Hystrix It. J. Mamm. (n.s.) 18 (2) (2007): 205-214

A SUMMER SURVEY OF CAVE-DWELLING BATS IN THE SOUTHERN TICINO CANTON (SWITZERLAND)

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Received 1 September 2007; accepted 13 November 2007

ABSTRACT - During the summer 2002-2003, mist-netting at seven cave entrances enabled a survey of cave-dwelling bats in the southern Ticino Canton (Switzerland). Overall, 36 individuals belonging to 7 species were recorded: *Rhynolophus ferrumequinum*, *Hypsugo savii*, *Plecotus austriacus*, *P. auritus*, *Myotis nattereri*, *M. daubentoni* and *M. bechsteinii*. On average, the percentage of positive surveys was 55.6%. The low number of trapped bats, the high preponderance of males and the low number of recaptures suggest that in the study area caves play a minor role as summer day- and/or night-roosts.

Key words: Chiroptera, summer roosts, karstic areas, Switzerland

RIASSUNTO - ***Censimento estivo dei chirotteri troglofili del Canton Ticino meridionale (Svizzera)***. Nel periodo estivo 2002-2003, è stato realizzato un censimento dei pipistrelli troglofili della regione meridionale del Cantone Ticino mediane l'uso di reti tipo mist-net poste all'ingresso di 7 grotte carsiche. Sono stati catturati 36 individui appartenenti a 7 diverse specie: *Rhynolophus ferrumequinum*, *Hypsugo savii*, *Plecotus austriacus*, *P. auritus*, *Myotis nattereri*, *M. daubentoni* e *M. bechsteinii*. In media, la percentuale di positività dei rilevamenti è stata pari al 55.6%. In considerazione del modesto numero di animali catturati, della netta predominanza dei maschi e del basso numero di ricatture, nell'area di studio le grotte sembrano rivestire un ruolo secondario come rifugi estivi diurni e/o temporanei notturni.

Parole chiave: Chiroptera, rifugi estivi, aree carsiche, Svizzera

INTRODUCTION

The first information about the bats of the Ticino Canton (southern Switzerland) dates back to the 19th century (Ghidini, 1904). In the second half of the 20th century, specific studies improved information on bat distribution, providing, in particular, new data about cave-dwelling species (e.g.

Cotti, 1957, 1959, 1972; Aellen and Strinati, 1956, 1962). Starting from the 1980s, the bat fauna of the Ticino Canton has been extensively investigated (e.g. Haffner and Stutz, 1989; Moretti and Maddalena, 2001; Moretti *et al.*, 2003), thanks to the establishment of the Swiss Centre for Bat Conservation (Schweizerische Koordinationsstelle für Fledermausschutz, SKF) and the Centre for Bat Conservation of the Ticino Canton (Centro Protezione chirotteri Ticino, CPT).

Getting precise information about roost use and location is fundamental for guaranteeing specific bat conservation measures. Among natural roosts, karstic caves are safe and stable environments, providing suitable roost-sites throughout the year (Humphrey, 1975; Racey, 2007).

In the Ticino Canton, sedimentary rocks are mainly located in the southern region, and particularly in the karstic areas of the Mendrisio district (e.g. Mount Generoso, Mount S. Giorgio) (Bianchi-Demicheli and Oppizzi, 2006).

The aim of this study was to investigate which bat species use natural caves in summer in the southern region of the Ticino Canton and to characterize roost types (day-, night- or maternity roosts), drawing a preliminary picture of bat roosting habits according to species and sex. Following the classification by Fridli and Haffner (1992), "summer roosts" include those that are used by bats from the beginning of April to the end of September.

STUDY AREA AND METHODS

The investigation took place in the southern part (i.e. Mendrisiotto district; 106 km^2) of the Ticino Canton (southern Switzerland), between the Lake of Lugano and Italy (Lombardy region; Fig. 1).

