ZVEZA ZA TEHNIČNO KULTURO SLOVENIJE

NATURA SLOVENIAE

Revija za terensko biologijo • Journal of Field Biology

Letnik • Volume 5 Številka • Number 1

Ljubljana
2003

NATURA SLOVENIAE

Revija za terensko biologijo • Journal of Field Biology

Izdaja • Published by
Zveza za tehnično kulturo Slovenije
Lepi pot 6, SI-1111 Ljubljana
Številka žiro računa: 50101-678-51259
Tel.: (01) 251 37 43, 425 07 69; Telefax: (01) 252 24 87

Naslov uredništva • Address of the Editorial Office
NATURA SLOVENIAE, Večna pot 111, SI-1111 Ljubljana, Slovenija

Izvlečki prispevkov so zavedeni v zbirkah ASFA, AGRIS in COBBIS.

ISSN: 1580-0814 **UDK: 57/59(051)=863=20**

Lektorji • Language Editors
za angleščino (for English): Henrik Ciglič
za slovenščino (for Slovene): Henrik Ciglič

Oblikovanje naslovnice • Layout
Daša Simčič akad. slikarka, Atelje T

Natisnjeno • Printed in
2003

Tisk • Print
Solidarnost d.d., Murska Sobota

Naklada • Circulation
500 izvodov/copies

Kazalo vsebine

Recenziji

Alge v velikem ali priobalnem jezeru v Fiesi, Slovenija

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Izvleček. V različnih letnih časih med letoma 1998 in 2000 smo vzorčevali perifitonske in planktonske alge v priobalnem jezeru v Fiesi - edinem brakičnem jezeru v Sloveniji. Namen raziskave je bil ugotoviti kvalitativno vrstno sestavo in relativno abundanco algnih združb. V letih 1999 in 2000 smo merili tudi nekatere fizikalne in kemijske parametre. Skupno smo določili 85 različnih vrst in podvrst iz šestih razredov alg. Po številu vrst in podvrst so prevladovale Bacillariophyceae, sledile so Cyanophyceae in Chlorophyceae. 19 vrst in podvrst je novih za Slovenijo, od tega pripada 15 vrst in podvrst razredu Bacillariophyceae, 4 vrste pa razredu Cyanophyceae. Največ novih vrst in podvrst pripada rodu *Navicula*. To je prva raziskava alg v priobalnem jezeru v Fiesi, ki je trajala daljše časovno obdobje in je zajela perifitonske in planktonske alge.

Ključne besede: alge, perifiton, fitoplankton, brakična jezera, Fiesa

Abstract. ALGAE OF THE FIESA COASTAL LAKE, SLOVENIA - In the years 1998, 1999 and 2000, samples were taken seasonally in the Fiesa lake situated next to the see - the only brackish lake in Slovenia. The purpose of the investigation was to establish qualitative species structure and relative abundance of the periphyton and the phytoplankton. In the years 1999 and 2000, some physical and chemical parameters were also measured. Altogether, 85 species and subspecies of algae (of six classes) were determined. Most of them belonged to Bacillariophyceae, followed by Cyanophyceae and Chlorophyceae. 19 species and subspecies are new to Slovenia, 15 of which belong to Bacillariophyceae and 4 to Cyanophyceae. Most of the new species and subspecies belonging to the genus *Navicula*. This is the first research into the Fiesa coastal lake's periphyton and phytoplankton carried out through a longer period of time.

Key words: algae, periphyton, phytoplankton, brackish lakes, Fiesa

Uvod

V Fiesi ležita dve jezeri (manjše gornje in večje priobalno), ki sta od leta 1989 zavarovani kot naravni spomenik. Jezeri sta umetnega izvora, nastali sta z izkopavanjem gline za opekarno, ki je stala na mestu današnjega hotela. Zaradi ilovnatih tal slana podtalnica kljub bližini morja ni mogla do spodnjega večjega jezera, dokler niso leta 1963 izkopali kanal od

spodnjega jezera do morja, tako da se ob plimah sladka voda meša z morsko. Je edino brakično jezero v Sloveniji, slanost z globino narašča.

Alge v priobalnem jezeru v Fiesi so bile v preteklosti zajete v okviru dveh raziskav. V ekološki študiji pri projektu Fiesa-Piran (1989) so raziskovali tako perifiton kot fitoplankton, vendar so bili vzorci odvzeti samo enkrat. Raziskava, ki jo je opravil Vrhovšek (1994), pa je bila omejena na fitoplankton. Več avtorjev se je posvetilo gornjemu sladkovodnemu jezeru v Fiesi (Lazar 1975, ekološka študija pri projektu Fiesa-Piran 1989, Vrhovšek 1994).

Opisana raziskava je prva te vrste v priobalnem jezeru v Fiesi, v kateri so bile zajete perifitonske in planktonske alge in je potekala v različnih letnih časih daljše časovno obdobje. Njen namen je bil ugotoviti kvalitativno vrstno sestavo in relativno abundanco perifitonskih in planktonskih algnih združb v priobalnem jezeru v Fiesi v letih 1998, 1999 in 2000. V letih 1999 in 2000 so bili merjeni tudi nekateri fizikalni in kemijski dejavniki, ki vplivajo na sestavo in številčnost algnih združb.

Opis vzorčnega mesta

Jezero je kotanjasto in plitvo, največja globina znaša 8,5 metra. Je precej izpostavljeno vetru, ščiti pa ga samo pas trstičja (*Phragmites communis* Trin.), ki sega do globine 0,5 metra. Jezerski litoral je dobro razvit, dno se počasi spušča proti sredini jezera. Dno je mehko in zamuljeno, kar omogoča naselitev trsta, ni pa primerno za uspevanje pravih submerznih makrofitov. Brežine porašča pas trstičja (*Phragmites communis*), ki je različno širok in na posameznih mestih umetno prekinjen zaradi lažjega dostopa do jezera. Na dveh zatišnih mestih se je obdržal manjši sestoj dristavca (*Potamogeton polygonifolius* Pourr.), v globini 1 do 2 m pa je precej gost pas močvirske vodopivke (*Zannichellia palustris* L.). Med lesnimi rastlinami, ki poraščajo breg, prevladujejo robinija (*Robinia pseudacacia* L.), črni bezeg (*Sambucus nigra* L.) in navadni lovor (*Laurus nobilis* L.). Voda v jezeru je slabo prezračena, njena prosojnost je slaba.

Material in metode dela

Perifiton in fitoplankton smo vzorčili v različnih letnih časih od leta 1998 do 2000. Skupno smo opravili pet vzorčenj (23.8.1998, 7.4.1999, 29.7.1999, 18.10.1999, 17.1.2000). Perifiton za kvalitativno analizo smo vzorčili tako, da smo postrgali površino prodnikov, kamnov, skal, makrofitov, potopljenega lesa in drugih potopljenih predmetov (steklenic, pločevink, plastenk, železnih palic…). Fitoplankton smo vzorčili s planktonsko mrežico z velikostjo odprtin 25 mm.

Vzorce perifitona in fitoplanktona smo že na terenu fiksirali s 35 % formalinom v razmerju ena proti devet, tako da je bila končna koncentracija formalina v vzorcih približno 4 %. Da smo lahko določili kremenaste alge, smo vzorce obdelali s koncentrirano HNO3.

V laboratoriju smo vzorce perifitona in fitoplanktona pregledali pod svetlobnim mikroskopom. Pri pregledovanju vzorcev smo ocenili pogostost posameznih vrst in podvrst alg s števili od 1 do 5: 1-posamična, 2-redka, 3-običajna, 4-pogosta, 5-prevladujoča. Pri določevanju alg smo uporabili naslednje določevalne ključe: Lazar (1960), Starmach (1966, 1972), Krammer & Lange-Bertalot (1986, 1988, 1991a, 1991b), Hindak et al. (1978), Hindak (1996), Popovsky & Pfiester (1990), Cvijan & Blaženčić (1996).

Nove vrste za Slovenijo so v tabeli vrstnega sestava (Tabela 2) označene z zvezdico.

29.7.1999, 18.10.1999 in 17.1.2000 smo merili tudi temperaturo vode, elektroprevodnost, pH, vsebnost kisika in nasičenost vode s kisikom.

Rezultati in razprava

Fizikalni in kemijski parametri

Vrednosti fizikalnih in kemijskih parametrov v priobalnem jezeru v Fiesi so prikazane v Tabeli 1. Spremembe v temperaturi vode so v teku leta sledile spremembam temperature zraka. Najvišjo temperaturo smo izmerili meseca julija (24,2 °C), najnižjo pa meseca januarja (4,5°C). Elektroprevodnost v celinskih vodah narašča z naraščanjem slanosti. Na slanost vplivajo tla s sestavo kamnin in njihovo topnostjo, podnebje, temperatura, preperevanje, prah,

padavine, izhlapevanje, vetrovi, oddaljenost od morja, rastlinstvo in živalstvo (Rejic 1988). V času meritev je bila elektroprevodnost v priobalnem jezeru v Fiesi visoka (3220-3990 mS/cm), saj je voda zaradi mešanja sladke in slane vode brakična. Voda je bila rahlo bazična ali bazična (pH 7,71-8,16). Koncentracije raztopljenega kisika in nasičenosti vode s kisikom so bile v mesecu juliju in januarju visoke. V mesecu oktobru pa je bila koncentracija kisika v vodi le 5,3 mg/l, nasičenost s kisikom pa le 53 %. To bi lahko bila posledica intenzivne razgradnje organskih snovi v vodi. Fizikalne in kemijske analize, ki jih je v priobalnem jezeru v Fiesi opravil Vrhovšek (1994), so pokazale visoke vrednosti hranilnih snovi. Še posebno zanimive so bile vrednosti fosfatov.

Biološki parametri

V raziskavi, ki jo je izvedel Vrhovšek (1994), je bila vrstna sestava fitoplanktona v priobalnem jezeru v Fiesi izredno skromna, saj je v letih od 1991 do 1993 v jezeru določil le 5 različnih vrst alg. Tam uspevajoča evglena (*Phacus longicauda*) je pokazala, da je bila kakovost vode v jezeru slaba. To je potrdila tudi tam rastoča kremenasta alga *Nitzschia palea*, ki je po saprobni pripadnosti a mezosaprobna. Inštitut za biologijo Univerze v Ljubljani je izvedel ekološko študijo pri projektu Fiesa-Piran (1989), v okviru katere so raziskali tudi perifiton in fitoplankton v priobalnem jezeru v Fiesi. Vzorčenje je bilo opravljeno novembra 1989. leta. Določili so 4 planktonske in 12 perifitonskih vrst alg. Poleg kozmopolitskih vrst so našli tudi nekatere vrste, značilne za okolja s povišano slanostjo: *Synedra tabulata*, *Nitzschia apiculata* in *Mastogloia braunii*. Glede na meritve klorofila a so priobalno jezero uvrstili med hiperevtrofna jezera.

Moss (1994) je primerjal združbi alg v sladkovodnem in brakičnem jezeru v Angliji in ugotovil, da obstajajo značilne razlike med obema jezeroma. V brakičnem jezeru sta bila zabeležena rod Chaetoceros in morska vrsta *Prymnesium parvum*. Značilne cianobakterije so bile kolonijske vrste iz rodov Aphanothece in Anabaenopsis. V sladkovodnem jezeru sta bili pogosti *Oscillatoria limnetica* in *O. agardhii*, prevladujoče pa so bile vrste iz rodu *Anabaena*. V brakičnem jezeru so bile spomladi prevladujoče penatne kremenastne alge, v sladkovodnem pa centrične.

V priobalnem jezeru v Fiesi smo skupaj določili 85 različnih vrst in podvrst iz šestih razredov alg (Tabela 2). Sestava alg po razredih je prikazana na Sliki 1. Po številu vrst in podvrst so prevladovale kremenaste alge, sledile so Cyanophyceae in Chlorophyceae. Tudi v raziskavah drugih avtorjev so v priobalnem jezeru v Fiesi prevladovale kremenaste alge (ekološka študija pri projektu Fiesa-Piran 1989, Vrhovšek 1994). Največje število vrst in podvrst (50) smo določili oktobra, najmanjše (25) pa aprila. V aprilskem vzorcu smo določili tudi najmanjše število vrst in podvrst kremenastih alg in cianobakterij. Kremenaste alge so v vseh vzorcih sestavljale nad 65 %, v januarskem vzorcu pa kar 81 % vseh določenih vrst in podvrst alg. Razred Zygnematophyceae je bil zabeležen le v julijskem in oktobrskem vzorcu, razred Chrysophyceae pa le v avgustovskem vzorcu. Številčno najbolj zastopani so bili rodovi *Navicula* in *Nitzschia*, vsak z desetimi vrstami in podvrstami in *Phormidium* s petimi vrstami (Tabela 2).

