

Swarming of Bats (Chiroptera, Mammalia) in the Vodnite Dupki Cave (Central Balkan National Park, Bulgaria)

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Abstract: Bats were captured at a swarming site in the Central Balkan National Park. Hundreds of bats of at least 16 species visited the cave in late summer, most of them for swarming. For comparison, data of two winter-censuses are given as well. *Rhinolophus euryale*, *Myotis nattereri* and *Eptesicus serotinus* were found for the first time within the territory of the national park. *Myotis alcathoe* is reported for the first time in Bulgaria. Recapture of a marked *Myotis emarginatus* reveals the longest flight known for the species in Bulgaria (105 km).

Key words: Swarming, Stara Planina Mountains, Bulgaria, bats, *Myotis* spp.

Introduction

Swarming of bats at caves during late summer and autumn is a widely-observed phenomenon in Europe and North America. The highest activity is registered between the beginning of August and October. During swarming vespertilionid bats arrive after dusk at underground sites and remain for several hours. A huge population overturn and a predominance of males are characteristic, most possibly bats assemble to find mates. Swarming has been extensively investigated in Western and Central Europe (for a recent review see PARSONS *et al.* 2003a), but it has not been the main focus of research in the Balkans. For example IVANOVA (1998) reported captures of swarming bats in late summer at caves of the Central Stara Planina Mountains in Bulgaria during her investigations of the bat fauna of the region. Our aim was to collect some preliminary basic data on swarming in Bulgaria. Without data on the seasonal occurrence of bats in roosts in South Europe, it is hard to make a distinction between cave-roosting and swarming bats. Therefore, we decided to study a cave located at the higher altitudes of the Stara Planina Mountains, where a few, if any, bat-species bred due to

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unsuitable microclimatic conditions and therefore the majority of captured bats were likely to visit the cave for swarming.

Methods and Materials

The Vodnite Dupki Cave (42°44'02" N; 24°54'00" E) is situated in the Severen Dzhenem Reserve of the Central Balkan Park in the Stara Planina Mountains, Bulgaria. It lies on the northern slope of the Botev Peak at an altitude of 1400 m a.s.l. The two entrances of the limestone cave are at different levels and are connected by a narrow and partially-blocked corridor. An underground brook comes out of the lower gallery. In summer the upper gallery is much warmer than the cold lower one. In winter, however, the temperature of the lower passages of the brook is slightly (1-2°C) higher than the horizontal parts of the upper ones. First data on summer use of Vodnite Dupki by bats were published by IVANOVA (1998). Winter censuses were made by B. P. Petrov.

The northern slopes of the Botev Peak (2376 m a.s.l.) are divided by deep valleys with high, inaccessible rocks. The mostly untouched natural forests are dominated by beech, at higher elevations fir becomes more prominent.

The cave was surveyed three times over the swarming period: on 28/08/2001, 13/08/2002 and 16/08/2003 and twice in winter: on 04/02/2001 and 01/02/2003. In winter bats were neither counted in details nor caught to avoid disturbance. In summer however, bats were caught with mist-nets that were placed at both entrances of the cave 30 minutes before sunset and removed at 1 a.m. After the nets were removed, the bat species were identified and standard measurements (lengths of forearm including wrist (FA+), 5th finger excluding wrist (D5-), 3rd finger excluding wrist (D3-) and weight (BW)) were taken. The reproductive condition of females was assessed by inspecting the nipples, and of males - by the size of the testes (T) and coloration and filling of the epididymis (E). Close-up photographs and tissue samples were taken from some individuals to document characters or to verify species identification. Skulls and skeletons of bats were collected from the caves and their species later determined by using a reference collection. For the identification of the sibling live *M. myotis* and *M. blythii* we have used ARLETTAZ *et al.* (1991) and for the subfossil material MENU, POPELARD (1987) and POPOV, SEDEFCHEV (2003).

Results

Species

A total of 318 bats representing 16 species were caught during the three capture-nights (Table 1). *Myotis blythii*, *Miniopterus schreibersii* and *Barbastella barbastellus* were the predominant species. Three species of the genus *Rhinolophus* were captured (*R. ferrumequinum*, *R. euryale* and *R. hipposideros*), but none of them were swarming at the cave: all individuals were caught emerging early in the evening. Apparently, the cave is used as a day roost. In the two big-*Myotis*-species, *Myotis blythii* was much more abundant than *M. myotis*. Only 10.7% of the total of individuals caught from both species and 5.6% of the skulls were *Myotis myotis*. During the day, many harems and single males of *Myotis blythii* were observed in the upper part of the cave. The species seems to be the only one to reproduce in the cave, judging by several carcasses and bones of juvenile bats found near the entrance of the upper gallery. Both big-*Myotis*

species hibernate in several clusters (80, 60, 40 specimens and rarely solitary) mainly in the second and the warmest room of the upper gallery (temperature about 3°C). In February 2001, about 250 individuals were counted (cf. BENDA *et al.* 2003), in February 2003 about 300 (new data). Numerous skeletons of adult *Myotis blythii* were found here in summer as well.

