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Bat diversity (Mammalia: Chiroptera) in the Parcani limestone mines

Alina Larion, Victoria Nistreanu, Vladislav Caldari, Natalia Dibolscaia, and Victor Sîtnic

Abstract. The study was conducted in 2023–2024 in various seasons in the limestone mine near Parcani locality. Seven species of bats were recorded: *Rhinolophus hipposideros*, *Myotis blythii*, *Myotis daubentonii*, *Myotis dasycneme*, *Myotis mystacinus*, *Plecotus auritus*, and *Plecotus austriacus*. The structure of the bat community was different depending on the season. The highest number of individuals was registered during the hibernation period, when *M. blythii* was the most abundant species. All species recorded in Parcani mine are protected at national and European level. The Parcani mine is an important hibernation and summer roost for many rare bat species.
Keywords: bats, diversity, hibernation, abundance, Parcani, limestone mine.

Diversitatea liliecilor (Mammalia: Chiroptera) în minele de calcar Parcani

Rezumat. Studiul a fost realizat în perioada 2023–2024, în diferite perioade ale anului, în mina de calcar din apropierea localității Parcani. Au fost înregistrate 7 specii de lilieci: *Rhinolophus hipposideros*, *Myotis blythii*, *Myotis daubentonii*, *Myotis dasycneme*, *Myotis mystacinus*, *Plecotus auritus* și *Plecotus austriacus*. Structura comunității de lilieci era diferită în funcție de sezon. Cel mai mare număr de indivizi a fost înregistrat în perioada de hibernare, când *M. blythii* a fost specia dominantă. Toate speciile înregistrate sunt protejate la nivel național și european. Mina Parcani este un important sit de hibernare și adăpost temporar pentru multe specii rare de lilieci.
Cuvinte-cheie: lilieci, diversitate, hibernare, abundență, Parcani, mină de calcar.

1. Introduction

Bats have certain preferences for ecosystem types, roosts for reproduction and hibernation depending on the species. Abandoned limestone mines are the most important underground shelters for cave bat species in the Republic of Moldova, both for hibernation and reproduction. Research on bat communities in artificial underground shelters began in the 1960s–1970s, especially in the central and northern areas of the republic [18, 21, 22, 23, 24]. As a result of the studies, 11 species of bats that hibernate in

underground shelters were identified, and some data on their ecology during hibernation were presented.

For about 20 years, the study of bats was practically abandoned, and in the mid-1990s, some investigations were continued in underground shelters in the central and northern areas of the republic, mainly in the Dniester River basin [17, 19, 20]. Since 2013, in-depth studies of bat species in previously known underground shelters, as well as in some new sites discovered in the last 10 years, have been carried out [1, 2, 10, 12, 14, 15, 16]. A high diversity and abundance of bats were found in the studied sites, most of them being represented by rare species.

The study and monitoring of bats in abandoned limestone mines is of huge importance for bat conservation, as these sites are the only roosts for cave species in the republic, being similar in microclimatic conditions to natural caves. The aim of the present work was the study of a new site – the Parcani mine – elucidating the diversity of bats in various phenological periods and highlighting the importance of the site in the conservation of bat diversity.

2. Materials and Methods

In the winter of 2023, a new bat roost was found near the village of Parcani, Șoldănești district, located in the northeastern part of the Republic of Moldova. The abandoned limestone mine is situated between the town of Șoldănești and the village of Parcani, in the gorge of the Ciorna River (47.821°N, 28.822°E), in a picturesque landscape, at an altitude of 120–130 m (Fig. 1).

There are several entrances into the limestone slope, and the mines are approximately 1 km long along the bank of the river (Fig. 2). The rocky slopes of the gorge are covered with trees and shrubs, which provide favorable conditions for forest bat species. The mine was excavated mechanically, the ceiling consists of multiple cracks, left over from stone extraction activities, and has a height of 1.5 to 2 m. The air temperature in summer varies between +12°C and +17°C, in winter – from +2.4°C to +8°C, the humidity varies from 60% to 80%, being higher in the cold period. The tunnels are long and parallel up to 300-500 m, all connected to each other by side rooms and tunnels. Inside, on both the right and left sides of the tunnels, there are many stone debris (rubble), fine as sand, occupying approximately half of the space, sometimes even blocking the tunnels. The research was carried out in 2023 – 2024 in different phenological periods: hibernation – 22.02.2023, 14.11.2024, mating – 19.09.2023 and summer – 23.05.2024.