V vseh petih vzorčenjih so bile zabeležene naslednje vrste: *Achnanthes minutissima*, *Amphora pediculus*, *Fragilaria fasciculata*, *Gomphonema truncatum*, *Nitzschia constricta*, *Oedogonium* sp., *Rhizoclonium hieroglyphicum* in *Rhoicosphenia abbreviata*. *Achnanthes minutissima*, *Fragilaria fasciculata* in *Rhoicosphenia abbreviata* so bile hkrati tudi številčno najbolj zastopane. *Achnanthes minutissima* in *Fragilaria fasciculata* sta bili prevladujoči (5) vrsti v perifitonu aprilskega vzorca, *Rhoicosphenia abbreviata* pa v perifitonu avgustovskega vzorca. Vse tri vrste so se v perifitonu pojavljale v precej večjem številu kot v planktonu. Edini predstavnik razreda Dinophyceae *Peridinium bipes* je bil prevladujoča (5) vrsta v fitoplanktonu obeh poletnih in jesenskega vzorca. Med cianobakterijami sta se najbolj množično pojavljali vrsti *Microcystis aeruginosa* (plankton avgustovskega vzorca) in *Phormidium dimorphum* (perifiton oktobrskega vzorca) z oceno običajna. V razredu Chlorophyceae pa se je najbolj množično pojavljala vrsta *Oedogonium* sp. v perifitonu avgustovskega vzorca z oceno pogosta (4). Edini predstavnik razreda Dinophyceae *Dinobryon* sp. je bil ugotovljen le v perifitonu avgustovskega vzorca z oceno posamičen.

Poleg sladkovodnih vrst smo v priobalnem jezeru v Fiesi določili morsko vrsto Amphora angusta ter mnoge slanoljubne brakične vrste: *Achnanthes amoena*, *Nitzschia commutatoides*, *N. dubia*, *N. tryblionella*, *N. filiformis*, *Mastogloia smithii*, *Navicula crucicula* var. *crucicula*, *N. salinarum*, *Surirella striatula* in *Phormidium dimorphum*. Pojavljanje mnogih vrst, ki so značilne

za srednje in močno organsko onesnažene vode, kaže na evtrofni značaj jezera: *Anabaena affinis*, *Microcystis aeruginosa*, *Navicula cincta*, *N. cuspidata*, *N. tripunctata*, *N. viridula* var. *rostellata*, *N. veneta*, *Nitzschia constricta*, *N. filiformis* in *N. palea*.

V priobalnem jezeru v Fiesi smo določili 19 vrst in podvrst, novih za Slovenijo (Tabela 2). 15 vrst in podvrst pripada razredu Bacillariophyceae, 4 vrste pa razredu Cyanophyceae. Največ novih vrst in podvrst (4) pripada rodu *Navicula*.

Tabela 1: Vrednosti nekaterih fizikalnih in kemijskih parametrov v priobalnem jezeru v Fiesi v letih 1999 in 2000.
Table 1: Values of some physical and chemical parameters in coastal Fiesa lake in the years 1999 and 2000.

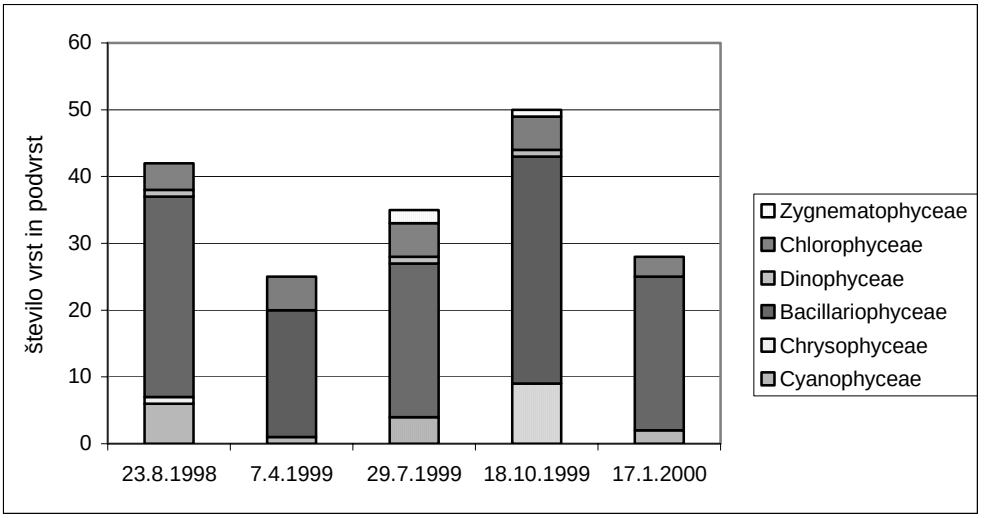
parameter/*parameter*	**enota/*unit***	**datum/ *date***		
		29.7.1999	18.10.1999	17.1.2000
temperatura	°C	24,2	16,4	4,5
elektroprevodnost	μS/cm	3520	3990	3220
pH		8,07	7,71	8,16
kisik	mg/l	10,4	5,3	13,4
nasičenost s kisikom	%	119	53	138

Tabela 1: Vrstna sestava alg z oceno abundance v priobalnem jezeru v Fiesi v letih 1998, 1999 in 2000; PR - perifiton, PL - plankton, * - vrste in podvrste nove za Slovenijo.
Table 1: Algal species list with estimation of abundance in coastal Fiesa lake in the years 1998, 1999 and 2000; PR - periphyton, PL - plancton, * - species and subspecies for SLovenia.

takson/taxon	datum vzorčenja/date of sampling									
	23.8.98		7.4.99		29.7.99		18.10.99		17.1.00	
	PR	PL	PR	PL	PR	PL	PR	PL	PR	PL
PROKARYOTA										
CYANOPHYTA										
CYANOPHYCEAE										
**Anabaena affinis* Lemm.		1		1		1		2		
Gloeocapsa crepidinum Thuret							1			
Merismopedia maior (Smith) Geitler								1		
Microcystis aeruginosa Kuetz.		3				1				
Microcystis grevillei (Hassal) Elenkin		1								
Microcystis muscicola (Menegh.) Elenkin					1		1			
Phormidium boryanum Kuetz.	1									
**Phormidium dimorphum* Lemm.							3			
**Phormidium henningsii* Lemm.		1							1	
Phormidium lucidum (Agardh) Kuetz.					1		1			
Phormidium sp.	1	1						1	1	1
Pseudanabaena constricta (Szafer) Lauterb.								1		
**Pseudospirulina amoena* Pankow & Jahnke								1		
EUKARYOTA										
HETEROKONTOPHYTA										
CHRYSOPHYCEAE										

takson/taxon	datum vzorčenja/date of sampling									
	23.8.98		7.4.99		29.7.99		18.10.99		17.1.00	
	PR	PL	PR	PL	PR	PL	PR	PL	PR	PL
Dinobryon sp.	1									
BACILLARIOPHYCEAE										
**Achnanthes amoena* Hust.							1	1		
**Achnanthes lanceolata* ssp. *frequentissima* Lan.-Bert.	1									
Achnanthes lanceolata (Breb.) Grun.								1		
Achnanthes minutissima Kuetz.	4	2	5	1	2	1	3	1	3	1
**Amphora angusta* (Greg.) Cleve					1		2	1		
Amphora coffeaeformis (Agardh) Kuetz.					1		2	1	1	1
Amphora pediculus (Kuetz.) Grun.	2	1	1		1			1		1
Cocconeis placentula Ehren.	2	1			1			1		
Cyclotella sp.	1						1	1	1	
**Cymatopleura solea* var. *apiculata* (W.Smith) Ralfs								1		
Cymbella affinis Kuetz.	1									
Cymbella cesatii (Raben.) Grun.		1								
Cymbella delicatula Kuetz.				1						
Cymbella microcephala Grun.	1		1		1		1	1		
Cymbella silesiaca Bleisch	3									
Diploneis elliptica (Kuetz.) Cleve	3		1		3		2			
Eunotia exigua (Breb.) Raben.					1					1
**Fragilaria biceps* (Kuetz.) Lan.-Bert.			1	1		1		1		
Fragilaria capucina Desm.	1									
Fragilaria fasciculata (Agardh) Lan.-Bert.	3	1	5	1	2	1	1	1	3	1
Fragilaria ulna var. *acus* (Kuetz.) Lan.-Bert.								1		
Fragilaria ulna var. *ulna* (Nitzsch.) Lan.-Bert.		1	1			1				
Frustulia rhomboides (Ehren.) De Toni								1		
Frustulia vulgaris (Thwait.) De Toni								1		
Gomphonema angustum Agardh						1				
Gomphonema clavatum Ehren.	1		1				1	1	1	
Gomphonema olivaceum (Horn.) Breb.										1
Gomphonema truncatum Ehren.	1		1	1	1			1	1	
Gyrosigma acuminatum (Kuetz.) Raben.	1		1					1		1
Mastogloia smithii Thwait.	2				1		1			
Navicula capitatoradiata Germain	1		1							
**Navicula cincta* (Ehren.) Ralfs & Prit.	3						1			
Navicula crucicula var. *crucicula* (W.Smith) Donkin			1					1	1	1
Navicula cuspidata Kuetz.	1									
**Navicula erifuga* Lan.-Bert.							1	1		
**Navicula salinarum* Grun.									1	1
Navicula sp.	1									
Navicula tripunctata (Muell.) Bory									1	
Navicula veneta Kuetz.	1		1	1			1	1	1	1
**Navicula viridula* var. *rostellata* (Kuetz.) Cleve			1						1	
Neidium affine (Ehren.) Pfitzer						1				
Nitzschia angustata (W.Smith) Grun.						1				
**Nitzschia commutatoides* Lan.-Bert.	1							1		
**Nitzschia constricta* (Kuetz.) Ralfs	1		1		1		1		1	
Nitzschia dubia W.Smith					1				1	1
**Nitzschia filiformis* var. *conferta* (Rich.) Lan.-Bert.							2			
Nitzschia filiformis var. *filiformis* (W.Smith) Van Heurck							3		1	1
Nitzschia fonticola Grun.	3									
Nitzschia frustulum (Kuetz.) Grun.			1		1		1		3	1
Nitzschia palea (Kuetz.) W.Smith	1					1				1
Nitzschia tryblionella Hant.								1		
Pinnularia subrostrata (A.Cleve) Cleve-Euler	1							1	1	
**Rhizosolenia eriensis* H.L.Smith	1				1					

takson/taxon	datum vzorčenja/date of sampling									
	23.8.98		7.4.99		29.7.99		18.10.99		17.1.00	
	PR	PL	PR	PL	PR	PL	PR	PL	PR	PL
Rhoicosphenia abbreviata (Agardh) Lan.-Bert.	5	1	3	1	3	1	3	1	3	1
Stauroneis tackei (Hust.) Kramm. & Lan.-Bert.	1									
**Surirella brebissonii* Kramm.& Lan.-Bert.			2		1			1	1	1
**Surirella striatula* Turpin								1		
DINOPHYTA										
DINOPHYCEAE										
Peridinium bipes Stein	1	5			1	5	1	5		
CHLOROPHYTA										
CHLOROPHYCEAE										
Chaetophora incrassata (Hudson) Hazen			1							
Cladophora fracta Kuetz.	2									
Cladophora glomerata (L.) Kuetz.			1		1		1			
Enteromorpha sp.					1					
Microspora amoena (Kuetz.) Raben.				1		1				
Oedogonium sp.	4	1	2	2	1	1	1	1	1	1
Oocystis sp.								1		
Pediastrum duplex Meyen.		1								
Rhizoclonium hieroglyphicum (Agardh) Kuetz.	1		1		1		2		2	
Scenedesmus quadricauda (Turp.) Breb.								1		
Ulothrix tenerrima Kuetz.									3	
ZYGNEMATOPHYCEAE										
Mougeotia sp.					1					
Spirogyra sp.					1		1	1		



Slika 1: Sestava alg po razredih v priobalnem jezeru v Fiesi v letih 1998, 1999 in 2000
Figure 1: Algal structure by classes in coastal Fiesa lake in the years 1998, 1999 and 2000

Povzetek

V nalogi smo raziskovali perifitonske in planktonske alge v priobalnem jezeru v Fiesi. Namen raziskave je bil ugotoviti kvalitativno vrstno sestavo in relativno abundanco združb v letih 1998, 1999 in 2000. To je prva raziskava alg v priobalnem jezeru v Fiesi, v kateri so zajete perifitonske in planktonske alge in je potekala v različnih letnih časih daljše časovno obdobje. Skupaj smo opravili pet vzorčenj. V laboratoriju smo vzorce perifitona in fitoplanktona pregledali pod svetlobnim mikroskopom. Pri pregledovanju vzorcev smo ocenili pogostost posameznih vrst in podvrst s števili od 1 do 5 (1-posamična, 2-redka, 3-običajna, 4-pogosta, 5-prevladujoča). V letih 1999 in 2000 smo merili tudi nekatere fizikalne in kemijske dejavnike, ki vplivajo na sestavo in številčnost algnih združb.

