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Checklist of amphipod crustaceans (Crustacea: Amphipoda) in Slovenia

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Abstract. Amphipods are among the most species-rich orders of peracarid crustaceans, inhabiting marine and fresh waters, including subterranean waters, as well as semi-terrestrial environments. Data on amphipods from Slovenia are scattered among published and unpublished references. We gathered all available data on amphipods in the country, using published and unpublished records from two databases, supplemented by additional published information and unpublished records from two collections of two institutions. All data were critically evaluated and species names updated to the latest taxonomically valid name. In total, we listed 198 species, belonging to 85 genera and 41 families. About two thirds of the species are marine, while the rest are semiterrestrial, brackish and freshwater species. Among the latter, subterranean species dominate. In total, 26 species endemic to Slovenia were identified, one of which lives in surface freshwater, and the rest in groundwaters. Surprisingly, no presence of invasive freshwater amphipod species has currently been confirmed. We provided critical comments on nine amphipod species that were listed erroneously for the country. Our work revealed two major knowledge gaps. Marine species records come from occasional sampling campaigns, and we suggest that this group calls for a more systematic research. More work has been done on freshwater species, which revealed many taxonomic uncertainties that cannot be resolved at present and call for additional taxonomic research.

Key words: Amphipoda, checklist, marine, freshwater, subterranean, taxonomy, semiterrestrial

Izvleček. Seznam rakov postranic (Crustacea: Amphipoda) v Sloveniji – Postranice so eden izmed najbogatejših redov rakov valilničarjev, ki poseljujejo morske in sladke vode, površinske in podzemne, ter tudi obrežne habitate. O slovenskih postranicah so poročali številni raziskovalci, vendar so podatki raztreseni po številnih objavljenih in neobjavljenih virih. Zbrali smo vse razpoložljive podatke o postranicah v državi, tako objavljene kot tudi neobjavljene podatke iz dveh podatkovnih zbirk in zbirk preparatov dveh inštitucij. Vsi podatki so bili kritično vrednoteni, imena vrst pa posodobljena glede na zadnje veljavno taksonomsko ime. Skupno smo zbrali podatke o 198 vrstah postranic, ki pripadajo 85 rodovom in 41 družinam. Približno dve tretjini vrst je morskih, ostale pa so obrežne, brakične in sladkovodne. Med slednjimi prevladujejo podzemne vrste. Identificirali smo 26 vrst, ki so endemne za Slovenijo, od katerih vse žive v celinskih vodah, od teh le ena v površinskih, vse ostale pa v podzemnih vodah. Presenetljivo je, trenutno še nimamo potrjenega podatka o pojavljanju invazivnih vrst postranic v celinskih vodah v Sloveniji. Podajamo komentar devetih vrst, ki so jih napačno navajali kot živeče v Sloveniji. V našem delu smo zaznali dve vrzeli v raziskanosti postranic. Podatki o morskih vrstah prihajajo le z naključnih vzorčenj; to skupino bi morali raziskati sistematičneje. Več dela je bilo narejenega na sladkovodnih vrstah, kjer pa so problem številne taksonomske nejasnosti, ki jih lahko razrešimo šele z dodatnimi taksonomskimi raziskavami.

Ključne besede: Amphipoda, seznam vrst, morski, sladkovodni, podzemni, taksonomija, obrežne postranice

Introduction

With over 10,000 species, the order Amphipoda is one of the largest groups in the superorder Peracarida in the classis Crustacea (Horton et al. 2021). Amphipods are distributed in all aquatic and semiterrestrial habitats around the globe. About 80% of species live in marine environments (Väinölä et al. 2008), and span between supralittoral to deepest trenches, where they represent an important fraction of deep-sea communities (Jamieson et al. 2010). The remaining 20% are freshwater (Väinölä et al. 2008), living in all types of freshwater including groundwater (Sket 1999a, Zagmajster et al. 2014).

Amphipods represent an ecologically important group that contributes to nutrient cycling. They act as detritivores, shredders, suspension feeders, scavengers, parasites or predators (Kaestner 1967, MacNeil et al. 1997, Ruffo et al. 1998) – and constitute an important food source for fish. Some species are intermediate hosts to acanthocephalan parasites (Westram et al. 2011, Shaw et al. 2020), some are hosts to ciliates (Gudmundsdóttir et al. 2018) or temnocephalid flatworms (Matjašič 1990), while several species live in associations with other animals, such as other crustaceans, bryozoans, mollusks, or cnidarians (Lörz et al. 2014, Vader & Myers 1993, Vader & Tandberg 2013, 2020). Because of the absence of dispersal larvae (Myers & Lowry 2009), many species are narrow endemics (Trontelj et al. 2009, Bregović et al. 2019, Esmaeili-Rineh et al. 2020) and an important part of natural heritage. Yet, few species have been rapidly expanding their original distributional ranges, and as invasive species remarkably modified native freshwater communities across Europe (Jazdzewski et al. 2004, Grabowski et al. 2012, Dodd et al. 2014). Importantly, many amphipod species have been included into ecotoxicological bioassays and used in monitoring schemes of water quality (Feckler et al. 2012, Major et al. 2013).

Amphipods thus constitute an important group of crustaceans for basic and applied research. Successful implementation of amphipod crustaceans into diverse research programs requires a resolved taxonomy, an easy identification system, good understanding of species' distributions, an estimation of potential threats and species' conservation status. On many occasions, this information is incomplete or completely lacking.

Slovenia has a long tradition in amphipod research. Yet, biological data on amphipod species are scattered in many sources or sometimes unpublished. As a consequence, we are facing larger or smaller knowledge gaps on the taxonomy, distribution, ecology and biology of many species. An updated checklist of species present in the country is the first step towards systematic studies of amphipods. Such a list is the most elementary document needed for inventory and planning of future research, be it basic or applied. The hitherto published lists of Slovenian amphipods (Karaman 1974, Sket 1996, Fišer 2002) have long been outdated and need to be revised and corrected. To progress towards proper and complete inventory of amphipods in Slovenia, we assembled all available published and unpublished data on amphipods and compiled the first comprehensive national checklist of all amphipods in coastal and inland waters.

Materials and methods

To assemble the list, we first used the records of all previously published checklists (Karaman 1974, Sket 1996, Fišer 2002), and supplemented it with data from literature published afterwards. For this, we used already extracted data stored in two databases, BioPortal (BioPortal, Centre for Cartography of Fauna and Flora – CKFF) and SubBioDB (SubBio Database, Subterranean Biology Laboratory at Department of Biology, Biotechnical Faculty, University of Ljubljana – SubBioLab). Additionally, we added new information from the specimen collections of the Marine Biological Station of Piran of the National Institute of Biology (hereinafter referred to as MBP) and of the SubBioLab. While preparing the checklist, we specifically considered the following points.

Names and taxonomy. We used the names evaluated as »accepted« in the World Register of Marine Species (Horton et al. 2021), with one exception, when we considered the relevant publication (Sket & Hou 2018 synonymized the genera *Chaetogammarus* and *Echinogammarus* into *Homoeogammarus*); all other names were discarded as synonyms and were not added to the checklist. We listed only formally described species, even though molecular analyses in many cases imply that morphological species comprise morphologically indistinguishable species complexes. These cryptic species (e.g., Copilaș-Ciocianu & Petrusek 2015, Mamos et al. 2016, Csapó et al. 2020, Hupało et al. 2020, Wattier et al. 2020) are not considered in this checklist, but we do discuss them when relevant. The possible new species candidates and problematic taxonomic cases are beyond the scope of this overview. The higher taxonomy of amphipods above the family rank has been challenged (Copilaș-Ciocianu et al. 2020). To keep the checklist simple and insensitive to taxonomic changes, we excluded ranks between order and family.

Ecology. Each species in the checklist is labelled according to its habitat where it can be primarily found. We introduced categories »marine«, »brackish«, »freshwater« (i.e. surface freshwater), »groundwater« (i.e., subterranean freshwater) and »semiterrestrial«, but do not make distinction among habitats within these categories (Trontelj et al. 2012, Culver & Pipan 2014). Species from springs, which some consider an ecotone between groundwater and surface waters, were assigned to the habitat typical for that genus.

Endemism. Present knowledge of many species is not sufficient to construct detailed maps of their distribution. We, however, indicated whether species are living within the political borders of Slovenia (endemics), or whether they are distributed also beyond the country borders.

Citation. Every species record is linked to the reference, supporting its presence in the country – either being a literature reference or a database. Therefore, the list of references should not be considered as a complete list of all references on amphipods of Slovenia. We selected the most comprehensive resources, to keep the list of supporting references at minimum.

Results

The checklist of amphipods of Slovenia encompasses a total of 198 species, belonging to 41 families and 85 genera (Tabs. 1, 2). Of all the species in the list, 77 are listed for the country for the first time, based on data coming from the collections of UL and MBP (Tab. 2).

Table 1. Numerical summary of all amphipod species confirmed to occur in Slovenia, according to the habitat they occur in. All three brackish species can also be found in surface freshwaters (to simplify, here referred to only as freshwater). [1]Members of some families and genera live in more than one environment, therefore the numbers do not simply sum up. The term endemic relates to species, occurring within Slovenian political borders only.

Tabela 1. Številčni povzetek vseh postranic, ki se potrjeno pojavljajo v Sloveniji, glede na habitate, kjer se pojavljajo. Vse tri brakične vrste so našli tudi v površinskih sladkih vodah. [1] Predstavniki nekaterih družin/rodov žive v več kot enem habitatu, zato se številke teh ne seštejejo. Oznaka »endemic« se nanaša na vrste, ki žive izključno znotraj političnih meja Slovenije.

	Number of families	Number of genera	Number of species	Number of endemics
marine	36	73	127	0
semiterrestrial	1	4	4	0
brackish	1	1	3	0
freshwater	2	4	7	1
groundwater	4	6	57	25
TOTAL[1]	41	85	198	26

Table 2. List of all amphipod species confirmed to occur in Slovenia, with notes on their main habitat, and whether they are distributed only within the political borders of Slovenia (endemics). The basis of the data assembly were the BioPortal (Centre for Cartography of Fauna and Flora) and the SubBioDB (SubBioLab – Subterranean Biology Laboratory) databases, but supplemented with data from morphological collections: MBP – the collection of the Marine Biological Station Piran (National Institute of Biology); SubBioLab –the collection of the SubBioLab (at Department of Biology, Biotechnical Faculty, University of Ljubljana). We retained only one reference, and do not list all references on the species for the country.

Tabela 2. Seznam vseh vrst postranic, ki se potrjeno pojavljajo v Sloveniji, s podatki o glavnem habitatu in morebitni razširjenosti le znotraj Slovenije (endemiti). Osnova za podatke sta bili zbirki podatkov BioPortal (Center za kartografijo favne in flore) in SubBioDB (SubBioLab- Raziskovalna skupina za speleobiologijo), ki smo ju dopolnili s podatki iz morfoloških zbirk MBP – zbirka Morske biološke postaje (Nacionalni inštitut za biologijo) in SubBioLab – zbirka skupine SubBioLab (Oddelek za biologijo, Biotehniška fakulteta, Univerza v Ljubljani). Za vsako vrsto navajamo le en vir in ne celotnega seznama vseh navedb iz Slovenije.

Family	Species	Habitat	Endemic	Reference
Ampeliscidae	*Ampelisca diadema* (Costa, 1853)	marine	no	SubBioLab
	Ampelisca intermedia Bellan-Santini & Diviacco, 1990	marine	no	SubBioLab
	Ampelisca pseudosarsi Bellan-Santini & Kaim-Malka, 1977	marine	no	SubBioLab
	Ampelisca pseudospinimana Bellan-Santini & Kaim-Malka, 1977	marine	no	SubBioLab
	Ampelisca ruffoi Bellan-Santini & Kaim-Malka, 1977	marine	no	SubBioLab
	Ampelisca sarsi Chevreux, 1888	marine	no	SubBioLab
	Ampelisca spinipes Boeck, 1861	marine	no	SubBioLab
	Ampelisca tenuicornis Liljeborg, 1856	marine	no	SubBioLab
	Ampelisca typica (Spence Bate, 1856)	marine	no	SubBioLab

Family	Species	Habitat	Endemic	Reference
	Ampelisca rubella A. Costa, 1864	marine	no	Ruffo et al. 1982
Amphilochidae	*Apolochus neapolitanus* (Della Valle, 1893)	marine	no	Fišer 2002
	Apolochus picadurus (J.L. Barnard, 1962)	marine	no	SubBioLab
Ampithoidae	*Ampithoe ramondi* Audouin, 1826	marine	no	Fišer 2002
	Ampithoe riedli Krapp-Schickel, 1968	marine	no	SubBioLab
	Biancolina algicola Della Valle, 1893	marine	no	SubBioLab
	Cymadusa crassicornis (Costa, 1853)	marine	no	SubBioLab
	Pleonexes helleri (Karaman, 1975)	marine	no	SubBioLab
	Sunamphitoe spuria (Krapp-Schickel, 1978)	marine	no	SubBioLab
Aoridae	*Aora spinicornis* Afonso, 1976	marine	no	Fišer 2002
	Autonoe spiniventris Della Valle, 1893	marine	no	MBP
	Lembos websteri Spence Bate, 1857	marine	no	SubBioLab
	Microdeutopus algicola Della Valle, 1893	marine	no	SubBioLab
	Microdeutopus anomalus (Rathke, 1843)	marine	no	Fišer 2002
	Microdeutopus chelifer (Spence Bate, 1862)	marine	no	SubBioLab
	Microdeutopus gryllotalpa Costa, 1853	marine	no	Fišer 2002
	Microdeutopus obtusatus Myers, 1973	marine	no	Fišer 2002
	Microdeutopus similis Myers, 1977	marine	no	SubBioLab
	Microdeutopus sporadhi Myers, 1969	marine	no	Fišer 2002
	Microdeutopus stationis Della Valle, 1893	marine	no	SubBioLab
	Microdeutopus versiculatus (Spence Bate, 1857)	marine	no	Fišer 2002
Aristiidae	*Perrierella audouiniana* (Spence Bate, 1857)	marine	no	MBP
Atylidae	*Nototropis guttatus* Costa, 1853	marine	no	SubBioLab
	Nototropis vedlomensis (Spence Bate & Westwood, 1862)	marine	no	MBP
Bogidiellidae	*Bogidiella albertimagni* Hertzog, 1933	groundwater	no	Karaman 1974
	Bogidiella semidenticulata Meštrov, 1962	groundwater	no	Karaman 1974
Calliopiidae	*Apherusa alacris* Krapp-Schickel, 1969	marine	no	Fišer 2002
	Apherusa chiereghinii Giordani-Soika, 1949	marine	no	Fišer 2002
Caprellidae	*Caprella acanthifera* Leach, 1814	marine	no	SubBioLab
	Caprella danilevskii Czerniavski, 1868	marine	no	SubBioLab
	Caprella equilibra Say, 1818	marine	no	SubBioLab
	Caprella scaura Templeton, 1836	marine	no	MBP
	Phtisica marina Slabber, 1769	marine	no	SubBioLab
	Pseudolirius kroyeri (Haller, 1879)	marine	no	MBP
	Pseudoprotella phasma (Montagu, 1804)	marine	no	SubBioLab
Cheirocratidae	*Cheirocratus sundevallii* (Rathke, 1843)	marine	no	SubBioLab
Cheluridae	*Chelura terebrans* Philippi, 1839	marine	no	MBP
Corophiidae	*Apocorophium acutum* (Chevreux, 1908)	marine	no	SubBioLab
	Corophium orientale Schellenberg, 1928	marine	no	SubBioLab
	Leptocheirus longimanus Ledoyer, 1973	marine	no	SubBioLab

Family	Species	Habitat	Endemic	Reference
	Leptocheirus mariae Karaman, 1973	marine	no	SubBioLab
	Leptocheirus pectinatus (Norman, 1869)	marine	no	SubBioLab
	Medicorophium annulatum (Chevreux, 1908)	marine	no	MBP
	Medicorophium rotundirostre (Stephensen, 1915)	marine	no	MBP
	Medicorophium runcicorne (Della Valle, 1893)	marine	no	SubBioLab
	Monocorophium insidiosum (Crawford, 1937)	marine	no	Fišer 2002
	Monocorophium sextonae (Crawford, 1937)	marine	no	Fišer 2002
	Monocorophium acherusicum (Costa, 1853)	marine	no	Heller 1866
Crangonyctidae	*Synurella ambulans* (F. Müller, 1846)	freshwater	no	Pekolj 2020
Cyproideidae	*Peltocoxa marioni* Catta, 1875	marine	no	Fišer 2002
Dexaminidae	*Dexamine spiniventris* (Costa, 1853)	marine	no	Fišer 2002
	Dexamine spinosa (Montagu, 1813)	marine	no	Fišer 2002
	Tritaeta gibbosa (Spence Bate, 1862)	marine	no	SubBioLab
Eusiridae	*Eusirus longipes* Boeck, 1861	marine	no	MBP
Gammaridae	*Homoeogammarus olivii* (H. Milne Edwards, 1830)	marine	no	Fišer 2002
	Homoeogammarus pungens (H. Milne Edwards, 1840)	brackish, freshwater	no	Karaman 1974
	Homoeogammarus stammeri (S. Karaman 1931)	freshwater	no	Karaman 1974
	Homoeogammarus stocki G. Karaman, 1970	brackish, freshwater	no	Karaman 1974
	Homoeogammarus veneris (Heller, 1865)	brackish, freshwater	no	Karaman 1974
	Gammarus aequicauda (Martynov, 1931)	marine	no	Fišer 2002
	Gammarus balcanicus Schäferna, 1923	freshwater	no	Sket et al. 2010
	Gammarus crinicornis Stock, 1966	marine	no	SubBioLab
	Gammarus fossarum Koch, 1836	freshwater	no	Fišer et al. 2007
	Gammarus insensibilis Stock, 1966	marine	no	SubBioLab
	Gammarus lacustris G.O. Sars, 1863	freshwater	no	Alther et al. 2016
	Gammarus roeselii Gervais, 1835	freshwater	no	Karaman 1974
	Gammarus subtypicus Stock, 1966	marine	no	Fišer 2002
	Jugogammarus kusceri (S. Karaman, 1931)	freshwater	yes	Karaman 1974
Hyalidae	*Apohyale crassipes* (Heller, 1866)	marine	no	Fišer 2002
	Apohyale perieri (Lucas, 1846)	marine	no	Fišer 2002
	Hyale stebbingi Chevreux, 1888	marine	no	SubBioLab
	Parhyale aquilina (Costa, 1857)	marine	no	Fišer 2002
	Protohyale grimaldii (Chevreux, 1891)	marine	no	SubBioLab
	Protohyale camptonyx (Heller, 1866)	marine	no	Fišer 2002

Family	Species	Habitat	Endemic	Reference
Ingolfiellidae	*Ingolfiella beatricis* Ruffo & Vonk, 2001	groundwater	yes	Sket 2000
Iphimediidae	*Iphimedia minuta* G.O. Sars, 1883	marine	no	MBP
Isaeidae	*Isaea montagui* H. Milne Edwards, 1830	marine	no	Heller 1866
Ischyroceridae	*Centraloecetes dellavallei* (Stebbing, 1899)	marine	no	SubBioLab
	Coxischyrocerus inexpectatus (Ruffo, 1959)	marine	no	Fišer 2002
	Ericthonius brasiliensis (Dana, 1853)	marine	no	SubBioLab
	Ericthonius punctatus (Spence Bate, 1857)	marine	no	Fišer 2002
	Jassa marmorata Holmes, 1905	marine	no	MBP
	Plumulojassa ocia (Spence Bate, 1862)	marine	no	Fišer 2002
Leucothoidae	*Leucothoe incisa* Robertson, 1892	marine	no	MBP
	Leucothoe oboa Karaman, 1971	marine	no	SubBioLab
	Leucothoe occulta Krapp-Schickel, 1975	marine	no	SubBioLab
	Leucothoe pachycera Della Valle, 1893	marine	no	SubBioLab
	Leucothoe richiardii Lessona, 1865	marine	no	Fišer 2002
	Leucothoe serraticarpa Della Valle, 1893	marine	no	MBP
	Leucothoe spinicarpa (Abildgaard, 1789)	marine	no	Fišer 2002
Liljeborgiidae	*Liljeborgia dellavallei* Stebbing, 1906	marine	no	Fišer 2002
Lysianassidae	*Lysianassa costae* H. Milne Edwards, 1830	marine	no	Fišer 2002
	Lysianassa pilicornis Heller, 1866	marine	no	MBP
Maeridae	*Abludomelita gladiosa* (Spence Bate, 1862)	marine	no	Ruffo et al. 1982
	Ceradocus orchestiipes Costa, 1853	marine	no	Ruffo et al. 1982
	Elasmopus brasiliensis (Dana, 1853)	marine	no	SubBioLab
	Elasmopus pocillimanus (Spence Bate, 1862)	marine	no	Fišer 2002
	Elasmopus rapax Costa, 1853	marine	no	Fišer 2002
	Maera grossimana (Montagu, 1808)	marine	no	Fišer 2002
	Othomaera schmidtii (Stephensen, 1915)	marine	no	MBP
	Quadrimaera inaequipes (A. Costa & Hope, 1851)	marine	no	Fišer 2002
Melitidae	*Melita hergensis* Reid, 1939	marine	no	Fišer 2002
	Melita palmata (Montagu, 1804)	marine	no	Fišer 2002
Microprotopidae	*Microprotopus maculatus* Norman, 1867	marine	no	Fišer 2002
Niphargidae	*Carinurella paradoxa* (Sket, 1964)	groundwater	no	Sket 1964
	Niphargobates orophobata Sket, 1981	groundwater	yes	Sket 1981
	Niphargus aberrans Sket, 1972	groundwater	no	Sket 1972
	Niphargus arbiter G. Karaman, 1984	groundwater	no	Delić et al. 2017a
	Niphargus arcanus G. Karaman, 1988	groundwater	yes	Karaman 1988
	Niphargus brachytelson S. Karaman, 1952	groundwater	yes	Karaman 1952
	Niphargus carniolicus Sket, 1960	groundwater	yes	Sket 1960
	Niphargus chagankae Delić, Trontelj & Fišer, 2017	groundwater	yes	Delić et al. 2017b
	Niphargus cvajcki Delić, Trontelj & Fišer, 2017	groundwater	yes	Delić et al. 2017b

