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A PRELIMINARY SURVEY OF CAVE-DWELLING BATS IN A REGIONAL NATURAL PARK OF CENTRAL ITALY

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ABSTRACT - The present work was carried out in the Gola della Rossa and Frasassi Natural Park (central Italy) between May 2004 and December 2006. Eleven species of bats were found and five colonies were identified and monitored in four different caves. Two neighbouring reproductive colonies of Schreiber's bat (*Miniopterus schreibersii*) and of greater and lesser mouse-eared bats (*Myotis myotis/blythii)* were found in the same cave (Grotta della Beata Vergine di Frasassi); a nursery colony of the Mediterranean horseshoe bat (*Rhinolophus euryale*) was found in another cave (Grotta del Fiume). The Schreiber's bat colony, hosting up to 11,280 adult individuals, appears to be amongst the largest ones so far recorded in central Italy.

Key words: Chiroptera, central Italy, karstic caves, nursery colonies

RIASSUNTO - ***Indagine preliminare sui chirotteri in ambienti ipogei del Parco Naturale Regionale Gola della Rossa e di Frasassi (Italia centrale).*** Il presente lavoro ha permesso di delineare un primo quadro delle presenze di chirotteri in cavità ipogee del Parco Naturale Regionale Gola della Rossa e di Frasassi. Lo studio è stato svolto nel periodo maggio 2004-Dicembre 2006, ed ha consentito di individuare undici specie e cinque colonie di chirotteri in quattro diverse cavità ipogee. Nella Grotta della Beata Vergine sono state rinvenute due colonie riproduttive costituite rispettivamente da *Miniopterus schreibersii* e *Myotis myotis/blythii* e nella Grotta del Fiume è stata individuata una colonia riproduttiva di *Rhinolophus euryale*. La colonia di *M. schreibersii*, composta da 11280 adulti, risulta essere una delle più importanti fra quelle finora censite nell'Italia centrale.

Parole chiave: Chirotteri, Italia Centrale, cavità carsiche, colonie riproduttive

INTRODUCTION

Literature on bats in the Marches region (central Italy) is very scarce, lacking a basic knowledge on the distribution of species (Bassi and Fabbri, 1987; Uncini, 1999).
In 2004, a research project was started in the Natural Park "Gola della Rossa e di Frasassi" to collect essential information on the presence, ecology and ethology of cave-dwelling bats, in order to devise appropriate conservation measures for the delicate hypogean environments (Racey and Entwistle, 2003).
Among Italian karstic sites, the network of caves in the Park appears to be the most popular for tourists and speleologists. It is therefore of the utmost importance to study bat populations and their dynamics, in order to implement adequate management policies for some of the natural caves, especially in those seasons which host breeding or wintering roosts.
The main goal of this research was to estimate the size of bat colonies and study the biological cycle of the different species, with regard to their hibernation and breeding sites.

STUDY AREA

Research covered the whole territory of the Natural Park "Gola della Rossa e di Frasassi" (Fig. 1), a mountainous area of over 9.167 ha, with a remarkable labyrinth of karstic caves (AA.VV., 2000). The Park is intersected by the rivers Sentino and Esino, which run through the limestone gorges of "Frasassi" and "Rossa". These two main watercourses, along with a number of streams, provide ideal foraging habitats for many bat species.
The study area is mainly covered by deciduous woods with a prevalence of hop-hornbeam (*Ostrya carpinifolia*), oaks (*Quercus* sp.) and manna-ash (*Fraxinus ornus*); evergreen and downy oaks (*Quercus ilex*, *Quercus pubescens*) as well as Mediterranean shrubs grow on the south facing rocky slopes. A few mature European beech (*Fagus sylvatica*) woods occur at high altitudes, followed by extensive coniferous woods resulting from reforestation efforts dating back to the 1950s. The mountains do not exceed 1090 m a.s.l.. Nevertheless, winter temperatures tend to be rather low due to cold fronts from the Balkans. Average winter and summer temperatures are about 4-5°C and 22-23°C respectively.
Ten cave systems were monitored for bats (Tab. 1).

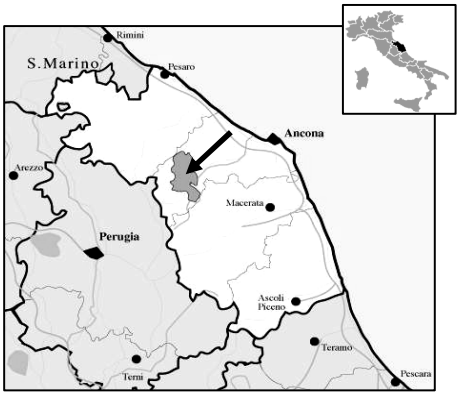

Figure 1 - Location of the study area.

