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Terrestrial isopods (Isopoda: Oniscidea) in the Upper Mežica Valley

Petra ŠTERN, Primož ZIDAR

Department of Biology, Biotechnical Faculty, University of Ljubljana, Jamnikarjeva 101, SI-1000 Ljubljana, Slovenia;
E-mails: petrca.stern@gmail.com, primoz.zidar@bf.uni-lj.si

Abstract. The distribution of terrestrial isopods in many parts of Slovenia is still poorly documented. This article is a contribution to the knowledge of the terrestrial isopod fauna in the Upper Mežica Valley, which is known for its long mining tradition. Isopods were collected from April to October 2022 by hand from 49 localities in the wider area of two towns – Žerjav and Črna na Koroškem in the area of Podpeca, the area above the Bistra Valley, and in the areas Spodnje Javorje and Javorje. Twelve different taxa of terrestrial isopods were determined, eleven of them to the species level. The most frequently found isopod was *Trachelipus ratzeburgii* as the researched area is mainly forest covered. However, the highest diversity of species was recorded in urban and semiurban areas. *Oniscus asellus* was found in the town Črna na Koroškem, which is probably the second documented location of *O. asellus* in Slovenia.

Key words: fauna, survey, terrestrial isopods, Upper Mežica Valley

Izvleček. Kopenski enakonožci (Isopoda: Oniscidea) zgornje Mežiške doline – Razširjenost posameznih vrst enakonožcev je po številnih predelih Slovenije še vedno slabo raziskana. Ta članek je prispevek k poznavanju favne kopenskih enakonožcev v zgornji Mežiški dolini, ki je znana po dolgoletni rudarski tradiciji. Enakonožce smo nabirali ročno od aprila do oktobra 2022 na 49 lokalitetah na širšem območju dveh mest – Žerjava in Črne na Koroškem, na območju Podpece, območju nad dolino Bistre, ter na območjih Spodnje Javorje in Javorje. Determinirali smo dvanajst taksonomskih skupin enakonožcev, enajst od tega do vrste. Najpogosteje popisana vrsta je bila *Trachelipus ratzeburgii,* saj je raziskovano območje večinoma pokrito z gozdom. Največjo vrstno pestrost enakonožcev pa smo zabeležili v urbanih in suburbanih okoljih. V mestu Črna na Koroškem je bil najden tudi *Oniscus asellus*, kar je verjetno drugo dokumentirano nahajališče *O. asellus* v Sloveniji.

Ključne besede: favna, popis, kopenski enakonožci, zgornja Mežiška dolina

Introduction

The fauna of terrestrial isopods in Slovenia consists of 74 species (Vittori et al. 2023) – two new species have been documented only recently (Vittori 2022; Vittori et al. 2023). Terrestrial isopods in Slovenia have been extensively documented initially by Potočnik (1979, 1980, 1981, 1984, 1992, 1993). In his publications, Potočnik documented species from different locations from the wider area of Slovenia (Potočnik 1979, 1980), including the Triglav National Park (Potočnik 1981), the Slovenian coast of the Adriatic Sea (Potočnik 1984), and the Karst Edge (Potočnik 1990). Most of the isopod data from Slovenia is not based on systematic research, but rather on coincidental findings (Potočnik 1979). For a better understanding of isopod distribution in Slovenia, systematic research of isopod fauna is especially needed in the Northern and Western parts of Slovenia (Potočnik 1990). Potočnik's work relied on existing isopod literature (especially the works by Karaman (1966)), museum collections, his own field work and samples collected from other researchers (Potočnik 1979, 1993). However, publications by Potočnik and other older literature do not provide a good figure of the distribution of different isopod species in Slovenia. Specifically, these publications indicate mostly locations of new species for Slovenia and do not provide an overview of all present species by region, nor species abundancy. Recently, the terrestrial isopod fauna has been investigated intensively in the Slovenian Karst (Vilisics & Lapanje 2005) and the Boč Massif area (Ravnjak & Kos 2014), but most regions of Slovenia remain quite poorly surveyed. One of those areas is also the Upper Mežica Valley, which is known for its heterogeneous geomorphological features and its long history of mining tradition, which resulted in extensive environmental pollution (Mioč 1975; Šajn 2002; Polšak 2011). The habitat diversity of the Mežica Valley and its surroundings as well as its long-term pollution with heavy metals make this area interesting also from the point of view of the terrestrial isopod fauna research, which was the purpose of this study.

Materials and methods

Geographical, geological and climatic characteristics of the region

The Upper Mežica valley lies in the Carinthia region, in the northern part of Slovenia. The area represents a juncture between the Eastern Alps, the Southern Kamnik–Savinja Alps and the Southern Karavanke mountain chain. The area, which is characterised by steep and mountainous terrain (Čas 1996; Perko 1998), is composed of silicate rocks (cca. 80%), such as andesite, dacite, tonalite, granite and gneiss, and carbonate rocks (cca. 20%) – mainly limestone and dolomite. It is also characterised by a variety of different forest communities, the most prevalent being Homogyno – Fagetum, Cardamini Savesni Fagetum and Blechno – Fagetum (ZGS 2022). Because of human interference and a long history of mining, the natural forest communities have undergone a series of drastic changes. The degradation of the vegetation coverage is therefore visible to this day (Polšak 2011).

The area is characterised by mountainous climate, with 1,000-2,300 mm rainfall per year (ARSO 2024a). The average temperatures in the warmest month of the year exceed 10°C and are below -3°C in the coldest months of the year (ARSO 2024b). The snow cover persists for 50 to 125 days per year (ARSO 2024a). The vegetation period is four to six months long (Čas & Adamič 1998).

Parts of the researched area are registered as valuable natural features (Podpeca – habitat of petrophilic and thermophilic butterfly species, Bistra – rock and mineral depository) and NATURA 2000 areas (Žerjav – Dolina smrti, Obistove skale, Cvelbar) (OJ EC 1992; Ur. l. RS 2004a; Ur. l. RS 2004b). A great part of the forest is protected on the national level (ARSO 2023).

Field work and determinations

Isopods, which were collected by hand from April to October 2022 at 49 localities inside the Upper Mežica Valley (Fig. 1), occurred in the area of the two small towns – Žerjav (localities 11–18; Tab. 2) and Črna na Koroškem (localities 19–23, Tab. 2), on the ridge between Žerjav and Črna (locality 27, Tab. 2), in the area of Podpeca (localities 28–40; Tab. 2), above the Bistra Valley (localities 1–5; Tab. 2), in the area Spodnje Javorje (localities 6–10 and 24–25; Tab. 2), and in the area of Javorje (localities 41–49; Tab. 2).

Sampling on some localities was repeated twice owing to low number of individuals found. The aim was to cover the researched area as evenly as possible. Isopods were collected from underneath bark, rocks, wood planks, moss and other objects found on the individual locality. At every locality, the coordinates (WGS84), altitude, habitats and microhabitats were recorded. Localities inside human settlements were characterized as urban, in the immediate vicinity of settlements as semi-urban, and other localities as non-urban.

Collected isopods were preserved in 70% ethanol and sorted by species using different identification keys (Hopkin 1991; Lapanje & Schmalfuss, unpublished). All species were determined by the authors (P. Š. and P. Z.), except for *Calconiscellus karawankianus* and *Tachysoniscus austriacus*, which was identified by Miloš Vittori (Department of Biology, Biotechnical Faculty, University of Ljubljana).

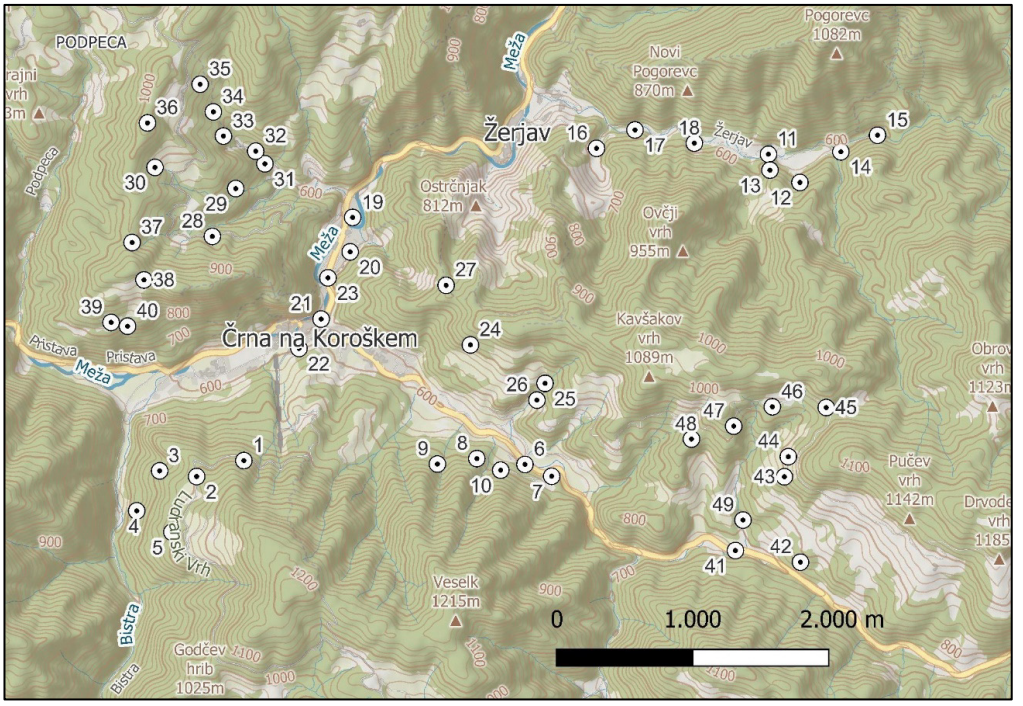

Figure 1. Map of the researched area (part of the Upper Mežica Valley; Žerjav and Črna na Koroškem) with marked localities. Number of localities refer to Tab. 2.
Slika 1. Zemljevid raziskovanega območja (del zgornje Mežiške doline; Žerjav in Črna na Koroškem) z označenimi lokalitetami. Številke lokalitet se nanašajo na Tab. 2.

Results and discussion

At the 49 surveyed localities, a total of 1,035 specimens of terrestrial isopods were collected, most of them underneath bark, rocks, and wood planks (Tab. 2). Twelve different taxa of terrestrial isopods were determined, eleven of them to the species level (Tabs. 1,2). That represents roughly 16% of all terrestrial isopod species found in Slovenia. All determined species had been previously recorded in Slovenia (Potočnik 1979, 1980, 1981, 1984, 1992, 1993; Vittori et al. 2023). The collected isopods belong to eight isopod families (Tab. 1). Parts of the researched area were impassable by foot, so a few sections of the area remain unsearched.

Table 1. List of isopod species found from April to October 2022 in the Upper Mežica Valley. The locality IDs are indicated by numbers from 1 to 49 as described in Tab. 2.
Tabela 1. Seznam vrst enakonožcev, nabranih od aprila do oktobra 2022 na območju zgornje Mežiške doline. Lokalitete so označene s števili od 1 do 49, kot opisano v Tab. 2.

Family/Species	Locality
Agaridae	
Protracheoniscus politus (Koch, 1841)	28, 31, 38
Armadillidiidae	
Armadillidium versicolor Stein, 1859	6, 17, 21, 22, 23, 25, 41
Armadillidium vulgare (Latreille, 1804)	19, 20
Cylisticidae	
Cylisticus convexus (De Geer, 1778)	17, 19, 28
Ligiidae	
Ligidium hypnorum (Cuvier, 1792)	25, 28, 32, 49
Oniscidae	
Oniscus asellus Linnaeus, 1758	21
Porcellionidae	
Porcellio scaber Latreille, 1804	19, 21, 41
Porcellio spinicornis Say, 1818	6, 19, 21, 22
Trachelipodidae	
Trachelipus ratzeburgii (Brandt, 1833)	all except 21, 23, 41
Trichoniscidae	
Calconiscellus karawankianus (Verhoef, 1908)	12, 14, 15
Hyloniscus sp.	18, 22
Tachysoniscus austriacus (Verhoeff, 1908)	31

The majority of specimens were collected in the forest or on the forest edge, near dirt roads, forest trails, meadows, and streams. The researched area is mainly forest covered, which suits the forest specialist *Trachelipus ratzeburgii*. The species constitutes a great majority of all collected specimens and was found on all researched localities, except for three of them (Tab. 1). *T. ratzeburgii* is commonly found in humid forest in Central and Southeast Europe (Radu 1985; Tomescu et. al. 2015). The species *Ligidium hypnorum*, *Calconiscellus karawankianus* and *Protracheoniscus politus* were found exclusively in wooded areas. *L. hypnorum* is distributed throughout Europe and West Asia. The species prefers humid deciduous forests, swamps, and banks (Friedrich 2004). *Protracheoniscus politus* was found only on three localities, although it has been frequently found in other regional studies of isopod fauna in Slovenia (Potočnik 1979, 1989, 1990; Vilisich & Lapanje 2005; Ravnjak & Kos 2014). The species *Armadillidium versicolor* was registered on 14% of all sampling sites, mostly those near a river or stream. The species is distributed in Eastern Europe, predominantly near rivers and lakeshores (Schmalfuss 2002; Csonka et al. 2013). The rest of the collected isopod species were found on less than 10% of all sampling sites.

The highest biodiversity of terrestrial isopods was ascertained in urban and semi-urban localities of Črna na Koroškem (Tab. 2). There we also found *Porcellio scaber*, *P. spinicornis*, *Cylisticus convexus* and *A. vulgare*, which are to be expected given by their synanthropic nature (Schmalfuss 2002; Magura et al. 2008; Holland 2014; Boeraeve et al. 2021). *P. spinicornis* is rarely found in Slovenia, but more often in the urban environment in neighbouring Austria (GBIF 2024). At a construction site in the centre of Črna na Koroškem (location 21; Tab. 2) we also

found one specimen of *Oniscus asellus*. *O. asellus* is mostly distributed in Northern and Western Europe, where it is frequently found in woodlands, but is common also in the human settlement areas like gardens. *O. asellus* often occurs sympatrically with *P. scaber* (Beyer 1964), which is a common synanthropic species in Slovenia, while the distribution of *O. asellus* in Slovenia is poorly recorded. Črna na Koroškem is probably the second documented location of *O. asellus* in Slovenia besides Ljubljana (Potočnik 1980). The town is located in the narrow valley of the river Meža and its tributaries, so an urban environment with parks and gardens is surrounded by steep slopes covered with forest. In such an environment, native forest and synanthropic species can be found, together with occasional introduced species, as most probably is the case of *O. asellus*. Earlier it was reported that urban environment might offer a great diversity of habitats, which also results in a greater species diversity of isopods (Vilisics et al. 2005; Vilisics & Hornung 2009).

Table 2. List of localities with corresponding coordinates, altitude (Alt, in metres), sampling date, habitat description and list of collected isopod taxa. The estimated number of isopods on the location is presented as N. Classif. refers to classification: U – urban, SU – semi-urban, NU – non-urban environment.

Tabela 2. Seznam lokalitet z opisom koordinat, nadmorsko višino (Alt, v metrih), datumom vzorčenja, opisom habitata in seznamom enakonožcev, nabranih na posamezni lokaliteti. Ocena številčnosti enakonožcev na lokaciji je podana kot N. Classif se nanaša na klasifikacija lokalitet: U – urbano, SU – delno-urbano, NU – neurbano okolje.

ID	Name	Lat, Lon (WGS84)	Alt (m)	Sampling date	Classif.	Habitat	Species (N)
1	N slope of Ludranski Vrh; SW of Črna na Koroškem	46.461525, 14.842983	878	15. 5. 2022	NU	forest edge (dirt road); underneath bark	*T. ratzeburgii* (> 20)
2	NW slope of Ludranski Vrh, above the Bistra Valley; SW of Črna na Koroškem	46.460462, 14.838461	886	15. 5. 2022	NU	forest edge (meadow, dirt road); underneath rocks	*T. ratzeburgii* (> 20)
3	W slope of Ludranski Vrh, above the Bistra Valley; SW of Črna na Koroškem	46.460834, 14.834918	788	15. 5. 2022	NU	forest (forest trail); underneath bark	*T. ratzeburgii* (> 20)
4	W slope of Ludranski Vrh, above the Bistra Valley; SW of Črna na Koroškem	46.458186, 14.832730	720	15. 5. 2022	NU	forest (forest trail); underneath rocks	*T. ratzeburgii* (7)
5	NW slope of Ludranski Vrh, above the Bistra Valley; SW of Črna na Koroškem	46.456786, 14.836105	906	15. 5. 2022	NU	forest (forest trail); underneath bark	*T. ratzeburgii* (> 50)
6	Forest edge near Spodnje Javorje, 50 m SW of Javorski potok; SE of Črna na Koroškem	46.461304, 14.869906	642	17. 4. 2022, 19. 9. 2022	SU	unpaved parking lot of wood production (near road, stream); underneath rocks, bark;	*T. ratzeburgii* (3) *A. versicolor* (7) *P. spinicornis* (4)
7	Forest near Spodnje Javorje, 100 m S of Javorski potok; SE of Črna na Koroškem	46.460525, 14.872465	647	17. 4. 2022	NU	forest edge (meadow, dirt road); underneath bark	*T. ratzeburgii* (8)
8	Forest near Spodnje Javorje; SE of Črna na Koroškem	46.461684, 14.865292	696	17. 4. 2022	NU	forest edge (dirt road); underneath rocks	*T. ratzeburgii* (8)