Family	Species	Habitat	Endemic	Reference
	Niphargus danconai Benedetti, 1942	groundwater	no	Sket 1996
	Niphargus dobati Sket, 1999	groundwater	yes	Sket 1999b
	Niphargus fongi Fišer & Zagmajster, 2009	groundwater	yes	Fišer & Zagmajster 2009
	Niphargus goricae Delić, Trontelj & Fišer, 2017	groundwater	yes	Delić et al. 2017b
	Niphargus gottscheeanensis Delić, Trontelj & Fišer, 2017	groundwater	yes	Delić et al. 2017b
	Niphargus grandii Ruffo, 1936	groundwater	no	Sket 1972
	Niphargus hadzii Rejic, 1956	groundwater	yes	Rejic 1956
	Niphargus hebereri Schellenberg, 1933	groundwater	no	Sket 1996
	Niphargus iskae Delić, Trontelj & Fišer, 2017	groundwater	yes	Delić et al. 2017b
	Niphargus karamani Schellenberg, 1935	groundwater	no	Delić et al. 2017b
	Niphargus kenki S. Karaman, 1952	groundwater	no	Karaman 1952
	Niphargus krameri Schellenberg, 1935	groundwater	no	Fišer et al. 2006a
	Niphargus labacensis Sket, 1956	groundwater	no	Prevorčnik et al. 2019
	Niphargus lattingerae G. Karaman, 1983	groundwater	no	Prevorčnik et al. 2019
	Niphargus liburnicus G. Karaman & Sket, 1989	groundwater	no	Zakšek et al. 2019
	Niphargus longidactylus Ruffo, 1937	groundwater	no	Prevorčnik et al. 2019
	Niphargus longiflagellum S. Karaman, 1950	groundwater	yes	Karaman 1950
	Niphargus malagorae Delić, Trontelj & Fišer, 2017	groundwater	yes	Delić et al. 2017b
	Niphargus microcerberus Sket, 1972	groundwater	no	Sket 1972
	Niphargus minor Sket, 1956	groundwater	no	Prevorčnik et al. 2019
	Niphargus multipennatus Sket, 1956	groundwater	no	Sket 1972
	Niphargus novomestanus S. Karaman, 1952	groundwater	yes	Karaman 1952
	Niphargus orcinus Joseph, 1869	groundwater	no	Fišer et al. 2006b
	Niphargus pachytelson Sket, 1960	groundwater	yes	Sket 1960
	Niphargus parapupetta G. Karaman, 1984	groundwater	no	Prevorčnik et al. 2019
	Niphargus pectinicauda Sket, 1971	groundwater	yes	Sket 1971
	Niphargus podpecanus S. Karaman, 1952	groundwater	yes	Karaman 1952
	Niphargus pupetta (Sket, 1962)	groundwater	no	Sket 1971
	Niphargus rejici Sket, 1958	groundwater	yes	Sket 1958
	Niphargus scopicauda Fišer, Coleman, Zagmajster, Zwittnig, Gerecke & Sket, 2010	groundwater	yes	Fišer et al. 2010
	Niphargus serbicus S. Karaman, 1960	groundwater	no	Sket 1972
	Niphargus slovenicus S. Karaman, 1932	groundwater	yes	Karaman 1932
	Niphargus sphagnicolus Rejic, 1956	groundwater	yes	Rejic 1956
	Niphargus spinulifemur S. Karaman, 1954	groundwater	no	Fišer et al. 2006a

Family	Species	Habitat	Endemic	Reference
	Niphargus spoeckeri Schellenberg, 1933	groundwater	yes	Schellenberg 1933
	Niphargus stenopus Sket, 1960	groundwater	yes	Sket 1960
	Niphargus steueri Schellenberg, 1935	groundwater	no	Zakšek et al. 2019
	Niphargus stochi G. Karaman, 1994	groundwater	no	Trontelj et al. 2012
	Niphargus stygius (Schiödte, 1847)	groundwater	no	Delić et al. 2021
	Niphargus subtypicus Sket, 1960	groundwater	no	Zakšek et al. 2019
	Niphargus timavi S. Karaman, 1954	groundwater	no	Fišer et al. 2006a
	Niphargus transitivus Sket, 1971	groundwater	no	SubBioDB
	Niphargus valachicus Dobreanu & Manolache, 1933	groundwater	no	Karaman 1974
	Niphargus wolfi Schellenberg, 1933	groundwater	no	Schellenberg 1933
	Niphargus zagrebensis S. Karaman, 1950	groundwater	no	Delić et al. 2017b
Nuuanuidae	*Gammarella fucicola* (Leach, 1814)	marine	no	Fišer 2002
Oedicerotidae	*Deflexilodes acutipes* (Ledoyer, 1983)	marine	no	MBP
	Deflexilodes gibbosus (Chevreux, 1888)	marine	no	SubBioLab
	Deflexilodes griseus (Della Valle, 1893)	marine	no	MBP
	Deflexilodes subnudus (Norman, 1889)	marine	no	MBP
	Perioculodes aequimanus (Kossman, 1880)	marine	no	SubBioLab
	Perioculodes longimanus (Spence Bate & Westwood, 1868)	marine	no	Fišer 2002
	Synchelidium longidigitatum Ruffo, 1947	marine	no	Fišer 2002
	Westwoodilla rectirostris (Della Valle, 1893)	marine	no	MBP
Phliantidae	*Pereionotus testudo* (Montagu, 1808)	marine	no	SubBioLab
Photidae	*Gammaropsis crenulata* Krapp-Schickel & Myers, 1979	marine	no	SubBioLab
	Gammaropsis maculata (Johnston, 1828)	marine	no	Fišer 2002
	Megamphopus brevidactylus Myers, 1976	marine	no	SubBioLab
Phoxocephalidae	*Harpinia antennaria* Meinert, 1890	marine	no	MBP
	Harpinia dellavallei Chevreux, 1910	marine	no	MBP
Podoceridae	*Podocerus variegatus* Leach, 1814	marine	no	SubBioLab
Podoprionidae	*Podoprion bolivari* Chevreux, 1891	marine	no	MBP
Pontogeneiidae	*Eusiroides dellavallei* Chevreux, 1899	marine	no	SubBioLab
Scopelocheiridae	*Scopelocheirus crenatus* Spence Bate, 1857	marine	no	Ruffo et al. 1989
	Scopelocheirus hopei (Costa & Hope, 1851)	marine	no	Heller 1866
Stenothoidae	*Stenothoe monoculoides* (Montagu, 1813)	marine	no	Fišer 2002
	Stenothoe tergestina (Nebeski, 1881)	marine	no	Fišer 2002
Talitridae	*Orchestia mediterranea* Costa, 1853	semiterrestrial	no	Fišer 2002
	Speziorchestia stephenseni (Cecchini, 1928)	semiterrestrial	no	Fišer 2002
	Talitrus saltator (Montagu, 1808)	semiterrestrial	no	SubBioLab
	Cryptorchestia garbinii Ruffo, Tarocco & Latella, 2014	semiterrestrial	no	MBP
Tryphosidae	*Hippomedon bidentatus* Chevreux, 1903	marine	no	MBP

Family	Species	Habitat	Endemic	Reference
	Lepidepecreum longicorne (Spence Bate & Westwood, 1861)	marine	no	MBP
	Orchomene humilis (Costa, 1853)	marine	no	Fišer 2002
	Tryphosa nana (Krøyer, 1846)	marine	no	Fišer 2002
Uristidae	*Tmetonyx nardonis* (Heller, 1867)	marine	no	Heller 1866

About two thirds of species (127 species, 73 genera and 36 families) are marine, one family with four genera totalling four species are semiterrestrial, three species can be found in both brackish and freshwaters, whereas the rest of the species (65) live in freshwater only. Among the latter, subterranean species (57 species) predominate. There are 26 species endemic to the country, of which only one is from surface freshwater, while all the rest are from groundwater (Tabs. 1, 2). We detected two alien marine species, of which one is invasive, but found no alien freshwater species.

Nine species are considered as erroneously listed for Slovenia, with detailed explanations on the reasoning behind exclusion from the national list of amphipods explained in Tab. 3.

Table 3. A list of amphipod species erroneously listed as present in Slovenia in previous papers. In a separate column, we justify their removal from the Slovenian checklist.
Tabela 3. Seznam vrst postranic, ki jih starejša dela zmotno navajajo kot del slovenske favne – kar je napaka. V ločenem stolpcu utemeljujemo njihovo odstranitev s seznama slovenske favne.

Family	Species	Reason to remove	Source
Hadziidae	*Hadzia fragilis stochi* Karaman, 1989	Present on Carso Goriziano, Italy, but its presence in Slovenia was never confirmed. Also Sket (1996) listed its presence as doubtful, with question mark added.	Sket 1996
Gammaridae	*Gammarus wautieri* Roux, 1967	A species distributed in France, identified using the identification key of Karaman and Pinkster (1977). According to molecular evidence, this is an error; it likely represents an unknown species from the complex *Gammarus fossarum.*	Sket 1970
Niphargidae	*Niphargus aquilex*	This species is one of the first described *Niphargus* species. It lives in Northern and Central Europe (McInerney et al. 2014), but morphologically similar species are found across the entire Europe. Mentioned as group or aggregate. The first records under the name *N. aquliex* agg. refer to *N. dobati*.	Sket 2000, Rejic 1958
	Niphargus croaticus (Jurinac, 1887)	This species lives in Croatia and Bosnia and Herzegovina (Delić et al. 2016, Zakšek et al. 2019). Before the revision, it was often erroneously confused with another species, *N. arbiter* (Karaman 1984). In Sket (2000) it is listed as *N.* cf. *croaticus*, which may lead to wrong conclusion of *N. croaticus* presence in Slovenia.	Sket 2000

Family	Species	Reason to remove	Source
	Niphargus kochianus	This species is one of the first described *Niphargus* species. It lives in Northern and Central Europe (McInerney et al. 2014), but morphologically similar species are found across the entire Europe. The first records under the name *N.* group *kochianus* refer to populations of *N. longidactylus, N. labacensis* and *N. minor.* Mentioned as *Niphargus kochianus* ssp. or *N.* gr. *kochianus*.	Sket 1972, Sket 1979, Sket & Velkovrh 1981, Sket 2000
	Niphargus jovanovici	This species lives in Macedonia and Greece (Karaman 2017), but several species from Slovenia were assigned as closely-related species or subspecies (*N. grandii*, *N. multipennatus*). Mentioned as *N. jovanovici* ssp. (Sket 1972).	Sket 1972
	Niphargus hrabei S. Karaman, 1932	This species is distributed throughout the Pannonian basin and could be expected in Slovenia (Copilaș-Ciocianu et al. 2017). However, its presence has never been confirmed, even though a related undescribed species lives in Krakovski gozd (Borko et al. 2021). Sket (1996) mentiones this species with question mark.	Sket 1996
	Niphargus puteanus (Koch & Panzer, 1836)	*Niphargus puteanus* is distributed in the Rhine and upper Danube basins and Luxembourg (Weber et al. 2020). However, this is the first *Niphargus* species to be described, and many other species were originally described as its subspecies. In Slovenia, *N. spoeckeri* and *N. krameri* were probably confused with this species.	Gherlizza 1999, Megušar 1914, Perko 1910
	Niphargus tauri	This species lives in Turkey, but similar species were reported from Western Balkans, including Slovenia. *N. carniolucus* was initially affiliated to this species. It was reported as *N. tauri* ssp. or as *N. tauri* gr.	Matjašič & Sket 1971, Sket 1970, Sket 1979, Sket & Velkovrh 1981

Discussion

In this contribution, we are increasing the number of registered species for Slovenia, as we list 77 (nearly 39%) of all amphipod species for the first time for our country. The large majority of species (131 species, 66% of all) is marine, found in the Slovenian part of the Northern Adriatic Sea. Two species (*Caprella scaura*, *Jassa marmorata*) are alien and one (*Monocorophium sextonae*) is cryptogenic (EASIN 2021). The marine species represent approximately 29% (127 out of 451) of all Mediterranean species (Ruffo et al. 1998). This is a relatively large share of regional species richness even though the Northern Adriatic Sea

represents only a small fraction of the entire Mediterranean Sea, with Slovenian sea representing even smaller fraction. The share of marine against all Slovenian amphipods (64%), however, is somewhat lower than their respective share on a global scale (80%, Horton et al. 2021). This deviation can be in part explained by the fact that marine amphipods have not been systematically studied, in contrast to intensively studied freshwater amphipods. We believe that more intense research should expand the list of inhabitants of Slovenian sea. For example, the monograph of Mediterranean amphipods reported six species from the sea near Rovinj (Croatia) and Trieste (Italy), i.e., south and north of Slovenian coast, respectively, the presence of which can be highly expected in the Slovenian sea as well (Krapp-Schickel & Zavodnik 1996, Ruffo et al. 1998). Finally, we found some individuals that may belong to alien species, but need a confirmation from a specialist for these families.

Among freshwater amphipod species, subterranean amphipod species (groundwater species) represent the main share of species (57 out of 64 freshwater species). Subterranean amphipods comprise species from currently six genera, *Bogidiella*, *Carinurella*, *Ingolfiella*, *Niphargus*, *Niphargobates* and *Synurella.* Two of them, *Niphargobates* and *Carinurella*, are in need of taxonomic revision, as they are nested in phylogenetic trees within the genus *Niphargus* (Esmaeili-Rineh et al. 2015, Borko et al. 2021). Species of the genus *Niphargus* dominate in groundwaters (53 species). The high number of *Niphargus* species seems to be a result of turbulent geological history that in a broader region of the Western Balkans prompted multiple evolutionary radiations, descendants of which dispersed into the territory that is nowadays called Slovenia (Borko et al. 2021). The number of current species of this genus is rather underestimated since the morphological identification of *Niphargus* species is challenging and the taxonomy of the genus incomplete. We estimate there might be between 30–50% additional and yet undescribed species (Borko et al., in revision).

The only *Synurella* species listed in the checklist needs further clarifications. Slovenian populations of *S. ambulans* colonized a number of Slovenian caves, with each subterranean population differing from neighbouring surface populations and hence suggesting multiple independent colonization events and probable ongoing speciation (Pekolj 2020). Some authors considered morphologically differentiated subterranean populations as a distinct subspecies named *S. ambulans subterranea* (Karaman 1931). Subterranean *Synurella* resembles the evolutionary history of the isopod species *Asellus aquaticus* (Linnaeus, 1758), which independently colonized subterranean waters several times, and molecular studies suggest that most of these cave populations deserve separate species status (Verovnik et al. 2009, Konec et al. 2015). By analogy, we assume that subterranean populations of *Synurella* represent distinct species, a hypothesis that should be tested using molecular tools.

Most endemic species are groundwater species, although there is one endemic species in the surface freshwater. The term »endemic« requires a caution note. For the needs of this checklist, we considered »endemic« those species the distributional range of which falls completely within the political borders of Slovenia. However, there are species having small distribution ranges, which also occur in either of the neighbouring countries (Italy, Croatia). Even though they are not national endemics, they are endemic to very small geographic area (often called subendemic). A different case of missed national endemics in the current list are some large-ranged species that may have genetically distinct populations in Slovenia (e.g. *N. liburnicus*, *N. krameri*) and await to be taxonomically evaluated, formally described as species, and put on a list of national endemics.

The most species from poor ecological categories are species from the surface water and species from brackish water. These include genera *Homoeogammarus*, *Gammarus, Jugogammarus* and *Synurella.* Taxonomically unambiguous is the monotypic species *Jugogammarus kusceri*, a narrow endemic species living in springs within the catchment of the Krka River (Sket 1996). The taxonomic status of species from other genera is highly questionable. Individuals characterized as nominal species *G. fossarum, G. balcanicus, G. roeselii* and *S. ambulans* in fact belong to species-rich complexes (Copilaş-Ciocianu & Petrusek 2015, Mamos et al. 2016, Csapó et al. 2020, Hupało et al. 2020, Wattier et al. 2020). With rare exceptions (Alther et al. 2017), most of Slovenian freshwater gammarids have never been studied genetically and we thus cannot evaluate their taxonomic status nor the true number of potential species. Consequently, distribution of these species in Slovenia and their conservation status remains poorly known.

Contrary to our expectations, as of present time and up to our knowledge, there is no confirmed record of invasive freshwater amphipod species presence from Slovenia. Many Ponto-Caspian species of the genera *Dikerogammarus, Chelicorophium* and *Obesogammarus* spread across the continent and through rivers and artificial channels and have reached Poland, Germany, France and Switzerland (Altermatt et al. 2014, Copilaş-Ciocianu et al. 2021). These species were recorded in the Drava and Sava Rivers in the territories of Croatia and Serbia more than a decade and five decades ago, respectively (Karaman 1974, Žganec et al. 2009). The probability that these species could be present also in Slovenia or could colonize Slovenian rivers, streams, and lakes in the near future is quite high. Thus, the here presented checklist offers a challenge to researchers, to look carefully into riverine benthos and check whether native fauna has encountered Pontocaspian newcomers.

Finally, while preparing and critically evaluating the checklist, several erroneous names resurfaced. Changes of species names are an integral part of taxonomic practice. Some species were in due revisions transferred to other genera during revisions, recognized as junior synonyms or erected from subspecies to species status. These names can be traced as synonyms on the World Register of Marine Species (Horton et al. 2021) and are not problematic. However, some sources of erroneous records can create confusion with the risk to be repeated when checklists are revised. First, some species were erroneously identified. As an example, in the past, individuals could have been identified as a widespread species (like *Niphargus puteanus*), but subsequent taxonomic work unveiled this individual belongs to another species (in this example, *N. krameri*) and the previously identified species (in this case *N. puteanus*) is not present in Slovenia (Weber et al. 2020). A similar confusion may derive from identification to the species level (e.g., *N. aquilex*) rather than to the subspecies level (in this case *N. aquilex dobati*), and subsequent taxonomic work raised subspecies to the species level (*N. dobati*); also in this example, nominal species does not live in the country (McInnerney et al. 2014). The last problem deals with dubious records, not backed with data. With the aim to remove such species from further lists, we decided to list them in this contribution, with the hope that they will no longer be listed as representatives of Slovenian amphipod fauna.

Povzetek

Postranice (Amphipoda) so z 10.000 vrstami med največjimi redovi rakov valilničarjev (Horton et al. 2021). Večina vrst je morskih (80 %), ostale (20 %) pa naseljujejo celinske vode vključno s podzemnimi vodami (Sket 1999a, Väinölä et al. 2008, Zagmajster et al. 2014). V tem delu smo posodobili seznam morskih in sladkovodnih vrst postranic z območja Slovenije. Posodobljeni seznam smo sestavili iz že objavljenih seznamov in jih dopolnili s podatki, objavljenimi po letu 2002. Slednje smo pridobili iz podatkovnih zbirk BioPortal (Center za kartografijo favne in flore) in SubBioDB (Raziskovalna skupina za speleobiologijo – SubBioLab). Ta seznam smo dopolnili z novejšimi in neobjavljenimi podatki iz zbirk Morske biološke postaje v Piranu (Nacionalni inštitut za biologijo) in skupine SubBioLab (Oddelek za biologijo, Biotehniška fakulteta Univerze v Ljubljani). V seznam smo vključili le formalno opisane vrste; navajamo pa jih z imeni, ki jih zbirka World Register of Marine Species (Horton et al. 2021) obravnava kot veljavna. Vsaki vrsti smo pripisali ekološko kategorijo (morska, morska, brakična, obrežna, površinska sladkovodna, podzemna sladkovodna) in morebiten status državnega endemita. Pojavljanje vrste v Sloveniji je podkrepljena z enim verodostojnim virom, bodisi objavo bodisi podatkom iz zbirke.

V Sloveniji smo do danes našli 198 vrst postranic, ki pripadajo 85 rodovom in 41 družinam. Za 77 vrst iz seznama je to prva navedba o njihovem pojavljanju na našem območju. Dve tretjini (127 vrst) sestavljajo morske postranice. Štiri vrste živijo na kopnem oz. obrežjih, tri vrste najdemo tako v brakičnih kot tudi celinskih vodah. Preostale vrste (64 vrst) živijo samo v celinskih vodah, od katerih prevladujejo tiste, ki jih najdemo v podzemnih vodah (57 vrst). Endemne vrste (26) so le v celinskih vodah in so, z eno izjemo, podzemne. Tujerodne vrste smo našli v morju, v celinskih vodah pa jih presenetljivo še nismo našli. Za devet vrst, ki pripadajo trem družinam in jih starejša dela navajajo kot del slovenske favne, smo ovrgli njihovo pojavljanje v Sloveniji.

Pregled seznama vrst razkriva dve osrednji težavi v razumevanju vrstne pestrosti postranic v Sloveniji. Morske vrste so bile vzorčene le priložnostno; njihovo število je podcenjeno zlasti na račun skromnega vzorčenja. Pri vrstah, ki naseljujejo celinske vode, so težave drugačne narave. Te vrste so pogosto kompleksi t. i. kriptičnih vrst. Razjasnitev njihovega taksonomskega statusa zahteva uporabo molekulske taksonomije, kar je zamuden proces in epilog lahko pričakujemo šele v naslednjih letih.

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First record of Violet Dropwing *Trithemis annulata* (Palisot de Beauvois, 1807) (Odonata: Libellulidae) in Slovenia

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Abstract. One adult male dragonfly Violet Dropwing *Trithemis annulata* was recorded at Lake Vogršček in the Vipava Valley (W Slovenia) during the Biological Students Research Camp – Otlica 2021. This first record for the country is presented and the species' distribution in Europe outlined. Behavioural observations and data on the accompanying Odonata fauna are included. This widespread Afrotropical species has rapidly expanded its range in south and south-western Europe in the recent two decades, with global warming apparently being the main driver of this expansion. Hence, 73 Odonata species belonging to 29 genera and nine families are now reported for Slovenia. *Trithemis* is the seventh genus to be added to the family Libellulidae for the country. The discovery of *T. annulata* in the Vipava Valley in Slovenia is significant for the fact of being the northernmost observation on the Balkan Peninsula to date.

Key words: dragonfly, Violet Dropwing, *Trithemis annulata*, first record, Slovenia, Vipava Valley, Lake Vogršček, climate change, Biological Students Research Camp

Izvleček. Prva najdba ciklamnega telovnikarja *Trithemis annulata* (Palisot de Beauvois, 1807) (Odonata: Libellulidae) v Sloveniji – Na Raziskovalnem taboru študentov biologije – Otlica 2021 je bil na jezeru Vogršček v Vipavski dolini (Z Slovenija) zabeležen odrasel samec kačjega pastirja ciklamnega telovnikarja *Trithemis annulata*. Prva najdba vrste v Sloveniji je predstavljena skupaj s pregledom razširjenosti v Evropi. Dodani so opis vedenja opazovanega samca ter podatki o favni kačjih pastirjev na jezeru. Ta široko razširjena afrotropska vrsta kačjih pastirjev je v zadnjih dveh desetletjih občutno povečala območje razširjenosti, predvsem v južni in jugozahodni Evropi, kar se zdi zlasti posledica globalnega segrevanja. Skupaj je tako za Slovenijo znanih 73 vrst kačjih pastirjev, uvrščenih v 29 rodov iz devetih družin, rod telovnikarjev pa je sedmi rod družine ploščecev v državi. Odkritje *T. annulata* v Vipavski dolini v Sloveniji je pomembno, saj gre za najsevernejše opazovanje na Balkanskem polotoku doslej.

Ključne besede: kačji pastir, ciklamni telovnikar, *Trithemis annulata*, prvi podatek, Slovenija, Vipavska dolina, jezero Vogršček, podnebne spremembe, Raziskovalni tabor študentov biologije

Introduction

Several dragonfly species (Insecta: Odonata) are strong fliers, able to cover long distances as occasional vagrants or regular true migrants, especially when supported by favourable winds (Corso et al. 2012, Dijkstra et al. 2020). Global warming is influencing also the distribution range of numerous Odonata species, causing northward expansions, while a tendency towards an increasing range of movements in their migratory patterns has been noticed as well (Boudot et al. 2009, Ott 2010a, b, Termaat et al. 2019). Some dragonfly species are spreading north from Africa or southern Europe, and are rapidly colonising new areas in central Europe, too. Violet Dropwing *Trithemis annulata* (Palisot de Beauvois, 1807) is also among such examples (Bonet Betoret 2000, Ott 2010a, Gheza et al. 2019, Dijkstra et al. 2020).

