was changed to the presumably correct combination *Erpobdella vilnensis* (Liskiewicz, 1925) and used by Trontelj et al. (1996), Nesemann & Neubert (1999) and several subsequent authors. Only recently, Košel (2020) discovered that priority has to be given to a much older description of this taxon from Budapest, and the valid new combination is *Erpobdella verrucosa* (Örley, 1886).

Dina lineata

The only authoritative source unambiguously referring to the occurrence of this species in Slovenia is the official national Red List (Ur. l. RS 2002). Although anonymized in the legislative document, the data have been provided by Boris Sket. The exact site of the corresponding discovery can only be reconstructed via a chronological examination of corresponding collection items – provided they still exist.

Dina cf. *punctata*

The material analyzed by Sket (1968) from western Slovenia and identified as *Dina apathy* does not belong to this species, as can be seen by drawing (No. 29 on page 183) of the male genital atrium. This is clearly of the *Dina*–type, while *D. apathy* has a *Trocheta*–type atrium (Nesemann & Neubert 1999; Grosser 2015). Although without locality data, *D. punctata* is listed in the national Red List (Ur. l. RS 2002). In Slovenia, there seem to be at least two species with *Dina*-like annulation and a colouration pattern consisting of light dots on dark background, matching the general description of *Dina punctata*. They are phylogenetically distinct from this Western European species (unpublished data) and may or may not be conspecific with one of several other European populations falsely attributed to *D. punctata* or, recently, described as separate species (Grosser et al. 2023 and references therein).

Dina sp.n.

This is the first markedly troglomorphic obligate cave leech from Slovenia, phylogenetically close to the *Dina absoloni* group. The first discoverers provided excellent photos (Fig. 1), based on which it could be unambiguously inferred that the find represents a hitherto undescribed species. Later, a specimen was obtained and deposited in the Zoological Collection of the Department of Biology (Biotechnical Faculty, University of Ljubljana, Slovenia) that will serve as holotype for the imminent description.

Figure 1. The first picture of *Dina* sp. n., taken on 12. 1. 2014 in the Čaganka Cave, southern Slovenia, at a depth of about 400 meters. The length of the leech on the picture is approx. 10 cm (photo: Anže Tomšič).

Slika 1. Prvi posnetek nove vrste pijavke, *Dina* sp. n., iz jame Čaganke na Kočevskem, na pribl. 400 metrih globine, z dne 12. 1. 2014. Dolžina pijavke na sliki je okrog 10 cm (foto: Anže Tomšič).

Discussion

Leeches are not as extensively studied and as popular with a wider number of naturalists as for example vertebrates or some groups of insects. It is therefore expected that the number on national and regional species lists will increase, both as a consequence of faunistic novelties and newly described species. In Slovenia, the number of known species has increased by 44% in the past two decades. With 33 species the Slovenian leech fauna is moderately diverse, when compared to the faunas of some nearby countries with recently published inventories: 50 species in Germany (Grosser et al. 2024), 47 species in Poland (Bielecki et al. 2011), 29 species in Montenegro (Grosser et al. 2015), 25 species in Bulgaria (Jueg 2010), 24 species in the Czech Republic (Košel 2014) and 21 species in Bosnia and Herzegovina (Dmitrović & Pešić 2020).

The known Slovenian leech fauna is comparatively poor in freshwater piscicolids, featuring only two species in contrast to 18 species in Germany (Grosser et al. 2024) or 21 species in Poland (Bielecki et al. 2011). The first major reason for this discrepancy is that the new approaches and expertise that gave rise to the great increase in freshwater piscicolid diversity (Bielecki 1997) have not yet been fully adopted by Slovenian researchers. The second and somewhat

hypothetical reason is that the mere extent of suitable fish leech habitats in Slovenia is not sufficient to support as many taxa as the lowland lakes and rivers of Central and Eastern Europe. Nevertheless, the diversity of freshwater fish leeches in Slovenia is expected to boost when more focus is put on this faunal segment.

A change in research focus is warranted also with respect to the expected arrival of invasive species. Several of them are already spreading across Europe, especially the self-fertilizing glossiphoniid *Helobdella europaea* (Ferreira et al. 2022) and the salifid *Barbronia weberi* (Sawyer 2020).

Finally, the updated national list of species can be seen as an incentive to revise the dated Red List of endangered leeches (Ur. l. RS 2002). Two of the newly added species appear to be exceedingly rare: *Xerobdella praealpina* and the undescribed *Dina* sp. n. from the Čaganka Cave. New data on their distribution, population status and ecology are needed just as much as appropriate legal measures. On the downside, the inclusion of *Glossiphonia slovaca* on the national Red List did not help preserve its sole known site. The last free-flowing stretch of the Sava River before the Slovenian-Croatian border is under threat by the imminent construction of the final hydro-powerplant in the Slovenian Lower-Sava chain (Hidroelektrarne na Spodnji Savi 2023).

Povzetek

Raziskanost favne in taksonomija pijavk bivše Jugoslavije sta doživela preporod v sodobnost z delom Borisa Sketa v drugi polovici prejšnjega stoletja. Že takrat je opozoril na izredno vrstno pestrost in visoko stopnjo endemizma, zlasti na območju Dinarskega krasa. Na ozemlju Republike Slovenije je odkril 22 vrst, tri med njimi je obravnaval kot podvrste (Sket 1968). Od tega mejnika dalje je odkrivanje novih vrst sprva naraščalo tako počasi, da je dobra tri desetletja kasneje kazalo, da je favnistično delo končano: »*Iz Slovenije pa je znanih trenutno 23 vrst in ta številka se kaj bistveno ne more več spremenit*« (Sket 2003). Ali je Boris Sket s to izjavo namerno ali nenamerno izzval mlajše kolege, ne bomo nikoli izvedeli. Dejstvo pa je, da je pričujoči seznam, ki temelji na objavljenih virih in neobjavljenih podatkih iz podatkovnih zbirk, kar za 44 % daljši in šteje 33 vrst.

Od novosti velja omeniti želvjo pijavko *Placobdella costata*, najdeno na močvirski sklednici, morsko ribjo pijavko *Trachelobdella lubrica* iz obrežnega pasu slovenske Obale, pretežno kopensko sorodnico konjske pijavke *Haemopis elegans*, ponovno odkrito »pozabljeno« vrsto medicinske pijavke *Hirudo verbana*, popolnoma kopensko pijavko *Xerobdella praealpina* – s katero je Slovenija postala domnevno edina država s potrjenimi najdbami vseh treh evropskih kopenskih pijavk iz rodu *Xerobdella* – in pa novo, še neopisano močno troglomorfno jamsko pijavko iz globokega brezna na Kočevskem. Nerazrešena ostaja taksonomska pripadnost dveh erpobdelidnih pijavk, katerih barvni vzorec na prvi pogled spominja na vrsto *Dina punctata*. S skorajšnjo gotovostjo lahko trdimo, da ne gre za to vrsto, pač pa za še neopisani ali pred kratkim opisani in premalo raziskani vrsti iz sorodstvene skupine *Dina/Trocheta*.

V primerjavi s srednjeevropskima državama z najbogatejšo favno pijavk, Nemčijo (50 vrst) in Poljsko (47 vrst), slovenski seznam zaostaja izključno na strani sladkovodnih ribjih pijavk. Ti sta pri nas dve, medtem ko jih je na Poljskem 21 vrst. K zaostanku verjetno več prispeva nizka pozornost, ki smo jo namenjali tej skupini, kot pa skromnejše omrežje naših površinskih voda. Najkasneje tukaj postane jasno, da je poznavanje slovenske favne pijavk še vedno nezadostno in da so potrebne obsežne dodatne biodiverzitetne

in taksonomske raziskave. Nezadostnost poznavanja pijavčje favne in splošno pomanjkanje zanimanja za to vsestransko pomembno komponento biodiverzitete naših celinskih voda se kaže v zastarelem rdečem seznamu in v njegovem neupoštevanju. Zaradi redkosti je bila vanj vključena vrsta *Glossiphonia slovaca*, najdena le v prodiščih Save pri Čatežu. Vseeno vrsta ni bila deležna nikakršne obravnave pri presoji načrtov za izgradnjo HE Mokrice, ki bi vrsto verjetno izbrisala iz seznama slovenske favne.

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A checklist of isopods (Crustacea: Isopoda) in Slovenia

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Abstract. Isopods are a diverse peracarid crustacean group with marine, freshwater and terrestrial representatives. Isopod species lists were typically prepared according to different habitats, which was also the case for Slovenia. Here, we prepared the first unified overview of isopod species of Slovenia, which is also the first list of marine isopods in the country. We examined scientific publications, research reports and institutional databases. A total of 125 species have been recorded in Slovenia, of which 30 are marine, 21 are found in inland waters, and 74 are terrestrial. Of these, we report seven marine and one terrestrial species for the first time. A major part of freshwater isopod richness is linked to the subterranean environment, where most endemic species for the country can be found. Among marine species, many are parasites, with potential economic impact, and two species are considered introduced. When the new species list was compared to the valid national Red List of endangered species from 2002 and the Decree on Protected Wild Animal Species from 2004, only 41 species retained the same taxonomic status. Taking into consideration the recent taxonomic insights, many synonyms and invalid taxa call for a revison of the national Red List of Malacostraca and other nature protection acts.

Key words: Peracarida, marine, freshwater, terrestrial, subterranean, fauna

Izvleček. Pregled vrst rakov enakonožcev (Crustacea: Isopoda) Slovenije – Enakonožci so pestra skupina rakov valilničarjev z morskimi, sladkovodnimi in kopenskimi predstavniki. Seznami vrst enakonožcev običajno predstavljajo posamezne habitate, kar drži tudi za Slovenske. V tem prispevku smo pripravili prvi skupni pregled vrst enakonožcev v Sloveniji, ki je tudi prvi pregled morskih vrst enakonožcev v državi. Nekateri, zlasti morski paraziti imajo lahko tudi negativen ekonomski učinek. Pregledali smo predhodno zbrane podatke o pojavljanju enakonožcev na ozemlju Slovenije v znanstvenih in strokovnih prispevkih, poročilih raziskav ter podatkovnih bazah sodelujočih ustanov. Skupno je bilo v Sloveniji zaznanih 125 vrst, od tega 30 morskih, 21 v celinskih vodah in 74 kopenskih. V tem prispevku prvič poročamo o pojavljanju sedmih morskih in ene kopenske vrste. Velik delež vrstnega bogastva enakonožcev je vezan na podzemlje, kjer lahko najdemo tudi večino slovenskih endemitov v celinskih vodah in na kopnem. Med morskimi vrstami je mnogo parazitov, ki imajo lahko ekonomski vpliv, ter dve tujerodni vrsti. Če prenovljeni seznam vrst primerjamo z veljavnim Rdečim seznamom ter Uredbo o zavarovanih prosto živečih živalskih vrstah, zgolj 41 vrst ohrani enake taksonomske statuse. Številni sinonimi in neveljavni taksoni glede na trenutno taksonomijo skupine kažejo na potrebo po reviziji nacionalnega Rdečega seznama višjih rakov ter drugih varstvenih aktov.

Ključne besede: Peracarida, morski, celinske vode, kopenski, podzemni, favna

Introduction

Isopods are a diverse order of peracarid crustaceans, with over 10,000 described species worldwide (Boyko et al. 2008). They inhabit almost all marine, freshwater, and terrestrial environments, from the deep sea to deserts (Sfenthourakis & Taiti 2015). Most species of the order are marine, while among non-marine ones, the suborder Oniscidea represents more than three quarters of known species (Boyko et al. 2008). This suborder is one of the few crustacean groups successful in terrestrial habitats, being an order of magnitude richer in terrestrial species than terrestrial decapods or amphipods (Broly et al. 2013).

Isopods are important decomposers of plant matter both in aquatic (Wilson 2008) and terrestrial environments (David 2014; Sfenthourakis & Taiti 2015); on land, they may contribute greatly to soil formation (Zimmer 2002; David 2014). Numerous marine isopods live in close association with other benthic organisms and many are parasites, often on fish (Poore & Bruce 2012). Parasitic and wood-boring marine isopods can have a considerable negative economic impact (Borges et al. 2014; Čolak et al. 2018). Isopods are also a very successful arthropod group in subterranean freshwater and terrestrial environments (Coineau & Boutin 2004; Hobbs 2012; Sfenthourakis & Hornung 2018).

As decomposers that tend to accumulate metals in their tissues, isopods are important experimental organisms in ecotoxicology, particularly in studies dealing with metal and nanoparticle toxicity. Terrestrial species are particularly well studied in this respect (van Gestel et al. 2018), but ecotoxicological studies have also been performed on aquatic species (Lukančič et al. 2010; Plahuta et al. 2017). This has been one of the most flourishing research topics concerning this group in the past few decades (Vittori & Dominko 2022). Isopods are also important in basic research, particularly in developmental biology, studies of microbe-host interactions and, as their representatives span various degrees of adaptation to terrestrial life, the study of the transition from water to land (Hornung 2011; Vittori & Dominko 2022). Isopods, particularly representatives of the genus *Asellus*, are also some of the best studied subterranean invertebrates and serve as models for studying adaptations to the subterranean environment (Konec et al. 2015; Re et al. 2018; Balázs et al. 2021).

Due to the success of isopods in the sea, in inland waters, and on land, studies of their diversity are generally in the domains of four categories of biologists: marine zoologists, limnologists, speleobiologists, and researchers dealing with the edaphic fauna. As a result, it is challenging to bring lists of species records together. Additionally, many isopods inhabit different subterranean habitats, aquatic as well as terrestrial. Caves harbour isopods that are amphibious or secondarily aquatic, particularly among Oniscidea (Sfenthourakis & Taiti 2015).

In Slovenia, overviews of species occurrence were made separately according to different habitats. For terrestrial species, Karaman (1966) and Potočnik (1989) assembled checklists for the former state of Yugoslavia in the Western Balkans, with species listed separately for each federal republic (now countries), including the territory of Slovenia. Potočnik published several works on the terrestrial isopods of Slovenia (Potočnik 1979, 1980, 1981, 1984, 1992; Potočnik & Novak 1980). As for aquatic isopods, a checklist with descriptions of known distributions was published in the overview of all aquatic crustaceans for the former state of

Yugoslavia (Sket 1967). The Asellidae, in particular, are well studied, with integrated occurrence, habitat, and molecular data now available in the World Asellidae Database, including data from Slovenia (Saclier et al. 2024). Only a few publications are available on the occurrence of marine isopods in Slovenia (Sket 2008; Tratar 2010). A checklist of crustaceans occurring in the Gulf of Trieste was compiled more than a century ago by Graeffe (1902), with many of the species likely occurring also in the Slovenian part of the Gulf.

The aim of this contribution is to provide an updated checklist of isopods in Slovenia that considers taxonomic revisions and data acquired after the 1980s. It represents a reference point regarding the present state of knowledge and can form the basis for planning much needed systematic studies of the isopod fauna in marine, freshwater, and terrestrial environments. An overview of species was needed also to evaluate the current species richness of isopods, identify newly introduced species and provide a reference for a revision of protective legislation.

Materials and methods

Data were mostly collected from published species checklists that either focus on or include isopods and other references that report on the occurrence of isopods in Slovenia. The information from such literature sources that refer to subterranean taxa and/or subterranean habitats were extracted from the database SubBioDB (a taxonomic distributional database, established and managed by the Subterranean Biology Laboratory (SubBioLab) at the Department of Biology, Biotechnical Faculty, University of Ljubljana). The overview of marine taxa was based mostly on records from specimen collections of the Marine Biology Station Piran (MBP), which is a part of the National Institute of Biology in Slovenia. Finally, data were supplemented with those from the database of the Center of Cartography of Fauna and Flora in Slovenia.

In addition to reviewing existing literature, we also checked the extensive terrestrial isopod collection in the Slovenian Museum of Natural History in Ljubljana (SMNH), deposited there by Franc Potočnik. In the collection, we focused on species with a single record to confirm their identifications and presence in the country. We were able to successfully identify previously reported and deposited material of *Philoscia muscorum*, *Porcellio marginalis* (Potočnik 1984), and *Oniscus asellus* (Potočnik 1980). We also consulted publicly accessible databases, the World Register of Marine Species (WoRMS Editorial Board 2023), the Global Biodiversity Information Facility (GBIF 2023), and the Pan-European Species Directories Infrastructure (PESI 2023).

As subspecies were often not reported and their statuses are in need of reassessment, the list is limited to species and the current statuses of subspecies are only discussed regarding protective legislation. The presence of each species is referenced by listing a single published reference, which in most cases represents the most recent publication that includes the species. The previous checklists we refer to should be used to identify primary sources of the records. For species previously not included in checklists, we provide the source publications reporting on their occurrence. In the case of unpublished records, we provide detailed localities where the species in question were recorded.

Even though we acknowledge that some isopods cannot be placed in a single habitat category, we add information on the preferred habitat (terrestrial, freshwater, or marine), and mark obligate subterranean species separately as well as information on whether a species is introduced, endemic, or parasitic. We also point out species that were scientifically described from the territory of Slovenia.

In a special section, we list the species that have been reported in the literature, but there is reasonable doubt that they occur in Slovenia.

