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Macroinvertebrate communities of karst springs in the Julian Alps in relation to environmental factors

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Abstract. Karst springs in the Julian Alps were investigated from May to September 1999 to examine the influence of physical and chemical characteristics on macroinvertebrate community composition. The study revealed a great heterogeneity of environmental characteristics and highly variable taxonomic composition and abundance of taxa among individual springs. The results of canonical correspondence analysis (CCA) showed that spring altitude and periphyton coverage were the only environmental parameters significantly influencing the macroinvertebrate community composition.

Key words: macroinvertebrates, karst springs, Julian Alps, spring ecology

Izvleček. VPLIV OKOLJSKIH DEJAVNIKOV NA ZDRUŽBE VELIKIH VODNIH NEVRETENČARJEV V KRAŠKIH IZVIRIH V JULIJSKIH ALPAH - Preučevali smo združbe velikih vodnih nevretenčarjev v 16 kraških izvirih na območju Julijskih Alp v povezavi z fizikalnimi in kemijskimi lastnostmi izvirskih habitatov v obdobju od maja do septembra 1999. Primerjava okoljskih dejavnikov in združb med posameznimi izviri je pokazala velike razlike tako v fizikalnih in kemijskih značilnostih kot v sestavi združb med posameznimi izviri. Rezultati kanonične korelacijske analize (CCA) kažejo, da sta edino nadmorska višina in pokritost substrata s perifitonom značilno vplivala na sestavo izvirskih združb.

Ključne besede: veliki vodni nevretenčarji, kraški izviri, Julijske Alpe, ekologija izvirov

Introduction

Springs, compared to headwater streams of comparable size, have reduced annual and diurnal fluctuations in water temperature (Mc Cabe 1998). The mean water temperature is nearly equal to the mean annual temperature for the area (van der Kamp 1995). Spring communities demonstrate the majority of structural and functional properties seen in other lotic communities, yet they are significantly less complex (Williams & Williams 1998).

Discharge and substrate particle size has been found as factor controlling spring communities (Bonettini & Cantonati 1996). Other studies showed correlation between spring macroinvertebrate communities and pH (Glazier 1991), alkalinity and macrophyte cover (Glazier & Gooch 1987). Recently, Smith et al. (2003) demonstrated that the flow permanence has a dominant control over community composition. However, some studies found no correlation between single environmental parameters and the spring community structure (Lindegaard et al. 1998).

The aim of our study was to define environmental factors controlling the macroinvertebrate communities of 16 karst springs in the Julian Alps, Slovenia.

Study area

The springs examined were located within the Soča and Sava catchments at the foothills of the eastern part of the Julian Alps (NW Slovenia) (Fig. 1). The climate of the region is mountainous, with a mean annual temperature of 8°C and annual rainfall from 1600 to 3000 mm per year (Ogrin 1998). Mainly Triassic limestone underlies the area. The springs were situated along deep narrow Alpine valleys at altitudes from 410 to 955 m. Most of the springs were rheocrenes, only Kropa was limnocrene and Tresli hygropetric rheocrene. Nine springs were perennial, two were intermittent and in five of them the emergence of groundwater fluctuated up or down in the channel depending on local precipitation and groundwater levels (linear springs).

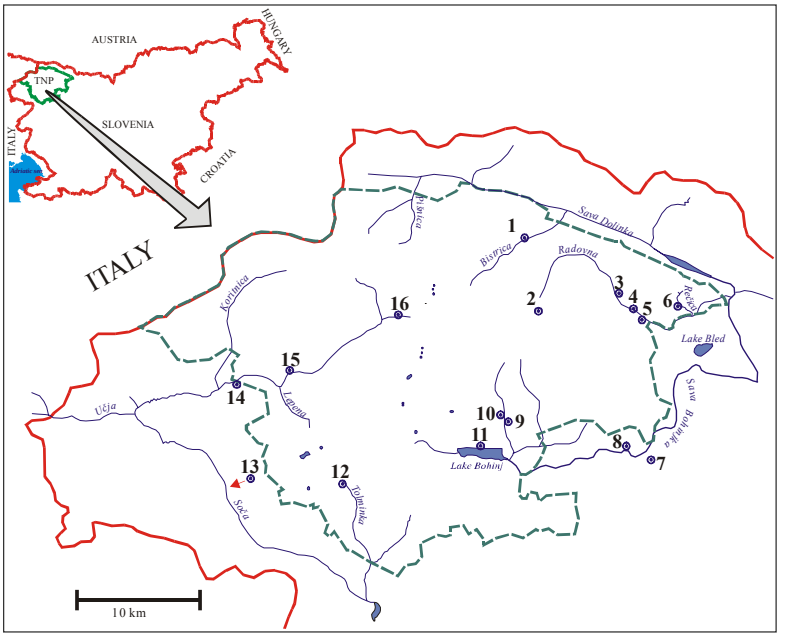

Figure 1. Map of the eastern part of the Julian Alps, indicating the location of sampling sites (1= spring in the Vrata valley, 2 = Krma, 3 = Frčkov rovt, 4 = Zatrep, 5 = Lipnik, 6 = Črna rečica, 7 = spring in Soteska, 8 = Nomenj, 9 = Kropa, 10 = Voje, 11 = spring at Lake Bohinj, 12 = Tolminka, 13 = Tresli, 14 = Kršovec, 15 = Roja, 16 = Krajcarica).
Slika 1. Zemljevid Julijskih Alp z označenimi vzorčnimi mesti (1 = izvir v dolini Vrat, 2 = Krma, 3 = Frčkov rovt, 4 = Zatrep, 5 = Lipnik, 6 = Črna rečica, 7 = izvir v Soteski, 8 = Nomenj, 9 = Kropa, 10 = Voje, 11 = izvir pri Bohinjskem jezeru, 12 = Tolminka, 13 = Tresli, 14 = Kršovec, 15 = Roja, 16 = Krajcarica).

Material and methods

The sampling of spring fauna was conducted in May, July and September 1999. Physical characteristics of the springs were noted on the spot (spring type, flow permanence, flow rate, substrate, periphyton, moss and organic matter cover) and temperature was measured. Water samples were collected at each spring-source, and analysed in the laboratory for pH, conductivity (μScm^{-1}), alkalinity (μeql^{-1}) and nitrate (mgl^{-1}) following standard methods (APHA 1998).

Aquatic macroinvertebrates were collected from each spring using a hand net (mesh size 100 µm) and standardised kicking technique (APHA 1998). Samples were preserved in 4 % formaldehyde solution. In the laboratory, organisms were identified to the lowest taxonomic

level possible by means of identification keys (Bole 1969, Karaman & Pinkster 1977, Rivosecchi 1984, Graf & Waringer 1997, Studeman et al. 1992). Since many of the organisms belonged to taxonomically difficult groups and many of them were immature, taxonomic units used were mostly above the species level.

To examine differences between the macroinvertebrate communities of the springs, the Shannon-Wiener diversity index and Pielou's evenness index were calculated. Bray-Curtis index of similarity was calculated to compare degree of resemblance among springs. Canonical correspondence analysis (CCA) was used to correlate community data to environmental variables. Data on taxa abundance were transformed by natural logarithms ln(x + 1) to down weight high abundant taxa. Significance of environmental variables in CCA was tested by Monte Carlo permutation test (999 permutations) in forward selection of variables. CCA was run by CANOCO 4.5 program (ter Braak & Smilauer 2002).

Results

The mean temperatures of the 15 spring sources were between 5.6 and 8.7 ºC, but the temperature of spring not shadowed by forest vegetation (Tresli) was 15.2 ºC (Tab. 1). Mean flow rates were higher than 0.3 ms^{-1} in four springs (Zatrep, Lipnik, Črna rečica, Roja) and lower than 0.1 ms^{-1} in Krma, Frčkov rovt, Tresli and Kršovec springs. Substrate composition varied between springs, but boulders and cobbles prevailed in most of the springs studied. Mean pH varied by 0.3 (range 7.7-8.0), mean conductivity by 205 μScm^{-1} (range 200-405 μScm^{-1}), mean alkalinity by 1887 μeql^{-1} (range 1633-3520 μeql^{-1}) and mean nitrates by 4 mgl^{-1} (range 0.4-4.4 mgl^{-1}).

During the study period, a total of 72 taxa were recorded from the 16 springs (Tab. 2). *Protonemura* sp. (Plecoptera), Chironomidae (Diptera), *Gammarus* cf. *fossarum* (Amphipoda), Limnephilidae (Trichoptera) and Tricladida (Turbellaria) were the most abundant taxa. The most widespread taxa, collected from the majority of sampling sites were Chironomidae, Nematoda, Limnephilidae, Enchytraeidae (Oligochaeta), Tricladida and *Belgrandiella kuesteri* (Gastropoda).

Table 1. Environmental parameters in 16 karst springs in the Julian Alps. Spring type: R = rheocrene; L = limnocrene; HR = hygropetric rheocrene. Flow permanence: 0 = intermittent; 1 = linear; 2 = perennial. Flow rate: 1 = < 0.1 ms^{-1}; 2 = 0.1-0.3 ms^{-1}; 3 = 0.3-0.55 ms^{-1}; 4 = > 0.6 ms^{-1}. Organic matter, periphyton, moss coverage: 1= < 10 %; 2 = 10-50 %; 3 = > 50 %.
Tabela 1. Okoljski dejavniki v 16 kraških izvirih v Julijskih Alpah. Vrsta izvira: R = reokren; L = limnokren; HR = higropetrični reokren. Stalnost pretoka: 0 = občasen; 1 = spreminjajoč; 2 = stalen. Hitrost toka: 1= < 0.1 ms^{-1}; 2 = 0.1-0.3 ms^{-1}; 3 = 0.3-0.55 ms^{-1}; 4 = > 0.6 ms^{-1}. Pokritost z organskim drobirjem, perifitonom in mahovi: 1 = < 10 %; 2 = 10-50 %; 3 = > 50 %.

	Vrata	**Krma**	**Frčkov rovt**	**Zatrep**	**Lipnik**	**Črna rečica**	**Soteska**	**Nomenj**	**Kropa**	**Voje**	**at the lake**	**Tolminka**	**Tresli**	**Kršovec**	**Roja**	**Krajcarica**
altitude (m)	730	955	690	660	650	650	550	620	700	685	530	690	620	410	480	720
spring type	R	R	R	R	R	R	R	R	L	R	R	R	HR	R	R	R
mean temperature	5.8	6.4	8.7	6.4	6.9	7.7	6.6	8.4	6.9	6.8	8.2	5.7	15.2	7.9	6.3	5.6
flow permanence	2	1	1	0	2	1	1	2	2	2	2	2	2	0	2	1
mean flow rate	2	1	1	4	4	3	2	2	2	2	2	2	1	1	4	2
substrate (%)																
boulders and cobbles	0.4	0.8	0.6	0.1	0.8	0	0.7	0	0.8	0.1	0	0.4	0.2	0.9	0.6	0.1
pebbles and gravel	0.6	0	0.3	0.8	0.1	0.6	0.2	0.1	0.2	0.1	0.6	0	0.4	0.1	0.4	0.3
sand and silt	0	0.2	0.1	0.1	0.1	0.4	0.1	0.1	0	0.1	0.4	0.3	0	0	0	0.3
organic matter	3	3	3	2	1	2	2	3	3	2	2	1	1	1	1	2
mean pH	8	7.9	7.8	7.7	7.8	7.8	7.9	7.9	7.7	7.9	7.8	8	8	7.9	7.9	8
conductivity (μScm^{-1})	228	256	363	276	316	363	285	331	330	226	292	203	405	257	200	210
alkalinity (μeql^{-1})	1796	2112	2964	2314	2536	2933	2286	2816	2738	2044	2428	1633	3520	2094	1644	1667
nitrate (mgl^{-1})	1.4	2.0	3.0	1.4	1.9	1.8	4.4	2.1	1.9	1.2	1.4	2.6	0.4	2.6	2.2	1.7
periphyton	2	1	2	2	1	2	2	1	3	1	1	1	1	1	1	1
moss	2	1	2	3	1	1	1	1	1	2	1	1	1	3	1	3

Table 2. Aggregated macroinvertebrate data indicating presence or absence and abundance for the 16 springs. Key to abundance: R = rare (1-10 individuals); O = occasional (11-30 individuals); C = common (31-100 individuals); A = abundant (> 100 individuals).
Tabela 2. Podatki o prisotnosti, odsotnosti in abundanci makroinvertebratov v 16 izvirih. Razlaga: R = redek; O = občasen; C = pogost; A = množičen.

Taxa	**Vrata**	**Krma**	**Frčkov rovt**	**Zatrep**	**Lipnik**	**Črna rečica**	**Soteska**	**Nomenj**	**Kropa**	**Voje**	**at the lake**	**Tolminka**	**Tresli**	**Kršovec**	**Roja**	**Krajcarica**
TURBELLARIA																
Tricladida	C		C		C	C	R		A	O	R		O	R		C
Polycelis sp.								A			A					
NEMATODA	R	R	R	R	R	R	R	O	C	R		R		R	R	R

Taxa	**Vrata**	**Krma**	**Frčkov rovt**	**Zatrep**	**Lipnik**	**Črna rečica**	**Soteska**	**Nomenj**	**Kropa**	**Voje**	**at the lake**	**Tolminka**	**Tresli**	**Kršovec**	**Roja**	**Krajcarica**
GASTROPODA																
Ancylus fluviatilis									R							
Belgrandiella kuesteri	R				C	R	R	O	R	R	C	O		O		
Belgrandiella fontinalis								C		O	C		O			
Bythinella schmidti	R		C		O	R		R	A	R						
Iglica hauffeni							R									
Lymnaea truncatulla			R										R			
OLIGOCHAETA																
Enchytraeidae			C	A	R	R		O		O	R	R		R	O	C
Lumbriculidae	O		O			R	R		C		R	R				
Eiseniella tetraedra	R		R												R	
Naididae	R		C						R	R						
AMPHIPODA																
Gammarus cf. fossarum	C				A	C	R	A			C					
Niphargus sp.			R				0					R			R	C
Niphargus gr. *kochianus*			O		R											
Niphargus gr. *longidactylus*						R										
Niphargus gr. *stygius*			R			R			R	R				R	R	
ISOPODA																
Proasselus deminutus agg.					R			R								
ACARINA																
Hydracarina					R								R			
PLECOPTERA																
Chloroperlidae	R															
Leuctra sp.			C		C	R			C	O						
Leuctra nigra	R									R						
Nemouridae		O	O		O								R			R
Nemoura sp.		C			R	R			R		R		R			R
Nemoura cf. *marginata*		R														
Protonemura sp.	R		O		O	A	R	C	O	C	A					
Perlodidae						C			C							
Dyctiogenus sp.	R		R						O							
Dyctiogenus cf. *alpinus*															R	
Isoperla sp.					R										R	
Perlodes sp.									R							
Brachyptera sp.				O	C	O			R							
Brachyptera risi														R		
TRICHOPTERA																
Lithax niger								R								
Limnephilidae	R		O	R	R	C	A	O	A	O	R	R				C
Allogamus uncatus		R														
Drusus sp.	R								O							
Drusus chrysotus										R						
Potamophylax sp.			R					R	R				O			
Potamophylax nigricornis	R															
Polycentropodidae		R														
Plectrocnemia conspersa		R														
Psychomyiidae					R											
Tinodes sp.														R		
Tinodes dives									R				R			
Ryacophilidae										R						
Ryacophila sp.			R			R		R	R							

Taxa	**Vrata**	**Krma**	**Frčkov rovt**	**Zatrep**	**Lipnik**	**Črna rečica**	**Soteska**	**Nomenj**	**Kropa**	**Voje**	**at the lake**	**Tolminka**	**Tresli**	**Kršovec**	**Roja**	**Krajcarica**
Sericostoma sp.									R							
EPHEMEROPTERA																
Baetidae																R
Baetis sp.	R		R					R								
Baetis melanonyx			O			O										
Baetis rhodani	O				R	R										
Ecdyonurus sp.	R															
Ecdyonurus picteti					R				A							
Ecdyonurus zelleri	O															
Rhithrogena sp.	R															
DIPTERA																
Ceratopogonidae	R		R	R	R			R	R	R			R			R
Chironomidae	C	C	C	C	O	O	R	O	C	O	R	C	C	R	C	C
Culicidae													R			
Dixidae			R							R			R	R		
Empididae	R	R	R					R	R							R
Limonidae							R						R			
Psychodidae	R									R			R			
Simulidae										R						
Stratiomyidae													R			
Thaumaleidae					R			R		R		R				
Tipulidae		R		R	R		R					R				R
COLEOPTERA																
Elmidae			R		R											
Elmis sp.								R								
Dryops sp.				R					R							
Agabus sp.			R													

The number of taxa per spring was between 8 and 26, while the number of individuals per spring varied between 35 and 907 (Tab. 3). Shannon-Wiener diversity index and Pielou's evenness were between 1.51 and 3.54, and 0.43 and 0.81 respectively. The lowest taxa richness and number of specimens were observed in the spring located at the highest altitude (Krma), in two intermittent springs (Kršovec, Zatrep), and in two springs with high flow rates, poor food resources and lower water temperatures than others (Roja, Tolminka). The highest taxa richness and abundances were recorded in limnocrene spring (Kropa) and in rheocrene springs with rich food resources (Vrata, Frčkov rovt, Črna rečica, Nomenj, Voje). However, Lipnik is among the richest in taxa number, but poor in food resources and with high flow rate. The lowest Shannon-Wienner diversity and also Pielou's evenness was measured in the spring Zatrep and in the Soteska valley. The latter was a linear spring with moving water emergence and mostly with Limnephilidae present.

