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

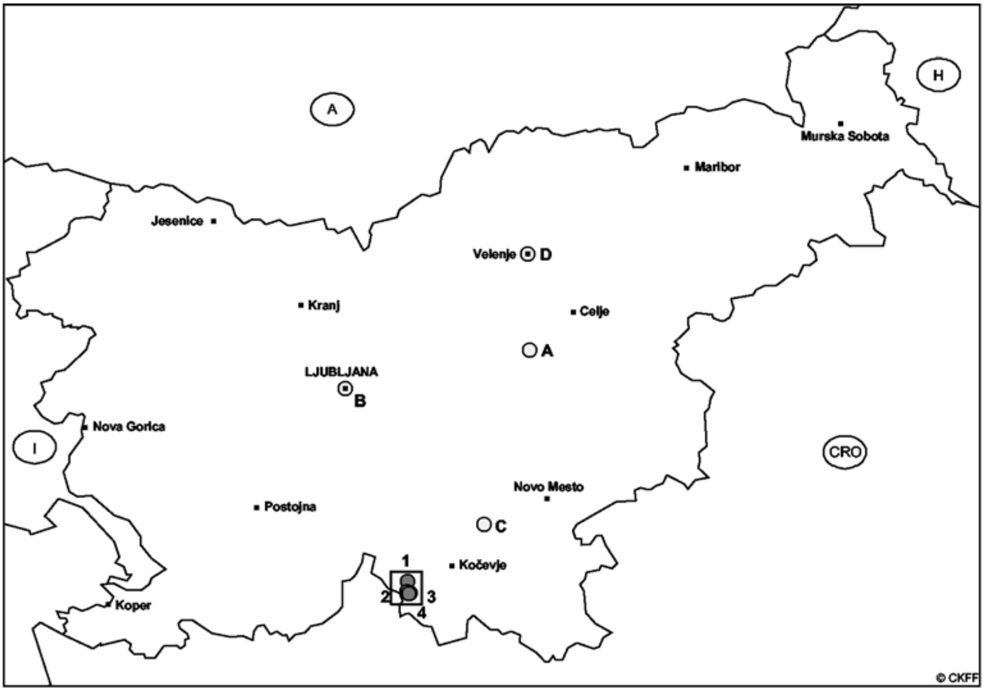

Figure 1. Known localities of *Vespertilio murinus* in Slovenia. Localities A-D are: A - Dol pri Hrastniku (Đulić 1959), B - Ljubljana (Kryštufek 1989), C - Velenje (Kryštufek & Červeny 1997), D - Rdeči kamen pri Luži (Kryštufek & Červeny 1997); localities 1-4 are new and described in this work.

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.

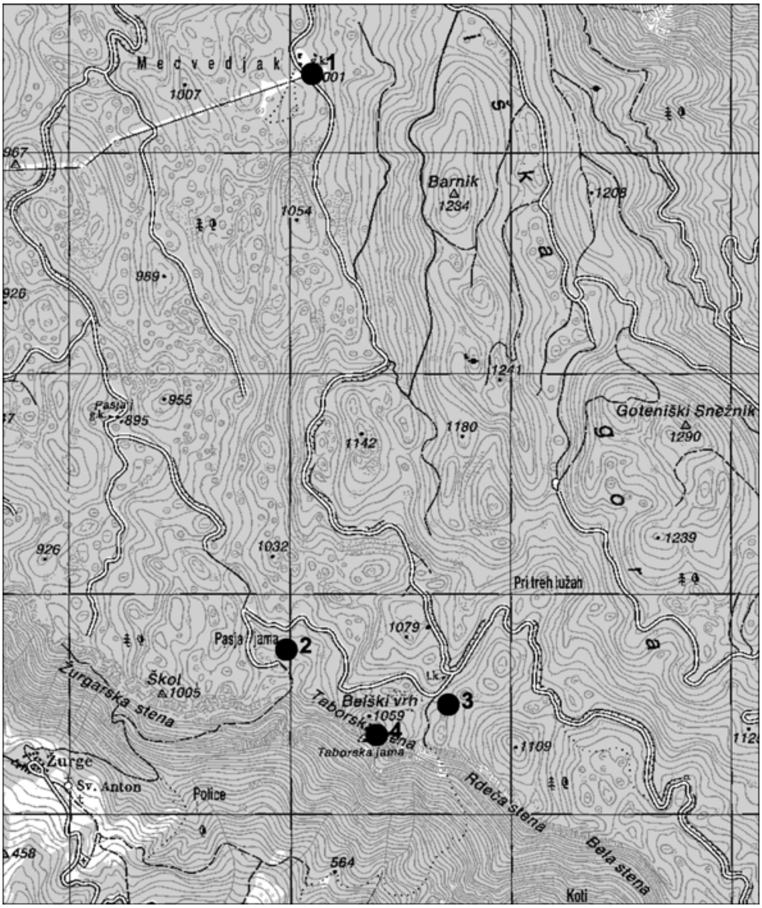

Figure 2. New localities of *Vespertilio murinus* near Goteniška gora Mt. in Slovenia, where display songs were recorded.
Slika 2. Nove lokalitete dvobarvnega netopirja (*Vespertilio murinus*) pri Goteniški gori v Sloveniji, kjer smo posneli svatbene napeve.