ID	Name	Lat, Lon (WGS84)	Alt (m)	Sampling date	Classif.	Habitat	Species (N)
9	Forest near Spodnje Javorje; SE of Črna na Koroškem	46.461319, 14.861521	733	17. 4. 2022	NU	forest edge (dirt road); underneath rocks	*T. ratzeburgii* (9)
10	Forest near Spodnje Javorje; SE of Črna na Koroškem	46.460923, 14.867582	682	17. 4. 2022	NU	forest edge (forest trail, near farm); underneath rocks, bark	*T. ratzeburgii* (9)
11	Forest edge, 100 m S of Jazbinski potok; E of Žerjav	46.481821, 14.893181	576	24. 4. 2022	SU	unpaved parking lot (forest edge); underneath rocks, wood planks	*T. ratzeburgii* (2)
12	Forest; E of Žerjav	46.479957, 14.896205	628	24. 4. 2022, 19. 9. 2022	NU	forest (forest trail); underneath rocks, bark	*T. ratzeburgii* (> 20) *C. karawankianus (4)*
13	Forest; E of Žerjav	46.480770, 14.893331	617	24. 4. 2022	NU	forest edge (dirt road); underneath rocks	*T. ratzeburgii* (> 20)
14	Forest edge near stream; E of Žerjav	46.481990, 14.900120	579	24. 4. 2022	NU	dirt road (near stream); underneath wood planks, rocks	*T. ratzeburgii* (> 20) *C. karawankianus (4)*
15	Forest edge, 100 m S of Jazbinski potok; E of Žerjav	46.483088, 14.903630	648	24. 4. 2022, 19. 9. 2022	NU	forest edge (near road); underneath bark, wood planks	*T. ratzeburgii* (> 20) *C. karawankianus (4)*
16	Forest near sandpit; SE of Žerjav	46.482193, 14.876708	576	7. 5. 2022	NU	woodshed, garage (forest edge, near dirt road, near quarry); underneath wood planks	*T. ratzeburgii* (> 20)
17	Forest edge, 50 m S of Jazbinski potok; E of Žerjav	46.483411, 14.880392	553	7. 5. 2022, 19. 9. 2022	SU	woodshed (forest edge, near road); underneath rocks, bark, wood planks	*T. ratzeburgii* (> 20) *A. versicolor* (1) *C. convexus* (1)
18	Forest edge near sandpit, 20 m S of Jazbinski potok; E of Žerjav	46.482547, 14.886083	574	7. 5. 2022	NU	closed sandpit (forest edge); underneath rocks, bark	*T. ratzeburgii* (> 20) *Hyloniscus sp. (1)*
19	Unpaved parking lot, 100 m W of Meža river; Črna na Koroškem	46.477603, 14.853358	552	7. 5. 2022, 19. 9. 2022	U	unpaved parking lot; underneath rocks, wood planks	*T. ratzeburgii* (2) *A. vulgare* (> 10) *C. convexus* (6) *P. scaber* (> 20) *P. spinicornis* (> 10)
20	Meadow near house; Črna na Koroškem	46.475327, 14.853126	572	7. 5. 2022	U	town (meadow); compost	*T. ratzeburgii* (> 50) *A. vulgare* (2)

ID	Name	Lat, Lon (WGS84)	Alt (m)	Sampling date	Classif.	Habitat	Species (N)
21	Construction site in town center, near Meža river; Črna na Koroškem	46.470882, 14.850357	577	7. 5. 2022	U	construction site (behind abandoned building); underneath wood planks	*A. versicolor* (7) *O. asellus* (1) *P. scaber* (7) *P. spinicornis* (2)
22	Forest edge near cementery; Črna na Koroškem	46.468941, 14.848243	600	7. 5. 2022, 1. 10. 2022	U	graveyard (stone wall, forest edge); underneath barrel, bark, roof tile	*T. ratzeburgii* (6) *A. versicolor* (3) *Hyloniscus sp. (2)* *P. spinicornis* (2)
23	Walkway in town center; Črna na Koroškem	46.473609, 14.851005	577	8. 5. 2022	U	walkway (near road in town centre); on pavement	*A. versicolor* (1)
24	Forest near Spodnje Javorje; E of Črna na Koroškem	46.469193, 14.864661	864	8. 5. 2022	NU	forest (dirt road); underneath bark	*T. ratzeburgii* (> 20)
25	Forest edge, S of Matvoz climbing area; E of Črna na Koroškem	46.466664, 14.871815	735	8. 5. 2022	NU	forest edge (near road, meadow); underneath bark	*T. ratzeburgii* (> 50) *A. versicolor* (1) *L. hypnorum* (1)
26	Forest near Spodnje Javorje; E of črna na Koroškem	46.465554, 14.871039	743	8. 5. 2022	NU	forest edge (near road); underneath bark	*T. ratzeburgii* (6)
27	Ridge S of Žerjav; NE of Črna na Koroškem	46.473128, 14.862325	829	8. 5. 2022	NU	forest (forest trail); underneath bark	*T. ratzeburgii* (> 50)
28	E slope of Podpeca; NW of Črna na Koroškem	46.476332, 14.839922	779	13. 4. 2022, 1. 10. 2022	NU	forest edge (dirt road); underneath rocks, moss	*T. ratzeburgii* (> 20) *C. convexus* (1) *L. hypnorum* (4) *P. politus* (1)
29	E slope of Podpeca; NW of Črna na Koroškem	46.479492, 14.842151	741	13. 4. 2022	NU	dirt road - underneath bark	*T. ratzeburgii* (9)
30	Ridge of Podpeca; NW of Črna na Koroškem	46.480880, 14.834410	905	1. 10. 2022	NU	wood pile (forest edge, dirt road, near farm); underneath bark	*T. ratzeburgii* (> 50)
31	E slope of Podpeca, near stream; NW of Črna na Koroškem	46.481133, 14.844944	651	13. 4. 2022, 1. 10. 2022	NU	farm (forest edge, near stream); underneath rocks, wood planks, bark	*T. ratzeburgii* (6) *P. politus* (1) *T. austriacus* (2)
32	E slope of Podpeca; NW of Črna na Koroškem	46.481966, 14.844057	697	13. 4. 2022, 1. 10. 2022	NU	forest (forest trail); underneath bark, on surface	*T. ratzeburgii* (> 10) *L. hypnorum* (1)
33	E slope of Podpeca; NW of Črna na Koroškem	46.482961, 14.840962	779	22. 5. 2022	NU	forest (forest trail); underneath bark	*T. ratzeburgii* (> 20)
34	E slope of Podpeca; NW of Črna na Koroškem	46.484555, 14.839993	823	22. 5. 2022	NU	forest (forest trail); underneath bark	*T. ratzeburgii* (> 100)
35	E slope of Podpeca; NW of Črna na Koroškem	46.486380, 14.838720	905	22. 5. 2022	NU	forest (forest trail); underneath bark	*T. ratzeburgii* (> 20)
36	Ridge of Podpeca; NW of Črna na Koroškem	46.483818, 14.833683	1010	22. 5. 2022	NU	forest (forest trail); underneath bark	*T. ratzeburgii* (> 20)

ID	Name	Lat, Lon (WGS84)	Alt (m)	Sampling date	Classif.	Habitat	Species (N)
37	Ridge of Podpeca; W of Črna na Koroškem	46.475915, 14.832233	908	22. 5. 2022	NU	forest edge (dirt road); underneath bark	*T. ratzeburgii* (6)
38	Ridge of Podpeca, W of zipline; W of Črna na Koroškem	46.473446, 14.833379	949	22. 5. 2022	NU	wood pile (forest edge, meadow, dirt road); underneath bark, branches	*T. ratzeburgii* (> 20) *P. politus* (1)
39	S slope of Podpeca; W of Črna na Koroškem	46.470634, 14.830239	780	22. 5. 2022	NU	forest edge (meadow, dirt road); underneath rocks, wood planks	*T. ratzeburgii* (5)
40	S slope of Podpeca; W of Črna na Koroškem	46.470384, 14.831814	796	22. 5. 2022, 1. 10. 2022	NU	forest (forest trail); underneath bark	*T. ratzeburgii* (> 20)
41	Parking lot in Javorje; SE of Črna na Koroškem	46.455636, 14.890071	690	18. 6. 2022	SU	unpaved parking lot (near wood production); underneath bark, wood planks, rocks	*P. scaber* (> 10) *A. versicolor* (7)
42	Forest near Javorje; SE of Črna na Koroškem	46.454873, 14.896300	738	18. 6. 2022	NU	forest edge (dirt road); underneath rocks, bark	*T. ratzeburgii* (> 20)
43	Forest near Javorje; E of Črna na Koroškem	46.460514, 14.894749	883	18. 6. 2022	NU	forest edge (meadow); underneath bark	*T. ratzeburgii* (8)
44	Forest near Javorje; E of Črna na Koroškem	46.461841, 14.895125	909	18. 6. 2022	NU	forest edge (meadow, dirt road); underneath bark	*T. ratzeburgii* (> 50)
45	Meadow near Javorje; E of Črna na Koroškem	46.465089, 14.898751	951	18. 6. 2022	NU	forest edge (meadow, dirt road); underneath wood planks, branches	*T. ratzeburgii* (> 20)
46	Forest edge near Javorje; E of Črna na Koroškem	46.465136, 14.893590	937	18. 6. 2022	NU	forest edge (meadow, dirt road); underneath wood planks, rocks	*T. ratzeburgii* (> 20)
47	Forest near Javorje; E of Črna na Koroškem	46.463854, 14.889891	912	18. 6. 2022	NU	forest edge (dirt road); underneath rocks, bark, branches	*T. ratzeburgii* (> 50)
48	Forest near Javorje; E of Črna na Koroškem	46.462997, 14.885844	865	18. 6. 2022	NU	wood production disposal area (forest edge, dirt road); underneath wood planks, branches, bark	*T. ratzeburgii* (> 50)
49	Forest edge by stream, near Javorje; SE of Črna na Koroškem	46.457653, 14.890792	700	18. 6. 2022	NU	edge of dirt road (forest edge, near stream); underneath rocks, bark	*T. ratzeburgii* (8) *L. hypnorum* (1)

Povzetek

Favna enakonožcev je kljub izčrpnim raziskavam Potočnika (1979, 1980, 1981, 1984, 1992, 1993) in drugih raziskovalcev (Vilisics & Lapanje 2005; Ravnjak & Kos 2014; Vittori 2022; Vittori et al. 2023) na številnih delih Slovenije še vedno slabo raziskana. Zgornja Mežiška dolina spada med manj raziskana območja, kar se tiče favne enakonožcev, čeprav je območje zaradi velike habitatne pestrosti ter dolgotrajne onesnaženosti s težkimi kovinami izredno zanimivo za raziskave. Med aprilom in oktobrom 2022 smo zato napravili popis enakonožcev na območju zgornje Mežiške doline. Enakonožce smo nabrali ročno na 49 lokacijah na območju dveh večjih krajev Žerjava (lokalitete 11–18) in Črne na Koroškem (lokalitete 19–23), na slemenu med Žerjavom in Črno (lokaliteta 27), na območju Podpece (lokalitete 28–40), nad dolino Bistre (lokalitete 1–5), na območju Spodnjega Javorja (lokalitete 6–10 in 24–25) in na območju Javorja (lokalitete 41–49). Skupno smo determinirali 12 taksonomskih skupin enakonožcev, enajst od tega do vrste. Najpogosteje popisana je bila vrsta *T. ratzeburgii*, ki smo jo zabeležili skoraj na vseh lokalitetah. Velik del območja namreč prekriva gozd, kar je razlog, da je vrsta, specializirana za gozdno okolje, splošno razširjena po celotnem raziskovanem območju. Med pogosto popisanimi je bila tudi vrsta *A. versicolor*, ki smo jo zabeležili na 14 % vseh lokalitet. Največjo vrstno pestrost smo zabeležili na urbanih oz. suburbanih lokalitetah na območju Črne na Koroškem, kjer smo našli sinantropne vrste *P. scaber*, *P. spinicornis*, *Cylisticus convexus* and *A. vulgare*. Posebej zanimiva je najdba *O. asellus* v središču Črne na Koroškem, saj gre za drugo zabeleženo najdbo te vrste v Sloveniji (Potočnik 1980).

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First records of the myrmecophilous spider *Thyreosthenius biovatus* (O. Pickard-Cambridge, 1875) for Slovenia and new Slovenian records for the myrmecophilous spider *Mastigusa arietina* (Thorell, 1871)

Gregor BRAČKO, Rok KOSTANJŠEK

University of Ljubljana, Biotechnical Faculty, Department of Biology, Jamnikarjeva 101, SI-1000 Ljubljana, Slovenia;
E-mails: gregor.bracko@bf.uni-lj.si, rok.kostanjsek@bf.uni-lj.si

Abstract. Ants from the *Formica rufa* group, also known as red wood ants, build large mound nests and play an important role in their environment, especially in forests. Their nests harbour a species rich and abundant myrmecophilous fauna, including a few European spider species. Myrmecophilous spiders in 40 nests of red wood ants from 25 sites were searched for in Slovenia. In each mound nest, four to five litres of material were collected, which were placed in a sifter, with the sifted material examined for the presence of spiders. Two myrmecophilous spider species were found in the nests: *Thyreosthenius biovatus* (fam. Linyphiidae), representing first records for Slovenia, and *Mastigusa arietina* (fam. Cybaeidae), previously known from several sites in western Slovenia, but never purposefully searched for in ant nests. The first spider species was found in half of the examined nests, belonging to all sampled species of red wood ants, most of them to *F. aquilonia*, and *M. arietina* was detected in 37.5% of the examined nests, belonging to *F. aquilonia* and *F. lugubris*. The two spider species are presumably not rare in Slovenia, especially in the areas with a high number of red wood ant nests.

Key words: distribution, *Formica*, myrmecophiles, red wood ants, Slovenia, spiders

Izvleček. Prve najdbe mirmekofilnega pajka *Thyreosthenius biovatus* (O. Pickard-Cambridge, 1875) za Slovenijo in nove slovenske najdbe mirmekofilnega pajka *Mastigusa arietina* (Thorell, 1871) – Mravlje iz skupine *Formica rufa*, poznane tudi kot rdeče gozdne mravlje, gradijo velika kopasta mravljišča in imajo v svojem okolju, še posebno v gozdovih, pomembno vlogo. Njihova mravljišča so zatočišča za vrstno bogato in številčno mirmekofilno favno, ki vključuje tudi nekaj evropskih vrst pajkov. Mirmekofilne pajke smo iskali v 40 mravljiščih rdečih gozdnih mravelj iz 25 lokalitet v Sloveniji. V vsakem od kopastih mravljišč smo vzeli od štiri do pet litrov materiala, ga dali v sejalnik in pregledali presejani material, ali so v njem pajki. V mravljiščih smo našli dve vrsti mirmekofilnih pajkov: *Thyreosthenius biovatus* (družina Linyphiidae), kar je prva najdba za Slovenijo, in *Mastigusa arietina* (družina Cybaeidae), ki je bila pred tem znana iz več lokalitet v zahodni Sloveniji, a nikoli ciljano iskana v mravljiščih. Prva vrsta pajka je bila najdena v polovici preiskanih mravljišč, ki so pripadala vsem vzorčenim vrstam rdečih gozdnih mravelj, vrsta *M. arietina* pa je bila odkrita v 37,5 % preiskanih mravljišč, ki so pripadala vrstama *F. aquilonia* in *F. lugubris*. Predvidevamo, da ti vrsti pajkov v Sloveniji nista redki, zlasti na območjih z velikim številom mravljišč rdečih gozdnih mravelj.

Ključne besede: razširjenost, *Formica*, mirmekofili, rdeče gozdne mravlje, Slovenija, pajki

Introduction

Ant colonies can be considered as partially isolated ecosystem, their nests and surroundings are structured into many diverse microhabitats (Hölldobler & Wilson 1990). Nests are often rich in long-lasting resources, such as brood, retrieved or cultivated food, and nutrient-rich refuse material (Parmentier 2020). Nest temperature is often strictly regulated, and colonies are commonly defended by an army of workers. These nest microhabitats are occupied by various organisms, which show special adaptations to each of the niche in turn (Hölldobler & Wilson 1990). They exploit the nest's resources and homeostatic conditions, at the same time, successful adaptation to the inner environment protects them from many predators that cannot penetrate this hostile space (Parmentier 2020).

Myrmecophiles are organisms that must spend at least part of their life cycle with ant colonies (Hölldobler & Wilson 1990). There is hardly any terrestrial arthropod group that does not include at least few myrmecophiles (Seifert 2018). They can prey on ants in the vicinity or inside nest, they can act as scavengers in the nest or prey on other myrmecophiles, some are ectoparasites or endoparasites, or in case of trophobionts, supply their ants with food (honeydew) in exchange for protection against predators (Hölldobler & Wilson 1990; Seifert 2018). Myrmecophiles use different tactics to avoid ant attacks, either they are swift and escape, use repellent secretions or mechanical defensive structures. Others are ignored because of their slow movement or an apparently indistinct odour (chemical insignificance). Some myrmecophiles have evolved different types of chemical, morphological and behavioural adaptations that deceive the host ants, which accept them as members of the colony (Hölldobler & Wilson 1990; Parmentier 2020). Ant species with the largest colonies generally harbour the greatest diversity of myrmecophiles, as nests of large colonies provide a larger variety of microhabitats and have longer life span, so they can sustain larger and more stable populations of guests over longer time periods (Hölldobler & Wilson 1990; Kronauer & Pierce 2011).

In Europe, ants from the *Formica rufa* group, also known as the red wood ants, usually build large mound nests constructed of dry plant material and soil particles (Fig. 1). They play an important role in their environment, especially in forests, where they are often ecologically dominant organisms and recognized as the keystone species and ecosystem engineers (Robinson & Stockan 2016; Sorvari 2016). Due to their large colonies and long life span, the nests of red wood ants harbour species rich and abundant myrmecophile fauna (Parmentier et al. 2014; Robinson et al. 2016).

Myrmecophilous spiders are known in 13 spider families (Cushing 1997, 2012). They can prey on ants or other myrmecophiles that live in host nests. Females of several myrmecophilous spiders lay their egg sacs inside the chambers of ant nests. Some spiders may be occasional visitors to ant colonies, using the nests as temporary refuges. In Europe, three spider species are considered myrmecophilous and are found in the nests of red wood ants, specifically *Mastigusa arietina* (Thorell, 1871) (after a recent revision by Castellucci et al. (2023a) placed to fam. Cybaeidae), *Thyreosthenius biovatus* (O. Pickard-Cambridge, 1875) and *Acartauchenius scurrilis* (O. Pickard-Cambridge, 1873) (both fam. Linyphiidae) (Cushing 1997; Parmentier et al. 2014). *Thyreosthenius biovatus* is a myrmecophile in the nests of *Formica* species, mainly from the *F. rufa* group, while the other two species are also associated with species from other ant

genera (e.g. *Lasius*, *Tetramorium*). In the nests, *T. biovatus* and *M. arietina* feed on other smaller myrmecophiles, ant eggs or ant prey (kleptoparasitism) (Parmentier et al. 2016a, 2018).

Figure 1. Nest of *Formica aquilonia* (locality Rogla (SW of the parking area)) (photo: Gregor Bračko).
Slika 1. Mravljišče vrste *Formica aquilonia* (lokaliteta Rogla (JZ od parkirišča)) (foto: Gregor Bračko).