Table 3. Summary of taxa richness, total abundance, Shannon-Wiener diversity index, and Pielou's evenness for all 16 springs. Data represent aggregated macroinvertebrate samples for the entire study period (May 1999-September 1999).
Tabela 3. Vrstna pestrost, skupna abundanca, Shannon-Wienerjev diverzitetni indeks in Pieloujev indeks enakosti za združbe 16 izvirov. Podatki temeljijo na združenih vzorcih iz obdobja od maja do septembra 1999.

Spring	**Taxa richness**	**Total abundance**	**Shannon-Wiener diversity**	**Pielou evenness**
spring in the Vrata valley	24	258	3.34	0.73
Krma	10	122	2.03	0.61
Frčkov rovt	26	590	3.54	0.75
Zatrep	8	229	1.51	0.50
Lipnik	24	409	3.39	0.74
Črna rečica	19	873	2.50	0.59
spring in the Soteska valley	12	234	1.54	0.43
Nomenj	19	560	2.83	0.67
Kropa	26	907	3.50	0.74
spring in the Voje valley	20	194	3.28	0.76
spring at the Lake Bohinj	11	439	2.46	0.71
Tolminka	9	104	1.67	0.53
Tresli	15	144	2.72	0.70
Kršovec	9	35	2.56	0.81
Roja	8	79	1.67	0.56
Krajcarica	12	313	2.70	0.75

Each spring appeared to have a distinct macroinvertebrate community (Fig. 2). The highest coefficient of similarity was up to 67 %, but the similarity between springs was mostly up to 29 %.

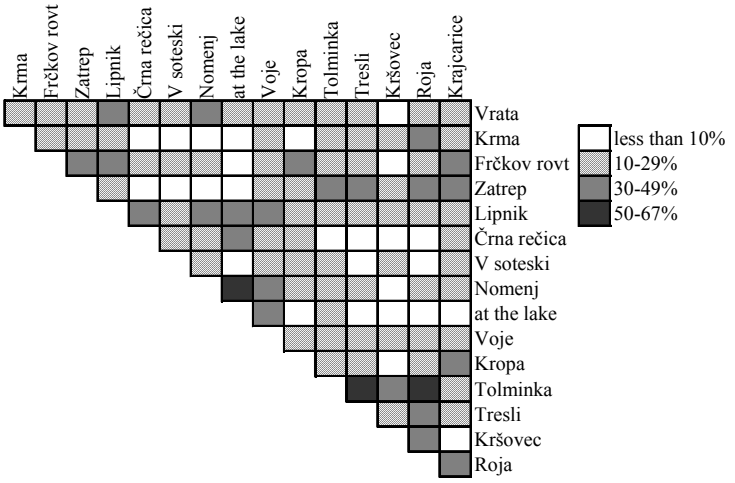

Figure 2. Similarity between 16 springs, based on the Bray-Curtis similarity index.
Slika 2. Podobnost med 16 izviri na osnovi Bray-Curtisovega indeksa podobnosti.

CCA accounted for 85.9 % of the total variance of the taxa data from the 16 springs. The eigenvalue for the first axis was 0.411 and for the second 0.333 (Fig. 4, Tab. 4). These two axes explained 30.1 % of the species-environment relation. The first CCA axis was primarily a positive gradient of altitude and negative gradient of periphyton coverage. The second axis was primarily a positive gradient of substrate and negative gradient of altitude. The only environmental variables found to be significant when examined using the Monte Carlo permutation test with the forward selection procedure were altitude and periphyton coverage. CCA clearly separated the spring Krma from others, primarily due to higher elevation and some taxa present only there. The Nomenj spring and the spring at the lake, and the springs Roja and Tolminka felt close together in the CCA ordination diagram.

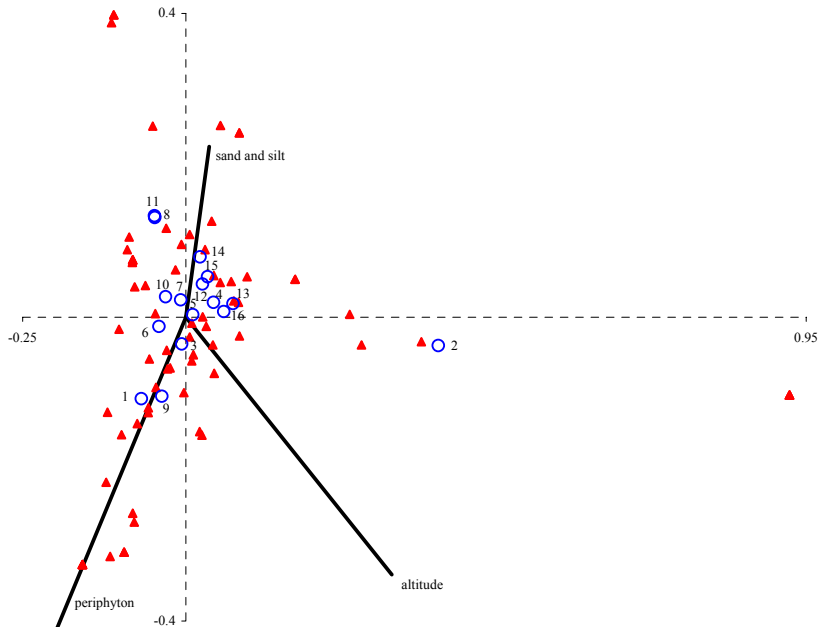

Figure 3. CCA ordination diagram based on taxa composition and abundance data of macroinvertebrates from 16 springs in relation to twelve environmental variables (only three are displayed). The eigenvalues of axis 1 (horizontally) and axis 2 (vertically) are 0.411 and 0.333 respectively. The first two axes account for 30.1 % of all variance explained by CCA. Sampling sites (circles); taxa (triangles); environmental variables (lines).
Slika 3. CCA ordinacijski diagram na osnovi makroinvertebratov, najdenih v 16 izvirih v povezavi z dvanajstimi okoljskimi dejavniki (trije so prikazani na sliki). Lastna vrednost prve osi je 0.411 in druge 0.333. Prvi dve osi pojasnjujeta 30.1 % celotne variance razložene z CCA. Vzorčna mesta (krogi); taksoni (trikotniki); okoljski dejavniki (črte).

Table 4. Summary of CCA analysis.
Tabela 4. Povzetek kanonične korespondenčne analize.

Axes	**1**	**2**	**3**	**4**	**Total inertia**
Eigenvalues	0.411	0.333	0.294	0.292	2.88
Species-environment correlations	0.991	0.994	0.998	0.995	
Cumulative percentage variance					
of species data	14.3	25.9	36	46.2	
of species-environment relation	16.6	30.1	42	53.8	
Sum of all eigenvalues					2.88
Sum of all canonical eigenvalues					2.474

Discussion

The fauna recorded in the 16 springs was composed of mainly lotic taxa, occurring in the rest of the river continuum, and to a lesser extent of hypogean taxa, belonging to the Gastropoda, Amphipoda and Isopoda groups. Chironomids and trichopterans turned out to be the most successful taxa in the spring environments, occurring frequently and in high abundances. Dipterans were recognised as the major part of the spring fauna in central Europe (Wagner et al. 1998) and chironomids as the taxonomic group richest in species in alpine springs (Gerecke et al. 1998).

Similarity between community composition was low (normally up to 29 %) due to the highly variable number of taxa and abundances among springs and due to the fact that most of the taxa found were recorded from only one or two springs. The geographical distance and isolation of those habitats, together with different combinations of environmental factors in individual spring, were probably the reasons for the great heterogeneity of macroinvertebrate communities.

The results suggested that the key environmental factors defining the macroinvertebrate spring communities were different among springs. No universal environmental factor determining all communities studied was recognised. Smith et al. (2003) showed that flow permanence, variation in water temperature and the input of leaf litter had dominant influence on the spring macroinvertebrate communities. We presume that spring morphology (type of spring), flow permanence and rate of discharge play the major role in shaping other environmental parameters. In limnocrene spring, permanent springs, springs with moderate flow rates, rich in organic matter, periphyton and moss cover, higher taxa number and density

was found than in intermittent or linear springs, or in springs with high flow rates, low organic matter, periphyton and moss cover. The communities from Roja and Lipnik springs were similar in all environmental factors mentioned above, but Lipnik had a considerably higher taxa richness, abundance and diversity. We presume that discharge and consequently the spring area are the main reasons for these differences. Lipnik is a much larger spring, with estimated discharge twice as great as Roja's. The positive correlation between diversity and discharge recorded in the springs of Finland demonstrated the general rule that larger ecosystems (springs) have a greater number of species than the smaller ones (Särkkä et al. 1997). In the CCA analysis, the spring Krma (the most elevated spring) was separated from others due to *Allogamus uncatus*, *Nemoura* cf. *marginata*, Polycentropodidae and *Plectrocnemia conspersa* present only here. The CCA ordination diagram clearly showed ordination of taxa and sample points along the periphyton gradient.

Povzetek

Na območju Julijskih Alp so bile maja, julija in septembra 1999 v 16 kraških izvirih opravljene raziskave združb velikih vodnih nevretenčarjev. Namen raziskave je bil ugotoviti, kateri so okoljski dejavniki, ki vplivajo na sestavo združb velikih vodnih nevretenčarjev v izvirskih habitatih. Raziskave združb so bile opravljene z metodo vzorčevanja, imenovano "kick sampling". Poleg bioloških analiz so bile opravljene tudi meritve kemijskih in fizikalnih dejavnikov. Izbrani izviri ležijo na nadmorskih višinah od 410 m do 955 m. Vsi izviri, razen dveh, od katerih je eden limnokren, drugi pa higropetrični reokren, so reokreni. Za izvire so bila značilna različna nihanja pretokov in relativno stabilne temperature vode. Izmerjene vrednosti pH so bile v bazičnem območju. Prevodnost in alkaliteta sta bili zaradi karbonatne podlage relativno visoki. V posameznih izvirih smo izmerili od 0 do 4,82 mgl^{-1} nitratov. V izvirih smo ugotovili najmanj 72 različnih taksonov velikih vodnih nevretenčarjev. Vrbnice (Plecoptera), dvokrilci (Diptera), postranice (Amphipoda), mladoletnice (Trichoptera) in vrtinčarji (Turbellaria) so bili najpogostejši predstavniki izvirskih združb. V posameznih izvirih je bilo število taksonov od 8 do 26. Največje število taksonov, visoke abundance in diverziteto smo zabeležili v izvirih s stalnim pretokom, bogatih z organskim materialom, perifitonom in mahovi. Nizke vrednosti števila taksonov, abundanc in diverzitetnih indeksov so bile v izvirih z nestalnim pretokom ali pa v izvirih, revnih z organskim materialom, perifitonom in mahovi in višjimi hitrostmi vodnega toka. Podobnost med izvirskimi združbami na osnovi Bray-Curtisovega indeksa je bila večinoma nižja od 29 %. Preučevanje vpliva okoljskih dejavnikov na sestavo združb velikih vodnih nevretenčarjev s kanonično korespondenčno analizo je pokazalo, da na sestavo združbe v največji meri vplivata nadmorska višina in perifiton.

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Large golden-ringed dragonfly *Cordulegaster heros* Theischinger 1979, new for the fauna of Italy (Odonata: Cordulegastridae)

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Abstract. The species has been recorded at three localities in the extreme eastern part of the Friuli-Venezia Giulia region, north-eastern Italy, thus bringing the number of Italian dragonfly species to 89. The distribution of *C. heros* in Slovenia and Italy is mapped and discussed from the zoogeographical point of view. Additionally, the collected faunistic data on other dragonfly species and sympatric occurrence of endangered frog species *Rana latastei* Boulenger are given. Due to inclusion of *C. heros* and *R. latastei* to the Annexes II and IV of the Habitat Directive of EU, the conservation of their habitats in Italy and western Slovenia is proposed within the European network of protected areas NATURA 2000.

Keywords: dragonflies, zoogeography, Habitat Directive, Natura 2000

Izvleček. VELIKI STUDENČAR *CORDULEGASTER HEROS* THEISCHINGER 1979, NOVA VRSTA ZA FAVNO ITALIJE (ODONATA: CORDULEGASTRIDAE) - Vrsta je bila ugotovljena na treh lokalitetah v skrajnem vzhodnem delu Furlanije-Julijske krajine, severovzhodna Italija, kar dviguje število zabeleženih vrst kačjih pastirjev v Italiji na 89. Razširjenost vrste *C. heros* v Sloveniji in Italiji je prikazana na zemljevidih ter prediskutirana z zoogeografskega stališča. Dodatno so navedeni tudi zbrani favnistični podatki o drugih vrstah kačjih pastirjev ter podatki o simpatričnem pojavljanju ogrožene laške žabe *Rana latastei* Boulenger. Zaradi vključitve vrst *C. heros* in *R. latastei* na Dodatka II in IV Habitatne Direktive EU je predlagano, da se njuna bivališča v Italiji in zahodni Sloveniji ohranijo v okviru evropskega omrežja zavarovanih območij NATURA 2000.

Ključne besede: kačji pastirji, zoogeografija, Direktiva o habitatih, Natura 2000

Introduction

According to Utzeri (1995), altogether 88 dragonfly species occur in Italy. Despite its size, the country is odonatologically relatively well explored, and in the easternmost Italian region

of Friuli-Venezia Giulia (NE Italy) some dragonfly research has also been carried out in the past. More than 30 years ago, a comprehensive overview of dragonfly fauna of the Friuli-Venezia Giulia region was made by Kiauta (1969a), following a similar study in the neighbouring Primorska region in Slovenia (Kiauta 1969a). In addition, only a few years ago Bognolo & Pecile (1995) thoroughly studied dragonfly fauna of the Trieste and Gorizia Karst in Italy and published an annotated list of species occurring in the region. As far as the genus *Cordulegaster* is concerned, only *C. bidentata* (Selys) and *C. boltonii* (Donovan) have been recorded from Friuli-Venezia Giulia so far (Kiauta 1969a, Bognolo & Pecile 1995). Until now, however, one of the most enigmatic European dragonfly species, *Cordulegaster heros* Theischinger, escaped the notice of odonatologists and has not been reported for Friuli-Venezia Giulia or for Italy as a whole yet (Utzeri 1995, Galletti & Pavesi 1985).

According to Wasscher & Bos (2000), *C. heros* is one of the ten dragonfly species endemic to Europe. Two additional *Cordulegaster species*, viz. *C. trinacriae* and *C. helladica*, are also confined to Europe, whereby the range of the first is limited to Sicily and southern Italy and that of the later to Greece. *C. heros* also has a relatively small range, occurring in Austria, Slovenia, Hungary, Croatia, Serbia, Macedonia, Bulgaria, Romania and Greece. Recently it was discovered in Slovakia (Blaškovič et al., in print), and the present article formally extends its distribution range to Italy.

In Slovenia, the species is quite common and it has been recorded by the members of the Slovene Odonatological Society from more than 340 localities (Fig. 1), whereas development of the species has been documented in more than 260 localities (Kotarac et al. 2003). The exceptional number is even more impressive by the fact that the number of all other known European localities of the species is by far lower. If the proportion of unsuitable habitat for *C. heros* in most of the Pannonian lowlands is taken into account, the speculation that Slovenia actually represents the core area of the species' distribution range in Europe is not far from reality.

However, in western Slovenia, close to the border to Italy, where *C. heros* reaches the extreme north-western edge of its European range, the suitable habitat is much scarcer and limited only to few stream catchments in the wider surroundings of the Vipava valley. The distribution of the species in this part of Slovenia has been described in detail by Bedjanič & Pirnat (2000), gathering their observation with the faunistic data from Pirnat (1996), Červek (1997), Kotarac (1997), Šalamun et al. (1997) and Bedjanič (2000). Few additional localities

have been added by Pirker (2002), and a very comprehensive overview has been presented by Kotarac et al. (2003).

Since the distribution of any living species is rarely limited by the state borders, the idea that *C. heros* might also occur in north-eastern Italy is not new in the minds of Slovene odonatologists. Kotarac (1997) has already predicted this possibility with the following words: *"We started to collect the data about C. heros in the eastern parts of Slovenia. In five years we harrowed the species to two spots about 1 km away from the national border with Italy. It is the turn of Italian odonatologists now."* In addition, Bedjanič & Pirnat (2000) stated in a similar way: *"It is interesting that so far C. heros has not been found in Italy, although it goes without saying that its already mentioned north-western distribution edge probably extends also to the western side of the Soča River."*

Quite surprisingly, nobody took over the pleasant challenge for years and there was no other possibility than to finally clear the situation by ourselves.