Changing taxonomy and improved knowledge results in changes in taxonomic statuses and new species descriptions. Considering the time lag since the publication of the last checklists of isopods and since the acceptance of the national Red List of Malacostraca (Ur. l. RS 2002), taxonomic and status changes could be expected. We prepared an overview of the current national Red List and an overview of changed statuses due to changes in taxonomy. Statuses of subspecies included in the Red List were checked in the World Register of Marine Species (WoRMS Editorial Board 2023). While we discuss the current taxonomic validity of the species in these lists, this is to spur the revision of legislation documents and not to determine or change the protection statuses of recorded species.

Results

Overview of the species checklist

A total of 125 species of isopods, belonging to seven suborders, 31 families and 62 different genera, can be confirmed for Slovenia (Tab. 1). For eight species, the presence in the country had not been published before, hence we provide the first data on their occurrence in Tab. 2. Eight species that have been reported for the country in past publications cannot reliably be considered as part of the Slovenian fauna. We comment on this in Tab. 3.

Table 1. An overview of isopod species confirmed to be present in Slovenia, listed in alphabetical order and according to suborders and families. A published reference for their occurrence in the country is provided, while detailed locality data on species reported for the first time are given in Tab. 2. The main habitat of each species is given in a separate column. The addition of the letter T marks obligate subterranean (or troglobiotic) species. Species marked with asterisks were scientifically described from Slovenia. Endemic, introduced, and ectoparasitic species are marked in the Remarks column.

Tabela 1. Pregled vrst enakonožcev, potrjenih v Sloveniji. Razporejeni so v abecednem vrstnem redu po podredovih in družinah. Dodane so objavljene reference pojavljajočih se vrst, natančni podatki o lokalitetah vrst, o katerih poročamo prvič, pa so podane v tabeli 2. Glavni habitat vsake vrste je podan v ločenem stolpcu. Črka T označuje obligatno podzemeljske (troglobiotske) vrste. Vrste, ki so označene z zvezdicami, so bile opisane iz Slovenije. Endemične, tujerodne in ektoparazitske vrste so označene v predzadnjem stolpcu.

Higher taxon	Species	Habitat	Remarks	Reference
Asellota				
Asellidae	*Asellus aquaticus* (Linnaeus, 1758)	freshwater		Sket 1967
	Asellus kosswigi Verovnik, Prevorčnik & Jugovic 2009	freshwater - T		Konec et al. 2015
	Proasellus coxalis (Dollfus, 1892)	freshwater		Sket 1967
	Proasellus deminutus (Sket, 1959) *	freshwater - T	endemic	Sket 1972
	Proasellus intermedius (Sket, 1965)	freshwater - T		Sket 1967
	Proasellus istrianus (Stammer, 1932)	freshwater		Sket 1967
	Proasellus orientalis Sket, 1965 *	freshwater - T	endemic	Sket 1971
	Proasellus parvulus (Sket, 1960) *	freshwater - T	endemic	Sket 1967
	Proasellus slavus (Remy, 1948)	freshwater - T		Sket 1972
	Proasellus slovenicus (Sket, 1957) *	freshwater - T	endemic	Sket 1967
	Proasellus vulgaris (Sket, 1965) *	freshwater - T	endemic	Sket 1967
Janiridae	*Jaera nordmanni* (Rathke, 1836)	marine		Tratar 2010
	Janira maculosa Leach, 1814	marine		new (MBP)
Munnidae	*Uromunna petiti* (Amar, 1948)	marine		Tratar 2010
Stenasellidae	*Balkanostenasellus skopljensis* (Karaman, 1937)	freshwater - T		Sket & Velkovrh 1981
Cymothoida				
Anthuridae	*Anthura gracilis* (Montagu, 1808)	marine		Sket 2003
	Cyathura carinata (Krøyer, 1847)	marine		Vrišer 2003
Cirolanidae	*Natatolana borealis* (Lilljeborg, 1851)	marine	ectoparasite	Vrišer 2003
	Sphaeromides virei (Brian, 1923)	freshwater - T		Sket 1964
Cymothoidae	*Anilocra physodes* (Linnaeus, 1758)	marine	ectoparasite	Vrišer 2003
	Ceratothoa parallela (Otto, 1828)	marine		Sket 2003
	Nerocila bivittata (Risso, 1816)	marine		Sket 2003
Expanathuridae	*Eisothistos macrurus* Wägele, 1979	marine		Lipej et al. 2016
Gnathiidae	*Gnathia dentata* (G. O. Sars, 1872)	marine	ectoparasite	Tratar 2010
	Gnathia oxyuraea (Lilljeborg, 1855)	marine	ectoparasite	new (MBP)
	Gnathia vorax (Lucas, 1849)	marine	ectoparasite	Tratar 2010
Paranthuridae	*Paranthura japonica* Richardson, 1909	marine	introduced	Ragkousis et al. 2020
Epicaridea				
Bopyridae	*Bopyrus squillarum* Latreille, 1804	marine	ectoparasite	Vrišer 2003
Limnoriidea				
Limnoriidae	*Limnoria tripunctata* Menzies, 1951	marine		Sket 2003
Oniscidea				
Agnaridae	*Orthometopon dalmatinum* (Verhoeff, 1901)	terrestrial		Vilisics & Lapanje 2005

Higher taxon	Species	Habitat	Remarks	Reference
	Orthometopon planum (Budde-Lund, 1885)	terrestrial		Potočnik 1990
	Protracheoniscus hermagorensis Verhoeff, 1927	terrestrial		Potočnik 1989
	Protracheoniscus politus (C. Koch, 1841)	terrestrial		Potočnik 1989
Armadillidae	*Armadillo officinalis* Duméril, 1816	terrestrial		Potočnik 1989
Armadillidiidae	*Armadillidium opacum* (C. Koch, 1841)	terrestrial		Potočnik 1989
	Armadillidium carniolense Verhoeff, 1901	terrestrial		Potočnik 1989
	Armadillidium klugii Brandt, 1833	terrestrial		Potočnik 1989
	Armadillidium nasatum Budde-Lund, 1885	terrestrial		Vilisics & Lapanje 2005
	Armadillidium pallasii Brandt, 1833	terrestrial		Potočnik 1989
	Armadillidium scaberrimum Stein, 1859	terrestrial		Potočnik 1989
	Armadillidium versicolor Stein, 1859	terrestrial		Potočnik 1989
	Armadillidium vulgare (Latreille, 1804)	terrestrial		Potočnik 1989
Cylisticidae	*Cylisticus convexus* (De Geer, 1778)	terrestrial		Potočnik 1989
Detonidae	*Armadilloniscus ellipticus* (Harger, 1878)	terrestrial		Potočnik 1989
Halophilosciidae	*Halophiloscia couchii* (Kinahan, 1858)	terrestrial		Potočnik 1989
	Halophiloscia hirsuta Verhoeff, 1928	terrestrial		Potočnik 1989
Ligiidae	*Ligia italica* Fabricius, 1798	terrestrial		Potočnik 1989
	Ligidium germanicum Verhoeff, 1901	terrestrial		Potočnik 1989
	Ligidium hypnorum (Cuvier, 1792)	terrestrial		Potočnik 1989
Mesoniscidae	*Mesoniscus graniger* (Frivaldszky, 1865)	terrestrial		Potočnik & Novak 1980
Oniscidae	*Oniscus asellus* Linnaeus, 1758	terrestrial		Potočnik 1989
	Oroniscus calcivagus Verhoeff, 1908 *	terrestrial		Potočnik 1989
Philosciidae	*Chaetophiloscia cellaria* (Dollfus, 1884)	terrestrial		Potočnik 1989
	Chaetophiloscia elongata (Dollfus, 1884)	terrestrial		Potočnik 1989
	Chaetophiloscia hastata Verhoeff, 1929	terrestrial		Potočnik 1989
	Chaetophiloscia splitensis Verhoeff, 1930	terrestrial		Potočnik 1989
	Lepidoniscus minutus (C. Koch, 1838)	terrestrial		Potočnik 1989
	Philoscia affinis Verhoeff, 1908	terrestrial		Potočnik 1989
	Philoscia muscorum (Scopoli, 1763) *	terrestrial		Potočnik 1989
Platyarthridae	*Platyarthrus hoffmannseggii* Brandt, 1833	terrestrial		Potočnik 1989
Porcellionidae	*Porcellio dilatatus* Brandt, 1831	terrestrial		Potočnik 1989
	Porcellio laevis Latreille, 1804	terrestrial		Potočnik 1989
	Porcellio longicornis Stein, 1859	terrestrial		Potočnik 1990
	Porcellio marginalis Budde-Lund, 1885	terrestrial		Potočnik 1989
	Porcellio scaber Latreille, 1804	terrestrial		Potočnik 1989

Higher taxon	Species	Habitat	Remarks	Reference
	Porcellio spinicornis Say 1818	terrestrial		Potočnik 1989
	Porcellionides pruinosus (Brandt, 1833)	terrestrial		Potočnik 1989
Trachelipodidae	*Porcellium conspersum* (C. Koch, 1841)	terrestrial		Potočnik 1981
	Porcellium fiumanum (Verhoeff, 1901)	terrestrial		Potočnik 1989
	Trachelipus arcuatus (Budde-Lund, 1885)	terrestrial		Potočnik 1989
	Trachelipus camerani (Tua, 1900)	terrestrial		Vilisics & Lapanje 2005
	Trachelipus nodulosus (C. Koch, 1838)	terrestrial		Potočnik 1989
	Trachelipus rathkii (Brandt, 1833)	terrestrial		Potočnik 1989
	Trachelipus ratzeburgii (Brandt, 1833)	terrestrial		Potočnik 1989
	Trachelipus razzautii (Arcangeli, 1913)	terrestrial		Potočnik 1989
	Trachelipus vespertilio (Budde-Lund, 1896)	terrestrial		Vittori 2022
Trichoniscidae	*Alpioniscus strasseri* (Verhoeff, 1927)	terrestrial - T		Potočnik 1989
	Androniscus degener Brian, 1927	terrestrial - T		Potočnik & Novak 1981
	Androniscus dentiger Verhoeff, 1908	terrestrial		Potočnik 1989
	Androniscus roseus (C. Koch, 1838)	terrestrial		Potočnik 1989
	Androniscus stygius (Nemec, 1897)	terrestrial - T		Potočnik 1989
	Androniscus subterraneus (Carl, 1906)	terrestrial - T		Potočnik 1989
	Buddelundiella cataractae Verhoeff, 1930	terrestrial		Potočnik 1989
	Calconiscellus gottscheensis (Verhoeff, 1927) *	terrestrial		Potočnik 1989
	Calconiscellus karawankianus (Verhoeff, 1908) *	terrestrial		Potočnik 1989
	Haplophthalmus abbreviatus Verhoeff, 1928*	terrestrial		Potočnik 1989
	Haplophthalmus danicus Budde-Lund, 1880	terrestrial		Potočnik 1989
	Haplophthalmus fiumaranus Verhoeff, 1908	terrestrial		Potočnik 1989
	Haplophthalmus mengii (Zaddach, 1844)	terrestrial		Potočnik 1989
	Haplophthalmus rhinoceros Verhoeff, 1930	terrestrial		Potočnik 1989
	Hyloniscus adonis Verhoeff, 1927 *	terrestrial		Potočnik 1989
	Hyloniscus riparius (C. Koch, 1838)	terrestrial		Potočnik 1989
	Hyloniscus vividus (C. Koch, 1841)	terrestrial		Potočnik 1989
	Moserius percoi Strouhal, 1940 *	terrestrial - T		Potočnik 1989
	Tachysoniscus austriacus (Verhoeff, 1908)	terrestrial		Potočnik 1989

Higher taxon	Species	Habitat	Remarks	Reference
	Thaumatoniscellus speluncae Karaman, Bedek & Horvatović, 2009	terrestrial - T		Polak et al. 2012
	Titanethes albus (C. Koch, 1841) *	terrestrial - T		Potočnik 1989
	Trichoniscus carniolicus Strouhal, 1939 *	terrestrial		Potočnik 1989
	Trichoniscus illyricus Verhoeff, 1931	terrestrial		Potočnik 1989
	Trichoniscus matulici Verhoeff, 1901	terrestrial		Potočnik 1989
	Trichoniscus provisorius Racovitza, 1908	terrestrial		new
	Trichoniscus stammeri Verhoeff, 1932 *	terrestrial - T	endemic	Potočnik 1989
Tylidae	*Tylos europaeus* Arcangeli, 1938	terrestrial		Potočnik 1989
Sphaeromatidea				
Sphaeromatidae	*Campecopea hirsuta* (Montagu, 1804)	marine		new (MBP)
	Cymodoce truncata Leach, 1814	marine		Vrišer 2003
	Dynamene bicolor (Rathke, 1836)	marine		Tratar 2010
	Dynamene edwardsi (Lucas, 1849)	marine		Tratar 2010
	Lekanesphaera hookeri (Leach, 1814)	marine		Sket 1967
	Monolistra bericum (Fabiani, 1901)	freshwater - T		Sket 1967
	Monolistra bolei (Sket, 1960) *	freshwater - T	endemic	Sket 1967
	Monolistra calopyge Sket, 1982 *	freshwater - T	endemic	Sket 1982
	Monolistra caeca Gerstaecker, 1856 *	freshwater - T		Sket 1967
	Monolistra racovitzai Strouhal, 1928 *	freshwater - T		Sket 1967
	Monolistra spinosa (Racovitza, 1929) *	freshwater - T	endemic	Sket 1967
	Monolistra spinosissima (Racovitza, 1929) *	freshwater - T	endemic	Sket 1967
	Monolistra velkovrhi Sket, 1960 *	freshwater - T		Sket 1967
	Paracerceis sculpta (Holmes, 1904)	marine	introduced	Ferrario et al. 2018
	Sphaeroma serratum (J. C. Fabricius, 1787)	marine		Vittori 2021
Valvifera				
Arcturidae	*Astacilla longicornis* (Sowerby, 1806)	marine		new (MBP)
	Astacilla dilatata G. O. Sars, 1883	marine		Sket 2003
Hognathidae	*Cleantis prismatica* (Risso, 1826)	marine		new (MBP)
Idoteidae	*Idotea balthica* (Pallas, 1772)	marine		Vrišer 2003
	Stenosoma appendiculatum (Risso, 1826)	marine		new (MBP)
	Stenosoma lancifer (Miers, 1881)	marine		new (MBP)
	Synischia hectica (Pallas, 1772)	marine		Lipej et al. 2013

The highest proportion of species, 74 (nearly 60%), are terrestrial (suborder Oniscidea), with the greatest richness found in the family Trichoniscidae with 26 species (Fig. 1). It is only in this family that terrestrial obligate subterranean species can be found (eight species). Other terrestrial families with more than five species are Armadillidiidae, Philosciidae, Porcellionidae and Trachelipodidae. There is only one terrestrial species endemic to Slovenia: *Trichoniscus stammeri* (Tab. 1 and Fig. 2). While it is difficult to be certain which of the currently cosmopolitan species present in Slovenia are native, no demonstrably introduced terrestrial species have been recorded so far.

Figure 1. Proportions of freshwater, marine and terrestrial isopods in Slovenia (inner level) and proportions of different families in each of these categories (outer level). Families represented by a single species are grouped under »Other«.
Slika 1. Razmerja enakonožcev celinskih vod ter morskih in kopenskih enakonožcev v Sloveniji (notranji nivo) ter razmerja med družinami v vsaki kategoriji (zunanji nivo). Zaradi preglednosti družine, zastopane z zgolj eno vrsto, niso prikazane ločeno.

