

***Myotis myotis* AND *Myotis blythii* (MAMMALIA: CHIROPTERA) PREFERENCE FOR THE USE OF PIATRA CRAIULUI CAVES DURING THEIR MATING AND HIBERNATION PERIODS**

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Abstract. The aim of our study was to identify the underground shelters used by the bat species *Myotis myotis* and *M. blythii* in Piatra Craiului massif of Piatra Craiului National Park. We verified 40 natural and artificial underground cavities (thirty three caves and seven abandoned mine galleries situated at an altitude between 770 - 1761 m) from the 813 caves mapped in the park. From these 40 shelters, the species *M. myotis* and *M. blythii* were found in eight caves and one mine gallery. The most important wintering shelters in the park are Colțul Surpat Cave and Zărnești mine quarry. Peștera cu Lilieci Cave from Peștera village is an important shelter cave for the mating of *M. myotis* and *M. blythii*. Most published data on these two species are on the qualitative aspects, giving data on the presence or absence of the bat species. Our study comes with new data about these species on the territory of Piatra Craiului National Park. In this paper, we report data on a cave that has not been investigated so far in terms of bat fauna (Arșiței Cave) and we complete the list of bat species for Peștera Decolmatată Cave and Vacilor Cave.

Keywords: bats, Piatra Craiului, Carpathians, Romania.

Rezumat. Preferințele speciilor *Myotis myotis* și *Myotis blythii* (Mammalia: Chiroptera) pentru utilizarea peșterilor din munții Piatra Craiului în perioadele de împerechere și hibernare. Scopul studiului a fost identificarea adăposturilor subterane utilizate de speciile *Myotis myotis* și *M. blythii* în masivul, respectiv, Parcul Național Piatra Craiului. Au fost verificate 40 de cavități subterane naturale și artificiale (33 de peșteri și 7 galerii de mină, situate la altitudini între 770 – 1761 m) dintre cele 813 cavități cartate în parc. Dintre aceste 40 de adăposturi, speciile *M. myotis* și *M. blythii* au fost întâlnite în opt peșteri și o galerie de mină. Cele mai importante adăposturi de hibernare din parc sunt Peștera Colțul Surpat și Mina din cariera Zărnești. Peștera cu Lilieci din satul Peștera constituie un adăpost de împerechere important pentru speciile urmărite. Majoritatea datelor despre aceste două specii, publicate până în prezent, sunt doar calitative, urmărind prezența sau absența speciilor. Articolul vine cu completări despre aceste specii pe teritoriul Parcului Național Piatra Craiului. Prezentăm date despre o peșteră care nu a mai fost cercetată până în prezent din punct de vedere al faunei de lilieci (Peștera Arșiței) și completăm lista speciilor de lilieci pentru Peștera Decolmatată și Peștera Vacilor.

Cuvinte cheie: lilieci, Piatra Craiului, Carpați, România.

INTRODUCTION

The study area comprises the territory of Natura 2000 site ROSCI0194 Piatra Craiului (15,867 ha), including the territory of Piatra Craiului National Park (14,773 ha), the last being located in the Eastern Southern Carpathians, polarized on the limestone ridge of Piatra Craiului Mountains. The relief has altitudes between 699 m - 2,238 m. The investigated territory consists in a complex karst system with predominant deciduous, coniferous and mixed forests, i.e. Dacian beech forests (Symphyto-Fagion), beech forests Luzulo-Fagetum type, *Picea abies* forests in the acidophilus mountain region (Vaccinio-Piceetea). The limestone Ridge of Piatra Craiului Mountains is about 20 km length. The caves are numerous, but most of them are short or poorly developed. The total length of the 836 known caves is about 14,640 m, with an average length for one cave about 17.5 meters.