In Slovenia, the spider fauna of the Prealpine region can be considered relatively well researched, while other biogeographic regions still have a considerable potential for new records (Kostanjšek & Kuntner 2015; Kuralt & Kostanjšek 2016). The initial checklist of Slovenian spiders comprises 738 species belonging to 286 genera and 43 families (Kostanjšek & Kuntner 2015), and over 35 additional species were subsequently found (Kuralt & Kostanjšek 2016, 2019; Kuralt et al. 2024). *Mastigusa arietina* is known from several sites in western Slovenia (Polenec 1961, 1963, 1964, 1966, 1969, 1975, 1979, 1981, 1989; Novak 2005; Gorjan 2014). It is worth mentioning that another species in the genus, specifically *M. macrophthalma* (Kulczyński, 1897), has also been recorded from several locations in western Slovenia (Kostanjšek & Kuntner 2015). Since the species differ from each other only in position and dimension of the posterior median eyes, it is not unlikely that the two forms represent separate races, rather than species (Roberts 1995). The taxonomic status of *M. macrophthalma* is therefore debated and the genus is currently under revision (Castellucci et al. 2023a). Two other myrmecophilous spiders, *Thyreosthenius biovatus* and *Acartauchenius scurrilis*, have so far never been recorded from Slovenia.

Our sampling of arthropods in the mound nests of the *Formica rufa* group at several sites in Slovenia yielded the first records of *Thyreosthenius biovatus* for the country and several new records of *Mastigusa arietina*.

Materials and methods

In the period from June to October 2023, we sampled arthropods in the mound nests of the *Formica rufa* group. Forty nests were examined at 25 sites, mainly in the northern parts of Slovenia (Tab. 1).

Table 1. Information on sampled nests of red wood ants (*Formica rufa* group) in Slovenia in 2023.
Tabela 1. Podatki o vzorčenih mravljiščih rdečih gozdnih mravelj (skupina *Formica rufa*) v Sloveniji leta 2023.

Nest no.	*Formica* species	Locality	WGS84 coordinates [dec. degr. N/E]	Altitude [m]	Habitat	Date of sampling
1	*F. aquilonia*	Vršič (near Erjavčeva koča)	46.4385/13.74817	1530	Alpine grassland with *Larix decidua*	12.9.2023
2	*F. polyctena*	Kranjska Gora (Golf Course)	46.4885/13.80517	780	belt of trees next to golf course	12.10.2023
3	*F. lugubris*	Vrata Valley (NE of Aljažev Dom)	46.41317/13.85	980	pasture with isolated spruces	12.10.2023
4	*F. lugubris*	Vrata Valley (NE of Aljažev Dom)	46.41317/13.85	980	edge of spruce forest	12.10.2023
5	*F. aquilonia*	Pokljuka (W of Planina Praprotnica loc. 1)	46.327/13.91283	1230	edge of spruce forest	23.7.2023
6	*F. aquilonia*	Pokljuka (W of Planina Praprotnica loc. 1)	46.327/13.91283	1230	edge of spruce forest	23.7.2023
7	*F. aquilonia*	Pokljuka (W of Planina Praprotnica loc. 2)	46.32567/13.9145	1230	pasture with isolated spruces	23.7.2023
8	*F. aquilonia*	Pokljuka (W of Planina Praprotnica loc. 2)	46.32567/13.9145	1230	open mixed forest	23.7.2023
9	*F. polyctena*	S of Matavun near Divača	45.661/13.992	410	mixed forest	27.9.2023
10	*F. lugubris*	Soriška Planina (NW of Lajnar)	46.24433/14.00667	1280	grassland with isolated spruces	20.8.2023
11	*F. lugubris*	Soriška Planina (SW of Lajnar)	46.2415/14.00767	1280	open spruce forest	20.8.2023
12	*F. lugubris*	Soriška Planina (SW of Lajnar)	46.2415/14.00767	1280	open spruce forest	20.8.2023
13	*F. lugubris*	Ljubelj Pass (W of parking area)	46.43183/14.25917	1060	edge of mixed forest along the path	12.10.2023
14	*F. rufa*	2.5 km NW of Podljubelj near Tržič	46.42033/14.26933	810	edge of mixed forest along the path	12.10.2023
15	*F. polyctena*	Krancelj near Škofja Loka	46.162/14.30133	460	edge of mixed forest	13.8.2023
16	*F. rufa*	1 km SW of Golnik near Kranj	46.31917/14.32383	450	edge of mixed forest along the road	14.10.2023
17	*F. rufa*	1.5 km N of Bevke near Vrhnika	45.99817/14.36167	300	spruce forest	16.7.2023
18	*F. rufa*	1.5 km N of Bevke near Vrhnika	45.99817/14.36167	300	edge of spruce forest	16.7.2023

Nest no.	*Formica* species	Locality	WGS84 coordinates [dec. degr. N/E]	Altitude [m]	Habitat	Date of sampling
19	*F. rufa* × *polyctena*	1.5 km N of Bevke near Vrhnika	45.99817/14.36167	300	edge of spruce forest	16.7.2023
20	*F. lugubris*	Menina Planina (NW area)	46.26883/14.805	1370	edge of spruce forest	8.7.2023
21	*F. lugubris*	Menina Planina (NW area)	46.26883/14.805	1370	edge of spruce forest	8.7.2023
22	*F. lugubris*	Menina Planina (NW area)	46.26883/14.805	1370	edge of spruce forest	8.7.2023
23	*F. aquilonia*	Menina Planina (0.5 km NW of the hut)	46.26433/14.81583	1420	open spruce forest	8.7.2023
24	*F. aquilonia*	Menina Planina (0.5 km NW of the hut)	46.26433/14.81583	1420	open spruce forest	8.7.2023
25	*F. aquilonia*	Menina Planina (0.7 km W of the chapel)	46.24517/14.83117	1310	edge of spruce forest	8.7.2023
26	*F. aquilonia*	Rogla (SW of the parking area)	46.44933/15.32033	1430	open spruce forest	10.6.2023
27	*F. aquilonia*	Rogla (SW of the parking area)	46.44933/15.32033	1430	open spruce forest	10.6.2023
28	*F. aquilonia*	Rogla (SW of the parking area)	46.44933/15.32033	1430	open spruce forest	10.6.2023
29	*F. aquilonia*	Rogla (S of the parking area)	46.44667/15.334	1350	spruce forest	10.6.2023
30	*F. aquilonia*	Rogla (S of the parking area)	46.44667/15.334	1350	spruce forest	10.6.2023
31	*F. aquilonia*	Pohorje (0.5 km N of Jurgovo)	46.46367/15.37267	1240	edge of spruce forest	24.6.2023
32	*F. aquilonia*	Pohorje (1 km S of Lukanja)	46.432/15.39383	1030	edge of spruce forest	24.6.2023
33	*F. aquilonia*	Pohorje (1 km S of Lukanja)	46.432/15.39383	1030	edge of spruce forest	24.6.2023
34	*F. aquilonia*	Pohorje (Osankarica)	46.45867/15.42683	1200	edge of spruce & pine forest	24.6.2023
35	*F. aquilonia*	Pohorje (Osankarica)	46.45867/15.42683	1200	edge of spruce forest	24.6.2023
36	*F. aquilonia*	Pohorje (Areh, near Ruška koča)	46.49717/15.51317	1200	edge of spruce forest	1.8.2023
37	*F. aquilonia*	Pohorje (Areh, near Ruška koča)	46.49717/15.51317	1200	edge of spruce forest	1.8.2023
38	*F. lugubris*	Mariborsko Pohorje (1.5 km SW of Hotel Bellevue)	46.50467/15.5625	1060	edge of mixed forest	1.8.2023
39	*F. lugubris*	Mariborsko Pohorje (slope NE of Hotel Bellevue)	46.51483/15.58083	1030	edge of spruce forest	1.8.2023
40	*F. rufa*	1.5 km S of Apače near Gornja Radgona	46.68467/15.906	220	mixed forest	2.8.2023

Sampling of spiders in the nests of the *Formica rufa* group was carried out by digging by hand inside the mound and collecting four to five litres of nest material. This was placed in the litter sifter with 5 × 5 mm mesh. The sifted material was placed on a white sheet and carefully examined for the presence of spiders (juvenile or adult specimens) and other arthropods. Detected specimens and some host ants were collected and preserved in 96% ethanol. After inspection, the nest material, together with ants, was returned to the sampled nest.

Spiders were identified using on-line taxonomic key Spiders of Europe (Nentwig et al. 2023), and *Formica* ants using key in Seifert (2018).

Results and discussion

Spiders and other arthropods were examined in 40 nests of the *Formica rufa* group: 20 examined nests belonged to *F. aquilonia*, 11 to *F. lugubris*, 5 to *F. rufa*, 3 to *F. polyctena*, and one colony was identified as a hybrid *F. rufa* × *polyctena* (Tab. 1). Our search for the red wood ants nests was not random, as we focused mainly on the areas where these nests are more common, specifically in the Alpine and Prealpine regions of Slovenia above 1,000 m altitude. In these areas, *F. aquilonia* and *F. lugubris* are by far the commonest species of the *F. rufa* group (Bračko 2023).

Thyreosthenius biovatus (Fig. 2A) was found at 13 different sites in 20 nests (half of all examined nests), belonging to all sampled species of red wood ants, most of them to *F. aquilonia* (Figs. 3, 4). *Mastigusa arietina* (Fig. 2B) was found at 11 sites in 15 nests (37.5% of the nests examined), but only in *F. aquilonia* and *F. lugubris* (Figs. 3, 4).

Of the two most frequently sampled ant species, i.e. *F. aquilonia* and *F. lugubris*, the first seems to be preferred by both myrmecophilous spiders. *Thyreosthenius biovatus* was recorded in 65% of *F. aquilonia* nests and in 36% of the *F. lugubris* nests examined, while *Mastigusa arietina* was found in 60% of the *F. aquilonia* and in 27% of the *F. lugubris* nests examined. In seven cases, both spider species were present in the same *F. aquilonia* nest, which was not detected in *F. lugubris* or any other sampled wood ant species. The reason for this preference could be that at the visited sites with *F. aquilonia*, the nests of this species were very numerous, especially in the area of Rogla and Pohorje, which enables larger populations of myrmecophiles.

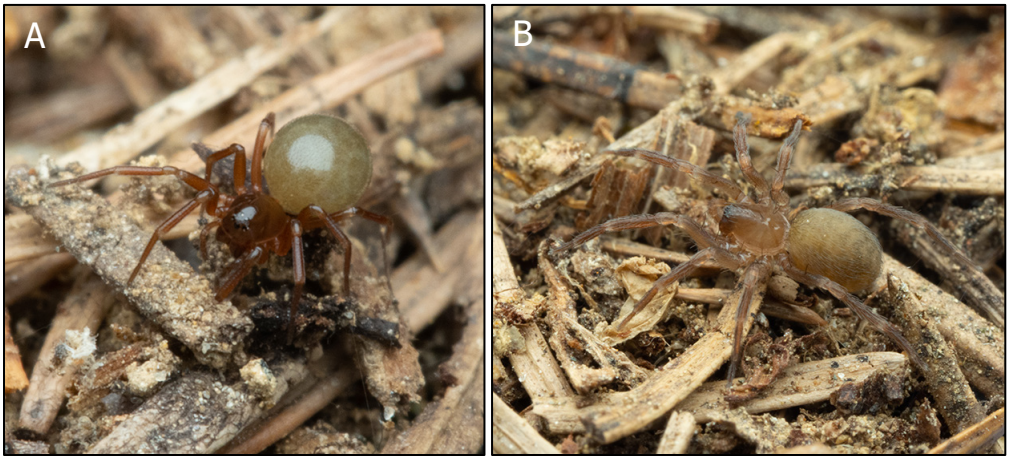

Figure 2. *Thyreosthenius biovatus* female (A) and *Mastigusa arietina* female (B) from locality Pohorje (1 km S of Lukanja) (photo: Gregor Bračko).
Slika 2. *Thyreosthenius biovatus* samica (A) in *Mastigusa arietina* samica (B) z lokalitete Pohorje (1 km J od Lukanje) (foto: Gregor Bračko).

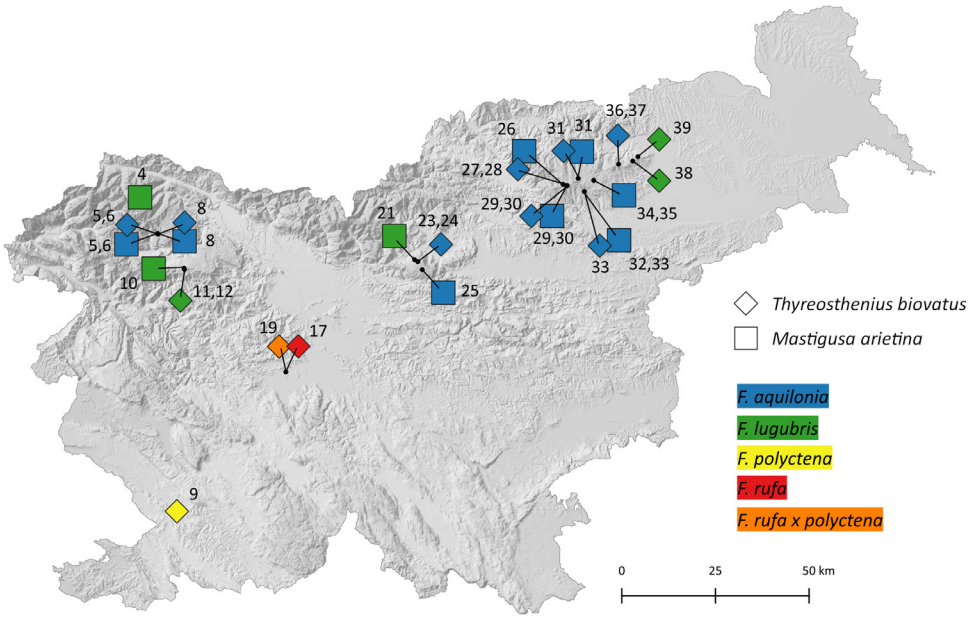

Figure 3. Localities of the spider species *Thyreosthenius biovatus* and *Mastigusa arietina* in Slovenia (the numbers next to symbols refer to successive nest numbers as shown in Tab. 1; the different colours of the symbols refer to different *Formica* host species).
Slika 3. Najdišča vrst pajkov *Thyreosthenius biovatus* in *Mastigusa arietina* v Sloveniji (številke ob simbolih se nanašajo na zaporedne številke mravljišč, kot so prikazane v Tab. 1; različne barve simbolov se nanašajo na različne gostiteljske vrste Formica).

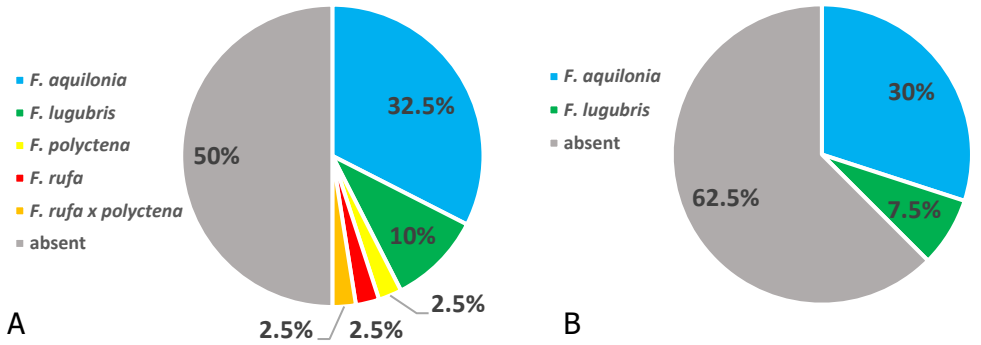

Figure 4. The presence of two myrmecophilous spider species (A – *Thyreosthenius biovatus*, B – *Mastigusa arietina*) in the examined ant nests of the *Formica rufa* group (percentage according to all examined nests (n = 40)).
Slika 4. Prisotnost dveh vrst mirmekofilnih pajkov (A – *Thyreosthenius biovatus*, B – *Mastigusa arietina*) v preiskanih mravljiščih mravelj skupine *Formica rufa* (odstotek glede na vsa preiskana mravljišča (n = 40)).

In a similar study conducted in the Italian Alps, the two myrmecophilous spider species were found in the nests of *F. aquilonia* (most frequently), *F. lugubris*, *F. paralugubris* (a species not known for Slovenia), *F. polyctena* and *F. rufa* (Castellucci et al. 2022). In contrast to our study, *M. arietina* was more common in the nests than *T. biovatus* (found in 81% of the examined nests compared to 31% for *T. biovatus*). Prior to their study, there had been no literature records of *M. arietina* from nests of *F. aquilonia*, *F. lugubris* and *F. paralugubris*, and *T. biovatus* had not been recorded from the nests of *F. aquilonia*. According to Castellucci et al. (2022), this is probably due to taxonomic uncertainties, as in previous literature many of the red wood ants were not correctly identified and were often given as *Formica rufa*. Our results confirm the conclusions of Castellucci et al. (2022), as the two spider species were regular guests in the *F. aquilonia* and *F. lugubris* colonies examined.

Despite long history of spider research in Slovenia, *T. biovatus* had not been recorded previously from the country, presumably due to absence of sampling in the mounds of red wood ants. Our results indicate that this species is not rare in Slovenia. We found it in half of the examined nests, which belonged to all of the studied ant species. The localities of *T. biovatus* are situated mainly in the Alpine and Prealpine parts of the country, but also in the Submediterranean region (locality Matavun).

Similarly to *T. biovatus*, *M. arietina* was never searched for inside red wood ant nests, or the nest of other ant species, despite of being aware of its common association with ants (Polenec 1964). Records of the species by Polenec and other authors (summarized in Kostanjšek & Kuntner 2015) originate mainly from sampling of *M. arietina* in pitfall traps or sifting the leaf litter, presumably close to host ant nests. This spider species is less integrated into wood ant colonies compared to *T. biovatus* (Parmentier et al. 2014, 2016b; Nentwig et al. 2023) and is probably more active also in the vicinity of the host nests. The results of the present study show that *M. arietina* is common in the nests of *F. aquilonia* and not rare in the nests of *F. lugubris*, which means that this spider species is probably widespread in the Alpine and at higher altitudes of Prealpine regions of Slovenia, where the two host ant species are common.

Similar to some other European countries, e.g. Spain (Castellucci et al. 2023b), Denmark (Scharf & Gudik-Sørensen 2006), Belgium (Parmentier et al. 2022) and Italy (Castellucci et al. 2022), our study confirms that additional approaches in fieldwork, such as sampling for spiders in ant nests, can provide new records of *T. biovatus* and *M. arietina* and reveal that these spiders are not as rare as previously thought. Myrmecophiles have never been systematically sampled in Slovenia, so many species are missing from the checklists. This should be improved by future studies on these guests of ant colonies.