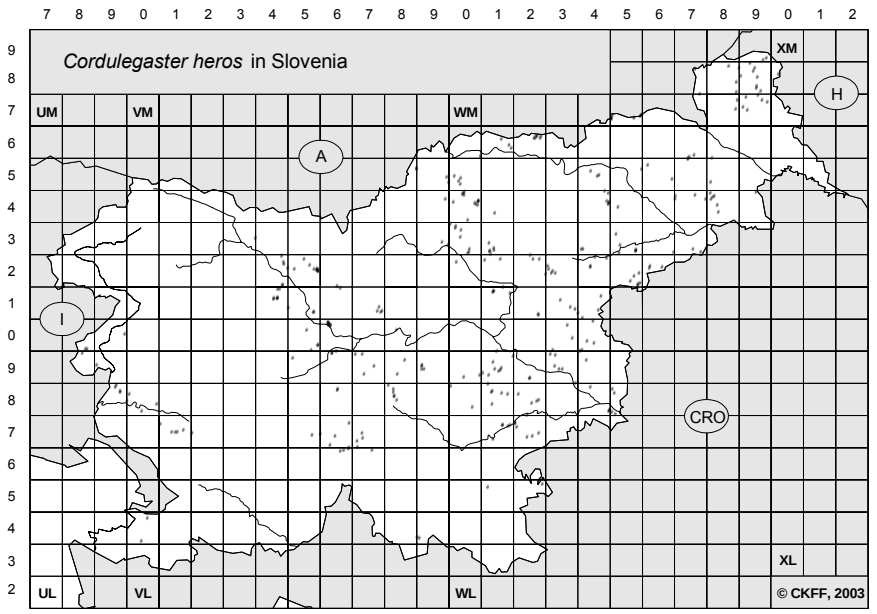

Figure 1: Distribution of *Cordulegaster heros* in Slovenia. Members of the Slovene Odonatological Society recorded the species from more than 340 localities and documented its development at more than 260 localities.
Slika 1: Razširjenost velikega studenčarja v Sloveniji. Člani Slovenskega odonatološkega društva so vrsto popisali na več kot 340 lokalitetah ter potrdili razvoj na več kot 260 lokalitetah.

Localities and faunistic data

On March 23rd, 2003, a number of streams between the Isonzo (Soča) and Iudrio (Idrija) rivers in the extreme eastern part of Friuli-Venezia Giulia (NE Italy) were systematically checked by the authors for the presence of dragonflies and frogs. Special interest was dedicated to the dragonfly species *Cordulegaster heros* Theischinger and the frog species *Rana latastei* Boulenger, which both are endangered and listed on the Annexes II and IV of the EU Habitat Directive.

The dragonfly fauna was sampled randomly at subjectively defined suitable places by the means of larvae collecting with a home-made water net. Larvae of *C. heros* were determined on the spot, checking specific characters by the help of magnifier (e.g. the presence and size of lateral spines on the ninth abdominal segment) and released afterwards. Individual frogspawns of *R. latastei* were visually counted at each locality at approximate stream length of 100-200 m. Although a number of streams were checked, only the ones with recorded presence of dragonflies and frogs are listed in further text. Beside exact geographical description, the UTM square and approximate altitude are given for each of the sites (Fig. 2).

The voucher material of *C. heros* was taken at the Rio Sniardar stream only. One dried final instar larva is deposited in the collection of the first author. The second larva from the same locality was reared in aquarium but died during the final shedding. The specimen is deposited in the second author's collection.

LOC 1A: Stream Groina (Grojnica) NW of Gorizia, 750 m above the place where it joins the Isonzo river (Soča); Gorizia (Gorica); Friuli-Venezia Giulia; NE Italy; UTM UL 99; alt. 80 m;
DRAGONFLIES: *Cordulegaster heros* 1 lar.

LOC 1B: Stream Groina (Grojnica) NW of Gorizia, 1 km above the place where it falls into the Isonzo river (Soča); Gorizia (Gorica); Friuli-Venezia Giulia; NE Italy; UTM UL 99; alt. 80 m;
DRAGONFLIES: *Somatochlora meridionalis* 1 lar.
FROGS: *Rana latastei* 25 spawns

LOC 2A: Left tributary of the stream Groina (Grojnica) close to the road to Scedina (Ščedno), 100 m above the spot where it joins the Groina; Gorizia (Gorica); Friuli-Venezia Giulia; NE Italy; UTM UL 99; alt. 80 m;
DRAGONFLIES: *Calopteryx virgo* 1 lar.
FROGS: *Rana latastei* 5 spawns

LOC 2B: Left tributary of the stream Groina (Grojnica) close to the road to Scedina (Ščedno), 700 m above the spot where it joins the Groina; Gorizia (Gorica); Friuli-Venezia Giulia; NE Italy; UTM UL 99; alt. 90 m;
DRAGONFLIES: *Cordulegaster heros* 1 lar.
FROGS: *Rana latastei* 10 spawns

LOC 2C: Left tributary of the Groina (Grojnica) at the bridge on the road to Scedina (Ščedno), 950 m above place where it joins the Groina; Gorizia (Gorica); Friuli-Venezia Giulia; NE Italy; UTM UL 99; alt. 90 m;
DRAGONFLIES: *Cordulegaster heros* 1 lar.
FROGS: *Rana latastei* 26 spawns

LOC 3: Stream Rio Sniardar (Smjardar) NE of Brazzano (Bračan), 100 m above the place where it joins the Rio Fidri stream (Fedrih); Brazzano; Cormons (Krmin); Friuli-Venezia Giulia, NE Italy; UTM UL 89; alt. 80 m;
DRAGONFLIES: *Cordulegaster heros* 13 lar., *Calopteryx virgo* 2 lar., *Platycnemis pennipes* 1 lar.
FROGS: *Rana latastei* 7 spawns

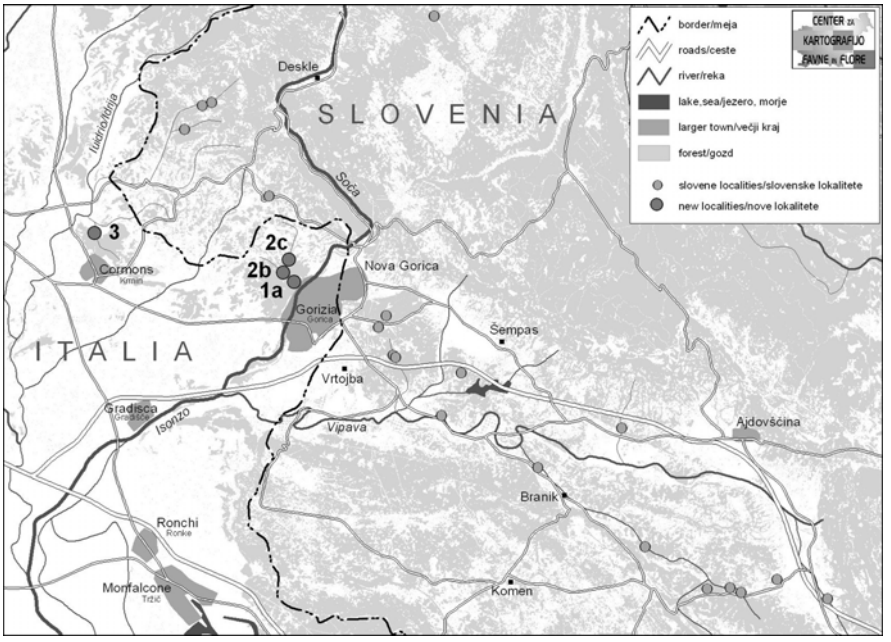

Figure 2: Distribution of *Cordulegaster heros* in western Slovenia and eastern part of Friuli-Venezia Giulia, northeastern Italy, with numbers indicating the three new Italian localities, where the species has been recorded recently.
Slika 2: Razširjenost velikega studenčarja v zahodni Sloveniji ter vzhodnem delu Furlanije-Julijske krajine, severovzhodna Italija. Nove najdbe vrste so označene s številkami.

Discussion

As already stated in the introductory part, the occurrence of *Cordulegaster heros* in the eastern part of Friuli-Venezia Giulia has been predicted and expected and is therefore not surprising at all. Even more, based on the experience from numerous Slovenian localities, the suitable places for *C. heros* were determined with the aid of a 1:50000 map in advance with great certainty and later on merely confirmed in the field. The recipe for such "map remote sensing" planning is quite simple: (1) stream in hilly to lowland landscape, (2) only gentle slope of the field, (3) altitude 100-400 m and (4) presence of forest. Such predispositions logically originate in ecological demands of the species. *C. heros* is essentially a dragonfly of small forest streams in the hilly country down to the flatlands. The strongest populations can be found in slow to moderate flowing agitated streams, where their bottoms consist of fine sand covered by a thin layer of fine organic detritus. These structures enable the larvae to burrow themselves in the bottom and, on the other hand, ensure a rich supply of invertebrate prey. Three new localities of *C. heros* in Italy are quite different in this respect. The Groina stream near Gorizia and its tributaries seem to be a suboptimal habitat for *C. heros* due to their stony beds and their drying up in the hot summer months (Fig. 3). Scarcity of other water invertebrates and very poor dragonfly fauna, consisting of single *Calopteryx virgo* and *Somatochlora meridionalis* larvae, could confirm the last assumption. On the other hand, the Rio Sniardar stream near Brazzano is an optimal habitat for *C. heros*. Its shallow water, slow current, appropriate fine substrate, rich water invertebrate fauna and natural bank vegetation agree well with the ecological demands of the species (Figs. 4, 5). Sympatric occurrence of common dragonfly species *Calopteryx virgo* and *Platycnemis pennipes* is not surprising either.

According to literature, both other *Cordulegaster* species, viz. *C. bidenatata* and *C. boltonii*, are rare in the Friuli-Venezia Giulia region (Kiauta 1969b, Bognolo & Pecile 1995). The latter has been recorded only in the vicinity of Pontebba in the Alpine northeastern part of Friuli-Venezia Giulia, some 60 km north of newly discovered *C. heros* localities. Since *C. boltonii* and *C. heros* are closely related, it would be very interesting to work out the exact limits of their range in this part of Europe. It is worth mentioning that the well established list of Slovene odonate fauna may be incomplete in this respect. Although numerous old records of *C. boltonii* from Slovenia have been attributed only to *C. heros* described in 1979 (Kotarac 1997), it is quite possible that *C. boltonii* occurs somewhere in northwestern Slovenia.

In any case, western Slovenia and the eastern Friuli-Venezia Giulia almost definitely constitute the extreme north-western edge of *C. heros* European range. Further to the west, the landscape flows into intensively farmed deforested plains, and not far to the north there are the Alps, both with almost no suitable habitat for this particular species. Although the

three new Italian localities in the surroundings of Gorizia and Cormons are certainly not the only ones, the potential habitat of *C. heros* in Italy is very limited and the species therefore definitely rare and endangered. South of Gorizia, there are no streams due to the area's karst landscape, but to the north some streams around Corno di Rosazzo and east of Cividale look very promising - at least on the map. In the field, there is indeed *"…the turn of Italian odonatologists now."*

Figure 3: Groina Stream NW of Gorizia, 750 m above the place where it joins the Isonzo river (Loc 1a). Suitable *Cordulegaster heros* microhabitat in the stream is very scarce, the bottom is too stony and at least some stream sections probably dry up during the summer. (Photo: M. Bedjanič)
Slika 3: Potok Grojnica SZ od Gorice, 750 m nad izlivom v Sočo (Lok 1a). Za velikega studenčarja primernih mikrohabitatov je malo, saj je struga kamnita, vsaj nekateri odseki potoka pa se poleti verjetno posušijo. (foto: Matjaž Bedjanič)

Figure 4 (left) and Figure 5 (right): Two aspects of the Rio Sniardar stream near Brazzano (Loc 3) above the place where it joins the Rio Fidri stream. Its shallow water, slow current, appropriate fine substrate and natural bank vegetation constitute an ideal habitat for *Cordulegaster heros*. (Photo: M. Bedjanič)
Slika 4 (levo) in Slika 5 (desno): Dva pogleda na potok Smjardar pri Bračanu nad izlivom v potok Fedrih (Lok 3). Plitva voda, miren tok, droben substrat ter naravna obrežna vegetacija sestavljajo idealen habitat za velikega studenčarja. (foto: Matjaž Bedjanič)

Nature conservation aspect

As mentioned earlier, a special attention was paid, in addition to *Cordulegaster heros*, to the frog species *Rana latastei*. Both species are endangered and listed on the *Annexes II* and *IV* of the *EU Habitat Directive (The Council Directive 92/43 EEC on the Conservation of Natural Habitats and on Wild Fauna and Flora, Off. Journal of the EC, No.L.206/7)*. They are stenotopic and live or breed almost exclusively in primary habitats, such as smaller forest streams and rivulets. The inclusion of *C. heros* and *R. latastei* to the *Annexes II* of the above-mentioned directive demands conservation of their habitats and obligates all member states, including Italy and Slovenia, to ensure long-term favourable conservation status for the

species in their territories. Their sympatric occurrence can therefore be of a great nature conservation importance.

As far as the newly discovered localities of *C. heros* in Italy are concerned, the Rio Sniardar stream near Brazzano (LOC 3) can definitely be proposed as future *SITE OF COMMUNITY IMPORTANCE (SCI)*, since it presents an ideal habitat for *C. heros* and *R. latastei* as well. On the other hand, additional faunistic research is needed in order to clear the status of *C. heros* in Italy. A study of the species' occurrence in the streams around Corno di Rosazzo and east of Cividale should be accomplished as soon as possible. Only then an assessment of the size and stability of the Italian *C. heros* population as well as an evaluation of potential threats and planning of appropriate conservation measures will be possible.

According to the strict provisions of the European Habitat Directive, Italy too should provide for a long-term survival of the *C. heros* population in its territory and effectively protect the species' selected habitats. Due to the fact that the eastern Friuli-Venezia Giulia constitutes the extreme north-western edge of *C. heros* European range, this obligation is even more important. In this respect, the sympatric occurrence of *C. heros* and *R. latastei* can serve as an additional argument. It can facilitate the designation of suitable habitats of both species as *SITES OF COMMUNITY IMPORTANCE (SCI)* and herewith ensure their inclusion in European NATURA 2000 network. In this respect, the action already undertaken by Slovenia can serve as a good example (Kotarac et al. 2003, Poboljšaj & Lešnik 2003).

Povzetek

Italija je z vidika favne kačjih pastirjev razmeroma dobro raziskana in tudi v njenem severovzhodnem delu - Furlaniji-Julijski krajini - je v preteklosti potekalo nekaj odonatoloških aktivnosti (npr. Kiauta 1969b, Bognolo & Pecile 1995). Iz rodu studenčarjev *Cordulegaster* sta bila doslej v Furlaniji-Julijski krajini zabeležena le povirni studenčar *C. bidentata* in prodni studenčar *C. boltonii*. Veliki studenčar *C. heros* doslej še ni bil zabeležen v omenjeni regiji in Italiji nasploh (Utzeri 1995, Galletti & Pavesi 1985).

Veliki studenčar je razširjen na razmeroma majhnem območju, ki se razteza prek Slovaške, Avstrije, Slovenije, Madžarske, Hrvaške, Srbije, Makedonije, Bolgarije, Romunije in Grčije, s pričujočim prispevkom pa se območje znane razširjenosti vrste razteza tudi v Italijo. V Sloveniji velja veliki studenčar *C. heros* za dokaj pogosto vrsto, saj je bil doslej zabeležen na prek 340 lokalitetah (Fig. 1), njegov razvoj pa potrjen na prek 260 lokalitetah (Kotarac et al. 2003). V zahodni Sloveniji, blizu meje z Italijo, dosega veliki studenčar *C. heros* skrajno severozahodno mejo območja razširjenosti in je mnogo redkejši (Kotarac et al. 2003). Kljub temu je bila najdba vrste v Italiji pričakovana in so jo napovedovali že Kotarac (1997) ter Bedjanič & Pirnat (2000).

V okviru raziskav kačjih pastirjev in dvoživk sta avtorja 23. marca 2003 pregledala nekaj potokov med rekama Idrijo (Iudrio) in Sočo (Isonzo) v skrajnem vzhodnem delu Furlanije-Julijske krajine. Posebna pozornost je bila namenjena potrditvi pojavljanja velikega studenčarja *C. heros* in laške žabe *Rana latastei*, ki sodita med evropsko ogrožene vrste in sta uvrščena na Dodatka II in IV Habitatne direktive EU. Vrsti sta bili zabeleženi na skupno treh lokalitetah v okolici Gorice (Gorizia) in Krmina (Cormons) (Fig. 2).

Potok Grojnica (Groina; Lok. 1A-B in 2A-C; Fig. 3) in njegovi pritoki zaradi neustreznega kamnitega substrata ter zelo verjetne poletne izsušitve niso ocenjeni kot najustreznejši habitat velikega studenčarja *C. heros*. Po drugi strani je potok Smjardar (Rio Sniardar, Lok. 3; Figs. 4, 5) pri Bračanu (Brazzano) ocenjen kot optimalen habitat te vrste. Gre za razmeroma plitev in počasi tekoč nižinski potok, katerega dno je pokrito z ustreznim drobnim substratom, kar se skupaj z bogato favno vodnih nevretenčarjev ter naravno obvodno vegetacijo v celoti pokriva z ekološkimi zahtevami velikega studenčarja *C. heros*.

Po podatkih iz literature sta tako povirni studenčar *C. bidentata* kot prodni studenčar *C. boltonii* v Furlaniji-Julijski krajini zelo redka (Kiauta 1969b, Bognolo & Pecile 1995). Ker je slednji v taksonomskem oziru zelo soroden velikemu studenčarju *C. heros*, bi bilo v prihodnosti zelo zanimivo podrobneje raziskati meje območij njune razširjenosti v severovzhodni Italiji in severozahodni Sloveniji. Novo odkrite lokalitete velikega studenčarja *C. heros* v Italiji nedvomno ležijo na skrajnem severozahodnem robu območja njegove razširjenosti. Sicer pa bo treba razširjenost in ogroženost velikega studenčarja v Italiji ter potencialno možnost, da se pojavlja tudi še nekoliko severneje, v okolici Korena (Corno di Rosazzo) in Čedada (Cividale del Friuli), preveriti z novimi raziskavami.