Trithemis annulata is common throughout most of Africa, except in areas with closed tropical forests, and widespread in most of the Arabian Peninsula, extending to eastern Iran and southern Turkey and rapidly colonizing south and south-western Europe (Kalkman et al. 2015). This ubiquitous and pioneer species inhabits a wide variety of sun-exposed, stagnant and slow-flowing waters, including freshwater lagoons, sluggish streams and rivers, as well as artificial water bodies like ditches, reservoirs, gravel pits, quarry lakes and barrage lakes (Kalkman et al. 2015, Wildermuth & Martens 2019, Dijkstra et al. 2020). For Europe, quarry lakes and large reservoirs are reported as the main reproductive habitats of *T. annulata* (Brochard & van der Ploeg 2013, Ottonello & Oneto 2013, Cabana et al. 2014, Fabbri et al. 2016, Gheza et al. 2019). The species is bivoltine in the Mediterranean area (Boudot et al. 2017). It can develop in waters with low oxygen concentrations (Balzan 2008) and neutral or slightly alkaline pH (Bonet Betoret 2000). The larvae show fast development of about 7–8 weeks (Boudot et al. 2017), being able to colonize also temporary water bodies (Wildermuth & Martens 2019). Imagoes can be easily identified by abdomen colour and patterning, thorax patterning and wing coloration. Its size is the same as that of the medium-sized *Sympetrum* species (32–38 mm) (Dijkstra et al. 2020). The flight season of *T. annulata* in Europe is reported to range from February to November (Kalkman et al. 2015, Chiari et al. 2020). It is a good flier and is able to cover even long distances; although it is not considered a true migratory species (Wildermuth & Martens 2019), its movements are essentially erratic or nomadic (Gheza et al. 2019).

In Europe, 163 species of Odonata have been recorded together with species that occasionally migrate from other continents, especially Africa (Dijkstra et al. 2020). Observation of the first individual of *T. annulata* in Slovenia was an expected surprise in 2021. Until recently, 72 Odonata species belonging to 28 genera and nine families were reported from Slovenia (Kotarac 2015), although some species have not been recorded in the last decades (Vinko et al. 2020).

With this contribution, the first observation of *T. annulata* in Slovenia at Lake Vogršček in the Vipava Valley is presented together with information about the species' distribution in Europe. Slovene name for *T. annulata* has already been provided – *ciklamni telovnikar* (Geister 1999); *ciklama* – cyclamen (from its colour), *telovnik* – vest. English name is Violet Dropwing (Dijkstra et al. 2020). Odonate fauna of the Vipava Valley has been fairly well studied, with 53 species reported for the region (Vinko 2016). Considering dragonflies, some abandoned claypits and Lake Vogršček are biodiversity hotspots in the region. As regards dragonflies, the Vipava Valley is the second richest region in Slovenia (Vinko 2016).

Materials and methods

The north-eastern inlet of Lake Vogršček (45°54'40.1" N, 13°45'06.0" E, 100 m alt., Fig. 1) in the Vipava Valley (W Slovenia) was investigated on 22. and 24.7.2021 during the field work carried out by the odonatological group at the Biological Students Research Camp (*Raziskovalni tabor študentov biologije*, RTŠB) – Otlica 2021, organized by the Biological Students' Society (*Društvo študentov biologije*). Due to the observation of *T. annulata* on 24.7.2021, targeted short trips to the same site were conducted by the first author also on 25. and 31.7.2021. Apart from observations of adult dragonflies (imagoes), search for larval skins was also performed at the spot. No voucher specimens of adults were taken and no larvae were sampled. The weather was sunny and hot.

Study area

The Vipava Valley is one of the warmest parts of Slovenia. Climate is sub-Mediterranean. Annual average temperature is 12°C, 21°C in July; the number of hot days with above 25°C is far above the Slovenian average (Pavšič 2013). Compared to the rest of the country, except for the coastal areas of Slovenian Istria, the insolation is significantly higher and the vegetation period is longer (Pavšič 2013).

Lake Vogršček, situated near the village of Šempas, is the largest water body in the Vipava Valley. This approximately 4 km long and 82 ha large reservoir was made between 1985 and 1989 upon eponymous stream, primarily for irrigation (Pavšič 2013). The lake is managed by the Ministry of the Environment and Spatial Planning, Slovenian Water Agency (*Direkcija Republike Slovenije za vode*). It is divided into three separate parts, with the two northern smaller inlets being more interesting for nature conservation. Here the depth of the lake reaches 6 m; on the surface, the water temperature reaches 28°C in summer (Mrzelj et al. 2020). Fishing as well as some water sports take place throughout the lake. The two northern smaller inlets, bounded by a highway embankment, are characterized by flat and overgrown shores, while in the rest of the lake the shores are barer and steeper. Thus, the diversity of microhabitats at northern inlets is greater, mainly owing to the better developed plant stands. Due to fishery, the vegetation at the north-eastern inlet is cut on several places (Fig. 1b), which in addition to the presence of fish also affects the lake's dragonfly distribution and diversity. Due to the dam maintenance on the western edge of the southern inlet and its surroundings, the largest inlet was almost dry during our visit. This somehow controversial maintenance, which is supposed to be finished by spring 2022, had no significant visual effects on the north-eastern inlet at the time of our fieldwork, although more than 12 tons of fish were transferred from southern to northern inlets in November 2021.

The lake has no conservation status; its shore borders Natura 2000 site Dolina Vipave (SI3000226) (Ur. l. RS 2004a, b). Prior to our field trips in 2021, a total of 37 dragonfly species had been recorded from both northern inlets (34 from north-eastern inlet alone) (Vinko 2016), with *Ceriagrion tenellum* (de Villers, 1789) being the most interesting as an endangered and nationally protected Odonata species (Vinko 2016).

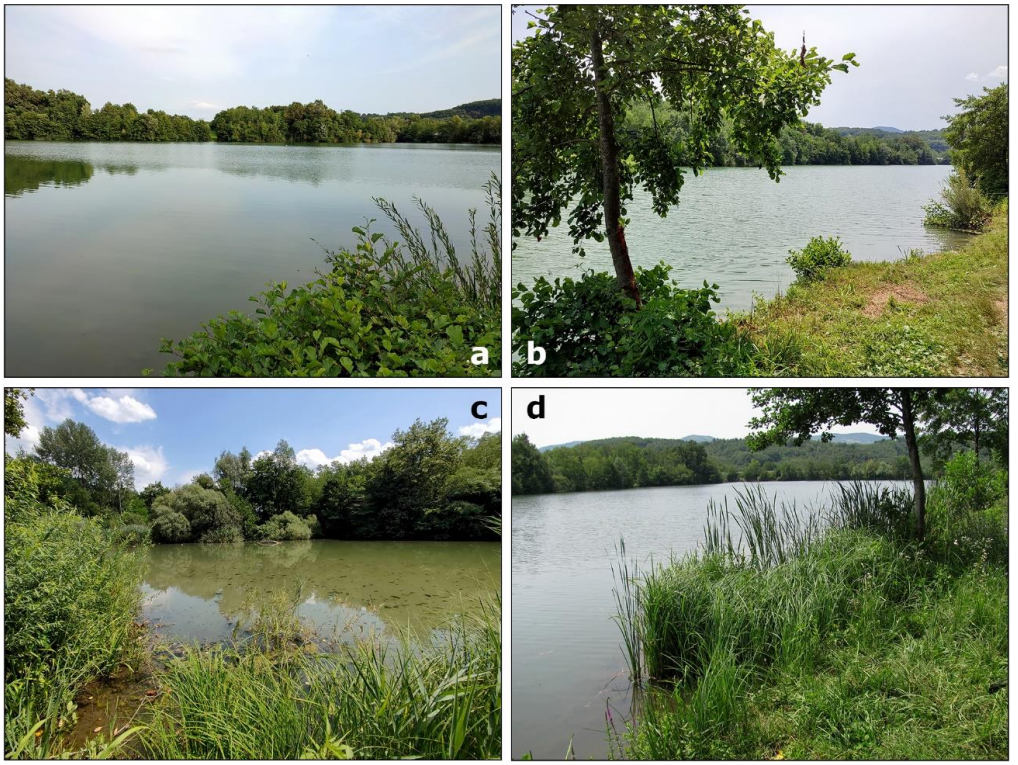

Figure 1. North-eastern inlet of Lake Vogršček, Vipava Valley, Slovenia (photo: D. Vinko, a–c – July 2021, d – July 2011).
Slika 1. Severovzhodni krak akumulacijskega jezera Vogršček, Vipavska dolina, Slovenija (foto: D. Vinko, a–c – julij 2021, d – julij 2011).

Results

During four field trips in July 2021, 18 Odonata species were recorded at north-eastern inlet of Lake Vogršček (Tab. 1). One singular vagrant male of *T. annulata*, detected on 24 July 2021 (around 15:10 hrs), was the most interesting observation, representing the first record for the species in Slovenia (Figs. 2, 3). No additional *T. annulata* individuals were found during other field trips (22, 25, 31 July 2021), nor on 3 and 11 August, when other field trips were taken (Kovačič S. unpubl., Kogovšek P. & Tivadar N. unpubl.).

Table 1. List of 18 Odonata species recorded at the north-eastern inlet of Lake Vogršček (Vipava Valley, western Slovenia) in late July 2021 (22, 24, 25, 31 July 2021). A total of 39 Odonata species have been recorded from Lake Vogršček to date [legit. & det. D. Vinko].
Tabela 1. Seznam 18 vrst kačjih pastirjev, zabeleženih na severovzhodnem kraku akumulacijskega jezera Vogršček (Vipavska dolina, zahodna Slovenija) konec julija 2021 (22., 24., 25., 31. 7. 2021). Skupno je bilo doslej na jezeru zabeleženih 39 vrst kačjih pastirjev [legit. & det. D. Vinko].

Species	**Slovene name**
Chalcolestes viridis (Vander Linden, 1825)	zelena pazverca
Calopteryx splendens (Harris, 1780)	pasasti bleščavec
Platycnemis pennipes (Pallas, 1771)	sinji presličar
Coenagrion puella (Linnaeus, 1758)	travniški škratec
Erythromma lindenii (Sélys, 1840)	prodni paškratec
Erythromma viridulum (Charpentier, 1840)	mali rdečeokec
Ischnura elegans (Vander Linden, 1820)	modri kresničar
Ceriagrion tenellum (de Villers, 1789)	rdeči voščenec
Anax imperator Leach, 1815	veliki spremljevalec
Anax parthenope (Sélys, 1839)	modroriti spremljevalec
Somatochlora meridionalis Nielsen, 1935	sredozemski lesketnik
Crocothemis erythraea (Brullé, 1832)	opoldanski škrlatec
Orthetrum albistylum (Sélys, 1848)	temni modrač
Orthetrum cancellatum (Linnaeus, 1758)	prodni modrač
Orthetrum coerulescens (Fabricius, 1798)	mali modrač
Sympetrum fonscolombii (Sélys, 1840)	malinovordeči kamenjak
Sympetrum sanguineum (Müller, 1764)	krvavordeči kamenjak
Trithemis annulata (Palisot de Beauvois, 1807)	ciklamni telovnikar

The male individual at Lake Vogršček was observed while engaged in territorial behaviour with *Crocothemis erythraea* (Brullé, 1832) and *Orthetrum albistylum* (Sélys, 1848), utilising small black alder bush *Alnus glutinosa* (L.) and surrounding plants on the bank (Fig. 1b) as perching sites. Besides the aforementioned territorial behaviour, the individual was performing rapid flights low over the water before caught by the first author. Obelisk position with drooped wings on a twig about 1 m above the water level was also observed.

All found Libellulidae exuviae belonged to *C. erythraea*, *O. albistylum*, *Orthetrum cancellatum* (Linnaeus, 1758) and *Sympetrum fonscolombii* (Sélys, 1840).

Calopteryx splendens (Harris, 1780) was recorded at Lake Vogršček for the first time and *Chalcolestes viridis* (Vander Linden, 1825) for the first time at its north-eastern inlet.

Figure 2. Male *Trithemis annulata* recorded at north-eastern inlet of Lake Vogršček (Vipava Valley, western Slovenia). Mature males are unique in Europe due to their cyclamen and wine-red colour combination, which makes them unmistakable. Vertex and dorsum of frons are violet-reddish metallic. The wing veins are red, base of the wings is amber orange (photo: D. Vinko, 24.7.2021).

Slika 2. Samec ciklamnega telovnikarja *Trithemis annulata*, zabeležen na severovzhodnem kraku jezera Vogršček (Vipavska dolina, zahodna Slovenija). Spolno zreli samci so zaradi ciklamne in vinsko rdeče barve v Evropi nezamenljivi z drugimi vrstami. Teme in dorzalni del čela sta kovinskega sijaja vijolično-rdeče barve. Žile na krilih so rdeče, baza kril pa je jantarno oranžna (foto: D. Vinko, 24. 7. 2021).

Discussion

Trithemis annulata favours warm conditions and shallow waters (Dijkstra et al. 2020). This widespread Afrotropical generalist species has in recent decades rapidly expanded its range in south and south-western Europe. Global warming seems to be the main driver of this expansion (Boudot et al. 2009, Ott 2010a).

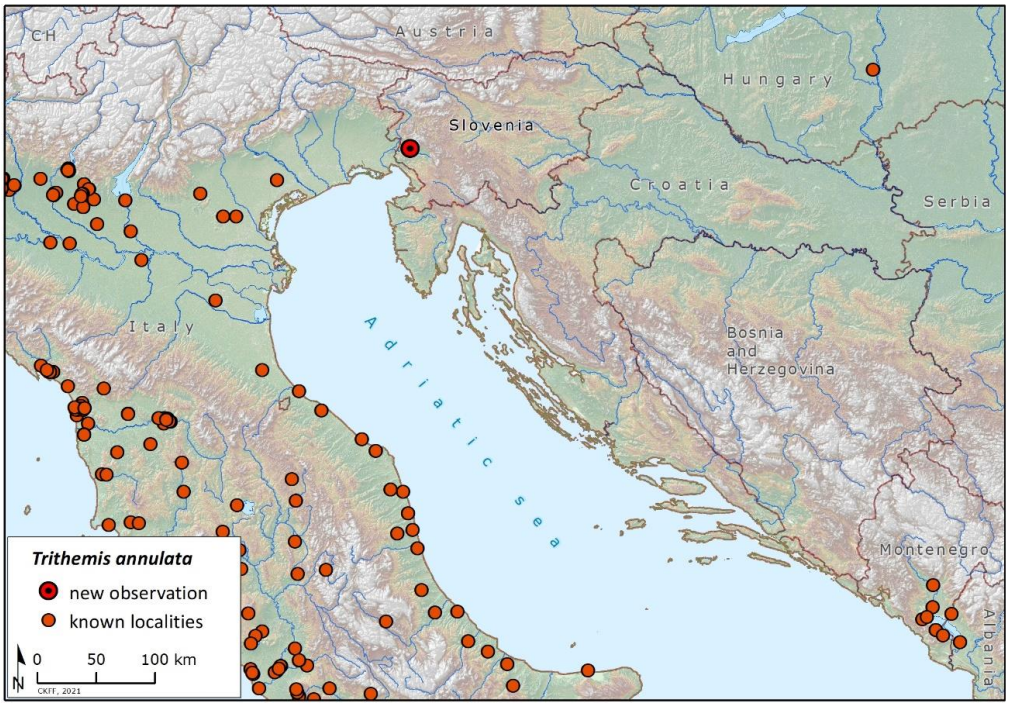

Figure 3. Observations of *Trithemis annulata* in Slovenia and nearest neighbouring countries (sources cited in Discussion).
Slika 3. Najdbe ciklamnega telovnikarja *Trithemis annulata* v Sloveniji in bližnjih državah (viri navedeni v Razpravi).

First recordings of *T. annulata* in Europe date back to the mid-19th century from southern Italy and Cyprus (Kalkman et al. 2015). However, it remained rare and local until the second half of the 20th century, when it expanded across the Mediterranean basin (Boudot et al. 2009). It colonised the entire Iberian Peninsula from 1978 onwards, was found on Corsica for the first time in 1988 and in continental France in 1994 (Bonet Betoret 2000, Boudot et al. 2009, Kalkman et al. 2015, Lohr 2021). In the following decade, *T. annulata* continued its expansion towards the western Mediterranean basin at progression rate of around 20 to 30 km per year (Renoult 2013), colonizing several waterbodies in a single flight season. Its colonisation in France is well documented, spreading separately on Atlantic and Mediterranean front (Deliry 2010), with records from the Loire River catchment representing the species' northern limit in Europe to date (GBIF 2021). Until the late 20th century, the distribution of *T. annulata* was limited in Italy to its southern regions – Sicily, Sardinia, Calabria, Basilicata, Apulia, Campania, Lazio (Conci & Nielsen 1956, Battaglini & Percuoco 1967, Carchini et al. 1985) – and Tuscany (Terzani 1991), while in the last two decades it colonised Abruzzo, Marche, Umbria, Emilia-Romagna and Liguria (Fabbri 2011, La Porta et al. 2013, Ottonello & Oneto 2013, Fabbri et al. 2016). Now it is widespread mostly in the areas with the Mediterranean bioclimate (Gheza et al. 2019, Odonata.it 2019). It was recently reported from Lombardy, these records being the northernmost for the country, with abundant populations during the summer of 2018 in Milan and Brescia cities and their surroundings (Gheza et al. 2019, Chiari et al. 2020). Since several records of *T. annulata*

were made in this region also in the ensuing years (iNaturalist 2021, GBIF 2021), it seems possible that its eggs or larvae are able to survive the winter season in more northern latitudes, or that imagoes migrate to these Italian northern provinces each year separately. In Lombardy, which is at about the same latitude as the Vipava Valley, *T. annulata* imagoes were observed from mid-June to early November (Gheza et al. 2019, Chiari et al. 2020, iNaturalist 2021). Closest to Slovenia, from the Veneto region, there are records of mature imagoes of *T. annulata* near Padua and Treviso (Odonata.it 2019, Chiari et al. 2020, iNaturalist 2021, Observation.org 2021). Records date from 2018 onwards with the nearest record from about 120 km away from Lake Vogršček. Single record in Hungary at the Danube's oxbow in the Tolna Region (Farkas 2017) is the species' north-eastern limit in Europe to date, indicating at least occasional migration of the species to the east as well. Prior to the species' observation in Slovenia, the record from Hungary was several hundred kilometres away from the closest known sites (Fig. 3). In south-eastern Europe, *T. annulata* is rare (Kalkman et al. 2015) or at least less documented. There are only few records from Montenegro, Albania and Bulgaria (Gligorović et al. 2010, De Knijf et al. 2013, Pešić et al. 2017, Shkëmbi et al. 2018, Shkëmbi 2019, iNaturalist 2021, Observation.org 2021). In Montenegro, the species successfully reproduces at Lake Skadar (De Knijf et al. 2013). Although it was officially recorded in Montenegro for the first time in 2008 (Gligorović et al. 2010), an older observation dating to August 1990 from a single locality south of Ulcinj is mentioned as in need of confirmation in Jović et al. (2008). In Greece, it is quite common on most of the islands and on the Ionian coast (Lopau 2010), with several thousand individuals reported on some sites (Brochard & van der Ploeg 2013). Records from Croatia, Bosnia and Herzegovina, Serbia and Northern Macedonia are to be expected.

The discovery of *T. annulata* in the Vipava Valley in Slovenia is significant as being the species' northernmost observation on the Balkan Peninsula (Fig. 3). As its expansion in Europe originates from the Iberian and Apennine peninsulas (Ott 2010a), and with the species current distribution in mind, we assume that the recorded individual wandered to Lake Vogršček from Italy rather than from the south of the Balkans. The finding of only one imago at Lake Vogršček suggests that our record concerns a wandering specimen not belonging to a local population. We can exclude that the species has been previously overlooked, given that the Vipava Valley has been fairly well investigated in the recent past (Vinko 2016).

Trithemis annulata is rather territorial and often extremely aggressive towards both conspecifics as well as considerably larger species (Balzan 2008, Corso et al. 2012, Gheza et al. 2019). This behaviour, as well as the persistent territory defence, may have helped this species to establish itself in fairly wide ranges. In order to investigate the ecological consequences of the species' expansion, further monitoring of Odonata populations is required. It is known that in some cases habitat colonisation by *T. annulata* resulted in local decline of the formerly abundant *C. erythraea* (Bonet Betoret 2000), which is also widely present at Lake Vogršček. To mitigate the impacts of global and local alterations and to develop sustainable management strategies, there is a need for biodiversity monitoring as well as for assessing and understanding the consequences of ecosystem changes (Ott 2010b, Hooper et al. 2012, Termaat et al. 2019). Bio-assessments of Odonata provide cost-effective and sensitive tool to monitor the consequences of human activities (Kalkman et al. 2010).

Within the last decade, two new Odonata species have been discovered in Slovenia, *Selysiothemis nigra* (Vander Linden, 1825) (Šalamun 2012) and *T. annulata*, both assumingly arriving to Slovenia from Italy (Vinko 2019). Global warming has clearly favoured the expansion of both species during the last years (Boudot et al. 2009, Lohr 2021) and due to their ecological characteristics, further records, including proof of breeding, are to be expected at least in the Primorska region, western Slovenia. As recent changes in distributions of both species among others show, Odonata are regarded as a good indicator group for climatic change as well (Ott 2010a, Termaat et al. 2019). Contrary to other insect taxa (e.g., butterflies, grasshoppers), they depend mostly on aquatic ecosystems and their expansion is not directly aided by humans depending only on their own dispersal and migration behaviours. With only rare exceptions, they do not depend on the presence of other species, thus representing a unique climate change indicator (Ott 2010b).

Together with *T. annulata*, 73 Odonata species belonging to 29 genera and nine families are now reported for Slovenia. *Trithemis* is the seventh genus to be added to the family Libellulidae in Slovenia. For the Vipava Valley, 54 Odonata species have been recorded.

Consequently, a total of 39 Odonata species have been recorded for both northern inlets of Lake Vogršček, which represents 53 % of this insect group fauna for Slovenia. Apart from *T. annulata* and *C. tenellum*, the Odonata assemblage observed at Lake Vogršček during our field trips is composed by species which are widespread in the Vipava Valley (Vinko 2016).