The Special Conservation Area includes 788 caves, as follows: 54 caves - scientific reserves (27 caves located in the northern sector in the Bârsa basin, 27 caves in southern sector, the catchment area of the Dâmbovița), 734 caves considered natural reserves (43 caves situated in Prăpăștiilor Valley sector, 86 caves in Seacă Valley - the Brusturetului Gorges sector, 86 caves the Dâmbovicioarei Gorges sector, 176 caves in the Small Gorges of the Dâmbovița, 343 in the Great Gorge of the Dâmbovița). The protected landscape area covers 48 caves (18 caves in the northern sector: the Small Bârsa Valley - Magura and 30 caves on the southern sector: Sbârcoara-Turcu valleys, Măgura, Peștera and Moeciu villages). From all these, 13 caves measure 5 - 10 m length, 686 caves have 10 - 20 m length, 117 caves have 20 - 50 m length, 13 caves between 50 and 100 m length, 5 caves between 100 and 500 m length and two caves measures more than 500 m in length. 514 caves are located between 700 and 1000 m altitude, 177 caves located from 1000 to 1200 m altitude, 63 caves between 1200 and 1500 m altitude, 56 caves located from 1500 to 1800 m altitude and 26 caves between 1800 m and maximum altitude (CONSTANTINESCU & DOBRESCU, 2006).

From all these caves listed before, GHEORGHIU & MURARIU (2006) selected 113 caves with bat fauna potential and verified 16 of them. We have re-inventoried some of these 113 caves (40 natural and artificial underground cavities, most with a minimum length of 30 m) in order to identify the species group *Myotis myotis/blythii*. According to the published data, *M. myotis* was observed in Colțul Surpat Cave and Peștera cu Lilieci Cave from Peștera Village (summer and winter roost), Dâmbovicioara Cave (hibernation roost), Zărnești quarry mine gallery and Stanciului Cave (hibernation roost), but also some ultrasound detection contacts are known in Călineț's Padina, Șpirlea

Valley, Avenul de sub Colții Grindului Cave, Garofița cottage from Brusturețului valley and Prăpăștiile Zărneștilor Gorges. Like the sister species, *M. blythii* has been observed in the same shelters and habitats (GHEORGHIU & MURARIU, 2006). Some of these data were republished, with additions of parasitological data collected from the encountered species (GHEORGHIU, 2006; MUNTEANU & GHEORGHIU, 2007). MURARIU (2003) mentions this species within the territory of Piatra Craiului National Park, without specifying the locations of his observations. Other authors found *M. myotis* in Dâmbovicioara Cave, Peștera cu Lileci Cave from Peștera village, Ulucelor Cave, Zărnești quarry mine gallery and Stanciului Cave, (GHEORGHIU & MURARIU, 2006; GHEORGHIU et al., 2003; NAGY et al., 2003, 2005, 2010; BARTI et al., 2006; Jere & Barti (pers. comm.)). Over 500 individuals of the species *M. myotis* and *M. blythii* were estimated in Avenul de sub Colții Grindului Cave, at an altitude of 2020 m, the authors assuming that the most of hibernating effective in this cave belong to the species *M. blythii*, (GHEORGHIU et al, 2003). According to the article, we could not assume this hibernacula estimation, because all the observations, were done in the period May-September by the exploration team members to the depth of 99 m. Since then, in a romanian-bulgarian caving expedition on 20th of June 2006, the bats were counted, being 20 individuals on the depth of 340 m (Kiten Topalov pers. comm., expedition team member). The last information regarding the presence of this species here *M. myotis* / *M. blythii* was given by Cristina Stika (one of the speleologist of the exploration team), from the 22nd of September 2010, that took photograph for us of all the 5 individuals of this species at a depth of 60 m. There is no evidence that Avenul de sub Colții Grindului Cave is a hibernacula, because, in winter, the access to this cave is dangerous and no one climb down into it.

MATERIALS AND METHODS

The study was achieved between November 2012 and February 2015. The field observations were undertaken in order to include all the aspects of these species during two years (population size, composition of the species, their conservation status, etc.). In order to identify the species in the summer shelters or during the hibernation period, the two species were considered together, to avoid confusion due to their similar morphological characters. During the mating period, when we captured them with mist nets, we took into account their morphological characters, (DIETZ & VON HELVERSON, 2004). To measure the microclimate conditions inside the shelters, we used a thermo-hygrometer (Extech Instruments), an anemometer and barometer (Sunartis - Mingle Instruments, GmbH D-47877 Europe, Willich Model: BKT381). For weighing bats we used a 50g Pesola scale and to capture them, ECOTONE monofilament nets.