Bats were studied directly by visual observations. Individuals difficult to identify visually were extracted and additional biometric measurements were made: body length

Figure 1. Location of the mine near the village of Parcani.

Figure 2. Several entrances to the Parcani mine.

and weight, tail length, ear and tragus length, forearm length, and identification keys were used [8, 11]. In the case of active individuals, which could not be identified by these methods, the ultrasound detector was used. In the case of compact aggregations of individuals, the numbers per unit area were estimated on site, and the exact count was carried out using photographs taken, by using statistical programs with extrapolation of the collected data [13].

3. Results and Discussions

At the end of February 2023, the end of the hibernation period, 945 individuals of 6 species were recorded: *Rhinolophus hipposideros*, *Myotis blythii*, *M. daubentonii*, *M. dasycneme*, *M. mystacinus* and *Plecotus auritus*. The dominant species was *M. blythii* –

with 84.34% (Fig. 3). The share of other species varied between 1.38% (*P. auritus*) and 7.51% (*M. daubentonii*).

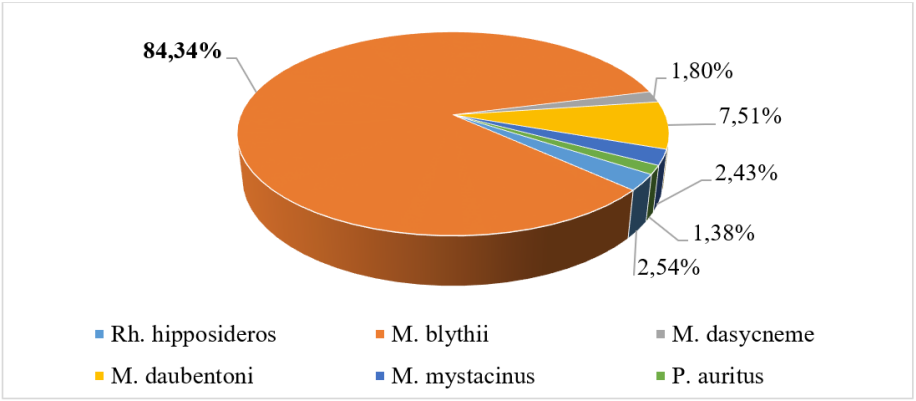

Figure 3. Structure of bat communities at the end of hibernation period.

At the end of September, the mating season, 134 individuals of 7 species were registered: *Rhinolophus hipposideros*, *Myotis blythii*, *M. daubentonii*, *M. dasycneme*, *M. mystacinus*, *Plecotus auritus* and *P. austriacus* (Fig. 4). The highest share was held by the species *M. daubentonii* (49.25%) and *M. blythii* (42.54%). The other species accumulated a lower share: *M. mystacinus* and *M. dasycneme* – 2.24% each, *P. auritus* and *P. austriacus* – 1.5% each and *R. hipposideros* – 0.75%. During this period, the species *P. austriacus* was also recorded.

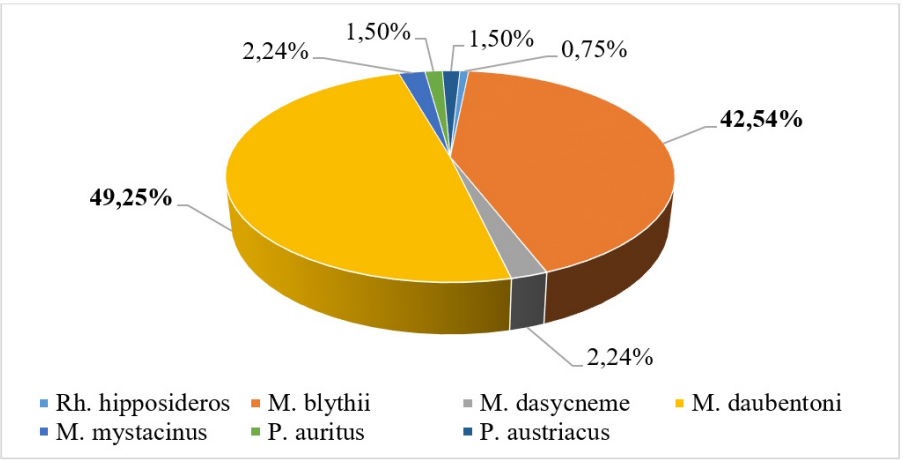

Figure 4. Structure of bat communities during the mating season.