METHODS

Field monitoring of nursery roosts was carried out between May 2004 and December 2006.
Potential reproductive sites were visited in daytime, whilst at night mist-nets were placed at the cave entrances for catching emerging bats.

Table 1 – Monitored caves and characteristics. The Grotta della Beata Vergine is connected to Grotta del Mezzogiorno, both being part of the same karstic system. The same situation exists between the Grotta del Fiume and the Grotta Grande del Vento.

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Cave	Altitude of entrance (m a.s.l.)	Total length (m)	Range in height (m)
1 - Grotta della Beata Vergine	320	4500	170
2 - Grotta del Mezzogiorno	490	4500	170
3 - Grotta del Buco Cattivo (Fiorini)	445	7500	173
4 - Grotta dell'Infinito	480	200	30
5 - Grotta del Paradiso	420	150	20
6 - Grotta del Fiume	200	23000	240
7- Grotta Bella	210	70	5
8 - Grotta dell'Inferno	480	200	60
9 - Grotta del Vernino	574	300	20
10 - Grotta del Buco Cattivo (Buca del Tasso)	445	7500	173

For each bat caught the following physical and biometric features were recorded: sex, weight, forearm length, reproductive status (e.g. pregnant or suckling female) and age class assessed by examining teeth wear and, for very young individuals, by observation of the degree of bone-tissue development in wing articulations (Racey, 1988). Species identification was based on works of Lanza (1959), Lanza and Agnelli (1999) and Dietz and Von Helversen (2004). Discrimination between greater and lesser mouse-eared bats was based, whenever possible, both on the biometric parameters pointed out by Arlettaz (1995), and on the discriminant formula proposed by Arlettaz *et al.* (1997):

$$Z = 0.433 \times LA + 3.709 \times APA - 114.887$$

where LA is the length of the forearm and APA is the height of the ear membrane. This criterion assures the correct classification of 98% of cases (Arlettaz *et al.*, 1997).

Discrimination between *Pipistrellus pipistrellus* and *P. pygmaeus* was based on the shape of wing and penis (Dietz and Von Helversen, 2004).

The size of the colonies was estimated using photographic counts (Agnelli *et al.*, 2001), which were done twice, in 2004 and 2005, for each colony. Minimum and maximum estimated numbers were assessed for each count.

The size of the wintering colony of *P. pipistrellus* was estimated by way of direct simultaneous counting undertaken by two operators, whose observations were compared.

RESULTS AND DISCUSSION

Eleven species of bats were found (Tab. 2), of which *Myotis capaccinii* and *M. blythii* had never been recorded before in Marches region (Lanza and Agnelli, 1999; Uncini, 1999; Agnelli *et*

Table 2 - Bat species found in the hypogean system of the Regional Natural Park "Gola della Rossa e di Frasassi" and their position according to Habitat Directive 92/43 EEC.

Species	Roosts	Habitats Directive (92/43/EEC)	Caves (see Tab. 1)
Rhinolophus ferrumequinum	Caves/buildings	Annex II	1, 4, 6, 8
Rhinolophus euryale	Caves/buildings	Annex II	6, 9
Rhinolophus hipposideros	Caves/buildings	Annex II	1, 6, 9, 10
Myotis blythii	Caves	Annex II	1
Myotis capaccinii	Caves	Annex II	1, 9
Myotis emarginatus	Cave/buildings	Annex II	6
Myotis myotis	Caves	Annex II	1
Pipistrellus pipistrellus	Caves/buildings	Annex IV	1, 2
Hypsugo savii	Buildings	Annex IV	4
Eptesicus serotinus	Caves/buildings	Annex IV	1, 4, 9
Miniopterus schreibersii	Caves	Annex II	1, 8, 9

al., 2004). For *Eptesicus serotinus* only one previous record (town of Ascoli Piceno) collected in the first half of the 19th century existed (Bonaparte, 1832-37 quoted in Gulino and Dal Piaz, 1939).

It was ascertained that there were two mixed nursery roosts located inside Grotta della Beata Vergine, hosting *Miniopterus schreibersii* and *Myotis myotis/blythii,* and there was a nursery roost of *Rhinolophus euryale* in Grotta del Fiume.

Although the capture of some pregnant females from Grotta del Vernino and Grotta dell'Infinito may indicate the presence of reproductive colonies, no direct observation has so far confirmed such hypothesis, due to difficulties connected with the morphology of the two karstic systems.

As a rule, roosts are not always found in the ideal conditions for successful photographic counting. As a conesquence, numeric estimates should be considered as conservative ones (Tab. 3). Schreiber's bat (*Miniopterus schreibersii*), a typical cave dweller which gathers in very large roosts, was the most abundant species recorded in the monitored caves. The total estimated number of adult individuals ranges from a minimum of 9950 to a maximum of 11280, of which 4100 – 4300 pregnant females from Grotta della Beata Vergine, 2650 – 3520 individuals from Grotta dell'Infinito and 2800 – 3460 individuals from Grotta del Vernino; in addition the presence of over 4000 newborns was recorded.