Z naravovarstvenega vidika je še posebej pomembno simpatrično pojavljanje velikega studenčarja *C. heros* in laške žabe *Rana latastei*. Gre namreč za evropsko ogroženi vrsti z relativno ozko ekološko valenco, ki naseljujeta skoraj izključno naravno ohranjene nižinske gozdne potoke. *Direktiva o habitatih* zavezuje Italijo in Slovenijo k ustreznemu ohranjanju njunih bivališč in zagotavljanju dolgoročno ugodnega ohranitvenega stanja njunih populacij. V tem oziru avtorja predlagata, da se njuna bivališča v Italiji in zahodni Sloveniji ohranijo v okviru evropskega omrežja zavarovanih območij NATURA 2000.

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The distribution of butterflies (Lepidoptera: Rhopalocera) in Haloze, East Slovenia

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Abstract. Almost nothing has been known about the butterfly fauna of Haloze prior to our survey. During our field trips, including an extensive survey carried within the framework of the Student Research Camp Videm 2002, surprisingly high butterfly diversity was established. Altogether, 96 butterfly species were recorded at 67 studied sites. The highest butterfly diversity was registered in dry grasslands in the western part of the studied area. Due to the presence of rare and endangered species, such as *Maculinea arion* (Linne, 1758), *Meleageria daphnis* (Denis & Schiffermüller, 1775), and *Polyommatus thersites* (Cantener, 1825), these habitats would require more conservation efforts and a suitable management. The few remaining humid grasslands in the eastern part of the region still host the majority of specialized hygrophilous butterflies, including *Maculinea nausithous* (Bergsträsser, 1779), *Maculinea teleius* (Bergsträsser, 1779), and *Lycaena dispar* (Haworth, 1802). Some of these sites are proposed to be included into the Natura 2000 network, which could enable their suitable protection and management.

Keywords: distribution, Rhopalocera, endangerment, conservation, dry grasslands

Izvleček. RAZŠIRJENOST DNEVNIH METULJEV (LEPIDOPTERA: RHOPALOCERA) V HALOZAH, VZHODNA SLOVENIJA - Do teh raziskav ni bilo o dnevnih metuljih Haloz znanega skoraj nič. Med terenskim delom, vključno z obsežnimi raziskavami med Študentskim raziskovalnim taborom Videm 2002, je bila ugotovljena presenetljivo visoka pestrost metuljev. Skupaj je bilo opaženih 96 vrst na 678 raziskanih lokalitetah. Največja pestrost je bila zabeležena na suhih travnikih v zahodnem delu regije. Ker tu živijo nekatere redke in ogrožene vrste, kot na primer *Maculinea arion* (Linne, 1758), *Meleageria daphnis* (Denis & Schiffermüller, 1775) in *Polyommatus thersites* (Cantener, 1825), ti habitati terjajo več naravovarstvenih naporov in pravilno upravljanje. Majhno število ohranjenih vlažnih travnikov v vzhodnem delu regije še vedno omogoča preživetje večini specializiranih higrofilnih metuljev, vključno z *Maculinea nausithous* (Bergsträsser, 1779), *Maculinea teleius* (Bergsträsser, 1779) in *Lycaena dispar* (Haworth, 1802). Nekatera izmed teh območij so predlagana za vključitev v območje Natura 2000, s čimer bi omogočili njihovo trajno zaščito in pravilno upravljanje.

Ključne besede: razširjenost, Rhopalocera, ogroženost, varovanje, suha travišča

Introduction

The area of Haloze is one of the least faunistically explored parts of Slovenia. Although it belongs to the Styria (Štajerska) region, there are no references to its butterfly fauna in the so far most comprehensive overview of the Styrian Lepidoptera by Hoffmann and Klos (1914). In his characterization of the butterfly fauna of the Podravje region, Jež (1983) gives mostly generalized remarks (e.g. "common throughout the region") about the species distribution, with few exceptions for Haloze. The most noteworthy is his observation of *Everse decoloratus* (Staudniger 1886) at Šega, south of Makole in the westernmost part of Haloze. The only available list of species has been given for a single locality in the western part of Haloze by Verovnik (1996). During the single visit at the end of July 1995, a total of 24 species were encountered near the village of Sitež (loc. no. 44).

The next visit made by the author to Haloze at the beginning of June 1999 was dedicated mostly to the search of *Colias myrmidone* (Esper 1780), whose presence was expected. Despite an unsuccessful search, the region proved to hold many promising sites with rich butterfly fauna. The greater part of our fieldwork was carried out during the Student Research Camp Videm 2002, where special attention was given to the diverse types of grasslands. The objective of the two subsequent visits in August 2002 and beginning of May 2003 was to discover further large satyrids and to supplement the list with early spring species. Altogether, 67 sites were visited enabling a good overview of the butterfly distribution in this region.

Geographical definition and description of the region

Haloze is a remote area in the eastern part of Slovenia situated south of the Dravinja and Drava Rivers. In the south it reaches the foothills of Boč and Macelj and continues along the Croatian border to the east. Its western border is less evident and usually generalised as "south of Makole", a town in the Dravinja valley. Haloze is approximately 30 km long and six to ten kilometres wide hilly country. Geologically, the area is entirely of Miocene deposits of sandy clay and marl (Gams & Vrišer 1998). The only small karst area near Žetale is covered entirely by woods.

The western part is characterised by higher hills (400 to 600 m) with steep slopes that are predominantly covered with mixed and deciduous forests. Most of the open land is situated either in deep shadowy valleys or on top of the ridges, where the majority of the steeper

cultivated grasslands have been abandoned. In some areas, the slopes are so steep that the open grasslands are maintained by occasional natural erosion. These habitats hold the highest number of butterfly species in the area. The only flatter part with humid grasslands is situated around the town of Žetale. Due to the intensive farming, these meadows are faunistically impoverished.

The central part around the Rogatnica stream valley is the flattest part of Haloze. Due to easier access, the flatlands and the nearby hills are intensively cultivated; they are mostly covered by vineyards or turned into arable land. Some small remnants of once humid grasslands are scattered along the Rogatnica stream.

The eastern part of the region is a gently undulating hilly country with hills reaching from 280 to 400 meters. The valleys are wider as in the western part, and in some of them small humid grasslands have been preserved. In certain areas, the humid grasslands are succeeded by dry grasslands on the southern exposed slopes. The intensification in the northern part and abandonment in the less accessible southern part of the area pose the major threat to the currently still abundant open grasslands.

Results

List of localities

The alphabetical list of localities contains a short description of the habitat, coordinates (Gauss-Krüger), UTM square and date of the observations. The observations were made by the author if not otherwise stated.

1. Belavšek at Videm, humid meadow S of the village Repišče, along the road Dolnji Leskovec-Cirkulane, coordinates - X: 573985, Y: 132644, UTM square: WM73, 224 m, 06.06.1999
2. Belavšek at Videm, humid meadows below the village, SE of Zgornji Leskovec, coordinates - X: 573491, Y: 131424, UTM square: M73, 235 m, 06.06.1999
3. Belski Vrh at Zavrč, cultivated grasslands on top of the Vrbanjšak hill, coordinates - X: 578863, Y: 136837, UTM square: WM73, 397 m, 14.07.2002 and 02.05.2003
4. Borl at Gorišnica, cultivated meadows SE of Borl Castle, coordinates - X: 577859, Y: 137194, UTM square: WM73, 249 m, 13.07.2002
5. Brezovec at Cirkulane, dry grassy slope E of the Ošnik farm, coordinates - X: 577809, Y: 134606, UTM square: WM73, 237 m, 06.06.1999, 13.07.2002, 09.08.2002 and 02.05.2003
6. Dobrina near Žetale, dry grassy slope 500 m E of the village of Globočec, coordinates - X: 563353, Y: 128007, UTM square: WM62, 275 m, 10.07.2002, 09.08.2002 and 02.05.2003

7. Dolence at Podlehnik, cultivated grassland and forest verge at the Ornik farm, 500 NW of the village, coordinates - X: 569226, Y: 132445, UTM square: WM63, 327 m, 12.07.2002
8. Dravinjski Vrh near Videm, cultivated grasslands on the Zdolčušak ridge, S of the farm Hegediš, coordinates - X: 569843, Y: 134524, UTM square: WM63, 305 m, 12.07.2002
9. Dravinjski Vrh near Videm, humid meadows along the stream N of the Kranjc farm, coordinates - X: 570619, Y: 134751, UTM square: WM73, 240 m, 12.07.2002
10. Duga at Cirkulane, humid meadow and forest edge in the valley of the Duga stream, E of the village, coordinates - X: 578286, Y: 133866, UTM square: WM73, 224 m, 15.06.2002 and 14.07.2002, observations on 15.06.2002 by Rebeušek Franc
11. Gorca at Podlehnik, cultivated grassland and forest verge N of the road to Gorca, coordinates - X: 565312, Y: 133503, UTM square: WM63, 390 m, 11.07.2002 and 02.05.2003
12. Gorenjski Vrh at Zavrč, dry grasslands in the Kojuhovski stream valley, N of the Repičak farm, coordinates - X: 580886, Y: 135693, UTM square: WM83, 226 m, 14.07.2002
13. Goričak at Zavrč, dry and cultivated meadows on the slopes S of the Masten farm, coordinates - X: 582327, Y: 135557, UTM square: WM83, 230 m, 14.07.2002
14. Grdina at Majšperk, dry grasslands on the slope NW of the village of Vrhe, coordinates - X: 557515, Y: 128488, UTM square: WM52, 438 m, 10.07.2002 and 09.08.2002
15. Gruškovec at Cirkulane, cultivated grasslands and fields on S slope of the Zgornji Hun hill, coordinates - X: 578970, Y: 131858, UTM square: WM73, 305 m, 13.07.2002
16. Jablovec at Podlehnik, forest verge in the valley E of the Krušič farm, coordinates - X: 565769, Y: 131144, UTM square: WM63, 254 m, 11.07.2002
17. Janški vrh near Majšperk, cultivated grasslands and forest edge on the ridge S of the village of Zgornje Lipno, coordinates - X: 559886, Y: 132028, UTM square: WM53, 415 m, 11.07.2002
18. Janški vrh near Majšperk, dry and cultivated meadows near the road NW of the Peskov breg hill, coordinates - X: 560028, Y: 131519, UTM square: WM63, 413 m, 11.07.2002
19. Jelovice at Majšperk, dry and cultivated grasslands around the Church of St. Bolfenk, coordinates - X: 558228, Y: 130324, UTM square: WM53, 531 m, 10.07.2002
20. Jelovice at Majšperk, dry grasslands N of the Church of St. Bolfenk, coordinates - X: 558296, Y: 130477, UTM square: WM53, 495, 10.07.2002
21. Jelovice at Majšperk, forest road W of the Lah farm, coordinates - X: 557642, Y: 129398, UTM square: WM52, 499 m, 10.07.2002
22. Jelovice at Majšperk, Rocky scree along the road 300 m N of the village of Plate, coordinates - X: 558281, Y: 129994, UTM square: WM52, 498 m, 10.07.2002
23. Kočice at Žetale, bushes and cultivated meadows on a steep slopes on the ridge N of the Frajmežna farm, coordinates - X: 560347, Y: 128853, UTM square: WM62, 385 m, 11.07.2002
24. Kočice near Žetale, forest verge in the Peklača stream valley, SW of the village of Krošlji Vrh, coordinates - X: 560887, Y: 129078, UTM square: WM62, 307 m, 11.07.2002
25. Korenjak at Cirkulane, cultivated meadows on the ridge 400 m S of the farm Koren, coordinates - X: 579547, Y: 133241, UTM square: WM73, 311 m, 14.07.2002
26. Kozminci at Podlehnik, cultivated meadow near small stream SE of the Hronek farm, coordinates - X: 566244, Y: 128040, UTM square: WM62, 251 m, 11.07.2002
27. Kupčinji vrh at Majšperk, dry grassland and bushes along a small stream S of the village, coordinates - X: 557075, Y: 126582, UTM square: WM52, 344 m, 10.07.2002

28. Kupčinji Vrh at Majšperk, dry grassland S of the Church of St. Mohor, coordinates - X: 557214, Y: 126917, UTM square: WM52, 430 m, 02.05.2003, observed by Rebeušek Franc
29. Ljubistava at Podlehnik, humid meadows E of the Topolovec farm, coordinates - X: 570705, Y: 133320, UTM square: WM73, 230 m, 12.07.2002
30. Ljubistava at Podlehnik, humid meadows in the Črna valley near the Junger farm, coordinates - X: 569777, Y: 133580, UTM square: WM63, 247 m, 12.07.2002
31. Majski Vrh at Videm, dry cultivated meadow and forest verge on the slope 200 m SE of the Zorinč farm, coordinates - X: 569252, Y: 135085, UTM square: WM63, 308 m, 16.07.2002
32. Mala Varnica at Podlehnik, humid meadow in the Psičina stream valley along the village, coordinates - X: 573714, Y: 129830, UTM square: WM72, 237 m, 12.07.2002
33. Medribnik at Cirkulane, humid meadow along the Bela stream, UTM square: W of the Church of St. Florjan, coordinates - X: 578030, Y: 131300, UTM square: WM73, 235 m, 13.07.2002
34. Nadole at Žetale, dry, partially cultivated meadow S of the village of Zlaka, coordinates - X: 559835, Y: 127059, UTM square: WM52, 366 m, 09.08.2002
35. Pestike at Zavrč, dry and cultivated meadows W of the Potočjak farm, coordinates - X: 579936, Y: 134133, UTM square: WM73, 261 m, 14.07.2002
36. Planjsko near Majšperk, dry grasslands on the ridge N of the village of Vinarje, coordinates - X: 560611, Y: 129621, UTM square: WM62, 413 m, 11.07.2002 and 09.08.2002
37. Planjsko near Majšperk, humid meadow W of the Šerbak farm, coordinates - X: 560800, Y: 130545, UTM square: WM63, 471 m, 11.07.2002
38. Podlehnik, dry cultivated grassland below the dam of Lake Dežno, coordinates - X: 567568, Y: 132234, UTM square: WM63, 233 m, 15.06.2003, observed by Rebeušek Franc
39. Podlehnik, humid meadows SW of the town, coordinates - X: 567981, Y: 132684, UTM square: WM63, 229 m, 10.07.2002
40. The village of Pohorje near Cirkulane, dry and humid meadows in the Belana stream valley near Mali Okič, coordinates - X: 575924, Y: 130836, UTM square: WM73, 255 m, 13.07.2002
41. Rodni Vrh at Podlehnik, cultivated meadow on the ridge S of the Hrvat farm along the road to the village of Rovce, coordinates - X: 564168, Y: 130827, UTM square: WM63, 370 m, 11.07.2002
42. Rodni Vrh at Podlehnik, dry grassland 100 m N of the Vindiš farm, coordinates - X: 564746, Y: 132356, UTM square: WM63, 373 m, 02.05.2003
43. Sedlašek at Videm, dry grasslands on the ridge E of the Kamen farm, Zgornje Gruškovje, coordinates - X: 568997, Y: 128946, UTM square: WM62, 448 m, 06.06.1999
44. Sitež at Majšperk, steep dry grassy slope W of the Dolič farm, coordinates - X: 559419, Y: 129237, UTM square: WM52, 294 m, 06.06.1999 and Verovnik (1996)
45. Skorišnjak at Cirkulane, cultivated meadow SW of Pristava, coordinates - X: 575854, Y: 132892, UTM square: WM73, 225 m, 13.07.2002
46. Skorišnjak at Cirkulane, pastures bellow the village on the slopes to Mali Okič, coordinates - X: 574644, Y: 130053, UTM square: WM73, 323 m, 06.06.1999
47. Skorišnjak at Cirkulane, ridge with dry grasslands E of the Frajglač farm, coordinates - X: 574588, Y: 130835, UTM square: WM73, 301 m, 13.07.2002
48. Soviče at Videm, cultivated meadow along a small tributary of the Psičina stream N of the village, coordinates - X: 572592, Y: 135350, UTM square: WM73, 226 m, 13.07.2002

49. Spodnje Gruškovje at Podlehnik, dry grassy slope between the Lipnica stream and the Cigler farm, coordinates - X: 569554, Y: 130514, UTM square: WM63, 352 m, 12.07.2002
50. Stanošina at Podlehnik, dry meadow along a path S of the village of Vranušek, coordinates - X: 567013, Y: 128876, UTM square: WM62, 341 m, 11.07.2002
51. Strajna at Videm, dry meadow and forest verge 200 m W of the Mlakar farm, coordinates - X: 565960, Y: 129894, UTM square: WM62, 295 m, 02.05.2003
52. Trdobojci near Videm, dry grasslands around the Oteno farm, coordinates - X: 570450, Y: 131306, UTM square: WM73, 370 m, 06.06.1999
53. Turški Vrh at Zavrč, Dry and cultivated meadows on the slope SE of the Habjanek farm, coordinates - X: 581575, Y: 134102, UTM square: WM83, 252 m, 14.07.2002 and 02.05.2003
54. Vareja at Videm, humid meadow along the Dravinja river N of Jaševar hill, coordinates - X: 571546, Y: 136372, UTM square: WM73, 211 m, 13.07.2002 and 09.08.2002
55. Velika Varnica at Podlehnik, humid meadows in the Psična stream valley SW of the Koštrunč farm, coordinates - X: 571286, Y: 127672, UTM square: WM72, 290 m, 12.07.2002
56. Veliki Okič at Cirkulane, humid meadow along the stream near the road to Veliki Okič, coordinates - X: 574094, Y: 132532, UTM square: WM73, 226 m, 13.07.2002
57. Veliki Okič at Cirkulane, humid meadow at the confluence of two small streams, on the road to Belavšek, coordinates - X: 573639, Y: 132499, UTM square: WM73, 225 m, 13.07.2002
58. Zakl at Podlehnik, cultivated meadow 100 m SW of the Vevečnik farm, coordinates - X: 566738, Y: 130538, UTM square: WM63, 263 m, 02.05.2003
59. Zakl at Podlehnik, humid and cultivated meadow on the E side of the road to Stanošina, coordinates - X: 566980, Y: 130283, UTM square: WM63, 240 m, 10.07.2002
60. Zavrč, sandbanks of the Drava River with willow forests NW of the town, coordinates - X: 580741, Y: 139217, UTM square: WM83, 199 m, 14.07.2002 and 09.08.2002
61. Zgornje Gruškovje at Podlehnik, dry grassland on the ridge 700 m NE of a small chapel, coordinates - X: 569284, Y: 129382, UTM square: WM62, 428 m, 12.07.2002
62. Zgornji Leskovec at Podlehnik, pastures and cultivated grasslands W of the town, near the Lipnica stream, coordinates - X: 571855, Y: 131841, UTM square: WM73, 229 m, 12.07.2002 and 02.05.2003
63. Zgornji Leskovec at Podlehnik, pastures and forest verge on the slopes 300 m E of the town, coordinates - X: 572770, Y: 132095, UTM square: WM73, 248 m, 15.6.2002, observed by Rebeušek Franc
64. Žetale, bushes and dry grassy slopes near the road 400 m W of the Church of St. Marija, coordinates - X: 560470, Y: 125649, UTM square: WM62, 356 m, 09.08.2002 and 02.05.2003, observed by Rebeušek Franc
65. Žetale, dry grasslands and bushes on the S slope to the Church of St. Marija W of the town, coordinates - X: 560957, Y: 125443, UTM square: WM62, 306 m, 17.07.2003
66. Žetale, dry meadow and forest verge E of the village of Podpeč, coordinates - X: 562676, Y: 126374, UTM square: WM62, 308 m, 17.07.2003
67. Žetale, humid cultivated meadow NW of the village of Čret, coordinates - X: 562520, Y: 125754, UTM square: WM62, 284 m, 10.07.2003

List of localities

Table 1: Distribution of butterflies in the Haloze area. The localities are numbered as in the List of localities chapter. The threat status in Slovenia (SLO) according to the new Red Data Book (Ur.l. RS, MP82/02: 8893-8975) and the inclusion in the *FFH directive* (FFH) annexes are indicated (*Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora*). The taxonomy and nomenclature are according to Karsholt & Razowski (1996).