The area is mainly mountainous and the plain is restricted to a small urbanized strip between the town of Chiasso and the lake. Mounts S. Giorgio (1097 m a.s.l.) and

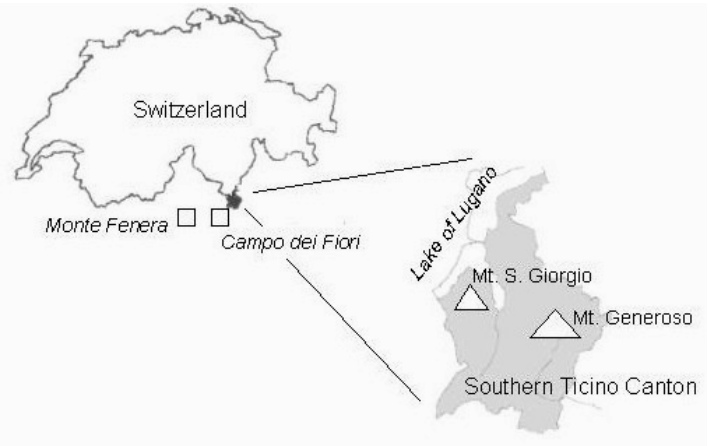

Figure 1 - Study area with the main sampling sites (triangles). Squares show the approximate location of two sampling sites in neighboring Italy for which published data are available (see text for more details).

Generoso (1700 m a.s.l.) are the major karstic massifs and have a well developed cave systems with over 90 known caves (Bianchi-Demicheli and Opizzi, 2006). The study area belongs to the Insubric region, characterized by a moist, warm, temperate climate. Mean temperature ranges from 2-3°C in January to 21-22°C in July (Spinedi and Isotta, 2004). Precipitation is low in winter (about 400 mm in November-February), whilst about 66% of rainfall occurs in June-September (about 200 mm per month). The vegetation occurs as a mixed broadleaf forest dominated by *Ostrya carpinifolia* (Mount S. Giorgio) or *Fagus sylvatica* (Mount Generoso). Other frequent species are: *Sorbus aria*, *Acer campestre*, *A. pseudoplatanus*, *Quercus petraea* and *Betula pendula*.

Between May 2002 and November 2003, bats were mist-netted at the entrances of 7 out of 14 caves (50%) for which bat records have been available after 1980 (data from CPT, reported in Pedroni, 2004). Easy and safe accessibility to the caves were the main factors determining the choice of trapping sites and the frequency of their monitoring (Tab. 1). Cave-dwelling bats were trapped during 4 hours after sunset, by carefully closing every known access to each cave with mist-nets.

During the same period, to get reference data on the occurrence of the different species in the study region, bat surveys were carried out on 4 water bodies (ponds and rivers), which are potentially used by many species for hunting or as flying routes. Up to 20, 6-12 m long mist-nets were used simultaneously from sunset till 3 a.m.

Sex, age class (juvenile, subadult, adult), reproductive status, forearm length (in mm using a vernier calliper) and body weight (in grams using a dynamometer) were recorded for each cave bat. A small spot of the fur on their back was cut to allow the short-term identification of single individuals. Flight direction (into or out the cave) and outside air temperature (°C) at time of capture were also recorded. Bats were released at mist-netting sites as soon as all measurements were taken.

Table 1 - Location, length (L. in m) and trapping effort for each monitored cave (for more details about caves see Bianchi-Demicheli and Oppizzi, 2006; Al. = altitude, m a.s.l.).