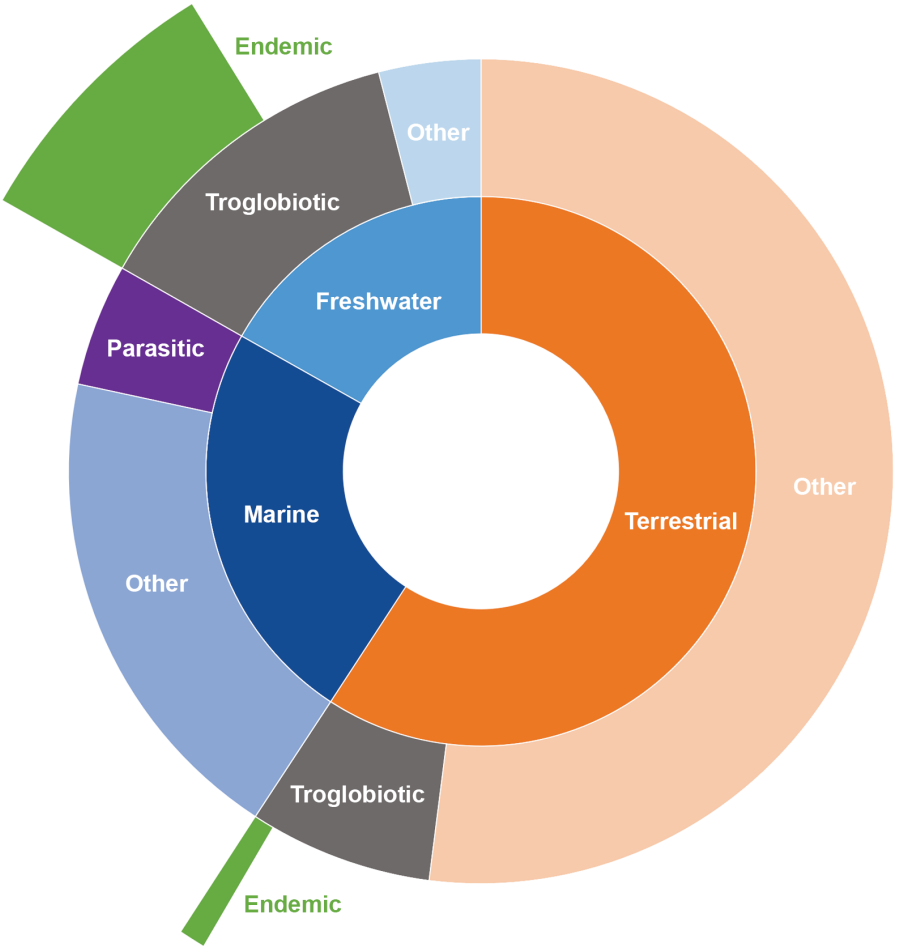

Figure 2. Proportions of freshwater, marine and terrestrial isopods (inner level) and corresponding proportions of parasitic species for marine isopods and troglobiotic species for the remaining two categories (second level). The proportion of endemic species is presented separately (outer level). There are no known endemic marine species.
Slika 2. Razmerja enakonožcev celinskih vod, morskih in kopenskih enakonožcev (notranji nivo) ter pripadajoči deleži parazitov pri morskih enakonožcih in troglobiontov pri ostalih dveh kategorijah (drugi nivo). Delež endemitov je podan ločeno (zunanji nivo). Morski endemiti niso znani.

The second group richest in species are marine isopods, with 30 species (approximately 25% of all species). Sphaeromatidae are the most diverse family with eight species, followed by Gnathiidae and Idoteidae (Fig. 1). The list contains two non-indigenous species: *Paracerceis sculpta* and *Paranthura japonica*. Both can be considered as established non-indigenous species in the Slovenian Sea. Eight species can be categorised as parasites (Fig. 2), predominantly with fish hosts. An exception is *Bopyrus squillarum*, which is hosted by *Palaemon* decapods.

The freshwater harbours a total of 21 species (about 15% of all), of which only three are not considered to be bound to subterranean habitats (Tab. 1 and Fig. 2). The most representatives in freshwater belong to Asellidae, followed by Sphaeromatidae (Fig. 1). The most species-rich genera in both families, *Proasellus* and *Monolistra*, respectively, are represented with nine species each. Many species in these genera are endemic to Slovenia. Specimens from the genus *Microcharon* were reported but were not identified to species level in the publication that lists this record (Brancelj et al. 2016). As a result, we only list the genus at this point.

There are eight marine and one terrestrial species for which no data have been published (Tab. 1). In Table 2 we provide information on records that confirm the presence of these species in Slovenia. New marine species for the Slovenian fauna were collected during sampling procedures of the marine benthic communities, conducted during various projects of the Marine Biological Station from 2008 onward. The new terrestrial species was recorded in synanthropic habitats, but it is widespread in Europe and has been reported from the Balkans before (Schmalfuss 2003). It is therefore difficult to assess whether it has been introduced or not.

Table 2. Details of records confirming the presence of eight marine and one terrestrial isopod species in Slovenia. The abbreviation MBP refers to Marine Biological Station of the National Institute of Biology.
Tabela 2. Podrobnosti novih najdb, ki potrjujejo pojavljanje osmih morskih in enega kopenskega enakonožca v Sloveniji. Kratica MBP označuje Morsko biološko postajo Nacionalnega inštituta za biologijo.

Family	Species	Locality	Lat, Lon (WGS84)	Date	Leg./ Det.	Remarks
Arcturidae	*Astacilla longicornis*	Sea at Strunjan	45.535900, 13.601967	10.06.2008	MBP/B. Mavrič	
Sphaeromatidae	*Campecopea hirsuta*	Piran, sea under medieval wall	45.529000, 13.573067	10.06.2008	MBP/B. Mavrič	
		Sea at Cape of Piran	45.530567, 13.565100	18.06.2008	MBP/B. Mavrič	
		Sea near the coastal road between Koper and Izola	45.548150, 13.700650	26.06.2008	MBP/B. Mavrič	
		Sea at Debeli Rtič	45.592617, 13.714683	17.06.2008	MBP/B. Mavrič	
		Sea at the youth rehabilitation centre at Debeli Rtič	45.587583, 13.706983	17.06.2008	MBP/B. Mavrič	
		Laguna Bernardin	45.514833, 13.573117	12.06.2008	MBP/B. Mavrič	
		Port of Piran	45.526583, 13.566733	12.06.2008	MBP/B. Mavrič	
		Sea at Jadranka Izola	45.539167, 13.670000	18.05.2009	MBP/B. Mavrič	
		Sea under the wall in front of Marina Portorož	45.504167, 13.594167	19.05.2009	MBP/B. Mavrič	
		Portorož beach	45.512778, 13.593611	19.05.2009	MBP/B. Mavrič	
Hognathidae	*Cleantis prismatica*	Sea soft bottom sample, Sv Nikolaj	45.574167, 13.740000	10.06.2009	MBP/B. Mavrič	

Family	Species	Locality	Lat, Lon (WGS84)	Date	Leg./ Det.	Remarks
		Sea soft bottom sample, Koper at the end of Semedelska road	45.543333, 13.720278	29.5.2009	MBP/B. Mavrič	
		Sea soft bottom sample, Strunjan, in front of Salina	45.526111, 13.601667	18.5.2009	MBP/B. Mavrič	
		Sea soft bottom sample, wall in front of Marina Portorož	45.504167, 13.594167	19.5.2009	MBP/B. Mavrič	
		Seagrass meadow in front of Strunjan	45.527594, 13.600892	21.5.2018	MBP/B. Mavrič	
Gnathiidae	*Gnathia oxyuraea*	Soft bottom taken with Van Veen grab, Bay of Sv. Jernej	45.594983, 13.709600	8.9.2021	MBP/B. Mavrič	National monitoring location VT2P2
Janiridae	*Janira maculosa*	Pacug	45.526186, 13.589369	10.8.2012	MBP/B. Mavrič	Within colonies of Mediterranean stony coral (*Cladocora caespitosa*) from the depth of 3–6 m
		Cape Strunjanček, Strunjan	45.537217, 13.601753	22.8.2012	MBP/B. Mavrič	Several invidivudals, within the colonies of Mediterranean stony coral (*Cladocora caespitosa*) from the depth of 3–6 m
Idoteidae	*Stenosoma appendiculatum*	Sample of muddy bottom taken with Van Veen grab at cape Ronek	45.542750, 13.624000	10.6.2019	MBP/B. Mavrič	National monitoring location VT4P12
	Stenosoma lancifer	Sea at Sv. Nikolaj 1	45.574167, 13.740000	10.6.2009	MBP/B. Mavrič	
		Sv. Nikolaj 2	45.574444, 13.737222	10.6.2009	MBP/B. Mavrič	
		Lazaret	45.590833, 13.719444	26.5.2009	MBP/B. Mavrič	
Trichoniscidae	*Trichoniscus provisorius*	Garden in Središče ob Dravi	46.395278, 16.266944	29.9.2019, 29.8.2021	M. Vittori/ M. Vittori	
		Fallen tree in front the Biotechnical Faculty main building, Ljubljana	46.048972, 14.475583	14.6.2023, 2.8.2023	U. Bogataj, K. Kunčič, M. Vittori/ M. Vittori	

There are eight species that were reported in some sources but cannot be considered as part of the Slovenian fauna due to different reasons (Tab. 3). They should be excluded from the list until a documented confirmation of their presence in the country is available.

Table 3. Excluded isopod species and species the presence of which cannot be currently confirmed and are therefore removed from the checklist of Slovenian isopod fauna.
Tabela 3. Izločene vrste enakonožcev in vrste, ki jih trenutno ne moremo potrditi, zato so izvzete iz seznama vrst enakonožcev Slovenije.

Family	Species	Source of record	Explanation
Asellidae	*Proasellus pavani* (Arcangeli, 1942)	PESI 2023	This species is mentioned in the PESI database. However, there are no other records, a primary source, or GBIF data that would support its occurrence in Slovenia.
Armadillidae	*Armadillidium dollfusi* Verhoeff, 1902	Potočnik 1979	According to Schmalfuss (2003), the record of this species from Slovenia might be a misidentification. Its known distribution is in northwest Italy (Schmalfuss 2003). We were able to locate one lot in SMNH that matches one of the published records of *A. dollfusi* in terms of year and locality (»Pred Planinsko jamo 1970«), but the *Armadillidium* specimens in this vial appear identical with *Armadillidium carniolense*. The presence of this species should be confirmed before considering it a part of Slovenian fauna.
	Armadillidium granulatum Brandt, 1833	PESI 2023	Mentioned in the PESI database, but not documented otherwise.
	Armadillidium quinquepustulatum Budde-Lund, 1885	Potočnik 1979	According to Schmalfuss (2003), the record of the species from Slovenia is likely a misidentification. Its known distribution is in southeast France (Schmalfuss 2003). This species was reported from a single locality (Potočnik 1979), but we were not able to find the corresponding material in SMNH at this point. Its presence should be confirmed.
Gnathiidae	*Paragnathia formica* (Hesse, 1864)	Lipej et al. 2013	The collected individuals of this species were in larval stages (pranizae) and their determination uncertain.
Idoteidae	*Stenosoma viridula*	Avčin et al. 1973; Lipej et al. 2013	This species is currently considered a synonym of *Synischia hectica* (Charfi-Cheikhrouha 2000) and is excluded from the list under this name.

Family	Species	Source of record	Explanation
Ligiidae	*Ligia oceanica* (Linnaeus, 1767)	Avčin et al. 1973	This species is found along the coasts of the North Atlantic and the Baltic Sea (Schmalfuss 2003), very far from Slovenia. The source of the record lists this species as being abundant in Strunjan Bay (Avčin et al. 1973), but the species that is indeed abundant is *Ligia italica*. *Ligia oceanica* has never been reported by other researchers in Slovenia, despite extensive work in the area (Potočnik 1984). It is therefore most likely that this report was a misidentification.
Porcellionidae	*Leptotrichus panzerii* (Audouin, 1826)	PESI 2023	Mentioned in the PESI database, but not documented otherwise.
Sphaeromatidae	*Dynamene bidentata* (Adams, 1800)	Sket 2003	The species *D. bidentata*, mentioned by Sket (2003), is not present in the Mediterranean Sea according to Vieira et al. (2016), hence the records should be regarded as *D. bicolor*.
Trichoniscidae	*Hyloniscus mariae* Verhoeff, 1908	PESI 2023	Mentioned in the PESI database, but not documented otherwise.
	Titanethes dahli Verhoeff, 1926	Polak et al. 2012	This species is currently considered as a form of *T. albus* and not a separate species (Karaman & Horvatović 2018).
	Trichoniscus strasseri	Schmalfuss 2003	This species was described from the Croatian island of Cres (Verhoeff 1938; Schmölzer 1965; Karaman 1966) and has not been recorded in Slovenia to our knowledge, nor has its presence in Slovenia been reported in the literature listed for this species in the World Catalogue (Schmalfuss 2003). The listing of Slovenia as its distribution range is likely an error.

Overview of isopod taxa in Slovenian legislation and comments on their validity

There are 72 different isopod taxa included in Slovenian nature protection legislation, although only 41 of the species bear the same name and the same protection status after considering taxonomic changes (Tab. 4).

Four species names have become synonymous with other valid names, where the taxonomic status can simply be transferred to the new name (*Armadillidium albanicum*, *Armadilloniscus litoralis*, *Trichoniscus turgidus*, *Tylos latreillei*; Tab. 4). One species of the genus *Monolistra* is no longer accepted as a species. As a result, its status is transferred to the valid subspecies (Tab. 4).

Table 4. An overview of isopod taxa listed in the Slovenian Red Data List (Ur. l. RS. 2002) and the Decree on Protected Wild Animal Species (Ur. l. RS. 2004). The column RL (Red List) marks the status of the species in the Slovenian Red Data list: E - endangered, V- vulnerable, R - rare, K - data deficient, I – not evaluated. The column Decree marks whether the species is listed in the Appendix 1A (species protected) or 2A (species' habitat protected) in the Decree on Protected Wild Animal Species.

Tabela 4. Pregled taksonov enakonožcev, naštetih v Rdečem seznamu višjih rakov (Ur. l. RS. 2002) in Uredbi o zavarovanih prosto živečih živalskih vrstah (Ur. l. RS. 2004). V stolpcu RL so označeni statusi vrst v Rdečem seznamu: E – ogrožena, V – ranljiva, R – redka, K - premalo znana, I – neopredeljena vrsta. Zadnji stolpec označuje, ali je vrsta našteta v Prilogi 1A (vrste, katerih živali so zavarovane) oz. Prilogi 2A (vrste, katerih habitat je varovan) Uredbe o zavarovanih prosto živečih živalskih vrstah.

Taxon	Valid taxon	Status	RL	Decree
Androniscus dentiger croaticus	Subspecies not valid	not transferred	R	
Androniscus roseus buccarensis	Subspecies not valid	not transferred	K	
Androniscus roseus dolinensis	Subspecies not valid	not transferred	R	
Androniscus roseus hamuligerus	*Androniscus roseus hamuligerus*	valid	R	
Androniscus stygius cavernarum	Subspecies not valid	not transferred	K	
Androniscus stygius dentatus	*Androniscus stygius dentatus*	valid	R	
Androniscus stygius scabridus	*Androniscus stygius scabridus*	valid	R	
Androniscus stygius strasseri	*Androniscus stygius strasseri*	valid	K	
Androniscus stygius stygius	*Androniscus stygius stygius*	valid	R	
Androniscus subterraneus degener	*Androniscus degener*	transferred to species	R	
Androniscus subterraneus nodosus	Subspecies not valid	not transferred	R	
Armadillidium albanicum	*Armadillidium klugii*	synonym; transferred to valid species	R	
Armadillidium carniolense schoebli	*Armadillidium carniolense*	transferred to species	R	
Armadillidium dollfusi	*Armadillidium dollfusi*	valid	K	
Armadillidium opacum	*Armadillidium opacum*	valid	K	
Armadillidium pallasii	*Armadillidium pallasii*	valid	K	
Armadillidium scaberrimum	*Armadillidium scaberrimum*	valid	K	
Armadilloniscus litoralis	*Armadilloniscus ellipticus*	synonym; transferred to valid species	E	
Asellus aquaticus	*Asellus aquaticus*	valid	V	
Asellus aquaticus cavernicolus	*Asellus aquaticus cavernicolus*	valid		2A
Balkanostenasellus skopljensis	*Balkanostenasellus skopljensis*	valid	R	2A
Buddelundiella cataractae	*Buddelundiella cataractae*	valid	R	
Calconiscellus gottscheensis	*Calconiscellus gottscheensis*	valid	K	
Calconiscellus karawankianus	*Calconiscellus karawankianus*	valid	K	
Chaetophiloscia cellaria	*Chaetophiloscia cellaria*	valid	E	
Chaetophiloscia splitensis	*Chaetophiloscia splitensis*	valid	E	
Halophiloscia aristotelis	*Halophiloscia couchii*	synonym; transferred to valid species	E	
Halophiloscia couchii	*Halophiloscia couchii*	valid	E	
Halophiloscia hirsuta	*Halophiloscia hirsuta*	valid	E	
Haplophthalmus abbreviatus	*Haplophthalmus abbreviatus*	valid	K	
Haplophthalmus fiumaranus dolinensis	*Haplophthalmus fiumaranus dolinensis*	valid	R	
Haplophthalmus fiumaranus fiumaranus	*Haplophthalmus fiumaranus fiumaranus*	valid	K	

Taxon	Valid taxon	Status	RL	Decree
Haplophthalmus fiumaranus dolinensis, fiumaranus	*Haplophthalmus fiumaranus*	transferred also to species	R, K	
Haplophthalmus mengii	*Haplophthalmus mengii*	valid	K	
Haplophthalmus rhinoceros	*Haplophthalmus rhinoceros*	valid	R	
Hyloniscus vividus	*Hyloniscus vividus*	valid	K	
Lekanesphaera hookeri	*Lekanesphaera hookeri*	valid	V	2A
Lepidoniscus minutus carniolensis	*Lepidoniscus minutus carniolensis*	valid	R	
Lepidoniscus minutus carniolensis	*Lepidoniscus minutus*	transferred also to species	R	
Lepidoniscus minutus pannonicus	Subspecies not accepted	not transferred	K	
Monolistra bolei	*Monolistra bolei*	valid	R	2A
Monolistra brevispinosa	*Monolistra bolei brevispinosa*	transferred to subspecies	R	2A
Monolistra caeca	*Monolistra caeca*	valid		2A
Monolistra calopyge	*Monolistra calopyge*	valid	R	2A
Monolistra racovitzai	*Monolistra racovitzai*	valid		2A
Monolistra racovitzai conopyge	*Monolistra racovitzai conopyge*	valid	R	
Monolistra schottlaenderi	*Monolistra schottlaenderi*	valid		2A
Monolistra spinosa	*Monolistra spinosa*	valid		2A
Monolistra spinosissima	*Monolistra spinosissima*	valid	R	2A
Monolistra velkovrhi	*Monolistra velkovrhi*	valid	V	2A
Moserius percoi	*Moserius percoi*	valid	R	
Oroniscus calcivagus	*Oroniscus calcivagus*	valid	R	
Philoscia affinis	*Philoscia affinis*	valid	K	
Porcellio dilatatus	*Porcellio dilatatus*	valid	K	
Porcellio marginalis	*Porcellio marginalis*	valid	R	
Porcellium conspersum	*Porcellium conspersum*	valid	R	
Proasellus parvulus	*Proasellus parvulus*	valid	R	
Proasellus pavani orientalis	*Proasellus orientalis*	transferred to species	R	
Proasellus slavus histriae	*Proasellus slavus histriae*	valid	R	
Proasellus slavus variabilis	nomen nudum	not transferred	K	
Proasellus slovenicus	*Proasellus slovenicus*	valid	R	
Protracheoniscus hermagorensis	*Protracheoniscus hermagorensis*	valid	K	
Sphaeromides virei	*Sphaeromides virei*	valid		2A
Sphaeromides virei virei	*Sphaeromides virei virei*	transferred to species	R	
Trachelipus arcuatus	*Trachelipus arcuatus*	valid	K	
Trachelipus nodulosus	*Trachelipus nodulosus*	valid	K	
Trachelipus pseudoratzeburgi apenninorum	Subspecies not accepted	not transferred	K	
Trachelipus razzautii	*Trachelipus razzautii*	valid	K	
Trichoniscus carniolicus	*Trichoniscus carniolicus*	valid	R	
Trichoniscus stammeri	*Trichoniscus stammeri*	valid	R	
Trichoniscus turgidus	*Trichoniscus matulici*	synonym; transferred to new species	I	
Tylos latreillei	*Tylos europaeus*	synonym; transferred to new species	E	

For three subspecies that are no longer considered valid, the protection status can be transferred to the species level (Tab. 4). This does not apply for seven other invalid subspecies where the species had more subspecies without protection statuses present in the country. The species therefore cannot assume the status determined for a single (invalid) subspecies without a re-evaluation of the whole species status. Interestingly, the national Red List also mentions a subspecies that is a *nomen nudum*. The subspecies was listed, with an explanation that it had not yet been described, in the publication that proposed Red List statuses for freshwater Malacostraca (Sket 1992). However, it was never formally described.