Povzetek

Mravljišča in njihovo neposredno okolico sestavlja veliko raznolikih mikrohabitatov, ki jih poseljujejo različni organizmi. Mirmekofili so organizmi, ki morajo vsaj del svojega življenja preživeti s kolonijami mravelj (Hölldobler & Wilson 1990). Zlasti velike, dolgoživeče kolonije vsebujejo vrstno bogato in številčno favno mirmekofilov (Hölldobler & Wilson 1990; Kronauer & Pierce 2011). Med takimi so tudi rdeče gozdne mravlje (skupina *Formica rufa*), ki gradijo velika kopasta mravljišča in imajo v okolju, ki ga poseljujejo, zelo pomembno vlogo, zato so pogosto prepoznane kot ključne vrste in ekosistemski inženirji (Robinson & Stockan 2016; Sorvari 2016).

Med mirmekofili, ki jih srečamo v mravljiščih rdečih gozdnih mravelj, so tudi pajki, v Evropi predvsem vrsti *Thyreosthenius biovatus* (O. Pickard-Cambridge, 1875) (družina Linyphiidae) in *Mastigusa arietina* (Thorell, 1871) (družina Cybaeidae) (Cushing 1997; Parmentier et al. 2014). V kolonijah gozdnih mravelj plenita bodisi druge manjše mirmekofilne vrste, jajca mravelj ali pa mravljam kradeta njihov plen (Parmentier et al. 2016a, 2018). Kljub relativno dolgi zgodovini raziskav favne pajkov v Sloveniji, vrsta *T. biovatus* pri nas še ni bila zabeležena, vrsta *M. arietina*, ki je sicer poznana iz več lokalitet v zahodni Sloveniji, pa nikoli ni bila ciljano vzorčena v mravljiščih (Kostanjšek & Kuntner 2015).

V obdobju od junija do oktobra 2023 smo sistematično iskali členonožce v mravljiščih rdečih gozdnih mravelj. Vzorčili smo na 25 lokalitetah, predvsem v severnem delu Slovenije. Iz kopastega dela mravljišča smo vzeli od štiri do pet litrov materiala in ga dali v sejalnik, presejani material skrbno pregledali in iz njega pobrali pajke ter druge členonožce.

Skupno smo pregledali 40 mravljišč rdečih gozdnih mravelj. Največ pregledanih mravljišč je pripadalo vrsti *F. aquilonia*, sledile so *F. lugubris*, *F. rufa*, *F. polyctena*, eno kolonijo pa smo določili kot hibrid *F. rufa* x *polyctena*. V naši raziskavi smo našli obe omenjeni vrsti mirmekofilni pajkov. *Thyreosthenius biovatus* smo odkrili v polovici od vseh preiskanih mravljišč, največkrat pri *F. aquilonia*, sicer pa smo jo zabeležili pri vseh vzorčenih vrstah rdečih gozdnih mravelj. *Mastigusa arietina* smo našli v 37,5 % pregledanih mravljišč, in sicer le pri vrstah *F. aquilonia* in *F. lugubris*. V sedmih primerih smo v istem mravljišču (v vseh primerih vrste *F. aquilonia*) zabeležili obe vrsti pajkov. Izmed dveh vrst mravelj, ki sta bili najpogosteje vzorčeni (*F. aquilonia* in *F. lugubris*), v naši raziskavi obe vrsti pajkov dajeta prednost gostovanju pri *F. aquilonia*.

Z našo raziskavo smo prvič pri nas ciljano ugotavljali prisotnost mirmekofilnih pajkov v mravljiščih rdečih gozdnih mravelj. Podatki raziskave nakazujejo, da obe vrsti pajkov v Sloveniji nista redki, še posebno v alpski regiji in v višjih predelih predalpske regije, kjer so rdeče gozdne mravlje (predvsem vrsti *F. aquilonia* in *F. lugubris*) precej pogoste.

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A contribution to the Slovenian spider fauna – V

Žan KURALT[1*], Neža PAJEK ARAMBAŠIČ[2], Maja FERLE[3], Rok KOSTANJŠEK[4]

[1]Genialis d.o.o., Vojkova cesta 63, SI-1000 Ljubljana, Slovenia
[2]Faculty of Computer and Information Science, University of Ljubljana, Večna pot 113, SI-1000 Ljubljana, Slovenia
[3]National Institute of Biology, Večna pot 121, SI-1000 Ljubljana, Slovenia
[4]Department of Biology, Biotechnical Faculty, University of Ljubljana, Jamnikarjeva 101, SI-1000 Ljubljana, Slovenia
[*]corresponding author; E-mail: zan.kuralt@gmail.com

Abstract. The present study discusses and reports on 29 spider species new to Slovenian fauna, specifically: *Larinioides patagiatus*, *Cyrtarachne ixoides*, *Pritha nana*, *Marinarozelotes adriaticus*, *Micaria micans*, *Scotophaeus blackwalli*, *Zelotes similis*, *Agyneta orites*, *Donacochara speciosa*, *Lasiargus hirsutus*, *Trichoncus sordidus*, *Walckenaeria vigilax*, *Alopecosa taeniata*, *Pardosa oreophila*, *Pardosa sordidata*, *Pardosa paludicola, Pardosa sphagnicola*, *Xerolycosa miniata*, *Mimetus laevigatus*, *Philodromus laricium*, *Philodromus vagulus*, *Attulus rupicola*, *Marpissa radiata*, *Micrommata ligurina*, *Euryopis quinqueguttata*, *Parasteatoda tabulata*, *Phoroncidia paradoxa*, *Rhomphaea rostrata*, and *Robertus mediterraneus*.

Key words: Araneae, new records, spiders, Slovenia, endemics, Neozoa, Southern Alps

Izvleček. Prispevek k slovenski favni pajkov – V – Prispevek obravnava najdbe 29 vrst pajkov, ki v Sloveniji doslej še niso bile zabeležene, in sicer: *Larinioides patagiatus*, *Cyrtarachne ixoides*, *Pritha nana*, *Marinarozelotes adriaticus*, *Micaria micans*, *Scotophaeus blackwalli*, *Zelotes similis*, *Agyneta orites*, *Donacochara speciosa*, *Lasiargus hirsutus*, *Trichoncus sordidus*, *Walckenaeria vigilax, Alopecosa taeniata, Pardosa oreophila, Pardosa paludicola*, *Pardosa sordidata, Pardosa sphagnicola*, *Xerolycosa miniata*, *Mimetus laevigatus*, *Philodromus laricium, Philodromus vagulus, Attulus rupicola*, *Marpissa radiata*, *Micrommata ligurina*, *Euryopis quinqueguttata*, *Parasteatoda tabulata*, *Phoroncidia paradoxa*, *Rhomphaea rostrata* in *Robertus mediterraneus*.

Ključne besede: Araneae, prve najdbe, pajki, Slovenija, endemiti, Neozoa, južne Alpe

Introduction

Slovenia's geographic position in the contact area of the Alpine, Pre-Alpine, Dinaric, sub-Pannonic, and sub-Mediterranean biogeographical regions is reflected in its diverse flora and fauna (Mršić 1997; Ciglič & Perko 2012). Although still considered under-surveyed, the spider fauna in Slovenia is no exception in this respect (Kostanjšek & Kuntner 2015). The spider fauna of the Pre-Alpine region can be considered the best studied due to its size, relative accessibility and, above all, the extensive work of the most renowned Slovenian arachnologist Anton Polenec (summarized in Kostanjšek & Kuntner 2015), while other biogeographic regions still lack comprehensive surveys.

The present paper reports on twenty-nine new species records for the Slovenian spider fauna, deriving from sampling efforts in different parts of Slovenia and revisions of some previously unidentified specimens.

Materials and methods

The majority of focused and organized araneological fieldwork in Slovenia in the past few decades has been conducted during the yearly »Biology Students Research Camps« (herein: biology camps), traditionally taking place in the second half of July. In the past few years, however, araneological fieldwork implemented during biology camps was complemented with other studies, (1) single-day samplings known as BioBlitz conducted yearly, (2) monthly surveys of spider fauna at Škocjan Caves Park (2017-2021), and (3) occasional coincidental findings. We also conducted a review of some older material provided by Rok Kostanjšek and Matjaž Gregorič.

Specimens were collected using different sampling methods (hand-collecting, forceps, aspirator, round sweep net, inverted leaf blower, leaf litter sifter, and pitfall traps) and preserved in denatured 70% ethanol. We used several determination keys for the identification of the collected material (Roberts 1995; Nentwig et al. 2023; Oger 2023). Extraction, identification, preparation, and observation of the specimens were performed at the Department of Biology of the Biotechnical Faculty, University of Ljubljana, using light stereomicroscopes.

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

For each new species, we provide data on the collecting site, geographic latitude and longitude (WGS84), altitude in metres above sea level (a.s.l.), date of collection, sampling method (if available), material provider (leg.), species determinator (det.), followed by data on the distribution of the species in other countries and comments on the findings.

The majority of specimens are deposited at the Department of Biology, Biotechnical Faculty, University of Ljubljana. Vouchers of *Mimetus laevigatus*, *Pardosa paludicola*, *Larinioides patagiatus*, *Micrommata ligurina*, and *Robertus mediterraneus* are stored at the Jovan Hadži Institute of Biology, Research Centre of the Slovenian Academy of Sciences and Arts.

Results and discussion

In the first part, we present new records for the Slovenian spider fauna, including specimens and sampling information, followed by comments and a discussion of distribution for individual species. We provide a general discussion at the end.

New records

Larinioides patagiatus (Clerck, 1757) – Araneidae

- 2.2 km W of Vnanje Gorice; Drpalež pri Vnanjih Goricah; lat: 46.0094°N; lon: 14.448°E; 290 m a.s.l.; riparian vegetation; 7. 5. 2008; 1 ♀; leg.: Gregorič M.; det.: Gregorič M., Kostanjšek R.

Distribution and comment: The species has a global distribution. It has been recorded in every European country except Albania and, until now, Slovenia (World Spider Catalog 2023). This species inhabits lower twigs of trees and bushes at forest edges (Nentwig et al. 2023). In our case, it was found in bushes of riparian vegetation. Due to its presence in neighbouring countries, the record of *L. patagiatus* in Slovenia was expected.

Cyrtarachne ixoides (Simon, 1870) – Araneidae

- 500 m NW of Bertoki; Škocjanski zatok; lat: 45.547121 N; lon: 13.760057 E; 3 m a.s.l.; riparian vegetation; multiple ♀; 17. 6. 2018; leg.: Vadnjal D.; det.: Ferle M.
- Ibidem, 29. 5. 2018; 2 ♀; leg.: Kastelic M.; det.: Gregorič M.
- Ibidem, 18. 6. 2018; 2 ♀; leg.: Kastelic M.; det.: Gregorič M.
- 2.4 km SE of Ankaran; lat: 45.568576 N; lon: 13.765808 E; 5 m a.s.l.; riparian vegetation; 1 ♀; 3. 7. 2020; leg.: Vadnjal D.; det.: Ferle M.
- 1.6 km NE of Bertoki; lat: 45.532522 N; lon: 13.756273 E; 20 m a.s.l.; vineyard; 1 ♀; 2. 7. 2021; leg.: Vadnjal D.; det.: Ferle M.

Distribution and comment: Multiple specimens were observed and photographed but not collected in the past years by two avid nature photographers Duša Vadnjal and Miroslav Kastelic at the Slovenian coast. Vadnjal provided us with photographs depicting an unmistakable habitus of the species, while Kastelic uploaded photographs to the Invertebrates Photo Database (Slovenian Museum of Natural History 2024) and were identified by Matjaž Gregorič. *Crytarachne ixoides* is a Mediterranean species. Females sit on leaves, imitating bird droppings (Nentwig et al. 2023)

Figure 1. Photographs of three different specimens of *Cyrtarachne ixoides*: A - 20. 7. 2018, Škocjanski zatok; B, C – 3. 7. 2020, Sermin (photo: Duša Vadnjal).
Slika 1. Fotografije treh osebkov vrste *Cyrtarachne ixoides*: A – 20. 7. 2018, Škocjanski zatok; B, C – 3. 7. 2020, Sermin (fotografija: Duša Vadnjal).

Pritha nana (Simon, 1868) – Filistatidae

- 600 m SE from Osp; Mišja peč; lat: 45.5674 N; lon: 13.8638 E; 103 m a.s.l.; forest edge and stone wall; 1 ♀; 22. 7. 2018; leg.: Ferle M., Kuralt Ž., Pajek Arambašič N., Velkavrh M., Mihelič P.; det.: Ferle M., Kuralt Ž., Pajek Arambašič N., Kostanjšek R.
- Ibidem; 3 ♀; 29. 8. 2018; leg.: Ferle M., Kuralt Ž., Pajek Arambašič N.; det.: Ferle M., Kuralt Ž., Pajek Arambašič N., Kostanjšek R.

Distribution and comment: *Pritha nana* is a Mediterranean species occurring under stones, on walls and buildings, where it builds an irregular messy cribellate web with a tube (Nentwig et al. 2023), often extending into small cracks or crevices, used by the species as a primary retreat. Usually, its web is covered with particulate and dust debris. This species, like other members of the *Pritha* genus, are often hemisynanthropic, as their webs are commonly encountered on the building walls and other man-made structures (Legittimo et al. 2017). Females can live for several years, while males are short-lived and occur in their adult form only for a short period of time in late spring or early summer (Nentwig et al. 2023).

Marinarozelotes adriaticus (Caporiacco, 1951) – Gnaphosidae

- SE of Koper; Osnovna šola Marezige; lat: 45.5098 N; lon: 13.8000 E; 269 m a.s.l.; school building and its vicinity; 1♀; 25. 7. 2018; leg.: Ferle M., Kuralt Ž., Pajek Arambašič N., Velkavrh M., Mihelič P.; det.: Ferle M., Kuralt Ž., Pajek Arambašič N., Kostanjšek R.

Distribution and comment: The species is distributed from Italy to China (World Spider Catalog 2023) and recently in Portugal (Nentwig et al. 2023). The records on its presence in the Balkan Peninsula include Croatia, Albania, and a few Greek islands.

Micaria micans (Blackwall, 1858) – Gnaphosidae

- N of Otlica; Kališki vrh; Primožev kal; lat: 45.9350 N; lon: 13.9226 E; 1040 m a.s.l., riparian vegetation and meadow; 1 ♀; 22. 7. 2021; leg.: Kuralt Ž., Pajek Arambašič N., Čeferin R., Ferlan N.; det.: Kuralt Ž., Pajek Arambašič N., Kostanjšek R.

Distribution and comment: *Micaria micans* can be found in Europe, the Caucasus, Russia (from Europe to South Siberia), Kazakhstan, and Central Asia (World Spider Catalog 2023). In Europe, it's been recorded in relatively warm parts of the Palearctic region (Řezáč et al. 2021). This ant-mimicking spider prefers dry, warm and sunny open habitats such as grassland fields, gardens, and forest edges (Muster & Michalik 2020).

Scotophaeus blackwalli (Thorell, 1871) – Gnaphosidae

- N of Ajdovščina; Otlica; Cerkovna; lat: 45.9268 N; lon: 13.9090 E; 815 m a.s.l.; forest and forest edge; found at night; 1 ♂; 21. 7. 2021; leg.: Kuralt Ž., Pajek Arambašič N., Čeferin R., Ferlan N.; det.: Kuralt Ž., Pajek Arambašič N., Kostanjšek R.

Distribution and comment: This species has a Palearctic distribution (Nentwig et al. 2023) and its presence in Slovenia was expected. *S. blackwalli* occurs under bark, in tree stumps, in other natural cavities as well as buildings. Adult females can be found throughout the year, while males reach their maturity period in late summer through early autumn (Christian 2015).

Zelotes similis (Kulczyński, 1887) – Gnaphosidae

- SE of Predmeja; Otlica; trail to Otliško okno; lat: 45.9213 N; lon: 13.9102 E; 800 m a.s.l.; thermophilic meadow; 1 ♀; 17. 7. 2021; leg.: Kuralt Ž., Pajek Arambašič N., Čeferin R., Ferlan N.; det.: Kuralt Ž., Pajek Arambašič N., Kostanjšek R.

Distribution and comment: The species is distributed from Central Europe to Turkey (World Spider Catalog 2023). It inhabits warm slopes with dwarf shrubs, heath and woodland with scarce vegetation up to 1,500 m (Nentwig et al. 2023), a habitat corresponding to the collection site of the present specimen.

Agyneta orites (Thorell, 1875) – Linyphiidae

- N of Hrib-Loški potok; 3 km E of Travnik; lat: 45.6888 N; lon: 14.6366 E; 850 m a.s.l.; meadow; 1 ♂; 24. 7. 2014; leg.: Kuralt Ž., Horvat E., Gregor P., Jager T.; det.: Pajek Arambašič N.
- N of Otlica; Kališki vrh; Primožev kal; lat: 45.9350 N; lon: 13.9226 E; 1040 m a.s.l.; riparian vegetation and meadow; 3 ♀, 2 ♂; 27. 7. 2021; leg.: Kuralt Ž., Pajek Arambašič N., Čeferin R., Ferlan N.; det.: Kuralt Ž., Pajek Arambašič N., Kostanjšek R.

Distribution and comment: *Agyneta orites* is an alpine species that has been found in Spain and the Alps (France, Italy, Switzerland, Austria, and Germany). The species is considered rare, since only very few specimens have been found so far (Nentwig et al. 2023).

Donacochara speciosa (Thorell, 1875) – Linyphiidae

- 500 m SW of Župančiči; E of Koštabona; Pinjevec; lat: 45.4788 N; lon: 13.7630 E; 100 m a.s.l.; riparian vegetation; pitfall traps; 1 ♀; 21. 7. 2018; leg.: Ferle M., Kuralt Ž., Pajek Arambašič N., Velkavrh M., Mihelič P.; det.: Ferle M., Kuralt Ž., Pajek Arambašič N., Kostanjšek R.

Distribution and comment: The species is distributed in Europe and Central Asia (World Spider Catalog 2023). It can be found in reeds of lakes and ponds and adjacent swamp meadows (Nentwig et al. 2023). Our specimen was caught in a pitfall trap set in riparian vegetation near the river.