Only single individuals of *Myotis nattereri* and *Eptesicus serotinus* were caught. A skeleton of *Myotis nattereri* was found in a crevice of the lower entrance together with bones of *Myotis bechsteinii*, *Myotis* spp. and *Barbastella barbastellus*, indicating a possible hibernation place. *Myotis bechsteinii*, *M. daubentonii*, *M. brandtii* and *M. aurascens* were captured on at least two of the three occasions. *Myotis emarginatus* was caught in low numbers during all the three capture-nights. On 16 August 2003, a banded individual was caught (Table 2). It had been marked by our team as a juvenile on 12/07/2001 at the Nanin Kamak Cave near Muselievo in the Danube Plain, 105 kilometres to the north.

M. alcathoe was caught for the first time in Bulgaria on 16 August 2003. Two adult males and one sub-adult female entered the upper entrance between 10 and 11 p.m. They were well distinguishable from the other whiskered bat species according to the characteristics given by VON HELVERSEN *et al.* (2001). Tissue samples of all the three individuals were analysed genetically (partial sequence of the ND1-gene) and confirmed the identification (F. MAYER personal com.). On 28 August 2001, many *Plecotus auritus* were captured. Many of the swarming bats observed later in that night also belonged to the genus *Plecotus*. However, on 16 August 2003, only a single individual was caught. Analysis of a 550 bp fragment of the 16S-rRNA from one male confirmed the identity of the species (A. KIEFER personal com.).

Twenty-three *Barbastella barbastellus* were caught on 28 August 2001 and ten on 16 August 2003. Many of the swarming bats in the late night of 28 August 2001 were *B. barbastellus*, their numbers were estimated at more than 50 individuals. In winter up to 30 individuals hibernated in two clusters (18-20 and 10-12 specimens respectively) in the lower gallery of the cave. The clusters were found above the underground brook at temperatures around 1-2°C. During both winter-visits the number of *B. barbastellus* was constant, in 2001 two inspected individuals were females, in 2003 two were males. *Miniopterus schreibersii* was generally caught in large numbers. During daytime, a summer colony of about 100 individuals was found in the upper part of the cave, consisting of bats that mainly roosted singly. Reproduction of this species in the cave was not confirmed: most of the individuals were males or non-breeding females and dead juveniles or skeletons were not found. The bats were mainly caught when leaving or entering the cave and swarming was not observed.

Weather conditions and swarming intensity

In the first capture night (28/08/2001), the weather was very warm and dry, which was reflected in the high number of bats caught (145 individuals in total). Even after the removal of the nets, bats were still arriving at the cave. The number of swarming bats at the lower entrance peaked around 3 a.m. and was estimated at 300 individuals (*Myotis* spp., *Plecotus auritus* and *Barbastella barbastellus*). Several hundred bats totally visited the cave during that night. However, on 13 August 2002 the night was rainy, following a week of cold and rainy weather and only a few bats were caught (29 individuals), while only 10 arrived from outside the cave. Bats arrived in the first two hours after dusk and the activity ceased completely later on. On 16 August 2003 the weather was

also cold and rainy, but the week before had been very warm and dry, and 144 bats were caught. Bats arrived infrequently at the beginning of the night, the activity culminated around midnight and it had diminished by 2 a.m. At midnight, up to 50 bats were swarming at the lower entrance of the cave and the total number of individuals did not exceed a few hundred.

Discussion

Most of the bat species caught by IVANOVA (1998) were observed. In addition, we are reporting here the first genetically-established observation of *Myotis alcathoe* in Bulgaria. *Rhinolophus euryale*, *Myotis nattereri* and *Eptesicus serotinus* were observed for the first time in the national park, where 22 bat species had been recorded so far.

Of the 16 bat species that we caught at the cave, 11 showed swarming behaviour (*Myotis blythii*, *Plecotus auritus* and *Barbastella barbastellus*). The others were caught either when leaving the day roost (*Rhinolophus* spp., *Miniopterus schreibersii*) or it was unclear whether they were really swarming or just entering the cave for night-roosting (*Eptesicus serotinus*). The cave might be too high in the mountains to hold bigger numbers of rhinolophoid bats, these species are distributed mainly in the lowlands (PANDURSKA 1997a,b).