The new status of the currently valid species *Haplophthalmus fiumaranus* could be taken from both subspecies that had protection statuses determined, i.e. *H. f. dolinensis* and *H. f. fiumaranus*. In such cases, both statuses are being transferred. According to the Red List (Ur. l. RS 2002), the highest protection status would be favoured, in this case rare instead of data deficient species. But as a status re-evaluation for the new taxon could reveal that a more suitable status would be »vulnerable«, we consider it safer to suggest both statuses, while ultimately a re-evaluation can determine the most suitable status.

Discussion

The present work provides the first complete checklist of all isopods from different habitats in Slovenia, and a list of species that cannot be considered as part of Slovenian fauna even though listed in some literature sources. The number of terrestrial species has remained roughly the same as in the most recent checklist (Potočnik 1992), but some species have been removed (mostly synonyms) and others added: one that we report in this work and five reported in recent publications (Vilisics & Lapanje 2005; Polak et al. 2012; Vittori 2022). In freshwater, there is a greater increase in the number of species as compared to Sket (1967), as new species have been described and certain subspecies elevated to species status. The list for marine isopods is the first comprehensive overview of the group for the country.

The species richness of terrestrial isopods is greatest in the Mediterranean region of Europe and decreases northward (Hornung 2011). The richness of terrestrial isopods in Slovenia is high for its size, as it is comparable to larger countries in the Balkans (Sfenthourakis & Hornung 2018). This is very likely related to the geographic diversity within the country, which includes the coast with suitable habitats for littoral species, numerous caves with troglobionts, as well as diverse surface habitats for widespread species of the Balkans and Central Europe. We should also consider that the terrestrial isopod fauna in Slovenia has been well studied in the past (Karaman 1966; Potočnik 1989) which, however, does not apply for all countries in Southeast Europe.

Although terrestrial isopods generally have limited dispersal abilities (Hornung 2011), there is only one terrestrial species endemic to Slovenia (*T. stammeri*). A species until recently considered endemic for Slovenia is *Calconiscellus gottscheensis*. However, this species has also been found in caves in nearby regions of Croatia (Jana Bedek, personal communication). *Trichoniscus carniolicus*, another species that used to be considered endemic (Potočnik 1992), has also been reported in Austria (Strouhal 1968), while *Oroniscus calcivagus* has been recorded

in Italy according to GBIF data supported by a deposited museum specimen (GBIF 2023). *Moserius percoi* was first described from a single female collected in 1885 (Strouhal 1940) from a cave near the border between Slovenia and Italy. The species was later discovered also in Tuscany in Italy (Taiti & Ferrara 1995), at a large geographical distance from its type locality. An examination of further specimens, especially males, from Slovenia would be welcome, as it could offer additional confirmation that both known populations of *M. percoi* belong to the same species.

There are some terrestrial isopod species that are expanding their ranges in Europe, particularly in synanthropic environments. These are predominantly Mediterranean species that have become cosmopolitans due to human introduction (Szlavecz et al. 2018). The ten most common woodlice in urban environments (Szlavecz et al. 2018) have already been recorded in synanthropic habitats in Slovenia, although some of these species have only been reported on single occasions (*Porcellio dilatatus*, *Porcellio laevis*), which makes it difficult to assess how common and widespread they are and whether or not they are permanently present. None of these species can be considered introduced.

A note must be made regarding the records of *Trachelipus illyricus*. Although the World catalogue of terrestrial isopods (Schmalfuss 2003) considers *T. illyricus* a synonym of *Trachelipus camerani* and one of its subspecies, *T. illyricus lasiorum*, a synonym of *Trachelipus ratzeburgii*, Schmidt (1997) synonymised *T. illyricus* exclusively with *T. ratzeburgii* and not *T. camerani* in his revision of the genus. While this synonymization was based only on the examination of male pereopod 7 and pleopod 1, these characters should be sufficient to distinguish *T. ratzeburgii* from *T. camerani*. Based on these considerations, it is best to regard past records of *T. illyricus* as *T. ratzeburgii*.

The richness of freshwater species is remarkable considering the size of Slovenia. Most of this richness is found in subterranean waters, which are also home to the greatest number of Slovenian endemic isopods. Parallels with this can be found in the freshwater fauna of amphipods in Slovenia, the great majority of which inhabit groundwater (Fišer et al. 2021). However, even groundwater species with distributions reaching into neighbouring countries have small distribution ranges (Stoch 1989; Prevorčnik et al. 2010; Konec et al. 2016).

The recorded isopod richness in the Slovenian Sea is relatively high compared to regions of similar size elsewhere in the Adriatic (Zavodnik & Kovačić 2000; Zavodnik et al. 2006). Thirty recorded species in the Slovenian Sea represent almost 40% of all species listed for the Adriatic Sea (Castelló et al. 2020). Among new species for the country, the records of *Campecopea hirsuta* in samples from hard bottom upper mediolittoral taken at different locations along the Slovenian coast and identified on the basis of well-defined characters (Bruce & Holdich 2002) are, to our knowledge, the first records of this species for the Adriatic Sea.

Slovenian coastal waters are continuously monitored by the Marine Biology Station of the National Institute of Biology, generally providing good insight into the benthic fauna. Nevertheless, dedicated publications dealing with isopods are scarce. Several specimens await determination to species level, such as those from the genus *Eurydice* (Pitacco et al. 2013) and *Arcturus* (Vrišer 2003). An additional problem with marine isopod taxonomy is that species descriptions, especially those from the late 19th and early 20th centuries, are vague and incomplete, calling for species redescriptions (Rincón et al. 2018). More systematic studies of

marine species are needed to improve our knowledge of the richness and the distribution of native isopods and to detect potential invasive species. The latter is important as numerous marine isopods can have considerable economic impact. Wood boring isopods, such as *Limnoria tripunctata*, can damage infrastructure (Borges et al. 2014), whereas parasitic taxa, such as representatives of Gnathiidae and Cymothoidae, can affect fisheries.

Even though research in some isopods, for example those in terrestrial habitats, has a long history in Slovenia, very little information is available on their distribution patterns. In the future, systematic distribution studies of the isopod fauna can fill this gap, resulting in distribution maps as prepared for ants in the territory of Slovenia by Bračko (2023), or for the terrestrial isopod fauna of Belgium, a country of similar size (Boeraeve et al. 2022). In addition, we can expect the detection of further terrestrial isopod species. Some species have likely been missed either by chance due to limited sampling or due to species not yet described at the time of collection. There is considerable likelihood that further species remain to be discovered in subterranean habitats. The use of molecular methods will further help identify species, as large genetic diversity has been confirmed within freshwater isopods and new species descriptions may follow. In the Slovenian Sea, the marine isopod fauna is also likely richer than is currently known and more studies are needed.

Further studies in different habitats are important also to detect introductions of alien species. Changes in land use and climate as well as transport of alien species due to increased traffic of goods provides opportunities for the introduction or natural expansion of species currently not found in Slovenia. In this way, several terrestrial isopod species have been spreading across Europe in recent years, such as *Armadillidium arcangelii* (Noél et al. 2022), *A. nasatum* and *Agabiformius lentus* (Cochard et al. 2010). In the Slovenian Sea, several introduced species have been identified, and emphasis should be put on detecting new ones, as they can have ecological and economic consequences.

If we compare the Decree on Protected Wild Animal Species (Ur. l. RS. 2004), listing twelve species and one subspecies as protected, and the national Red List with 45 species and 9 subspecies with determined statuses (Ur. l. RS. 2002), there are some inconsistencies between the two documents. According to the Decree, all taxa with protection statuses should be listed in the Red List, but this is not always the case, as the Red List has not been updated since its publication in 2002. For example, there is only one subspecies of *Monolistra*, *M. racovitzai conopyge*, included in the Red List, but *M. racovitzai* is protected according to the Decree. In another case, it is vice versa. The subspecies *Asellus aquaticus cavernicolus* is listed in the Decree, while the species *A. aquaticus* has vulnerable status in the Red List. In such cases, the status is valid also for the subspecies. These examples point out the need for a review of the current national Red List of endangered species, as taxonomy and knowledge of the distribution of species have changed. Importantly, more data on species distribution, habitat requirements and temporal changes in distribution would help improve the assignment of conservation statuses. The acquisition of such data has been performed on a scale comparable to the size of Slovenia in Flanders (De Smedt et al. 2022). The lack of data was also pointed out as an important issue by researchers who prepared the initial publications proposing Red List statuses for isopod taxa in Slovenia (Potočnik 1992; Sket 1992). In these publications, endemism, small documented distribution ranges, threats to habitats and type localities in Slovenia were major criteria for the proposal of Red List statuses and protective measures. Even though we provide comments on the potential transfer of statuses in the current situation, this should not be treated

as a suggestion on species/subspecies statuses in the reviewed Red List. The latter should be made by expert work considering all relevant taxonomic and distributional data on each taxon and an evaluation of its conservation status in the country.

Povzetek

Enakonožci so skupina višjih rakov z več kot 10.000 vrstami, od katerih nekatere živijo v morju, druge v sladkih vodah, številne pa so kopenske (Boyko et al. 2008). So pomembni razkrojevalci tako v vodnih kot kopenskih okoljih. Med vodnimi predstavniki je precej parazitov, najpogosteje na ribah, in ti so lahko ekonomsko pomembni (Čolak et al. 2018). Številni so pomembni razkrojevalci v vodnih in kopenskih okoljih (Wilson 2008; David 1012). Enakonožci so uspešna skupina tudi v podzemlju (Coineau & Boutin 2004; Sfenthourakis & Hornung 2018). Zaradi njihove ekološke pestrosti so pregledi njihovega vrstnega bogastva razdrobljeni in običajno ločeni po habitatih. Za ozemlje Slovenije obstajajo starejši seznami vrst, ki obravnavajo bodisi vrste celinskih vod (Sket 1967) bodisi kopenske vrste (Potočnik 1989), za morske pa takšnega seznama še ni bilo. V tem prispevku smo pripravili prvi skupni pregled vrst enakonožcev v Sloveniji. Pregled upošteva spremembe taksonomije ter vrste, zaznane v zadnjih treh desetletjih. Podatke o pojavljanju vrst smo zbrali iz objavljene literature ter podatkovnih baz Nacionalnega inštituta za biologijo, Oddelka za biologijo Biotehniške fakultete Univerze v Ljubljani ter Centra za kartografijo favne in flore. Skupno smo v Sloveniji zaznali 125 vrst enakonožcev, od tega 30 morskih vrst, 21 vrst v celinskih vodah in 74 kopenskih vrst. Med morskimi po pestrosti prevladuje družina Sphaeromatidae, ki je na račun rodu *Monolistra* močno zastopana tudi v podzemeljskih celinskih vodah. V slednjih je najpestrejša družina Asellidae, na kopnem pa prednjači družina Trichoniscidae. V tem prispevku prvič poročamo o pojavljanju sedmih morskih in ene kopenske vrste. Velik delež vrstnega bogastva enakonožcev celinskih vod in na kopnem sestavljajo vrste, živeče v podzemlju, med katerimi je tudi večina (10) slovenskih endemitov. V površinskih celinskih vodah ter na kopnem najdemo zgolj po eno endemično vrsto. Med morskimi vrstami je šest parazitov ter dve tujerodni vrsti, medtem ko tujerodnih vrst v ostalih dveh kategorijah nismo zasledili. Zgolj 41 vrst, navedenih v Pravilniku o uvrstitvi ogroženih rastlinskih in živalskih vrst v rdeči seznam (Ur. l. RS 2002) ter v Uredbi o zavarovanih prosto živečih živalskih vrstah (Ur. l. RS 2004), je v trenutni taksonomiji ohranilo svoje taksonomske statuse, medtem ko so številne v zakonodaji navedene vrste in podvrste bodisi neveljavni taksoni bodisi sinonimi drugih vrst enakonožcev. To kaže na potrebo po reviziji varstvenih aktov. Za vzpostavitev ustreznega varstva enakonožcev bi bilo nujno pridobivanje podatkov o njihovi razširjenosti in njenem spreminjanju, ki trenutno manjkajo.

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Observation of heterospecific mating attempt by blue chaser *Libellula fulva* Müller, 1764 and broad-bodied chaser *L. depressa* Linnaeus, 1758 (Odonata: Libellulidae)

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Abstract. A successful copula formation between a *Libellula fulva* male and a *L. depressa* female was documented photographically on 23. 6. 2022 along a small stream at the Natura 2000 site Ličenca pri Poljčanah in NE Slovenia. This represents the first record of an anomalous mating attempt with copula formation between the species involved. Their distribution in Slovenia as well as syntopic and syntemporal observations in the country are presented and briefly discussed, as are the site-specific factors and aged female colouration that may have contributed to the described rare attempt of heterospecific mating.

Key words: Odonata, dragonflies, mating, copulation, wheel position, syntopic occurrence

Izvleček. Opazovanje poskusa heterospecifičnega parjenja črnega ploščca *Libellula fulva* Müller, 1764 in modrega ploščca *L. depressa* Linnaeus, 1758 (Odonata: Libellulidae) – Dne 23. 6. 2022 je bila ob manjšem potočku v območju Natura 2000 Ličenca pri Poljčanah v SV Sloveniji foto dokumentirana uspešna formacija paritvenega koleslja med samcem črnega ploščca *Libellula fulva* in samico modrega ploščca *L. depressa*. To je prvi zapis o poskusu parjenja s formacijo paritvenega koleslja med vpletenima vrstama. Na kratko so predstavljena in obravnavana njuna razširjenost v Sloveniji ter prostorsko in časovno prekrivajoča se opazovanja v državi, prav tako pa so obravnavani specifični dejavniki na mestu opazovanja in obarvanost postarane samice, ki bi lahko prispevali k opisanemu redkemu poskusu heterospecifičnega parjenja.

Ključne besede: Odonata, kačji pastirji, parjenje, kopulacija, paritveni koleselj, sintopično pojavljanje

Introduction

Dragonflies (Insecta: Odonata) have a unique mode of reproduction among insects with indirect insemination and delayed fertilization. In order to reproduce, sexually mature dragonflies must encounter a conspecific of the opposite sex, recognize it and mate with it. Prior to copulation, sperm is transferred from the male's primary genitalia at the tip of the abdomen to his secondary genitalia at the base of the abdomen, and during the formation of the heart-shaped copula or mating wheel, it is transferred to female's genitalia. The eggs are not fertilized until they are laid. Recognition of sex and species in most odonates is primarily based on visual

characteristics such as size, body shape, flight style, colour and colour pattern (Corbet 1999; Wildermuth & Martens 2019).