Povzetek

Kačji pastirji so učinkovita bioindikatorska skupina za ocenjevanje sprememb v okolju (Kalkman in sod. 2010) ter tudi dober kazalnik za spremljanje podnebnih sprememb in ugotavljanje njihovih vplivov (Ott 2010a). Podnebne spremembe med drugim vplivajo na območje razširjenosti številnih vrst kačjih pastirjev in na njihove selitvene vzorce (Ott 2010b, Termaat in sod. 2019). Nekatere vrste se širijo na sever iz Afrike ali iz južne Evrope in hitro kolonizirajo nova območja tudi v srednji Evropi (Bonet Betoret 2000, Gheza in sod. 2019, Dijkstra in sod. 2020). Med njimi je tudi ciklamni telovnikar *Trithemis annulata* (Palisot de Beauvois, 1807). Ta široko razširjena afrotropska vrsta kačjih pastirjev je v zadnjih dveh desetletjih občutno povečala območje razširjenosti, kar se zdi zlasti posledica globalnega segrevanja (Boudot in sod. 2009). Vrsta naseljuje najrazličnejše soncu izpostavljene, počasi tekoče in stoječe vode (Kalkman in sod. 2015). Spolno zreli samci so zaradi ciklamne in vinsko rdeče barve telesa v Evropi nezamenljivi z drugimi vrstami.

V prispevku poročamo o prvi najdbi ciklamnega telovnikarja za Slovenijo. Dne 24. 7. 2021 smo na Raziskovalnem taboru študentov biologije – Otlica 2021 na severovzhodnem kraku jezera Vogršček v Vipavski dolini (zahodna Slovenija) popisali odraslega samca (Sl. 2). Med sicer štirimi obiski Vogršča (Sl. 1) konec julija 2021 smo vrsto zabeležili le enkrat. Dodan je opis vedenja zabeleženega samca ter združbe kačjih pastirjev na jezeru (Tab. 1).

V prispevku predstavljamo razširjenost vrste v Evropi, kjer je kljub prvim podatkom za celino iz sredine 19. stoletja vrsta ostala redka in lokalno razširjena vse do druge polovice 20. stoletja, ko se je v večji meri razširila predvsem v južni in jugozahodni Evropi (Kalkman in sod. 2015). Z izjemo večine grških otokov in tamkajšnje ionske obale je na Balkanu redka, z le nekaj najdišči v Črni gori, Albaniji in Bolgariji (Gligorović in sod. 2010, De Knijf in sod. 2013, Pešić in sod. 2017, Shkëmbi in sod. 2018, Shkëmbi 2019,

iNaturalist 2021, Observation.org 2021). Odkritje *T. annulata* v Vipavski dolini, ki je ena najtoplejših regij v Sloveniji (Pavšič 2013), je pomembno, saj gre za najsevernejše opazovanje na Balkanskem polotoku doslej (Sl. 3). Sklepamo, da je zabeleženi samec priletel iz Italije, kjer je vrsta bolj razširjena (Odonata.it. 2019). Zaradi ekoloških značilnosti vrste je v prihodnje pričakovati nove podatke o pojavljanju ciklamnega telovnikarja najmanj na Primorskem (zahodna Slovenija), vključno s potrditvijo razvoja.

Za Slovenijo je tako znanih 73 vrst kačjih pastirjev, uvrščenih v 29 rodov iz devetih družin, rod telovnikarjev je sedmi rod družine ploščecev v državi. V Vipavski dolini je skupno z novo najdbo doslej zabeleženih že 54 vrst kačjih pastirjev, z jezera Vogršček pa je znanih 39 vrst.

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ZNANSTVENI ČLANEK

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Prva potrditev pojavljanja obalnega murna *Pseudomogoplistes squamiger* (Fischer, 1853) (Orthoptera: Mogoplistidae) v Sloveniji

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Izvleček. Pojavljanje obalnega murna v Sloveniji je bilo prvič nedvoumno potrjeno z opazovanjem samcev, samic in ličink dne 25. 9. 2021 v slovenski Istri, na morskem nabrežju pod Belvederom pri Izoli in v Fiesi pri Piranu, zahodna Slovenija. Razširjenost in biologija te specializirane vrste, vezane na le ozek pas primernega obalnega habitata, sta nepopolno poznani. Zaradi pretekle degradacije in še vedno trajajočih različnih pritiskov na obalo slovenskega morja je vrsta ogrožena, za podrobnejšo oceno velikosti in ogroženosti njenih populacij v Sloveniji pa so potrebne nadaljnje terenske raziskave.

Ključne besede: kobilice, *Pseudomogoplistes squamiger*, razširjenost, ogroženost, Slovenija, slovenska Istra

Abstract. First confirmation of Mediterranean beach-cricket *Pseudomogoplistes squamiger* (Fischer, 1853) (Orthoptera: Mogoplistidae) occurring in Slovenia – The occurrence of the Mediterranean Beach-cricket in Slovenia is confirmed herewith unambiguously for the first time, based on observations of males, females and larvae on 25. 9. 2021 in Slovenian Istria, on the seacoast below Belvedere near Izola and at Fiesa near Piran, western Slovenia. The distribution and biology of this specialised species, which is restricted to only a narrow belt of suitable costal habitat is incompletely known. Due to past degradation and still ongoing multiple pressures on the Slovenian seashore, the species is threatened and further field research is needed for a more detailed evaluation of the size and threat status of the species' population in Slovenia.

Key words: grasshoppers, *Pseudomogoplistes squamiger*, distribution, threat status, Slovenia, Slovenian Istria

Uvod

Obalnega murna *Pseudomogoplistes squamiger* (Fischer, 1853) uvrščamo v družino Mogoplistidae. Sodi med manjše vrste kobilic, telo odraslih samcev meri komaj 8–10 mm, medtem ko so samice z 9–12 mm nekoliko večje. Telo je svetlo rjave do temno sive barve, prekrito z majhnimi sivimi bleščečimi luskami, glava in predprsje sta pogosto rdečkastorjava. Odrasle žuželke so brezkrile, predprsje je pravokotno, bolj široko kot dolgo, sprednji rob predprsja je poraščen z vrsto gostih štrlečih dlačic. Pri samcih je konica zadka široka in značilno topo pravokotno prisekana, dolgi cerki so divergentno upognjeni navzven. Tudi pri samicah so cerki upognjeni navzven, leglica je rahlo upognjena navzgor in nekoliko krajša od cerkov (Us 1992, Bellmann et al. 2019).

Obalni muren je posebnež med kobilicami, saj je ena redkih vrst, ki živi med prodom, kamenjem in rastlinskimi ostanki neposredno na morskem obrežju in je vezan na le ozek pas primernega obalnega habitata. Razširjen je po obalah celotnega Sredozemlja, od Turčije, Grčije, Albanije, južne Italije, Sicilije, severne obale Alžirije in Španije do Francije, Korzike in severozahodne Italije (Skejo et al. 2018, Pelozuelo 2021). Opisan je bil z obale Jadranskega morja pri Dubrovniku (Fischer, 1853). Tudi sicer je s tega dela Sredozemlja znanih veliko podatkov, Skejo et al. (2018) denimo navajajo vrsto za območje Istre, Kvarnerja, Dalmacije, Dubrovnika kot tudi za območje jadranskih otokov in jo opredeljujejo kot široko razširjeno. Več konkretnih favnističnih podatkov za hrvaško obalo so nedavno na podlagi pregleda muzejskih zbirk predstavili Puskás et al. (2018). Historične podatke za Kvarner podaja Padewieth (1900), povzema jih tudi Karny (1907). V hrvaški Istri je vrsto južno od Pulja našel že Krauss (1878), ki jo označuje za pogosto. Iz tega dela Hrvaške najdemo v literaturi še podatke za Rabac (Werner 1909) in Vrsar (Sombke & Schlegel 2007). V neposredni bližine Slovenije je bil obalni muren najden pri Sesljanu severozahodno od Trsta (Fontana & Kleukers 2002). Sicer je vrsta v Italiji znana še z nekaj obalnih lokalitet na južnem delu Apeninskega polotoka ter na Sardiniji in manjših otokih okoli Sicilije, vendar avtorji dodajajo, da je nedvomno pogosto spregledana (Iorio et al. 2019). K pregledu zapisov o razširjenosti naj za zaključek dodam še naravovarstveni segment – v Rdečem seznamu kobilic Evrope (Hochkirch et al. 2016) je obalni muren uvrščen v IUCN-kategorijo neogroženih vrst (Least Concern – LC).

Prvotna omemba obalnega murna za Slovenijo, brez konkretnih favnističnih podatkov, je stara že skoraj tri desetletja. V monografiji »Favna ortopteroidnih insektov Slovenije« je Us (1992) zanj zapisal naslednje: *»… Mediteranska vrsta. Živi na obalah pod kamni in pod morskimi naplavinami. Znana je iz južne Francije, Italije, Istre, Dalmacije, kakor tudi iz Alžirije. Verjetno nastopa tudi na Primorskem*«. Na podlagi te navedbe omenjajo Gomboc et al. (2006) obalnega murna med vrstami, katerih status v Sloveniji je negotov oz. dvomljiv. Kljub temu je bila vrsta kasneje nekritično uvrščena na seznam kobilic v Sloveniji (Gomboc & Šegula 2014), kar pa je v pregledu favne kobilic Slovenske Istre popravil Gomboc (2019), ki obalnega murna ne uvršča na seznam vrst in dodaja, da njegovo pojavljanje na tem območju za zdaj še ni potrjeno.

Že dalj časa pričakovana najdba obalnega murna v Sloveniji je bila udejanjena s ciljnim iskanjem vrste šele v letu 2021, kar predstavljam podrobneje v nadaljevanju prispevka. Na tej podlagi lahko obalnega murna prvič nedvoumno uvrstimo na seznam favne kobilic Slovenije.

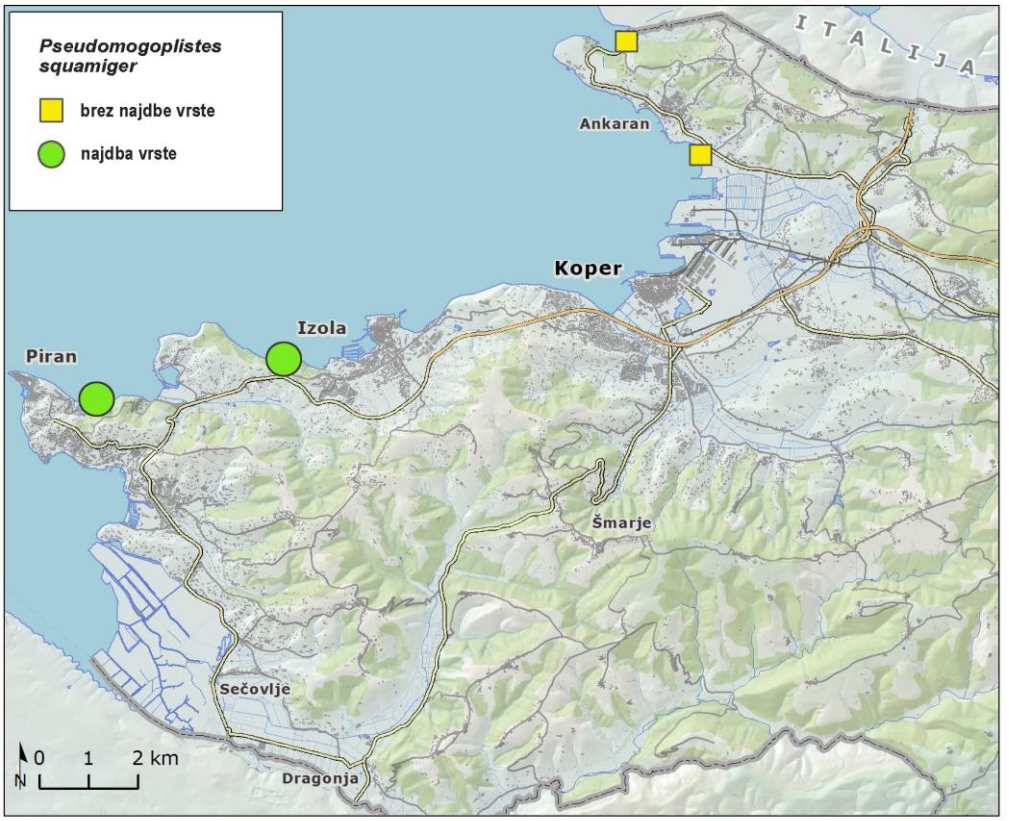
Materiali in metode

Ortopterološke raziskave v slovenski Istri, v okviru katerih sem posebno pozornost namenil iskanju obalnega murna, so potekale 1. 10. 2017, 3. 9. 2021 in 25. 9. 2021. Uporabil sem terensko metodo pazljivega obračanja večjih in manjših kamnov na morski obali v zgornjem pasu supralitorala. Zabeleženi ravnokrilci so bili fotografirani, vrste sem določal na terenu in v laboratoriju na podlagi pregleda fotografij in strokovne literature. Raziskava je potekala na podlagi dovoljenja za izjemen lov in raziskovanje vseh vrst kobilic (Orthoptera) za potrebe znanstvenoraziskovalne in izobraževalne dejavnosti, ki ga je pod številko 35601-14/2011-08 dne 22. 3. 2011 izdalo Ministrstvo za okolje, prostor in energijo.

Opis raziskovanega območja

Slovenska Istra je slovenska primorska pokrajina, ki leži med Tržaškim zalivom na zahodu, Slavnikom s Čičarijo na vzhodu, na severu in jugu pa jo zamejujeta državni meji z Italijo in Hrvaško. Ožje območje, na katerem je potekala raziskava, zajema morsko obrežje od zaliva Sv. Jerneja vzhodno od Debelega rtiča na severu pa do Fiese vzhodno od Pirana na zahodu (Sl. 1). Podnebje na tem območju je submediteransko, najtoplejše v Sloveniji. Obalni pas slovenske Istre ima do nadmorske višine 350 metrov povprečno letno temperaturo okoli 13 ºC, januarsko od 4 do 6 ºC in julijsko od 22 do 24 ºC. Tudi razporeditev padavin z letno količino okoli 1000 mm je submediteranska, najbolj namočena je jesen, najmanj padavin pa pade ob koncu zime in začetku pomladi ter v juliju in avgustu, ko se pojavi suša (Ogrin 2019). Morska obala na raziskovanem območju je raznolika in zajema tako obalne ravnice kot flišne klife, ki jih gradijo različno debele plasti peščenjaka, muljevca, meljevca, laporovca ter tu in tam apnenčeve breče. Predeli strmih klifov z ozko abrazijsko teraso ob stiku z morjem so pretežno naravno ohranjeni, medtem ko je obrežni pas obalnih ravnic večinoma močno predrugačen.

Naravni ohranjeni deli morske obale, kjer je potekala raziskava, so zavarovani kot botanične, zoološke, ekosistemske, hidrološke, geološke in/ali geomorfološke naravne vrednote (NV Zaliv sv. Jerneja – trstišča, NV Debeli rtič - klif z morjem, NV Debeli rtič - Valdoltra – klif, NV Ankaran - obrežno močvirje pri sv. Nikolaju, NV Žusterna - Izola – klif, NV Izola - apnenčasta obala, NV Korbat, NV Strunjanski klif, NV Bele skale pod Strunjanskim klifom, NV Strunjan – rt, NV Strunjan - Pacug – klif z morjem, NV Pacug - Fiesa – klif z morjem), krajinski parki (KP Debeli rtič, KP Strunjan) in Natura 2000 območja (npr. SAC Debeli Rtič - SI3000243, SAC Ankaran - Sv. Nikolaj - SI3000241, SAC Med Izolo in Strunjanom – klif - SI3000249, SAC Med Strunjanom in Fieso - SI3000307) (Naravovarstveni atlas – Natura 2000; www.naravovarstveni-atlas.si).



Slika 1. Območje zahodnega dela slovenske Istre z označenimi podatki o pojavljanju obalnega murna *Pseudomogoplistes squamiger* na morskem nabrežju pod Belvederom pri Izoli in v Fiesi pri Piranu, zahodna Slovenija (kartografska osnova: Ali Šalamun).

Figure 1. Map of the western part of Slovenian Istria with indicated data on the occurrence of the Mediterranean Beach-cricket *Pseudomogoplistes squamiger* at the sea-shore under Belvedere near Izola and at Fiesa near Piran, western Slovenia (base map: Ali Šalamun).

Rezultati

Obalnega murna sem med priložnostnimi raziskavami kobilic v slovenski Istri že večkrat iskal. Brez poprejšnjih lastnih izkušenj glede njegovega habitata, biologije in fenologije sem denimo že 1. 10. 2017 neuspešno pregledoval obalo v Zatoku Sv. Jerneja, 700m V od Debelega rtiča (WGS 84 Lat./Long.: 45.591309 °N, 13.721312 °E). Pod pregledanimi kamni na obali sem izmed ravnokrilcev zabeležil 30 ličink in 5 odraslih osebkov obalne strigalice *Anisolabis maritima* (Bonelli in Gené, 1832). Dne 3. 9. 2021 sem, tokrat na podlagi svežih prvih lastnih opazovanj obalnega murna s hrvaškega otoka Paga, poskusil s pregledom morskega nabrežja v zalivu Sv. Nikolaja

pri Ankaranu (WGS 84 Lat./Long.: 45.574650 °N, 13.737472 °E). Podroben pregled približno 350 metrov obale v kontekstu iskane vrste ni bil uspešen, izmed ravnokrilcev sem zabeležil le 3 ličinke in 6 odraslih osebkov obalne strigalice ter 5 ličink in 10 odraslih osebkov peščene strigalice *Labidura riparia* (Pallas, 1773). Ocenjujem, da tip obale oz. habitat na omenjenih obiskanih lokalitetah, kjer obalnega murna nisem našel (Sl. 1), zanj ni primeren. Morsko obrežje z zelo finim peskom in muljem, blazinami naplavljene morske trave in le redkim kamenjem v supralitoralnem pasu vrsti očitno ne ustreza.

V slovensko Istro sem se z namenom iskanja obalnega murna ponovno odpravil 25. 9. 2021. Tokrat sem izbral drugačen, prodnat tip morskega obrežja z veliko kamenja, in sicer pod Strunjanskim klifom, severno od Belvedera pri Izoli. Na približno 500 metrih obale sem med obračanjem kamenja našel 3 ličinke, 2 samca in 3 samice obalnega murna (Tab. 1, Lok 1; Sl. 2a, 3a, 3c). Izmed ravnokrilcev sem na tej lokaliteti zabeležil še 6 odraslih osebkov obalne strigalice. Kasneje sem obiskal še podoben tip flišne obale pod klifom med Fieso in Strunjanom, severovzhodno od Fiese. Tudi tukaj sem bil že kmalu uspešen. Na približno 250 metrov dolgem pregledanem odseku sem med kamenjem zabeležil 15 ličink in 3 samice obalnega murna (Tab. 1, Lok 2; Sl. 2b, 3b). Izmed ravnokrilcev sem tudi na tej lokaliteti opazoval le 4 odrasle osebke obalne strigalice.

Obalni muren v Sloveniji je tako odslej znan z dveh območij na slovenski obali, geografska lega lokalitet je prikazana na Sl. 1, podrobni podatki pa v Tab. 1.

Tabela 1. Podatki o pojavljanju obalnega murna *Pseudomogoplistes squamiger* na morskem nabrežju v slovenski Istri. Geografska lega lokalitet je prikazana na Sl. 1.
Table 1. Data on the occurrence of the Mediterranean Beach-cricket *Pseudomogoplistes squamiger* on the sea-shore in Slovenian Istria. Geographic position of localities is depicted in Fig. 1.

Zap. št. lokalitete	**Opis lokalitete, koordinate in datum opazovanja**	**Opazovalec**
Lok 1	Izola, Belvedere, Strunjanski klif, morsko nabrežje 200 m S od turističnega naselja Belvedere; WGS 84 Lat./Long.: 45.532845 °N, 13.633875 °E; 25. 9. 2021	M. Bedjanič
Lok 2	Piran, Fiesa, morsko nabrežje 300 m SV od Velikega jezera v Fiesi; WGS 84 Lat./Long.: 45.526273 °N, 13.584767 °E; 25. 9. 2021	M. Bedjanič

Obalni muren je v ekološkem oziru specializirana vrsta, ki naseljuje le zelo ozek pas primernega obalnega habitata. Našel sem jo pod in med kamni na zgornji meji supralitorala, v pasu, ki ga plimovanje ne dosega. Ta del obrežnega pasu površinsko rahlo omoči le pršec, občasno ga doseže le vrh razlivanja visokih valov, ki na obali ponekod puščajo naplavljene morske trave in druge organske ostanke. Za bolj omočen del tega obrežnega pasu sta značilna postranica *Talitrus saltator* (Montagu, 1808) in enakonožec *Ligia italica* Fabricius, 1798, medtem ko naseljuje obalni muren nekaj decimetrov oddaljen in nekoliko bolj suh del obrežja in ga skupaj z omenjenima vrstama rakov nisem opazoval.

Slika 2. Lokalitete v Slovenski Istri, kjer je bil 25. 9. 2021 opazovan obalni muren *Pseudomogoplistes squamiger*: (a) morsko nabrežje pod Belvederom pri Izoli, (b) morsko nabrežje v Fiesi pri Piranu (foto: M. Bedjanič)
Figure 2. Localities in Slovenian Istria where Mediterranean Beach-cricket *Pseudomogoplistes squamiger* was observed on 25. 9. 2021: (a) sea-shore under Belvedere near Izola, (b) sea-shore at Fiesa near Piran (photo: M. Bedjanič)

Razprava

Pojavljanje obalnega murna je v Sloveniji prvič nedvoumno potrjeno z opazovanjem samcev, samic in ličink na morskem obrežju v slovenski Istri. Vrsta je za zdaj znana z dveh območij, potrjeno naseljuje kamnito morsko obrežje pod Strunjanskim klifom severno od Belvedera pri Izoli in podoben tip morskega obrežja pod flišnim klifom med Fieso in Strunjanom. Glede na najdbe vrste v Istri na Hrvaškem (Krauss 1878, Werner 1909, Sombke & Schlegel 2007) ter pri Sesljanu severozahodno od Trsta v Italiji (Fontana & Kleukers 2002) je bila najdba obalnega murna v Sloveniji pričakovana. Seznam favne kobilic slovenske Istre, ki ga podaja Gomboc (2019), šteje skupaj z nedavnim dodatkom kobilice selke *Locusta migratoria* Linnaeus, 1758 (Bedjanič & Žunič Kosi 2020) in z obalnim murnom iz pričujočega prispevka tako že 99 vrst.

Biologija in ekologija obalnega murna sta slabo poznani, znotraj rodu je več znanja zbranega le za ogroženo sorodno vrsto *Pseudomogoplistes vicentae* Gorochov, 1996, ki zelo raztreseno naseljuje atlantsko obalo Kanarskih otokov, Maroka, Portugalske, Španije, Francije in Velike Britanije (Vahed 2020, Pelozuelo 2021). Tudi fenologija, ki je pomembna v kontekstu detekcije vrste, je nepopolno poznana. Najdbe odraslih osebkov na obalah Jadranskega morja izhajajo

večinoma iz obdobja od konca julija do konca avgusta (npr. Krauss 1878, Skejo et al. 2018, Puskás et al. 2018), pričujoče najdbe iz Slovenije pa kažejo, da tako odrasle osebke kot ličinke najdemo še vsaj konec septembra. Zanimiv je podatek iz Fontana & Kleukers (2002), ki prikazuje fotografijo samice iz Sesljana v začetku aprila. Tudi za omenjeno sorodno vrsto *Pseudomogoplistes vicentae* so raziskave pokazale, da odrasle samice preživijo obdobje zime do pomladi, medtem ko naj bi samci poginili do novembra (Vahed 2020).