RESULTS AND DISCUSSION

We checked 33 caves and 7 mine galleries (two of them could not be crossed entirely due the lack of adequate equipment). The total length of the inventoried underground cavities summarizes 2534 m and the total length of the interest cavities represents about 8.5 % of the total area of underground cavities of studied area (1738 m long).

1. **Colțul Surpat Cave** is situated at an altitude of 850 m, on the right side of the Small Gorges of the Dâmbovița and measured 540 m length, consisting in a large access gallery and two branched galleries (MUNTEANU & GHEORGHIU, 2007). The access to the cave is easily arranged by stairs near the road side that connects Podu Dâmboviței with Sățicul de Sus villages. Due the facilitated access, the protection system was vandalized and the presence of tourists and locals is obviously. On the map (figure 1), the location of the cave is marked with a star and number eight. The cave was monitored in the last 15 years by the Romanian Bat Protection Association members (NAGY et al., 2003, 2005, 2010; BARTI et al., 2006). The cave has the status of natural reserve and area of special conservation.

We found the maximum number of the sibling species *M. myotis/blythii* in the cave at the end of the hibernation period, respectively, 91 individuals (the 28th of March, 2014, table 1). They gathered in the last autumn and left the hibernacula in May. This cave seems to be an important mating place as well in the area of these species.

2. **Peștera Decolmatată Cave**. The cave is also known as Badgers Cave. It is located on the right side of the Dâmbovița valley, at an altitude of 785 m. The cave is 87 m long and has 1 m unevenness. On the map, the location of the cave is marked with a star and number 10. No interest in terms of bat fauna, only one individual of the species *M. blythii* being observed in hibernation at the end of December. The shelter is not used in the rest of the year. There is no data in the published literature regarding the species *M. myotis* and *M. blythii* in Peștera Decolmatată Cave. The cave is situated in the special conservation area and has the status of a natural reserve.

3. **Arșiței Cave** is located on the right side of the Dâmbovița valley at an altitude of 815 m. This cave measures 26 m length. On the map, the location of the cave is marked with a star and number 24. The cave is used mainly for hibernation, in this period being seen 4 species of bats, while during the year, only occasionally. There are no published data about bat species in this cave. Arșiței Cave is located in the special conservation area and has the status of natural reserve.

Table 1. The inventory results of *M. myotis* and *M. blythii* species group.