Reports of anomalous mating attempts between different dragonfly species are not extremely rare, and comprehensive reviews on this topic have been presented by e.g. Bick & Bick (1981), Utzeri & Belfiore (1990), and Corbet (1999). They include both observations of homosexual heterospecific male tandems, as well as heterosexual heterospecific pairing attempts. The latter usually include observations of interspecific tandems within the same genus (e.g. Heidemann 1982; Miller & Fincke 2004; Chovanec 2022), less frequently combinations between representatives of different genera (e.g. Bedjanič 2006; Wildermuth 2015), or even between different families within the same suborder (e.g. Corbet 1999; Kosterin et al. 2001; Tamm et al. 2015). In most instances, the anomalous mating attempt ends in the tandem stage, before the contact of male's secondary copulation organ and female's genitalia and thus prior to actual sperm transfer. Less commonly, the heterospecific mating wheel is formed, which is an obligatory stage in the functional framework for potential insemination and subsequent fertilization. The reports of subsequent oviposition after heterospecific copulation are much rarer (e.g. Kunz 2010), while reports on confirmed interspecific hybrids in dragonflies are only occasional (Corbet 1999; Futahashi & Hayashi 2004, Okude & Futahashi 2022; Solano et al. 2018).

Within the family Libellulidae, heterospecific mating errors were most frequently reported in *Sympetrum* species, either as intrageneric pairs (e.g. Bick & Bick 1981; Rehfeldt 1993; Kornová et al. 2022) or more rarely heterogeneric pairs (e.g. Rehfeldt 1993; Richardson & Smith 2012; Wildermuth 2015). In other libellulid genera, such as *Leucorrhinia* (e.g. Utzeri & Belfiore 1990) and *Orthetrum* (e.g. Khelifa 2013; Chovanec 2022; Thio & Ngiam 2023), reports are sparser. Nevertheless, with rare exceptions (e.g. Kunz 2010), the great majority of reports only documents tandem formation, without actual copulation, i.e. without the formation of a mating wheel. In the genus *Libellula*, individual cases of heterospecific copulation have been reported in the Nearctic (Bick & Bick 1981) and Oriental species (Utzeri & Belfiore 1990), while only a few scattered reports are known for European representatives of the genus – e.g. Seggewiße (2008) documented an apparently unsuccessful attempt of copula formation between a *L. fulva* male and a *L. quadrimaculata* female, while Wildermuth & Martens (2019) briefly mention exceptional cases of anomalous mating attempts between *L. depressa* and *L. quadrimaculata*. A further observation of heterospecific copulation between a *L. fulva* male and a *L. depressa* female, not previously reported in the literature, is added in this article.

Materials and methods

The observations described in the sequel were made on 23. 6. 2022 at the Natura 2000 site Ličenca pri Poljčanah in NE Slovenia. The locality is a small right tributary of the Ličenca stream at the bridge of the Ponevnik–Zgornje Laže side road, 200 meters N of the settlement of Zgornje Laže (WGS 84 Lat./Long.: 46.3223 °N, 15.5396 °E). The aforementioned small tributary of the Ličenca stream is less than 1 meter wide, the water current is slow and the richly overgrown riparian vegetation almost completely covers the water surface. On the upstream side of the

bridge, a small widening is present, forming a shallow 1.5 × 0.5 m wide pool, overgrown with *Sparganium* sp. and some clumps of *Carex* sp. and *Iris pseudacorus*, but still with some open water surface. The surrounding landscape is an open mosaic agricultural land, upstream of the bridge on one side there is a regularly mown semi-intensive meadow, while the other side is bordered by a field. Along the stream there is a narrow, unmown belt of vegetation with a few small *Salix* shrubs.

The observations on site were made from the road bridge. In the afternoon, between 15:15 and 15:25 p.m. (Central European Summer Time), the weather was predominantly sunny with 25°C, very light cloud cover and no wind. Photographs were taken with the Sony Cyber-Shot RX10 IV digital camera. The precise time of each individual photograph was subsequently determined at home using the automatically saved image properties.

Results and discussion

On arrival at the site, already known from previous visits, regular rapid dragonfly inventory was carried out from the road bridge. Soon, a somewhat strange, restlessly flying tandem was spotted, and only seconds later I realized that it consisted of a *L. fulva* male and a *L. depressa* female. Apparently, the female was trying to free herself from the grasp of male's appendages, but was unsuccessful. The pair in tandem was restless, the potential mates repeatedly settled down for a few seconds and then flew off again and changed position. After observing this behaviour for about a minute and being unable to take a photo, the first observed copula was formed at around 15:19:40 (Fig. 1a) and lasted less than 15 seconds. Then the copula disbanded and the pair still remained in tandem at the same location. From above, at a distance of a few centimetres and without any contact, it was harassed for a few seconds by a flying *L. depressa* male (Fig. 1b). After changing position and flying around at short intervals, the pair successfully formed the second copula at around 15:20:25, whereupon several successful photos were taken (Fig. 1c, d). The pair in the copula changed position on *Sparganium* leaves once or twice, but remained in the copula at least until 15:22:12, when the last photo was taken. After that, visual contact with the pair was lost, and they did not return to the same location for the next two or three minutes before I left. Other dragonfly specimens observed during my brief visit to this locality were: *Calopteryx splendens* 2♂, 1♀, *Coenagrion ornatum* 2♂, 1♀, *C. puella* 1♂, *Platycnemis pennipes* 3♂, 1♀, *Orthetrum brunneum* 3♂, *O. coerulescens* 4♂, 1 copula and *Libellula depressa* 2♂.

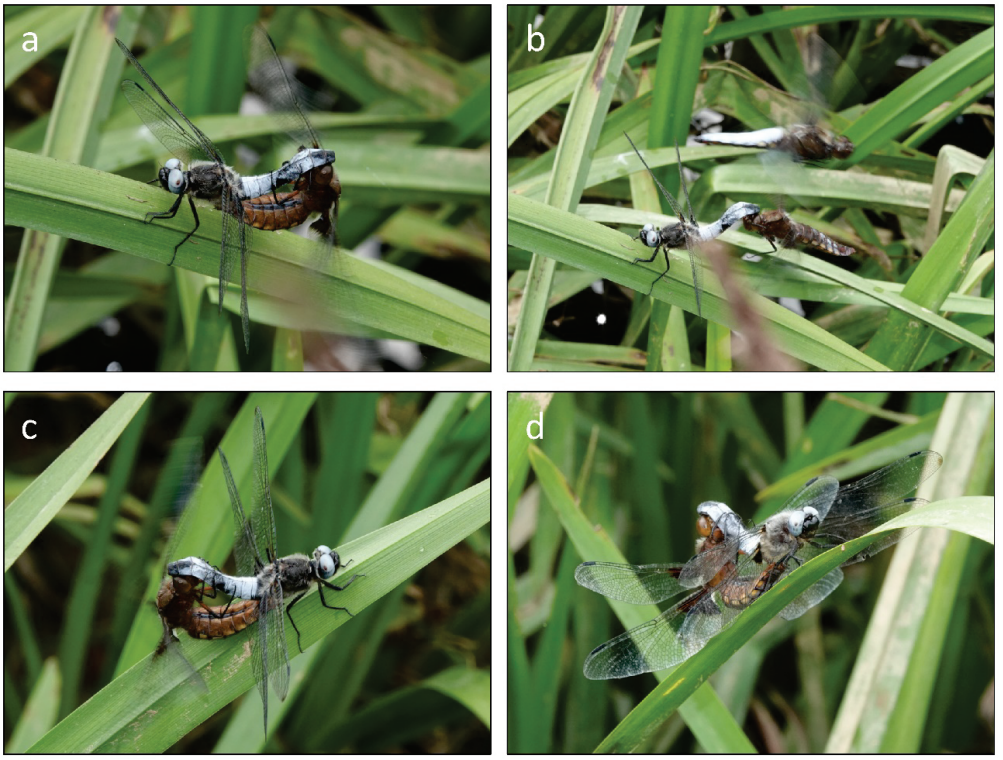

Figure 1. Temporal sequence of successful copula formation between a Blue Chaser *Libellula fulva* male and a Broad-bodied Chaser *L. depressa* female: (a) first successful copula formation (15:19:52 p.m.), (b) copula breaking up, pair remains in tandem, harassed by a Blue Chaser *L. depressa* male from above (15:20:00 p.m.), (c) second successful copula formation (15:21:00 p.m.), (d) after changing the resting place the pair still remains in second successful copula formation (15:21:34 p.m.) (photo: M. Bedjanič, Ličenca pri Poljčanah, 23. 6. 2022).

Slika 1. Časovno zaporedje uspešne formacije paritvenega koleslja med samcem črnega ploščca *Libellula fulva* in samico modrega ploščca *L. depressa*: (a) prva uspešna formacija paritvenega koleslja (15:19:52), (b) razpad paritvenega koleslja, par ostane v tandemu, ki ga od zgoraj nadleguje samec modrega ploščca *L. depressa* (15:20:00), (c) druga uspešna formacija paritvenega koleslja (15:21:00), (d) po spremembi počivališča par še vedno vztraja v drugi uspešni formaciji paritvenega koleslja (15:21:34) (foto: M. Bedjanič, Ličenca pri Poljčanah, 23. 6. 2022).

The basic prerequisite for potential heterospecific sexual interaction is clearly the simultaneous occurrence of adult dragonflies in space and time. Regarding the known occurrence of both species in Slovenia, the database of the Slovene Dragonfly Society and the Centre for Cartography of Fauna and Flora (as of October 2023) contains 571 localities with 937 faunistic data for *L. fulva*, while *L. depressa* is much more common with 2,200 known localities and 3,768 faunistic data (Fig. 2). More importantly, both species were recorded at the same locality in 337 cases with 814 faunistic data. Their co-occurrence on the same date was recorded at 279 localities for which 375 such faunistic data are available, the latter meaning the simultaneous observation of both species at the same location and on the same date.

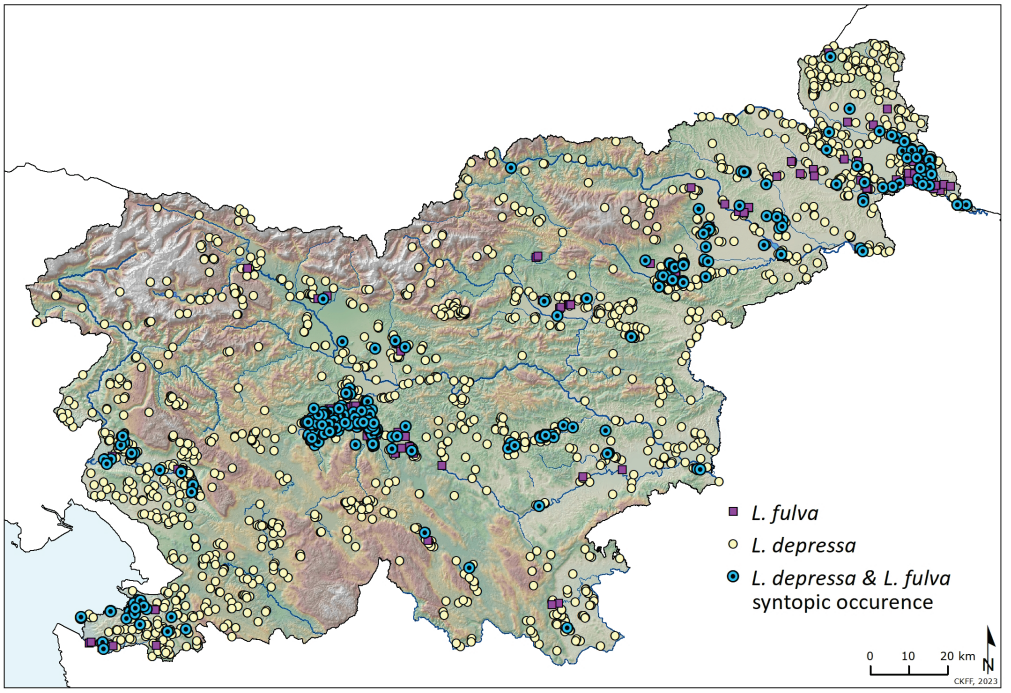

Figure 2. Distribution of broad-bodied chaser *Libellula depressa* and blue chaser *L. fulva* in Slovenia, with indicated localities of syntopic occurrences of both species (source: database of the Slovene Dragonfly Society and the Centre for Cartography of Fauna and Flora, October 2023)

Slika 2. Razširjenost modrega ploščca *Libellula depressa* in črnega ploščca *L. fulva* v Sloveniji, z označenimi lokalitetami sintopičnega pojavljanja obeh vrst (vir: podatkovna zbirka Slovenskega odonatološkega društva in Centra za kartografijo favne in flore, oktober 2023)

As for the observations of mating activity of both species, considering conspecific pairs with copula or tandem formation, the above-mentioned database contains 164 data for *L. depressa* and 147 for *L. fulva*, but with an inverse ratio of only 220 individual conspecific pairs observed in the former and 471 pairs observed in the latter. Regardless of the commonness of *L. depressa*, the above numbers are not surprising due to the different mating behaviour. In *L. fulva*, copulation usually lasts between 10–15 minutes, with the pair usually settling in a sunny place after a short zigzag flight, while in *L. depressa*, copula formation is very short and copulation completed in flight usually lasts only 4–30 seconds (Sternberg 2000; Sternberg et al. 2000; Wildermuth & Martens 2019). However, the presented data from Slovenia show that the observations of conspecific mating attempts extracted from all faunistic data of the species are not rare, but nevertheless much more frequent in *L. fulva* (15.7 %) than in *L. depressa* (4.4 %).

Other factors that may have contributed to the rare anomalous mating attempt are the specifics of the microlocality, where the road bridge and overgrown upstream section direct the adult dragonflies to concentrate around a small shallow pool and stream section with some open water surface only a few square meters in size. In such small-size environment, conspecific and heterospecific interactions are more likely to occur. It should also be noted that the end of June falls towards the end of flight period for both species, which means that the individuals are

already old, and have much less vivid colour patterns, as evident from the dull brownish coloration of the *L. depressa* female, which has also developed a slight light blue pruinescence on the dorsum of the middle abdominal segments (Fig. 1b). Neglecting considerably broader abdomen and the larger dark basal spots on the fore and hind wings, this colouration somewhat resembles the colouration of old *L. fulva* females and may have contributed to the observed mating confusion.

As the Slovenian odonatological records clearly show, it is obvious that *L. fulva* and *L. depressa* occur together spatially and temporally and that they often share the same habitats at the same time. The situation is probably similar in many other parts of their range in Central Europe at least. It is therefore surprising that the present observation is only the first evidence of an anomalous mating attempt with copula formation between the species involved. In the present case, the locality specifics and the older age colouration of the involved *L. depressa* female could have been the decisive factors. In any case, the complete lack of similar reports from elsewhere suggests that the mate recognition and other mechanisms that prevent heterospecific mating attempts between the two species are apparently very effective.

Povzetek

Poročila o heterospecifičnih poskusih parjenja pri kačjih pastirjih niso skrajno redka (Bick & Bick 1981; Utzeri & Belfiore 1990; Corbet 1999). Tudi znotraj družine ploščcev (Libellulidae) so bili poskusi heterospecifičnega parjenja, ki so posledica napačne prepoznave samice s strani samca, opazovani že velikokrat (npr. Bick & Bick 1981; Rehfeldt 1993; Wildermuth 2015; Kornová et al. 2022; Chovanec 2022). Velika večina poročil pa temelji le na opazovanjih tandemov samca in samice, brez dejanske kopulacije. Opazovanja heterospecifičnih paritvenih kolesljev so mnogo redkejša (npr. Kunz 2010). Za vrste ploščcev (*Libellula* spp.), ki se pojavljajo v Evropi, je znanih le nekaj primerov heterospecifične kopulacije (npr. Seggewiße 2008; Wildermuth & Martens 2019). V pričujočem članku je predstavljeno opazovanje heterospecifične kopulacije med samcem črnega ploščca *L. fulva* in samico modrega ploščca *L. depressa*, o čemer v literaturi še ni bilo poročil.

Konec junija 2022 je bila ob manjšem potočku v območju Natura 2000 Ličenca pri Poljčanah v severovzhodni Sloveniji prvič fotografirana uspešna formacija paritvenega koleslja omenjenih vrst (Sl. 1a–d). Samec črnega ploščca in samica modrega ploščca sta po nemirnem spreletavanju v tandemu prvič oblikovala paritveni koleselj le za nekaj sekund (Sl. 1a), po razpadu katerega sta ostala v tandemu (Sl. 1b) in vnovič tvorila paritveni koleselj za poldrugo minuto (Sl. 1c, d), potem pa odletela in ju ni bilo več na spregled.

Sočasno pojavljanje odraslih kačjih pastirjev v prostoru in času je predpogoj za morebitno heterospecifično spolno interakcijo. Predstavljena razširjenost črnega in modrega ploščca v Sloveniji (Sl. 2) kaže na številna prostorsko prekrivajoča se opazovanja. Podobno velja tudi za časovni vidik – obe vrsti sta bili zabeleženi hkrati na isti datum na 279 lokalitetah, za katere je znanih 375 favnističnih podatkov. K opisanemu redkemu poskusu heterospecifičnega parjenja so morda prispevali tudi specifični dejavniki na majhnem zaraščenem odseku potočka z le nekaj odprte vodne površine. Podobno velja za obarvanost postarane samice modrega ploščca (Sl. 1b), ki je kljub znatno širšemu zadku in večjim temnim lisam na bazi sprednjih in zadnjih kril, s prevladujočo rjavkasto obarvanostjo in rahlim sivkastim voskastim poprhom na zadku, nekoliko spominjala na obarvanost starih samic črnega ploščca.