In winter, the Grotta della Beata Vergine hosted over 3500 individuals (December 2005).

The three colonies of Schreiber's bat in

the Park were closely interconnected, as their respective roosts were on average 4.5 kilometres apart (Fig. 2).
This seems to be a very short distance for a species which is known to have wide home-ranges.
Schreiber's bat populations roosting in the karstic area of Frasassi undoubtedly ranks among the largest in Central Italy; for this reason concrete conservation measures need to be taken. Considering that captures of this species in Grotta del Vernino and Grotta dell'Infinito (2004) included a few pregnant females (not confirmed in 2005), further investigation are required to ascertain the role played by these caves in Schreiber's bats ecology.

Table 3 - Species abundance estimates for bat colonies identified in the studied area. Maximum and minimum values are given for each roosting condition.

Species	wintering	breeding	uncertain
Rhinolophus ferrumequinum	287	-	-
Rhinolophus euryale	396-405	550-600	-
Miniopterus schreibersii	>3500	4100-4300	2650-3520
Myotis myotis/blythii	-	530-660	-
Pipistrellus pipistrellus	320-339	-	-

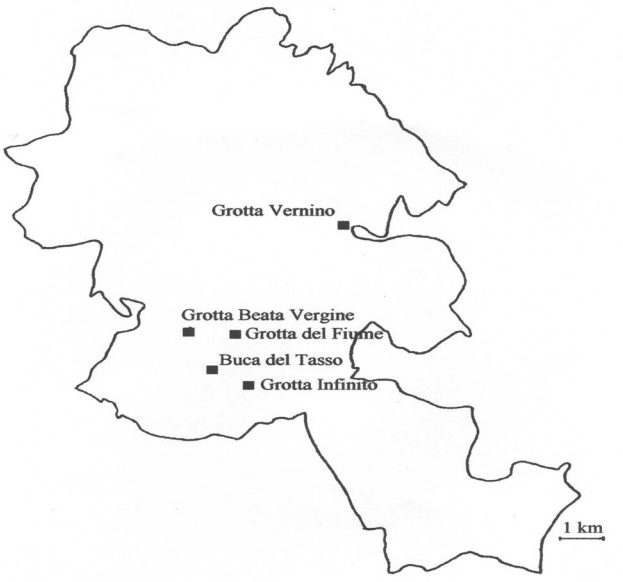

Figure 2 - Map of the five most important caves in the Regional Natural Park “Gola della Rossa e di Frasassi”.

The only known nursery roost of *Myotis myotis/blythii*, both cave-dwellers which frequently share roosts, was located inside the Grotta della Beata Vergine, which hosted between 530 and 660 females, with an apparent predominance of *M. blythii*.

The common pipistrelle (*Pipistrellus pipistrellus*) was observed only between December and February. A large colony spent this period hibernating in a long, narrow crevice located on the roof of the Grotta della Beata Vergine, not far from the entrance.

At the peak of their presence (December 2005), about 320-339 individuals were directly counted. The Mediterranean horseshoe bat (*Rhinolophus euryale*), which is known to find refuge both in buildings and in caves, appeared to be particularly abundant in the Grotta del Fiume, where a nursery of about 550–600 females was recorded. In winter a different section of the same cave hosted a fairly large hibernation roost, including 396 individuals in December 2004, 403 in December 2005 and 405 in December 2006.

R. ferrumequinum was abundant in the Buca del Tasso, where its hibernation colony contained 287 individuals.

Different birth times were recorded for each of the species forming maternity roosts in the study area (Tab. 4).

In this period, tourism and caving are serious threats to bat populations. Therefore, the access to caves should be restricted for the whole period during which females nurture and suckle newborns, in order to prevent disturbance which may result in the abandonment of roosting sites.

This research project has given a general picture of the bat fauna in the Regional Natural Park "Gola della Rossa e di Frasassi". The discovery of large colonies places the area among the most important sites for bat conservation in Central Italy. Further investigation would afford a clearer understanding of these important karstic habitats, which should result in better conservation measures.

Actually a set of guidelines regulating access to natural caves has been issued with the aim of making cave users' activities compatible with bat conservation, particularly during the most delicate periods of their biological cycle.

Table 4 - Birth times of the 3 species which form maternity roosts in the monitored caves.

Births	May				June						July		
	15	20	25	30	05	10	15	20	25	30	05	10	15
Myotis myotis/blythii													
Miniopterus schreibersii													
Rhinolophus euryale													

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