Tabela 1: Razširjenost vrst dnevnih metuljev v Halozah. Lokalitete so oštevilčene kot v seznamu lokalitet. Prikazana sta še varstveni status v Sloveniji (SLO) na podlagi novega Rdečega seznama (Ur.l. RS, MP82/02: 8893-8975) in vključitve v sezname *Direktive o habitatih* (FFH) (*Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora*). Taksonomija in nomenklatura sta povzeti po Karsholt & Razowski (1996).

Species	Localities	SLO	FFH
PAPILIONIDAE			
Papilio machaon	3, 5, 6, 28, 30, 34, 36, 38, 41, 51, 61, 63, 63, 65		
Iphiclides podalirius	3, 4, 5, 6, 7, 10, 11, 13, 14, 15, 17, 18, 19, 20, 21, 23, 26, 27, 28, 29, 30, 31, 32, 33, 35, 36, 37, 39, 44, 45, 47, 49, 50, 53, 55, 61, 63, 65, 66, 67		
Parnassius mnemosyne	3	V	♦
PIERIDAE			
Pieris brassicae	14, 17, 27, 36, 46, 50, 65		
Pieris rapae	3, 4, 5, 6, 6, 7, 10, 13, 14, 17, 20, 28, 29, 30, 31, 32, 33, 36, 37, 38, 41, 42, 44, 48, 49, 53, 54, 55, 57, 60, 61, 65, 66, 67		
Pieris mannii	5, 6, 11, 15, 18, 21, 25, 27, 40	V	
Pieris napi	2, 3, 10, 11, 22, 24, 27, 42, 54, 58, 60, 63, 65		
Antocharis cardamines	3, 5, 6, 11, 28, 42, 51, 53, 58, 63, 65		
Pontia daplidice	5, 17, 18, 49, 50, 61		
Colias croceus	5, 6, 13, 14, 30, 33, 34, 44, 45, 53, 60, 63, 64, 65, 66, 67, 68		
Colias hyale	4, 62		
Colias alfacariensis	5, 6, 13, 14, 15, 18, 19, 20, 21, 23, 29, 30, 36, 37, 44, 47, 49, 50, 53, 57, 61, 68		
Gonepteryx rhamni	6, 10, 11, 12, 14, 16, 18, 19, 21, 22, 23, 24, 26, 27, 28, 29, 33, 50, 53, 54, 57, 65		
Leptidea sinapis/reali	2, 3, 5, 6, 7, 8, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 24, 25, 26, 27, 28, 29, 31, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 44, 45, 47, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 60, 61, 63, 64, 65, 66, 67, 68		
LYCAENIDAE			
Callophrys rubi	5, 53		
Thecla betulae	15		
Satyrium acaciae	11, 14, 21, 23, 36		
Satyrium spini	17, 23, 36, 37		
Satyrium pruni	65		
Satyrium w–album	11, 21, 40		
Lycaena phlaeas	5, 14, 36, 54, 63, 64, 65, 66		
Lycaena dispar	1, 2, 5, 10, 33, 38	V	♦
Lycaena virgaureae	2, 6, 19, 21, 27, 32, 62		
Lycaena tityrus	5, 12, 13, 18, 20, 21, 22, 27, 29, 32, 33, 34, 35, 37, 40, 44, 47, 48, 53, 54, 55, 56, 59, 65, 66		
Lycaena alciphron	2	V	
Lycaena hippothoe	10, 29, 57	V	
Leptotes pirithous	54		
Everes decoloratus	3	R	

Species	Localities	SLO	FFH
Everes argiades	3, 4, 5, 6, 9, 10, 12, 13, 14, 15, 16, 20, 23, 25, 28, 30, 31, 35, 36, 38, 42, 44, 45, 47, 48, 50, 51, 53, 54, 56, 57, 58, 60, 63, 64, 65, 66, 67, 68		
Cupido minimus	31, 66		
Celastrina argiolus	3, 7, 10, 11, 13, 16, 21, 29, 31, 32, 38, 51, 53, 54, 57, 60, 65		
Glaucopsyche alexis	52		
Maculinea teleius	10, 26, 29, 30, 32, 39, 45, 54, 59	V	♦
Maculinea nausithous	10, 29, 30, 32, 54	V	♦
Maculinea arion	5, 6, 14, 18, 19, 20, 21, 23, 31, 36, 37, 40, 44, 50, 53, 65, 66, 67	V	♦
Plebeius argyrognomon	6, 13, 15, 23, 35, 36, 40, 53	V	
Plebeius argus	6, 44, 66		
Plebeius idas	3, 4, 5, 6, 7, 8, 9, 14, 23, 25, 32, 34, 35, 36, 44, 46, 49, 50, 52, 53, 55, 57	V	
Aricia agestis	14, 18, 20, 21, 22, 23, 37, 49, 66		
Cyaniris semiargus	2, 3, 13, 29, 33, 47, 56, 57, 67		
Polyommatus thersites	5, 6, 11, 14, 18, 19, 23, 27, 34, 36, 37, 47, 50, 53, 61, 66	E	
Polyommatus dorylas	14, 40, 43, 52, 54, 67		
Polyommatus icarus	2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 24, 25, 26, 27, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 43, 44, 44, 45, 46, 47, 48, 49, 50, 52, 53, 54, 55, 56, 57, 59, 60, 61, 63, 64, 65, 66, 67, 68	V	
Meleageria bellargus	5, 14, 36		
Meleageria daphnis	5, 6, 12, 14, 20, 21, 22, 23, 36, 44, 47, 49, 53, 61		
RIODINIDAE			
Hamearis lucina	3, 5, 6, 7, 8, 9, 10, 12, 14, 16, 18, 24, 25, 27, 28, 29, 31, 32, 35, 40, 47, 48, 50, 53, 54, 55, 56, 58, 65, 67		
NYMPHALIDAE			
Apatura iris	16, 32		
Apatura ilia	27, 54, 60	V	
Limenitis reducta	4, 31, 54		
Limenitis camilla	60		
Neptis sappho	11, 16, 24, 27, 48, 54, 56, 60, 62		
Neptis rivularis	16, 55		
Nymphalis antiopa	33		
Inachis io	9, 14, 21, 22, 24, 27, 28, 30, 32, 39, 50, 53, 54, 57, 58, 60, 65		
Vanessa atalanta	5, 6, 9, 16, 21, 23, 24, 31, 36, 38, 40, 53, 54, 60, 65		
Vanessa cardui	3, 5, 7, 14, 15, 19, 28, 30, 33, 36, 42, 51, 53, 58, 63, 65, 66, 68		
Aglais urticae	5, 21, 27, 52, 62		
Polygonia c-album	2, 3, 6, 13, 16, 21, 24, 29, 50, 52, 54, 55, 60, 62		
Araschnia levana	1, 3, 4, 5, 6, 9, 10, 10, 11, 14, 16, 18, 20, 21, 23, 24, 27, 29, 31, 32, 33, 35, 36, 38, 40, 48, 50, 52, 53, 54, 55, 58, 60, 64, 65, 68		
Argynnis paphia	21, 44, 62		
Argynnis aglaja	29		
Argynnis adippe	21		
Argynnis niobe	2		
Issoria lathonia	4, 6, 11, 12, 13, 15, 18, 27, 29, 30, 35, 47, 63, 65, 68		
Brenthis daphne	5, 6, 7, 10, 11, 14, 16, 18, 20, 21, 26, 27, 29, 32, 35, 36, 37, 38, 41, 44, 49, 52, 56, 64, 68		
Clossiana selene	2, 29	V	

Species	Localities	SLO	FFH
Clossiana dia	3, 5, 6, 9, 10, 13, 14, 20, 28, 33, 34, 36, 40, 42, 50, 51, 53, 54, 57, 64, 65, 67		
Melitaea phoebe	3, 4, 5, 6, 7, 9, 10, 12, 13, 14, 18, 19, 29, 30, 32, 33, 35, 40, 44, 46, 47, 52, 53, 63, 66, 67, 68		
Melitaea didyma	4, 6, 12, 13, 14, 29, 30, 34, 36, 43, 44, 47, 48, 53, 61, 63, 64, 65, 66		
Melitaea diamina	57	V	
Melitaea britomartis	43, 44	V	
Melitaea athalia	2, 5, 6, 9, 10, 13, 26, 28, 29, 30, 31, 32, 33, 34, 38, 44, 45, 46, 47, 48, 48, 52, 53, 54, 55, 63, 64, 65, 66, 67, 68		
Melanargia galathea	2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 14, 16, 17, 18, 19, 20, 23, 24, 27, 29, 31, 32, 33, 35, 36, 37, 38, 40, 41, 43, 44, 45, 46, 47, 48, 49, 52, 54, 55, 56, 57, 59, 61, 63, 64, 66, 67, 68		
Hipparchia fagi	5, 6, 14, 17, 21, 34, 46, 49, 61, 62		
Minois dryas	3, 4, 5, 6, 8, 12, 14, 15, 23, 24, 29, 31, 32, 34, 35, 36, 40, 44, 47, 49, 54, 61, 66		
Brintesia circe	14, 18, 20, 32, 47, 52, 64		
Erebia aethiops	16, 24, 27, 62		
Maniola jurtina	2, 3, 4, 5, 6, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 23, 24, 25, 26, 27, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 43, 44, 45, 46, 47, 48, 49, 50, 52, 53, 54, 55, 56, 57, 59, 63, 64, 65, 66, 67, 68		
Aphantopus hyperantus	3, 5, 6, 7, 9, 10, 12, 16, 18, 19, 20, 21, 23, 27, 29, 31, 32, 33, 35, 36, 40, 41, 47, 50, 55, 60, 66, 67		
Coenonympha pamphilus	2, 3, 4, 5, 5, 6, 9, 10, 11, 12, 13, 14, 15, 18, 19, 25, 28, 31, 33, 34, 35, 36, 37, 38, 39, 44, 45, 47, 48, 49, 53, 54, 56, 57, 59, 60, 63, 63, 64, 65, 66, 67, 68		
Coenonympha arcania	42, 43, 44, 52		
Coenonympha glycerion	2, 4, 5, 6, 13, 14, 34, 36, 38, 44, 46, 52, 54, 64, 65, 66		
Pararge aegeria	3, 24, 54		
Lasiommata maera	52		
Lasiommata megera	5, 11, 14, 17, 19, 28, 35, 36, 37, 42, 49, 50, 54, 58, 59, 64, 65, 66		
HESPERIIDAE			
Pyrgus malvae	6, 13, 32, 35, 44, 53, 54, 55, 57, 58, 63, 65, 66, 67		
Pyrgus armoricanus	6, 9, 14, 33, 57, 65	V	
Spialia sertorius	5, 6, 18, 28, 36, 49, 53		
Carcharodus alceae	6, 11, 14, 17, 18, 22, 27, 40, 44, 49, 53, 57	V	
Erynnis tages	3, 4, 5, 6, 6, 9, 10, 12, 13, 14, 15, 18, 20, 21, 23, 28, 29, 30, 32, 33, 35, 36, 37, 40, 41, 42, 44, 45, 48, 49, 50, 51, 53, 54, 55, 56, 57, 58, 61, 63, 65, 66, 67, 68		
Carterocephalus palaemon	28, 51, 53		
Heteropterus morpheus	6, 8, 14, 16, 17, 18, 20, 23, 24, 27, 29, 32, 35, 40, 41, 44, 49, 50, 55, 61, 67		
Thymelicus lineola	3, 6, 8, 9, 13, 20, 29, 30, 33, 40, 44, 46, 47, 52, 56, 61, 63		
Thymelicus sylvestris	6, 7, 8, 9, 10, 12, 18, 19, 20, 21, 23, 29, 36, 38, 40, 45, 49, 64, 65, 66, 68		
Hesperia comma	5, 65		
Ochlodes venata	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 16, 17, 19, 20, 21, 23, 24, 26, 27, 29, 31, 32, 35, 36, 38, 40, 41, 47, 48, 50, 53, 54, 55, 56, 57, 60, 61, 67		

Diversity distribution and coverage of the region

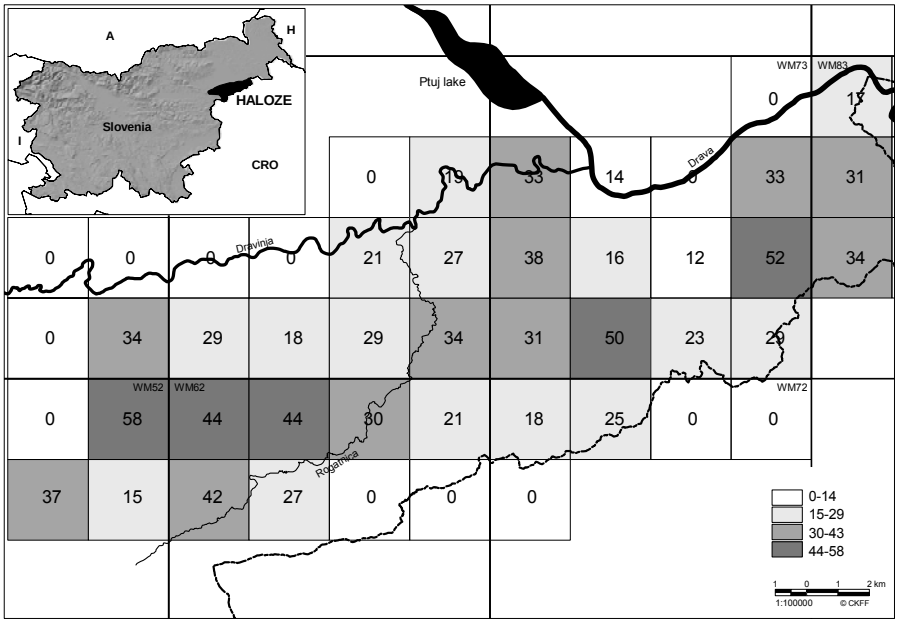

Figure 1: Pattern of the butterfly diversity in Haloze. The grid size is 2.5 km^2 and is based on UTM squares (1/16). The absolute numbers of species observed are given in the centre of each grid. The shading intensity increases with the number of observed species. The position of Haloze in Slovenia is given.
Slika 1: Vzorec razporeditve pestrosti dnevnih metuljev v Halozah. Stranica kvadratov je dolžine 2.5 km^2 in temelji na UTM mreži (1/16). Številke v sredini vsakega kvadrata ponazarjajo skupno število opaženih vrst metuljev. Intenziteta senčenja narašča s povečevanjem pestrosti. Podana je lega Haloz v Sloveniji.

To achieve a higher resolution, the UTM squares covering the Haloze area were divided into 16 squares measuring 2,5 km x 2,5 km. Except for the few bordering squares, all were visited at least once. Those on the northern border were superficially surveyed from the car, but no promising sites were observed. The only area deserving further attention is the forested hilly region E of Žetale on the border with Croatia. As the Haloze area is relatively well covered with the visited localities, some basic inferences on the diversity distribution are possible. The highest numbers of species were observed in the extreme western part of Haloze. This could be explained with high habitat diversity ranging from humid forested valleys to extreme thermophilous grasslands on steep slopes. Similar butterfly diversity was observed in two squares in the eastern part of Haloze, where humid grasslands still host some of the rare and threatened hygrophilous butterfly species. In general, the butterfly diversity is

lower around the Rogatnica River and in the northern part of Haloze, where farming is more intensive owing to a better accesiblitiy.