Skupaj smo določili 85 različnih vrst in podvrst iz šestih razredov alg. Prevladovale so kremenaste alge, sledile so Cyanophyceae in Chlorophyceae. Številčno najbolj zastopani so bili rodovi *Navicula* in *Nitzschia*, vsak z desetimi vrstami in podvrstami, in *Phormidium* s petimi vrstami. Poleg sladkovodnih vrst smo v priobalnem jezeru v Fiesi določili morsko vrsto Amphora angusta ter mnoge slanoljubne brakične vrste: *Achnanthes amoena*, *Nitzschia commutatoides*, *N. dubia*, *N. tryblionella*, *N. filiformis*, *Mastogloia smithii*, *Navicula crucicula* var. *crucicula*, *N. salinarum*, *Surirella striatula*, *Phormidium dimorphum*. V vseh petih vzorčenjih so bile ugotovljene naslednje vrste: *Achnanthes minutissima*, *Fragilaria fasciculata* in *Rhoicosphenia abbreviata* (to so bile hkrati tudi najbolj številčne vrste) ter *Amphora pediculus*, *Gomphonema truncatum*, *Nitzschia constricta*, *Oedogonium* sp. in *Rhizoclonium hieroglyphicum*.

V priobalnem jezeru v Fiesi smo določili 19 vrst in podvrst, novih za Slovenijo. 4 vrste pripadajo razredu Cyanophyceae, 15 vrst in podvrst pa razredu Bacillariophyceae. Največ novih vrst in podvrst (4) pripada rodu *Navicula*.

Summary

Periphyton and phytoplankton studies were carried out in the Fiesa coastal lake. The purpose of the investigation was to establish qualitative species structure and relative abundance in the years 1998, 1999 and 2000. This is the first research into the Fiesa lake's periphyton and phytoplankton carried out through a longer period of time. Five samples of periphyton and phytoplankton were taken. Algal species were determined with light microscope. Abundance was estimated with numbers from 1 to 5 (1-single, 2-rare, 3-customary, 4-frequently, 5-dominate). In the years 1999 and 2000, some physical and chemical parameters were measured.

Altogether, 85 species and subspecies of algae (of six classes) were determined. Most of them belonged to Bacillariophyceae, followed by Cyanophyceae and Chlorophyceae. Most of the species and subspecies belonged to the genera *Navicula* (10), *Nitzschia* (10) and *Phormidium* (5). Beside freshwater species, a single see species *Amphora angusta* and the following brackish species were recorded: *Achnanthes amoena*, *Nitzschia commutatoides*, *N. dubia*, *N. tryblionella*, *N. filiformis*, *Mastogloia smithii*, *Navicula crucicula* var. *crucicula*, *N. salinarum*, *Surirella striatula*, *Phormidium dimorphum*. In all five samples of the Fiesa lake the following species were determined: *Achnanthes minutissima*, *Amphora pediculus*, *Fragilaria fasciculata*, *Gomphonema truncatum*, *Nitzschia constricta*, *Oedogonium* sp., *Rhizoclonium hieroglyphicum* and *Rhoicosphenia abbreviata*. *Achnanthes minutissima*, *Fragilaria fasciculata* and *Rhoicosphenia abbreviata* were the most abundant species.

In the coastal Fiesa lake, 19 species and subspecies new to Slovenia were determined, 15 of which belonged to Bacillariophyceae and 4 to Cyanophyceae. Most of the new species and subspecies (4) belonged to the genus *Navicula*.

Zahvala

Zahvaljujem se prof. dr. Danijelu Vrhovšku, ki mi je omogočil izvedbo naloge. Dr. Gorazdu Kosiju se zahvaljujem za strokovno pomoč, možu Gorazdu pa za pomoč pri nabiranju vzorcev.

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New species for the ant fauna of Slovenia (Hymenoptera: Formicidae)

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Abstract. A list of 14 ant species, reported for the first time for the Slovenian fauna, is given, namely: *Cryptopone ochracea*, *Proceratium melinum*, *Myrmica lonae*, *Myrmica salina*, *Aphaenogaster epirotes*, *Aphaenogaster muelleriana*, *Leptothorax albipennis*, *Leptothorax corticalis*, *Leptothorax crassispinus*, *Leptothorax exilis*, *Leptothorax flavicornis*, *Leptothorax gredleri*, *Liometopum microcephalum*, *Formica lusatica*. The new ant species were established from recently collected material and after re-examining the material from various collections by considering recent taxonomic revisions. *Leptothorax nylanderi* should be deleted from the ant list for Slovenia.

Keywords: ants, Formicidae, fauna, Slovenia

Izvleček. NOVE VRSTE ZA FAVNO MRAVELJ SLOVENIJE (HYMENOPTERA: FORMICIDAE) - Predstavljen je seznam 14 vrst mravelj, ki so prvič omenjene za slovensko favno, in sicer: *Cryptopone ochracea*, *Proceratium melinum*, *Myrmica lonae*, *Myrmica salina*, *Aphaenogaster epirotes*, *Aphaenogaster muelleriana*, *Leptothorax albipennis*, *Leptothorax corticalis*, *Leptothorax crassispinus*, *Leptothorax exilis*, *Leptothorax flavicornis*, *Leptothorax gredleri*, *Liometopum microcephalum*, *Formica lusatica*. Nove vrste so bile ugotovljene iz nedavno nabranega materiala in po ponovnem pregledu materiala iz nekaterih zbirk, upoštevaje novejše taksonomske revizije. Vrsto Leptothorax nylanderi je treba izbrisati s seznama mravelj Slovenije.

Ključne besede: mravlje, Formicidae, favna, Slovenija

Introduction

Until recently, the ants were a quite poorly investigated group of insects in Slovenia. Contributions on ant fauna were mainly restricted to particular parts of the country. Bračko (2000) was the first who published a more general review of the ant fauna of Slovenia, which included data from the literature and, until then, unpublished collected material. In his review,

105 ant species are listed. Several new species were expected to be found in Slovenia, as some parts of the country had not been researched at all and, moreover, the analysis of the species found indicated that Slovenian territory had, due to its geographical position, rather diverse ant fauna.

This paper brings a list of 14 ant species reported for the first time from Slovenia. Most of new data have been contributed by the author, and some by his colleagues as well as biology students. Certain species were confirmed to be present after re-examining some material by considering recent taxonomic revisions.

Material and methods

The author collected ants in different parts of Slovenia. Specimens were preserved in 70 % ethanol. The material, which had been collected by biology students (and deposited at the Department of Biology of the Biotechnical Faculty in Ljubljana) but not included in previous studies, was also checked. Determination keys in Müller (1923), Kutter (1977), Agosti & Collingwood (1987), and Seifert (1996) were used for identification of ant specimens. *Leptothorax exilis* was kindly identified by Andreas Schulz.

In order to take into consideration some recent taxonomic revisions (Seifert 1996, Seifert 1997, Orledge 1998, Radchenko 2000), material from the zoological collection of the Department of Biology, Jeager Collection of the Slovenian Museum of Natural History and the author's collection was re-examined from those groups, in which the mentioned revisions had not been included in previous studies (i.e. *Myrmica*, *Leptothorax*, *Formica*).

Results and discussion

In the list of ants new to Slovenia, 14 species are presented. *Leptothorax nylanderi* has been omitted from previous lists as only its sibling parapatric species *Leptothorax crassispinus* has been proved to occur in Slovenia (for details see notes for this species). Altogether, 118 ant species have been thus recorded in our country. For each new species, data on its localities in Slovenia, and some notes are given in the following list.

***Cryptopone ochracea* (Mayr, 1855)**

RECORDS FROM SLO: Fiesa, Piran, UTM UL84, lawn, 1 alate queen, 20-IX-2001, leg. G. Bračko
NOTES: hypogeic species, distributed mainly in Southern Europe, in Crimea and Caucasus (Baroni Urbani 1971, Atanassov & Dlusskij 1992), but also found in Southern Switzerland (Kutter 1977)

***Proceratium melinum* (Roger, 1860)**

RECORDS FROM SLO: near Škocjanski zatok, Bertoki, Koper, UTM VL04, 1 alate queen, IX-1996, leg. biology students
NOTES: the same as *Cryptopone ochracea*, this species is mainly known form Southern Europe, although there are also some records from Central Europe, i.e. from Austria (Steiner et al. 2002), Hungary (Gallé et al. 1998), Moravia and Slovakia (Werner 1989, Bezděčka 1996). It is a hygrophilic, hypogeic species, often nesting in the ground at the base of trees, and near human habitations (Baroni Urbani 1971).

***Myrmica lonae* Finzi, 1926**

RECORDS FROM SLO: Škrubi, Črna na Koroškem, UTM VM84, 22-VII-1974, leg. biology students; Planica valley, Kranjska Gora, UTM VM04, among *Pinus mugo*, nesting in the ground under a stone, 3-VIII-1997, leg. G. Bračko
NOTES: *Myrmica lonae* had been for years treated as a synonym or variety of *M. sabuleti*. Seifert (1993, 1996) raised it to species by considering the differences in size of its antennal lobe. Occurs in Central and Eastern Europe, Scandinavia and Southern Finland, southern part of Western Siberia, and Northern Kazakhstan (Radchenko et al. 1997). It is not as common as

M. sabuleti, but certainly more abundant in Scandinavia and S Finland (Seifert 1996, Kvamme 1999). In contrast to *M. sabuleti*, it inhabits open moorland and thermophilic deciduous or coniferous forests, although it can also be found in open xerothermous habitats where both species can occur syntopically (Seifert 1996). In Slovenia, *M. lonae* is much rarer than *M. sabuleti*.

***Myrmica salina* Ruzsky, 1905**

RECORDS FROM SLO: Lipovec pri Škofji vasi, Celje, UTM WM22, meadow, 12-IX-2002, leg. G. Bračko
NOTES: *M. salina*, which is not a common *Myrmica species*, is distributed in Central and Eastern Europe and in SW Siberia. It is characteristic of high salinity habitats, which are often margins of salt lakes. However, it can also be found in steppe-like habitats, in xerothermous limestone grasslands or xerothermous margin lines in agricultural regions (Seifert 1988).

***Aphaenogaster epirotes* (Emery, 1895)**

RECORDS FROM SLO: Fiesa, Piran, UTM UL84, forest edge, 28-IX-2002, leg. G. Bračko
NOTES: known from the Balkans (Baroni Urbani 1971, Atanassov & Dlusskij 1992)

***Aphaenogaster muelleriana* Wolf, 1914**

RECORDS FROM SLO: 2 km N of Podnanos, Vipava, UTM VL17, margin of meadow with some shrubs, nesting in wall crevice, 16-VI-2001, leg. G. Bračko
NOTES: distribution of this species is limited to the territory along the Eastern Adriatic from Italy to Albania. It is a nocturnal species, found almost exclusively in urban areas, mostly on walls and rocks, and nesting in their crevices (Zimmermann 1934, Baroni Urbani 1971). The Slovenian locality is well out of the urban area, but the ants were, as a rule, observed on the wall of a solitary ruined building.

***Leptothorax albipennis* (Curtis, 1854)**

RECORDS FROM SLO: Robanov Kot, Luče ob Savinji, UTM VM73, 27-VIII-1986, leg. biology students; Planica valley, Kranjska Gora, UTM VM04, forest edge, nesting in the ground under a stone, 3-VIII-1997, leg. G. Bračko; Globoki laz, Hrib-Loški Potok, UTM VL66, forest edge, nesting in the ground, 31-VIII-2002, leg. G. Bračko

NOTES: this species has until recently been known as *L. tuberrointeruptus*, but even more often considered as a synonym of different species. Moreover, Douwes & Stille (1991) showed that *L. tuberointerruptus* could interbreed with *L. tuberum*, *L. nigriceps*, and *L. unifasciatus*, which makes the species even more difficult to distinguish. Seifert (1996) indicated certain differences in sculpture and colouration to distinguish *L. tuberointerruptus* from other species. On the basis of the material from Great Britain, Orledge (1998) established that *L. tuberointerruptus* was the junior synonym of *L. albipennis* and that all British records of *L. tuberum* referred to *L. albipennis*. In connection with this, it is also quite doubtful whether *L. tuberum* was actually recorded in Slovenia. Bračko (2000) gave 3 records for *L. tuberum*. Since the one from UTM VM73 (wrongly indicated as VM74 in that paper) is now identified as *L. albipennis*, and as "*L. tuberum*" specimen from the Jaeger Collection (UTM WM41) is a misidentification, the only unchecked data for this species is then from Mayr (1855), which could also actually be *L. albipennis*. This species is otherwise known from Central Europe, Pyrenees, The Netherlands, Italy, Southern England and Wales (Radchenko et al. 1999). It is quite rare, but is likely to become more common since it has been frequently mixed with L. tuberum and L. unifasciatus. It is a xerothermophilic species, found mostly in grasslands with single shrubs or in light scrub, and nesting in dead wood, in stony ground, or inside dry empty stems of herbaceous plants (Seifert 1996, Radchenko et al. 1999).

***Leptothorax corticalis* (Schenck, 1852)**

RECORDS FROM SLO: 1.5 km SW of Iljaševci, Ljutomer, UTM WM85, forest, 26-VII-2001, leg. G. Bračko; Urbarija, Dobrovnik, Lendava, UTM XM07, clearing with shrubs and individual trees, 27-VII-2001, leg. G. Bračko

NOTES: distributed in Southern and Central Europe, central part of Eastern Europe, S Sweden, Crimea, Caucasus and Algeria, but everywhere rare (Radchenko et al. 1999). It is an arboreal species, inhabiting mainly dry light forests and nesting in dead tree branches (mainly on oaks) or in bark crevices. Owing to its strict arboreal life, it has probably been often overlooked (Seifert 1996).