Lasiargus hirsutus (Menge, 1869) – Linyphiidae

- N of Gornja Radgona; 1 km N of Ptujska cesta; lat: 46.6249 N; lon: 16.0035 E; 240 m a.s.l.; meadow; 3 ♀; 26. 7. 2011; leg.: Kostanjšek R., Horvat D., Koršič M., Kuralt Ž., Pretnar G., Sivec N., Velkavrh M.; det.: Pajek Arambašič N., Kostanjšek R.

Distribution and comment: The species inhabits low plants in coastal areas and sandy localities. Although widespread throughout Europe, the species is rarely found (Nentwig et al. 2023).

Trichoncus sordidus (Simon, 1884) – Linyphiidae

- NW of Črni Kal; 600 m SE of Osp; Mišja peč; lat: 45.567502°N; lon: 13.863681°E; 103 m a.s.l.; holm oak forest and rock wall; hand picking; 1 ♀; 22. 7. 2018; leg.: Ferle M., Kuralt Ž., Pajek Arambašič N., Velkavrh M., Mihelič P.; det.: Ferle M., Kuralt Ž., Pajek Arambašič N., Kostanjšek R.

Distribution and comment: The species is distributed in Europe, current data confirm its presence in France, Germany, Italy, Slovakia, Balearic Islands, Croatia, Albania, and Greece. Its biology is mostly unknown and it is rarely found according to Nentwig et al. (2023).

Walckenaeria vigilax (Blackwall, 1853) – Linyphiidae

- 500 m E of Nemški Rovt; lat: 46.273361°N; lon: 13.987028°E; 760 m a.s.l.; forest; pitfall traps; 2 ♀, 1 ♂; 3. 7. 2022; leg.: Ferle M.; det.: Ferle M., Kuralt Ž.

Distribution and comment: The species has a Holarctic distribution (World Spider Catalog 2023). It prefers humid conditions and can be found in the wet places on the grass and mosses (Locket & Millidge 1953), as well as in arable fields (Nentwig et al. 2023).

Alopecosa taeniata (C. L. Koch, 1835) – Lycosidae

- 5.2 km SE of Črna na Koroškem; Peca; lat: 46.5068°N; lon: 14.8049°E; 2125 m a.s.l.; scarce vegetation above treeline on the summit of Mt Peca; 1 ♀ 1 ♂; 17. 7. 2023; leg.: Pajek Arambašič N., Pušnar Ž., Erzin M., Cigoj K.; det.: Pajek Arambašič N., Kuralt Ž., Kostanjšek R.
- 4.6 km SE of Črna na Koroškem; Podpeca; lat: 46.491773°N; lon: 14.798741°E; 1410 m a.s.l.; parking lot; 1 ♂; 17. 7. 2023; leg.: Pajek Arambašič N., Pušnar Ž., Erzin M., Cigoj K.; det.: Pajek Arambašič N., Kuralt Ž., Kostanjšek R.

Distribution and comment: *A. taeniata* is distributed in Europe and Russia (World Spider Catalog 2023). The species is eurytopic (with wide ecological amplitude) and adaptable to various conditions (Muster 2001).

Pardosa oreophila (Simon, 1937) – Lycosidae

- 5.2 km SE of Črna na Koroškem; Peca; lat: 46.5068°N; lon: 14.8049°E; 2125 m a.s.l.; scarce vegetation above treeline on the summit of Mt Peca; 3 ♀ 3 ♂; 17. 7. 2023; leg.: Pajek Arambašič N., Pušnar Ž., Erzin M., Cigoj K.; det.: Pajek Arambašič N., Kuralt Ž., Kostanjšek R.

Distribution and comment: This species is present in Central and Southern Europe (World Spider Catalog 2023). It can be found in meadows and open areas from 1,000 to 2,700 metres above sea level (Nentwig et al. 2023).

Pardosa paludicola (Clerck, 1757) – Lycosidae

- 2.3 km W of Dolina pri Lendavi; 1.7 km NE of Petišovci; confluence of Ledava and Črnec spring; lat: 46.5379°N; lon: 16.4756°E; 160 m a.s.l.; riparian vegetation; 1 ♀, 1 ♂; 30. 3. 2008; leg.: Čandek K., Gregorič M.; det.: Pajek Arambašič N., Kostanjšek R.
- Mali Ribnik pond; lat: 46.4349°N; lon: 15.6791°E; 250 m a.s.l.; riparian vegetation; 1 ♀; 15. 6. 2018; leg.: Kuralt Ž., Sivec N., Knapič T.; det.: Kuralt Ž., Knapič T.

Distribution and comment: The species has a global distribution and has been recorded in most European countries (World Spider Catalog 2023). Consequently, its occurrence in Slovenia was expected. The species inhabits damp areas and is described by Nentwig et al. (2023) as not frequent.

Pardosa sordidata (Thorell, 1875) – Lycosidae

- 4.6 km SE of Črna na Koroškem; Peca; trail to Mt Peca below treeline; mountain hut below Peca; lat: 46.491773°N; lon: 14.798741°E; 1665 m a.s.l.; 3 ♀; 17. 7. 2023; leg.: Pajek Arambašič N., Pušnar Ž., Erzin M., Cigoj K.; det.: Pajek Arambašič N., Kostanjšek R.

Distribution and comment: *P. sordidata* is rarely found throughout Europe. However, it has been identified multiple times in different parts of Austrian mountain ranges. It can be found in moist tall herbaceous meadows, stream banks, as well as forest clearings and edges in mountain ranges from 700 m to 1,500 m (Komposch 2000, 2023).

Pardosa sphagnicola (Dahl, 1908) – Lycosidae

- Ljubljana; 200 m SW of Ljubljana ZOO; Department of Biology; wet meadow; lat: 46.051856°N; lon: 14.470328°E; 297 m a.s.l.; 1 ♀; 26. 7. 2017; leg.: Kuralt Ž., Velkavrh M., Šramel N., Premate E., Štrekelj N., Pajek Arambašič N., Ferle M.; det.: Kuralt Ž., Kostanjšek R.

Distribution and comment: The species is found in Europe and Russia, widely distributed in the north, including Iceland (Thaler & Buchar 1996). Its presence was confirmed in Northern, Eastern, Western, and Central Europe, but is missing in some Mediterranean and Balkan countries. The species is boreomontane, inhabiting bogs and raised bogs (Nentwig et al. 2023).

Xerolycosa miniata (C. L. Koch, 1834) – Lycosidae

- NE of Lozice; Strmec; Podraška bajta; lat: 45.79466°N; lon: 14.01907°E; 810 m a.s.l.; xerophilic meadow; 1 ♀; 18. 7. 2021; leg.: Gabor M.; det.: Kuralt Ž., Pajek Arambašič N., Kostanjšek R.
- 1 km NE of Draga; S of Hrib-Loški potok; lat: 45.639212°N; lon: 14.660902°E; 800 m a.s.l..; forest clearing; 1 ♀; 24. 7. 2014; leg.: Kuralt Ž., Horvat E., Gregor P., Jager T.; det.: Kuralt Ž.

Distribution and comment: The species has a Palearctic distribution. It inhabits sunny open areas with short grass. Its presence in Slovenia was expected, as it has already been confirmed in all of the neighbouring countries (Nentwig et. al 2023).

Mimetus laevigatus (Keyserling, 1863) – Mimetidae

- 1.3 km NW of Divača; 500 m E of Gorenje pri Divači; lat: 45.6937°N; lon: 13.9624°E; 415 m a.s.l.; riparian vegetation; 1 ♀; 25. 5. 2012; leg.: Pipan M.; det.: Pajek Arambašič N., Kostanjšek R.

Distribution and comment: The species is distributed from the Mediterranean to Central Asia (World Spider Catalog 2023). It inhabits bushes and can also be found under stones. The species appears to be short-lived, since the presence of adult specimens appears confined to May and June (Nentwig et. al 2023).

Philodromus laricium (Simon, 1875) – Philodromidae

- 6 km SE of Šoštanj; Solčava; Podolševa; lat: 46.445774°N; lon: 14.673639°E; 1,405 m a.s.l.; under a stone; handpicking; 1 ♀; 19. 7. 2023; leg.: Kepic T.; det.: Pajek Arambašič N., Kuralt Ž., Kostanjšek R.

Distribution and comment: *P. laricium* is an endemic species of (south)-western-European mountain ranges. According to Muster et al. (2009), it is distributed from the southwestern Alps to the northern calcareous Alps in Tyrol, residing on tree branches, in crevices of limestone rocks, and on scree slopes (Muster et al. 2009).

Philodromus vagulus (Simon, 1875) – Philodromidae

- 5.2 km SE of Črna na Koroškem; Peca; lat: 46.5068°N; lon: 14.8049°E; 2125 m a.s.l.; scarce vegetation above treeline on the summit of Mt Peca; 8 ♀; 17. 7. 2023; leg.: Pajek Arambašič N., Pušnar Ž., Erzin M., Cigoj K.; det.: Pajek Arambašič N., Kuralt Ž., Kostanjšek R.

Distribution and comment: It has European distribution (World Spider Catalog 2023). Arboreal species, occasionally found in heath (Muster 2001).

Attulus rupicola (C. L. Koch, 1837) – Salticidae

- W of Lendava; 1 km W of Hotiza; Ložič; lat: 46.556219°N; lon: 16.333299°E; 170 m a.s.l.; xerophilic meadow; 2 ♂; 16. 7. 2022; leg.: Barbo J., Jeromen M., Pajek Arambašič N., Pušnar Ž.; det.: Pajek Arambašič N., Kuralt Ž., Kostanjšek R.
- SW of Črna na Koroškem; Bukovnik; Mt Grohot; lat: 46.422031°N; lon: 14.744593°E; 1,460 m a.s.l.; meadow; 1 ♀, 2 ♂; 20. 7. 2023; leg.: Kuralt Ž., Pušnar Ž., Cigoj K., Erzin M.; det.: Pajek Arambašič N., Kuralt Ž., Kostanjšek R.

Distribution and comment: European species. It can be found among stones and rocks up to 1,700 m (Nentwig et al. 2023), where it prefers warm places (Żabka 1997). Its presence in Slovenia was expected, as it has already been confirmed in three of the neighbouring countries.

Marpissa radiata (Grube, 1859) – Salticidae

- SE of Lendava; 2.3 km NE of Podturen; Črni jarek; lat: 46.476988°N; lon: 16.572355°E; 160 m a.s.l.; riparian vegetation; 1 ♀; 17. 7. 2022; leg.: Barbo J., Jeromen M., Pajek Arambašič N. Pušnar Ž.; det.: Pajek Arambašič N., Kostanjšek R.

Distribution and comment: Palearctic species. It can be found in wet meadows and near standing waters, especially in bent leaves of cattail (*Typha*) and common reed (*Phragmites*), where it builds typical retreats (Żabka 1997).

Micrommata ligurina (C. L. Koch, 1845) – Sparassidae

- NE of Sežana; 800 m SE of Griže; lat: 45.7505°N; lon: 13.9509°E; 484 m a.s.l.; overgrowth; 1 ♀; 21. 6. 2011; leg.: Gregorič M., Čandek K.; det.: Pajek Arambašič N., Kostanjšek R.

Distribution and comment: *Micrommata ligurina* is a Mediterranean species (Nentwig et al. 2023). In more temperate climates, the species is frequently overlooked due to misidentification as a much more common *M. virescens*.

Euryopis quinqueguttata (Thorell, 1875) – Theridiidae

- SE of Lendava; 2.2 km S of Dolina pri Lendavi; Ledava and Črnec stream confluence; lat: 46.535334°N; lon: 16.477790°E; 160 m a.s.l.; riparian vegetation; 1 ♂; 18. 7. 2022; leg.: Barbo J., Jeromen M., Pajek Arambašič N. Pušnar Ž.; det.: Pajek Arambašič N., Kostanjšek R.

Distribution and comment: Widely distributed species. It is partial to very warm places where hiding under stones. It can be found on south-exposed slopes only in some places in Central Europe (Nentwig et al. 2023). Its presence in Slovenia was expected, since it has already been confirmed in three of the neighbouring countries.

Parasteatoda tabulata (Levi, 1980) – Theridiidae

- E of Trebnja Gorica; 200 m N of Gradiček; Krka spring; lat: 45.886679°N; lon: 14.768162°E; 300 m a.s.l.; riparian vegetation and cave entrance; 1 ♀ 1 ♂; 19. 7. 2019; leg.: Ferle M., Kuralt Ž., Pajek Arambašič N., Mihelič P.; det.: Ferle M., Kuralt Ž., Pajek Arambašič N.
- JZ of Škofja Loka; Gorenja vas; Ivan Tavčar Gorenja vas primary school buildings; lat: 46.101155°N; lon: 14.140822°E; 420 m a.s.l.; 1 ♀ 1 ♂; 17. 7. - 26. 7. 2020; leg.: Ferle M., Kuralt Ž., Pajek Arambašič N., Prevc J.; det.: Ferle M., Kuralt Ž., Pajek Arambašič N., Kostanjšek R.

Distribution and comment: Species of Asian origin, introduced to Europe (Nentwig et al. 2023). Its presence has already been confirmed in Eastern and Central European countries. It is found on south-exposed walls of buildings, commonly synanthropic (Nentwig et al. 2023).

Phoroncidia paradoxa (Lucas, 1846) – Theridiidae

- SE of Divača; 750 m N of Matavun; Betanja; lat: 45.664775°N; lon: 13.988571°E; 417 m a.s.l.; holm oak forest; pitfall traps; 1 ♀; 19. 9. 2018; leg.: Ferle M., Kuralt Ž., Pajek Arambašič N.; det.: Ferle M., Kuralt Ž., Pajek Arambašič N., Kostanjšek R.

Distribution and comment: The species is distributed in the Mediterranean area. It inhabits holm oak forest, garrigue, heathlands, and the bush layer (Nentwig et al. 2023).

Rhomphaea rostrata (Simon, 1873) – Theridiidae

- SE of Koper; Marezige; Ivan Babič-Jager Marezige primary school; lat: 45.509851°N; lon: 13.800083°E; 269 m a.s.l.; vegetation in the vicinity of Ivan Babič-Jager Marezige primary school; 1 ♂; 25. 7. 2018; leg.: Kos A.; det.: Kuralt Ž., Kostanjšek R.

Distribution and comment: Mediterranean species, inhabiting garrigue, on oaks and heather (Nentwig et al. 2023).

Robertus mediterraneus (Eskov, 1987) – Theridiidae

- NE of Sežana; 800 m SE of Griže; lat: 45.7505°N; lon: 13.9509°E; 484 m a.s.l.; forest; 1 ♀; 21. 6. 2011; leg.: Gregorič M., Čandek K.; det.: Pajek Arambašič N., Kostanjšek R.

Distribution and comment: As the name implies, *R. mediterraneus* is a Mediterranean species, found in the ground layer of forests of medium altitudes (Nentwig et al. 2023). Its distribution range extends from the Caucasus through Romania to Italy, South Tyrol, and Ticino (Komposch et al. 2023).

General discussion

The present paper, the fifth in the series (see Kostanjšek 2010; Kostanjšek & Gorjan 2013; Kuralt & Kostanjšek 2016, 2019), presents twenty-nine new records of spider species for Slovenia. The extent of the newly recorded species and the fact that most of the additions to the Slovenian spider fauna reported here can be considered expected, confirm the previously noted under-recording of the spider fauna in Slovenia compared to neighbouring countries (Kostanjšek & Kuntner 2015; Kuralt & Kostanjšek 2016). The fact that many of the new records in our study originate from the sub-Mediterranean region of the country is also not surprising and could arise from the fact that the region has not been thoroughly studied yet. Apart from having higher spider diversity compared to other biogeographical regions in Slovenia (Kuntner & Kostanjšek 2000), the sub-Mediterranean region additionally represents the most likely dispersal area for true Mediterranean species in the face of impending climate change (Thuiller 2004; Hampe & Petit 2005; Krehenwinkel et al. 2016; Kuralt 2016). One of such species is *Micrommata ligurina*, a Mediterranean species resembling a widespread *Micrommata virescens* and could be misidentified as the latter, especially in the sub-Mediterranen region. Another species worth mentioning is *Parasteatoda tabulata*, an introduced species originating in Asia that has been spreading throughout Eastern Europe in recent years (Nentwig et al. 2023).

Given that the reported species were documented in Slovenia for the first time, assessing their conservation status poses a challenge. However, we can derive insights into their status by referencing neighbouring countries or similar zoogeographical regions. Notably, the Carinthian Red List of Spiders (Komposch 2023) includes 14 of the abovementioned species, categorizing them as vulnerable (*Agyneta orites*, *Xerolycosa miniata*, *Attulus rupicola*, *Philodromus laricium*, *Improphantes nitidus*), endangered (*Zelotes similis*, *Donacochara speciosa*, *Hypomma bituberculatum*, *Lasiargus hirsutus*, *Pardosa paludicola*, *Marpissa radiata*, *Robertus mediterraneus*, *Pardosa sordidata*), and even critically endangered (*Pardosa sphagnicola*).

In summary, this study highlights the importance of ongoing faunistic efforts in Slovenia. Continued endeavours are crucial to fill gaps in our understanding of spider biodiversity and to accurately assess the conservation statuses of these species. By prioritizing further field surveys and collaborative research, we can provide for a more comprehensive understanding of spider fauna in Slovenia and contribute to possible conservation strategies.

Povzetek

Prispevek je peti v seriji prispevkov o favni pajkov Slovenije. Obravnava 29 vrst pajkov, ki do sedaj v Sloveniji še niso bile zabeležene, in sicer: *Larinioides patagiatus* (Clerck, 1757), *Cyrtarachne ixoides* (Simon, 1870), *Pritha nana* (Simon, 1868), *Marinarozelotes adriaticus* (Caporiacco, 1951), *Micaria micans* (Blackwall, 1858), *Scotophaeus blackwalli* (Thorell, 1871), *Zelotes similis* (Kulczyński, 1887), *Agyneta orites* (Thorell, 1875), *Donacochara speciosa* (Thorell, 1875), *Lasiargus hirsutus* (Menge, 1869), *Trichoncus sordidus* (Simon, 1884), *Walckenaeria vigilax* (Blackwall, 1853), *Alopecosa taeniata* (C. L. Koch, 1835), *Pardosa oreophila* (Simon, 1937), *Pardosa paludicola* (Clerck, 1757), *Pardosa sordidata* (Thorell, 1875), *Pardosa sphagnicola* (Dahl, 1908), *Xerolycosa miniata* (C. L. Koch, 1834), *Mimetus laevigatus* (Keyserling, 1863), *Philodromus laricium* (Simon, 1875), *Philodromus vagulus* (Simon, 1875), *Attulus rupicola* (C. L. Koch, 1837), *Marpissa radiata* (Grube, 1859), *Micrommata ligurina* (C. L. Koch, 1845), *Euryopis quinqueguttata* (Thorell, 1875), *Parasteatoda tabulata* (Levi, 1980), *Phoroncidia paradoxa* (Lucas, 1846), *Rhomphaea rostrata* (Simon, 1873) in *Robertus mediterraneus* (Eskov, 1987).