Glede na pogostost črnega in modrega ploščca v Sloveniji in Evropi preseneča, da poskusi heterospecifičnega parjenja med njima doslej še niso bili zabeleženi. Ustrezno prepoznavanje potencialnih paritvenih partnerjev in drugi mehanizmi, ki preprečujejo heterospecifične poskuse parjenja, so pri obeh vpletenih vrstah očitno zelo učinkoviti.

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Overview of the pond slider *Trachemys scripta* (Thunberg in Schoepff, 1792) (Testudines: Emydidae) records in Montenegro

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Abstract. The Pond Slider is one of the 100 world's most invasive alien species, widely introduced to Europe and all over the world. The number of specimens recorded in nature is increasing in the Balkans, including Montenegro. In this paper, we present literature and new findings of pond sliders in this country. So far, 10 known localities have been identified, most of them in the Mediterranean biogeographical region. Records are from different aquatic ecosystems, including lakes, ponds, rivers and streams. Locality Mrke-Blizna is identified as a potential breeding site, as numerous specimens are present here including hatchlings.

Key words: invasive species, distribution, pond slider, Montenegro

Izvleček. Pregled najdb okrasne gizdavke *Trachemys scripta* (Thunberg in Schoepff, 1792) (Testudines: Emydidae) v Črni gori – Okrasna gizdavka je ena od 100 najbolj invazivnih tujerodnih vrst na svetu, ki je bila vnesena v Evropo in po vsem svetu. Na Balkanu, vključno s Črno goro, se število osebkov, zabeleženih v naravi, povečuje. V tem prispevku predstavljamo literaturne in nove najdbe okrasnih gizdavk v Črni gori. Do zdaj je bilo v državi zabeleženih 10 nahajališč, večinoma v mediteranski biogeografski regiji. Podatki so iz različnih vodnih ekosistemov, tako jezer, ribnikov, rek kot potokov. Nahajališče Mrke-Blizna je potencialno mesto razmnoževanja, saj je bilo tu najdenih veliko osebkov, vključno z mladiči.

Ključne besede: invazivne vrste, razširjenost, okrasna gizdavka, Črna gora

Introduction

The pond slider *Trachemys scripta* (Thunberg in Schoepff, 1792) is among 100 of the World's worst invasive alien species (Lowe et al. 2000). It originated from SW USA, and has been and still is introduced worldwide as a pet (Speybroeck et al. 2016). Although three subspecies are recognized, i.e. the yellow-bellied slider *T. s. scripta* (Thunberg in Schoepff, 1792), the red-eared slider *T. s. elegans* (Wied-Neuwied, 1839) and the cumberland slider *T. s. troostii* (Holbrook, 1836), new molecular findings by Vamberger et al. (2020) challenge the current intraspecific systematics of *T. scripta* and suggest that the conspicuous differences in colouration and pattern reflect population-specific, rather than taxonomic, differentiation.

The pond slider specimens are released in nature by irresponsible owners and up until now the species has become distributed in the wild in almost all European countries, where they also breed successfully (e.g. Vamberger et al. 2012; Standfuss et al. 2015; Speybroeck et al. 2016; Stănescu et al. 2017; Koren et al. 2018; Urošević et al. 2019; Kornilev et al. 2020). As the European Union banned import and trade of *T. s. elegans* in 1997, other two subspecies have become substitute species in the pet markets (Urošević et al. 2019). Since 2014, all three subspecies have been listed under Regulation (EU) on the prevention and management of the introduction and spread of invasive alien species (EU 2014).

In this paper, we present all available literature and unpublished data on the current range of *T. scripta* ssp. in Montenegro.

Material and methods

Data for this study are compiled from published literature, websites, and unpublished records collected during different field surveys in the last eight years. Unpublished records also include data donated by other colleagues and local people (see Acknowledgments). The authors' unpublished records were made during their field surveys for the native freshwater turtles *Emys orbicularis* (Linnaeus, 1758) and *Mauremys rivulata* (Valenciennes, 1833) using traps – *hoop-nets* (Mali et al. 2014) in the coastal area of the country in the territory of Municipalities Herceg Novi, Tivat, Kotor, Budva, Bar and Ulcinj. Species identification is done according to Bringsøe (2006).

Results and discussion

Two subspecies are present in Montenegro, *T. s. elegans* and *T. s. scripta* (Tab. 1). All known findings of *T. scripta* ssp. are shown on the map (Fig. 1). There are a total of 10 localities where *T. scripta* ssp. were identified. Two recorded localities are from literature, seven localities are new, and at one locality the species is reconfirmed (Fig 1.).

Most findings have been recorded in the Mediterranean biogeographical region (< 30 m a.s.l.) and one finding in the Alpine biogeographical region (about 650 m a.s.l). This is related to the fact that more systematic surveys have been done in the coastal area, which was not the case as far as other parts of the country are concerned. The records made in Croatia by Koren et al. (2018) were almost equal in the Mediterranean and Continental regions, without any findings in the Alpine region, while Urošević et al. (2019) reported that most pond slider findings in Serbia were in habitats below 100 m a.s.l. In Bulgaria, the pond slider's vertical distribution ranged from sea level up to 956 m, with most findings below 250 m a.s.l., and just three findings above 600 m a.s.l. (Kornilev et al. 2020). Contrary to our results, the above mentioned field survey data include both, random findings and targeted surveys for the pond slider.

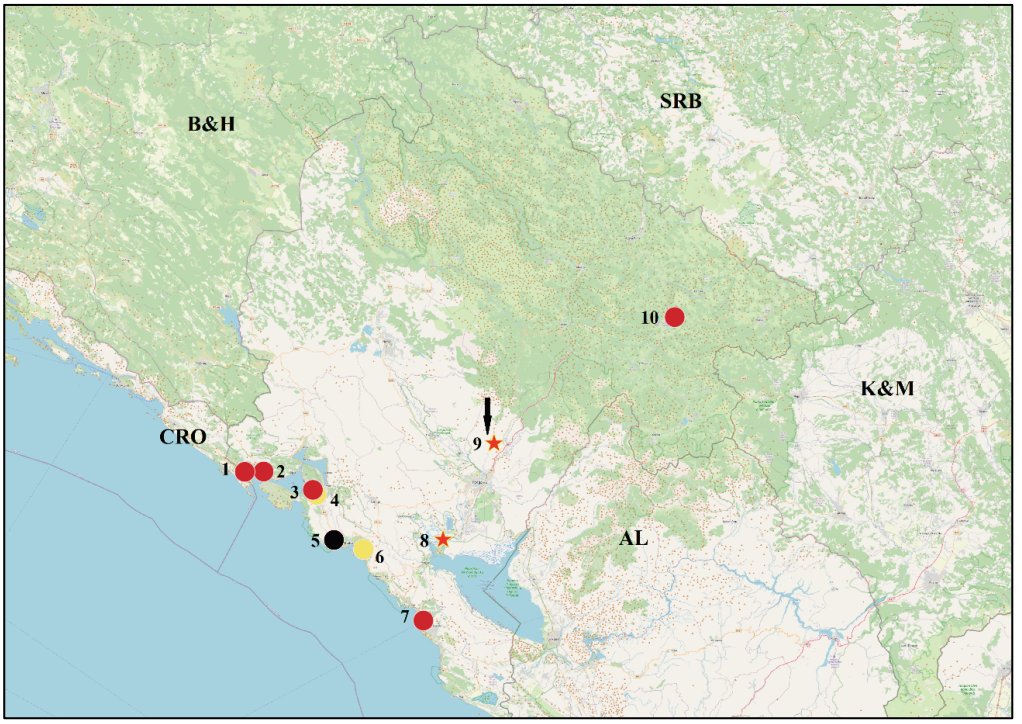

Figure 1. Map showing the findings of *Trachemys scripta* ssp. in Montenegro: yellow circle – published record; black circle – reconfirmed record; red circle – unpublished new record; red asterisk – unpublished record, some data available on internet sites (see Tab. 1 for links). Arrow indicates the potential breeding site (Mrke-Blizna), where hatchlings were observed.

Slika 1. Zemljevid, ki prikazuje nahajališča *Trachemys scripta* ssp. v Črni gori: rumen krog – objavljen podatek; črn krog – ponovno potrjen podatek; rdeč krog – neobjavljen nov podatek; rdeča zvezdica - neobjavljen podatek, podatki iz internetnih virov (glej, Tab. 1 za povezave). Puščica prikazuje potencilano mesto razmnoževanja (Mrke-Blizna), kjer so bili najdeni mladiči.

Pond slider findings in Montenegro are from different aquatic ecosystems, including lakes, ponds, rivers, and streams close to urban areas. Those results are in agreement with data from other Balkan countries (Jelić & Jelić 2015; Koren et al. 2018; Urošević et al. 2019; Kornilev et al. 2020), which unequivocally confirms the fact that specimens are released by owners in urban aquatic ecosystems as unwanted pets. Our results indicated that among most localities one to five specimens were observed, while at the pond at Mrke-Blizna, numerous specimens exist. This locality is also identified as a potential breeding site, as hatchlings are present here (personal communication with owners). Here, a shelter for animals was built, and humans often bring Pond Sliders with intention to release them into the pond (personal communication with owners). This locality is quite isolated and far away from natural aquatic ecosystems (about 7 km away from the Morača River), so this population can be considered as under control if we keep in mind that Pond Slider presence in the isolated ponds, e.g. more than several kilometres apart, especially in the Mediterranean part of the country, somewhat limits their propagation potential, as well as their potential of spreading to different habitats (Ryan et al. 2008).

Table 1. Overview of all known records of *Trachemys scripta* ssp. in Montenegro, with details on localities, dates of findings, number of observed individuals and reference/legator.
Tabela 1. Pregled vseh znanih podatkov za *Trachemys scripta* ssp. v Črni gori, s podrobnostmi o lokaciji, datumih najdbe, številu opaženih osebkov in viru/nabiralcu.

Locality number	Locality	Latitude, Longitude	Altitude [m a.s.l]	Date	Reference/ Legator	Subspecies	Notes
1	River Sutorina, Herceg Novi	42.451858, 18.498898	10	15.04.2017	Vuk Iković	*T. s. elegans*	1 individual, adult, caught in trap
1	River Sutorina, Herceg Novi	42.454012, 18.497619	10	09.10.2018	Vuk Iković	*T. s. elegans*	1 individual, adult, caught in trap
1	River Sutorina, Herceg Novi	42.456739, 18.501610	10	15.04.2017	Vuk Iković	*T. s. elegans*	1 individual, adult, caught in trap
2	Brackish water in marina, Meljine, Herceg Novi	42.453887, 18.559895	0	18.03.2023	Danijel Đorđević	*T. s. scripta*	1 individual
3	Lake Tivat, Tivat field, Tivat	42.413256, 18.721259	10	2017	Vuk Iković	*T. s. elegans*	1 individual, adult, caught in trap
4	Pond Lovanja, Tivat field, Kotor-Tivat	42.402000, 18.733300	11	15.06.2019	Ljubisavljević, 2022	*T. s. scripta*	1 individual
5	Lake Jaz, Mrčevo field, Budva-Kotor	42.294401, 18.793939	10	24.04.-29.04.2005	Lužnik et al. 2006	*T. s. elegans*	
5	Lake Jaz, Mrčevo field, Budva-Kotor	42.294401, 18.793939	10	9.05.2008	http://www.hylawerkgroep.be/jeroen/index.php?id=45	*T. s. elegans*	
5	Lake Jaz, Mrčevo field, Budva-Kotor	42.294401, 18.793939	10	13.07.2017 06.09.2018	Vuk Iković	*T. s. elegans*	3 individuals, adults, caught in trap
5	River Jaz, Mrčevo field, Budva-Kotor	42.290230, 18.793454	10	17.07.2015	Aleksandar Simović	*T. s. elegans*	1 individual
5	River Jaz, Mrčevo field, Budva-Kotor	42.294988, 18.793107	10	07.07.2016 23.03.2017 21.06.2017	Vuk Iković	*T. s. elegans*	3 individuals, adults, caught in trap
5	River Jaz, Mrčevo field, Budva-Kotor	42.290552, 18.795492	10	20.08.2017	Vuk Iković	*T. s. elegans*	1 individual, adult, caught in trap
6	Stream in Kamenovo, Budva	42.273701, 18.890569	20	23.04.-29.04.2005	Žagar et al. 2013	*T. s. elegans*	1 individual

Locality number	Locality	Latitude, Longitude	Altitude [m a.s.l]	Date	Reference/ Legator	Subspecies	Notes
7	River Željeznica, Bar	42.106214, 19.089180	3	21.05.2018	Vuk Iković	*T. s. elegans*	2 individuals, adults, caught in trap
8	Lake Skadar, Vranjina, Podgorica	42.301400, 19.147000	25	9.05.2022	(HP Eckstein) https://observation.org/locations/129858/observations/?date_after=2022-04-20&date_before=2023-04-20&species=1424&species_group=&rarity=&search=&user=&sex=&life_stage=&activity=&method=	*T. s. elegans*	1 individual
9	Pond in Mrke-Blizna, Podgorica	42.534905, 19.305896	430	2019, 2020, 2021, 2022, 2023	https://www.facebook.com/Prihvatili%C5%A1te-i-Oporavak-%C5%BDivotinja-Crna-Gora-112032268830136	*T. s. elegans*	numerous, adults and juveniles
9	Pond in Mrke-Blizna, Podgorica	42.534905, 19.305896	430	2019, 2020, 2021, 2022, 2023	https://www.facebook.com/Prihvatili%C5%A1te-i-Oporavak-%C5%BDivotinja-Crna-Gora-112032268830136	*T. s. scripta*	numerous, adults and juveniles
10	Lake Batuni, Berane	42.845306, 19.887668	650	12.04.2022	Stefan Ralević	*T. s.*.ssp.	1 individual, caught by fishing hook

On 18.03.2023, one individual of *T. s. scripta* was observed by locals in brackish water at Meljine – Herceg Novi (Lazure Marina). In the vicinity of this marina runs the stream named »Nemila«, where *E. orbicularis* and *M. rivulata* occur (Vuk Iković, personal unpublished data), so we assume that the Nemila stream probably washed *T. s. scripta* specimen into the sea. According to the locals, the turtle was quite active, swimming and basking on the surface. This finding is not surprising if we have in mind that *T. s. elegans* has a strong resistance to high salinity (Hong et al. 2014) and can even live in low salinity water environments (Gibbons et al. 1979).

Among all habitats at the coast, as well as in Lake Skadar, native terrapins *E. orbicularis* and *M. rivulata* are present (Jovanović 2009; Stanković 2009; Žagar et al. 2013; Polović & Čađenović 2014; Katnić et al. 2017; Crnobrnja-Isalović et al. 2018; Ljubisavljević 2022; Iković Vuk personal unpublished data), so in future these terrapins could possibly compete with the pond slider. This competition can be related to food, egg-laying sites, basking places, as well as pathogens

transmission (Koren et al. 2018; Kornilev et al. 2020) and better adaptation to pollution (Ljubisavljević 2022).

Although the Law on Invasive Species was adopted in Montenegro in 2019 (Official Gazette of the Republic of Montenegro No. 18/2019), it has still not come into effect due to delays in the preparation and adoption of the List of invasive species (Ljubisavljević 2022).

In conclusion, it is necessary to implement monitoring of this invasive species in Montenegro and to make a plan for the future removal of this species from the natural habitats to minimize its possible negative impact on native terrapins (*E. orbicularis* and *M. rivulata*) and aquatic ecosystems in Montenegro. Education is also of great importance to avoid the unconscionable release of terrapins into nature when they become unwanted pets.

Povzetek

Okrasna gizdavka *Trachemys scripta* (Thunberg in Schoepff, 1792) je po vsem svetu razširjena kot domača žival (Speybroeck et al. 2016) in je ena najbolj invazivnih tujerodnih vrst na svetu (Lowe et al. 2000). Vrsta je postala široko razširjena po Evropi, tudi v Črni gori.

V tem prispevku predstavljamo vse razpoložljive literaturne in še neobjavljene podatke o trenutni razširjenosti vrste *T. scripta* ssp. v Črni gori, zbrane v zadnjih osmih letih. Avtorji so zbrali podatke na obalnem predelu države, med terenskimi raziskavami domorodnih sladkovodnih želv *Emys orbicularis* (Linnaeus, 1758) in *Mauremys rivulata* (Valenciennes, 1833).