***Leptothorax crassispinus* Karawajew, 1926**

RECORDS FROM SLO: more than 130 localities from all parts of Slovenia

NOTES: Seifert (1995) first pointed out that *Leptothorax nylanderi*, a widespread species in Europe, consists of two morphologically different parapatric populations, treated as two different subspecies, *Leptothorax nylanderi nylanderi*, which is distributed in Western Europe, and *L. nylanderi slavonicus* from Eastern Europe. The two subspecies have a known contact

zone in East Germany. Seifert (1996) later regarded *L. slavonicus* to be a good species, and Radchenko (2000) then showed that *L. slavonicus* was actually a junior synonym of *Leptothorax crassispinus*. On the basis of the gross distribution pattern of the two sibling species and from the data from some neighbouring territories, it could be expected that Slovenian territory belongs to the range of *L. crassispinus*. In Austria, *L. nylanderi* is known only from Vorarlberg (westernmost part of the country), while *L. crassispinus* is distributed in the rest of Austria east of Arlberg (Glaser 2000). *L. crassispinus* is also known from NE Italy (Seifert 1995). After examining more than 130 "*L. nylanderi*" samples from all over Slovenia, they were all identified as *L. crassispinus*. It can be therefore assumed that only this species occurs in Slovenia and that *Leptothorax nylanderi* should be omitted from previous lists.

***Leptothorax exilis* Emery, 1869**

RECORDS FROM SLO: Križišče, Dragonja, Piran, UTM UL93, grove edge, 5-VII-2000, leg. G. Bračko, det. A. Schulz
NOTES: this is a Southern European species, and this Slovenian site probably delineates the northern border of its range. *L. exilis* may be found in very hot and dry habitats, usually nesting under stones (Schulz pers. comm.). The specimens were found above a limestone cliff, which is one of the few places in coastal Slovenia, where warm limestone offers refuge to true Mediterranean plant and animal species.

***Leptothorax flavicornis* Emery, 1870**

RECORDS FROM SLO: Škocjanski zatok, Bertoki, Koper, UTM VL04, bank of the brackish lagoon, nesting on stony ground between roots of the halophyte *Artemisia caerulescens*, 31-V-2001 and 17-V-2003, leg. G. Bračko
NOTES: rare species known from Italy, Southern Switzerland, and Western Balkans (Müller 1923, Petrov 2000). Nests can be found under stones, in hollow acorns in deciduous forests or in shrubs (Buschinger 1999). The Slovenian site, located in the Škocjanski Zatok Nature Reserve, could be an important contribution to the knowledge of this species.

***Leptothorax gredleri* Mayr, 1855**

RECORDS FROM SLO: near Hrastje-Mota, Radenci, UTM WM86, forest edge, 24-V-2001, leg. G. Bračko

NOTES: it has been mainly reported from Central Europe, and also from Greece and the former Yugoslavia (Radchenko et al. 1999). *L. gredleri* inhabits shady and moist deciduous or mixed forests, nesting in rotten wood and under bark.

***Liometopum microcephalum* Panzer, 1798**

RECORDS FROM SLO: 0.5 km S of Dolina pri Lendavi, Lendava, UTM XM15, meadow with individual trees, nesting in the trunk of a large *Quercus robur*, 22-V-2001, leg. G. Urbanič
NOTES: *L. microcephalum* is mainly distributed in Southern and Eastern Europe, in Caucasus and Asia Minor, but is quite scarce in Central Europe (Baroni Urbani 1971, Kutter 1977, Atanassov & Dlusskij 1992). Builds carton nests in hollow parts of trees, mostly in different Quercus species.

***Formica lusatica* Seifert, 1997**

RECORDS FROM SLO: Modrejce, Tolmin, UTM VM01, 4-VII-1992, leg. biology students; near Borjana, Kobarid, UTM UM82, stony ground along the road, 14-VII-2001, leg. G. Bračko
NOTES: this species was described by Seifert (1997) as a sympatric sibling species of *F. cunicularia* and *F. rufibarbis*. *Formica lusatica* is also a correct name for the ant species previously named as *Formica glauca* (Seifert 1996). It is an aggressive species, even more xerothermophilic than *F. rufibarbis*, and prefers xerothermous grasslands with sparse vegetation. In Slovenia, it appears to be much rarer than its two sibling species.

Povzetek

Za območje Slovenije je bilo do sedaj znanih 105 vrst mravelj. Ta seznam je dopolnjen s 14 vrstami, ki so prvič omenjene za slovensko favno mravelj, in sicer: *Cryptopone ochracea*, *Proceratium melinum*, *Myrmica lonae*, *Myrmica salina*, *Aphaenogaster epirotes*, *Aphaenogaster muelleriana*, *Leptothorax albipennis*, *Leptothorax corticalis*, *Leptothorax crassispinus*, *Leptothorax exilis*, *Leptothorax flavicornis*, *Leptothorax gredleri*, *Liometopum microcephalum*, *Formica lusatica*. Nekatere izmed teh novih vrst so bile nabrane v zadnjem času v okviru vzorčevanja mravlje favne na različnih koncih Slovenije. Vključen je bil tudi do sedaj še nepregledan starejši material, shranjen na Oddelku za biologijo Biotehniške fakultete v Ljubljani. Določeni rodovi mravelj (*Myrmica*, *Leptothorax*, *Formica*) so v zadnjem času doživeli taksonomske revizije, zato so bili primerki iz omenjenih skupin ponovno pregledani. Tako je z do sedaj poznanega seznama mravelj Slovenije treba izbrisati vrsto *Leptothorax nylanderi*, saj je bila na tem območju najdena le njena sorodna parapatrična vrsta *Leptothorax crassispinus*.

Acknowledgements

I wish to thank Andreas Schulz (Leverkusen) for identifying *Leptothorax exilis*, and Andrea Colla (Museo Civico di Storia Naturale, Trieste) for sending me *Aphaenogaster epirotes* specimens for comparison. I am grateful to my colleague Gorazd Urbanič (Biotechnical Faculty, Ljubljana) for the collected ant specimens. I also wish to thank Tomi Trilar and Matjaž Černila (Slovenian Museum of Natural History, Ljubljana) for giving me access to the ants from the Jaeger Collection.

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Display song of parti-coloured bat *Vespertilio murinus* Linnaeus, 1758 (Chiroptera, Mammalia) in southern Slovenia and preliminary study of its variability

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Abstract. In September 2000, display song of parti-coloured bat *Vespertilio murinus* Linnaeus, 1758, was recorded for the first time in Slovenia. Bats emitted the song at four localities near Goteniška gora Mountain in southern Slovenia while flying above the canopy or above open land surrounded by forests. In the area of Medvedjak, the display song consisted of 8 frequency modulated sweeps on average and a final frequency modulated – quasi-constant frequency call (average frequency of maximum energy in quasi-constant frequency part of the final call was 14.69 kHz). Final calls of the display song from three localities were significantly different in four measured parameters. Possible causes for this are discussed.

Keywords: *Vespertilio murinus*, display song, distribution, Kočevska, Slovenia, bats, Chiroptera

Izvleček. SVATBENI NAPEV DVOBARVNEGA NETOPIRJA *VESPERTILIO MURINUS* LINNAEUS, 1758 (CHIROPTERA, MAMMALIA) V JUŽNI SLOVENIJI IN PRELIMINARNA ŠTUDIJA NJEGOVE VARIABILNOSTI - Septembra 2000 je bil prvič v Sloveniji posnet svatbeni napev dvobarvnega netopirja *Vespertilio murinus* Linnaeus, 1758. Na štirih lokalitetah pri Goteniški gori (južna Slovenija) so se netopirji oglašali med letom nad krošnjami ali odprtimi jasami, obdanimi z gozdom. Svatbeni napev z Medvedjaka je bil sestavljen iz povprečno 8 frekvenčno moduliranih klicev in končnega frekvenčno moduliranega - kvazi-konstantno frekvenčnega klica (povprečna frekvenca z maksimalno energijo v kvazi-konstantno frekvenčnem delu končnega klica je bila 14,69 kHz). Končni klici svatbenih napevov s treh lokalitet so bili v štirih merjenih parametrih statistično značilno različni. Obravnavani so možni vzroki za različnosti.

Ključne besede: *Vespertilio murinus*, svatbeni napev, razširjenost, Kočevska, Slovenija, netopirji, Chiroptera

Introduction

Among the 29 bat species found in Slovenia so far (Kryštufek & Červeny 1997, Presetnik et al. 2001, Spitzenberger et al. 2002), the parti-coloured bat *Vespertilio murinus* Linnaeus, 1758 is one of the least known. In the territory of Slovenia, the species was recorded for the first time in October 1930, when a specimen was found at Dol pri Hrastniku (Đulić 1959). More than 50 years later, individual specimens were found in Ljubljana (Kryštufek 1989), Velenje

and in Kočevski Rog (Kryštufek & Červeny 1997). The latter was a pregnant female, mist-netted at Rdeči Kamen near Luža, which confirmed the reproduction of the species in Slovenia (Kryštufek 1997).

Vespertilio murinus is a Palearctic species. In Europe, it is distributed from northern Russia to southern Sweden, southern Norway, eastern Denmark, northeastern Germany, to France, through the Italian Alps, southeast to northern Greece and Caucasus (Baagøe 1999). The northern border coincides with limes norrlandicus, the line marking the border between broad-leaved forests and boreal pine forests (Ahlen & Gerrell 1989). It is a migratory species, with populations moving between summer roosts in the East and winter roosts in the West. A male ringed in July 1988 in Estonia was found in Steiermark, Austria, in November of the same year - at an aerial distance of 1440 km (Masing 1989 cit. after Baagøe 2001). There are small distance migrations in populations in Denmark (Baagøe 1999, 2001) and Czech Republic (Červeny & Bürger 1989).

The primary habitat of *V. murinus* are rocky mountains, where these bats prefer crevices (Bauer 1954, Helversen et al. 1987). It is a highly synantropic species. In Denmark, all summer roosts were found in buildings (Baagøe 1986). Bauerova & Ruprecht (1989) and Zöllick et al. (1989) also found nursery colonies in buildings, whereas in Russia they were also found in hollow trees and nest boxes (Baagøe 1999). It adapted successfully to living in high buildings in the cities (Ryberg 1947, Bauer 1954, Baagøe 1986, Helversen at al. 1987). It was observed feeding in diverse habitats: above forests and agricultural land (Ahlen & Gerell 1989), near road lamps (Baagøe 1986) and in gardens and orchards near tundra-like pastures (Baureova & Ruprecht 1989).

Vespertilio murinus has very variable orientation calls. These are pulses of frequency modulated (FM) sweeps that level out to quasi-constant frequency (QCF). They are best heard at the frequency of about 25-27 kHz (Ahlen 1990), but Zingg (1990) gives lower values of 22-25 kHz. In fact, it is considered to be the species with the broadest variability of calls in Europe, causing difficulties in distinguishing it from species of the genera Eptesicus and Nyctalus (Weid 1988, Zingg 1990, Ahlen 1990, Ahlen & Baagøe 1999). Nevertheless, with certain amount of experience it is possible to recognise it in the field (Ahlen 1990, Rydell 1992).

Like many bat species, *V. murinus* also emits signals for communication (Ahlen 1990, Ahlen & Baagøe 1999). Social calls can be used for distinguishing the species (Russo & Jones 1999). In autumn, i.e. in mating season, *V. murinus* emits very characteristic display or territorial song, which is unique and enables accurate identification of the species (Ahlen &

Baagøe 1999). Computer analysis of sound recordings, made in the forests near Goteniška gora Mt. in southern Slovenia revealed *V. murinus*.

Material and methods

Observation sites

Vespertilio murinus individuals were observed at four localities near Goteniška gora Mt. in southern Slovenia (Figure 1) on 26 and 27 Sept 2000. The localities are in the area of dense Dinaric fir-beech forests (Abieti-Fagetum dinaricum Tregubov, 1957), which are here and there interrupted by forest roads, small meadows and openings. Average annual temperatures of the area are 6-8°C, in January (-2)-0°C and in July 18-20°C. Average precipitation is 1800-2000 mm (Zupančič 1991). Geological substrate is limestone and dolomite (Buser & Draksler 1989).

The localities are marked in Figure 2. Location 1 (Loc1) is a large meadow near a couple of foresters' cottages on Medvedjak. There is a group of trees with a raised hide in the middle of the meadow and a dirt forest road leading past the two cottages. Location 2 (Loc2) is a small opening surrounded by woods in the vicinity of Pasja jama. It is situated at the end of the forest road. Location 3 (Loc3) is near the forest road leading from the cottages northeast of Taborska stena. Location 4 (Loc4) is in front of the Taborska jama Cave in the rocky walls called Taborska stena. In front of the cave and the walls there are high trees.

At certain localities, temperatures were measured with digital thermometer GTH 175/MO. Time of observation, temperature and elevation are given in Table 1.