Poleg nekaterih redkih vrst – na primer *Lasiargus hirsutus, Trichoncus sordidus* in *Philodromus vagulus* – je bila večina vrst, živečih v Sloveniji in predstavljenih v prispevku, pričakovana. Omeniti pa gre velik delež toploljubnih in mediteranskih vrst, ki smo jih zabeležili v jugozahodnem delu države, kar kaže na pomanjkljivo raziskanost favne pajkov nekaterih zoogeografskih regij Slovenije.

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Travniški postavnež *Euphydryas aurinia* (Rottemburg, 1775) (Lepidoptera: Nymphalidae) na Ljubljanskem barju: prvi vpogled v gostiteljske rastline in pregled razširjenosti

Barbara ZAKŠEK[1], Nika KOGOVŠEK[1], Marijan GOVEDIČ[1], Tatjana ČELIK[2]

[1]Center za kartografijo favne in flore, Tacenska 20, SI-1210 Ljubljana-Šentvid, Slovenija; E-mails: barbara.zaksek@ckff.si, nika.kogovsek@ckff.si, marijan.govedic@ckff.si
[2]Biološki inštitut Jovana Hadžija ZRC SAZU, Novi trg 2, SI-1000 Ljubljana, Slovenija; E-mail: tatjana.celik@zrc-sazu.si

Izvleček. V prispevku predstavljamo prvi vpogled v gostiteljske rastline travniškega postavneža (*Euphydryas aurinia*) na Ljubljanskem barju in podajamo pregled razširjenosti vrste v tem območju. V območju sta prisotni dve populaciji travniškega postavneža, in sicer v Dolini Drage pri Igu in v dolini potoka Strajanov breg. Glavna gostiteljska rastlina travniškega postavneža na Ljubljanskem barju je travniška izjevka (*Succisa pratensis*), preadultni stadiji pa so bili najdeni tudi na svilničevolistnem svišču (*Gentiana asclepiadea*) in navadnem objedu (*Succisella inflexa*). Z večanjem nabora različnih vrst gostiteljskih rastlin se povečuje verjetnost dolgoročnega preživetja vrste, poznavanje lokalne ekologije razvojnih stadijev pa je ključno za učinkovito načrtovanje upravljanja z življenjskim prostorom te vrste.

Ključne besede: travniški postavnež, *Euphydryas aurinia*, razširjenost, ekologija, Natura 2000, *Succisa pratensis*, *Gentiana asclepiadea*, *Succisella inflexa*

Abstract. Marsh fritillary *Euphydryas aurinia* (Rottemburg, 1775) (Lepidoptera: Nymphalidae) on the Ljubljansko barje: first insight into the species' host plants and an overview of its distribution – The article presents the first insight into the host plants of the marsh fritillary (*Euphydryas aurinia*) in the Ljubljansko barje region and provides recent information on the species distribution in this area. There are two permanent populations of the marsh fritillary in the region, i.e. in the Draga Valley near Ig and the valley of Strajanov breg stream. The main larval host plant at Ljubljansko barje is devil's-bit scabious (*Succisa pratensis*). Preadult stages have also been found on willow gentian (*Gentiana asclepiadea*) and southern succisella (*Succisella inflexa*). The expanding diversity of host plants increases the likelihood of long-term survival of the species. Therefore, understanding the local ecology of the preadult stages is crucial for planning effective management strategies for the species.

Key words: Marsh Fritillary, *Euphydryas aurinia*, distribution, ecology, Natura 2000, *Succisa pratensis*, *Gentiana asclepiadea*, *Succisella inflexa*

Uvod

Travniški postavnež, *Euphydryas aurinia* (Rottemburg, 1775) (Lepidoptera: Nymphalide), je v rdečem seznamu metuljev Slovenije opredeljen kot ranljiva vrsta (V) (Ur. l. RS 2002). Osebki in njihova bivališča so v Sloveniji zavarovani (Ur. l. RS 2004a). Vrsta je uvrščena na Prilogo II Direktive o habitatih (OJ EC 1992), kar države EU obvezuje, da za vrsto opredelijo posebna varstvena območja (območja Natura 2000) in v njih populacije ohranjajo v ugodnem stanju. V Sloveniji je za travniškega postavneža opredeljenih 34 območij Natura 2000, med njimi je tudi območje Ljubljansko barje (SI3000271) (Ur. l. RS 2004b, 2016). V strokovnih izhodiščih za vzpostavljanje omrežja Natura 2000 za metulje (Čelik et al. 2004) je za varstvo travniškega postavneža na Ljubljanskem barju predlagana zgolj dolina potoka Strajanov breg.

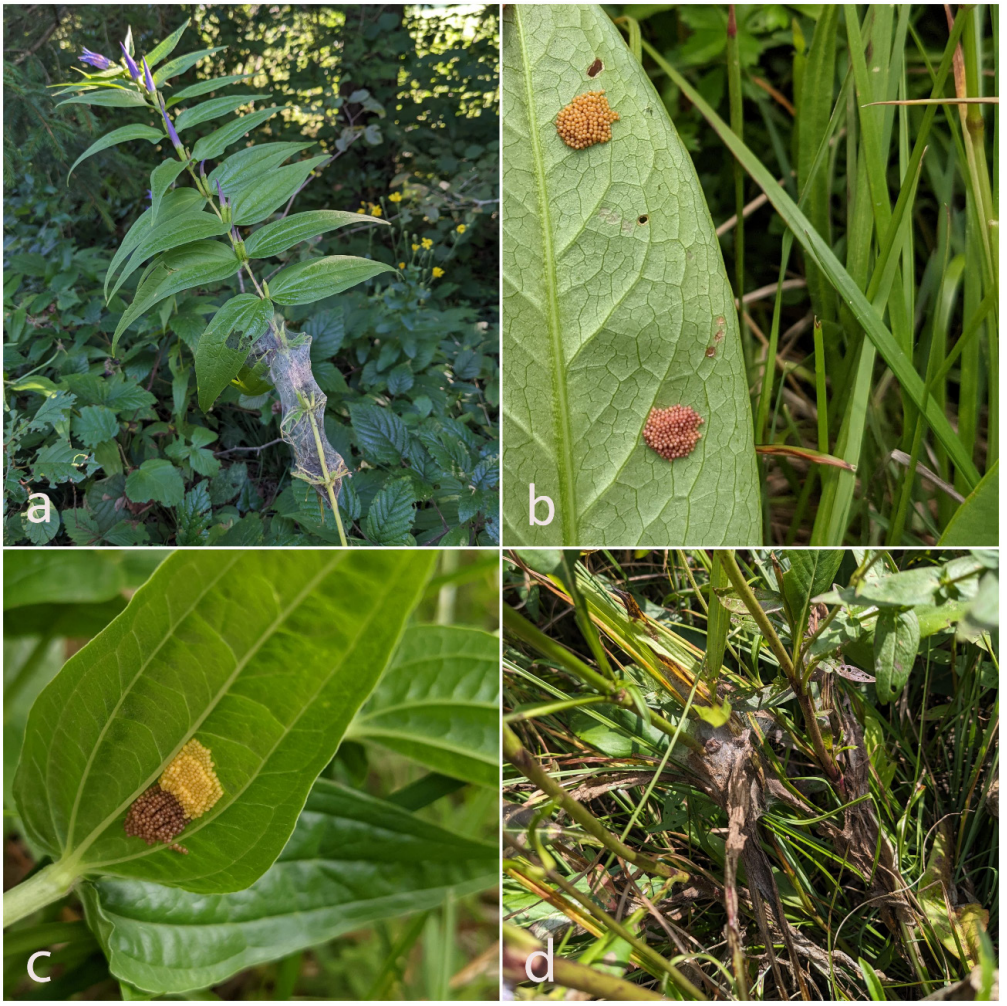
Območje razširjenosti vrste sega od Iberskega polotoka na zahodu prek Evrope in zmernega pasu Azije do Koreje na vzhodu (Kudrna 2002). V prejšnjem stoletju je bil v večini evropskih držav zaznan upad populacij travniškega postavneža (van Swaay et al. 2010). V Nemčiji se je območje razširjenosti vrste med letoma 1950 in 2002 zmanjšalo za 75 % (Anthes et al. 2003). V Italiji je zaradi uničevanja bivališč vrste izumrlo vsaj 12 populacij (Bonelli et al. 2011). Stabilne populacije vrste živijo le v Mediteranu in vzhodni Evropi (Warren et al. 1994; Balletto et al. 2014). Upad populacij in lokalno izumiranje je bilo zabeleženo tudi v Sloveniji (Zakšek et al. 2021).

V Sloveniji je vrsta sklenjeno razširjena na Primorskem, v zahodnem delu Notranjske, v Škofjeloškem hribovju in v Zasavju. Drugje se pojavlja lokalno, zelo redka je v severovzhodni Sloveniji in na Dolenjskem (Verovnik et al. 2012). V Julijskih Alpah je prisotna visokogorska morfološka oblika vrste, forma *glaciegenita* (Čelik et al. 2005).

V Sloveniji živijo trije ekotipi populacij travniškega postavneža, vlagoljubni, suholjubni in visokogorski. Prve poseljujejo negnojena in največ enkrat v letu košena mokrotna do vlažna travišča na s hranili revnih tleh (nizka barja, travniki s prevladujočo modro stožko *Molinia caerulea* (L.) Moench). Suholjubne populacije živijo na toploljubnih, večinoma zaraščajočih se suhih traviščih na apnenčastih podlagi (Čelik et al. 2022), medtem ko se visokogorske pojavljajo le na alpskih tratah (Verovnik et al. 2012). Ekološka raznolikost življenjskih okolij vrste se kaže v širokem naboru rastlinskih vrst, ki so gostiteljske rastline travniškega postavneža. Ovipozicijske in hranilne rastline gosenic vlagoljubnega ekotipa so v Evropi predvsem travniška izjevka (*Succisa pratensis* Moench) (Anthes et al. 2003; Sardet & Betremieux 2006; Porter & Ellis 2011; Verovnik et al. 2012; Eeles 2014; Meister et al. 2015) in svilničevolistni svišč (*Gentiana asclepiadea* L.) (Anthes et al. 2003). Precej bolj pester je nabor hranilnih rastlin suholjubnega in visokogorskega ekotipa (Pinzari et al. 2016), ki pa ju v tem prispevku ne obravnavamo.

Samice odlagajo jajčeca v skupkih, tudi do 300 jajčec, na spodnjo stran listov gostiteljske rastline (Wahlberg 2001; Kuussaari et al. 2004; Smee et al. 2011; Nunner et al. 2013). Po 3-4 tednih se iz jajčec izležejo gosenice. Vrsta ima v Evropi šest larvalnih stadijev, tri pred prezimitvijo in tri po njej. Gosenice od prvega do petega stadija živijo skupaj (gregarno), gosenice zadnjega stadija pa posamič (solitarno). Po izvalitvi iz jajčec živijo gosenice v rahlem svilnatem zapredku (gnezdu) okoli listov gostiteljske rastline in se hranijo z rastlino, na kateri so se izlegle. Ta zapredek je rahel in zelo občutljiv za morebitne poletne poplave (Betzholtz et al.

2007). Ko gosenicam na matični rastlini zmanjka hrane, se skupaj premaknejo na bližnjo hranilno rastlino in tam naredijo novo gnezdo. Gosenice so slabo mobilne in se do prezimitve premaknejo do največ 50 cm od matične rastline (Liu et al. 2006; Tjørnløv et al. 2015). Prezimijo v četrtem larvalnem stadiju v skupnem gnezdu, ki je kompaktno in vodoodporno, blizu tal (Betzholtz et al. 2007). Po prezimitvi se gosenice še nekaj časa zadržujejo in prehranjujejo skupaj, dokler ne zaživijo solitarno (Warren 1996; Kuussaari et al. 2004). Zabubijo se spomladi na rastlinju blizu tal (Warren 1996). V posamezni populaciji naj bi se gosenice večinoma hranile samo z eno vrsto rastline, torej so populacije navadno monofagne (Meister et al. 2015).



Slika 1. Gnezdi gosenic (a in d) in jajčeca (b in c) travniškega postavneža (*Euphydryas aurinia*) na svilničevolistnem svišču (*Gentiana asclepidaea*) (a in c) in travniški izjevki (*Succisa pratensis*) (b in d). Foto: Nika Kogovšek.
Figure 1. Larval webs (a and d) and egg batches (b and c) of the marsh fritillary (*Euphydryas aurinia*) on Willow Gentian (*Gentiana asclepidaea*) (a and c) and on Devil's-bit Scabious (*Succisa pratensis*) (b and d). Photo: Nika Kogovšek.

Odrasli osebki travniškega postavneža se v večjem delu Slovenije pojavljajo v maju in juniju, v toplejših delih države lahko že od konca aprila, na višjih nadmorskih višinah tudi julija (Verovnik et al. 2012). Gnezda gosenic so najbolj opazna v poznem poletju in zgodnji jeseni. Nabor rastlinskih vrst, ki gostijo slovenske populacije travniškega postavneža, ni znan. Za vlagoljubni ekotip so na voljo le maloštevilni podatki o gostiteljskih rastlinah v različnih strokovnih poročilih (npr. Čelik 2015; Zakšek & Kogovšek 2021a, 2021b; DPOMS 2021), kjer so kot gostiteljske rastline navedene travniška izjevka, svilničevolistni svišč in navadni objed (*Succisella inflexa* (Kluk) Beck).

Za območje Ljubljanskega barja z zaledjem so za obdobje pred letom 2004 podatki o pojavljanju travniškega postavneža maloštevilni in velikokrat prostorsko nenatančno opredeljeni, npr. Mala Ligojna, okolica Iga, okolica Pijave Gorice in Želimeljska dolina ter Nadgorica (Ljubljana), Podutik (Ljubljana), Glince (Ljubljana), Turjak, Krim, Mokrec, Pokojišče, Rakitna in Polhograjska Grmada iz zaledja (Čelik & Rebeušek 1996; Kryštufek et al. 2001). Ti podatki so bili dopolnjeni v poročilu Strokovna izhodišča za vzpostavljanje omrežja Natura 2000 (Čelik et al. 2004). Na podlagi teh so bila leta 2004 opredeljena območja Natura 2000 za travniškega postavneža v Sloveniji. Iz omenjenih podatkov je razvidno, da so bila do tega leta nahajališča travniškega postavneža na Ljubljanskem barju omejena zgolj na njegovo obrobje.

V prispevku podajamo prvi vpogled v gostiteljske rastline travniškega postavneža na Ljubljanskem barju in celosten pregled razširjenosti vrste v tem območju za obdobje po letu 2004.

Materiali in metode

Opis območja

Ljubljansko barje je bilo do leta 1825, ko so se začeli veliki osuševalni posegi, antropogeno le malo preoblikovano in še v dokaj naravnem stanju (Melik 1946; Orožen Adamič 1985). Takrat je bilo eno najjužnejših visokih barij v Evropi, danes pa so zelo skromni fragmenti visokega barja ohranjeni le še na Podpeškem mahu in na Malem placu (Martinčič 1987; Šilc et al. 2022). Z rezanjem šote, predvsem v drugi polovici 19. stoletja, se je šotna odeja visokega barja zniževala in postopoma izenačevala z višino nizkega barja, za Ljubljansko barje značilne poplave so postale pogostejše in obsežnejše (Melik 1946). Z razsežnimi osuševalnimi posegi so ljudje nekdanje površine visokega in nizkega barja postopoma spremenili v kmetijske in zazidalne površine. Tako je z agrarno kolonizacijo, rezanjem šote ter postopno izgradnjo obsežnega in močno razvejenega osuševalnega sistema jarkov celotna pokrajina dobila podobo antropogeno preoblikovane krajine. V današnji krajini Ljubljanskega barja prevladujejo njive, različni tipi predvsem intenzivno obdelanih travnikov, pašniki, grmišča, mejice ter urbane površine (naselja, ceste, poti). Večje površine s hranili revnih mokrotnih travnikov so le še v okolici Bevk, Bresta (NR Iški morost), severno od ceste Ig–Škofljica ter v mokrotnih dolinah potokov, kot so Draščica, Želimeljščica in Strajanov breg.

Zbiranje podatkov

Pregled podatkov o pojavljanju vrste na Ljubljanskem barju po letu 2004 temelji na sistematičnih študijah razširjenosti vrste, ki sta potekali v letih 2015 (Čelik 2015) in 2023 (Zakšek et al. 2023), ter naključnih opažanjih vrste. V letu 2015 so bila pregledana vsa območja, na katerih se je vrsta pojavljala v preteklosti. Na podlagi rezultatov omenjene raziskave in naključnih opažanj do leta 2023 smo leta 2023, v času generacije odraslih osebkov, raziskovali pojavljanje vrste na vlažnih traviščih na jugovzhodnem delu Ljubljanskega barja: območje severovzhodno in vzhodno od Iga, okolica Drage pri Igu in dolina Drage pri Igu, severni del Želimeljske doline ter dolina potoka Strajanov breg južno in jugovzhodno od Podblata.

Podatke o gostiteljskih rastlinah travniškega postavneža na Ljubljanskem barju smo zbrali med ciljnim terenskim delom v letih 2021 in 2023. Leta 2021 smo v dolini Drage pri Igu na mokrotnih traviščih, primernih za vrsto, ciljno pregledovali znane potencialne vrste gostiteljskih rastlin in ugotavljali prisotnost jajčec tako, da smo pregledovali spodnjo stran listov travniške izjevke, navadnega objeda in svilničevolistnega svišča, ali pa opazovali odlaganje jajčec na gostiteljski rastlini. Leta 2023 smo ciljno pregledali potencialne vrste gostiteljskih rastlin na travnikih na jugovzhodnem delu Ljubljanskega barja (dolina potoka Strajanov breg, Želimeljska dolina in dolina Drage pri Igu).

V poznem poletju/jeseni 2023 smo med ponovnim pregledom vseh območij, kjer smo maja in junija opazili odrasle osebke, ciljno iskali gnezda gosenic, ker so lažje opazna kot skupki jajčec. V obeh letih smo beležili vrsto gostiteljske rastline, na kateri so bili najdeni preadultni stadiji (skupek jajčec, gnezdo gosenic).