Discussion

General observations

If the geography and geology of the Haloze area are taken into consideration, one could conclude that the region hosts low butterfly diversity due to lack of calcareous areas and vertical span. The present research proved, quite on the contrary, that the region has one of the highest species counts in inland Slovenia with nearly 100 species recorded. The reason for such unexpected high butterfly diversity is the presence of extensively used grasslands and their heterogeneity. The hilly relief provides different inclinations and expositions of the thermophilous grasslands, which are additionally diversified by natural erosion, different levels of shrub encroachment and grazing. The remains of humid grasslands in the valleys of the eastern part of Haloze still provide shelter for many specialised and endangered butterfly species. Further surveys in May and June could bring discoveries of further species and new records of some underrecorded species. Among these, we could mention *Apatura ilia* (Denis & Schiffermüller, 1775), *Limenitis camilla* (Linne, 1758) and *Neptis rivularis* (Scopoli, 1763), whose suitable habitats occur commonly throughout the region.

The most surprising was the high diversity of butterflies in dry grasslands and the wide distribution of some otherwise rare thermophilous species. *Pieris mannii* (Mayr, 1851) was recorded for the first time in NE Slovenia. Its occurrence in inland Slovenia is very sporadic except for the SE part, where the species is locally common (Verovnik & Škvarč 2002). Among rare lycaenid thermophilous species, *Maculinea arion* (Linne, 1758), *Meleageria daphnis* (Denis & Schiffermüller, 1775), *Plebeius idas* (Linne, 1758) and *Polyommatus thersites* (Cantener, 1825) were commonly observed. The latter has been so far considered extremely rare in central Slovenia with only few scattered records around Ljubljana, Zasavje and Slovenske Gorice. The thermophilous character of the entire Haloze area is best illustrated by wide distribution of *Iphiclides podalirius* (Linne, 1758), *Melitaea phoebe* (Denis & Schiffermüller, 1775), *Melitaea didyma* (Esper, 1778) and *Erynnis tages* (Linne, 1758). These species were commonly observed also in the degraded and intensively farmed meadows. Despite higher expectations, only two species of large satyrids were present in the region. *Brintesia circe* (Fabricius, 1775) is widespread in Slovenia and was relatively rare in Haloze, while the more

thermophilous *Hipparchia fagi* (Scopoli, 17863) was more common here as in the other parts of inland Slovenia.

The humid grassland species have a much more limited distribution in Haloze and should be considered much more vulnerable to extinction. The *Maculinea teleius* (Bergsträsser, 1779) and *M. nausithous* (Bergsträsser, 1779) occurred syntopically at few sites in the eastern pat of the area. The first species was found in more degraded habitats of the Rogatnica valley as well. Other hygrophilous species were even less common. *Lycaena alciphron* (Rottemburg, 1775), *L. hippothoe* (Linne, 1761), *Clossiana selene* (Denis & Schiffermüller, 1775) and *Melitaea diamina* (Lang, 1789) were found only at a single or up to three sites. Although they are not considered threatened in Slovenia in general, they show a similar limited distribution in Haloze as in the Goričko area (Verovnik 2000).

Along with some of the previously mentioned thermophilous species, the ecological generalists, such as *Pieris rapae* (Linne, 1758), *Polyommatus icarus* (Rottemburg, 1775), *Araschnia levana* (Linne, 1758), *Melanargia galathea* (Linne, 1758), *Maniola jurtina* (Linne, 1758), *Coenonympha pamphilus* (Linne, 1758) and *Ochlodes venata* (Bremer & Gray, 1853) were among the most commonly observed species. Some of the forest or forest verge species, like *Apaturia iris* (Linne, 1758), *Argynnis paphia* (Linne, 1758), *Argynnis aglaja* (Linne, 1758) and *Pararge aegeria* (Linne, 1758), had much more limited distribution than in other parts of central Slovenia. *Argynnis aglaja* along with other two large fritillaries *(A. adippe* (Denis & Schiffermüller, 1775) and *A. niobe* (Linne, 1758)) are still common in the southwestern part of Slovenia, but have become increasingly rare in the other parts of the country (personal observations). Similar declines have been observed in other parts of Central and northern Europe (Settele et al. 2000, Asher et al. 2001, Beneš & Konvička 2002).

The conservation value of Haloze

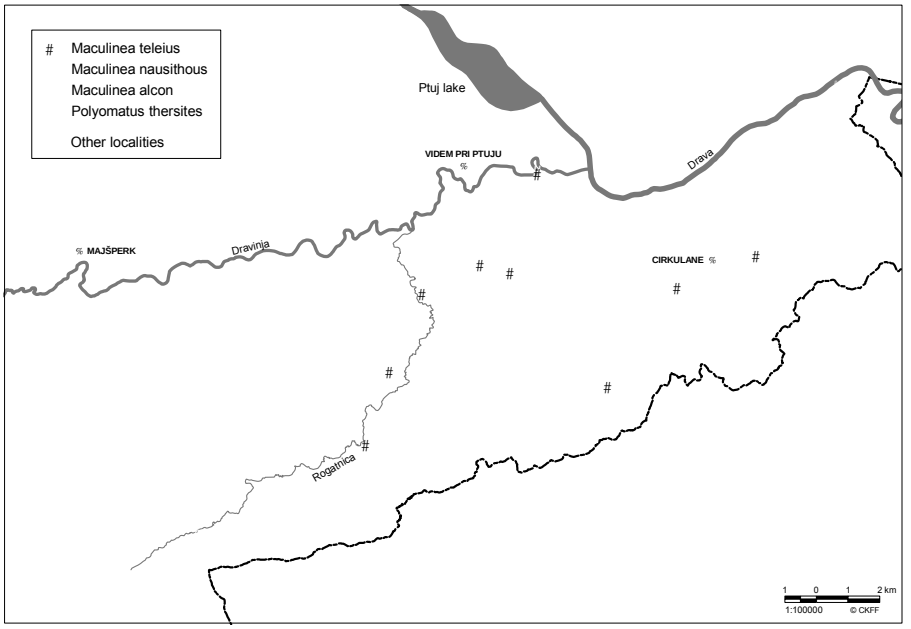

Figure 2: The distribution of threatened and *FFH directive* butterfly species considered endangered in Slovenia in the area of Haloze. Overlapping of the presence of two species in the same locality is indicated by combined symbols.
Slika 2: Razširjenost ogroženih vrst dnevnih metuljev v Halozah ter tistih vrst iz *Direktive o habitatih*, ki so v Sloveniji ogrožene. Pojavljanje dveh vrst na isti lokaliteti je prikazana s prekrivajočimi se simboli.

Twenty of the 96-recorded species are included in the *Red Data Book of Slovenia (Ur.l. RS, MP82/02: 8893-8975)*. Only a single species *Polyommatus thersites* is considered threatened (IUCN old category: E) in Slovenia. It has one of its distribution centres in the western part of Haloze. As its presence mostly coincides with the distribution of *Maculinea arion* (Fig. 2), a vulnerable species also listed in the *Annex IV* of the *FFH directive*, their habitats should be given a high conservation priority in Haloze. These dry grasslands also host the highest diversity of butterflies in the area (Fig. 1) and are present in sufficient numbers to support a potential metapopulation structure of most lycaenid species. Much more research would have to be carried out as certain specific ecological requirements of each species and to recommend exact conservation measures. Nevertheless, a continued current use of the grasslands with the same intensity should preserve the rare and endangered butterfly species.

Revitalisation of the abandoned dry grasslands and extensive grazing would certainly have a further positive effect on the distribution of these species.

Although the humid grasslands are much more limited in their size and number, they still host the majority of the hygrophilous species present in Slovenia. Despite isolation, the high density of both *Maculinea teleius* and *M. nausithous* at some of the sites gives us new hope for their long-term survival. As these two lycaenids and *Lycaena dispar* (Haworth, 1802) are the priority species for conservation in Europe, Slovenia is liable to protect a sufficient part of its populations with inclusion in the Natura 2000 network. The designation of some of the sites in Haloze as Natura 2000 areas could enable proper management and restoration of the nearby more intensively farmed humid grasslands. According to the present survey, the following sites could be included:

- (10) Duga at Cirkulane - all three species are present. The bordering grasslands would require minimum alterations in their use, especially mowing, to enable expansion of these species.
- (29, 30) The upper part of the Črna stream valley - the potentially largest site with both *Maculinea* species. Currently, two large density sites are connected by approximately a kilometre of intensively cultivated humid grasslands, where *Sanguisorba oficinalis* L. is present in low numbers. Only minimum management and limitations of the mowing period would enable expansion of both species.
- (32) Mala Varnica in the Psičina stream valley - both *Maculinea* species are present in great numbers. The site is threatened due to its abandonment and encroachment by tall herbs. The neighbouring grasslands are already unsuitable due to the prevailing tall herb vegetation. Only regular mowing, which would suppress and remove the tall herbs after the first larval stages of both species are completed (late September), would enable their survival.

Some further sites in the eastern part of Haloze should be monitored for possible discovery of *Colias myrmidone*. These sites have a suitable habitat structure and large number of its potential larval foodplant *Chamaecytisus supinus* L. (Beneš & Konvička 2002). The Haloze area could also provide further clues about the habitat requirements and distribution of the rare lycaenid *Everes decoloratus*, whose presence in Slovenia is not well known. Haloze have surprisingly high butterfly diversity and would deserve a further faunistic research and more conservation efforts.

Povzetek

Haloze sodijo med zoološko najmanj raziskane dele Slovenije. O njihovih dnevnih metuljih je bilo doslej objavljenih le nekaj posameznih podatkov (Jež 1983, Verovnik 1996) o skupno 25 vrstah. Tako je bil glavni namen terenskih raziskav v letih 1999, 2002 in 2003 v čim večjem obsegu raziskati celotno območje. Poudarek raziskav je bil predvsem na sonaravno izkoriščanih termofilnih in higrofilnih traviščih, kjer je pestrost dnevnih metuljev potencialno največja. Geografsko lahko Haloze razdelimo na zahodni, bolj gozdnat in hribovit del, ter vzhodni, bolj gričevnat del. Loči ju dolina Rogatnice, ki je eno izmed najbolj intenzivno obdelanih območij Haloz.

Zaradi majhnega vertikalnega razpona in enotne geološke podlage je bilo 96 ugotovljenih vrst dnevnih metuljev visoko nad pričakovanji. Predvsem je bila presenetljiva velika pestrost metuljev suhih travišč v zahodnem delu Haloz, kjer je bilo pogosto na isti lokaliteti opaženih več vrst v osrednji Sloveniji sicer redkih in ogroženih vrst metuljev. V prvi vrsti velja omeniti modrine *Maculinea arion* (Linne, 1758), *Meleageria daphnis* (Denis & Schiffermüller, 1775), *Plebeius idas* (Linne, 1758), *Polyommatus thersites* (Cantener, 1825) ter belina *Pieris mannii* (Mayr, 1851). V vzhodnem delu Haloz je pestrost dnevnih metuljev na suhih traviščih praviloma manjša, vendar še obstajajo fragmenti vlažnih travišč, kjer še najdemo skoraj vse slovenske specializirane higrofilne vrste dnevnih metuljev. Zelo redka sta pisančka *Clossiana selene* (Denis & Schiffermüller, 1775) in *Melitaea diamina* (Lang, 1789), v večjih gostotah pa se lokalno pojavljata *Maculinea teleius* (Bergsträsser, 1779) in *M. nausithous* Bergsträsser, 1779.

Naravovarstveno so pomembna suha travišča v zahodnem delu Haloz, kjer se sintopo pojavljata dve ogroženi vrsti modrinov *Polyommatus thersites* in *Maculinea arion* (Sl. 2). Njihov obstoj najbolj ogroža zaraščanje, kot posledica opuščanja košnje. Skupaj z *Lycaena dispar* (Haworth, 1802) sodita med najpomembnejše vrste za varovanje v Evropi med metulji Haloz uvrščeni še *Maculinea nausithous* in *M. teleius*. Za te vrste je Slovenija dolžna zavarovati večji del populacij in njihov življenjski prostor v okviru mreže Natura 2000. Z vključitvijo nekaterih območij iz vzhodnega dela Haloz v to mrežo bi lahko zagotovili pravilno upravljanje in renaturacijo sosednjih intenzivneje izkoriščanih vlažnih travnikov. Glede na dosedanje terenske raziskave bi tak status lahko pripisali območjem:

- (10) Duga pri Cirkulanah - pojavljajo se vse tri vrste. Sosednja travišča bi lahko izboljšali že z omejitvami košnje v času letanja imagov in prvih larvalnih stadijev.
- (29, 30) Zgornji del doline potoka Črna - potencialno največje območje, kjer se pojavljata obe vrsti iz rodu *Maculinea*. Trenutno sta dve populaciji z veliko gostoto imagov ločeni s približno kilometrom intenzivno rabljenih vlažnih travnikov, kjer je hranilno rastlino *Sanguisorba oficinalis* L. opaziti le v manjšem številu. Že z omejitvami košnje v času letanja imagov in prvih larvalnih stadijev bi lahko zagotovili razširitev areala obeh vrst.
- (32) Mala Varnica, v dolini potoka Psičina - obe vrsti iz rodu *Maculinea* z veliko gostoto imagov. Območje je ogroženo predvsem zaradi opuščanja rabe in širjenja visokih steblik. Le z redno košnjo v poznem septembru bi lahko omogočili preživetje teh populacij in razširitev ustreznega habitata na sosednje že zaraščene travnike.

V Halozah je bila ugotovljena presenetljivo visoka pestrost dnevnih metuljev. Zaradi tega si to območje zagotovo zasluži nadaljnje favnistične raziskave in več naravovarstvenih prizadevanj.

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Opazovanja kolonije belorobega netopirja *Pipistrellus kuhlii* v Krašnji (osrednja Slovenija) v letu 2002 - spremembe številčnosti, čas izletavanja in prehranjevalni habitati

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Izvleček. V prispevku so podana opazovanja 20 belorobih netopirjev, ki so se zadrževali v špranji pod zunanjim opažem stanovanjske hiše od marca do oktobra leta 2002. Največje število osebkov je bilo zabeleženih meseca maja. Prvi belorobi netopir je izletel povprečno 18,3 minute po sončnem zahodu. Belorobi netopirji so se prehranjevali v bližini cestnih luči.

Ključne besede: Chiroptera, belorobi netopir, zatočišče, čas izletavanja, prehranjevalni habitati

Abstract. MONITORING OF THE KUHL'S PIPISTRELLE *PIPISTRELLUS KUHLII* COLONY AT KRAŠNJA (CENTRAL SLOVENIA) IN 2002 - CHANGES IN THEIR NUMBERS, EMERGENCE TIME AND FORAGING HABITATS - A small colony of about 20 Kuhl's pipistrelles occupied fissures behind the weatherboarding of an apartment house from April to November, most numerous being in May. Mean first emergence of Kuhl's pipistrelle was 18,3 minutes after the sunset. The bats were later seen foraging around street lamps.

Key words: Chiroptera, *Pipistrellus kuhlii*, roost, emergence, foraging habitats, Slovenia

Uvod

Belorobi netopir (*Pipistrellus kuhlii*) živi v južni in zahodni Evropi. Severna meja njegove razširjenosti poteka od centralne Francije prek Švice, Avstrije in Madžarske do južne Ukrajine in Bolgarije (Vernier & Bogdanowicz 1999), videti pa je, da je pri nas splošno razširjen (Koselj 2000, 2001, Koselj & Aupič 2001, Presetnik 2001, 2002a, b, Presetnik & Žibrat in prep.). Kljub temu da za zatočišča pogosto uporablja dele stanovanjskih stavb (Vernier & Bogdanowicz

1999) in drugih objektov v urbanih okoljih (Vernier 1995), ni veliko poročil o biologiji belorobega netopirja v Sloveniji. Zato smo se leta 2002 posvetili spremljanju sprememb števila belorobih netopirjev v hiši v Krašnji, času njihovega večernega izletavanja in iskanju njihovih prehranjevalnih habitatov.

Metode

Zbrali smo vsa pričanja o bivanju netopirjev v enostanovanjski hiši v Krašnji. Naselje leži na nadmorski višini 370 m, na severovzhodnem pobočju sto do tristo metrov široke doline, katere velik del zavzemata regionalna in nova avtocesta Ljubljana-Maribor. Na dnu doline je še nekaj polj in travnikov, ob južnem robu pa teče v precejšnji meri regulirana rečica Radomlja. Pobočja doline so večinoma poraščena z mešanim gozdom.

Dnevno smo spremljali prisotnost netopirskih iztrebkov pod opaži na zahodni in vzhodni strani hiše. Na netopirje smo zvečer čakali ob njihovih izletalnih odprtinah, izbira opazovalnega prostora pa je temeljila na količini iztrebkov, ki so bili na dan opazovanja najdeni pod opažem. Vse najdene iztrebke smo posušili na zraku in jih spravili v nepredušno zaprte posode, tako da so na voljo za raziskavo sestave prehrane belorobega netopirja. Beležili smo tudi temperaturo zraka in druge vremenske razmere. Kot čas sončnega zahoda smo upoštevali srednjeevropski čas ob zahodu sonca v Ljubljani (Razinger et al. 2002). Povezavo med časom izletavanja in sončnim zahodom smo ugotavljali s programom SPSS (SPSS 10.0.1 for Windows, SPSS Inc.). Dvakrat smo mrežili pred izletalnimi odprtinami. Ugotovoli smo vrsto, spol, starost in reprodukcijsko stanje ujetih netopirjev (Racey 1990) in jih nato izpustili. Belorobe netopirje smo iskali z ultrazvočnimi detektorji tipa Peterson 200 in Tranquility II v njihovih prehranjevalnih habitatih v dolini potoka Radomlja v okolici Krašnje. Pregledali smo najrazličnejše habitate (gozd, rob gozda, obvodno rastje, njive, cestne luči). Pri delu z ultrazvočnimi detektorji smo upoštevali vire: Ahlen (1990), Limpens & Roschen (1995), Barataud (1996) in Russo & Jones (1999).