In many West- and Central-European caves, *Myotis daubentonii* forms the biggest part of the swarming population (PARSONS *et al.* 2003a; our own data). However, *M. daubentonii* was caught relatively rarely at the Vodnite Dupki. A reason for this might be that the Central Balkan range is quite far away from the lowland rivers, where the only known colonies in Bulgaria exist (DIETZ, SCHUNGER, own data). On the other hand, *Myotis bechsteinii*, *M. brandtii* and *Barbastella barbastellus* were captured regularly in the cave and these species are typical of natural mountain forests. Our findings indicate that they form resident populations in the national park. Vodnite Dupki is one of the sites known in Bulgaria to be with the greatest population density of these three forest dwelling bat species (PETROV, in press).

IVANOVA (1998) reports *Myotis myotis*, but not *M. blythii* from the Vodnite Dupki, which is in contrast to our data (Table 1). In our captures and in the collected skulls, *Myotis blythii* was by far the most dominant species. However, a sympatric occurrence of both species is not surprising in Bulgaria.

Myotis aurascens is a typical bat of lowland rivers and common in Bulgaria (DIETZ, SCHUNGER, own data). For swarming, this species seems to use caves at higher altitudes, which possibly are used for hibernation as well. *Myotis alcathoe* was described as a new species in 2001 (VON HELVERSEN *et al.* 2001). Up to now it has never been reported in Bulgaria (BENDA, TSYTSULINA 2000, BENDA *et al.* 2003), but some of the very small *Myotis mystacinus* caught there previously (KVARTIRNIKOV 1957, HORACEK *et al.* 1974) might have belonged to this species (cf. BENDA *et al.* 2003). The habitat requirements of *Myotis alcathoe* are old natural forests (VON HELVERSEN *et al.* 2001). The habitat quality and our finding of a sub-adult female make the reproduction of the species in the beech forest of the national park very likely.

The earlier observation of *Plecotus austriacus* from the Vodnite Dupki Cave (IVANOVA 1998) is doubtful, because this species is distributed mainly in the lowlands and avoids the closed forests and mountains that are inhabited by *P. auritus* (VON HELVERSEN, WEID 1990, BENDA, IVANOVA 2003). We think that the bats may either have

Table 1. Numbers of bats caught and skulls collected in the Vodnite Dupki Cave. The number of individuals is given as: total sum of caught individuals and the number of males/females in brackets. The data from 15.08.1997 are published by IVANOVA (1998) and are given for comparison.

Species	15/08/1997 (IVANOVA, 1998)	28/08/2001	13/08/2002	16/08/2003	Skulls found inside the cave
<i>Rhinolophus ferrumequinum</i> (SCHREBER, 1774)	0	2 (2/0)	0	0	1
<i>Rhinolophus hipposideros</i> (BECHSTEIN, 1800)	0	1 (0/1)	0	0	0
<i>Rhinolophus euryale</i> BLASIUS, 1853	0	1 (1/0)	0	0	1
<i>Myotis myotis</i> (BORKHAUSEN, 1797)	13 (8/5)	4 (3/1)	1 (1/0)	5 (4/1)	7
<i>Myotis blythii</i> (TOMES, 1857)	0	53 (37/16)	3 (1/2)	37 (22/15)	126
<i>Myotis myotis/blythii</i>	0	0	0	0	34
<i>Myotis bechsteinii</i> (KUHLE, 1817)	9 (9/0)	11 (10/1)	0	4 (4/0)	1
<i>Myotis nattereri</i> (KUHLE, 1817)	0	1 (1/0)	0	0	1
<i>Myotis emarginatus</i> (GEOFFROY, 1806)	2 (1/1)	8 (8/0)	4 (4/0)	5 (5/0)	0
<i>Myotis daubentonii</i> (KUHLE, 1817)	2 (2/0)	4 (4/0)	2 (1/1)	4 (4/0)	0
<i>Myotis brandtii</i> (EVERSMANN, 1845)	3 (3/0)	0	1 (0/1)	6 (6/0)	0
<i>Myotis aurascens</i> (KUZIJAKIN, 1935)	7 (6/1)	1 (1/0)	3 (3/0)	3 (3/0)	0
<i>Myotis alcathoe</i> VON HELVERSEN, HELLER 2001	0	0	0	3 (2/1)	0
<i>Myotis spec.</i>	0	0	0	0	4
<i>Eptesicus serotinus</i> (SCHREBER, 1774)	0	0	0	1 (1/0)	0
<i>Plecotus auritus</i> (LINNAEUS, 1758)	0	19 (8/11)	0	1 (1/0)	0
<i>Plecotus austriacus</i> (FISCHER, 1829)	2 (1/1)	0	0	0	0
<i>Barbastella barbastellus</i> (SCHREBER, 1774)	3 (3/0)	23 (17/6)	0	0	0
<i>Miniopterus schreibersii</i> (KUHLE, 1817)	7 (3/4)	17 (4/13)	15 (6/9)	10 (8/2)	1
Total	48	145	29	144	179

been confused with *P. auritus* or may in fact have been *P. macrobullaris*. Alpine habitats in the Central Stara Planina may fit well with the ecological demands of the latter species.