No.	Underground shelter	Coordinates N	Coordinates E	Altitude (meters)	No. of individuals/ Species	Date
1	Colțul Surpat Cave	45.420603°	25.192647°	780	2 <i>M. myotis/blythii</i> 57 <i>M. myotis/blythii</i> 87 <i>M. myotis/blythii</i> 91 <i>M. myotis/blythii</i> 22 <i>M. myotis/blythii</i> 1 <i>M. myotis</i> 22 <i>M. myotis/blythii</i> 42 <i>M. myotis/blythii</i> 2 <i>M. blythii</i>	September 14, 2013 October 30, 2013 November 17, 2013 March 28, 2014 April 21, 2014 August 20, 2014 December 21, 2014 February 8, 2015 February 8, 2015
2	Peștera Decolmatată Cave	45.422737°	25.190942°	785	1 <i>M. myotis/blythii</i>	December 29, 2014
3	Arșiței Cave	45.410781°	25.174011°	815	1 <i>M. myotis/blythii</i>	November 22, 2014
4	Vacilor Cave	45.450952°	25.217620°	980	1 <i>M. myotis</i>	December 22, 2014
5	Dâmbovicioara Cave	45.44419°	25.22262°	900	2 <i>M. myotis/blythii</i>	November 22, 2014
6	Peștera cu Lilieci Cave from Peștera village	45.507594°	25.292383°	950	3 ♂♂ și 1 ♀ adults <i>M. myotis</i> 1 ♂ <i>Myotis blythii</i> 1 <i>M. myotis</i>	August 18, 2014 August 18, 2014 August 18, 2014
7	Uluce Cave	45.410156°	25.261177°	972	2 <i>M. myotis/ blythii</i> 2 <i>M. myotis/ blythii</i> 2 <i>M. myotis/ blythii</i> 3 <i>M. myotis/ blythii</i> 3 <i>M. myotis</i>	November 16, 2013 March 15, 2014 September 28, 2014 November 22, 2014 December 15, 2014
8	Stanciului Cave	45.506901°	25.194565°	1705	16 <i>M. myotis</i> 17 <i>M. myotis/ blythii</i>	October 26, 2013 February 8, 2015
9	The gallery mine from Zărnești quarry	45.539709°	25.297466°	927	1 ♂ <i>M. myotis</i> 14 <i>M. myotis/blythii</i> 14 <i>M. myotis</i> 10 <i>M. myotis/blythii</i> 6 <i>M. myotis/ blythii</i> 1 <i>Myotis blythii</i>	August 18, 2014 October 30, 2014 November 2, 2014 December 01, 2014 January 24, 2015 January 24, 2015

4. **Vacilor Cave**, also known as "Peșteruca din Plai" (GHEORGHIU & MURARIU, 2006), is located on the right side of Piatra Craiului Ridge, on Dâmbovicioara Gorges sector, the right side of Peșterii Valley, at an absolute altitude of 980 m. This cave measures 26 m length. The cave is used as a shelter for cattle. It may be the reason the bats stay rarely inside the cave. We observed one individual of *M. myotis* hibernating inside the cave. This species was not mentioned in the literature so far. On the map, the location of the cave is marked with a star and no. 7.

5. **Dâmbovicioara Cave** is located on the southern slope of Piatra Craiului Massif, on the left side of Dâmbovicioara valley, 1 km away from Dâmbovicioara village (MUNTEANU & GHEORGHIU, 2007). The dimension of the cave is 558 m length, four or five meters width and a few branches, being developed on a single gallery. The unvisited part of the cave has the status of a natural reserve, while the visited sector was arranged for tourism purposes. The cave is located in the special conservation area and it is closed to the public access; the visit is possible just in the presence of one guide. On the map, the location of the cave is marked with a star and no. 1. Apparently, the cave did not gather the requirements of these hibernating species; only two individuals were observed at the beginning of the hibernation period, in the visited sector of cave.

6. **Bats Cave from Peștera Village** is located in the north of Rucăr-Bran passage, on the eastern slope of Bisericii Hill, at an altitude of 950 m. On the map, the location of the cave is marked with a star and number 19. The cave is located in the protected landscape area. It has no restrictions on visitation on its entire length of 162 m (MUNTEANU & GHEORGHIU, 2007). DUMITRESCU et al. (1962 – 1963) reported the species *M. myotis* and a nursing colony of *Myotis myotis*; MURARIU (2003), GHEORGHIU & MURARIU (2006) mentioned the presence of both species during the active season and during the hibernation period. We found this species at the beginning of the mating season. On the 18th of August 2014, the flying activity of bats was relatively low (three males and a female of *M. myotis*, one male of *M. blythii*) from a total of seven individuals captured within 5 hours and 45 minutes, belonging to three species (Table 1). The mist net was placed on the shelter entrance from 9:00 p.m. to 2:45 a.m. The climatic conditions were: 14.4 °C, 87% H, clear sky (Table 2). The first which came into the mist net from outside were two males of *M. myotis*. They were captured about an hour and a half after the mist net was placed; the other bats were captured after midnight. The mist net was packed away an hour after catching the last bat. In the early and mid-hibernation period we have not observed any of these species. The explanation may probably due to uncontrolled tourism and constant disturbance.

Table 2. Cave microclimate and external weather conditions on the inventory date.