Rezultati in razprava

Zatočišče belorobih netopirjev

Belorobi netopirji so se zadrževali v manj kot 2 cm široki špranji med zidom in zunanjim lesenim opažem, približno 5 m nad tlemi. Tam so se naselili že jeseni 1978, takoj ko je bila dokončana fasada in nameščen opaž. Ker jih stanovalci niso preganjali, so za svoja poletna zatočišča redno uporabljali špranjaste prostore za opažem na zahodni ali vzhodni strani hiše. Sodeč po količini opaženih iztrebkov se je število tam skrivajočih netopirjev med posamezno poletno sezono spreminjalo.

Glede na poletni čas zadrževanja pod opaži so netopirji uporabljali zatočišče tudi za kotišče. To domnevo podpirjo najdba onemogle samice z mladičem 9. julija 1996 in rezultati mreženj leta 2001 (opaženih 34 izletelih osebkov) in 2002, ko smo ulovili doječe samice ali samice, ki so najmanj enkrat že dojile, ter mlade osebke belorobih netopirjev (Tab. 1). Poroženele bradavice netopirk smo vzeli kot znamenje, da je samica najmanj enkrat v življenju že dojila (Racey 1990).

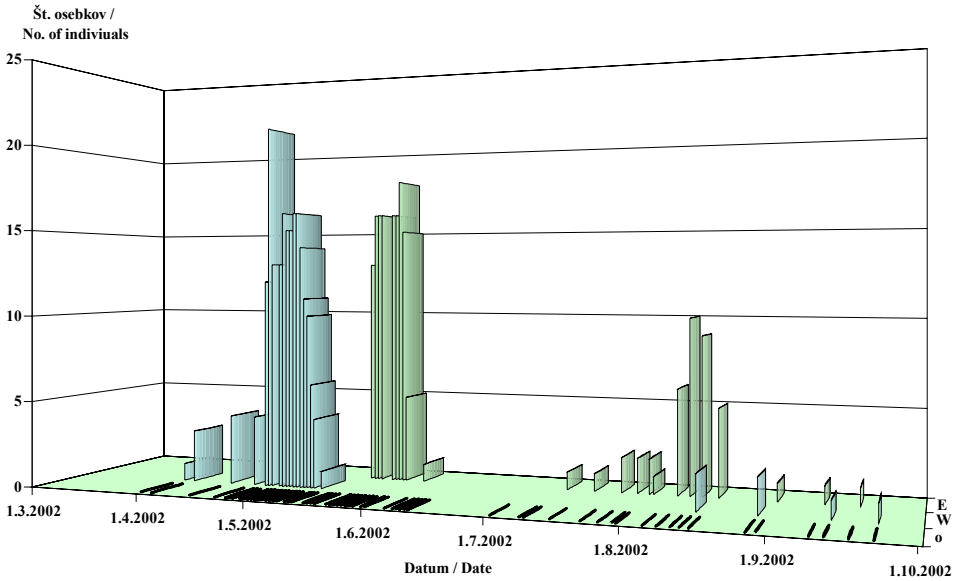
Tabela 1: Podatki o ulovljenih belorobih netopirjih (*Pipistrellus kuhlii*) v Krašnji v letih 2001/02 (AD - odrasel, JUV - mladič, ♂ - samec, ♀ - samica, AB - dolžina podlakti).
Table 1. Data on Kuhl's pipistrelle (*Pipistrellus kuhlii*) caught at Krašnja in 2001/02 (AD - adult, JUV - juvenile, ♂ - male, ♀ - female, AB - forearm length).

Datum/ Date	Starost/ Age	Spol/ sex	Reprodukcijsko stanje/ Repoduction state	AB [mm]	Masa/ Weight [g]
24.7.01	JUV	♂	/	34,5	5,5
24.7.01	AD	♀	doji / lactating	36,5	7
24.7.01	JUV	♀	/	35,7	6
24.7.01	JUV	♀	/	34,2	6
24.7.01	AD	♀	doji / lactating	34,5	5
26.4.02	AD	♂	/	36,4	/
26.4.02	AD	♀	še ni dojila / nulliparous	35,5	/
26.4.02	AD	♀	predhodno leto dojila / lactated previous year	36,0	/
26.4.02	AD	♀	predhodno leto dojila / lactated previous year	34,5	/

Število in čas zadrževanja belorobih netopirjev

Netopirji so zasedali prostore za opaži od približno 22. marca do 14. oktobra 2002, ko smo prvič in zadnjič opazili netopirske iztrebke pod opaži. Sprva so se zadrževali pod zahodnim opažem od 22. marca, ko je bil opažen prvi iztrebek, do 10. maja, ko nismo več opazili izletov netopirjev izpod zahodnega opaža. Število izletelih netopirjev se je zmanjševalo že šest

predhodnih dni (Sl. 1). Toda 15. maja smo na vzhodni strani hiše našteli skoraj identično število izletelih osebkov, kot smo jih videvali deset dni predtem na zahodni strani. Zato je najverjetneje, da je celotna kolonija le zamenjala mesto zatočišča. Netopirji so se zadrževali pod vzhodnim opažem do 25. maja, ko se je večina osebkov odselila na neznano lokacijo (Sl. 1). Posamezni osebki so se zadrževali pod opažem vse poletje, kar smo lahko posredno sklepali tudi po najdenih iztrebkih. V večjem številu so se belorobi netopirji vrnili v začetku avgusta, ko so se vnovič naselili na vzhodni strani hiše. Vendar je bilo število netopirjev približno za polovico manjše od njihovega največjega števila, opaženega spomladi (Sl. 1).



Slika 1. Spremembe številčnosti in mesta zadrževanja kolonije belorobih netopirjev za zunanjimi opaži stanovanjske hiše v Krašnji (o - datum neposrednih opazovanj; W / E - netopirji so se zadrževali za zahodnim / vhodnim zunanjim opažem).
Figure 1. Changes in numbers and roosting place of Kuhl's pipistrelle colony behind weatherboarding of a residential house at Krašnja (o - observations dates; W / E - bat occupied fissures behind west / east weatherboarding).

Opažanja v letu 2002 so potrdila vzorec predhodnih let, ko so netopirji uporabljali zatočišči tako na vzhodni kot zahodni strani hiše, številčnost kolonije pa se je med poletnimi meseci spreminjala.

Menjavo poletnih zatočišč malih netopirjjev (*Pipistrellus pipistrellus*) sta v Nemčiji preučevala Feryerabend & Simon (2000), katerih opazovana kolonija je prek poletja uporabljala osem zatočišč, ki so bila med seboj v povprečju oddaljena približno 900 metrov. V dveh zaporednih sezonah so mali netopirji uporabljali zatočišča v podobnem vrstnem redu, v

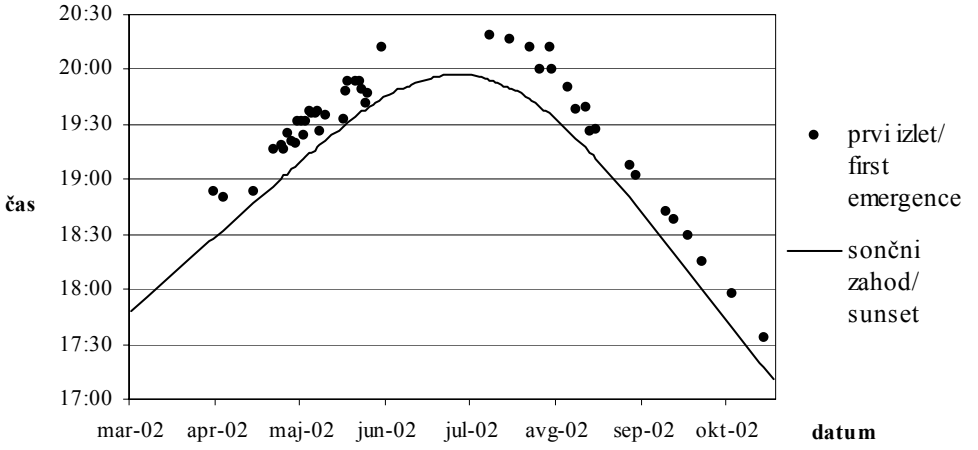
njih pa so se zadrževali 7-19 dni. Čas zadrževanja v posameznem zatočišču je podoben našim opazovanjem, ko se je se kolonija belorobih netopirjev (več kot 5 osebkov) zadrževala v istem zatočišču enkrat 13 in dvakrat po 11 dni (24. april - 7. maj, 15. maj -25. maj, 5. avgust -15. avgust; Sl. 1). Feryerabend & Simon (2000) sta opazila, da so zatočišča menjavale predvsem samice z mladiči, medtem ko so bili samci in samice malih netopirjev, ki v tisti sezoni niso imele mladičev, samotarji in so ostajali zvesti predvsem enemu zatočišču. Zato domnevamo, da so se tudi v Krašnji prek poletja (od 26. maja do 3. avgusta) posamično zadrževali samci ali nerazmnoževalne samice belorobega netopirja.

Kot glavni vzrok selitve med zatočišči Feryerabend & Simon (2000) omenjata zmanjševanje razdalj do prehranjevalnih okolij in temperaturni režim v zatočišču. Kot manjše vzroke menjave zatočišč navajata izogibanje zunanjim parazitom, kot navaja Wolz (1986) za velikega navadnega netopirja (*Myotis bechsteinii*), ali kot na splošno predvideva Gottfried (1996). Po vsej verjetnosti so vsi navedeni vzroki oziroma njihova kombinacija vplivali tudi na menjavo zatočišč belorobega netopirja v Krašnji.

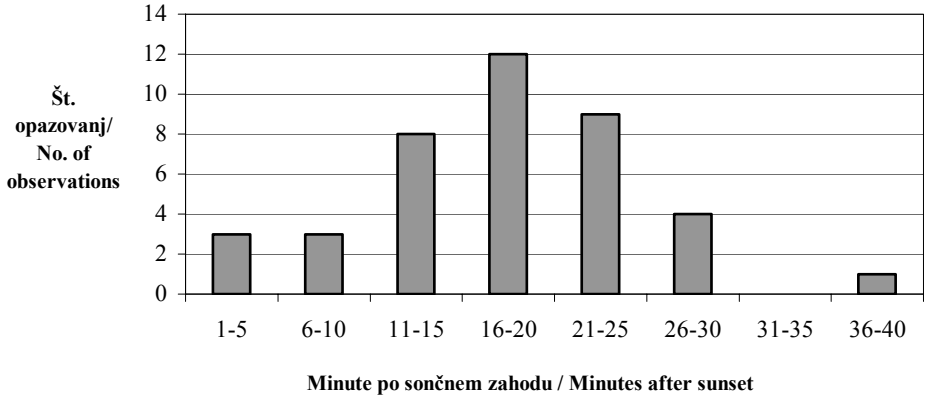
Čas izletavanja belorobih netopirjev

V 63 neposrednih opazovanih smo netopirje videli izleteti 48-krat (Sl. 1). Nekaj minut pred izletom belorobih netopirjev smo slišali njihove socialne klice. Po izletu so nekaj minut krožili (rojili) blizu zatočišča, nato pa jih je večina vzdolž dreves odletela proti severozahodu. V 21 primerih je zatočišče zapustilo 10 ali več netopirjev, v 11 primerih pa le en netopir.

Prvi belorobi netopir je iz zatočišča izletel povprečno 18,3 + 6,7 (N = 47) minut po sončnem zahodu (Sl. 2, 3). Čas prvega izleta je bil v statistično značilni pozitivni korelaciji s časom sončnega zahoda (Pearsonov koeficient = 0,98, $p < 0,001$), kot je splošno pravilo za mnoge vrste netopirjev (npr. Jones & Rydell 1994, Bullock et al. 1987, Petrželková & Zukal 2001).



Slika 2. Čas sončnega zahoda in prvega izleta belorobih netopirjev v Krašnji.
Figure 2. Sunset time and time of first emergence of Kuhl's pipistrelles at Krašnja.



Slika 3. Frekvenčni histogram števila prvih izletov belorobih netopirjev glede na sončni zahod v Krašnji leta 2002.
Figure 3: Number of first emergences of Kuhl's pipistrelles in minutes after sunset at Krašnja in 2002.

Bullock et al. (1987) so dokazali, da za primerjalne namene mediana časa trajanja izletanja statistično bolje opiše čas izletanja netopirjev v koloniji kot pa čas izleta prvega osebka. Zato podajamo tudi mediano časa trajanja izletanja za spomladanske dni od 24. aprila do 24. maja 2002, ko smo v posameznem opazovanju našteli 10 ali več netopirjev (19 opazovanj), z izjemo opažanja 15. maja, ko niso bili zabeleženi časi posameznih izletov (Tab. 2). Za isto obdobje

podajamo tudi trajanje izletanja (duration of emergence) in pogostost izletov - število izletelih netopirjev na minuto (rate of emergence) (Petrželková & Zukal 2001). Znotraj obravnavanega obdobja so se mediane časov izletov razporejale normalno (p = n.s.), zato sta bili vrednosti mediane in aritmetične sredine trajanja izletavanja podobni (Tab. 2).

Tabela 2. Opisna statistika časa in pogostost izletov belorobih netopirjev v Krašnji med 24. aprilom in 24. majem 2002 (Vključenih je 19 opazovanj; Ar - aritmetična sredina, Sd - standardna deviacija, Me - mediana, pogostost izletov je podana v številu izletelih netopirjev na minuto).
Table 2. Summary of emergence parameters of Kuhl's pipistrelle at Krašnja between 24th April and 24th May 2002 (19 observations are included; Ar - mean, Sd - standard deviation, Me - median, Min - minimum, Max - maximum; time parameters are in minutes after sunset, rate of emergence in given as number of bats emerged in a minute).

	Ar	Sd	Me	Min	Max
število netopirjev / number of emerged bats	14,9	2,5	15,0	10,0	21,0
začetek izletanja / onset of emergence	17,3	5,9	19,0	4,0	24,0
konec izletanja / end of emergence	30,6	7,2	30,0	12,0	44,0
mediana izletanja / median of emergence	22,7	5,1	23,0	10,0	32,0
trajanje izletanja / duration of emergence	13,4	5,1	11,0	7,0	22,0
pogostost izletov / rate of emergence	1,3	0,5	1,1	0,6	2,3

Kljub različnim prehranskim virom in razlikam v izkoriščanju teh virov so netopirji po vsem svetu skoraj izključno nočne živali, kar Duvergé et al. (2000) pojasnjujejo kot izogibanje plenjenju dnevno aktivnih uje oz. kot izogibanje kompeticiji s ptiči (Schober & Grimmberger 1993). Vendar imajo mnoge žuželke številčni višek v večernem mraku in zato ima čas večernega izletavanja pomembno vlogo pri preživetju netopirjev (Racey & Swift 1985). Jones & Rydell (1994) sta dokazala negativno korelacijo med obremenitvijo letalne površine (wing loading) (Norberg & Rayner 1987) in hitrostjo leta oz. časom izletanja netopirjev. Pokazala sta tudi, da na čas izleta vpliva tudi sestava prehrane. Netopirji zasledovalci (ariel hawkers, Norberg & Rayner 1987), ki so se prehranjevali z letečimi žuželkami, roječimi v mraku, so izletali prej kot tisti, ki so se prehranjevali večinoma z metulji ali neletečimi žuželkami, ki so bile dostopne večji del noči.

V našem primeru so belorobi netopirji izletavali relativno zgodaj (Tab. 2) v primerjavi z drugimi evropskimi netopirji (Jones & Rydell 1994). Zato naši rezultati podpirajo predvidevanja, da so belorobi netopirji razmeroma hitri letalci, kar sta glede na aerodinamične značilnosti prhuti roda malih netopirjev (*Pipistrellus*) predvidela že Norberg & Rayner (1987).

Prehranjevalni habitati

S heterodinim ultrazvočnim detektorjem belorobih netopirjev ni mogoče razlikovati od Nathusijevih netopirev (*Pipistrellus nathusii*). Slednji so pri nas le redko najdeni (Kryštufek 1991), zato je verjetno večina osebkov, uvrščenih v takson *Pipistrellus kuhlii/nathusii*, pripadala vrsti belorobega netopirja (Tab. 3). Te smo slišali le, ko so se prehranjevali ob lučeh cestne razsvetljave (Tab. 3), pa čeprav smo pregledovali tudi rob gozda, obvodno rastje in travnike v bližini Krašnje. Belorobi netopirji so lovili na višini od 4 do 8 metrov, med kroženjem okoli cestnih svetilk. Po približno 15 minutah so se preselili k sosednji svetilki in domnevno polovili razpoložljive žuželke okoli prve luči. V istem okolju smo opazovali malega netopirja pri drugačnem načinu lova, kjer je netopir redno letal sem in tja vzdolž vrste svetilk. Ob lučeh so se redkeje prehranjevali tudi pozni netopirji *Eptesicus serotinus* (Tab. 3), v začetku večera pa so visoko nad dolino krožili navadni oz. veliki mračniki (*Nyctalus noctula/lasiopterus*) .