Rezultati in razprava

Razširjenost vrste na Ljubljanskem barju po letu 2004

Po letu 2004 je bil travniški postavnež na Ljubljanskem barju zabeležen v šestih območjih: Gorenje Blato, dolina potoka Strajanov breg, Ig–Škofljica, Draga pri Igu, Želimeljska dolina in Gumnišče (Tab. 1). Prvih pet leži v območju Natura 2000 Ljubljansko barje (SI3000271), medtem ko sta nahajališči Gumnišče in eno do nahajališč v območju Gorenje Blato (Tab. 1) manj kot 100 metrov oddaljeni od jugovzhodne meje območja Natura. Zaradi nenatančne prostorske opredelitve nahajališč vrste pred letom 2004 za nekatera najdišča po tem letu ne moremo zagotovo definirati, ali gre za novo ali že znano nahajališče vrste. Stare navedbe o razširjenosti vrste (okolica Iga, Pijave Gorice, Želimeljska dolina) so se namreč lahko nanašale na vse zgoraj navedene lokacije, z izjemo nahajališča Mala Ligojna, kjer je bila vrsta najdena leta 2001 (Škvarč 2002), v sistematični raziskavi razširjenosti travniškega postavneža na Ljubljanskem barju v letu 2015 pa vrsta na tej lokaciji ni bila potrjena. V območjih Gorenje Blato, Ig–Škofljica in Gumnišče (Tab. 1) je bil od leta 2015 opažen le po en odrasel osebek. Največji in stalni populaciji travniškega postavneža na Ljubljanskem barju sta v dolinah potoka Strajanov breg in Draga pri Igu. V dolini potoka Strajanov breg, kjer so mokrotni travniki z modro stožko, je bila vrsta opazovana v letih 2000, 2001 in 2003 (Čelik et al. 2004). V tem prispevku smo dolino razdelili na dva dela, na spodnji del, kjer so redno košeni mokrotni travniki, in zgornji del,

kjer je nizko barje, ki je bilo po letu 2015 revitalizirano (odstranjena lesna zarast) (Tab. 1). V dolini Draga pri Igu je bil travniški postavnež prvič zabeležen leta 2016 na enem travniku, leta 2017 pa je bil v sklopu popisovanja za BioBlitz Slovenija (BioBlitz 2017) opazovan na več travnikih, tako na severnem kot južnem delu doline (Tab. 1).

V letu 2023 smo med sistematično raziskavo o razširjenosti vrste na Ljubljanskem barju travniškega postavneža našli v treh območjih: dolina Draga pri Igu (severni in južni del), dolina potoka Strajanov breg in severni del Želimeljske doline (Tab. 1, Fig. 1). V dolinah Draga pri Igu in potoka Strajanov breg so bili opazovani odrasli osebki in preadultni stadiji. V Želimeljski dolini sta bila opazovana zgolj dva odrasla osebka, razmnoževanja vrste nam v tem območju ni uspelo potrditi.

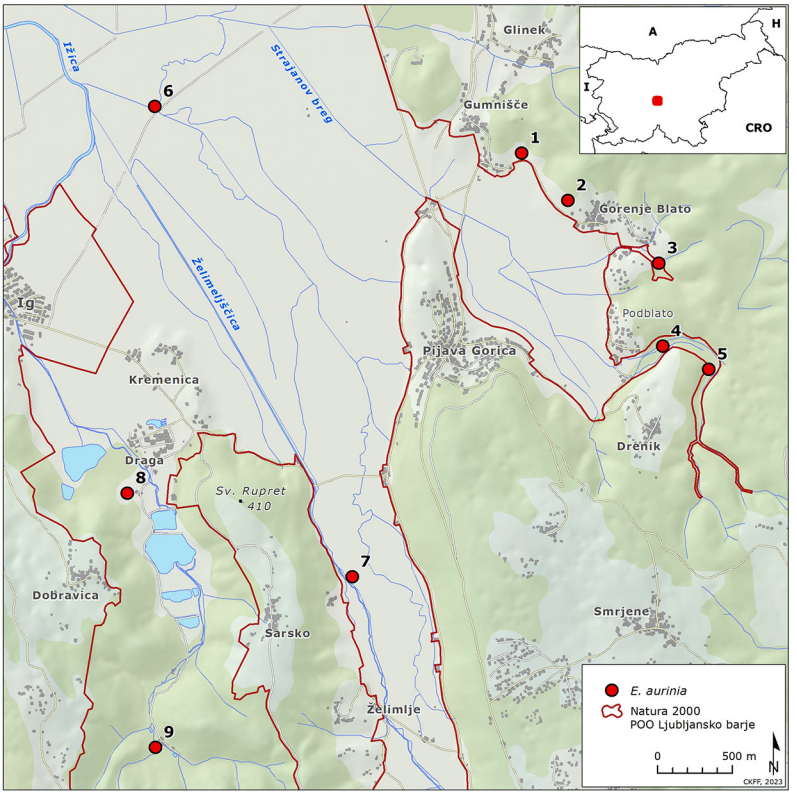
Tabela 1. Pregled podatkov o razširjenosti travniškega postavneža (*Euphydryas aurinia*) na Ljubljanskem barju po letu 2004. Opazovani razvojni stadiji: A – odrasel osebek; E – jajčeca; L – gnezdo gosenic.
Table 1. Overview of the recent records of the marsh fritillary (*Euphydryas aurinia*) at Ljubljansko barje after 2004. Observed developmental stages: A – adult; E – eggs; L – larval webs).

Območje	Nahajališče	N	E	Oznaka	Datum (stadij)	Popisovalec/ Vir	N2k Lj.b. (SI3000271)
Gumnišče	Travnik ob gozdu, JV od vasi Gumnišče	45,9643	14,5793	1	5. 6. 2021 (A)	Šturm Luka	ne
Gorenje Blato	Travnik ob gozdu, SZ od Gorenjega Blata	45,9615	14,5833	2	21. 5. 2022 (A)	Šturm Luka	ne
	Močvirna dolina JV od Gorenjega Blata	45,9577	14,5912	3	11. 6. 2009 (A)	Čelik Tatjana	da
					10. 6. 2015 (A)	Kogovšek Nika	
Strajanov breg	Košeni travniki JV ob vasi Podblato	45,9527	14,5916	4	1. 6. 2023 (A, E)	Zakšek Barbara	da
	Revitalizirano nizko barje , 500 m JV od vasi Podblato	45,9514	14,5956	5	17. 6. 2021 (A, E)	Čelik Tatjana	da
					13. 9. 2021 (L)	Hladnik Petra, Lipovšek Gregor, Oven Anja	
					1. 6. 2023 (A, E)	Zakšek Barbara	
					21. 6. 2023 (A, E)	Kogovšek Nika	
					5. 9. 2023 (L)	Kogovšek Nika	
					29. 9. 2023 (L)	Kogovšek Nika, Zakšek Barbara	
Ig–Škofljica	Travnik ob parkirišču ob cesti Ig-Škofljica, pri mostu čez potok Dremavščica	45,9670	14,5476	6	18. 5. 2018 (A)	Verovnik Rudi	da

Območje	Nahajališče	N	E	Oznaka	Datum (stadij)	Popisovalec/ Vir	N2k Lj.b. (SI3000271)
Želimeljska dolina	Travniki na S delu doline, 180 m SV od domačije Prhaj	45,9388	14,5649	7	1. 6. 2023 (A)	Zakšek Barbara	da
Draga pri Igu	Travniki na S delu doline Drage pri Igu, v okolici ribnikov	45,9437	14,5455	8	4. 6. 2016 (A)	Pajnič Peter	da
					19. 5. 2017 (A)	BioBlitz 2017	
					10. 6. 2021 (A)	Čelik Tatjana, Kogovšek Nika, Zakšek Barbara	
					23. 5. 2023 (A)	Zakšek Barbara	
	Travniki na J delu doline Drage pri Igu, v okolici domačije Rebel	45,9285	14,5480	9	19. 5. 2017 (A)	BioBlitz 2017	da
					10. 6. 2021 (A, E)	Čelik Tatjana, Kogovšek Nika, Zakšek Barbara	
					23. 5. 2023 (A)	Zakšek Barbara	
					8. 6. 2023 (A, E)	Kogovšek Nika	
					5. 9. 2023 (L)	Kogovšek Nika	

Pregled zabeleženih gostiteljskih rastlin

V letih 2021 in 2023 smo zbrali 58 podatkov o pojavljanju preadultnih stadijev travniškega postavneža na Ljubljanskem barju (Tab. 2), in sicer 17 najdb jajčec in 41 gnezd gosenic na 54 rastlinah. Gostiteljske rastline so bile travniška izjevka, svilničevolistni svišč in navadni objed (Tab. 2). Na eni rastlini travniške izjevke in eni rastlini svilničevolistnega svišča sta bila v letu 2021 odložena po dva skupka jajčec. V letu 2023 smo dve gnezdi gosenic našli na isti rastlini travniške izjevke na kateri smo pred tem opazili že odložena jajčeca, in sicer eno v dolini Drage in eno v dolini potoka Strajanov breg. Najpogostejša gostiteljska rastlina je bila travniška izjevka (48 opazovanj). V dolini potoka Strajanov breg (36 opazovanj) smo jajčeca našli na travniški izjevki in na navadnem objedu (1 skupek jajčec), medtem ko smo gnezda gosenic opazili le na travniški izjevki (Tab. 2). V dolini Drage pri Igu (22 opazovanj) smo tako jajčeca kot gnezda gosenic našli na travniški izjevki (13 opazovanj) in svilničevolistnem svišču (9 opazovanj). V dolinah Draga pri Igu in potoka Strajanov breg uspevajo vse tri gostiteljske vrste rastlin (travniška izjevka, svilničevolistni svišč in navadni objed). V Želimeljski dolini na lokaciji, kjer je bil zabeležen travniški postavnež, uspevata le travniška izjevka in navadni objed. Metulja sta bila namreč opazovana na travnikih, kjer svilničevolistni svišč, ki je vrsta gozdnega roba, ne uspeva.



Slika 2. Razširjenost travniškega postavneža (*Euphydryas aurinia*) na Ljubljanskem barju po letu 2004. Številka ob lokaciji ustreza oznaki v Tab. 1.
Figure 2. Distribution of the marsh fritillary (*Euphydryas aurinia*) at Ljubljansko barje after 2004. The numbering corresponds to the locations in Tab. 1.

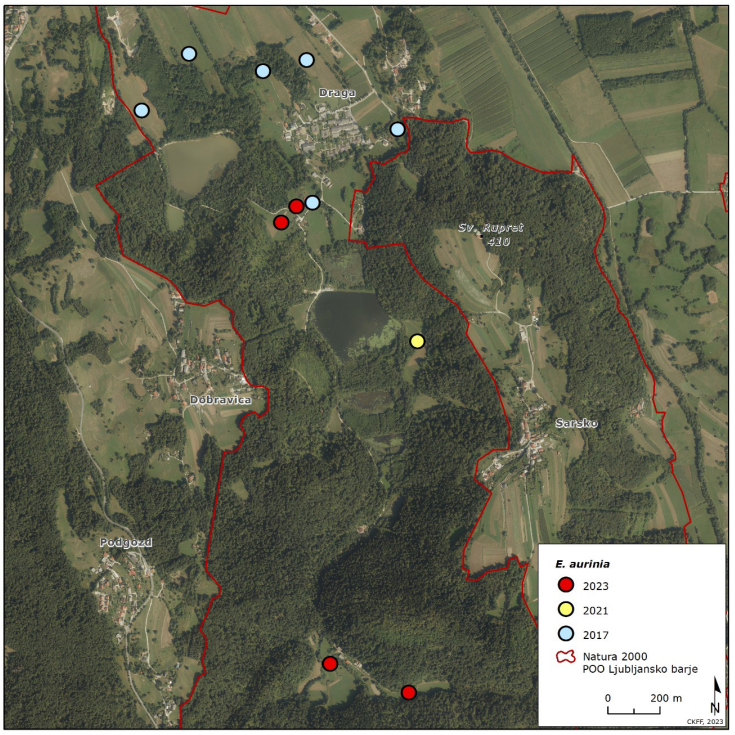
Tabela 2. Število opažanj preadultnih stadijev (skupek jajčec, gnezdo gosenic) travniškega postavneža (*Euphydryas aurinia*) na rastlinskih vrstah, ki so bile ugotovljene kot gostiteljske na Ljubljanskem barju v letih 2021 in 2023.
Table 2. The number of observations of preadult stages (egg batches, larval webs) of the Marsh Fritillary (*Euphydryas aurinia*) on plant species identified as hosts at Ljubljansko barje in 2021 and 2023.

Območje	Leto	Preadultni stadij	Travniška izjevka (*Succisa pratensis*)	Svilničevolistni svišč (*Gentiana asclepiadea*)	Navadni objed (*Succisella inflexa*)
Dolina Drage pri Igu	2021	jajčeca	8	6	/
	2023	jajčeca	1	/	/
		gnezdo gosenic	4	3	/
Strajanov breg	2021	gnezdo gosenic	22	/	/
	2023	jajčeca	1	/	1
		gnezdo gosenic	12	/	/

Komentar k razširjenosti

Sedanja razširjenost travniškega postavneža na Ljubljanskem barju je omejena na njegovo obrobje, in sicer na tri območja na jugovzhodu: Želimeljska dolina ter dolini potoka Strajanov breg in Draga pri Igu. V slednjih sta prisotni stalni (meta)populaciji (potrjena prisotnost preadultnih stadijev) travniškega postavneža. V dolini potoka Strajanov breg je bila vrsta prisotna že pred letom 2004, vendar med ciljno raziskavo leta 2015 vrsta tam ni bila potrjena. To je lahko posledica nizke številčnosti (in s tem težje zaznave) odraslih osebkov (op. v tem območju se v 2015 ni spremljalo prisotnosti preadultnih stadijev) in zaraščenosti zgornjega dela doline z lesno vegetacijo. Po revitalizaciji nizkega barja z odstranitvijo lesne zarasti je ta del doline postal ugodno življenjsko okolje za travniškega postavneža, saj se je povečala številčnost travniške izjevke (lastna opazovanja). V tem območju smo v letih 2021 in 2023 opazovali tako odrasle osebke kot preadultne stadije. V letu 2023 smo v enem terenskem dnevu (1. 6. 2023; Tab. 1) opazili 77 odraslih osebkov, prevladovali so samci, opažena je bila tudi ena samica med odlaganjem jajčec.

V dolini Drage pri Igu smo travniškega postavneža v letih 2021 in 2023 našli na več lokacijah na severnem in južnem delu doline (Sl. 3). Na največ lokacijah je bila vrsta v tej dolini zabeležena leta 2017, med ciljno raziskavo leta 2015 pa to območje ni bilo preiskano.



Slika 3. Zadnji podatki o prisotnosti travniškega postavneža (*Euphydryas aurinia*) v dolini Draga pri Igu v letih 2017–2023.
Figure 3. The most recent record of the marsh fritillary (*Euphydryas aurinia*) presence in the Draga Valley near Ig in years 2017–2023.

V Želimeljski dolini razmnoževanja vrste nismo potrdili, saj smo tam leta 2023 opazili le dva odrasla osebka. Želimeljska dolina leži med dolinama Draga pri Igu in potoka Strajanov breg, kjer so prisotne stalne populacije travniškega postavneža. Zračna razdalja med najdbami travniškega postavneža v dolini Drage pri Igu in Želimeljski dolini je manj kot kilometer (prb. 900 m), kar pomeni, da bi lahko dva opazovana metulja priletela iz populacije v dolini Drage. Med Želimeljsko dolino in populacijo travniškega postavneža v dolini potoka Strajanov breg je 2,5 km zračne razdalje. Obe razdalji sta znotraj meje disperzijskega potenciala travniškega postavneža, saj Zimmermann et al. (2011) navajajo, da lahko občasno posamezni osebki preletijo tudi 10 km ali več. Zato je v Želimeljski dolini smiselno nadaljnje spremljanje prisotnosti travniškega postavneža kot tudi ohranjanje površine in izboljševanje stanja mokrotnih travnikov z gostiteljskimi rastlinami travniškega postavneža (predvsem travniško izjevko). Dolge razdalje lahko metulji premostijo tudi s pomočjo vetra, kar je domnevni razlog, da je bil en odrasel osebek travniškega postavneža maja 2018 zabeležen med Igom in Škofljico. Le mesec kasneje je bil v tem območju po skoraj 50-ih letih opažen tudi en osebek gozdnega postavneža (*Euphydryas maturna*; leg. Čelik T., 21. 6. 2018). Glede na to, da v tem območju že 25 let redno poteka spremljanje populacije barjanskega okarčka (in hkrati beleženje vremenskih razmer), ki poseljuje travišča, na katerih sta bila leta 2018 (in v naslednjih letih nikoli več) najdena osebka obeh postavnežev, je zelo verjetno, da sta oba osebka priletela z južnimi vetrovi iz doline Draga pri Igu oz. bližnjega zaledja, ki je od območja Ig–Škofljica oddaljeno le 2,2 km. Manj kot 2 km od meje Krajinskega parka Ljubljansko barje sta oddaljeni populaciji travniškega postavneža na jasi Gradna (območje Natura 2000 Stržene luže SI3000139), kjer je bilo potrjeno razmnoževanje v letu 2017 (Zakšek et al. 2017) in na travniku ob vasi Gornji Rogatec (Korelc ustno, Šturm ustno).

Komentar h gostiteljskim rastlinam

Populacije v dolinah Draga pri Igu in potoka Strajanov breg pripadajo vlagoljubnemu ekotipu, saj je primarna gostiteljska rastlina travniška izjevka. Tudi navadni objed je ekološko vezan na oligotrofne mokrotne travnike, medtem ko je svilničevolistni svišč vrsta gozdnega roba. Kombinacija večjega števila, v tem primeru dveh gostiteljskih rastlin, kot sta travniška izjevka in svilničevolistni svišč (dolina Draga pri Igu), omogoča travniškemu postavnežu večjo verjetnost dolgoročnega preživetja. Na travniški izjevki se skupki jajčec in gnezda mladih gosenic vedno pojavljajo na listih pritlične rozete, zato jih s košnjo uničimo (Scherer et al. 2023). Na svilničevolistnem svišču se preadultni stadiji ponavadi pojavljajo na višje rastočih listih nad okoliško vegetacijo, kjer so dobro osončeni (Anthes et al. 2003). V primeru, da gozdnega roba ob travišču ne kosijo ali pa ga kosijo prostorsko in časovno mozaično, je vsaj delu populacije preadultnih stadijev travniškega postavneža omogočeno preživetje. O enaki kombinaciji vrst gostiteljskih rastlin poročajo tudi iz Nemčije (Anthes et al. 2003). Ni pa nam uspelo najti vira, ki bi navajal navadni objed kot ovipozicijsko rastlino travniškega postavneža. Naša najdba jajčec na tej rastlinski vrsti v dolini potoka Strajanov breg ni presenetljiva, saj to vrsto skupaj s travniško izjevko uvrščamo v isto družino (ščetičevke, Dipsacaceae). V Sloveniji smo gnezda gosenic travniškega postavneža na navadnem objedu opazovali tudi na Goričkem in na Radenskem polju (Zakšek & Kogovšek 2021a, 2021b).