Cave	Date	Cave microclimate	External weather conditions
Arșiței Cave	September 15, 2014	Not evaluated	Not evaluated
	November 22, 2014	5:30 p.m.: 10.1 °C, 100%H	cloudy
Bat Cave from Peștera village	August 28, 2014	10 °C; 89.7%H	9:30 p.m.: clear, 903 hPa, 14.4 °C; 87%H
	December 30, 2014	3:15 p.m.: 4°C; 100%H	3:15 p.m. -10 °C; snow, clear
Peștera Decolmatată Cave	August 21, 2014	5:25 p.m.: 16 °C; 89%H, airflow: 0 Bf	5:25 p.m.: 29 °C; 47.4%H, airflow: 0 Bf.
	December 30, 2014	11:03 a.m.: 4.2°C; 97-100%H, airflow: 0 Bf	11:03 a.m.: -10 °C, sun, snow
Vacilor Cave	December 22, 2014	11:35 a.m., 2.7 °C; 81.2%H	11:35 a.m.: 1°C ; 77%H
Uluce Cave	March 15, 2014	3:15 p.m.: Corridor: 5.3°C, vestibular zone: 7.7 °C.	3:15 p.m.: 9.8 °C at the entrance of the cave; humidity not evaluated.
	September 25, 2014	7.8 °C; 88.1%H	9:05 p.m.: clear sky, 6 °C; 67%H, 915 hPa
	November 22, 2014	6:30 p.m.: 2.2 °C, 88.4%H	6:30 p.m.: 1 °C, 98%H
	February 8, 2015	6:30 p.m.: 9.5 °C, 60.6%H	-7 °C, 55%H.
Colțul Surpat Cave	September 14, 2014	9 p.m.: 10.8 °C; 94.4%H	Not evaluated
	April 21, 2014	5:50 p.m.: 7 °C; 92%H	Not evaluated
	February 8, 2015	5:20 p.m.: 8 °C; 87.1%H	5:20 p.m.: -5 °C, 56.1%H
Stanciului Cave	October 26, 2013	9:50 p.m.: 5 °C; 86.5%H	9:50 p.m.: 2 °C, 68.4 %H
	February 8, 2015	3 p.m.: -1.6 °C; 77.1%H, airflow: 0 Bf	3 p.m.: -8.7 °C; 77.1%H, airflow: 0-1Bf
The gallery mine from Zărnești quarry	August 27, 2014	9:00 p.m.: 7.3 °C; 97%H, airflow: 0Bf	9:00 p.m.: clear 11 °C; 98%H, airflow: 0Bf
	December 20, 2014	2:20 p.m.: 9 °C; 65%H	2:20 p.m.: 4 °C; 64%H

7. **Stanciului Cave** is situated on the western slope of the limestone ridge Piatra Craiului, between a pathway and Marele Grohotiș. On the map, the location of the cave is marked with a star and number 18. The cave is about 95 m length, has the status of natural reserve and is situated in the special conservation area. Initially it was considered an important wintering shelter for some bat species, including the group *M. myotis/blythii* (MUNTEANU & GHEORGHIU, 2007; GHEORGHIU & MURARIU, 2006). On the cave visit time (after a 15 months interval) we found that the cave roosts a small number of bats, all belonging to the group *M. myotis/blythii*. The reason can be attributed to the disturbance caused by tourists' entering, camping and firing overnight inside the cave. The shelter is used by bats during the mating period.