Locality	Cave (register code)	Municipality	Al.	L.	N° of surveys	% of positivity
Mt. S.Giorgio	Antro della Castellana (TI-150)	Tremona	620	140	12	75.0
	Grotta Bögia (TI-8)	Meride	760	370	9	33.3
Mt. Generoso	Böcc da la Togna (TI-20)	Caneggio	500	25	2	50.0
	Cava Scerri (TI-94)	Castel S. Pietro	480	40	15	73.3
	Fiadoo di Pianello (TI-89)	Salorino	938	146	3	0.0
	Tana delle Bricolle (TI-55)	Arogno	942	40	2	50.0
	Grotta Nevera (-)	Erbonne, Italy	1160	3000	2	0.0
	Total				45	55.6

Bats were identified according to Helversen (1989), SSF/KOF (1994), Schober and Grimmberger (1997) and Roesli and Moretti (2000). The cryptic species *Myotis myotis* and *M. blythii*, and *Pipistrellus pipistrellus* and *P. pygmaeus*, were not discriminated. Male bats of the genus *Plecotus* were identified as *P. auritus* or *P. austriacus* according to penis morphology. Females were generically ascribed to *P. auritus*, which is more common in the Ticino Canton (Moretti *et al.*, 2003). Recently, *P. macrobullaris*, which is more similar to *P. auritus* (Dietz and von Helversen, 2004), has been recorded also in the Ticino Canton and many *Plecotus* bats kept at the Museum of Natural History in Lugano seem to belong to this species (Marzia Mattei-Roesli, pers. com.). Consequently, previous identifications of long-eared bats must be considered with caution. Audible echolocation sounds allowed the recording of *Tadarida teniotis* presence over mist-netting sites.

Chi square test (χ^2) with Yates correction for small samples (Yates, 1934) was used to compare raw frequency data about sex ratio and the influence of air temperature (four classes: T <10, 10-15, 16-20, >20 °C) on captures.

RESULTS AND DISCUSSION

Overall 53 net-trapping sessions were carried out at cave entrances (N = 45) and over water bodies (N = 8), sampling 78 bats (36 and 42 individuals respectively) belonging to at least 14 species (14-16, considering the cryptic species *Myotis myotis/blythii* and *Pipistrellus pipistrellus/pygmaeus*) out of 17 recorded for the southern Ticino Canton (Moretti *et al.*, 2003; Tab. 2). The Notch-eared bat (*Myotis emarginatus*) - a rather rare species in Switzerland (Moretti *et al.*, 2003), which in the past has been observed at the Antro della Castellana as well as in other caves of Mt. S. Giorgio (Marzia Mattei-Roesli, pers. com.) -, was the only certainly missing species, suggesting that our survey provided a rather representative and reliable picture of the bat fauna of the study area.

Mist-netting over water bodies gave 9-11 species (Tab. 3), *P. pipistrellus/pygmaeus* being the species most frequently caught (33.3%). Among them *M. myotis*, *M. blythii* and *Eptesicus serotinus* are red listed in Switzerland as highly endangered species (Duelli, 1994).

Cave–dwelling bats amounted to 7 species (Tab. 4) out of the 11 ones recorded for the Ticino Canton which potentially visit caves as summer cave dwellers (Krapp, 2001; Hausser, 1995; Moretti *et al.*, 2003). *Plecotus auritus* was by far the dominant species (61.1% of captures), occurring from the beginning of March to November. The greater horseshoe bat (*Rhynolophus ferrumequinum*) is included in the Swiss Red List as a critically endangered species (Duelli, 1994). Despite the species having been occasionally recorded in some caves of the southern Ticino Canton (Tab. 5), in the overall Canton its previously known summer roosts in buildings have not been occupied for over 10 years, except for one located 50 km north of the study area, where two individuals were observed in 2007 (Marzia Mattei-Roesli, pers. com.). For these reasons, the occurrence of *R. ferrumequinum* at the Antro della Castellana is remarkable from the viewpoint of conservation. In the whole Canton a quite fragmented distribution is also shown by *P. austriacus*,

Table 2 - List of the 17 bat species recorded in the southern Ticino Canton (Moretti *et al*., 2003) and sampled during our study (+) (* = cryptic species not discriminated during our study; § = recorded while in flight over caves entrances). The status of each species is assessed according to the Swiss red list (RL; Duelli, 1994): 1 = risk of extinction; 2 = highly endangered; 3 = endangered; 4 = potentially endangered; n = not endangered; ? = not assessable).