Table 1. Dates and time of observations of *Vespertilio murinus* at four localities near Goteniška gora Mt., southern Slovenia; temperature, when measured, and elevation are given; * - explanation of the abbreviations is given in the text.
Tabela 1. Datumi in časi opazovanj dvobarvnih netopirjev (*Vespertilo murinus*) na štirih lokalitetah pri Goteniški gori; podane so tudi izmerjene temperature in nadmorska višina; * - razlaga okrajšav je v tekstu.

locality/lokaliteta	date/datum	time/ura	T	altitude/nadmorska višina
Loc1*	26. 9. 2000	21.30 - 21.50	9.1 °C	1001 m
	27. 9. 2000	22.20 - 22.30	/	
Loc2*	26. 9. 2000	20.55 - 21.20	/	1060 m
Loc3*	27. 9. 2000	20.45 - 20.50; 21.40	/	1000 m
Loc4*	27. 9. 2000	20.55 - 21.30	14°C (21.00) 11.7°C (21.28)	950 m

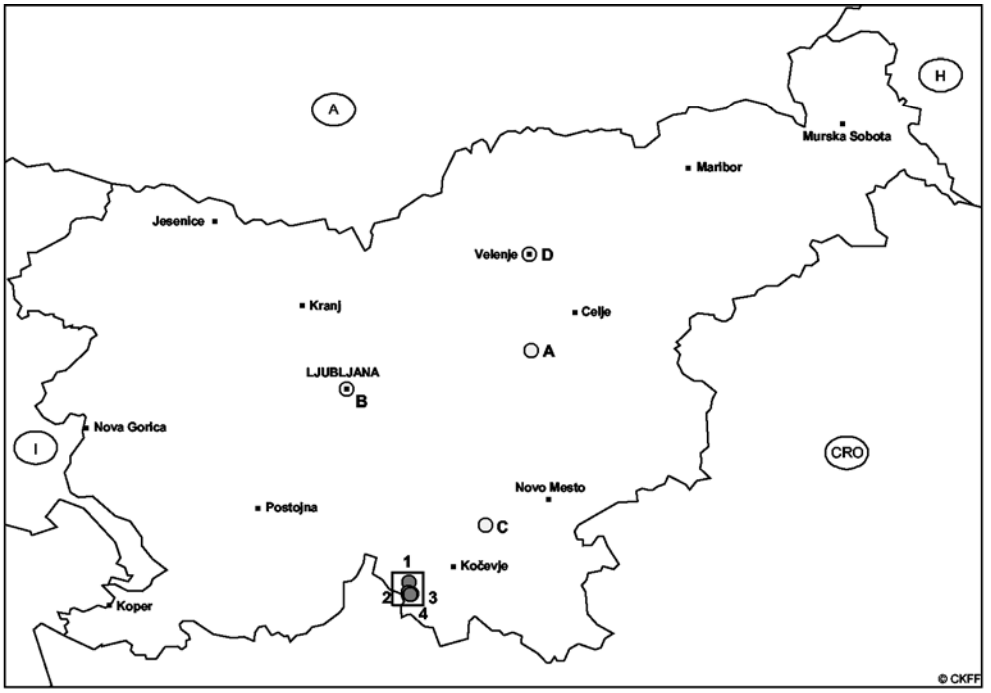

Figure 1. Known localities of *Vespertilio murinus* in Slovenia. Localities A-D are: A - Dol pri Hrastniku (Đulić 1959), B - Ljubljana (Kryštufek 1989), C - Velenje (Kryštufek & Červeny 1997), D - Rdeči kamen pri Luži (Kryštufek & Červeny 1997); localities 1-4 are new and described in this work.

Slika 1. Poznane lokalitete dvobarvnega netopirja (*Vespertilio murinus*) v Sloveniji. Lokalitete A-D so: A - Dol pri Hrastniku (Đulić 1959), B - Ljubljana (Kryštufek 1989), C - Velenje (Kryštufek & Červeny 1997), D - Rdeči kamen pri Luži (Kryštufek & Červeny 1997); lokalitete 1-4 so nove in opisane v tem delu.

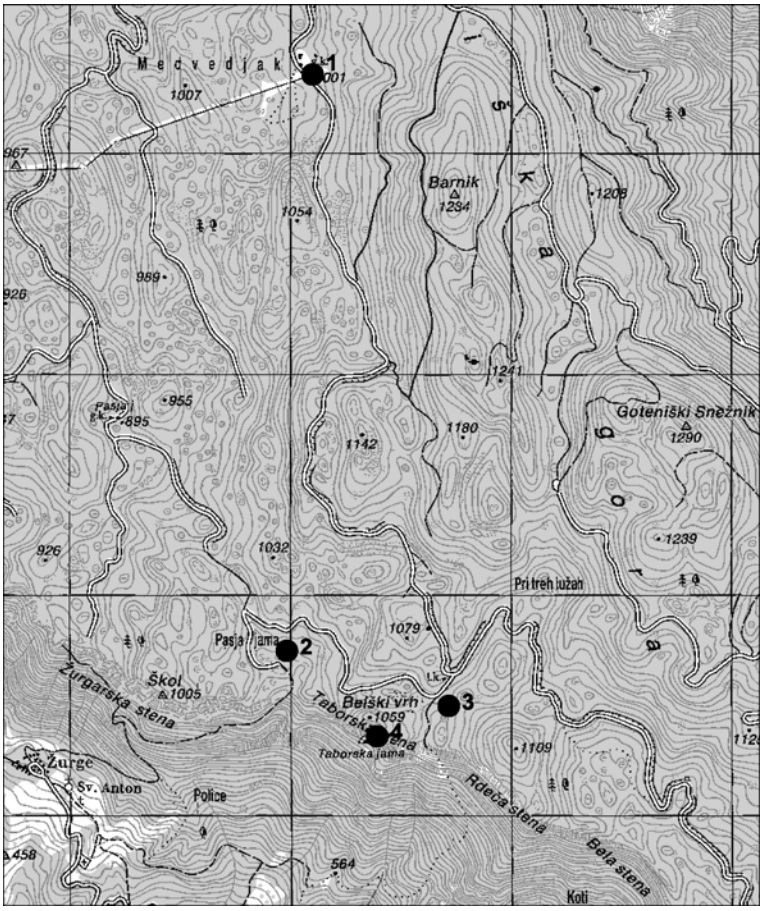

Figure 2. New localities of *Vespertilio murinus* near Goteniška gora Mt. in Slovenia, where display songs were recorded.
Slika 2. Nove lokalitete dvobarvnega netopirja (*Vespertilio murinus*) pri Goteniški gori v Sloveniji, kjer smo posneli svatbene napeve.

Recording and sound analysis

Bat detectors Pettersson D200 (Pettersson Elektronic) and Tranquillity II (David J. Bale) were used to detect and record bat sounds. The former enabled only listening in heterodyne mode, which is listening to the tuned frequency in real time, while the latter included time expansion modeas well. It recorded time intervals of 1.2 s and replayed them slowed by a factor 10 (for a detailed explanation, see Russ 1999). Output was stored on tape (SONY, UX-

S, IEC II/Type II, Chrome), using SONY Stereo Cassette Recorder TC-D5M. Whenever possible, bats were observed visually lit with halogen reflector light.

The recordings were put in the computer Macintosh G4 with Protools computer program (sampling rate 48 kHz, 16 bit). They were analysed with the sound analysis software Canary, ver. 2.1.

For the comparison of display songs, only parameters (Table 2) of the last FM-QCF call were measured (Figure 3). Frequencies of maximum energy were measured from the power spectrum, but other parameters were taken from the sonogram (Russ 1999).

Average values are given (Table 3). Non-parametric Mann-Whitney U test of medians and Kruskal-Wallis test (Fowler et al. 1998) were used for comparison of parameters from different localities.

Table 2. Abbreviations used for the parameters measured on the final call of display song of *Vespertilio murinus*.
Tabela 2. Okrajšave za parametre, ki so bili merjeni na končnem delu svatbenega napeva dvobarvnega netopirja (*Vespertilio murinus*).

abbreviation/okrajšava	**parameter/parameter**
fMax	maximum frequency
fMin	minimum frequency
fMaxE_FM	frequency of maximum energy in FM part of the call
fMaxE_QCF	frequency of maximum energy in QCF part of the call
sQCF	start of QCF part of the call
CD	call duration
IPI	inter-pulse interval

Table 3. Number of frequency modulated sweeps in 13 (n) analysed display songs of *Vespertilio murinus*, recorded at Loc1 (Medvedjak) (n:1-4 on 26. 9. 2000, n:5-13 on 27. 9. 2000).
Tabela 3. Število frekvenčno moduliranih klicev v 13 (n) analiziranih svatbenih napevih dvobarvnega netopirja (*Vespertilio murinus*), posnetega na Loc1 (Medvedjak) (n:1-4 dne 26. 9. 2000, n:5-13 dne 27. 9. 2000).

n	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
FM	8	8	8	9	10	9	8	9	10	7	7	5	6

Results

Display song

Although the duration of observations was relatively short, notes on behaviour of *V. murinus* at each locality can be given:

Loc1: Bat flew to and fro, west from the foresters' cottages on the edge of the meadow. It flew above the road and open grassland in a strait line.
Loc2: Bat circulated above an opening and above the tree canopy. Then it flew away and it did not return for the next 20 minutes.
Loc3: Bat flew above the canopy, where it circulated for a few minutes, and then flew away.
Loc4: Bats flew near or above the trees in front of the Taborska jama Cave and near rocky walls. After 21.15 they became silent.

Vespertilio murinus emitted display song, which ends with frequencies that can be heard by human ear (Figure 3). It consists of a row of FM sweeps, followed by a final FM-QCF call. The intensity of FM sweeps was very low at most of the localities, so they could be best seen only on the recordings from Loc1. The average number of FM sweeps of 13 display songs was 8 (Table 3). The final call of the song was analysed in detail and the values of measured parameters are given in Table 4.

Variability of display song

Table 4 presents the parameter values of the final call of the song from four localities. Display songs from Loc1 were compared separately from each separate day of recording. U-test gave no statistically significant differences in the measured parameters, except in the frequency of maximum energy (Table 5).

Among the parameters of the final calls of display song, only four could be included in the comparison, since the frequency of maximum energy and therefore call duration could not be measured on some recordings from Loc2 and Loc3. Calls from Loc4 were excluded from the analysis, since the number of bats in our surroundings could not be determined. Frequency of maximum energy in FM and QCF part of final call, call duration and inter-pulse interval were all significantly different among localities (Table 6).

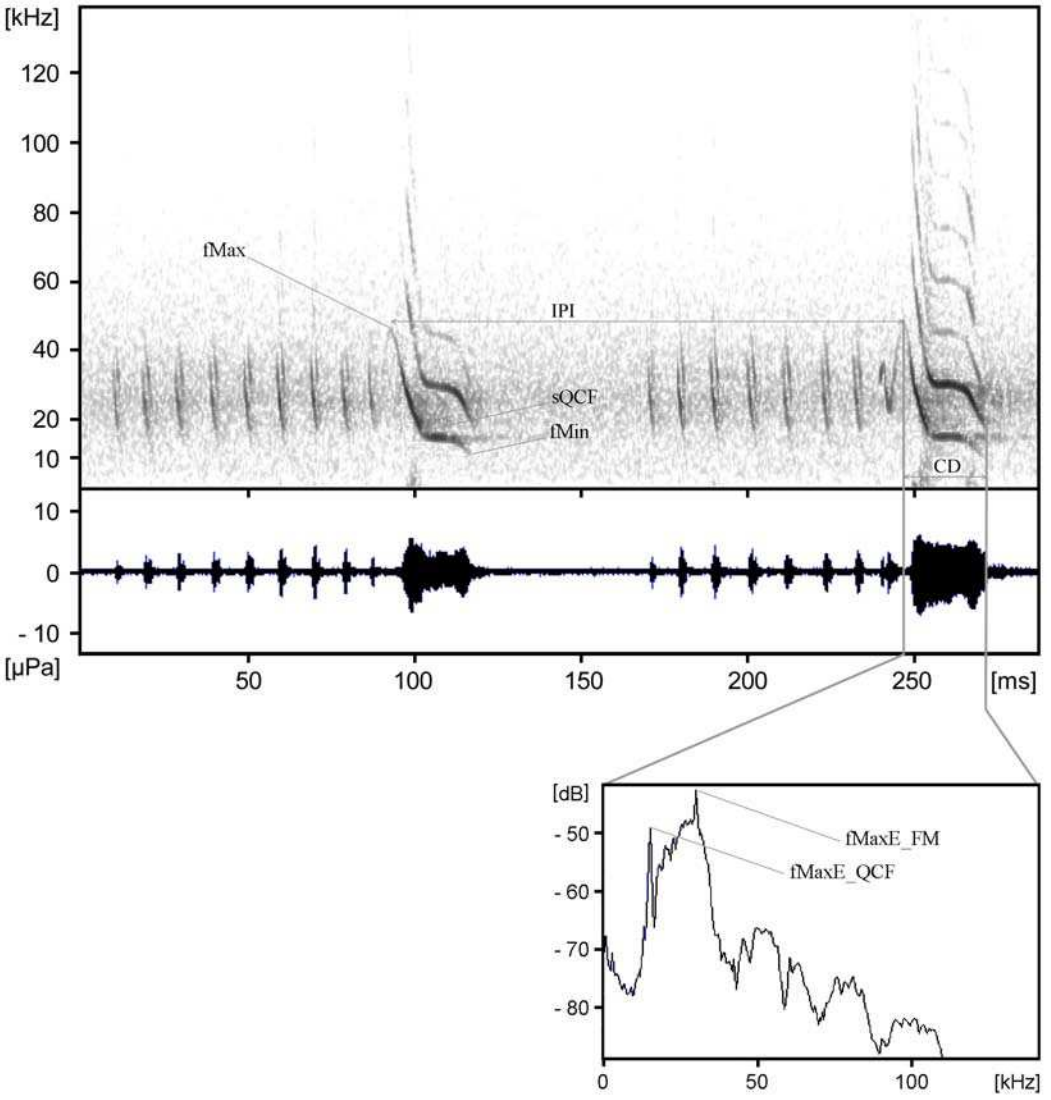

Figure 3. Sonogram, wave presentation and power spectrum of display song of *Vespertilio murinus* (FFT 4096, Hanning window), with measured parameters drawn in (abbreviations are explained in Table 2).
Slika 3. Sonogram, oscilogram in energijski spektrogram svatbenih napevov dvobarvnega netopirja (*Vespertilio murinus*) (FFT 4096, Hanning window). Vrisani so merjeni parametri, okrajšave so pojasnjene v Tabeli 2.