Slika 3. Obalni muren *Pseudomogoplistes squamiger*: (a) samec, Belvedere, Izola; (b) ličinka, Fiesa, Piran; (c) samica, Belvedere, Izola (foto: M. Bedjanič, 25. 9. 2021)
Figure 3. Mediterranean Beach-cricket *Pseudomogoplistes squamiger*: (a) male, Belvedere, Izola; (b) larva, Fiesa, Piran; (c) female, Belvedere, Izola (photo: M. Bedjanič, 25. 9. 2021)

Kljub temu, da je obalni muren na slovenski morski obali zelo verjetno pogostejši, kot kažejo doslej zbrani podatki, preliminarno ocenjujem, da sodi med ogrožene vrste. Glavni razlog je v pretekli degradaciji in še vedno trajajočih različnih pritiskih na obalo slovenskega morja. Morsko obrežje je ohranjeno v naravni obliki, z vsemi obrežnimi pasovi, vključno s pršnim pasom oz. supralitoralom, le še na slabi petini slovenske obale (Centrih Genov et al. 2019). Čeprav sta obe doslej znani območji pojavljanja obalnega murna pod Strunjanskim klifom in pod flišnim klifom med Fieso in Strunjanom formalno »pokriti« z naravovarstvenimi statusi naravne vrednote, krajinskega parka in Natura 2000 območij in čeprav so tudi drugi potencialni habitati vrste na slovenski morski obali kot zadnji ostanki ohranjene narave na tem območju večinoma zavarovani, je vprašanje, ali bo vse to dovolj za dolgoročni obstoj vrste pri nas. Globalne podnebne spremembe namreč povzročajo dvig gladine oceanov, in slovensko morje pri tem ni izjema. V zadnjih nekaj desetletjih znaša rast srednje gladine morja pri nas prek 4 mm na leto (Ličer et al. 2021). Modelske projekcije predvidevajo, da bo do leta 2050 srednja gladina morja v Tržaškem zalivu najverjetneje narasla za 30 do 50 centimetrov, do konca stoletja pa za 40 do 100 cm, s čimer je povezana tudi strma rast pogostosti poplav (Ličer et al. 2021). Ker je obalni muren specializirana vrsta, ki naseljuje le zelo ozek pas primernega obalnega habitata na zgornjem robu supralitorala, je z ozirom na obstoječo degradacijo slovenskega morskega obrežja in fizično konfiguracijo še ohranjenih delov obrežja z razmeroma ozko abrazijsko teraso pod flišnimi klifi jasno, da se mu zaradi grozečih posledic globalnih klimatskih sprememb ne piše najbolje. Ocenjujem, da že danes potencialna razširjenost oz. habitat obalnega murna v Sloveniji meri krepko manj od kvadratnega kilometra. Tudi s tega vidika zaključujem s priporočilom, da so za oceno dejanske razširjenosti ter velikosti, viabilnosti in spremljanje ogroženosti populacij obalnega murna v Sloveniji potrebne nadaljnje terenske raziskave.

Summary

The Mediterranean Beach-cricket *Pseudomogoplistes squamiger* is a peculiarity among grasshoppers, being one of the few species living among gravel, rocks and plant debris directly on the seashore and is tied only to a narrow strip of suitable coastal habitat. It is widespread along the coasts of the entire Mediterranean, from Turkey, Greece, Albania, southern Italy, Sicily, Sardinia, the northern coasts of Algeria and Spain to France, Corsica and northwestern Italy (Skejo et al. 2018, Bellmann et al. 2019, Pelozuelo 2021).

The presence of the Mediterranean Beach-cricket in Slovenia, without concrete faunistic data, was already mentioned as probable by Us (1992). Based on this statement, the species was uncritically included in the checklist of Orthoptera in Slovenia (Gomboc & Šegula 2014), but in the recent review of the grasshopper fauna of Slovenian Istria, the species was correctly not listed and is mentioned among the species not yet confirmed in this part of Slovenia (Gomboc 2019).

In the present account, the occurrence of the Mediterranean Beach-cricket in Slovenia is confirmed unambiguously for the first time, based on observations of males, females and larvae on 25 September 2021 in Slovenian Istria, on the seashore under Belvedere near Izola and at Fiesa near Piran. These recent data are presented by locality details given in Tab. 1 and Fig. 1, as well as by photographs of the localities (Figs. 2a-b) and of the observed insects (Figs. 3a-c). According to the records of the species in Istria in Croatia (Krauss 1878, Werner 1909, Sombke & Schlegel 2007) and near Sistiana northwest of Trieste in Italy (Fontana & Kleukers 2002), the discovery of the Mediterranean Beach-cricket in Slovenia has been expected. The distribution and biology of this specialised species, which is restricted only to a narrow belt

of suitable costal habitat, remains incompletely known. Together with the recently added migratory locust *Locusta migratoria* (Bedjanič & Žunič Kosi 2020) and the record of the Mediterranean Beach-cricket from the present article, the list of Orthoptera of Slovenian Istria presented by Gomboc (2019) thus includes 99 species.

Although the Mediterranean Beach-cricket is listed as a non-endangered species in the European Red List of Grasshoppers, Crickets and Bush-crickets (Least Concern – LC; Hochkirch et al. 2016), the author tentatively concludes that its long-term survival in Slovenia is at risk. The main reason for this is past degradation and still ongoing diverse pressures on the Slovenian seashore, of which less than one fifth is still preserved in its natural state. Although the two areas where the species is known to occur to date are formally »covered« with nature conservation statuses of natural values, landscape parks and Natura 2000 sites, global climate change and associated sea level rise in the Gulf of Trieste are likely to worsen conditions for this specialist cricket species, for which even today the extent of potential habitat in Slovenia is estimated at less than one square kilometre.

Further field research is needed to assess the actual distribution as well as the size, viability and threat status of the species' populations in Slovenia.

Zahvala

Za informacije o potencialnem habitatu priobalnega murna na slovenski obali se zahvaljujem sodelavkama dr. Janji Francé in dr. Vesni Flander Putrle z Nacionalnega inštituta za biologijo – Morske biološke postaje Piran. Ali Šalamun je prijazno pomagal s kartografsko podlago slovenske Istre. Hvala recenzentoma za pregled rokopisa. Pripravo članka je v okviru raziskovalnega programa št. P1-0255 sofinancirala Javna agencija za raziskovalno dejavnost Republike Slovenije iz državnega proračuna.

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Larval habitat characteristics of eastern eggar *Eriogaster catax* (Linnaeus, 1758) (Lepidoptera: Lasiocampidae) in Slovenia

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Abstract. The ecology of the eastern eggar (*Eriogaster catax*) in Slovenia has not been well characterized to date. Within the framework of this study, focusing on the larval habitat of the species, a total of 489 caterpillar webs found in different areas of Slovenia were recorded and a number of important variables documented. These included the host plant species, the size of the web, the height of the web from the ground, the height of the host plant, the trunk diameter at ground level, the web aspect and the general habitat characteristics. The most important host plants turned out to be blackthorn (*Prunus spinosa*) and hawthorn (*Crataegus* spp.), with one web found on *Pyrus pyraster* and one on *Amelanchier ovalis*. The web sizes varied largely, with the median size reaching 54 cm^2. The position and height of the web from the ground was correlated with the height of the plant. Most caterpillar webs (67.4%) were oriented to the south, south-west or south-east. 61.5% of caterpillar webs were recorded in temperate heath and scrubs, with the majority of them found in sub-Mediterranean blackthorn-privet scrub (25.4%), followed by Atlantic and medio-European blackthorn-privet scrub (18.0%) and shrub woodland (13.1%). The present study provides the first insight into the ecology of the eastern eggar in Slovenia, focusing on larval habitat. The characterization of the larval habitat is of particular importance for the conservation of the eastern eggar and its potential habitat in Slovenia.

Key words: *Eriogaster catax*, ecology, habitat, caterpillar web, Slovenia, Natura 2000, Habitats Directive

Izvleček. Značilnosti larvalnega habitata hromega volnoritca *Eriogaster catax* (Linnaeus, 1758) (Lepidoptera: Lasiocampidae) v Sloveniji – V članku predstavljamo prvo študijo o ekologiji hromega volnoritca (*Eriogaster catax*) v Sloveniji, s poudarkom na larvalnem habitatu. Skupno smo popisali 489 gnezd gosenic hromega volnoritca v različnih delih Slovenije. Tem gnezdom smo določili oziroma izmerili različne parametre: vrsto hranilne rastline gnezda, njeno velikost, velikost gnezda gosenic, višino, na kateri je bilo gnezdo, usmerjenost gnezda glede na smeri neba, debelino debla rastline pri tleh in tip habitata na mestu lokacije gnezda gosenic. Najpomembnejši hranilni rastlini sta glog (*Crataegus* spp.) in črni trn (*Prunus spinosa*), po eno gnezdo gosenic pa smo našli tudi na drobnici (*Pyrus pyraster*) in šmarni hrušici (*Amelanchier ovalis*). Gnezda gosenic so bila različnih velikosti z mediano (dolžina×širina) pri 54 cm^2. Mesto gnezda gosenic na rastlini, torej oddaljenost gnezda od tal, je odvisna od višine rastline. Večina gnezd gosenic (67,4 %) je bila orientirana proti jugu, jugozahodu ali jugovzhodu. Največ gnezd gosenic (61,5 %) smo našli v resavah in grmiščih v zmernih klimatskih predelih, med temi so gnezda gosenic prevladovala v submediteranskih listopadnih grmiščih (25,4 %), sledijo srednjeevropska toploljubna bazifilna grmišča s kalino in črnim trnom (18,0 %) ter mešani grmičasti gozdovi in površine, zaraščajoče se z listnatimi in iglastimi drevesnimi vrstami (13,1 %). Pričujoči prispevek predstavlja pomembne ugotovitve in predloge, ki jih lahko uporabimo pri varstvu hromega volnoritca v Sloveniji.

Ključne besede: hromi volnoritec, *Eriogaster catax*, ekologija, habitat, Slovenija, Natura 2000, Direktiva o habitatih

Introduction

The eastern eggar moth, *Eriogaster catax* (Linnaeus, 1758) (Lepidoptera: Lasiocampidae), is widely distributed across Europe and Asia, from Northern Spain through Central and Southern Europe to Russia and Western Asia (Ebert et al. 1994). As in many other countries (Kadej et al. 2017), the species distribution is locally aggregated in Slovenia as well (Zakšek et al. 2016). According to the IUCN classification, the species is in the Data Deficient (DD) category (IUCN 1996). It is listed on Annexes II and IV of the Habitats Directive (OJ EC 1992) and in Appendix II of the Bern Convention (Ur. l. RS 1999). The last assessment of the species for the 2013–2018 period revealed an unfavourable conservation status in most EU Member States, including in Slovenia (for Continental biogeographical region) (EIONET 2018). The main reasons for new records of the species in many states is an increase in targeted research (Sáfián 2006, Straka 2006, García-Pérez et al. 2009, Chrzanowski et al. 2013, Bury 2015, Zakšek et al. 2016, Teodorescu & Stănescu 2019) and not the consequence of a shift to a favourable conservation status.

Although the species' distribution in Slovenia has not been well described, current sightings clearly show its distribution in the Goričko region in the NE, Bela krajina in the SE and through central Slovenia to the Primorska region, with most records made in the SW of the country (Zakšek et al. 2016). Sighting of the species in Slovenia have been made in the Atlantic and medio-European blackthorn-privet scrub (31.8121), Sub-Mediterranean blackthorn-privet scrub (31.8122), Xero-thermophile fringes (34.41), Thermophilous and supra-Mediterranean oak woods (41.7) and Hedgerows (84.2) (Čelik et al. 2005) according to the Classification of Palaearctic Habitats (Devilliers & Devilliers-Terschuren 1996).

The research carried out to date on the eastern eggar in Europe has focused on its geographical distribution with limited focus given to local ecology (Sáfián 2006, García-Pérez et al. 2009, Chrzanowski et al. 2013, Bury 2015, Zakšek et al. 2016, Teodorescu & Stănescu 2019), with very few surveys focusing on the ecology and habitat preferences of the species (Ruf et al. 2003, Höttinger 2005, Dolek et al. 2008, Valchářová 2012, Kadej et al. 2017). The moth is a thermophilic species that can be found in warm habitats such as open forests, forest edges, hedges, clearings, or meadows with shrubs where the larval host plants occur. Most studies have shown that *Crataegus* spp. and *Prunus spinosa* are the most important larval host plants, with others like *Pyrus* spp., *Rosa* spp., *Quercus* spp., *Betula* spp., *Populus* spp., *Ulmus* spp., *Dorycnium pentaphyllum* and *Berberis* spp. found to be less common (Bolz 1998, Carron 2009, Höttinger 2005, Dolek et al. 2008, García-Pérez et al. 2009, Valchářová 2012, Kadej et al. 2017, Sitar et al. 2019). The prevailing larval host plant differs across the European habitat of the species. For example, in South western Poland (Kadej et al. 2017) and in Bavaria (Dolek et al. 2008), *Prunus spinosa* is the prevailing host plant. In Danube-Auen National Park in Austria (Höttinger 2005), Cantabria in Spain (García-Pérez et al. 2009) and in the Czech Republic (Valchářová 2012) *Crataegus* spp. is dominant, while in Switzerland (Carron 2009) both *Crataegus* spp. and *Prunus spinosa* are equally significant species.

Even though the eastern eggar was included in Habitats Directive as early as 1992 (OJ EC 1992), there is still a lack of knowledge about its ecology. This research is a prerequisite for the development of effective conservation strategies and management of the species. Importantly, ecological preferences can differ through a species distribution range, as has been found in other Lepidoptera species (Čelik et al. 2015, Lindman et al. 2017, Tartally et. al. 2019). Therefore, detailed knowledge about the species habitat requirements at local scales (Čelik et al. 2015, Kadej et al. 2017) is very important. For species with low mobility, such as the eastern eggar, insight into larval habitat characteristics and oviposition preference is crucial for further conservation actions in the future.

In Slovenia, specimens of eastern eggar and their habitats are legally protected by the national Decree on Protected Wild Animal Species (Ur. l. RS 2004b). The implementation of the Habitats Directive for the eastern eggar in Slovenia is still in progress since Natura 2000 sites have not been fully designated due to poor knowledge of the distribution and ecology of this species (Zakšek et al. 2016). So far, only three Natura 2000 sites have been designated for eastern eggar in western Slovenia: Slovenska Istra (SI3000212), Kras (SI3000276) and Sečoveljske soline in estuarij Dragonje (SI3000240) (Ur. l. RS 2004a, 2013).

No recent surveys have described the species' distribution in Slovenia in detail so far (Zakšek et al. 2016). More specifically, surveys concerning the habitat requirements, life history, population dynamics and conservation management have never been conducted. Čelik et al. (2005) concluded that there is a lack of knowledge about this species' distribution and ecological preferences in Slovenia.

This study is the first in Slovenia and in the Balkan region that specifically characterizes the ecological preferences of the larval habitat of the eastern eggar moth. Focus is given to identification of larval host plants, description of caterpillar webs and the general larval habitat of the species in Slovenia. The findings of this study are a vital contribution to the conservation efforts and protection of the eastern eggar moth and its habitat in Slovenia.

Materials and methods

Study species

Adults of the eastern eggar moth (*Eriogaster catax*) in Slovenia are active in the autumn from September to November (Zakšek et al. 2016). Females lay their eggs in one batch on the host plant covered by a layer of hairs from their abdomen. The eggs overwinter and from the end of March to the beginning of April caterpillars hatch. In first instars, caterpillars live socially on webs built on the host plant, often above the eggs or nearby on the same plant (Pro Natura 2000). This stage lasts from two to four weeks (personal observations). Young caterpillars feed on deciduous trees and shrubs, mainly on *Prunus spinosa* and *Crataegus* spp., while older solitary caterpillars have a wider spectrum of food plants (polyphagus). After three to four weeks caterpillars pupate in a cocoon on the ground (Freina & Witt 1987).

Field surveys

Field data were collected from 2011 to 2020 from the end of March to the end of April (depending on the season) around Slovenia (Fig. 1). Areas were not selected systematically. Most locations were chosen based on historical data of the presence of the species (Zakšek et. al 2016). At each field site we examined potential habitats, such as forest edges, shrubs and hedges with dominant host plants, *Prunus spinosa* and *Crataegus* spp., and searched for caterpillar webs. We only recorded occupied plants in these areas.

For each caterpillar web we recorded the exact location using GPS (Fig. 1). Additionally, the following variables were recorded: (1) the host plant species; (2) the size (length, width) of the web; (3) the height from the ground; (4) the aspect of the web (N, NE, E, SE, S, SW, W, NW) on the plant; (5) the height of the plant (in cm); (6) the trunk diameter at ground level. The total number of measurements differed for individual variables because we were not able to record all variables for some caterpillar webs. In some cases, only the habitat type and no other variables were measured. To avoid misinterpretation, we have included the number (N) of measurement for every variable in the results.

Crataegus host plants were not identified to the species level due to high variability and occurrence of hybrids making identification difficult even for specialists (Martinčič et al. 2007). *C. monogyna* and *C. laevigata* are widespread and common in Slovenia, whereas *C. curvisepala* is rare (Jogan et al. 2001).

Data analysis

Caterpillar web variable data was grouped according to location (marked with different colours and letters in Fig. 1). We used GIS softwares (ArcGIS, QGIS) and Excel for analysis.

To define the habitat type for each caterpillar web we used data from habitat type mapping of Slovenia (Leskovar et al. 2001, Brancelj et al. 2002, Kaligarič et al. 2003, 2018, Babij et al. 2004, Erjavec et al. 2004, 2007, Jakopič et al. 2004, Petrinec & Kovačič 2005, Poboljšaj et al. 2005, Kaligarič & Sedonja 2006, Trčak et al. 2008, 2012, Petrinec et al. 2015, 2020, Trčak & Petrinec 2018). Habitat type mapping, names and codes (Physis) follow the Classification of Palaearctic Habitats (Devilliers & Devilliers-Terschuren 1996) and were adapted and improved in order to fit local conditions in Slovenia (Jogan et al. 2004). We gathered data from habitat mappings for 366 caterpillar webs and habitat types were reasonably combined on different levels.

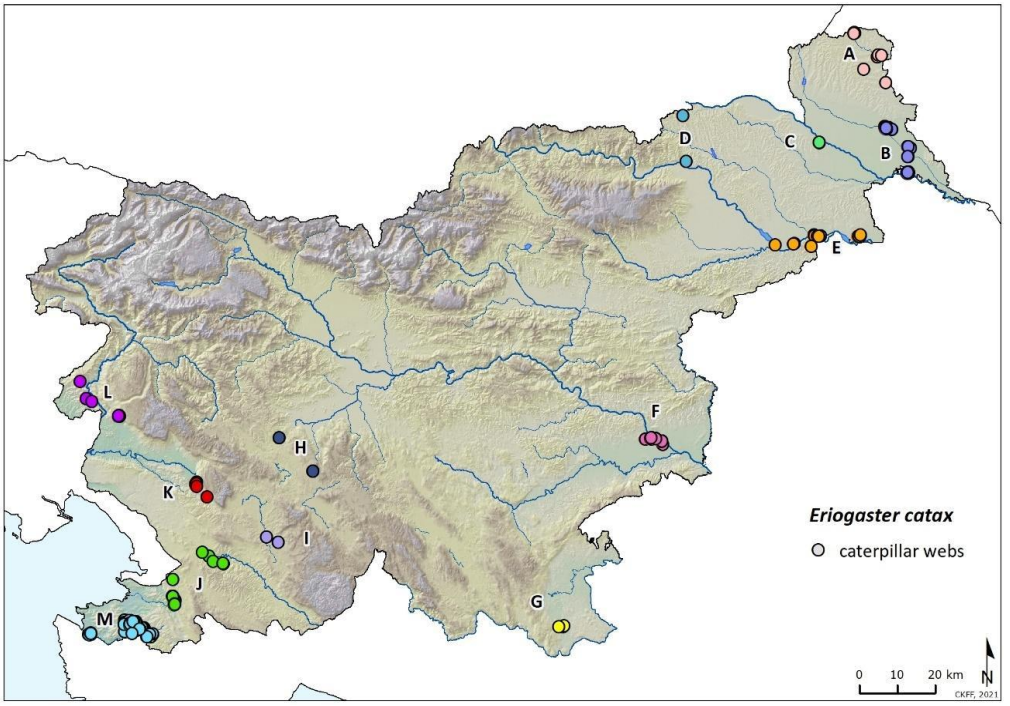

Figure 1. Locations of caterpillar webs of eastern eggar (*Eriogaster catax*) in Slovenia (N=489) in this study.
Slika 1. Lokacije gnezd gosenic hromega volnoritca (*Eriogaster catax*) v Sloveniji (N=489), vključenih v to študijo.

Results

A total of 489 caterpillar webs (Fig. 1) were recorded. The most important host plants were *Prunus spinosa* (49.6%, N=230) and *Crataegus* spp. (50.0%, N=232). One web was found on *Pyrus pyraster* (0.2%, N=1) and one on *Amelanchier ovalis* (0.2%, N=1) (Fig. 2). The finding of a caterpillar web on *Pyrus pyraster* was from Goričko (A) and on *Amelanchier ovalis* from Slovenian Istria (M) (Fig. 2). In most cases (94.3%), there was only a single caterpillar web per host plant. The exceptions were 2 webs on the same plant on 4 different plants of *Prunus spinosa* and on 10 plants of *Crataegus* spp.

In the Goriška region (L), all caterpillar webs were located on *Crataegus* spp. (N=10). In the following regions, the majority of webs were found on *Crategus* spp.: Istria (M) (N=160, 63.8% on *Crataegus* spp., 35.6% on *P. spinosa*), Karst region (J) (N=27, 59.3% on *Crataegus* spp., 40.7% on *P. spinosa*) and Vipava valley (K) (N=11, 63.6% on *Crataegus* spp., 34.4% on *P. spinosa*). An equal distribution between the two host plant species was recorded in areas of Maribor (D) (N=2, 50.0% on *Crataegus* spp., 50.0% on *P. spinosa*), Brežice (F) (N=35, 45.7% on *Crataegus* spp., 54.3% on *P. spinosa*) and Pivka (I) (N=2, 50.0% on *Crataegus* spp., 50.0%

on *P. spinosa*), while in Bela krajina (G) *P. spinosa* was the only host plant (N=4, 100% on *P. spinosa*). It was the dominant species in NE Slovenia (A (N=15, 26.7% on *Crataegus* spp., 66.7% on *P. spinosa*), B (N=126, 38.1% on *Crataegus* spp., 61.9% on *P. spinosa*), C (N=4, 25.0% on *Crataegus* spp., 75.0% on *P. spinosa*) and E (N=65, 38.5% on *Crataegus* spp., 61.5% on *P. spinosa*)) and in central Slovenia (H) N=3, 33.3% on *Crataegus* spp., 66.7% on *P. spinosa*) (Fig. 2).