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).

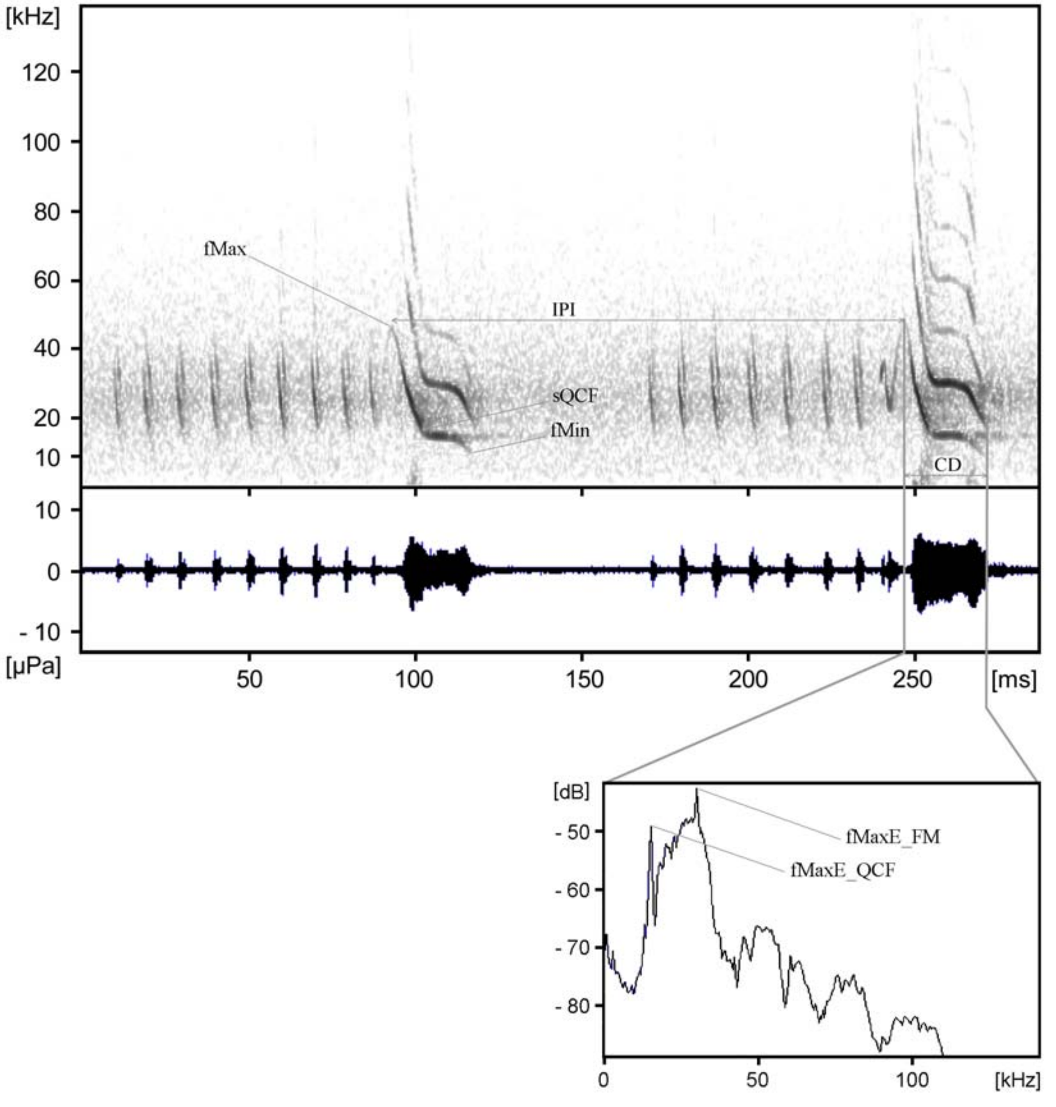

Figure 3. Sonogram, wave presentation and power spectrum of display song of *Vespertilio murinus* (FFT 4096, Hanning window), with measured parameters drawn in (abbreviations are explained in Table 2).
Slika 3. Sonogram, oscilogram in energijski spektrogram svatbenih napevov dvobarvnega netopirja (*Vespertilio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

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