Table 4. Values of parameters, measured on the final call of the display song of *Vespertilio murinus* from four localities and on Loc1 on both days. Mean value ± standard deviation are given, with numbers of measured calls in brackets; * - explanation of the abbreviations is given in the text.
Tabela 4. Vrednosti parametrov, ki so bili merjeni na končnem klicu svatbenih napevov dvobarvnega netopirja (*Vespertilio murinus*) s štirih lokacij in na Loc1 v obeh dnevih. Podani sta povprečna vrednost ± standardna deviacija, število analiziranih klicev je v oklepaju; * - razlaga okrajšav je v tekstu.

parameter	Loc1*		Loc2*	Loc3*	Loc4*
	26.9.	27.9.			
fMin (kHz)	10.36 ± 1.38 (n=25)	9.3 ± 0.48 (n=28)	/	/	/
fMax (kHz)	32.09 ± 1.79 (n=25)	39.13 ± 4.07 (n=28)	/	/	/
fMaxE_QCF (kHz)	14.69 ± 0.6 (n=25)	14.69 ± 0.43 (n=28)	13.71 ± 0.27 (n=23)	13.26 ± 0.13 (n=22)	14.35 ± 0.39 (n=7)
fMaxE_FM (kHz)	22.65 ± 2.46 (n=24)	24.79 ± 1.15 (n=28)	21.88 ± 0.73 (n=23)	22.10 ± 0.85 (n=22)	21.46 ± 0.98 (n=7)
SQCF (kHz)	15.54 ± 0.32 (n=25)	15.64 ± 0.43 (n=28)	14.68 ± 0.34 (n=23)	14.67 ± 0.43 (n=22)	15.41 ± 0.42 (n=7)
CD (ms)	21.06 ± 2.01 (n=25)	22.2 ± 1.73 (n=28)	/	/	/
IPI (ms)	175.39 ± 10.41 (n=21)	175.16 ± 12.70 (n=25)	243.98 ± 9.19 (n=21)	253.17 ± 9.42 (n=24)	188.66 ± 5.55 (n=8)

Table 5. Comparison of parameters of the final call of display song of *Vespertilio murinus*, taken on two consecutive nights at Loc1 (Medvedjak). U values of the Mann-Whitney test are given and whether the difference between medians is statistically significant (P=0.05) is stated.
Tabela 5. Primerjava parametrov končnega klica svatbenih napevov dvobarvnega netopirja (*Vespertilio murinus*), posnetih v dveh zaporednih nočeh na lokaliteti Loc1 (Medvedjak). Podane so U vrednosti Mann-Whitneyevega testa in ali je razlika med medianami statistično značilna (P=0,05).

Parameter	U	stat. sign. (P=0.05)
fMin	192	no
fMax	33.5	yes
fMaxE_QCF	309	no
fMaxE_FM	140.5	no
sQCF	302.5	no
CD	245	no
IPI	252.5	no

Table 6. Comparison of the final calls of display song of *Vespetilio murinus* from three different localities (Loc1, Loc2, Loc3). K values of the Kruskal-Wallis test are given and whether the difference among medians is statistically significant (P=0.05) is stated; explanation of the abbreviations for localities is given in the text.
Tabela 6. Primerjava končnih klicev svatbenega napeva dvobarvnega netopirja (*Vespertilio murinus*) s treh različnih lokalitet (Loc1, Loc2, Loc3). Podane so vrednosti K Kruskal-Wallis testa in ali je razlika med medianami statistično značilna (P=0,05); razlaga okrajšav za lokalitete je v tekstu.

parameter	K	stat.sign. (P=0.05)
fMaxE_QCF	59.96	yes
fMaxE_FM	45.87	yes
sQCF	42.55	yes
IPI	51.46	yes

Discussion

A more intensive use of bat detectors in Slovenia after 1998 has enabled us to gather additional knowledge on the distribution and ecology of bats (i.e. Presetnik et al. 2001). Certain species can be recognised with bat detectors in heterodyne mode in the field (Limpens & Roschen 1995, Russ 1999). Combination with time expansion mode enables a more reliable species recognition (Barataud 1996, Ahlen & Baagøe 1999), as it enables both recording of the calls and a subsequent computer analysis. This proved to be a very important element in recognising display song of *V. murinus* in our case, even without prior experience with this species. Parts of display song can be heard with bare ears, which is very similar to hearing echolocation calls of *Tadarida teniotis* (Rafinesque, 1814) (Ahlen 1990). The same is reported by Helversen & Helversen (1994), as they heard parts of advertisement calls of *Nyctalus leisleri* (Kuhl, 1817) with bare ears. But listening with bat detectors reveals that the frequency is higher than in *T. teniotis* (Ahlen 1990). The sonogram made from recordings in time expansion mode reveals the characteristic design of *V. murinus* display song (Ahlen & Baagøe 1999).

There are many bat species in the temperate climatic zone that emit special display calls in autumn, in order to attract females and defend mating territories. Males of *Nyctalus noctula* (Schreber, 1774) emit advertisement calls from the entrance of their mating roost in the tree (Ahlen 1990). In *N. leisleri* and *Pipistrellus nathusii* (Keyserling & Blasius, 1839) males fly between trees and emit advertisement song while flying or sitting near or at the entrance of the roost (Gerell-Lundberg & Gerell 1994, Helversen & Helversen 1994). Similar to *Pipistrellus pipistrellus* (Schreber, 1774), males of parti-coloured bat mostly sing in flight (Ryberg 1947, Gerell-Lundberg & Gerell 1994, Ahlen 1990). In our case, *V. murinus* were also calling in flight, flying to and fro or circling above the canopy or open land. In the rocky walls of Taborska stena, bats could also be emitting the song while sitting.

Display behaviour of *V. murinus* is reported mostly from the surroundings of high buildings in the cities (Ryberg 1947, Spitzenberger 1994). The buildings probably resemble rocky walls in the mountains, which are supposed to be the primary habitat of the species (Bauer 1954, Helversen et al. 1987). Weid (1988) observed display behaviour in the forests of Rhodopi Mountains in Greece. Males flew above the forest canopy, over open areas of roads, circling or flying along the roads. The same was observed in the forests of Kočevska. The rocky walls of Taborska stena are part of a larger rocky walls massif, which could harbour many *V. murinus*. It is also probable that *V. murinus* hibernate in those walls, as they were observed hibernating

in buildings around which they emitted display song (Ahlen & Baagøe 1999). The gravid female was caught above a pond some 25 km northeast from display sites (Kryštufek & Červeny 1997) in the same type of forest, which implies the importance of the latter for *V. murinus*.

As far as *N. leisleri* is concerned, males arrive at mating places before females, which are attracted by them to the site afterwards (Helversen & Helversen 1994). For *V. murinus*, Spitzenberger (1994) states similar observations from Austria: males arrive at mating places as early as in the beginning of August, but females arrive more than a month later. Helversen et al. (1987) observed display song only in the first half of October in SüdBaden in Germany. Our observations were made at earlier date, but a more thorough research is needed to assess the period of display behaviour of *V. murinus* in Slovenia. They can be most probably heard at the same sites in successive years, as reported from certain localities (Spitzenberger 1984, Helversen et al. 1987).

Recorded display songs are of the same structure as described in Ahlen & Baagøe (1999). The best recordings, where somewhat weaker FM calls could be counted, were from Medvedjak (Loc1). On average, eight FM sweeps were followed by a final FM-QCF call, with the frequency of maximum energy in CF part of the call 14.69 kHz (Tabela 4). Ahlen & Baagøe (1999) report the frequency of 14 kHz.

Social calls are used in communication between bats. In some species, individual differences in isolation calls of infants help the mothers to recognise their young (Fenton 1986, Rasmuson & Barclay 1992). Display song is emitted in territorial flight and it could contain certain information about the fitness of the calling bat. Correlation among the peak frequency of echolocation calls and the mean frequency of maximum amplitude in social calls was found in *Pipistrellus kuhlii* (Kuhl, 1817) (Russo & Jones 1999). In some species, a relation among the main frequency of echolocation calls and the sex, age and the size of the bat as well as geographic variation in the main frequency was discovered (Jones 1995, Thomas et al. 1987, Barclay et al. 1999). It is possible that certain differences in display songs of different males would reveal some information to a female about the male, which is referred to by Jones (1995) as well.

Parameters measured on the final call of display song were compared, since weaker FM sweeps were not very clear on most of the recordings. The comparison of display songs from Medvedjak (Loc1), measured in two consecutive nights, showed only differences in the values of maximum frequency (Tabela 5). This is the result of high attenuation of high frequencies:

the larger the distance from the bat, the larger the loss of the high frequency part of the call (Jones 1995, Russ 1999). Thomas et al. (1987) noticed almost twice as high coefficient of variation in maximum frequencies as in minimum frequencies. Considering the recordings were made in short time intervals, it is highly probable that the same bat was recorded at the same locality in both nights. In the mating behaviour of *P. pipistrellus* it was observed that males defended the same roost and its surroundings during the whole mating season (Gerell & Lundberg 1985).

Only four parameters were measured on the final calls of display songs from other localities, since weaker high frequency sounds were not recorded. This might be due to either bigger attenuation of high frequencies or the limited sensitivity of the bat detector to weaker high frequency sounds at the time of recordings. Recordings from the fourth locality were excluded from comparison, since the number of bats present could not be determined. The median values of all measured parameters differed significantly among the three localities. As lower frequencies are less prone to attenuation with distance, the observed variation in minimum frequencies could be the consequence of intraspecific variation (Thomas et al. 1987). It is therefore possible that different individuals were recorded. The differences in display song could be related to their size or fitness, but this assumption can only be confirmed by light tagging a known and previously measured bat. Neither can we rule out the possibility that the same bat changes the song according to different flying conditions as is known to happen in echolocation signals (Ahlen 1990, Russ 1999). Russo & Jones (1999) state the hypothesis that the differences they observed in peak frequencies of social calls of two populations of *P. kuhlii* could be the result of adaptation to habitat structure. In our case, bats were observed in similar environments, so this hypothesis does not seem to explain the differences observed.

Characteristic display song of *V. murinus* can be very helpful in improving our knowledge about species distribution. Certain variability in display song exists, and it could contain certain information on individual bats. Additional surveys on the subject should be carried out to test these assumptions.

Povzetek

Septembra 2000 smo na štirih lokacijah v bližini Goteniške gore v gozdovih južne Slovenije opazovali svatbeni napev samcev dvobarvnega netopirja *Vespertilio murinus* Linnaeus, 1758. Ta slabo poznana vrsta je bila doslej zabeležena na štirih lokacijah drugod po Sloveniji.

Del napeva je bil slišen s prostimi ušesi, sicer pa smo jih poslušali in posneli z ultrazvočnimi detektorji. Računalniška analiza posnetkov je pokazala značilno obliko svatbenega napeva dvobarvnega netopirja, ki je sestavljen iz zaporedja povprečno osmih frekvenčno moduliranih (FM) klicev in končnega dela klica, ki je sestavljen iz FM in kvazi-konstantno frekvenčnega dela (QCF). Frekvenca z maksimalno energijo v QCF delu končnega klica svatbenega napeva je bila 14,69 kHz.