At the end of May, the lowest number of bats was observed – only 49 individuals from 5 species: *Myotis dasycneme*, *M. blythii*, *M. daubentonii*, *M. mystacinus* and *Rhinolophus hipposideros* (Fig. 5). The dominant species was *M. blythii* – with 55.1%, quite numerous were the species *M. daubentonii* – with 20.41% and *M. dasycneme* – 14.29%. *M. mystacinus* had a share of 8.16%, the smallest share belonged to *R. hipposideros* – 2.04%.

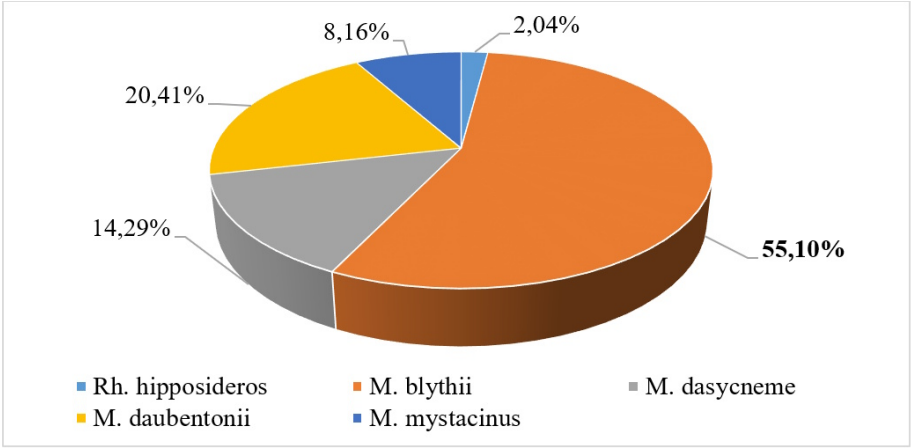

Figure 5. Bat community structure during the summer period.

During the hibernation period, in mid-November, the number of bats increased significantly, with 323 individuals from 6 species being registered: *R. hipposideros*, *M. blythii*, *M. daubentonii*, *M. dasycneme*, *M. mystacinus* and *Plecotus auritus* (Fig. 6). The dominant species was *Myotis blythii* with 62.21%, quite numerous was *R. hipposideros* – 22.3%. *M. daubentonii* had a share of 11.15%, the share of the other species varied between 1.86% (*M. dasycneme*) and 1.24% (*M. mystacinus* and *P. auritus*).

The most abundant species in most phenological periods was *M. blythii*. The lesser mouse-eared bat hibernates in the cracks of the mine ceiling solitary, but more frequently in groups, which ranged from a few dozen to a few hundred individuals (Fig. 7). The number of recorded individuals reached about 800, being the largest hibernation colony of the species among all known underground roosts of the country.

During the study period, 1451 individuals from 7 species were registered, belonging to two families: one species from the Rhinolophidae family – *Rhinolophus hipposideros* (Bechstein, 1800) – lesser horseshoe bat and 6 species from the Vespertilionidae family: *Myotis blythii* (Tomes, 1857) – lesser mouse-eared bat, *Myotis daubentonii* (Kuhl, 1819) – water bat, *Myotis dasycneme* (Boie, 1825) – pond bat, *Myotis mystacinus* (Kuhl, 1819)

– whiskered bat, *Plecotus auritus* (Linnaeus, 1758) – brown long-eared bat and *Plecotus austriacus* (Fischer, 1829) – grey long-eared bat.