Poznavanje lokalne ekologije travniškega postavneža na Ljubljanskem barju omogoča učinkovitejše načrtovanje upravljanja s populacijami vrste v tem območju Natura 2000. Poznavanje nabora gostiteljskih rastlin, ki so ekološko vezane na različni življenjski okolji

(mokrotna travišča – travniška izjevka in navadni objed; svetel gozdni rob – svilničevolistni svišč), pomeni, da je v načrt upravljanja treba vključiti ukrepe za ohranjanje obeh. Glede na lego Želimeljske doline je v njej smiselno dolgoročno ohranjati in izboljševati potencialna življenjska okolja (mokrotne travnike z gozdnim robom), ki bi travniškemu postavnežu lahko omogočala kolonizacijo območja, nastanek novih lokalnih populacij in s tem vzpostavitev metapopulacije na Ljubljanskem barju.

Summary

The marsh fritillary (*Euphydryas aurinia*) is defined as a vulnerable species (V) in the Red List of Butterflies in Slovenia (Ur. l. RS 2002). Individuals and their habitats are protected in Slovenia, with the species listed in Annex II of the Habitats Directive, which obliges EU countries to maintain populations in a favourable condition within Natura 2000 sites. In Slovenia, 34 Natura 2000 sites have been designated for the marsh fritillary, including Ljubljansko barje (SI3000271).

The marsh fritillary occurs in Slovenia in three ecotypes: hygrophilous, xerophilous and alpine. The former inhabits unfertilized wet to moist meadows on nutrient-poor soils (low marshes, meadows with the predominant moor grass (*Molinia caerulea*)), which are mown once a year. The host plants of the hygrophilous ecotype in Europe are mainly devil's-bit scabious (*Succisa pratensis*) (Anthes et al. 2003; Sardet & Betremieux 2006; Porter & Ellis 2011; Verovnik et al. 2012; Eeles 2014; Meister et al. 2015), although some populations also use willow gentian (*Gentiana asclepiadea*) (Anthes et al. 2003).

In our study, we examined two populations of the marsh fritillary regarding host plant usage in the Ljubljansko barje area, in the Draga Valley near Ig, and the Strajanov breg Valley. The main larval host plant of both populations is devil's-bit scabious. In the Draga Valley, the important host plant is also willow gentian, on which egg batches were found in 2021 and larval webs in 2023. In the Strajanov breg Valley, the main larval host plant is devil's-bit scabious, with only one egg batch found on *Succisella inflexa* at this site. All three plant species have also been recorded from other regions of Slovenia as larval host plants of marsh fritillary (Čelik 2015; Zakšek & Kogovšek 2021a, 2021b; DPOMS 2021). The adults of marsh fritillary were also found in the Želimlje Valley, but no larval stages were detected there. This raises the question of whether this is part of the metapopulation. Further research is needed on this topic.

Expanding the diversity of host plants increases the likelihood of long-term survival of the species. Therefore, understanding the local ecology of the preadult stages is crucial for planning management strategies for this particular species.

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Hibernacula of greater horseshoe bat *Rhinolophus ferrumequinum* (Schreber, 1774): data from four deep caves in Slovenia

Aja ZAMOLO[1], Teo DELIĆ[2]

[1]Centre for Cartography of Fauna and Flora, Antoličičeva ulica 1, SI-2204 Miklavž na Dravskem polju, Slovenia;
E-mail: aja.zamolo@ckff.si
[2]SubBio Laboratory, Department of Biology, Biotechnical Faculty, University of Ljubljana, Jamnikarjeva 101,
SI-1000 Ljubljana, Slovenia

Abstract. In this paper, we present data on not yet surveyed hibernacula of the greater horseshoe bat (*Rhinolophus ferrumequinum*) from three deep caves in SE Slovenia (Čaganka, Kaščica, Topli vrh 5) and one in W Slovenia. We found between 161 and 255 overwintering greater horseshoe bats in the caves, in addition to six other species. These data show that some deep caves are still unexplored for bats, although bat sightings have been reported in the past. Targeted survey of caves that are harder to access or those from which larger number of bats have been reported from could contribute not only additional distribution data, but also data on higher concentrations of hibernating bats.

Key words: Banjščice, Dolenjska, hibernacula, large groups, *Rhinolophus ferrumequinum*, *Rhinolophus hipposideros*, vertical caves

Izvleček. Prezimovališča velikega podkovnjaka *Rhinolophus ferrumequinum* (Schreber, 1774): podatki iz štirih globokih jam v Sloveniji – V članku predstavljava podatke o še nepopisanih prezimovališčih velikega podkovnjaka (*Rhinolophus ferrumequinum*) iz treh globokih jam JV Slovenije (Čaganka, Kaščica, Topli vrh 5) in ene iz Z Slovenije. V jamah smo našli med 161 in 255 prezimujočih velikih podkovnjakov, poleg tega pa smo zabeležili še šest drugih vrst. Ti podatki kažejo, da so nekatere globoke jame še vedno neraziskane za netopirje, četudi so v preteklosti že poročali o opažanjih netopirjev. Ciljno raziskovanje težje dostopnih jam in tistih, iz katerih že imamo opažanja večjega števila netopirjev, bi lahko prineslo ne le dodatne podatke o razširjenosti, temveč tudi podatke o večjih koncentracijah prezimovajočih netopirjev.

Ključne besede: Banjščice, brezna, Dolenjska, prezimovališča, *Rhinolophus ferrumequinum, Rhinolophus hipposideros*, velike skupine

Introduction

The greater horseshoe bat, *Rhinolophus ferrumequinum* (Schreber, 1774) is the largest of only five Rhinolopidae species known in Europe (Dietz et al. 2009). During hibernation, individuals regularly aggregate in large groups hanging from the ceiling. Such behavior enables

relatively easy and precise counting. A number of winter roosts are relatively well studied in Slovenia. Most of them are monitored within the National bat monitoring scheme (Presetnik et al. 2023), and are presented by horizontal caves or caves with shorter vertical parts, making them relatively easily accessible (Presetnik et al. 2023). Differently, the caves with repetitive vertical segments, demanding usage of single-rope technique, hereafter referred to as the deep caves, were rarely surveyed for the presence of bats. Nevertheless, large bat groups, counting more than 30 specimens, were reported from such caves by cavers and biologists, surveying caves or sampling subterranean fauna, respectively (e.g. Hudoklin & Presetnik 2012). Based on the published data, one can conclude that systematic surveys for unknown cave hibernacula in deep caves were not conducted in Slovenia. To gather more data on hibernacula from deep caves we surveyed three caves in the Dolenjska region, where large bat numbers were already reported (Čaganka, Kaščica, Topli vrh 5; e. g. Hudoklin & Presetnik 2012, Hudoklin 2002). None of the caves was surveyed thoroughly before, but there are reports on larger groups of bats, including the estimation of seen individuals, provided by cavers. In Čaganka, more than 100 greater horseshoe bats were observed on 14. 12. 2008 (Hudoklin & Presetnik 2012; data from 14. 12. 2008), 140 greater and 10 lesser horseshoe bats were observed on 18. 1. 2014 (Delić & Trontelj, personal communication) and more than 103 lesser horseshoe bats on 30. 12. 2022 (Šinigoj, personal communication; animals counted based on the provided photo). In Kaščica, 11 greater and 3 lesser horseshoe bats were observed on 27. 2. 1994 (Kryštufek & Hudoklin 1999), whereas Hudoklin (2002) reported it to home a large group of bats. Finally, a large group of bats was observed in Topli vrh 5 on 13. 2. 2011 (Hudoklin & Presetnik 2012, Rukše 2012; date of observation according to original data). In addition to the caves in region Dolenjska, where bats have been reported from before, we also report on a newly-discovered hibernaculum from the Banjščice plateau, western Slovenia.

Material and methods

We surveyed three deep caves, namely Topli vrh 5 (2021), Kaščica (2022) and Čaganka (2023) (all in Dolenjska, SE Slovenia), where large groups of bats were already reported, but were never subjected to thorough studies. The fourth cave, Roupa (Banjščice, W Slovenia), was surveyed in 2020, primarily for subterranean fauna. All caves were visited only once, with additional information on dates of visits, surveyed species and numbers of individuals available in Tab. 1.

The three caves in region Dolenjska were visited in the wintertime, following a prolonged period of steady and low temperatures, whereas Roupa was visited in the beginning of March. We counted bats throughout the caves, also inspecting for the bats hibernating in crevices. Almost 500 m deep Čaganka cave was surveyed to the depth of 244 m, dominated by a series of up to 40 m deep pits. In addition to pits, the bats were counted throughout the galleries of »Južni rov«, to the so-called »Inverzna dvorana«, and in the collapsed gallery named »Game Over«. Counting was not conducted further from this point, as hibernating bats were only rarely found there. The remaining three caves are characterized by the exchange of spacious pits and galleries, with limited horizontal development; all known parts of those caves were surveyed thoroughly. The depth of observed bats was estimated based on the available cave surveys.

Results and discussion

Large numbers of greater horseshoe bats (*R. ferrumequinum*), between 161 and 255 individuals, and numerous (43–363) lesser horseshoe bats (*R. hipposideros*), were found in all four visited caves (Tab. 1). Majority of the greater horseshoe bats were hanging at a close distance to each other, i.e. aggregated in groups (numbering maximum 240 individuals in Čaganka at the depth of 210 m; Fig. 1). The remaining greater horseshoe bats hung solitarily or in smaller aggregations located in different parts of caves, at the depth of 40–210 m. Similarly, the lesser horseshoe bats either hung solitarily, distributed in all parts of the caves, or in aggregations of up to 174 specimens in large galleries (in Čaganka at the depth of 250 m). In addition to horseshoe bats, we also found greater/lesser mouse-eared bat (*Myotis myotis/blythii*) in Kaščica, *Pipistrellus* bats in Roupa, serotine bat (*Eptesicus serotinus*), barbastelle (*Barbastella barbastellus*) and two smaller Vespertilionid bats in Čaganka (Tab. 1).

Table 1. Results of hibernacula surveys in three caves in region Dolenjska, South-east Slovenia and in one cave in Banjščice plateau, West Slovenia.
Tabela 1. Rezultati pregleda prezimovališč netopirjev v treh jamah na Dolenjskem, jugovzhodna Slovenija ter eni jami na Banjščicah, zahodna Slovenija.
»cave cad. no.« – cave cadastre number; »m a.s.l.« – meters above sea level; »lat.« – latitude; »lon.« – longitude; »no. of individuals« – number of individuals; »A.Z.« – Aja Zamolo; »T.D.« – Teo Delić; »D.Š.« – David Škufca; »S.P.« – Slavko Polak

Cave (cave cad. no.) [lat. (°N), long. (°E), m a.s.l. / total length (m), total depth (m)]	**Date; leg.**	**Taxa**	**No. of individuals**	**Location in the cave**
region Dolenjska				
Čaganka (9500) [45.549890, 15.082150, 690 / 2431, 475]	19. 2. 2023; A.Z., T.D.	*Rhinolophus ferrumequinum*	255	A group at depth of 210 m
		Rhinolophus hipposideros	363	Throughout the cave
		Eptesicus serotinus	1	Entrance pit
		Barbastella barbastellus	1	Entrance pit
		Vespertilionidae	2	At depth of 210 m
Kaščica (2852) [45.499670, 15.1437, 547 / 364, 110]	26. 2. 2022; A.Z., T.D.	*Rhinolophus ferrumequinum*	210	Two groups at depth of approx. 40 m
		Rhinolophus hipposideros	43	Throughout the cave
		Myotis myotis /blythii	1	At depth of 60 m
Topli vrh 5 (10304) [45.579010, 15.108690, 598 / 190, 86]	21. 2. 2021; A.Z., T.D., D.Š.	*Rhinolophus ferrumequinum*	161	A group at depth of 60 m
		Rhinolophus hipposideros	106	Throughout the cave
Banjščice plateau				
Roupa (1417) [46.05169, 13.71611, 720 / 500, 219]	4. 3. 2020; T.D., S.P.	*Rhinolophus ferrumequinum*	172	A group at depth of 50 m
		Rhinolophus hipposideros	67	
		Pipistrellus sp.	1	

Figure 1. Aggregation of greater horseshoe bats (240) hibernating at the beginning of »Južni rov« in cave Čaganka, SE Slovenia (photo: Aja Zamolo, 19. 2. 2023).
Slika 1. Prezimujoča skupina velikih podkovnjakov na začetku Južnega rova v jami Čaganka, S Slovenija (foto: Aja Zamolo, 19. 2. 2023).

No roost with higher number of overwintering greater horseshoe bats was known for any of the two regions, although their presence was expected. For Dolenjska, where bats were first counted more than 30 years ago (e.g. Kryštufek & Hudoklin 1999) and are regularly monitored since (Presetnik & Hudoklin 2022, Presetnik et al. 2023), our observations present a valuable contribution to the extant knowledge on their distribution and seasonal dynamics. Numbers of hibernating animals in Kaščica (210) and Čaganka (255) are the highest known in Slovenia to date, exceeding observation in the cave Lobašgrote (cave cadastre number 2882; 200 animals in winter 2017/2018) (Presetnik et al. 2020). There are four more caves in Dolenjska (Jazbina pri Podturnu, Lobašgrote, Flekova jama, Kostanjeviška jama) in which number of hibernating animals exceeded 100 (Presetnik et al. 2023). Similarly to this, bat community in Roupa presents by far the largest colony of the greater horseshoe bat in 40 km radius (available data for Slovenia). Based on the newly available data, expressing large number of overwintering greater horseshoe bats, Roupa presents an important bat roost.

All three caves from Dolenjska are a part of the Natura 2000 area Kočevsko (Ur. l. RS 2004), which was designated also for conservation of the greater horseshoe bat, lesser horseshoe bat and the greater mouse-eared bat habitats. Although we have not observed any threat to the hibernating bats or their habitats, we propose to include all three caves in the next *Plan for the management of Natura 2000 sites* (RS 2023), as specific sites of habitat conservation importance. As for Roupa, its entrance lies less than 20 m from the Natura 2000 area Banjščice-travišča. Therefore, the area might be relatively easily expanded. By enlarging it, Natura 2000 area Banjščice-travišča would gain two additional qualifying species (lesser and greater horseshoe bat) for which favorable conservation status of their habitats must be achieved.

Our data points to a series of possible indications. First, deep caves, which have more vertical parts and demand usage of a single-rope technique, are not surveyed sufficiently throughout the country. To improve our knowledge on the basic species diversity in such caves, and to acquire long-term population size dynamics, it is crucial to survey caves where bats have been reported from. In addition, we must note that some of the important data from deep caves was reported by cavers, who are often the only visitors of these habitats. To further facilitate gathering of such data we strongly recommend reporting data on bats in caves through citizen science platforms, i.e. BioPortal or Živo Podzemlje. If necessary, citizen science reports could be checked within an existing bat monitoring scheme, under the distributional monitoring approach, which enables checking additional sites, originally not included in the scheme. Finally, some of these sites might be added to the scheme at the discretion of experts.

Second, targeted surveying of deep caves might bring both additional distributional data and generate data on larger concentrations of hibernating bats. Therefore, we encourage further gathering of data on bat colonies from deep caves. To overcome existing shortcomings, present in this study, it would be worth to survey all known hibernacula of greater horseshoe bat in Dolenjska region within the same season and under similar weather conditions. If possible, without any intermittent thaws. Such planned activities would minimize the possibility of counting same specimens in different caves. In the long term, we recognize the combination of accidental data and planned surveys, as provider of the basic distributional data, which can be used as a solid ground for future conservations purposes.

Povzetek

Mnoga prezimovališča velikega podkovnjaka (*Rhinolophus ferrumequinum*) so v Sloveniji dobro poznana in vključena v shemo državnega monitoringa izbranih ciljnih vrst netopirjev (Presetnik et al. 2023). Kljub razmeroma dobri raziskanosti pa smo z načrtnim pregledom treh globokih jam na Dolenjskem (Čaganka, Kaščica, Topli vrh 5) za netopirje pridobili nove podatke o velikih prezimujočih skupinah velikih podkovnjakov. Iz vseh treh jam so jamarji že v preteklosti poročali o opažanju večjega števila netopirjev (npr. Hudoklin & Presetnik 2012; Hudoklin 2002). Poleg navedenih jam podajamo tudi rezultate pregleda jame Roupa na planoti Banjščice, ki je novo odkrito prezimovališče za to vrsto.

Veliko število prezimujočih tako velikih (161–255) kot malih podkovnjakov (43–363) je bilo opaženo v vseh štirih jamah. Večina velikih podkovnjakov je visela v skupinah, skupno največ 240 živali v jami Čaganka. Poleg navedenih vrst iz družine podkovnjakov, smo našli tudi posamezne netopirje vrste navadni/ostrouhi netopir (*Myotis myotis/Myotis blythii*) v Kaščici, netopirja iz rodu malih netopirjev (*Pipistrellus*) v Roupi in poznega netopirja (*Eptesicus serotinus*), širokouhega netopirja *(Barbastella barbastellus*) ter dva gladkonosa netopirja (Vespertilionidae) v Čaganki.

Nadaljnje tarčne raziskave globokih jam (jam z več vertikalnimi deli, ki zahtevajo uporabo vrvne tehnike in so zato težje dostopne) za netopirje, predvsem tiste, iz katerih so jamarji že poročali o netopirjih, lahko predstavljajo pomemben doprinos ne le k poznavanju razširjenosti, temveč tudi prispevajo podatke o številu in letni dinamiki posameznih vrst. S prispevkom želimo poudariti pomen tovrstnih podatkov in pozvati k posredovanju opažanj tako s strani biologov kot laikov, torej jamarjev.

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