Primerjava napevov, posnetih v dveh zaporednih dneh na Medvedjaku, med merjenimi parametri končnega dela klica ni dala statistično značilnih razlik. Te so se pokazale pri maksimalni frekvenci klica, najbolj verjetno zaradi povečane zračne atenuacije visokih frekvenc z razdaljo. V obeh nočeh je netopir letal sem-ter-tja nad odprto jaso pod gozdarskimi kočami. Napevov, ki smo jih posneli v bližini Taborske stene, nismo vključili v primerjalno analizo, ker nismo mogli ugotoviti števila netopirjev v okolici. Ti so po približno pol ure našega opazovanja potihnili. Merjeni parametri (frekvenca z maksimalno energijo v FM in v delu QCF, začetek dela QCF in medklicni interval) so bili statistično značilno različni med preostalimi tremi lokacijami (Medvedjak, jasa v bližini Pasje jame, ob poti do Taborske jame). To bi bila lahko posledica različnih snemalnih razmer, vendar je vpliv zračne atenuacije pri nižjih frekvencah majhen. Zelo mogoče je, da smo posneli različne osebke, saj bi razlike v svatbenih napevih lahko bile povezane z velikostjo oz. stanjem netopirja. Izključiti ne moremo tudi možnosti, da posamezen netopir spreminja svatbeni napev glede na značilnosti habitata, kot je to poznano pri eholokacijskih klicih. Za potrditev teh domnev so potrebne nadaljnje študije s poznanimi osebki.

Acknowledgements

My sincere thanks are due to Vanja Kovačič, Blanka Marković, Tana Oblak and Rudi Potočnik who accompanied me during my fieldwork. Matija Gogala entrusted me his Macintosh computer in the Slovenian Museum of Natural History, for which I am very grateful. Tomi Trilar assisted me when using sound software and searching and copying the literature. He made the figure of display song. Ali Šalamun from Centre for Cartography of Fauna and Flora made the maps with the selected localities. Drago Samec from the ZRC SAZU Library and Klemen Koselj helped me in searching the literature. Otto von Helversen, Hans J. Baagøe and Ronald Weid have kindly furnished me with some articles. Andrej Blejec, Hubert Potočnik and Klemen Koselj gave advice on statistical analysis. I thank Boris Sket and Špela Gorički for comments and corrections in the English text. The ultrasound detector, recorder and thermometer were lent to me by the Biology Students' Society.

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On the presence of *Iolana iolas* (Ochsenheimer, 1816) in Slovenia

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Iolana iolas is one of the largest European lycaenids limited to the southern part of the continent with locally distributed populations extending from south Spain to southern Alps and Balkan Peninsula (Tolman & Lewington 1997). It is a monophagous species, whose distribution is limited by the availability of its larval foodplant *Coluthea arborescens* L. In the neighbouring regions of Slovenia, this butterfly species is known from NE Italy (Reichel 1992), SW Hungary (Varga Z., pers. com.) and Croatian coastal region south of Rijeka (Jakšić 1988).

For Slovenia, it was mentioned for the first time in the national Red List of Butterflies and Moths (Macrolepidoptera) (Carnelutti 1992), but the author doubted the validity of the information about its presence on Mt. Nanos. The species has been afterwards intensively searched for on the southern slopes of Mt. Nanos in the nineties, but without any success. In the year 2000, a female ex larvae was received by Lasan from Italian collector Bruno Castella, who had collected larvae of *Iolana iolas* on the slopes of Mt. Nanos in 1990. In 2002, the species was finally confirmed by the authors independently at two separate localities. The currently available information on the distribution of this rare lycaenid in Slovenia is:

- 2.7. 1991 ex larvae – Mt. Nanos, Yugoslavia; Castella B.
- 1.6.2002 – on a road bend NW of Kubed, southern slopes of Mt. Krasca, altitude: 210 m, coordinates: x: 411970, y: 42911; Verovnik, R.
- 13.6.2002 – E of the road to Mt. Nanos, on its southern slopes, altitude: 550 m, coordinates: x: 422927, y: 72443; Lasan M.

An ovipositing female was observed near Kubed on a road verge where few larval foodplants were present. In thirty minutes two males were observed flying restlessly up and

down the nearby bushy slope. On Mt. Nanos only males were found flying near the bushes of *Coluthea arborescens*. As the foodplant is more widespread in the Primorje region (Jogan & Bačič 2001), we expect to find further localities of *Iolana iolas* in this part of Slovenia. At most sites only few bushes of the foodplant are avaliable, which is the reason why we consider *Iolana iolas* a rare and threatened species in Slovenia. As suitable habitats are few and far apart, even limited collecting could cause an extinction of a local population. We thus urge all lepidopterists not to collect adults or larvae and to document the presence of this rare species in Slovenia only by photographing.

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Jože Papež (ur.): Panovec

Mestna občina Nova Gorica, Zavod za gozdove Slovenije, Območna enota Tolmin. 199 str.

Pred nedavnim je izšla razkošno opremljena knjiga z naslovom "Panovec" in podnaslovom "Včeraj, danes, jutri", ki ga lahko preberemo le na notranji naslovnici. V knjigi je urednik (in hkrati tudi avtor skoraj polovice besedila) Jože Papež zbral prispevke 12 avtorjev, ki v 14 poglavjih obravnavajo nekatere bolj znane skupine organizmov Panovca. Posamezno poglavje obsega 3 do 25 strani, slovenskemu besedilu sledita povzetka v angleščini (ki je mestoma preveč domača) in italijanščini, besedilu pa so dodane posamezne črnobele fotografije, nekaj tabel in ličnih barvnih zemljevidov. Strani med poglavji krasijo razkošne celostranske ali celo dvostranske barvne fotografije, ki pa z besedilom nimajo neposredne zveze.

In kaj sploh je Panovec? Za Novogoričane je to primestni gozd, ki jim je znan tako kot Ljubljančanom Golovec ali Mariborčanom Stražun, in morda je urednik prav zaradi te lokalne samoumevnosti poznavanja Panovca preprosto pozabil na zemljevid, v katerem bi bil gozd predstavljen skupaj z bližnjim zaledjem in na katerem bi lahko bralec poiskal krajevna imena uporabljena v knjigi.

Že v predgovoru urednik oblikuje idejo, ki jo zasledimo še na več mestih v knjigi, da je Panovec s svojim vrstnim bogastvom "vroča točka Slovenije in verjetno tudi Evrope". Takega laskavega naziva bi si za svoj primestni gozd seveda želelo marsikatero mesto, da bi se potem lahko njegovi politiki in meščani ponašali pred sosedi. Žal pa nadaljnji poskusi podkrepitve te teze ne zdržijo kritične presoje. Vrstno bogastvo posameznih skupin organizmov Panovca se namreč preprosto primerja s pestrostjo teh skupin na območju celotne Slovenije in ob tem gladko predpostavlja linearno povezavo med velikostjo površine in številom na njej zastopanih vrst. Vsakomur je lahko že po kratkem razmisleku jasno, da tak način ocenjevanja "biodiverzitete" pripelje do hudih popačenj v korist manjših površin, že dolgo pa je znano, da je odvisnost med omenjenima dvema spremenljivkama logaritemska. Dodatna napaka, ki jo v svojih sklepih stori Papež, je enakovredno upoštevanje tujerodnih in samoniklih vrst. Žal predstavlja Panovec z velikim številom vanj sajenih tujerodnih vrst pravo "kužno žarišče" za biodiverziteto širše okolice, saj se prav s tega območja začenja širjenje številnih invazivnih rastlin, ki izpodrivajo avtohtono floro in vegetacijo v Vipavski dolini in okolici.

Papeževi sta tudi prvi dve poglavji, v katerih zelo na kratko predstavi "Krajinske in ekološke značilnosti" ter obširneje "Dosedanje gospodarjenje z gozdom". Sledi poglavje o "Rastlinstvu in rastju", ki ga je napisal Igor Dakskobler in v katerem izčrpno predstavi zgodovino raziskovanj flore in vegetacije, današnjo vegetacijo in nekatere floristične posebnosti Panovca. Gabrijel Seljak v nadaljevanju predstavi "Glive", pri obravnavi katerih vnaprej opozori na parcialnost

obravnave, nato pa poda pregled gliv po rastiščih Panovca. Sledi nekaj kratkih poglavij, v katerih so predstavljeni "Lišaji" (Franc Batič), "Ptice" (Mirko Perušek), "Dvoživke" (Mirjam Gorkič in Katja Poboljšaj), "Plazilci" (Staša Tome), dnevni "Metulji" (Bojan Zadravec), "Divjad" (Jože Papež, Igor Zadravec), "Obremenitve gozda" (Zoran Zavrtanik) in "Gozdna učna pot Panovec" (Marijan Šebenik). Nenavaden je predvsem Zavrtanikov pristop, ki med obremenitvami gozda ne obravnava npr. lova, gozdarstva in vnašanja tujerodnih vrst, predlaga pa med drugim resen razmislek o prepovedi vseh oblik nabiralništva. Najobsežnejše poglavje "Ohranjanje biotske raznolikosti" je ponovno Papeževo, v glavnem pa gre za pogled na biodiverziteto skozi gozdarsko prizmo. Tu ponovno naletimo na že omenjena napačna razpredanja o "vroči točki", zelo nekritičen pa je tudi avtorjev odnos do tujerodnih vrst, ki predstavljajo trajno grožnjo biodiverziteti širše okolice in so jih gozdarji namenoma vnašali v Panovec. Zadnje poglavje z naslovom "Ovrednotenje prostora" je daljši povzetek knjige s predlogi za bodočo ureditev Panovca.

Sledi še dodatek s seznamom na območju Panovca znanih vrst višjih rastlin, gliv, lišajev in metuljev.

Ugotovimo lahko, da nam knjiga o Panovcu dokaj dobro predstavlja naravno bogastvo njegovega živega sveta, da pa se nikakor ne smemo pustiti pretentati nekaterim izpeljavam, predvsem ne tistim, ki jih ponuja glavni avtor in urednik. Z le 50 odstotki biomase, ki jo v gozdu predstavljajo avtohtone rastlinske vrste, je Panovec predvsem spomenik več desetletij dolgemu napačnemu odnosu do narave, ki kot tak, kot je bilo že omenjeno, predstavlja hudo grožnjo okoliški biodiverziteti, pa čeprav je ni več ostalo kaj dosti. In isti človek, ki z zvenečimi besedami pospremi na pot knjigo o Panovcu, je tudi eden najodločnejših pobudnikov uničenja od Panovca le streljaj oddaljenih zadnjih mokrotnih travnikov v spodnji Vipavski dolini, saj si je kot tedanji župan Mestne občine Nova Gorica ob Ajševici zamislil športno letališče. Je to le naključje?

Nejc JOGAN

Paul Veenvliet & Jana Kus Veenvliet: Dvoživke Slovenije: priročnik za določanje

Symbiosis - Zavod za naravovarstveno raziskovanje in izobraževanje, Grahovo. 74 str.

Dvoživke Slovenije: priročnik za določanje, avtorjev Paul Veenvliet, ki je tudi ilustrator in Jane Kus Veenvliet obsega 74 strani, založnik je Symbiosis - Zavod za naravovarstveno raziskovanje in izobraževanje iz Grahovega (www.zavod-symbiosis.si), knjiga je izšla leta 2003 v nakladi 500 izvodov.

Plastificirane platnice, povoščeni papir in spiralna vezava formata A5 pričajo o bralnem okolju terenskih herpetologov, z mokrimi prsti in v neudobnem položaju. Vsebina je bila v slovenskem prostoru že nekajkrat obdelana, če začnemo z Bevkovimi Vretenčarji Slovenije iz leta 1957, nadaljujemo s Sketovim ključem Dvoživke (1967) in zaključimo s ključem za določanje dvoživk Nuše Vogrin (1999). Od prejšnjih obdelav jih loči sodobnejši in širši vsebinski pristop, predvsem pa kvalitetne in številne (179) ČB risbe.

Vsebino tvorijo štiri poglavja: uvod, priročnik za določanje vrst, ključ za določanje paglavcev ter slovarček s seznamom literature. V uvodnem poglavju so razložene splošne značilnosti dvoživk in potem sta predstavljena oba evropska redova: repatih in brezrepih dvoživk. Posebno podpoglavje je namenjeno predstavitvi vzrokov ogroženosti dvoživk. Na prvem mestu ogrožanja je uničevanje vodnih habitatov. Na eni strani to pomeni zasipavanje, izsuševanje ali spremembo namembnosti, na drugi strani pa nevzdrževanje oz. zaraščanje nekaterih vodnih objektov antropogenega nastanka. Prometna infrastruktura predvsem pa odseki cest, ki prečkajo ustaljene selitvene poti dvoživk povzročajo hude izgube lokalnih populacij. Vnos novih plenilcev lahko močno ogroža stabilnost avtohtonih populacij dvoživk. V zgornjih delih potokov predstavljajo tri vrste vloženih rib: kalifornijska in potočna postrv ter jezerska zlatovščica, močan plenilski pritisk na ličinke navadnega močerada ter navadnega in planinskega pupka. Onesnaževanje vodnih habitatov z vnosom organskih snovi negativno vpliva na uspešni razvoj paglavcev. Velike izgube odraslih osebkov povzroča kmetovanje, pri čemer gre za več oblik ogrožanja, od mehanskih poškodb pri delu s stroji, preko intenziviranja travniške proizvodnje, do uporabe zrnatih umetnih gnojil, ki močno poškodujejo kožo dvoživk. Na koncu avtorja navajata lov pravih žab zaradi prehrane. Osebno se z zadnjim vzrokom ogrožanja, vsaj v slovenskem prostoru, ne strinjam, kar pa seveda ne pomeni, da ne obstaja. Zakonsko varovanje dvoživk v Sloveniji je predstavljeno v naslednjem podpoglavju. Od 19 vrst dvoživk v Sloveniji jih je 18 zavarovanih z Uredbo o zavarovanih ogroženih živalskih vrstah, vse vrste so tudi uvrščene na Rdeči seznam od tega so tri vrste v kategoriji prizadetih vrst, preostale pa so ranljive ali pa zunaj nevarnosti. Na dodatek Habitatne direktive je uvrščenih 15

vrst, vseh 19 pa je tudi zavarovanih z Bernsko konvencijo. V nadaljevanju avtorja predstavita osnovne metode dela na terenu, kako ravnati z ujetimi dvoživkami in poimenovanje delov telesa z merjenjem.