V Črni gori sta bili doslej ugotovljeni dve podvrsti, in sicer na 10 nahajališčih. Da večina najdb izvira iz mediteranske biogeografske regije, je povezano z dejstvom, da je bilo več sistematičnih raziskav opravljenih v obalnih predelih. Vrsta je bila najdena predvsem v bližini urbanih območij, v različnih vodnih ekosistemih, vključno z jezeri, ribniki, rekami in potoki. To povezujemo z možnostjo, da lastniki izpustijo osebke v mestne vodne ekosisteme, ko postanejo nezaželeni ljubljenčki. Na vsakem nahajališču je bilo zabeleženih od enega do pet osebkov, razen v Mrke-Blizni, kjer je bilo najdenih veliko osebkov, vključno z mladiči (osebna komunikacija z lastniki), in zato je ta lokacija potencialno mesto razmnoževanja.

Zelo pomembno bi bilo uvesti spremljanje *T. scripta* v Črni gori in spodbujati izobraževanje, da bi se izognili brezobzirnemu spuščanju želv v naravo, ko te postanejo nezaželeni ljubljenčki.

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The highest-altitude recorded find of the adder *Vipera berus* (Linnaeus, 1758) in Slovenia on Mt Mali Kanin (Western Julian Alps)

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Abstract. The article describes the find of a single individual of the adder (*Vipera berus*) on Mt Mali Kanin (Western Julian Alps, Slovenian-Italian border) at 2,570 m a.s.l. on 8.7.2023. The animal with a total length of about 40 cm was photographed on a patch of soil and low alpine vegetation in a predominantly rocky habitat. According to the available published and unpublished data, this find is 325 m higher than the previous highest-altitude recorded find of the species in Slovenia.

Izvleček. Najvišja dokumentirana najdba navadnega gada *Vipera berus* (Linnaeus, 1758) v Sloveniji z Malega Kanina (Zahodne Julijske Alpe) – Prispevek opisuje najdbo enega osebka navadnega gada (*Vipera berus*) na Malem Kaninu (Zahodne Julijske Alpe, slovensko-italijanska meja) na nadmorski višini 2570 m dne 8.7.2023. Živali v skupni dolžini okoli 40 cm je bila fotografirana na zaplati zemlje in nizkega alpskega rastlinja v pretežno skalnatem okolju. Glede na razpoložljive objavljene in neobjavljene podatke je ta najdba 325 m višja od doslej najvišje zabeležene najdbe navadnega gada v Sloveniji.

On 8.7.2023, at 10:03 a.m., the second author of this field note (M.B.) noticed a snake while hiking at Mt Mali Kanin. The snake was basking on a hiking trail on a flat terrain about 13 m northwest of the Slovenian-Italian border milestone, which is positioned on the highest point of Mt Mali Kanin / M. Canin Basso (2,571 m a.s.l.) (Fig. 1). According to the Naravovarstveni atlas (ZRSVN 2021), the location of the find (46.357270° N, 13.437504° E; accuracy 3 m) lies in the Slovenian-Italian border area at an altitude of 2,570 m a.s.l., which corresponds to the estimated altitude in the field. M. B. managed to take photos of an individual and later sent them to the first author of this field note (V. C.), who identified the individual as an adder (*Vipera berus*).

Figure 1. The highest point of Mt Mali Kanin (2,571 m a.s.l.) marked with a milestone. The adder (*V. berus*) was found close to the milestone (photo: Marko Berginc).
Slika 1. Z mejnikom označena najvišja točka Malega Kanina (2571 m n. m.). V bližini mejnika je bil najden navadni gad (*V. berus*) (foto: Marko Berginc).

The snake, measuring roughly 40 cm in total length, was light brown with clearly marked continuous dark brown zig-zag vertebral stripe (Fig. 2). This type of colouration is frequent in female adders (Arnold 2002; Kreiner 2007). Head scalation, visible on the photos, was typical of adders (Kreiner 2007; Speybroeck 2016) – the top of the head was covered with more than 12 scales, including a large frontal scale and two parietal scales that were all undivided. The animal was found on a patch of soil and low alpine vegetation between rocks in a predominantly rocky habitat. During the observation, the weather at Mt Mali Kanin was sunny with temperatures around 20°C and almost no wind. There were no other hikers to be seen on the hiking trail.

Mt Mali Kanin is part of Kaninsko pogorje (Kanin mountain range), the largest mountain massif in the Western Julian Alps in NW Slovenia. Kaninsko pogorje consists of limestone and some dolomite. The surface is heavily cracked and has numerous karst formations, a large number of abysses, and a small number of caves. Due to its high elevation, proximity and openness to the Adriatic Sea, Mt Kanin has a special mountain climate. Kaninsko pogorje is considered one of the wettest places in Slovenia, but the rainwater and melted snow sink rapidly (ZRSVN 2021).

Figure 2. The adder (*V. berus*) found on 8.7.2023 on Mt Mali Kanin at 2,570 m a.s.l. (Western Julian Alps, Slovenian-Italian border) (photo: Marko Berginc).
Slika 2. Navadni gad (*V. berus*), najden 8.7.2023 na Malem Kaninu na 2570 m n. v. (Zahodne Julijske Alpe, slovensko-italijanska meja) (foto: Marko Berginc).

The adder lives in most parts of northern Europe and Great Britain, has a fragmented distribution pattern in western and central Europe and the Balkans, and ranges far into Russia to Sakhalin, northern Mongolia, and northwestern China (Speybroek 2016; Munkhbayar et al. 2021). In the Alps, adders occur particularly between 1,500 and 2,400 m a.s.l., with occasional maximum altitude records of up to 3,000 m a.s.l. (Kreiner 2007). In Italy, the adder is extremely rare above 2,500 m, with the highest recorded elevation reaching 2,958 m a.s.l. (peak of Sassopiatto) (Sindaco et al. 2006). Austria's maximum altitude record is at 2,420 m a.s.l. (Cabela et al. 2001), while Switzerland's is at 2,700 m a.s.l. (Hofer et al. 2001).

In Slovenia, Škufca & Premate (2016) reported on a find of adders on the northeastern slope of Mt Viševnik at 1,928 m a.s.l. At the time, the find was considered the highest-altitude record of the species in Slovenia, which included details of the exact location and a photo of the individuals. Until now, the highest recorded published observation of the adder has been at 2,245 m a.s.l., near the peak of Mt Travnik (2,256 m a.s.l., Julian Alps) (Vek et al. 2019), where Damjan Šonc photographed an adult adder on 22.7.2009 at the exact coordinates 46.337504° N 13.744254° E (CKFF 2023, D. Šonc pers. comm.). The review of publicly available data on the distribution of the adder in Slovenia in the web databases Bioportal (CKFF 2023) and iNaturalist (2023) shows that there are currently no unpublished records with an exact location above 2,245 m a.s.l. The adder from Mt Mali Kanin was observed 325 m higher than the individual from Mt Travnik and thus represents the highest recorded find of the species in Slovenia to date.

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An interesting observation of Eurasian beaver *Castor fiber* Linnaeus, 1758 in Vidovec Cave (Metlika, Slovenia)

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Abstract. The Eurasian beaver is a common rodent which became extinct in Slovenia in the 18th century and reappeared in the 1990's. This field note describes an encounter with a beaver inside the Vidovec Cave (Metlika, Southeastern Slovenia). Apart from a sign of beaver presence, we also noticed a straw mat presumably used for sleeping. The described observation is probably the first of its kind in Slovenia, although similar observations are known from Croatia as well.

Izvleček. Zanimivo opažanje evropskega bobra *Castor fiber* Linnaeus, 1758 v jami Vidovec (Metlika, Slovenija) – Evrazijski bober je glodavec, ki je v Sloveniji izumrl v 18. stoletju in se ponovno naselil v devetdesetih letih prejšnjega stoletja. V terenski notici je opisano opažanje prisotnosti bobra in ležiščae iz slame v jami Vidovec (Metlika, jugovzhodna Slovenija). Opisana najdba je verjetno prva tovrstna v Sloveniji, a so bila podobna opažanja že zabeležena tudi na Hrvaškem.

The Eurasian beaver (*Castor fiber)* is the largest European rodent, typically inhabiting water bodies such as rivers, streams or lakes. The animals themselves are rarely sighted directly, but their presence can be confirmed by finding faeces, footprints, lodges, dams, gnawed and fallen trees (Macdonald et al. 1995; Kryštufek et al. 2006).

The Eurasian beaver was widespread throughout Europe, but almost became extinct due to excessive hunting and trapping for fur at the end of the 19th century. In the 20th century, beavers were reintroduced in several countries. In 1998, dispersing animals from the reintroductions in Croatia in 1996 also reached the Slovene territory via the Sava River (Kryštufek et al. 2006). In 2006, the beaver's presence was further confirmed along the border with Croatia, i.e., in the eastern parts of the Prekmurje and Dolenjska regions (Kryštufek et al. 2006). Since the first reappearance of the beaver in Slovenia, its abundance has increased. Kryštufek et al. (2006), for example, estimated that there were less than ten individuals on the Krka River, while a later study on the abundance of the beaver estimated the population size at between 168–392 individuals (Juršič et al. 2017). According to the Life Beaver project website (LIFE BOBER 2023), beavers in Slovenia currently live in the catchments of the Mura, Drava, and Sava Rivers.

Here we report an interesting observation of a single Eurasian Beaver in a cave near Metlika in the Bela krajina region, Slovenia. Around 3 p.m. on 19. 11. 2022 we entered the Vidovec Cave (latitude 45.645452, longitude 15.377206, Slovenian cadastral number 3342; eKataster jam 2023; Fig. 1) as part of a field excursion organised by the Biology Students' Society. The cave entrance is located east of the village of Božakovo in the Municipality of Metlika. The cave is a source cave, shaped by the Vidovec stream which permanently flows through it. The cave is about 270 m long and ends with a syphon (eKataster jam 2023). The Vidovec stream is a tributary of the Kolpa River, which is part of the Sava River catchment area (Fig. 1).

During our visit to the cave, we were surprised to observe a beaver swimming in the stream, about 40 m inside the cave. The animal retreated to the side of the stream and began swimming in the opposite direction deeper into the cave, where it hid in a narrow, flooded corner. The animal seemed wary but showed no aggression towards us. About 50 m from the entrance, a straw mat (Fig. 2) and a similar smaller but shapeless pile of straw were found lying on the muddy bank. We also noted beaver footprints in the mud in several places up to about 100 m inside the cave. The cave was visited again on 25. 12. 2022. Although the beaver was not observed on this day, the mat was still there.

To our knowledge, this is the first field observation of a beaver and its shelter in a cave in Slovenia. However, Pleistocene beaver remains from the last ice age in the Alpine region have confirmed that caves were used as shelters even before the extinction and reintroduction of beavers in Europe (Kryštufek et al. 2006). Remains of beaver bones were also found in several caves in Slovenia

(Kryštufek et al. 2006). In addition, there are several recent observations of beaver shelters in caves in Croatia. In the Plitvice Lakes National Park (Karlovac, Croatia), beaver shelters were found in the caves during a survey conducted on beaver population in this area (Augustinović 2022). The beavers in this area built shelters under waterfalls or chose caves instead of open parts of lakes and water bodies as their dwelling sites (Marijan Grubešić, pers. comm., January 2023). In close vicinity to the Vidovec Cave, a beaver was also observed dwelling about one kilometre inside the cave, which was formed by a sinking stream that resurfaces after one kilometre and flows into the Dobra River, Croatia (Marijan Grubešić, pers. comm., January 2023). Moreover, Gore and Wilson Baker (1999) reported similar behaviour in another beaver species. They observed beavers (*C. canadensis*) in Northern Florida, where the beavers used the caves as shelters but hypothesised that unless the cave entrance was permanently flooded, caves served only as low-cost, temporary shelters for subadult beavers during the dispersal period. However, it can be assumed that beaver families only choose caves with permanent underwater entrances to provide sufficient protection. Mats made of vegetation, tracks, faeces and a subadult animal were found in observed caves (Gore & Wilson Baker 1999).

According to the available literature, the Beaver observed in the Vidovec Cave may have been a dispersing individual. However, further visits to the Vidovec Cave and perhaps observations with an infrared camera could provide additional insights into the use of the cave as a shelter by beavers and the regularity of this behaviour. Further targeted surveys could elucidate the role of caves in beaver ecology.

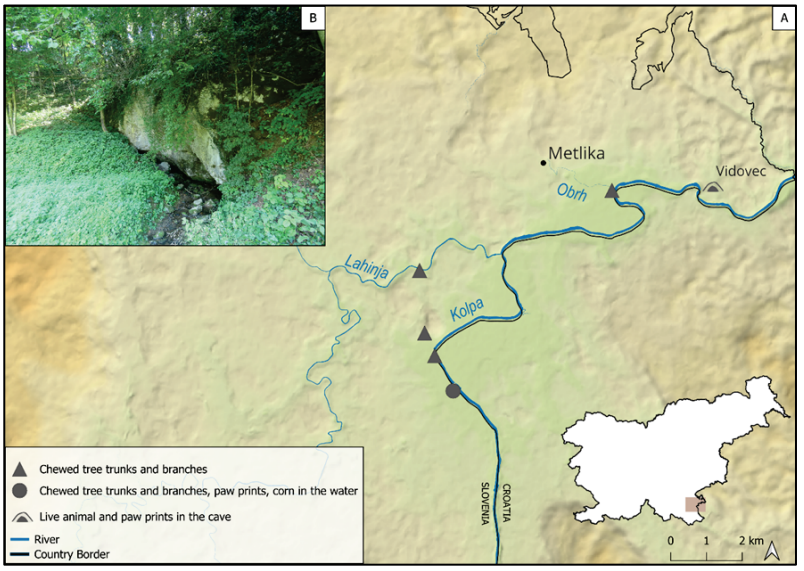

Figure 1. A: A map of the beaver presence in the south-eastern part of the Sava catchment in the surroundings of the Vidovec Cave where the beaver was observed. Data on other beaver occurrences is from the database maintained by the Inštitut Lutra (2023). Other map layers are from Copernicus data and information funded by the European Union - EU-DEM (EU 2016), and GURS (2010) (rivers and state border). Map produced with QGIS version 3.32.3. B: entrance of the Vidovec Cave. Photo: Primož Presetnik

Slika 1. A: Zemljevid pojavljanja bobra v jugovzhodnem delu porečja Save, v bližini jame Vidovec, kjer je bil opažen bober. Podatke o pojavljanju bobra smo pridobili iz zbirke podatkov Inštituta Lutra (2023). Drugi uporabljeni sloji so podatki Copernicus in informacije, ki jih financira Evropska unija - EU-DEM (EU 2016) in GURS (2010) (sloj rek in državna meja). Zemljevid smo izdelali s programom QGIS verzija 3.32.3. B: Vhod v jamo Vidovec. Foto: Primož Presetnik

Figure 2. Beaver straw mat inside the Vidovec Cave. Photo: Łukasz Popowicz.
Slika 2. Bobrovo ležišče iz slame v jami Vidovec. Foto: Łukasz Popowicz.

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NAVODILA AVTORJEM

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PREDLOŽITEV ROKOPISOV

Rokopisi naj bodo oddani prek spletnega portala Založbe Univerze v Ljubljani: https://journals.uni-lj.si/NaturaSloveniae.

Vse rokopise bo recenziral vsaj po en recenzent. Avtorji lahko predlagajo imena in kontakte potencialnih recenzentov, uredništvo pa si pridržuje pravico, da izbere kateregakoli drugega. Po pregledu s strani recenzenta(-ov), avtor ali avtorji sami pripravijo novo verzijo rokopisa. Popravljen rokopis je treba vrniti z označenimi spremembami (lahko uporabite orodje Track changes) skupaj z različico brez označenih sprememb ali pripomb in spremnim dopisom, v katerem so pojasnjene opravljene spremembe.

Predloženi rokopis ne sme biti predhodno objavljen v nobeni obliki in ne sme biti hkrati predložen drugam (v drugo revijo, bilten ali kongresno publikacijo). Z oddajo rokopisa podelijo založniku pravico do prve izdaje članka po licenci Creative Commons Attribution 4.0 International.

FORMAT IN OBLIKA PRISPEVKA

Rokopisi so lahko predloženi v obravnavo kot znanstveni članek, kratka znanstvena vest in terenska notica. Dobrodošli so tudi drugi formati prispevkov (pregledni članki, komentarji, mnenjski članki), vendar se je treba o tem predhodno posvetovati z urednikom.

Znanstveni članek je popoln opis izvirne raziskave, vključno z uvodnim pregledom ozadja in stanja poznavanja tematike. Struktura sledi principu »IMRAD« (uvod, material in metode, rezultati, razprava), sledijo sklepi (neobvezno), zahvala (neobvezno), literatura, povzetek, dodatno gradivo (neobvezno).

Kratka znanstvena vest je izvirno delo, ki poroča o manjšem naboru podatkov ter o delnih ali predhodnih rezultatih raziskav. Struktura sledi principu »IMRAD«, vendar je poenostavljena, na primer z enotnim razdelkom »rezultati in razprava«. Glavnemu besedilu sledijo zahvala (neobvezno), literatura, povzetek in dodatno gradivo (neobvezno).

Terenska notica je kratko poročilo o novih in zanimivih najdbah, ki izhajajo iz biološkega terenskega dela ali so z njim povezane. Vsebuje glavno besedilo, zahvalo (neobvezno) in literaturo.

Naslov prispevka mora biti informativen, jasen in jedrnat. Naslovu morajo slediti imena in priimki ter polna imena avtorjev s poštnimi in elektronskimi naslovi. Lahko so dodane številke ORCID.