Swarming sites might be very important for the gene-flow between different sub-populations (see KERTH *et al.* 2003, PARSONS *et al.* 2003a,c) and might therefore have a key function in the reproductive biology as well as for the conservation of bats. Long-distance flights might help to sustain the gene-flow even between populations of different landscape units. Our juvenile *Myotis emarginatus* had been banded in a nursery colony in a lowland cave and was recaptured two years later in full reproductive condition in a mountainous swarming cave at a distance of more than 100 kilometres (Table 2). This is the longest flight, which has ever been recorded for this species in Bulgaria (BERON 1963; PANDURSKA 2000). The maximum range from the swarming site back to the roost was shown by telemetry to be around 30 kilometres in *Myotis daubentonii*, *M. nattereri* (PARSONS, JONES 2003c) and *M. myotis* (A. NAGEL, personal com.).

Table 2. Mark-recapture data of a male *Myotis emarginatus*, ring № A 00823. FA- forearm length including wrist; D5- length of the 5th finger excluding wrist; BW- weight; T- size, coloration and filling of the testes and epididymis (E). “+” enlarged; “-“ normal.

Date	Locality	FA+ mm	D5- mm	BW g	Age	Reproductive condition
12/07/2001 capture	Nanin Kamak Cave (140 m) 43°37'37" N; 24°51'22" E	38,9	49,3	6,7	Juv	T-, E- black
16/08/2003 recapture	Vodnite Dupki Cave (1400 m) 42°44'02" N; 24°54'00" E	39,1	51,6	6,6	Ad	T+, E+ white
Distance	105 km, south					

Among all the species that were captured in large numbers, males were much more dominant than females, except in *Miniopterus schreibersii*. This is a typical trait of a swarming population (PARSONS *et al.* 2003a). PARSONS *et al.* (2003b) found greater swarming activity at higher temperatures and lower activity on days with rainfall. This is in accordance with our observations of a marked variation of swarming activity in weather conditions. In the mountains, weather conditions change very quickly and frequently, so we speculate that nights with high swarming activity are rarer there than in lowland areas.

The winter censuses from the Vodnite Dupki provide some of the first data on hibernation of bats in these altitudes in Bulgaria. In support of BENDA *et al.* (2003) and PANDURSKA, IVANOVA (2003), the large numbers of hibernating big-*Myotis* bats and one of the few records of a hibernation colony of *Barbastella barbastellus* in Bulgaria outline the importance of the cave for hibernation as well. The total number of bats even might be much higher, an inspection of the very deep cracks and crevices was not possible during the two visits.

Our study supports the conclusion of IVANOVA (1998) that the Central Balkan National Park with its extended natural beech-forests is very important for the bat fauna and for the conservation of bats. The large number of forest-dwelling bats that are rarely found elsewhere in Bulgaria shows the importance of the area. Special consideration in conservation management of the national park is necessary. Continued capture efforts at high-altitude swarming caves in the Balkans may reveal further details

of the distribution of rare or unrecorded bats (*Myotis alcaethoe*, *Eptesicus nilssonii*, *Plecotus macrobullaris*) and on the ecology of the little-known forest-dwelling species.

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Струпуване на прилепи в пещерата Водните дупки (Национален парк "Централен Балкан", България)

(Резюме)

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Прилепи са ловени с мрежи на входа на пещерата "Водните дупки" в масива на вр. Ботев в Централния Балкан. Неколкостотин прилепа от поне 16 вида използват пещерата за размножаване, дневно убежище или за зимуване. През късното лято повечето от уловените екземпляри посещават пещерата само с цел размножаване.

За сравнение са представени данни и от зимни преброявания на прилепи. Видовете *Rhinolophus euryale*, *Myotis nattereri* и *Eptesicus serotinus* са установени за първи път за територията на парка. *Myotis alcaethoe* се съобщава за първи път от България. Установен е и най-дългия прелет на опръстенен *Myotis emarginatus* в България (105 km).