2. poglavje prinaša opise: določevalnih znakov, pregled podvrst v Sloveniji, habitov, razširjenosti v Sloveniji in razlikovanje med podobnimi vrstami, za vseh 19 vrst in enega hibrida. Tehnično je priročnik urejen na levo – tekstovno in desno – ilustrativno stran. Opisi in ilustracije živali se nanašajo na vse razvojne stadije od jajc oz. mresta in ličink oz. paglavcev do ločene predstavitve spolov odraslih živalih. Preko Slovenije poteka hibridizacijski pas nižinskega in gorskega urha. V določevalni praksi načeloma naj ne bi imeli težav pri prepoznavanju križancev, vendar nas avtorja opozarjata da se morfološki znaki ne ujemajo vedno z rezultati genetskih analiz. Z biološkega in genetskega vidika je nadvse zanimiv obstoj hibridne vrste zelena žaba (Rana kl. esculenta). Avtorja sta na nazoren način pojasnila izvor zelenih žab, ki so rezultat križanja pisane žabe in debeloglavke, in genetski mehanizem ohranjanja kleptonskega taksona.

Avtorja sta mnenja, da dihotomni določevalni ključ za odrasle živali ni potreben. Iz izkušenj nekajletne pedagoške prakse se strinjam, da za red Urodela ni potreben, pri redu Anura pa ima študent začetnik resne težave, da se prikoplje do »približne« določitve. Slednja pomanjkljivost je odpravljena pri določanju paglavcev.

Slovarček manj znanih izrazov obsega 36 osnovnih strokovnih pojmov iz sveta dvoživk. Avtorja bi lahko, če sta se že odločila za slovar, bistveno razširila nabor pojmov tako v anatomsko morfološki, kot ekološko naravovarstveni smeri.

Seznam literature prinaša bolj ali manj naključni izbor 49 strokovno znanstvenih člankov, različnih priročnikov in zakonskih predpisov. Pogrešam pa nekaj temeljnih domačih (npr. Freyer 1842, Fauna der in Krain bekannten Säugetiere, Vögel, Reptilien und Fische, Bevk 1957, Vretenčarji Slovenije) in svetovnih del (npr. Böhme 1981 in ostale izdaje, Handbuch der Reptilien und Amphibien Europas).

Franc JANŽEKOVIČ

NAVODILA AVTORJEM

NATURA SLOVENIAE objavlja izvirne prispevke, ki imajo za ozadje terensko delo s področja biologije in/ali prispevajo k poznavanju favne in flore Slovenije. Prispevki so lahko v obliki znanstvenih člankov ali kratkih notic.

> **Znanstveni članek** je celovit opis izvirne raziskave in vključuje teoretično ozadje tematike, območje raziskav in metode uporabljene pri delu, podrobno predstavljene rezultate in diskusijo, sklepe ter pregled literature. Dolžina naj ne presega 20 strani.
> **Kratka notica** je izvirni prispevek, ki ne vsebuje podrobnega teoretičnega pregleda. Njen namen je seznaniti bralca z delnimi ali preliminarnimi rezultati raziskave. Dolžina naj ne presega 5 strani.

Vsi prispevki bodo recenzirani. Avtorji lahko v spremnem dopisu sami predlagajo recenzente, kljub temu pa urednik lahko izbere tudi kakšnega drugega recenzenta. Recenziran članek popravi avtor oz. avtorji sami. Po objavi prejme prvi avtor vsakega prispevka brezplačno 50 separatov. V primeru zavrnitve se originalne materiale skupaj z obrazložitvijo glavnega urednika vrne prvemu avtorju.

Prispevki, objavljeni v reviji *Natura Sloveniae*, ne smejo biti predhodno objavljeni ali sočasno predloženi in objavljeni v drugih revijah ali kongresnih publikacijah. Avtorji se s predložitvijo prispevkov strinjajo, da ob njihovi potrditvi, ti postanejo last revije.

Prispevke lahko oddate na naslov *Natura Sloveniae*, Oddelek za biologijo Univerze v Ljubljani, Večna pot 111, 1111 Ljubljana, Slovenija, (telefon: (01) 423 33 88, E-mail: rok.kostanjsek@uni-lj.si).

FORMAT IN OBLIKA PRISPEVKA

Prispevki naj bodo napisani v programu Word for Windows, v pisavi "Times New Roman CE 12", z levo poravnavo in 3 cm robovi na A4 formatu. Med vrsticami naj bo dvojni razmak, med odstavki pa prazna vrstica. Naslov prispevka in naslovi posameznih poglavij naj bodo natisnjeni krepko v velikosti pisave 14. Latinska imena rodov in vrst morajo biti pisana ležeče. Uredniku je potrebno prispevek oddati v dveh izvodih, ter na priloženi 3.5"disketi (1.44 Mb) v Rich text formatu (.rtf).

Naslov prispevka (v slovenskem in angleškem jeziku) mora biti informativen, jasen in kratek. Naslovu naj sledijo celotna imena avtorjev in njihovi naslovi (po možnosti tudi E-mail naslovi).
Izvleček v slovenskem jeziku mora na kratko predstaviti namen, metode, rezultate in zaključke. Dolžina izvlečka naj ne presega 200 besed za znanstveni članek oziroma 100 besed za kratko notico. Pod izvlečkom naj bodo ključne besede, ki predstavljajo področje raziskave. Njihovo število naj ne bo večje od 10. Sledi abstract in key words v angleškem jeziku, za katere velja enako kot za izvleček in ključne besede.
Glavnina prispevka naj bo pisana v slovenskem ali angleškem jeziku. Prispevek, ki je pisan v slovenskem jeziku mora vsebovati obširnejši angleški povzetek-*summary*, prispevek pisan v angleškem jeziku pa obširnejši slovenski povzetek (200-500 besed).

SLIKE IN TABELE

Skupno število slik in tabel v prispevku naj ne bo večje od 10, njihovo mesto naj bo v članku nedvoumno označeno. Posamezne tabele z legendami naj bodo na ločenih listih. Naslovi tabel naj bodo nad njimi, naslovi slik in fotografij pa pod njimi. Naslovi in legenda slik in tabel naj bodo v slovenskem in angleškem jeziku. Pri navajanju slik in tabel v tekstu uporabljajte okrajšave (npr. angl: Tab. 1 ali Tabs. 1-2, Fig. 1 ali Figs. 1-2 in slo.: Tab. 1 in Sl. 1).

NAVAJANJE LITERATURE

Navajanje literature v besedilu mora biti na ustreznem mestu. Kadar citiramo enega avtorja, pišemo Schultz (1987) ali (Schultz 1987), če sta avtorja dva (Parry & Brown 1959) in če je avtorjev več (Lubin et al. 1978). Kadar navajamo citat večih del hkrati, pišemo (Ward 1991, Pace 1992, Amman 1998). V primeru, ko citiramo več del istega avtorja objavljenih v istem letu, posamezno delo označimo s črkami (Lucas 1988a, b). Literatura naj bo urejena po abecednem redu.

Primeri:

- članke iz revij citiramo:

Schultz J.W. (1987): The origin of the spinning aparatures in spiders. *Biol. Rev.* 62: 123-134.

Parry D.A., Brown R.H.J. (1959): The hydraulic mechanysm of the spider leg. *J. exp. Biol.* 36: 654-657.

Lubin Y.D., Eberhard W.G., Montgomery G.G. (1978): Webs of *Miagrammopes* (Araneae: Araneaidae) in the neotropics. *Psyche* 85: 1-13.

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

Lucas S. (1988b): Spiders and their silks. *Discovery* 25: 1-4.

- knjige, poglavja iz knjig, poročila, kongresne povzetke citiramo:

Foelix R.F. (1996): Biology of spiders, 2. edition. Harvard University Press, London, pp. 155-162.

Nentwig W., Heimer S. (1987): Ecological aspects of spider webs. In: Nentwig W. (Ed.), *Ecophysiology of Spiders*. Springer Verlag, Berlin, 211 pp.

Edmonds D.T. (1997): The contribution of atmospheric water vapour to the formation of a spider's capture web. In: Heimer S. (Ed.), *Proceedings of the 17th European Colloquium of Arachnology*. Oxford Press, London, pp. 35-46.

INSTRUCTIONS TO AUTHORS

NATURA SLOVENIAE publishes original papers in Slovene and English which contribute to the understanding of the natural history of Slovenia. Papers may be submitted as "Scientific Papers" or as "Short Notes".

> **Scientific Paper** is a complete description of the original research including theoretical review, research area, methods, detailed presentation of the results obtained and discussion, conclusions and references. The length of the Scientific Paper may not exceed twenty (20) pages.
> **Short Communication** is an original paper without detailed theoretical review. Its purpose is to introduce partial or preliminary results of the research. The length of the Short Note may not exceed five (5) pages.

All papers will be subject to peer review by one referee. Authors are invited to suggest the names of referees, although the editor reserves the right to elect an alternative referee to those suggested. The reviewed paper should be corrected by author or authors themselves. After the publication fifty (50) reprints of each article will be sent to the first-named author free of charge. In the case of the rejection, the original materials will be sent back to the first-named author with the editors explanation.

The submitted papers should not have been previously published and should not be simulatenously submiteed or published elsewhere (in other journals, bulletins or congress publications). By submitting a paper, the authors agree that the copyright for their article is transferred to the publisher if and when the article is accepted for publication.

Papers should be submitted to *NATURA SLOVENIAE*, Oddelek za biologijo Univerze v Ljubljani, Večna pot 111, SI-1111 Ljubljana, Slovenia (telephone: (++386 1) 423 33 88, E-mail: rok.kostanjsek@uni-lj.si).

FORMAT AND FORM OF ARTICLES

Papers should be written with Word for Windows using "Times New Roman CE" size 12 font, align left and margins of 3 cm on A4 pages. Double spacing should be used between lines and paragraphs should be separated with a single empty line. The title and chapters should be written bold in font size 14. The latin names of all genera and species must be written italic. Two copies of all submissions should be sent to the editor together with the copy on the 3.5"diskette (1.44 Mb) in Rich text format (.rtf).

Title of paper should be informative, understandable, and concise. The title should be followed by the name(s) and full adress(es) of the author(s), and if possible E-mail adresse(s).

Abstract must give concize information about the objectives, methods used, results and the conclusions. The abstract length should not exceed 200 words for "Scientific Papers" and 100 words for "Short Notes". There should be no more than ten (10) keywords which must accurately reflect the field of research covered in the paper.

ILLUSTRATIONS AND TABLES

Papers should not exceed a total of ten (10) illustrations and/or tabels, with their positon amongst the text clearly indicated by the author(s). Tables with their legends should be submitted on separate pages. Titles of tables should appear above them, and titles of illustrations and photographs below. Illustrations and tables should be cited shortly in the text (Tab. 1 or Tabs. 1-2, Fig. 1 or Figs. 1-2).

LITERATURE

References should be cited in the text as follows: a single author is cited, as Schultz (1987) or (Schultz 1987); two authors would be (Parry & Brown 1959); if a work of three or more authors is cited, (Lubin et al. 1978); and if the reference appears in several works, (Ward 1991, Pace 1992, Amman 1998). If several works by the same author published in the same year are cited, the individual works are indicated with the added letters a, b, c, etc. (Lucas 1988a, b). The literature should be arranged in alphabetical order.

Examples (use the the following forms):

- articles from journals:

Schultz J.W. (1987): The origin of the spinning aparatures in spiders. *Biol. Rev.* 62: 123-134.

Parry D.A., Brown R.H.J. (1959): The hydraulic mechanysm of the spider leg. *J. exp. Biol.* 36: 654-657.

Lubin Y.D., Eberhard W.G., Montgomery G.G. (1978): Webs of *Miagrammopes* (Araneae: Araneaidae) in the neotropics. *Psyche* 85: 1-13.

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

Lucas S. (1988b): Spiders and their silks. *Discovery* 25: 1-4.

- for books, chapters from books, reports, and congress anthologies:

Foelix R.F. (1996): Biology of spiders, 2. edition. Harvard University Press, London, pp. 155-162.

Nentwig W., Heimer S. (1987): Ecological aspects of spider webs. In: Nentwig W. (Ed.), *Ecophysiology of Spiders*. Springer Verlag, Berlin, 211 pp.

Edmonds D.T. (1997): The contribution of atmospheric water vapour to the formation of a spider's capture web. In: Heimer S. (Ed.), *Proceedings of the 17th European Colloquium of Arachnology*. Oxford Press, London, pp. 35-46.