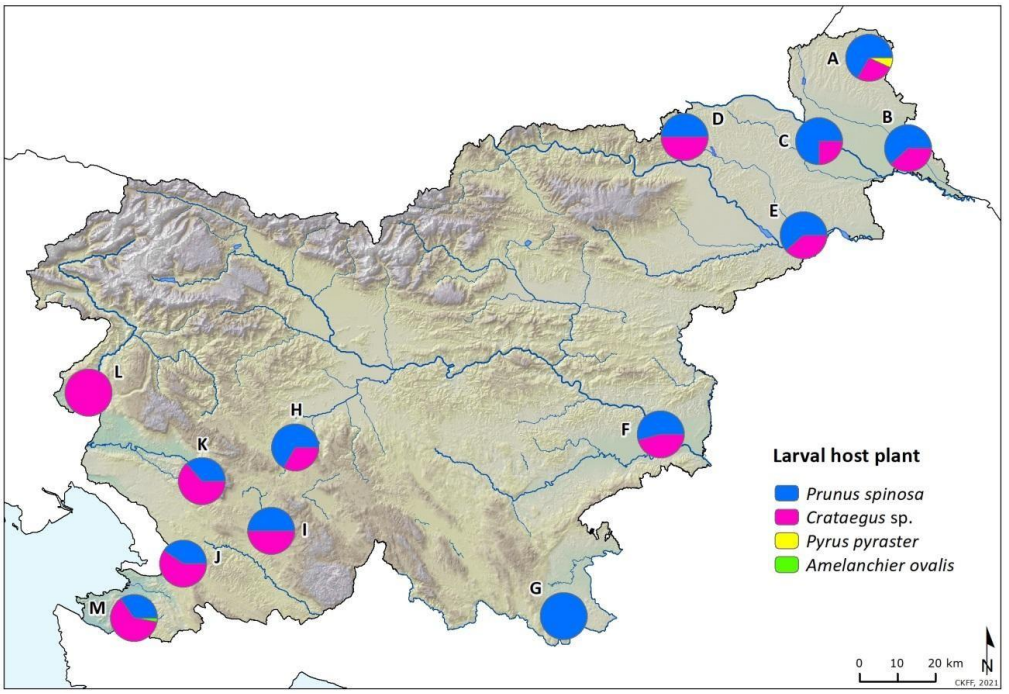

Figure 2. Proportion of eastern eggar (*Eriogaster catax*) caterpillar webs (N=464) on different larval host plants in Slovenia.
Slika 2. Delež gnezd gosenic hromega volnoritca (*Eriogaster catax*) (N=464) na larvalnih hranilnih rastlinah v Sloveniji.

Half of the caterpillar webs had a width between 4 to 7 cm (Me=5 cm, min–max: 1–13 cm, N=423) and length between 8 to 13 cm (Me=10 cm, min–max: 2–28 cm, N=423) (Fig. 3). The median of caterpillar web size in two dimensions (length × width) was 54 cm^2 (Q1–Q3: 35–54 cm^2, min–max: 2–220 cm^2, N=423).

Caterpillar webs were located from 20 to 300 cm from the ground (Q1–Q3: 70–140 cm, Me: 100 cm, N=439) (Fig. 3). The median height of all host plants was 180 cm (Q1–Q3: 130–230 cm, min-max: 40–500 cm, N=408) (Fig. 3). The median height of *Prunus spinosa* with caterpillar webs was 160 cm (Q1–Q3: 120–200 cm, min–max: 40–500 cm, N=211) and 200 cm (Q1–Q3: 150–250 cm, min–max: 90–500 cm, N=195) for *Crataegus* spp. The height of the web from the ground was correlated with the height of the plant (*Crataegus* spp.: $r=0.59$, $p<0.001$, N=192; *Prunus spinosa*: $r=0.73$, $p<0.001$, N=209). The median trunk diameter at the ground level was 3 cm (Q1–Q3: 2–5 cm, min–max: 0.5–25 cm, N=404).

Most caterpillar webs (68.4%) were oriented to the south (38.4%), south-west (15.7%) and south-east (14.3%) (Fig. 4).

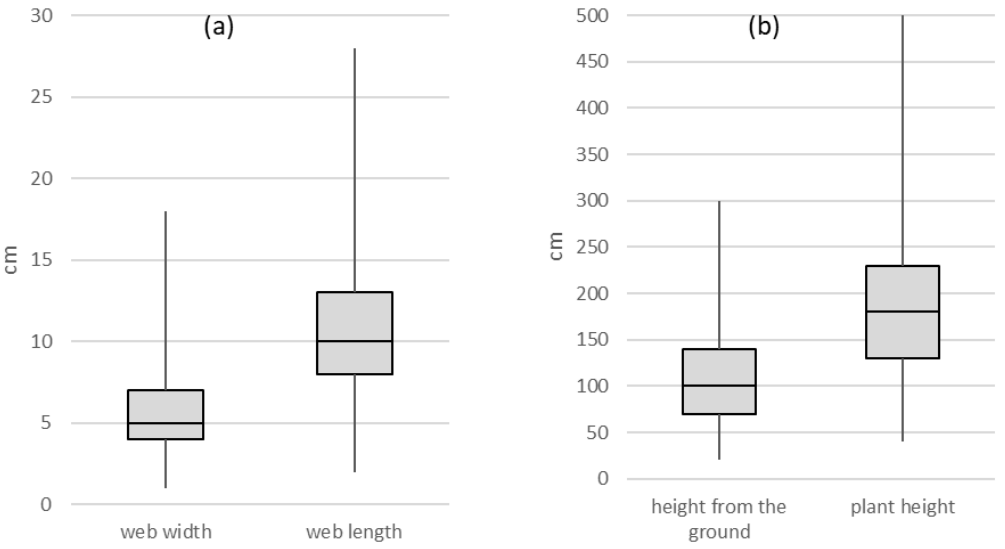

Figure 3. Boxplots of characteristics of eastern eggar (*Eriogaster catax*) caterpillar webs in Slovenia: (a) width and length (N=423); (b) height from the ground (N=439) and plant height (N=408).
Slika 3. Širina in dolžina gnezd gosenic hromega volnoritca (*Eriogaster catax*) (a) (N=423); višina, na kateri je bilo gnezdo najdeno (N=439); (b) višina rastline (N=408).

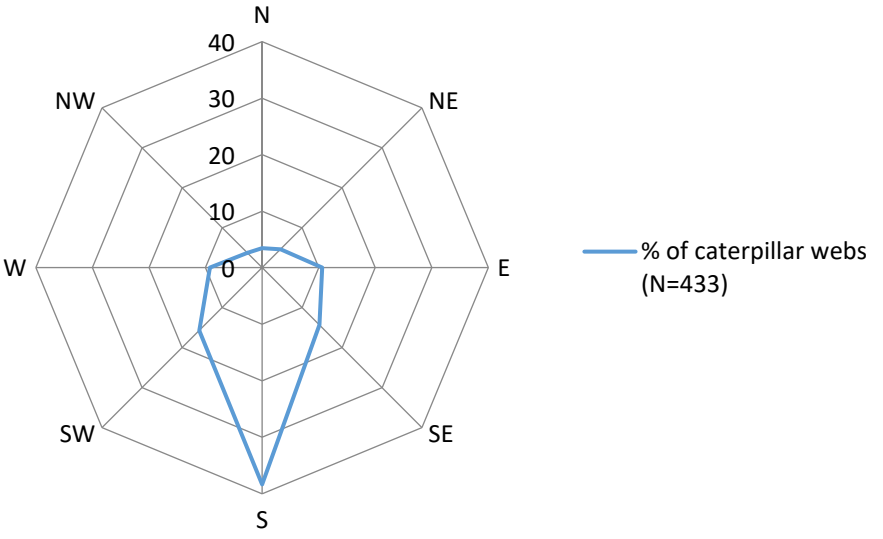

Figure 4. Radar chart of the aspects of the eastern eggar (*Eriogaster catax*) caterpillar webs (N=433) on the larval host plants in Slovenia.
Slika 4. Usmerjenost gnezd gosenic hromega volnoritca (*Eriogaster catax*) (N=433) na hranilnih rastlinah v Sloveniji.

Most caterpillar webs (61.5%) were recorded in temperate heath and shrubs (Physis 31), with the majority of them found in sub-Mediterranean blackthorn-privet scrub (25.4%, Physis 31.8122), followed by Atlantic and medio-European blackthorn-privet scrub (18.0%, Physis 31.8121) and shrub woodland (13.1%, Physis 31.8G, 31.8D, 31.8F). 11.5% of webs were found in steppes and dry calcareous grasslands in different successional stages (Physis 34), 6.6% in different types of forests and 5.7% caterpillar webs in hedgerows (Tab. 1).

Table 1. List of habitat types and % of eastern eggar (*Eriogaster catax*) caterpillar webs (N=366). Names and Physis codes follow Classification of Palaearctic Habitats (Devilliers & Devilliers-Terschuren 1996). Asterixes refer to (Annex I of the Habitats Directive (OJ EC 1992)): * – FFH code 6210(*), ** – FFH code 62A0.

Tabela 1. Seznam habitatnih tipov, v katerih so bila najdena gnezda gosenic hromega volnoritca (*Eriogaster catax*) (N=366) in njihov delež (%). Imena in Physis kode so povzeti po evropski klasifikaciji palearktičnih habitatov (Devilliers & Devilliers-Terschuren 1996). Zvezdice se nanašajo na Prilogo I Direktive o habitatih (OJ EC 1992): * – FFH koda 6210(*), ** – FFH koda 62A0.

Name of habitat type	Physis	% of caterpillar webs
Temperate heath and scrub	31	61.4
Blackthorn-bramble scrub	31.811	4.6
Blackthorn-privet scrub	31.812	0.3
Atlantic and medio-European blackthorn-privet scrub	31.8121	18.0
Sub-Mediterranean blackthorn-privet scrub	31.8122	25.4
Scrub woodland	31.8G, 31.8D, 31.8F	13.1
Steppes and dry calcareous grasslands	34	11.5
Sub-Atlantic semidry calcareous grasslands	34.32*	0.5
Middle European [Bromus erectus] semidry grasslands	34.322*	4.1
Middle European [Brachypodium] semidry grasslands	34.323*	2.2
Mountain savory-chrysopogon dry grassland	34.752**	1.4
Viper's grass dry grasslands	34.753**	1.1
Viper's grass-lime sieglingia grasslands	34.7531-S1**	2.2
Dry siliceous grasslands	35	2.5
Humid grassland and tall herb communities	37	1.6
Mesophile grasslands	38	3.3
Forests	4	6.6
Hedgerows	84.2	5.7
Others		7.4

Discussion

The results of this study show that *Prunus spinosa* and *Crataegus* spp. are the most important larval host plants for populations of eastern eggar in Slovenia. Only two webs out of a total of 464 were found on other host plants (*P. pyraster* and *A. ovalis*). Among the four recorded larval host plants, *P. spinosa* and the genus *Crataegus,* are the most commonly found species in Slovenia. While *P. pyraster* is also widespread, the thermophilic *A. ovalis* is highly present in the SW part of Slovenia, but missing from the NE. Our study does not have sufficient data to explain why more caterpillar webs were not found on *P. pyraster* and *A. ovalis* species, despite being commonly occurring species in areas with recorded eastern eggar presence.

Similar larval host plant preferences and geographical differences have been shown in other surveys. In Switzerland, both species are important host plants (Carron 2009), while in Poland most (92.3%) egg batches were found on *Prunus spinosa* and less on other food plants like *Pyrus* spp., *Rosa* spp. and *Crataegus* spp. (Kadej et al. 2017). Similar results came from Bavaria and Romania, where *Prunus spinosa* was preferred (Dolek et al. 2008, Sitar et al. 2019). In the Czech Republic, more caterpillar webs were found on *Crataegus* spp. than on *Prunus spinosa* (Valchářová 2012). Finally, in Austria caterpillar webs were found only on *Crataegus* spp. (Höttinger 2005). Our study showed only small-scale differences on a national level. Despite regional differences in habitat composition, there was no significant pattern of geographical preferences for host plants in Slovenia. Therefore, we can conclude that both *Prunus spinosa* and *Crataegus* spp. are equally important for conservation of the eastern eggar in Slovenia.

Although some host plants were quite tall and heavily branched, providing space for multiple webs, we observed only a single caterpillar web per plant on most recorded plants (94.3%). In 14 cases (5.7%), two caterpillar webs were found on the same plant. Similarly, a single caterpillar web per plant was found in the Czech Republic (Valchářová 2012) in 95.5% of all cases. The maximum number of caterpillar webs of eastern eggar per plant observed to date was four webs found on a single host plant in the Palava region during the same survey. The authors concluded that females avoid laying eggs on the same plant to avoid competition for resources.

The web sizes (length, width) varied largely in this study. This could be explained by the measured webs being in different phases of development. The surveyed caterpillars ranged in age from the L1 to L3 stadium. Ruf et al. (2003) estimated that caterpillar webs were roughly 300 cm^3 in size, which agrees with our measurements where the median of length × width is 54 cm^2.

The position of the web from the ground was correlated with the height of the plant. On plants higher than 2 m, the webs were not placed below 50 cm. Our results of the height of caterpillar webs from the ground (Q1-Q3: 70–140 cm, range 20–300 cm) are similar to those found in other studies. In Poland, the vertical position of the egg batches ranged from 27–248 cm from the ground (Q1-Q3: 75.5–127 cm; N=436) (Kadej et al. 2017). In Switzerland, the caterpillar webs were found at heights ranging from 25 cm to 220 cm from the ground on *Crataegus* spp. and 30 to 107 cm on *P. spinosa* (Carron 2009).

Most caterpillar webs require much sunlight for development, which they can get with positioning on a southern exposure. Our survey showed that 67.4% caterpillar webs were oriented to the south, south-west or south-east. Similar results were also published by other researchers (Ruf et al. 2003, Höttinger 2005, Dolek et. al 2006, Valchářová 2012, Kadej et al. 2017). Direct exposure to the sun is very important for species that develop in the spring when day and night temperatures are lower, compared to species that develop later in the summer. Caterpillar webs that were not oriented to southern exposures were mostly located on the plant in a way that allowed a lot of sunlight penetration during most of the day. The grasslands with solitary larval host plants or in different stages of succession are the most important habitats for this species. Solitary host plants can also get more direct sunlight. Moreover, preferences for a warm microclimate of the eastern eggar moth were confirmed through the positioning of the caterpillar webs higher in the host tree.

The essential components of the larval habitat of the eastern eggar are larval host plants *P. spinosa* and *Crataegus* spp., which can be found as components in various habitat types (Tab 1). In cases where *P. spinosa* and *Crataegus* spp. are the dominant plants, the habitat type is classified as an independent habitat type with blackthorn (Physis code: 31.811, 31.812, 31.8121, 31.8122). Our study has confirmed that the eastern eggar can be found in different habitat types in Slovenia, from different types of meadows and pastures (with solitary bushes) to hedgerows and forests. We confirmed all habitat types listed in Čelik et al. (2005) and have added others considered important.

The most important habitats for the presence of the eastern eggar were scrubs (which can be found in dry and wet areas), followed by dry calcareous grasslands. Dry grasslands indicate that the eastern eggar in Slovenia is a xero-thermophilic species. On the other hand, humid grasslands indicate that it can also be a thermo-hydrophilic species. In Slovenia, the eastern eggar is present in various locations, such as areas of sporadic river floods and locations in the thermophilic dry karst areas with no surface waters. The low number of caterpillar webs found in the habitat type described as hedgerows (5,7%) in this study could be due to the general classification of shrubs as temperate heath and scrub (Physis code: 31). These habitats can, however, be found in the form of hedgerows, but may not have been classified as such during habitat mapping.

As most caterpillar webs were found on young plants (trunk diameter 2–5 cm), we can conclude that habitats with predominantly old and tall plants, such as hedges, are less important for this species. A favourable habitat for the development of eastern eggar larvae consists of host plants of different ages. We hypothesize that disturbances of the hedges (e.g., partial removal of older plants) can be beneficial for this species. Because of the species' low dispersal potential (Bolz 1998), shrub removal should be limited to targeted and small-scale disturbances only. These should be coordinated in a way that allows removal of older plants in areas where no web development is currently taking place, but would allow younger host plants to thrive in the future and become available for web colonisation. In Slovenia, shrubs can only be removed in autumn and winter, due to national regulations predominantly focused on nesting birds and parturition of mammals. They prohibit shrub removal from March 1st to August 1st. This timing can be devastating for the eastern eggar moth, because it overlaps with the development cycle of the species. By removing host plants in the autumn and winter, egg batches that are on the plants are also being removed. The same applies for other species of Lepidoptera that winter in the stadium of eggs on shrub host plants, like some species of hairstreaks (Theclinae). Our recommendation is that shrubs are not removed during the winter, but during the late spring, when the eastern eggar is in the stadium of pupae in the ground. Additionally, the work should always be done on a small scale. Kadej et al. (2017) suggested that professional inspections should be carried out to exclude the presence of eggs or caterpillars of eastern eggar if cutting is to be done between late September and May.

We did not find any caterpillar webs in shrubs or in hedges bordered by crop fields, which could be the result of using pesticides or some mechanical damage of the plants. We conclude that small hedgerows in intensive agricultural land dominated with crop fields are less important for the target species. In these areas it is important to have hedgerows with plants in different stages (from young to old plants), which are big enough to neutralize impacts of intensive agriculture.

In this study we found only 6.6% of caterpillar webs in the forest. It should be noted that forest was investigated for eastern eggar presence in only a few locations during this study. Some recent findings in Slovenia have shown that some types of forest like black alder forests, e.g. Polanski log and Črni log in the NE part of Slovenia, could be important for this species. In the future we need to put more effort into validating forests as a potential habitat of the eastern eggar. *P. spinosa* and *Crataegus* spp. grow in most forests in the first succession stages and are then replaced by other tree species.

Current landscape management practices are focusing less on implementation of active and dynamic disturbances which facilitate cycles of successions in habitats. These approaches, where important young host plants are allowed to establish themselves in existing habitats, are essential for species such as populations of the eastern eggar moth. Therefore, they should be prioritised in recommendations for conservation efforts of the species.

Povzetek

Hromi volnoritec (*Eriogaster catax*) je vrsta nočnega metulja, ki je navedena v Prilogi II in IV Direktive o habitatih. Osebki te vrste in njihov habitat so v Sloveniji zavarovani z Uredbo o zavarovanih prosto živečih živalskih vrstah. Kljub temu da je poznavanje razširjenosti in ekologije hromega volnoritca nujno za uspešno varstvo vrste, je le-to v Sloveniji še vedno slabo.

V letih od 2011 do 2020 smo skupno popisali 489 gnezd gosenic hromega volnoritca v različnih delih Slovenije. Tem gnezdom smo določili oziroma izmerili različne parametre: vrsta gostiteljske hranilne rastline gnezda in njena velikost, velikost gnezda gosenic, višina, na kateri je gnezdo, usmerjenost gnezda glede na smeri neba, debelina debla rastline pri tleh in tip habitata na mestu lokacije gnezda gosenic. Tistim gnezdom gosenic, za katera so bili na voljo podatki o tipu habitata iz obstoječih kartiranj habitatnih tipov, smo pripisali habitat, v katerem je bilo najdeno gnezdo gosenic.

Najpomembnejši hranilni rastlini sta glog (*Crataegus* spp.) (50,0 %, N=232) in črni trn (*Prunus spinosa*) (49,6 %, N=230), po eno gnezdo gosenic pa smo našli tudi na drobnici (*Pyrus pyraster*) (0,2 %, N=1) in šmarni hrušici (*Amelanchier ovalis*) (0,2 %, N=1). Mediana širine gnezda je bila 5 cm, dolžine pa 10 cm. Mediana velikosti gnezda je bila 54 cm^2. Mediana višine, na kateri je bilo gnezdo, je bila 100 cm, pozicija gnezda gosenic na rastlini pa je odvisna od višine rastline. Večina gnezd gosenic (67,4 %) je bila orientirana proti jugu (38,4 %), jugozahodu (15,7 %) ali jugovzhodu (14,3 %) (N=433).

Največ gnezd gosenic (61,5 %) smo našli v resavah in grmiščih v zmernih klimatskih predelih, med temi so gnezda gosenic prevladovala v submediteranskih listopadnih grmiščih (25,4 %), sledijo srednjeevropska toploljubna bazifilna grmišča s kalino in črnim trnom (18,0 %) ter mešani grmičasti gozdovi in površine, zaraščajoče se z listnatimi in iglastimi drevesnimi vrstami (13,1 %).

Habitat hromega volnoritca sestavljajo skupine hranilnih rastlin različnih starosti, kar pomeni, da je za vzdrževanje habitata nujno odstranjevanje starejše zarasti na manjših območjih. Pri tem je treba poudariti, da lahko odstranjevanje zarasti v zimskih mesecih vodi tudi v odstranitev nemobilnih stadijev hromega volnoritca (jajčec), torej lahko vrsto dodatno ogroža. Zato predlagamo, da se odstranjevanje opravi zunaj te sezone, ali pa se pred odstranjevanjem grmovne zarasti v zimskih mesecih predhodno preveri, ali morda obstajajo jajčeca hromega volnoritca v grmiščih.

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Butterfly diversity (Lepidoptera: Papilionoidea) of Mt. Blegoš and Mt. Koprivnik (Škofjeloško hribovje, Slovenia)

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Abstract. An overview of the surveys of butterfly fauna of Mt. Blegoš, Mt. Koprivnik and their surroundings is provided. In 2018, 14 surveys were performed and 80 butterfly species on eight transects recorded in the process. Additional surveys in 2019 and 2020 yielded 5 additional butterfly species. Among the butterflies observed, *Parnassius mnemosyne*, *Lycaena hippothoe*, *Euphydryas maturna*, *Euphydryas aurinia*, *Melitaea britomartis*, *Melitaea diamina*, and *Pyrgus alveus* are identified as vulnerable species, while both *Phengaris arion* and *Phengaris alcon* are classified as endangered species in Slovenia. The latter was found on two occasions in July 2018 and July 2020 on a single locality. Eggs of *P. alcon* were found on the host plant *Gentiana cruciata* at the same locality. Despite the fact that many species characteristic of higher altitudes were observed, like *Aricia artaxerxes*, *Pyrgus alveus*, *Erebia stiria* and *Lasiommata petropolitana*, other, which had still been present a few decades ago, were not found (*Parnassius apollo* and *Boloria pales*). In this article, the problem of loss of important butterfly habitats in the region due to overgrowing, and the negative impacts of overgrazing is also highlighted.