Belorobi netopir (vkjučujoč takson *Pipistrellus kuhlii/nathusii*) po vsej Sloveniji lovi pri cestni razsvetljavi, redkeje pa ga slišimo loviti drugje (Koselj & Aupič 2001, Presetnik & Žibrat in prep.). Ob cestnih lučeh lovi tudi mali netopir, vendar ga vidimo tam predvsem tedaj, ko ni v bližini belorobega netopirja (Presetnik 2001, Presetnik - neobjavljeni podatki). Iz Švice podobna opažanja navajata Haffner & Stutz (1985-86). Višje število belorobih netopirjev ob cestnih svetilkah kot malih netopirjev avtorja pripisujeta predvsem večji prilagoditvi belorobih netopirjev na urbano okolje, ne pa neposrednemu tekmovanju med vrstama, kljub temu da je ne izključujeta.

Belorobi netopir je hiter letalec - zasledovalec (Norberg & Rayner (1987), ki bi se predvidoma moral prehranjevati predvsem z žuželkami, ki se združujejo v velike roje, npr. z nematocernimi dvokrilci. Takšna predvidevanja je podprl Beck (1994-1995) s količinsko omejeno raziskavo sestave prehrane (pregled 40 iztrebkov). Glede na pogostnost pojavljanja so si sledile skupine Diptera (75 % pregledanih iztrebkov), Lepidoptera (38 %), Trichoptera (30 %) in Hemiptera (15 %). V predhodno pregledanih iztrebkih belorobih netopirjev iz Krašnje je bila odkrita visoka pogostnost metuljev, kar pa je vsaj delno pričakovano glede na prehranjenje netopirjev okoli luči, ki so privlačile tudi metulje (Uroš Žibrat - neobjavljeni podatki). Podrobnejša primerjava z rezultati, ki jih podaja Beck (1994-1995), bo mogoča šele po opravljeni celoviti analizi iztrebkov.

Tabela 3. S heterodinim ultrazvočnim detektorjem odkriti prehranjevalni habitati netopirjev v okolici Krašnje v letu 2002.
Table 3. Bats' feeding habitats, determined with heterodine bat detector at Krašnja and its vicinity in 2002

Lokaliteta / Locality	Datum / Date	Prepoznane vrste / Recognised species	Št. osebkov / No. of indiv.
Krašnja - luči	25.5.2002	*P. kuhlii/nathusii*	1
	14.6.2002	*P. kuhlii/nathusii*	1
		P. pipistrellus	1
		P. kuhlii/nathusii	2
	5.7.2002	*P. kuhlii/nathusii*	1
	7.9.2002	*P. pipistrellus*	1
		Eptesicus serotinus	1
Blagovica - luči	25.5.2002	*P. kuhlii/nathusii*	1
	14.6.2002	*P. kuhlii/nathusii*	1
Prevoje - luči	25.5.2002	*P. kuhlii/nathusii*	1
		Eptesicus serotinus	2
	14.6.2002	*P. kuhlii/nathusii*	1
		Eptesicus serotinus	2
Luč pri odcepu za Podsmrečje	14.6.2002	*P. kuhlii/nathusii*	1

Summary

Although Kuhl's pipistrelle (*Pipistrellus kuhlii*) is a common species in Slovenia, its biology is poorly known. The paper presents results of the monitoring of the Kuhl's pipistrelle colony occupying a 2 cm wide crevice behind the weatherboarding of a residential house at Krašnja (Central Slovenia; 320 m above sea level). The colony initially appeared there in the September 1978, almost immediately after the weatherboarding was installed. Since then, the house owners could watch the colony appearing each summer, occupying places behind the east or west panelling, app. 5 m above the ground. The fissures behind weatherboarding were also used as maternity colony ward (Tab. 1). In 2002, the bats were observed from March 22nd till November 14th. During this period, we made 63 evening surveys. Emerging bats were seen during 48 visits. During the spring numerical peak, Kuhl's pipistrelles first occupied the fissures on the eastern side of the house (April 24th - May 8th). Thereupon the entire colony moved to the western side (May 15th - May 25th). The second numerical peak was reached in mid summer (August 5th - August 15th), although single specimens used the roost for the entire period (Fig. 1). The mean first emergence for the entire season was 18,3 + 6,9 (N = 47) minutes after the sunset (Fig. 2, 3). The median of emergence, duration of emergence and the rate of emergence (Tab. 2) are also given for the April 24th - May 24th period (number of bats > 10 specimens). Kuhl's pipistrelle was seen feeding exclusively around street lamps, along with less numerous common pipistrelles (*Pipistrellus pipistrellus*) and serotines (*Eptesicus serotinus*) (Tab. 3). With the use of heterodine bat detector, *Nyctalus noctula/lasiopterus* was also recorded at Krašnja and its vicinity.

Zahvala

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Prispevek k poznavanju razširjenosti močvirske sklednice (*Emys orbicularis* (Linnaeus, 1758)) ob reki Dravi v Sloveniji

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Izvleček. Predstavljene so nove in že objavljene najdbe močvirske sklednice v Podravju. Prvič v Sloveniji je bila potrjena podvrsta *Emys orbicularis orbicularis*.

Ključne besede: močvirska sklednica, *Emys orbicularis orbicularis*, Podravje, Slovenija

Abstract. A CONTRIBUTION TO THE KNOWLEDGE OF THE EUROPEAN POND TURTLE (*EMYS ORBICULARIS* (LINNAEUS, 1758)) DISTRIBUTION ALONG THE DRAVA RIVER IN SLOVENIA - New discoveries together with published data on European pond turtle along the Drava river in Slovenia are presented. Subspecies *Emys orbicularis orbicularis* was comfirmed for the first time in Slovenia.

Key words: European pond turtle, *Emys orbicularis orbicularis*, Drava river, Slovenia

Močvirska sklednica (*Emys orbicularis*) je danes razširjena po večjem delu Evrope, ni je le v Skandinaviji in na Britanskem otočju. Na vzhodu je razširjena do Kaspijskega jezera in Urala, na jugu pa do podsaharske Afrike (Fritz 1992, Gasc et al. 1997, Mršić 1997). Geografska variabilnost močvirske sklednice je dobro izražena. Opisanih je več podvrst, v srednji Evropi in na Balkanu sta poznani *E. o. orbicularis* (Linnaeus, 1758) in *E. o. hellenica* (Valenciennes, 1832), stično območje med obema podvrstama pa bi naj potekalo tudi prek Slovenije (Fritz 1992).

Še nedolgo tega je bila močvirske sklednica poznana samo na Ljubljanskem barju, v Beli krajini, Krški kotlini in ob reki Krki (Mršić 1997), v zadnjih letih pa se je poznavanje razširjenosti precej izboljšalo (Tome 1996, 1998, 2001, 2003).

V porečju reke Drave v Sloveniji so bili v zadnjih sedmih letih na različnih lokalitetah ugotovljeni trije osebki močvirske sklednice (Sl. 1). Podatki o teh treh najdbah pa so trenutno tudi edini novejši podatki o pojavljanju močvirske sklednice v tem območju.

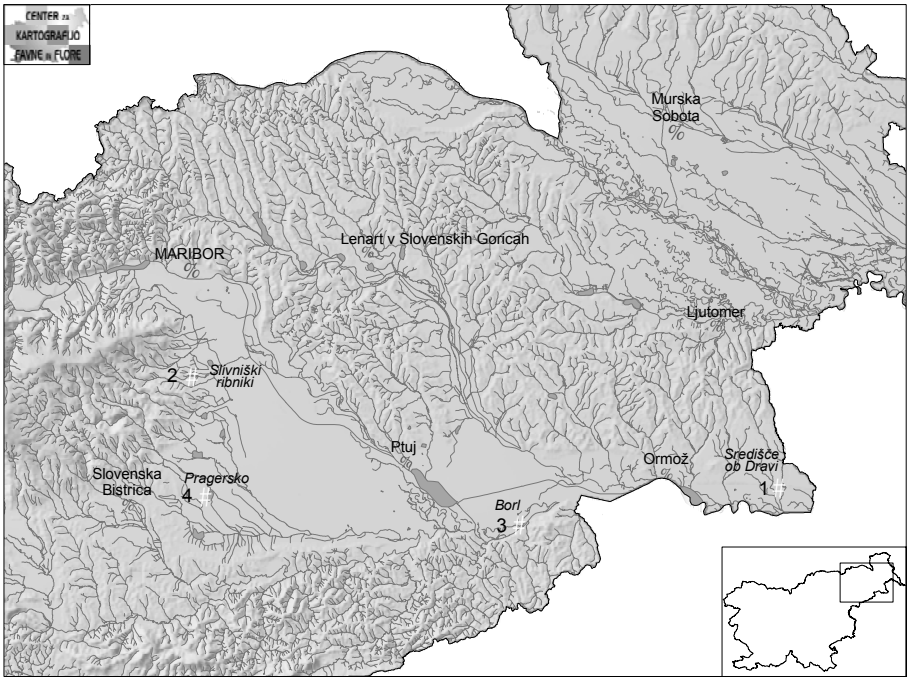
Prva najdba je z dne 4.8.1997, ko je močvirsko sklednico na cesti ob cerkvi v vasi Središče ob Dravi našel domačin Jože Zemljič (Sl. 1: najdišče št. 1). Najdbo navajajo Planinc (1999) in Tome (2003) kot podatek za kvadrat WM94, Štumberger (2001) za mrtvice pri Središču ob Dravi v območju IBA Drava, in Kočevar (2003) za območje bodočega Krajinskega parka Središče ob Dravi. Želva je bila s ceste odnešena v manjši opuščeni glinokop 500 m S od mesta najdbe. Biometrični podatki na dan najdbe: masa 0,11 kg, širina carapaxa (CL) 72 mm, dolžina carapaxa (CB) 87 mm (meritve po Fritz 1995).

Drugi primerek močvirske sklednice je bil opazovan 24.8.1998 v Slivniških ribnikih (Milan Vogrin, ustno; Sl. 1: najdišče št. 2). Ta podatek je predstavljen tudi v Tome (2003).

Tretji primerek sklednice je našel domačin Bojan Mihelač poleti 2002, ko je prečkala cesto Stojnci-Borl JV od Ptuja (Sl. 1: najdišče št. 3). Želvo je odnesel domov, kjer je na vrtu uspešno prezimila. Izpuščena je bila 10.5.2003 ob reki Dravi blizu mesta najdbe. Ob izpustitvi je bila masa sklednice 0,45 kg, CL 154 mm (meritve po Fritz 1995). Na podlagi rjavih oči sklepava, da je bil samec. Temen carapax brez rumenih pik in relativno temen trebušni ščit (plastron) podpirata uvrstitev osebka v podvrsto *E. o. orbicularis* (Fritz 1992, 1995; Sl. 2).

Edini starejši literaturni vir, ki obravnava močvirsko sklednico na območju reke Drave, je Jež (1983), ki jo navaja za Pragersko (Sl. 1: najdišče št. 4). To informacijo je dobil od nekdanjega direktorja Mariborskega akvarija, biologa Rehbergerja, ki bi naj bil med obema vojnama močvirske sklednice videval v jarkih ob železniški progi od Pragerskega proti Mariboru (Jež, ustno). Ti jarki so bili skopani med graditvijo železnice Pragersko-Maribor, ki je bila odprta leta 1846, zasuti pa po drugi svetovni vojni, ko je bil zgrajen drugi tir. Jež (1983) dodaja, da sam močvirske sklednice tam več ni našel.

Kljub temu da močvirska sklednica živi zelo skrito življenje in jo je težko odkriti, sklepava, da so najdbe ostanek nekoč številne populacije sklednice v Podravju. Ker so bili v zadnjih letih na obravnavanem območju opaženi samo trije primerki, o populaciji močvirskih sklednic v Podravju ne moreva govoriti. V Sloveniji je trgovanje z močvirskimi sklednicami in prenos čez mejo prepovedan, vendar obstaja tudi možnost vnosa. Domnevava, da najdene močvirske sklednice niso izpuščene ujete živali, in napovedujeva nove najdbe.



Slika 1: Razširjenost močvirske sklednice (*Emys orbicularis*) v Podravju.
Figure 1: Distribution of European pond turtle (*Emys orbicularis*) in the Drava region.

Slika 2: Hrbtni in trebušni ščit močvirske sklednice *Emys orbicularis orbicularis*, najdene pri Borlu. (foto F. Janžekovič)
Figure 2: Carapax and plastron of the European pond turtle *Emys orbicularis orbicularis* found at Borl. (photo F. Janžekovič)

Summary

According to literature data, a juncture area of *E. o. orbicularis* (Linnaeus, 1758) and *E. o. hellenica* (Valenciennes, 1832) subspecies of the European pond turtle should run across Slovenia. Only three specimens of this turtle have been found so far along the Drava river in Slovenia in the last few years, i.e. at Središče ob Dravi (1997), Slivniški ribniki (1998), and Borl (2002). Some older literature sources refer to pond turtles occurring near Pragersko between the two world wars, but they are no to be found there any more. The specimen found at Borl was determined as subspecies *Emys orbicularis orbicularis* and is the first record of the European pond turtle at the subspecies level for Slovenia. The authors believe that the found turtles are in fact remains of once numerous population living in the Drava region, and predict new finds.

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Najdba laškega gada *Vipera aspis* v Breginjskem kotu poleti 2001

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Izvleček. Članek opisuje najdbo laškega gada (*Vipera aspis*), ki je bil junija 2001 opažen in fotografiran v bližini vasi Logje južno od Breginja. Gre za eno redkih najdb v novejšem času, ki potrjuje pojavljanje te vrste v Sloveniji. Poleg laškega gada smo na območju Breginjskega kota zabeležili še štiri vrste kač.

Ključne besede: plazilci, kače, *Vipera aspis*, razširjenost, Slovenija

Abstract. OBSERVATION OF THE ASP VIPER *VIPERA ASPIS* AT BREGINJSKI KOT (W SLOVENIA) - The article presents the results of the snake fauna survey carried out at Breginjski kot in July 2001. Five snake species were recorded, the most important among them being the Asp Viper Vipera aspis. It was found and photographed in the vicinity of the village of Logje, south of Breginj. This very rare observation of *Vipera aspis* confirms the occurrence of this species in Slovenia.

Key words: reptiles, *Vipera aspis*, snakes, distribution, Slovenia

Na skrajnem zahodu Slovenije, v Breginjskem kotu, so bile doslej zabeležene štiri vrste kač: navadni gož *Elaphe longissima*, smokulja *Coronella austriaca*, beloluška *Natrix natrix* in laški gad *Vipera aspis* (Mršić 1997, Tome 1996, 2002). Ob popisu kač na prisojnih pobočjih Kobariškega Stola in Muzca, v okolici kraja Breginj in na obrežjih zgornjega toka reke Nadiže (UTM kvadrata UM82 in UM72) smo v obdobju med 2. in 20.7.2001 poleg omenjenih vrst zabeležili še kobranko (*Natrix tessellata*) ter potrdili pojavljanje laškega gada, ki je v Sloveniji izredno redko opažena vrsta. Navadnega goža smo našli na pobočjih Kobariškega Stola in Muzca kot tudi v širši okolici Breginja. V okolici Breginja smo opazili še smokuljo in laškega gada, na obrežjih Nadiže pa kobranko in belouško.

Posebno pomembna je najdba laškega gada. Najstarejše najdbe te vrste na ozemlju Slovenije datirajo v začetek 20. stoletja (Dolce 1979, Tome 1996). Po letu 1932 ga navaja Brelih (1954), vendar pa potrjenih najdb ni bilo že več kot pol stoletja (Brodmann 1987, Mršić 1992, 1997; Tome, 1996). Mršić (1992) ga je na Rdečem seznamu ogroženih plazilcev v

Sloveniji uvrstil med domnevno izumrle vrste. V zadnjih letih je bil laški gad nekajkrat opažen na območju Kobariškega Stola (Tome, ustno), zato ima v *Pravilniku o uvrstitvi ogroženih rastlinskih in živalskih vrst v rdeči seznam (Ur.l. RS 12(82)): 8994-8975 (24.9.2002)* zdaj status prizadete vrste (E).

Kulturna krajina na območju Breginjskega kota se hitro spreminja, še posebno po potresu leta 1976, ki je povzročil izseljevanje prebivalstva in posledično opuščanje ter zaraščanje travnikov in pašnikov. V obravnavanem območju je zaradi večje osenčenosti vedno manj suhih in toplih prisojnih leg, nujnih za laškega gada, z izjemo pobočij Kobariškega Stola in Muzca. Zmanjševanje ugodnih habitatov bi lahko vplivalo na razširjenost laškega gada v Sloveniji, zato bi bili smiselno ohraniti kulturno krajino tudi z vidika te prizadete živalske vrste. Za boljše poznavanje razširjenosti in ekoloških zahtev laškega gada v Sloveniji bi bilo nujno več časa posvetiti usmerjenim raziskavam.

Slika 1. Laški gad (*Vipera aspis*), fotografiran v bližini vasi Logje poleti 2001.
Figure 1. Asp Viper (*Vipera aspis*), photographed in summer 2001 near the village of Logje (W Slovenia).

Summary

The article presents the results of the snake fauna survey carried out in July 2001 at Breginjski kot. Five snake species were found: Asculapian Snake *Elaphe longissima*, Smooth Snake *Coronella austriaca*, Grass Snake *Natrix natrix natrix*, Dice Snake *Natrix tessallata*, and Asp Viper *Vipera aspis*. The observation of Asp Viper is certainly the most important among them. It was found and pictured in the vicinity of the

village of Logje, south of Breginj. This rare observation confirms the occurrence of *Vipera aspis* in Slovenia.

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