Vsak prispevek mora vsebovati **izvleček**, ki vključuje zgoščeno predstavitev ciljev, uporabljenih metod, rezultatov in zaključkov. Izvleček naj ne bo daljši od 250 besed za znanstvene članke, 200 besed za kratke znanstvene vesti in 100 besed za terenske notice.

Avtorji naj vključijo **pet do največ deset ključnih besed**, zapisanih po abecednem vrstnem redu, ki morajo odražati področje raziskav in vsebino, zajeto v prispevku. Terenska notica ne vsebuje ključnih besed.

Znanstveni članki in kratke znanstvene vesti morajo vsebovati **povzetek**, ki sledi glavnemu besedilu rokopisa. Namen povzetka je zagotoviti izčrpne informacije za slovensko govoreče bralce, kadar je prispevek napisan v angleščini, ali neslovensko govoreče, kadar je prispevek v slovenščini. Povzetek naj ne bo le ponovitev izvlečka, ampak naj vsebuje več informacij o ciljih, metodah, rezultatih, razpravi in lahko vključuje navedbe literature ter sklice na slike in tabele. Priporočena dolžina povzetka je približno 500 besed za znanstvene članke in 300 besed za kratke znanstvene vesti. Pisci, ki ne govorijo slovensko, lahko pripravijo angleški izvleček, ključne besede in povzetek, te pa bo uredništvo prevedlo v slovenščino. Terenska notica nima povzetka.

Rokopisi morajo biti predloženi v enem od razširjenih formatov za urejanje besedila, kot sta Microsoft Word (docx, doc) ali tekstovni dokument ODF (odt), po možnosti s pisavo »Times New Roman« velikosti 12, levo poravnavo in 3 cm robovi na A4 straneh. Med vrsticami naj bo dvojni razmik, vrstice naj bodo oštevilčene neprekinjeno po celem rokopisu. Naslov prispevka ter naslovi poglavij in podpoglavij morajo biti napisani s krepko pisavo velikosti 14. Znanstvena imena vseh rodov in vrst morajo biti zapisana v ležečem tisku.

SLIKE IN TABELE

Prispevki lahko vsebujejo do deset slik in/ali tabel. Tabele in slike, vključno z legendami, je treba umestiti v rokopis na želeno mesto. Ločljivost slik v rokopisu je lahko nižja, da se zmanjša velikost oddane datoteke. Če je rokopis sprejet v objavo, je treba slike predložiti ločeno kot visokokakovostne vektorske ali rastrske grafike v formatih pdf, svg, jpg ali tiff. Slike morajo biti pripravljene brez elementov, kot so robovi in podnapisi; te lahko dodate v rokopis z uporabo urejevalnika besedil. Če potrebujete pomoč pri pripravi grafike ustrezne kakovosti, se obrnite na urednika.

Slike in tabele morajo biti oštevilčene zaporedno (Slika 1, Slika 2 ..., Tabela 1, Tabela 2 ...), v tekstu se je treba vsaj enkrat sklicevati na vsako sliko in tabelo v skrajšani obliki (Sl. 1 ali Sl. 1, 2; Tab. 1 ali Tab. 1, 2).

Tabele in slike morajo skupaj s naslovi/podnaslovi in legendami vključevati dovolj podrobnosti, da so razumljive

same po sebi. Naslovi/podnaslovi naj bodo v obeh jezikih (angleščini in slovenščini), ne glede na glavni jezik besedila. Za neslovensko govoreče avtorje bo za slovenske prevode poskrbelo uredništvo.

Če so vključene fotografije, je treba v oklepaju navesti ime in priimek avtorja.

DRUGA NAVODILA ZA OBLIKOVANJE

Vsi datumi se pišejo s številkami, ne glede na jezik prispevka, gre za obliko: Dan.Mesec.Leto, na primer 23.5.2000, 16.6.2015.

Domačih imen ne pišemo z veliko začetnico, izjema je poimenovanje po osebi (npr. Savijev netopir).

Kadar se domače in znanstveno ime uporabljata skupaj, velja naslednje: znanstveno ime sledi domačemu brez oklepajev le v naslovu, v besedilu pa ga je treba navesti v oklepaju. Obe imeni skupaj naj se uporabljata le pri prvi omembi v besedilu prispevka, pozneje pa naj se dosledno uporablja le ena oblika. Vsako znanstveno ime naj bo vsaj enkrat zapisano v celoti, tj. vključno z avtorjem in letnico opisa.

Koordinate lokalitet naj bodo v WGS84 decimalnih stopinjah. Za Slovenijo so lahko tudi v veljavnem koordinatnem sistemu ETR89. Koordinatni sistem mora biti jasno označen.

LITERATURA

Navajanje literature in seznam literature naj bosta v skladu s slogom »Council of Science Editors« (CSE) (https://www.councilscienceeditors.org/scientific-style-and-format), z uporabo sistema »Name-Year«, z nekaterimi spremembami (navedenimi v nadaljevanju): https://www.mcgill.ca/library/files/library/cse-name-year-citation-style-guide.pdf

V besedilu:

V besedilu sta priimek avtorja in letnica objave navedena v oklepaju takoj za besedilom, na katerega se nanaša:

Večina samic odlaga jajca v prvi polovici junija (Fritz 2003) in...

Če ima vir dva avtorja, sta navedena oba priimka med katerima je znak "&" (to se razlikuje od navodil na zgornji povezavi!). Pri delih s tremi ali več avtorji se navede samo priimek prvega avtorja, ki mu sledi "et al.":

...označene želve z marginalnim vrezovanjem (Vamberger & Kos 2011)...
...živi v spodnjem toku reke Save na Hrvaškem (Šalamon et al. 2013)...

Če se navaja več virov hkrati, jih je treba navesti v kronološkem zaporedju in po abecednem redu, če so viri objavljeni v istem letu strani istega avtorja/-jev, med sabo pa jih ločiti s podpičjem. Dve ali več del, ki jih je napisal isti avtor v istem letu, je treba letnici dodati oznako (a, b, c ...). Enake oznake se navedejo v seznamu literature.

... (Müller 1921; Seifert 2007a, 2007b; Ionescu-Hirsch et al. 2009; Lapeva-Gjonova & Kiran 2012; Wiezik & Wieziková 2013).

Če je avtor reference organizacija, inštitucija, univerza itd., se v besedilu uporabi skrajšana oblika imena, tako da se ohrani prva črka besed v imenu ali priznana kratica:

... (ARSO 2022).

Seznam literature:

Seznam literature naj sledi spodnjim primerom, a za dodatne primere naj se sledi prej navedenim smernicam za citiranje:

[ARSO] Agencija Republike Slovenije za okolje. 2022. Podnebne značilnosti oktobra 2022. Ljubljana (SI): Agencija Republike Slovenije za okolje, Ministrstvo za okolje, podnebje in energijo. https://meteo.arso.gov.si/met/sl/climate/current/climate_month/ [accessed on 26.11.2022]

Balestrieri A, Remonti L, Prigioni C. 2015. Towards extinction and back: Decline and recovery of otter populations in Italy. In: Angelici FM, editor. Problematic Wildlife. Springer International. Switzerland. p. 91-105. https://doi.org/10.1007/978-3-319-22246-2_5

Gregorc T, Nekrep I. 2010. Poročilo skupine za vidro. In: Vinko D, editor. Raziskovalni tabor študentov biologije Most na Soči 2010. Ljubljana (SI): Društvo študentov biologije. p. 12-21.

Kruuk H, Conroy JWH, Glimmerveen U, Ouwerkerk EJ. 1986. The use of spraints to survey populations of otters (*Lutra lutra*). Biological Conservation. 35: 187-194. https://doi.org/10.1016/0006-3207(86)90050-9

Gorički Š, Stanković D, Snoj A, Kuntner M, Jeffery WR, Trontelj P, Pavic M, Grizelj Z, Năpăruș-Aljančič M, Aljančič G. 2017. Environmental DNA in subterranean biology: Range extension and taxonomic implications for *Proteus*. Scientific Reports. 7: 1-11. https://doi.org/10.1038/srep45054

Navajanje zakonodajnih dokumentov:

Slovenska zakonodaja:

Navajanje v besedilu: (Ur. l. RS 2002) ali (Ur. l. RS 2004a) ali (Ur. l. RS 2004b)

Seznam literature:

Ur. l. RS. 2002. Pravilnik o uvrstitvi ogroženih rastlinskih in živalskih vrst v rdeči seznam. Uradni list RS, št. 82/02, 42/10.

Ur. l. RS. 2004a. Uredba o zavarovanih prostoživečih živalskih vrstah. Uradni list RS, št. 46/04, 109/04, 84/05, 115/07, 32/08 – odl. US, 96/08, 36/09, 102/11, 15/14, 64/16, 62/19.

Zakonodaja EU, mednarodne konvencije:

Navajanje v besedilu: (UL ES 1992)

Seznam literature:

OJ EC. 1992. Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. Official Journal of the European Communities L 206, 22.7.1992. p. 7-50.

INSTRUCTIONS TO AUTHORS

The mission of **NATURA SLOVENIAE** is to foster the understanding of the natural history of Central and Southeastern Europe by publishing the results of field-biological research and data. Manuscripts reporting significant and new distributional records, species lists from all kingdoms as well as ecological, biogeographical, biodiversity and conservation studies are welcome. Papers are published in English or Slovenian language.

The journal is being published by University of Ljubljana Press on behalf of the Biotechnical Faculty of the University of Ljubljana and the National Institute of Biology (Slovenia).

The address of the Editor in Chief: Maja Zagmajster, Department of Biology, Biotechnical Faculty, University of Ljubljana, Večna pot 111, SI1000 Ljubljana; maja.zagmajster@bf.uni-lj.si

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Manuscripts should be submitted via the web portal of the University of Ljubljana Press:
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All manuscripts will be subject to peer review by at least one referee. Authors are invited to suggest the names and contacts of potential referees, although the editor reserves the right to select any other. Once reviewed by the referee(s), the manuscript should be revised by the author or authors themselves. The revised manuscript should be returned with marked changes (Track changes tool can be used) along with a clean version (no marked changes or comments) and a rebuttal letter explaining the changes made.

The submitted manuscript must not have been previously published in any form and must not be simultaneously submitted elsewhere (in other journals, bulletins or congress publications). By submitting a manuscript, the authors the authors grant the publisher right of first publication with the work simultaneously licensed under the Creative Commons Attribution 4.0 International License.

TYPES AND FORMAT OF CONTRIBUTIONS
Manuscripts may be submitted for consideration as Scientific Papers, Short Communications and Field Notes. Other formats of contributions are also welcome (review articles, comments, opinion papers), but should be discussed beforehand with the editor.

Scientific Paper is a complete description of original research including an introductory overview of the state-of-the-art. The structure is typically IMRAD (Introduction, Material and Methods, Results, Discussion), followed by Conclusions (optional), Acknowledgements (optional), References, Summary, Supplementary material (optional).
Short Communication is an original paper reporting on a smaller dataset as well as partial or preliminary research results. The structure follows the IMRAD logic but is simplified, for example by fusing the Results and Discussion sections. The main text is followed by Acknowledgements (optional), References, Summary, and Supplementary material (optional).
Field Note is a short report on new and interesting findings coming from or related to biological field work. It contains information in the main text, Acknowledgements (optional) and References.

The **title of the contribution** should be informative, clear and concise. The title should be followed by the **name(s) and full affiliations of the author(s)**, with postal and e-mail addresses. ORCID numbers are optional.

Each contribution should contain the **abstract** which includes concise information about the objectives, methods used, results and conclusions. The abstract should not exceed 250 words for Scientific Papers, 200 words for Short Communications and 100 words for Field Notes.

Authors should include **five to maximum ten keywords**, written in alphabetical order, which must accurately reflect the field of research and content covered in the paper. A Field Note does not contain key words.

Scientific Papers and Short Communications should include a **Summary** following the main text of the manuscript. The purpose of the Summary is to provide comprehensive information for Slovenian or non-Slovenian speaking readers when the contribution is written in English or Slovenian, respectively. The Summary should not be a repetition of the abstract but contain more information on objectives, methods, results, discussion, and may include citations from the reference list or mentions of figures and tables. The recommended length is about 500 words for Scientific Papers and 300 words for Short Communications. Non-Slovenian speaking writers can provide English Abstract, Keywords and Summary. These will be translated into Slovenian by the editorial team. A Field Note does not contain a Summary.

Manuscripts should be submitted in one of the major text editing formats such as Microsoft Word (docx, doc) and ODF text document (odt), preferably using »Times New Roman« size 12 font, align left and margins of 3 cm on A4 pages. Double spacing should be used between lines, which should be numbered continuously for the whole manuscript. The manuscript title and headings of chapters and subchapters should be written in bold font size 14. The scientific names of all genera and species must be written in italic.

ILLUSTRATIONS AND TABLES
Papers should contain up to ten figures and/or tables. Tables and figures, including legends, should be inserted in the manuscript at the desired position. The resolution of figures in the manuscript may be reduced to ensure a manageable file size. If the manuscript is accepted for publication, figures should be submitted separately as high-quality vector or raster graphics, in pdf, svg, jpg, or tiff formats. Figures should be prepared without graphical elements such as borders and captions; those can be added in the manuscript using the word processor instead. Please contact the editor if you need assistance with preparing graphics of sufficient quality.

Figures and tables should be numbered consecutively throughout the manuscript (Figure 1, Figure 2 …, Table 1, Table 2 …). Each Figure and Table should be referred to at least once in the main manuscript text, in abbreviated form (Fig. 1 or Figs. 1, 2; Tab. 1 or Tabs. 1, 2).

Tables and figures along with their titles and legends should contain enough details to be self-explanatory. Titles should be given in both languages (English and Slovenian), regardless of the language of the main text. For non-Slovenian speaking writers, Slovenian translations will be provided by the editorial team.

When photographs are included, the author's name and surname should be given in brackets.

OTHER FORMAT GUIDELINES

All dates are written with numbers, no matter the language of the contribution, it is the form: Day. Month. Year, for example 23. 5. 2000, 16. 6. 2015.

Vernacular names should not be capitalized, an exception being naming after a person (e.g. Savi's pipistrelle). When vernacular and scientific name are used together, the following applies: the scientific name follows the vernacular without brackets only in the title, while in the text it should be given in parentheses. Both names together should be used only at the first mention in the contribution text, while later only one form should be used consistently. Each scientific name should at least once be written in full, i.e. including taxonomic authority and year of description.

Coordinates of localities should be given in WGS84 decimal degrees format. For Slovenia, they can also be in the valid ETR89 coordinate system. The coordinate system must be clearly indicated.

REFERENCES

Citing of the references and the format of the reference list should follow the Council of Science Editors (CSE) style (https://www.councilscienceeditors.org/scientific-style-and-format), using Name-Year system, with some modifications (listed below): https://www.mcgill.ca/library/files/library/cse-name-year-citation-style-guide.pdf

In the text:

The author's surname and the year of publication are enclosed in parentheses immediately following the text to which it refers:

Most females lay eggs in the first half of June (Fritz 2003) and…

If a reference has two authors, both surnames are included separated by "&" (this is different to instructions in the link!). For works with three or more authors, only the first author's name is included, followed by et al.:

…marked turtles by marginal notching (Vamberger & Kos 2011)…

…does live downstream along the Sava River in Croatia (Šalamon et al. 2013)…

If several sources are cited at once, they should be listed in chronological order and alphabetically among references published in the same year, separated by a semicolon. Two or more works written by the same author in the same year should be marked by a designator (a, b, c…) to distinguish them. The same designators are used in the reference list.

… (Müller 1921; Seifert 2007a, 2007b; Ionescu-Hirsch et al. 2009; Lapeva-Gjonova & Kiran 2012; Wiezik & Wieziková 2013).

If the author of a reference is an organization, institution, university, etc., an abbreviated form of the name is used in the in-text citation, by retaining the first letter of each word in the name, or some other recognized abbreviation:

… (FAO 2007).

Reference list:

The reference list should follow the below examples, but see the above given citation guidelines:

[ARSO] Agencija Republike Slovenije za okolje. 2022. Podnebne značilnosti oktobra 2022. Ljubljana (SI): Agencija Republike Slovenije za okolje, Ministrstvo za okolje, podnebje in energijo. https://meteo.arso.gov.si/met/sl/climate/current/climate_month/ [accessed on 26.11.2022]

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Citing legislation documents:

Slovenian legislation:

Citation in the text: (Ur. l. RS 2002) or (Ur. l. RS 2004).

Reference list:

Ur. l. RS. 2002. Pravilnik o uvrstitvi ogroženih rastlinskih in živalskih vrst v rdeči seznam. Uradni list RS, no. 82/02, 42/10.

Ur. l. RS. 2004. Uredba o zavarovanih prosto živečih živalskih vrstah. Uradni list RS, no. 46/04, 109/04, 84/05, 115/07, 32/08 – odl. US, 96/08, 36/09, 102/11, 15/14, 64/16, 62/19.

EU legislation, international conventions:

Citation in the text: (OJ EC 1992)

Reference list:

OJ EC. 1992. Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. Official Journal of the European Communities L 206, 22.7.1992. p. 7-50.