Key words: transect surveys, grazing, overgrowing, *Phengaris alcon*, *Phengaris arion*, Slovenia

Izvleček. Raznolikost dnevnih metuljev (Lepidoptera: Papilionoidea) Blegoša in Koprivnika (Škofjeloško hribovje, Slovenija) – V članku predstavljamo popise favne dnevnih metuljev Blegoša in Koprivnika z njuno okolico. V letu 2018 smo opravili 14 popisov, med katerimi smo zabeležili 80 vrst metuljev na 8 transektih. Med dodatnimi popisi v letih 2019 in 2020 pa smo opazili še 5 dodatnih vrst. Izmed zabeleženih metuljev spadajo *Parnassius mnemosyne*, *Lycaena hippothoe*, *Euphydryas maturna*, *Euphydryas aurinia*, *Melitaea britomartis*, *Melitaea diamina* in *Pyrgus alveus* med ranljive vrste, medtem ko sta *Phengaris arion* in *Phengaris alcon* klasificirana kot ogroženi vrsti za Slovenijo. Slednji je bil najden zgolj med dvema popisoma v juliju 2018 in 2020 na eni sami lokaciji, prav tako pa smo na rastlini *Gentiana cruciata* našli njegova jajčeca. Kljub dejstvu, da smo opazili določene vrste značilne višje nadmorske višine, kot so *Aricia artaxerxes*, *Pyrgus alveus*, *Erebia stiria* in *Lasiommata petropolitana*, pa dveh, ki smo ju lahko opazovali še pred nekaj desetletji, nismo našli (*Parnassius apollo* in *Boloria pales*). V članku poudarjamo tudi problem izgube pomembnih habitatov v regiji zaradi zaraščanja in negativnega vpliva prekomerne paše.

Key words: transektni popisi, pašništvo, zaraščanje, *Phengaris alcon*, *Phengaris arion*, Slovenija

Introduction

Škofjeloško hribovje, a roughly 25 km long mountain chain, is one of the highest in Slovenia outside the Alps (Perko & Orožen-Adamič 2001). It is positioned in the southwestern part of the country in the Gorenjska region. Due to its location it forms a barrier between three different climates – continental to the east and south, alpine to the north and sub-Mediterranean to the southwest. Due to its specific geological structure and climate it has a very diverse morphology, with a plethora of different habitats, which is reflected in a diverse fauna and flora found in the region (Ilešič 1938, Šifrer 1974). Due to the rich diversity and unique habitats, Mt. Blegoš is also a part of the Natura 2000 network (Blegoš; SI3000260; Ur. l. RS 2004a).

The two highest points of the mountain chain are Mt. Blegoš (1,562 m) and Mt. Koprivnik (1,393 m), which have been surveyed for butterflies since the first half of the 20th century (Carnelutti 1980, Withrington 2003). However, apart from those general overviews, with only the most interesting species mentioned, there has been no extensive account of the butterfly fauna of the two mountains published. Nevertheless, Carnelutti (1980) provides some interesting observations, which can be used for the comparison with the current situation. He mentions several subalpine or alpine species for Mt. Blegoš, specifically *Boloria pales*, *Parnassius apollo* (already extinct at that time), *Erebia euryale*, *E. medusa*, and *Pieris bryoniae*. The only other faunistic survey, which only partially overlaps with our studied area, was done by Verovnik (2000), however, the aforementioned highest peaks were not visited at the time.

Given the lack of systematic research, our main objective was to survey the butterfly fauna of the region and check for potential habitats and presence of the interesting species mentioned in the previous studies. We also provide an evaluation of the conservation status and threats to the butterflies in the region.

Geographical characteristics of the region

Škofjeloško hribovje is a mountainous region between the Poljanska Sora River to the south and the Selška Sora River to the north. It is a diverse mountainous landscape which merges to the west, just north of Cerkno, with Cerkljansko hribovje and its highest mountain Porezen (1,630 m), and with Mt. Lubnik (1,025 m), just above Škofja Loka, reaches its easternmost point. Mt. Blegoš and its neighbour, Mt. Koprivnik, are located north of the villages of Volaka and Gorenja Žetina, respectively, and are the highest peaks of the region (Šifrer 1974).

The two mountains are surrounded with an old Paleozoic, presumably Silurian, shale and chives, while their peaks are predominantly composed of younger dolomites and shell limestone, which lie atop the Carboniferous layers. The limestone and dolomites are especially predominant at the top of Mt. Blegoš (Ilešič 1938, Šifrer 1974, Marinček & Wraber 1980). Due to the very complex geological structure composed of mainly impermeable rocks, which represents a transition point between the Alps and the Karst, the surrounding area of Mt. Blegoš is densely intersected with smaller gorges and ravines created by strong temporary torrents (Šifrer 1974).

Mt. Blegoš and Mt. Koprivnik have, like the major part of Škofjeloško hribovje, a typical continental climate characteristic of the Ljubljana basin, with alpine climate influences at higher altitudes, especially above 1,300 m. On warmer southern slopes, the influence of the neighbouring sub-Mediterranean climate is evident (Ilešič 1938, Marinček & Wraber 1980). The wider area of Škofjeloško hribovje has high annual rainfall of around 1,800–2,000 mm on average (Nadbath 2010, Vertačnik & Bertalanič 2017), while the highest parts of Mt. Blegoš and Mt. Koprivnik receive on average between 2,000–2,600 mm annually (Vertačnik & Bertalanič 2017). The annual mean temperatures for the highest parts of Mt. Blegoš are between 4–6 °C, and 6–8 °C for lower parts (including Koprivnik) while the average temperature in July is between 12–14 °C for Mt. Blegoš and 14–16 °C for Mt. Koprivnik (Marinček & Wraber 1980, Vertačnik & Bertalanič 2017).

Given the amount of precipitation and specific geology, the region is characterised by lush vegetation, especially dense mixed woods, consisting predominantly of *Fagus sylvatica*, *Abies alba* and *Picea abies*. *F. sylvatica* is especially common on the limestone and dolomite near the top of Mt. Koprivnik and in particular Mt. Blegoš, while the surrounding area is mostly covered by mixed woods (49 %) with a predominance of conifers. Those woods have the characteristics of sub-alpine mixed forest of *Luzulo-Abieti-Fagetum praealpinum* or *Luzulo-Fagetum montanum praealpinum*, depending on the altitude. Above 1,450 m they are considered as part of *Fagetum subalpinum* forests (Ilešič 1938, Marinček & Weber 1980). Ash, an important larval host plant of *Euphydryas maturna*, is also found in the area, especially around »Likar's hayfield« locality.

The highest parts of Mt. Blegoš are covered with extensive grasslands and pastures, which are present also on the southern slopes. These, despite showing the characteristics of a true alpine grasslands and pastures in some places, are of anthropogenic origin, which can be seen in an advanced overgrowing of uncut and un-grazed areas, as well as in a very high upper tree line limit, which nowadays reaches up to 1,500 m. Also typical of Paleozoic shales are low woodland shrubs and vegetation, like *Vaccinium myrtillus*, *Calluna vulgaris* and different species of ferns, which are especially common in the overgrown grasslands of Mt. Koprivnik (Ilešič 1938, Marinček & Weber 1980).

One of the main agricultural activities in the region and especially Mt. Blegoš is grazing. Before 1900, it was very widespread, also extending to other parts of the mountain chain (e.g. Mt. Koprivnik). After 1900, however, with the newly formed border between Italy and Slovenia, the grazing activity started to decline (Ilešič 1938). This has been even more prominent in recent decades when there was also a shift from sheep to now predominant cattle grazing (own observations).

Materials and Methods

Description of the surveys

Despite a few observations of butterflies around Mt. Blegoš, Mt. Koprivnik and their surroundings, no thorough research has ever been undertaken in this region. Thus, a more extensive survey was performed in order to determine the most important species and habitats

from the conservation perspective. We established surveys on 8 transects/localities and, weather permitting, visited them at least once every second week from 27. 5. to 8. 9. 2018, counting the number of butterflies (species and individuals) in the process.

Table 1. The list of transects surveyed during the study. Coordinates are given in a WGS 84 projection. In the case of a broader locality, the observations were made near the transect location, but are sometimes not restricted to the indicated habitat type of the transect. Start/End refer to start and end points of each transect.
Tabela 1. Seznam transektov, ki smo jih vzorčili med študijo. Koordinate so podane v WGS 84 projekciji. V primeru širše lokacije so bili popisi opravljeni v bližini transekta, a niso bili vedno omejeni le na habitatni tip, značilen za tisti transekt. Start/End se nanašata na začetno in končno točko transekta.

No.	Name (ENG/SLO)	Description	Habitat type	Start	End	Length [m]
1	Meadow under Mt. Koprivnik/Travnik pod Koprivnikom	Mt. Koprivnik, meadow 500 m S of the top	Intensive grassland	X: 46.171691, Y: 14.140815; Alt.: 1112 m	X: 46.171944, Y: 14.142006; Alt.: 1116 m	120 m
2	Potok/Potok	Potok, meadow 500 m SE of the village entre	Intensive grassland	X: 46.180063, Y: 14.110464; Alt.: 970 m	X: 46.179911, Y: 14.109219; Alt.: 921 m	150 m
3	Mt. Koprivnik/ Koprivnik	Mt. Koprivnik, meadow 200 m SE of the top	Extensive grassland	X: 46.174310, Y: 14.143750; Alt.: 1268 m	X: 46.175569, Y: 14.141969; Alt.: 1368 m	300 m
4	Likar's hayfield/ Likarjeva senožet	Mt. Blegoš, 1900 m S of the top	Extensive grassland	X: 46.146215, Y: 14.119547; Alt.: 1051 m	X: 46.148255, Y: 14.118667; Alt.: 1137 m	300 m
5	Forest clearing/ Gozdna poseka	Mt. Blegoš, 650 m SE of the top	Forest clearing	X: 46.159735, Y: 14.118791; Alt.: 1333 m	X: 46.161318, Y: 14.118619; Alt.: 1376 m	170 m
6	Forest by the macadam/ Gozd ob kolovozu	Mt. Blegoš, 850 m S of the top	Forest clearing	X: 46.156421, Y: 14.113011; Alt.: 1296 m	X: 46.154801, Y: 14.107443; Alt.: 1229 m	570 m
7	Mt. Blegoš: meadow under the hilltop/Blegoš: travnik pod vrhom	Mt. Blegoš, 300 m S of the top	Pasture meadow	X: 46.161210, Y: 14.112718; Alt.: 1473 m	X: 46.162834, Y: 14.110422; Alt.: 1441 m	270 m
8	Mt. Blegoš: hilltop/Blegoš: vrh	Mt. Blegoš, 150 m S of the top	Pasture meadow	X: 46.163187, Y: 14.112729; Alt.: 1509 m	X: 46.163685, Y: 14.115937; Alt.: 1498 m	330 m

The transect surveys were performed according to the Pollard walk method (Pollard 1977). In total, 14 surveys were conducted on all transects on the given dates: 27.5., 3.6., 10.6., 17.6., 26.6., 1.7., 7.7., 22.7., 30.7., 4.8., 13.8., 19.8., 28.8. and 8.9., all in 2018. The only exception is the transect No. 2 – Potok, where only 13 surveys were performed – the survey wasn't performed on 22.7.2018 due to bad weather conditions. After extensive surveys in 2018, additional visits were made on some of the localities near the transects in 2019 and 2020, to check for additional expected species. In 2019, one additional survey was performed on localities near transects Nos. 1, 3, 6 (all on 2.6.) and 4 (14.7.), while in 2020, one additional survey was performed on localities near transects Nos. 1, 2, 6 (all 13.4.) and 8 (20.7.), two additional surveys on localities near transects No. 5 and 7 (4.7. and 20.7.), and three additional surveys on locality near transect No. 4 (11.4., 4.7. and 20.7.). Unlike in 2018, the Pollard walks were not carried out in 2019 and 2020. During this research, no major floristic surveys were performed and only certain larval host plants are pointed out in this article.

The selected transects included four main different habitat types (pastures, intensive grasslands, extensive grasslands and forest clearings) at different altitudes, in order to cover as many different ecotypes as possible. Two transects/localities were selected for each habitat type. The individual butterflies were caught (if necessary) with a butterfly net and determined using Tolman & Lewington's (2008) butterfly guide.

Data analysis

We calculated a population density of each species for each transect separately. The population density of species is expressed as number of individuals per survey per 100 m of transect, and was adapted from Čelik & Verovnik (2020) with slight alterations:

$$Population\ density\ of\ species = (X * 100\ m)/(Y * Z) \quad (1)$$

Where X is the sum of all imagines of species observed in 2018 on a transects during all surveys, Y is the number of surveys performed on a transect (13 for locality »Potok«, and 14 for all other localities) and Z is the length of the transect in metres.

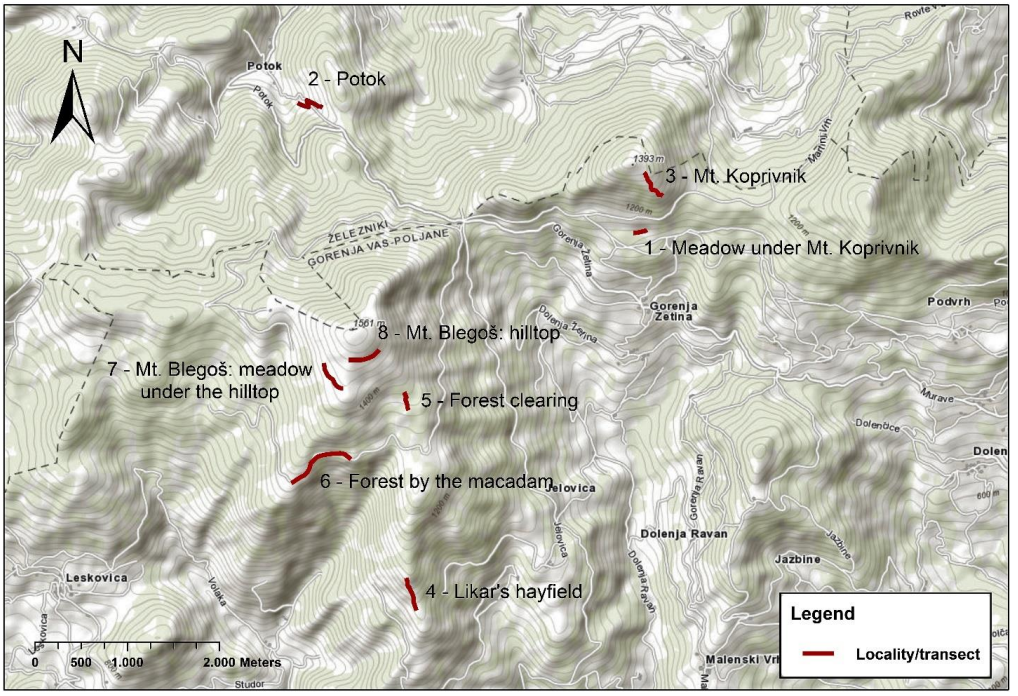

Figure 1. Position of transects for butterfly surveys on Mt. Blegoš and Mt. Koprivnik in Škofjeloško hribovje.
Slika 1. Mesta transektov za popise dnevnih metuljev na območju Blegoša in Koprivnika v Škofjeloškem hribovju.

Figure 2. Habitats of selected transects/localities on Mt. Blegoš, Mt. Koprivnik and their vicinity: A) Potok; B) Meadow under Mt. Koprivnik; C) Mt. Koprivnik; D) Mt. Blegoš: meadow under the hilltop; E) Mt. Blegoš: hilltop; F) Likar's hayfield; G) Forest clearing; H) Forest by the macadam (main part); I) Forest by the macadam (the part with rocky cliffs).

Slika 2. Življenjski prostori izbranih transektov/lokacij na Blegošu, Koprivniku in njuni okolici: A) Potok; B) Travnik pod Koprivnikom; C) Likarjeva senožet; D) Blegoš: travnik pod vrhom; E) Blegoš: vrh; F) Likarjeva senožet; G) Gozdna poseka; H) Gozd ob kolovozu (glavni del); I) Gozd ob kolovozu (del s skalnimi stenami).

Results

Altogether, 80 species and 5,012 specimens were observed between 27.5. and 8.9.2018. Among these, 1,050 specimens and 52 species were observed on pastures, 890 specimens and 53 species in intensive grasslands, 763 specimens and 53 species inside forest clearings, and 2,309 specimens and 65 species in extensive grasslands. The complete butterfly survey of Mt. Blegoš, Mt. Koprivnik and their surroundings, which also included additional location-specific surveys in 2019 and 2020, yielded altogether 85 species (Tab. 2). Of these, 9 species are listed as vulnerable, while two are considered endangered in either Slovenia or Europe (Tab. 2). Most of those species were found on more than one occasion and in more than one locality.

Table 2. Population densities of individual species per survey per 100 m of transect/locality in 2018, with the addition of species observed only in 2019 or 2020. Nomenclature follows Verovnik (2019). X – Species found only in the vicinity of the transect; Y – Species observed only in 2019 and/or in 2020, but not in 2018.

Tabela 2. Populacijska gostota posamezne vrste na vzorčenje na 100 m transekta v 2018, z dodatkom vrst, ki so bile najdene samo v letu 2019 ali 2020. Poimenovanje je povzeto po Verovnik (2019). X – Vrsta najdena samo v okolici transekta; Y – Vrsta opažena samo v letu 2019 in/ali 2020, ne pa tudi v letu 2018.

Family	Species\ Locality	1	2	3	4	5	6	7	8
Papilionidae	*Papilio machaon*	Y		0.05	0.17		X	X	0.02
	Iphiclides podalirius				Y				
	Parnassius mnemosyne	0.06	0.05	1.17	0.02	2.52	0.04	0.66	0.17
Pieridae	*Aporia crataegi*		0.05						
	Pieris brassicae	0.06	0.05	0.24	0.10	0.21	0.31	0.13	0.09
	Pieris rapae	0.12	0.10	0.07	0.12	0.08	0.29	0.16	0.09
	Pieris bryoniae						0.01	0.03	
	Pieris napi	0.24	0.72	0.83	0.55	0.88	0.65	0.21	0.06
	Anthocharis cardamines	X		X		0.08	0.09	0.03	
	Colias alfacariensis/hyale			0.02	X				0.02
	Colias crocea	0.71	0.05	0.05	0.24	0.08	0.09	0.42	0.39
	Gonepteryx rhamni		0.10	0.02	0.02	0.17	0.30	0.08	
	Leptidea sinapis/juvernica	1.49	0.41	1.07	0.10	0.04	0.09	0.05	
Lycaenidae	*Satyrium ilicis*				0.02				
	Satyrium spini				1.71		0.25		
	Callophrys rubi				0.02		Y	0.03	
	Lycaena phlaeas	Y				0.04			
	Lycaena virgaureae		0.10	0.07	0.05	0.04			
	Lycaena tityrus	0.48	0.21	0.12	0.02			0.08	0.02
	Lycaena alciphron	0.36	0.21	0.07					
	Lycaena hippothoe	2.74	0.10	0.26	0.02			0.40	0.09
	Celastrina argiolus			0.02		X	0.03	0.03	
	Cupido minimus	0.42	0.10	0.21	0.55	0.08	0.01	0.53	0.37
	Phengaris alcon							0.08	
	Phengaris arion				0.02		0.03	0.03	
	Plebejus argus	0.18		0.07	0.07			0.16	
	Aricia agestis	0.95		0.43	0.02	X		0.08	0.13
	Aricia artaxerxes	X		0.12	Y			0.03	0.06
	Cyaniris semiargus	0.48	0.72	0.38	0.02	0.04	0.03	0.66	0.89
	Lysandra bellargus	0.30		0.05	0.05			0.05	0.02
	Lysandra coridon	0.06	1.85	0.14	1.43	0.21	0.03	1.90	0.19
	Polyommatus dorylas	0.48			0.02			0.34	0.15
	Polyommatus icarus	0.83	0.21	0.07	0.12	0.04		1.30	0.19
Riodinidae	*Hamearis lucina*		0.21	0.10	0.05		0.01	0.03	0.06
Nymphalidae	*Apatura iris*					X			
	Limenitis populi					X			
	Limenitis reducta						0.03		
	Issoria lathonia			0.07	X	0.17	X	X	0.02
	Argynnis paphia		0.36	0.14	0.14	0.97	0.25	X	0.02
	Speyeria aglaja	0.18	0.31	0.43	0.02	0.13		0.21	0.09
	Fabriciana adippe			0.05	Y	0.08	0.03		
	Brenthis daphne		0.05	0.12	0.05	0.13	0.01		
	Boloria euphrosyne	Y	0.05	0.45	0.52	1.34	0.39	0.08	X
	Boloria dia	3.33	0.15	0.07	X	0.17			
	Aglais io	0.12	0.10	0.14	0.07	3.15	0.05	X	0.02
	Aglais urticae	X	0.10	0.07	0.14	0.08	0.10	0.21	0.63
	Polygonia c-album		0.10			X	0.01	0.03	

Family	Species\ Locality	1	2	3	4	5	6	7	8
	Nymphalis polychloros		X				0.01		
	Nymphalis antiopa		Y						
	Vanessa atalanta	X	0.15	0.02	0.05	0.21	0.08	X	0.02
	Vanessa cardui	0.12		0.07	0.26	0.04	0.05	0.13	0.04
	Melitaea cinxia	0.54	0.05	0.05				0.03	
	Melitaea phoebe		0.05	0.14	0.05			0.03	
	Melitaea diamina		0.10	0.36					
	Melitaea britomartis				Y				
	Melitaea didyma	1.55	X	0.02	0.05		0.01		
	Melitaea athalia	2.32	1.64	1.81	0.14	0.13	X	0.03	
	Euphydryas maturna			0.07	0.07				
	Euphydryas aurinia			0.02	0.36	0.29			
	Melanargia galathea	0.48	3.44	4.45	6.90	X	0.19	0.05	0.04
	Hipparchia fagi				X				
	Minois dryas				0.07				
	Brintesia circe	0.06	X	0.05	0.21	0.04	0.01		0.02
	Erebia ligea		0.15	0.50	0.05	0.08	0.05		
	Erebia aethiops		0.10		1.07	X	0.23		Y
	Erebia medusa	0.42	1.38	1.64	1.55	X	0.13	0.37	0.41
	Erebia stiria						0.43		
	Erebia euryale					Y			Y
	Maniola jurtina	1.96	3.64	0.52	0.24	0.13	0.06	0.05	0.02
	Coenonympha pamphilus	4.46	0.10	0.31	0.12	0.04		1.14	0.15
	Coenonympha arcania	0.06	2.41	2.19	11.67	0.04	0.33	0.05	0.02
	Pararge aegeria					X	Y		
	Lasiommata megera				0.14		0.01		
	Lasiommata maera		0.10	0.33	0.43	0.04	0.64	0.08	0.04
	Lasiommata petropolitana						Y		
	Lopinga achine		0.15		0.02		0.03		
Hesperiidae	*Pyrgus malvae*	0.18	0.15	0.17	0.10	Y		0.21	0.02
	Pyrgus alveus					0.04		0.03	0.02
	Erynnis tages	0.12	0.05	0.07	0.02	0.08	0.03	0.71	0.11
	Carterocephalus palaemon		0.21	0.36					
	Heteropterus morpheus				X				
	Thymelicus lineola	0.60		0.02				0.03	
	Thymelicus sylvestris	X	0.31	0.33	Y	0.08			
	Hesperia comma	0.60	0.62	0.14	0.14	0.46	0.01	8.28	2.12
	Ochlodes sylvanus	X	1.08	3.00	0.93	0.13	0.41	0.16	
Number of species	**85**	**43**	**49**	**57**	**63**	**49**	**48**	**50**	**39**

It is worth noting that the detailed data on exact dates of finding the species and their abundances were not included, due to the sheer amount of obtained information (eight tables were merged in one), but are available on request from the authors of the paper.