Bat species	RL	Caves	Water bodies
R. ferrumequinum	1	+	
M. nattereri	4	+	
M. bechsteinii	4	+	
P. austriacus	4	+	
T. teniotis§	4	+	
H. savii	4	+	+
P. auritus	3	+	+
M. daubentoni	3	+	+
P. pipistrellus	n		+*
P. pygmaeus	?		
P. kuhlii	n		+
M. myotis	2		+*
M. blythii	2		
M. mystacinus	3		+
E. serotinus	2		+
N. leisleri	4		+
M. emarginatus	4		

M. nattereri and *M. bechsteinii* (Moretti *et al*., 2003), most of the monitored caves representing new roosts for these species in the southern Ticino Canton (Tab. 5).

P. auritus, *M. daubentoni* and *H. savii*, which are among the most abundant cave-dwellers in the Ticino Canton (Moretti *et al*., 2003) were the only species to be mist-netted both at cave entrances and over water bodies. *Tadarida teniotis*, on the other hand, was often heard while flying over cave entrances.

On average, the percentage of positive cave surveys (i.e. providing at least one captured individual/survey) was 55.6%, rising to 63.8% when considering only the three most monitored caves. Only two caves sheltered two bat species simultaneously: *P. auritus* + *R. ferrum-equinum* (Antro della Castellana, 30/8/2003) and *P. auritus* + *M. nattereri* (Cava Scerri, 13/6/2003). On the whole, the highest number of species (5) was sampled in the Cava Scerri (Tab. 4), where three pregnant females of *P. auritus* were caught in late spring and which probably also offers suitable roosts (rock crevices) for *T. teniotis*.

Accordingly to other studies (e.g. Hill and Smith, 1984; Choate and Anderson, 1997), among cave-dwelling bats

Table 3 - Results of mist-netting over water bodies (*P. k.* = *P. kuhlii*; *P. pi./py.* = *P. pipistrellus/pygmaeus*; *H. s.* = *H. savii*; *M. m./b.* = *M. myotis/blythii*; *M. m.* = *M. mystacinus*; *P. a.* = *P. auritus*; *M. d.* = *M. daubentoni*; *E. s.* = *E. serotinus*; *N. l.* = *N. leisleri*).

Date	Locality	Water body	*P. k.*		*P. pi./py.*		*H. s.*		*M. m./b.*		*M. m.*		*P. a.*		*M. d.*		*E. s.*		*N. l.*	
			M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
June-02	Castel	ponds		4	1	5		2	1	1									3	
July-02	S. Pietro				1				2	1				2						
June-03						1		1												
Sept-03																			1	
June-02	Balerna	R. Breggia				1									2					
July-02	Muggio				2	3													1	
July-02	Bruzella	R. Crotta					1	1		1	1								1	
Aug-03								1										1		
	Total		0	4	4	10	1	5	3	3	1	0	0	2	2	0	0	1	6	0
	%		9.5		33.3		14.3		14.3		2.4		4.8		4.8		2.4		14.3	

males strongly predominated (χ^2 = 14.7, P = 0.00013, 1 d.f.), whilst no difference between sexes was recorded for bats trapped over water bodies (χ^2 = 0.92, n.s., 1 d.f.). Only three individuals (8.3%) were caught twice, during consecutive surveys (Tab. 4).

Most captures occurred when air temperature ranged between 16 and 20°C (χ^2 = 16.6, P<0.001, 3 d.f.).

The irregular pattern of cave occupancy, which implies roost-switching behaviour, together with the sharp predominance of males suggest that in summer the caves of the Ticino canton mainly represent day-roosts or night-roosts. Accordingly, 46% of bats were caught while emerging from caves between 8.15 and 9.35 p.m., whilst 54% were caught while entering them (particularly Antro della Castellana, and Cava Scerri) at a time ranging between 8.30 p.m. and midnight. Caves were used as stop-overs during night hunting mainly by *P. auritus*, which is known to pause to eat large and tough prey (Hausser, 1995). The use of caves as roosts in summer could allow bats to save energy by thermoregulating in the fresh and constant underground temperatures. In late summer, caves can be visited by bats of both sexes during exploratory searching for suitable hibernacula.