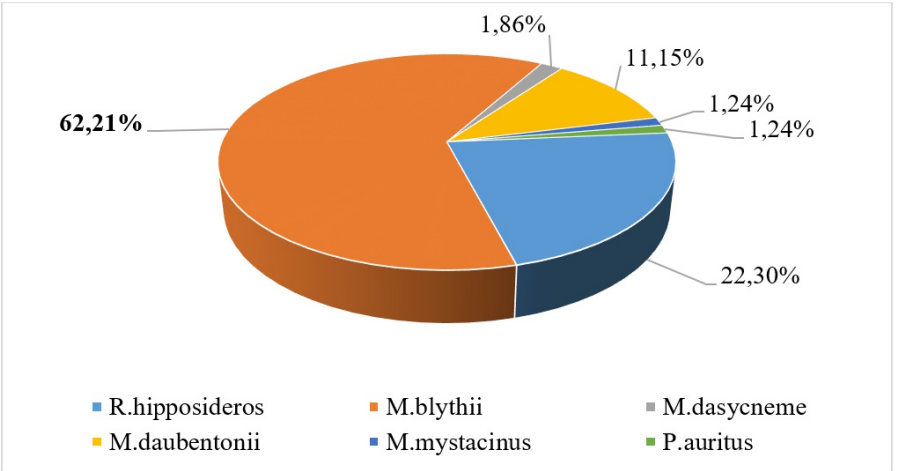

Figure 6. Bat community structure at the beginning of hibernation period.

Figure 7. *Myotis blythii* in hibernation, solitary and group individuals (original).

The structure of the bat community was different depending on the season, because in the summer period the forest species (*M. dasycneme*, *M. mystacinus*, *Plecotus*) leave the hibernation roosts. Thus, their number is very low or they were not recorded at all in the warm season (Fig. 5).

All the species registered in Parcani mine are rare, protected at national and international level (Tab. 1). All species are listed in the Red Book of the Republic of Moldova [3]. In neighboring countries – in the Red Book of Vertebrates of Romania [4] and in the Red Book of Ukraine [24] all bat species registered with different rarity status are included. All species are included in Appendix II of the Bern Convention (strictly protected species)

[5], in Appendix II of the Convention on the Conservation of Migratory Species [6] and in the Agreement on the Conservation of Populations of Bats in Europe (EUROBATS) [7].

In the IUCN Red List, the species *Myotis blythii* and *Myotis dasycneme* are vulnerable species in Europe, and *Plecotus austriacus* is near threatened (NT) globally, the other species being of least concern (LC) [9].

Table 1. Protection status of bat species from the Parcani site

Nr	Species	RBM	RBVR	RBU	Bern Convention	CSM
1.	*Rhinolophus hipposideros*	EN	VU	vulnerable	Appendix II	Appendix II
2.	*Myotis blythii*	VU	EN	vulnerable	Appendix II	Appendix II
3.	*M. mystacinus*	EN	EN	vulnerable	Appendix II	Appendix II
4.	*M. daubentoni*	VU	CR	vulnerable	Appendix II	Appendix II
5.	*M. dasycneme*	EN	CR	endangered	Appendix II	Appendix II
6.	*Plecotus auritus*	EN	VU	vulnerable	Appendix II	Appendix II
7.	*P. austriacus*	VU	EN	rare	Appendix II	Appendix II

Note: CRM – Red Book of the Republic of Moldova; CRVC – Red Book of Vertebrates from Romania; CRU –Red Book of Ukraine; CSM – Convention on the Conservation of Migratory Species; VU – vulnerable species; EN – endangered, CR – critically endangered

Thus, the Parcani mine represents an important hibernation roost for many species of bats, especially for *M. blythii*, which was recorded in the highest number of all the limestone mines studied. During the summer, the mines serve as temporary shelter for many rare species.

4. Conclusions

In the Parcani site, a rather high diversity was found, with 7 bat species recorded: *Rhinolophus hipposideros*, *Myotis blythii*, *Myotis daubentonii*, *Myotis dasycneme*, *Myotis mystacinus*, *Plecotus auritus*, and *Plecotus austriacus*.

The structure of the bat community was different depending on the season. The largest number of individuals was recorded during the hibernation period. During the hibernation period, the largest share belonged to *M. blythii* (62% - 84%), followed by *R. hipposideros* with over 20%. During the summer period, *M. blythii* (55%) was also dominant, followed

by *M. daubentonii* (20.41%) and *M. dasycneme* (14.29%). In the mating period, the dominant species were *M. daubentonii* (49.25%) and *M. blythii* (42.54%).

The Parcani mine is an important hibernation roost for many species of bats, especially *M. blythii*. All species recorded in the Parcani mine are protected at national and European level.

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(Alina Larion, Victoria Nistreanu, Vladislav Caldari, Natalia Dibolscaia) Institute of Zoology, Moldova State University
E-mail address: alina.larion@sti.usm.md, victoria.nistreanu@sti.usm.md, vladislav.caldari@sti.usm.md, natalia.dibolscaia@sti.usm.md

(Victor Sîtnic) Institute of Zoology, Moldova State University, National Agency for Public Health
E-mail address: victor.sitnic@sti.usm.md