Table 3. Conservation status of butterfly species observed on Mt. Blegoš, Mt. Koprivnik and their surroundings in Slovenian and in European context. The European conservation status of butterfly species is based on van Swaay et al. (2010), while the Slovenian conservation status is based on rules on the classification of endangered plant and animal species in the Red List (Ur. l. RS 2002). LC – least concern species, NT – near threatened species, VU – vulnerable species, EN – endangered species.
Tabela 3. Varstveni status ogroženih vrst metuljev, najdenih na Blegošu, Koprivniku in v njuni okolici v Sloveniji in Evropi. Status ogroženosti v Evropi bazira na van Swaay et al. (2010), medtem ko varstveni status v Sloveniji bazira na pravilniku o uvrstitvi ogroženih rastlinskih in živalskih vrst v rdeči seznam (Ur. l. RS 2002). LC – vrsta zunaj nevarnosti, NT – vrsta blizu ogroženosti, VU – ranljiva vrsta, EN – prizadeta vrsta.

Family	Species	Conservation status in Slovenia	Conservation status in Europe	Inclusion into the Decree on protected wild animal species (UR. l. RS 2004b)
Papilionidae	*Parnassius mnemosyne*	VU	NT	Appendices 1, 2
Lycaenidae	*Lycaena alciphron*	VU	LC	Not included
	Lycaena hippothoe	VU	LC	Not included
	Phengaris alcon	EN	LC	Appendices 1, 2
	Phengaris arion	VU	EN	Appendices 1, 2
Nymphalidae	*Melitaea diamina*	VU	LC	Not included
	Melitaea britomartis	VU	NT	Not included
	Euphydryas maturna	VU	VU	Appendices 1, 2
	Euphydryas aurinia	VU	LC	Appendices 1, 2
	Lopinga achine	LC	VU	Appendices 1, 2
Hesperiidae	*Pyrgus alveus*	VU	LC	Not included

Table 4. Comparison of all eight transects and the number of butterflies/species found during 2018 surveys.
Tabela 4. Primerjava vseh osmih transektov in števila metuljev/vrst, popisanih v letu 2018.

Transect/locality (No.)	Habitat type	No. species on wider locality	No. species on transect	Transect length [m]
1 - Meadow under Mt. Koprivnik	intensive grassland	40	34	120
2 - Potok	intensive grassland	48	45	150
3 - Mt. Koprivnik	extensive grassland	57	56	300
4 - Likar's hayfield	extensive grassland	58	53	300
5 - Forest clearing	forest clearing	47	38	170
6 - Forest by the macadam	forest clearing	45	42	570
7 - Mt. Blegoš: meadow under the hilltop	pasture	50	45	270
8 - Mt. Blegoš: hilltop	pasture	37	36	330

Discussion

Until now, the butterfly fauna of Mt. Blegoš and Mt. Koprivnik has been relatively poorly studied, as the latest records date back more than 15 (Withrington 2003) or more than 40 years (Carnelutti 1980). The relatively high number of species recorded in the surveyed area, compared to similar areas such as Šentvid plateau (Torkar et al. 2013) or Cerkljansko-Idrijsko region (Verovnik 2000), could be explained by sampling during the main adult butterfly season in eight different localities, coupled with sampling during the period of 3 years, as well as the influence of different climates. Compared to previously mentioned surveys (Verovnik 2000, Torkar et al. 2013), almost 10 % more species have been observed around Mt. Blegoš and Mt. Koprivnik. As Mt. Blegoš with its 1,562 m is considered a low mountain, many species found here are typical of higher altitudes (above 1,000 m). These are: *Pyrgus alveus*, *Phengaris alcon* f. *rebeli*, *Lasiommata petropolitana*, *Pieris bryoniae*, *Aricia artaxerxes*, *Erebia stiria* and *Erebia euryale* (Verovnik et al. 2012).

Among the species mentioned, *P. bryoniae*, *P. alveus*, *A. artaxerxes* and *P. alcon* f. *rebeli* are occasionally also found in the lowland areas (Verovnik et al. 2012). *E. stiria* and *L. petropolitana* are more petrophilous and were observed on cliffs along a macadam road below Mt. Blegoš (Fig. 2 - I). The latter species was already mentioned for Mt. Blegoš by Withrington (2003), but without precise location. *P. alcon* f. *rebeli* was first recorded in 2018, but only a single imago was observed on the transect, and not more than 3 were seen in the locality altogether. However, in July 2020, at least 5 imagines were present, giving hope that this tiny population might still survive. On the other hand, a related species, *Phengaris arion*, was found in three localities, two of those situated at lower altitudes. The species is localised but widespread in the wider region, including the village of Trebija (Verovnik et al. 2012), Slajka Hill, Makovce plateau, and Jelovica below Mt. Blegoš (own observations in 2020).

Among other observed butterflies, *Euphydryas* species were most common in extensive meadows, but are present also in wider area of Škofjeloško hribovje (Verovnik et al. 2012). The species *E. euryale* and *Erebia ligea* were found only on few occasions during the 2018 surveys, but were very common in 2017 and 2019 (own observations). Biennial development, resulting in much higher adult numbers in alternate years, is a common feature of this genus (Warren 1936, Kleckova et al. 2015). The low abundance of both species in 2018 could be attributed to constant rainy afternoons that dominated during flight period and to the lack of suitable nectar sources.

When compared to the nearby Cerkljansko-Idrijsko region and particularly its highest peak Mt. Porezen (1630 m), the butterfly fauna of Mt. Blegoš and Mt. Koprivnik is surprisingly richer, also containing more species characteristic of altitudes above 1,000 m (Verovnik 2000). This is especially evident even when comparing the number of species for the relatively close survey dates of 27.7.–2.8. for Mt. Porezen (4 localities) and 30.7. for Mt. Blegoš and Mt. Koprivnik (8 localities). The number of species found on these dates on Mt. Blegoš and Mt. Koprivnik reaches 42, while the number of species found on Mt. Porezen was only 24. This might be partially explained by the non-carboniferous soil dominating Mt. Porezen, and different climate surrounding the mountains. In terms of species characteristic for altitudes above 1,000 m, only *Erebia pronoe*, which is still common around the peak of Mt. Porezen, was not recorded on

Mt. Blegoš. Interestingly, there is a specimen of *E. pronoe* collected by Mate Hafner in 1911 in the collection of Slovenia NHM (Verovnik et al. 2012) from Mt. Blegoš, a record neglected in the overview by Carnelutti (1980).

Since the latest records of biodiversity in 1980, agricultural activities became more intensive. Yet, while predominantly lowland habitats are mostly machined and fertilized, many habitats at higher altitudes are in the final overgrowth phase due to isolated intensive grazing (sheep, goats and cattle) and abandonment of mowing (Ilešič 1938). The most obvious is the overgrowing of the higher meadows of Mt. Koprivnik, where mowing or grazing is completely absent. Only the meadows by the macadam road leading to Črni Kal below Mt. Koprivnik are intensively mown. On the other hand, the intensification of agriculture impacted the grazing activity in the highest meadows of Mt. Blegoš. Due to isolated grazing with cattle, some larval food or host plants, such as *Gentiana cruciata* and once common *Arnica montana*, are being diminished in number. Lower meadows are sparse and occur mainly in very steep and exposed areas, such as »Forest by the macadam« and »Likar's hayfield« transects. The latter presents the largest meadow area, where overgrowing is less problematic for the time being. Thus, habitat loss, due to rapid overgrowing and intensive grazing, is the greatest danger to the biodiversity of local butterflies. Some butterflies, like *Parnassius apollo*, have already disappeared presumably owing to this very reason.

Based on the uniqueness of the habitat and the diversity of butterflies found we defined 4 nature conservation important localities for butterflies in the region, based on the surveyed transect routes: »Mt. Koprivnik«, »Likar's hayfield«, »Forest by the macadam« and »Mt. Blegoš: meadow under the hilltop«.

Transects »Mt. Koprivnik« and »Likar's Hayfield« are the two most important sites with extensive meadows. Unfortunately, both localities, especially meadows of »Mt. Koprivnik«, are subject to overgrowing. Meadows of »Likar's hayfield« are especially characterised by the minor sub-Mediterranean influence as indicated by the presence of thermophilous species such as *Satyrium spini*, *Lysandra coridon*, *Minois dryas*, and *Hipparchia fagi*. The area consists of south-facing dry bushy grasslands, where in addition *Libelloides macaronius* is abundant, despite not being reported for the Škofjeloško hribovje (Devetak et. al. 2007). However, the find is not surprising, as it was also recently discovered in NW Slovenia on the Šentvid plateau (Torkar 2021). Both »Mt. Koprivnik« and »Likar's Hayfield« have the highest number of species recorded and are important for both – unique fauna and flora.

The »Forest by the macadam« represents the longest and most heterogeneous transect, consisting mainly of forest clearings, which is in the centre characterised by approximately 50 m of rocky cliffs. This unique habitat for the region hosts the two petrophilous species *L. petropolitana* and *E. stiria*. Despite not being listed as threatened in Slovenia or wider, their isolated occurrence on Mt. Blegoš is still of conservation importance.

The last among the important transects is »Mt. Blegoš: meadow under the hilltop«, which represents the largest open pasture partially intensively grazed by cattle. The impact of intensive grazing is manifested by trampled ground and low herbal height. The steeper rockier parts to the northeast of Mt. Blegoš peak are now mostly overgrown by trees. The locality is of particular conservation importance due to the presence of a small colony of *P. alcon* f. *rebeli* and its host plant *G. cruciata*.

From the conservation point of view, the presence of both *Euphydryas* species, *Parnassius mnemosyne*, *Lopinga achine* and *P. arion*, all included in the Annexes II and/or IV of the Habitats Directive, (OJ EC 1992) is of great importance. Their presence merits further investigations into their population size, distribution, threats and could provide foundations for long term conservation of their habitats and butterfly richness as a whole in both studied mountains.

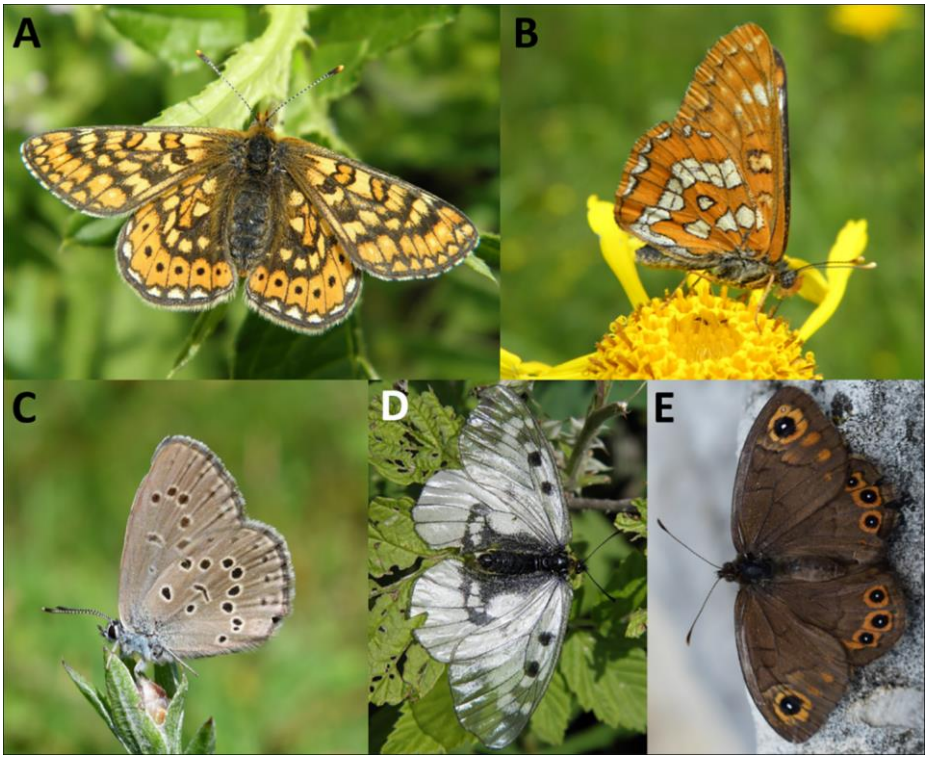

Figure 3. Selection of butterfly species of conservation concern found on Mt. Blegoš, Mt. Koprivnik and their surroundings: A – *Euphydryas aurinia* (Mt. Koprivnik, 3.6.2018); B – *Euphydryas maturna* (Likar's hayfield, 10.6.2018); C – *Phengaris alcon f. rebeli* (Mt. Blegoš: meadow under the hilltop, 20.7.2020); D – *Parnassius mnemosyne* (Mt. Koprivnik, 4.7.2017); E – *Lasiommata petropolitana* (Forest by the macadam, 2.6.2019)

Slika 3. Nekatere izmed naravovarstveno pomembnih vrst dnevnih metuljev, najdenih na Blegošu, Koprivniku in v njuni okolici: A – *Euphydryas aurinia* (Koprivnik, 3.6.2018); B – *Euphydryas maturna* (Likarjeva senožet, 10.6.2018); C – *Phengaris alcon f. rebeli* (Blegoš: travnik pod vrhom, 20.7.2020); D – *Parnassius mnemosyne* (Koprivnik, 4.7.2017); E – *Lasiommata petropolitana* (Gozd ob kolovozu, 2.6.2019)

Conclusions

The complete butterfly survey of Mt. Blegoš, Mt. Koprivnik and their surroundings, which took place between 27.5. and 8.9.2018 and included additional location-specific surveys in 2019 and 2020, yielded altogether 85 species, which amounts to 47 % of the butterfly fauna of Slovenia (Verovnik 2019). Among the surveyed species, 11 are defined as vulnerable or endangered in Slovenia or Europe (Ur. 1. RS 2002, Van Swaay et al. 2010).

The most interesting find is *P. alcon* f. *rebeli*, observed only in the high-lying pastures of Mt. Blegoš, not mentioned in the previous surveys. Abandonment of extensive farming, overgrowing of habitats and intensive grazing are the most likely causes for the absence of *Boloria pales*. The localities were also monitored for the presence of *Sedum album*, a larval food plant for the locally already extinct butterfly *P. apollo* (Carnelutti 1980), but unfortunately the plant has never been found.

The authors conclude that Mt. Blegoš and its wider surroundings are an important and biodiversity rich area worth preserving, and that its inclusion in the Natura 2000 conservation network is well deserved. The study also reveals some of the problems with the habitat loss which might arise in the future, due to the abandonment of mowing and grazing in certain areas. In order to preserve such habitats, the old farming practices should be re-implemented, wherever possible.

Povzetek

V članku predstavljamo popise favne dnevnih metuljev Blegoša in Koprivnika z njuno okolico, ki so potekali med 27. majem in 8. septembrom 2018 na 8 izbranih transektih. Med 14 popisi nam je uspelo zabeležiti 80 vrst dnevnih metuljev in njihovo število na posamezni popisni lokaciji/transektu. Med dodatnimi popisi v letih 2019 in 2020 smo opazili še 5 novih vrst metuljev, ki jih predhodno na teh lokacijah nismo našli. Vzorčenje je potekalo po principu metode transektnega monitoringa, kjer opazovalec počasi hodi po vnaprej začrtani poti in šteje metulje v vse smeri 2,5 m okoli sebe (levo, desno, spredaj in zgoraj) (Pollard 1977). Posamezne transekte, vključene v raziskavo, smo zbrali na podlagi nadmorske višine, dostopnosti in tipa habitata. Izmed zabeleženih metuljev zbujajo največ pozornosti *Parnassius mnemosyne*, *Lycaena hippothoe*, *Euphydryas maturna*, *Euphydryas aurinia*, *Melitaea britomartis*, *Melitaea diamina* in *Pyrgus alveus*, ki jih uvrščamo med ranljive vrste, medtem ko sta *Phengaris arion* in *Phengaris alcon* klasificirana kot ogroženi vrsti za Slovenijo. Medtem ko je bil *P. arion* najden na več kot eni lokaciji, je bil *P. alcon* zabeležen zgolj med dvema popisoma julija 2018 in 2020 na enem samem transektu. Njegova jajčeca smo leta 2018 našli tudi na rastlini *Gentiana cruciata* na isti lokaciji, a so bile do naslednjega popisa v juliju vse rastline že popasene. Med popisom smo posebno pozornost posvečali tudi vrstam, ki jih najdemo v visokogorju oz. na višjih nadmorskih višinah (nad 1000 m). Čeprav dveh vrst, ki smo ju tu beležili še pred nekaj desetletji, nismo našli (*Parnassius apollo*, *Boloria pales*) (Carnelutti 1980), so bile nekatere druge, kot so *Aricia artaxerxes*, *Pyrgus* alveus, *Erebia stiria* in *Lasiommata petropolitana*, najdene med popisi, zadnji dve vrsti zgolj na eni sami lokaciji. Slednja lokacija je bila tudi edina s strmejšim skalnatim previsom, kakršne je na Blegošu sicer že večinoma prerasel gozd. Posledično pričakujemo, da sta *E. stiria* in *L. petropolitana* tu redki vrsti, ki bi že v prihodnosti lahko dokončno izginili. Med popisom smo iskali tudi rastlino *Sedum album*, hranilno rastlino lokalno že izginulega metulja *Parnassius apollo*, vendar neuspešno. Izginitev hranilne rastline tega metulja gre pripisati zaraščanju skalnatih predelov Blegoša, kar je verjetno povezano tudi z izginitvijo še ene visokogorske vrste *Boloria pales*. V tem članku smo zato poudarili prav problem

izgube pomembnih habitatov v regiji zaradi zaraščanja in negativnega vpliva prekomerne paše. Na območju Koprivnika in določenih delih Blegoša je pašna aktivnost namreč opuščena, kar se kaže v zaraščanju ekstenzivnih suhih travišč, po drugi strani pa se na drugih predelih Blegoša pojavlja problem intenzivne paše z govedom, ki ogroža predvsem travniške vrste na vrhu in tik pod njim. V članku smo ocenili še pomembnost posameznih transektov kot tudi celotnega območja pri vključitvi v Naturo 2000.

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Discovery of the second nursery roost of the barbastelle bat *Barbastella barbastellus* (Schreber, 1774) in Slovenia

Odkritje drugega kotišča širokouhega netopirja *Barbastella barbastellus* (Schreber, 1774) v Sloveniji

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The (western) barbastelle bat *Barbastella barbastellus* (Schreber, 1774) is a Western Palaearctic bat species, commonly associated with forested or otherwise vegetated habitats. Its main summer roosts are trees openings, such as wood crevices and loose bark (Russo et al. 2004, Dietz & Kiefer 2014). Additionally, *B. barbastellus* can also be found utilising bat-boxes and buildings, where it shelters behind external woody structures (Dietz & Kiefer 2014). During the winter, the species hibernates in trees, caves and other underground or rocky structures. It can be commonly found at entrance parts of caves, since it is highly tolerant to colder temperatures (Dietz & Kiefer 2014). *B. barbastellus* is under increased pressure and therefore classified as vulnerable on the European Red List of Threatened Species (Hutson et al. 2007). In Slovenia, the species is considered a widespread inhabitant of forested areas. Although it can often be encountered when surveying forest waters or cave entrances during swarming or hibernation (Petrinjak 2007, 2009, Gojznikar & Zidar 2020; own observations), *B. barbastellus* nurseries remain virtually unknown. So far, only one legitimate finding of a nursery roost for the species was recorded. Kryštufek (1997) reported on a maternity group, comprising 15 individuals, from Pogorelec forest cottage on the plateau of Kočevski Rog in the south-eastern part of the country. Since then, no other nursery roost has been found and, additionally, the abovementioned group has not been reobserved (Petrinjak 2009). Other sporadic findings of *B. barbastellus* roosts do exist, although they occur as single individuals and usually only temporary (Petrinjak 2007).

During our roost survey carried out on 9. 8. 2021 in the Church of St. Janez Krstnik at Gornja Lokvica near Metlika in Bela krajina, the family of the church key keeper alerted us to the presence of bats at their home. We visited their house (Gornja Lokvica 5a; lat. 45.6696, long. 15.2826, 255 m. a. s. l.) and noted medium-sized bat guano accumulated on the floor below wooden cladding, which extended from the roof onto the façade, about 0.5 metres in length. Upon closer inspection, we noticed that there was a noticeable gap between the cladding and the wall, which was inhabited by bats. These turned out to be *B. barbastellus*. Most individuals (at least 11) were grouped behind the cladding on the north-western side of the house (Fig. 1), while a

Figure 1. Group of *Barbastella barbastellus* found under wooden cladding on the north-western side of the house (photo: Jan Gojznikar).
Slika 1. Skupina *Barbastella barbastellus*, najdena pod lesenim opažem na severozahodni strani hiše (foto: Jan Gojznikar).

single individual was hiding beneath the cladding above the balcony on the north-eastern side of the house. The owners highlighted that bats appeared to be present throughout the year, regularly switching their positions on various sides of the house.

We caught two females using a hand net: a juvenile and an adult (Fig. 2). The caught females were measured using a calliper and weighted with a spring scale, with reproductive status and age being assessed using Haarsma's (2008) manual. The measurements are given in Tab. 1.

Figure 2. The captured *Barbastella barbastellus* females (photo: Jan Gojznikar).
Slika 2. Ujeti samici *Barbastella barbastellus* (foto: Jan Gojznikar).

The positioning of the roost in the middle of a rural settlement might seem interesting, since *B. barbastellus* mainly forages in forests. However, it can also use riparian and other vegetation belts (Zeale et al. 2012, Dietz & Kiefer 2014). Indeed, the local landscape contained various hedgerows, orchards, and other smaller tree patches in the immediate vicinity. Additionally, the first smaller forest patch was 200–250 metres away, with two larger forested areas located approximately 600 metres to the west and 700 metres to the east, offering a potentially suitable foraging habitat nearby. According to Zeale et al. (2012; see also Dietz & Kiefer 2014), *B. barbastellus* females can travel several kilometres to their foraging areas.

To our knowledge, this is only the second time a nursery roost of *B. barbastellus* was found in Slovenia and the first after more than 20 years. What makes our find additionally interesting is, however, that the species used a residential building with permanent human residence. The owners also told us that bats seem to be present throughout the summer (albeit under claddings on different sides of the house) and had occupied the building for several years. *B. barbastellus* is otherwise known to be prone to switching roost sites (e. g. Russo et al. 2005). Our finding also highlights the importance of good conservational consultancy. The residents of the house were not overimpressed with bat presence but took some interest in the fact that they host this endangered bat species. Nonetheless, this newly discovered nursery of *B. barbastellus* is under threat from possible future renovations.

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Table 1. Measurements of the two *Barbastella barbastellus* females, caught at Gornja Lokvica 5a on 9. 8. 2021. Abbreviation: AB – forearm length.
Tabela 1. Meritve dveh samic *Barbastella barbastellus*, ujetih v Gornji Lokvici 5a dne 9. 8. 2021. Okrajšava: AB – dolžina podlakti.

Sex	Age	AB (mm)	Mass (g)	Reproductive status
female	adult	40.1	9.0	parous
female	juvenile	38.3	9.0	/

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Lucas S. (1988a): Spiders in Brasil. Toxicon 26: 759-766.
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