8. **The gallery mine from Zărnești quarry** is also known as the "Tunelul de la Carieră" (GHEORGHIU & MURARIU, 2006); it is situated on the right side of Prăpăștiilor valley and was a prospecting gallery. The gallery has about 250 m length and an accentuated state of degradation, with down ceiling sections (MUNTEANU & GHEORGHIU, 2007). On the map, the location of the mine is marked with a star and number 32. From the all checked mine galleries, this is the only one where we found the sibling species, probably because the access to the entrance is more difficult and is rarely disturbed by tourists or local people than others, it is larger and the microclimate is suitable for hibernation. During the mating period, the gallery is apparently out of interest for the bats, although the flight and feeding activity of several species was intense out of the entrance in the mine gallery. The mist net was placed at 9:00 p.m., at 5 m from the entrance, inside the gallery, to be more difficult to be detected, and was closed half past four hours later, because of the few captured bats: four individuals belonging to four species. From these, a male *M. blythii*, the only individual in the group *M. myotis /blythii* came inside around 11:00 p.m. In winter, we observed 10 to 14 individuals of *M. myotis* and *M. blythii* in hibernation. Outside the hibernation period, the bats stay there just occasionally.

9. **Uluce Cave** is classified as protected area. Although situated on the territory of Leaota site, about 5 km from the National Park boundary, the cave was checked to see if the cave roosts important colonies of bats. On the map, the location of the cave is marked with a star and number 25. Here, we observed four species, including the group *M. myotis/blythii*.

The other natural and artificial underground galleries where we have not found these species are marked with numbers: 2, 3 – Dâmbovicioara Valley caves; 4 – Peștera Uscată Cave from Rea Valley; 5 – Peștera cu Apă Cave from V. Rea; 6 – Hoșilor Cave; 7 – Vacilor Cave; 9 – Tunelul cu Cabluri (mine gallery); 11 – Gallery mine no. 1 over Peștera Decolmatată Cave; 12 – Gallery mine no. 2 over Peștera Decolmatată Cave; 13 – cave on the right side of the Dâmbovița Valley; 14 – Tunelul cu Lilioci (mine gallery); 15, 16 – caves over Tunelul cu Lilioci; 17 – Peștera de sub Pietricica Cave; 20, 21 – The caves no 1 and 2 from the left side of the Dâmbovița Valley (Sătic village, AG); 22 – Dracilor Cave; 23 – Dobreștilor Cave; 26 – The Cave from Cheii Valley; 27 – Cave no. 1 from the Great Gorges of the Dâmbovița Valley; 28,29 – Cave no. 2 and 3 from the Great Gorges of the Dâmbovița Valley; 30 – Cave no. 4 from the Great Gorges of the Dâmbovița Valley; 31 (marked with arrow) – Miresii Cave; 33 – Doranca Cave; 34 – Colții Chiliilor Cave; 35 – Mine Gallery no. 2 Zărnești; 36 – Mine Gallery no. Zărnești; 37 – Avenul din Colții Grindului Cave; 38 – The Big Cave from Ulmului Valley; 39, 40 – Caves from Ulmului Valley.



Figure 1. Locations of underground shelters (Map in Google Earth).

Note: Starred markings: shelters where we observed the species *M. myotis/blythii*; thumbtack markings: shelters verified where the species was not observed; arrow markings: possible maternity colony.

CONCLUSIONS

The species *M. myotis* and *M. blythii* were found in nine underground shelters (eight caves and one abandoned mine gallery) from a total of 40 natural and artificial underground shelters checked in the area of Piatra Craiului Mountains. The shelter microclimate measured under bat colonies were between -1.6°C and 9.5°C and between 60.6 % H and 88.4 % H. One of the most important sites of hibernation of *M. myotis/blythii* species group known in Piatra Craiului National Park are now Colțul Surpat Cave and the Mine of Zărnești quarry. The bat effectives inside Colțul Surpat Cave grow in winter; so, it is possible that this cave is an important collector shelter for the entire area between Făgăraș Mountains, Piatra Craiului National Park, Iezer-Păpușa massif, Dâmbovița valley and Rucăr-Bran couloir. The mine gallery is one of the most important hibernacula in Piatra Craiului massif, but unfortunately it is affected by the collapse of the ceiling. We contribute with new data regarding the bat species *M. blythii* in Peștera Decolmatată Cave, *M. myotis* in Vacilor Cave and the species group *M. myotis/blythii* in Arșiței Cave. These species were not mentioned before in these caves. It seems that the rest of the investigated caves do not meet the requirements of microclimate or space.

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