Data from nearby karstic areas in neighbouring Italy are available for the Regional Park Campo dei Fiori (Varese province, Lombardy) and for the Natural Park Monte Fenera (Vercelli province, Piedmont) and surroundings (the cave "Grotta di Bergovei", Biella province), even if different methods and/or survey periods allow only a rough comparison. The main difference between the cave-dwelling bats sampled in the Park Campo dei Fiori

Table 4 - Results of mist-netting at caves entrances; re-captures (*) are not considered in the total (*M. b.* = *M. bechsteinii*; *M. n.* = *nattereri*; *M. d.* = *daubentoni*; *P. a.* = *P. auritus*; *P. au.* = *P. austriacus*; *H.s.* = *H. savii*; *R. f.* = *R. ferrumequinum*).

		M. b.		*M. n.*		*M. d.*		*P. a.*		*P. au.*		*H. s.*		*R. f.*	
Date	Cave	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Mar 2003	Antro							3+1*							
May 2003	della							1							
June 2003	Castellana			1+1*											
Aug 2003				1				1						1	1
Sept 2003								3+1*							
Sept 2002	Böcc da la Togna									1		1			
Mar 2002	Cava	1													
June 2002	Scerri			1											
Sept 2002								1		1					
Mar 2003								1							
Apr 2003								1	2						
May 2003									2						
June 2003				1					1						
Aug 2003								1				2			
Sept 2003								2							
Nov 2003								1							
Mar 2003	Grotta					1									
May 2003	Bögia					1									
June 2003								1							
Sept 2003	Tana delle Bricolle							1							
Total		1	0	4	0	2	0	17	5	2	0	3	0	1	1
%		2.8		11.1		5.6		61.1		5.6		8.3		5.6	

(7 species; Fornasari *et al.*, 1999; De Carli, 2001) and those of our study, was the occurrence of *M. capaccinii* and *R. hipposideros*, two species that in Ticino became extinct in the 20th century (Moretti *et al.*, 2003). In northern Piedmont (5 species), *R. ferrumequinum* is the species most frequently recorded in winter (Pascutto and Balestrieri, 2000). According to our data, in both parks only a few individuals, belonging to only 1-2 different species, were recorded for each monitored cave. Particularly, cave inspection allows to record only those species which are visibly hanging on the vault and walls, whilst it tends to underestimate the species that occupy deep cracks and remote/inaccessible parts of the caves.

Considering the few bats of each species recorded during our survey (with the exception of *P. auritus*), caves play only a minor role as summer roosts in the southern Ticino Canton. Moreover, the low number of recaptures suggests that other suitable roosts are quite available during the warm season, such as trees, rock crevices and buildings. Caves might

Table 5 - Past (P; data from CPT) and new (N) bat records for the five monitored caves.

Bat species	Caves				
	Antro della Castellana	Böcc da la Togna	Cava Scerri	Grotta Bögia	Tana delle Bricolle
R. ferrumequinum	N		P	P	
M. daubentoni	P			P/N	
M. emarginatus	P				
M. nattereri	N		N		
M. bechsteinii			N		
P. pipistrellus/pygmaeus				P	
H. savii		N	N		
P. auritus	P/N		N	P/N	N
P. austriacus		N	P/N		

play a major ecological role as hibernacula for most bat species, but knowledge about winter roosts is still negligible (Stutz, 2000; Moretti *et al*., 2003). Considering the difficulty of inspecting carefully large cave systems in winter, close collaboration with speleologists is strongly recommended.

ACKNOWLEDGMENTS

We are grateful to Marzia Mattei-Roesli, Responsible of the Centro protezione chirotteri Ticino, who kindly provided the state of the art on the occurrence and distribution of bat species in the Ticino Canton. We are also grateful to all those who provided voluntary help during the project.

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