DISTRIBUTION AND DIVERSITY OF BATS' SPECIES FROM POLOVRAGI CAVE (CĂPĂȚÂNII MOUNTAINS, ROMANIA) AND SOME REMARKS ON THE MICROCLIMATIC CONDITIONS OF HIBERNATION

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Abstract. *The Polovragi cave is an important site for the presence of bat species in the south-western part of Romania, included in the National Monitoring Programme in 2002. We describe the bat colonies from this cave, one of them for the first time in literature. The study was conducted between 2002 and 2009 and we compared our observations with the old data from literature. This cave is also a tourist site, being protected by two caretakers. The first part of the cave has a tourist management implemented by the Gorj County Museum. One of the bat colonies lives in this part of the cave; the second bat colony is present in the second part of the cave that is natural and it is in the custody of the Speleological Association "Focul Viu" – Bucharest. We describe new species for this cave forming the second bat colony. We estimate the colonies size. We give ecological and behavioural observations viewing these two distinct parts of the cave.*

Keywords: *bats, species, colonies, conservation.*

Rezumat. Distribuția şi diversitatea speciilor de lilieci (Ord. Chiroptera) din Peştera Polovragi (Munții Căpățânii, România) şi câteva aspecte asupra condițiilor microclimatice din timpul hibernării. *Peştera Polovragi este un sit important pentru lilieci, mai ales pentru partea de SV a României, care a fost inclusă în programul național de monitorizare în anul 2002. Descriem coloniile de lilieci din această peşteră, una din ele pentru prima dată în literatură. Studiile au fost făcute între anii 2002-2009 şi am comparat observațiile noastre cu cele existente în bibliografie. De asemenea, am urmărit aspectele ecologice şi etologice ale chiropterelor, precum şi cele legate de habitatul de hibernare.*

Cuvinte cheie: *lilieci, specii, colonie, conservare.*

INTRODUCTION

Polovragi Cave is situated in Gorj County, at 1.2 kilometres from Polovragi village. In the system UTM, it is GR20. In terms of geographic location, the cave is situated in Capățânii Mountains, on the left side of the Olteț Gorges, at about 200 m from the entrance of the gorges downstream, at an altitude of 650 m.

Polovragi Cave was declared Natural Reserve by the Government of Romania by Law 5/2000 concerning the approval of the national territory arrangement plan - Section III - protected areas, according to which it is part of the "protected natural areas of national interest." It is classified according to Law 462 as a natural reserve, IUCN category IV, Class B.

The cave presently has a development of 10,350 m and a level oscillation of 90 m (-62, +28); it is a fossil meander of the Olteț river, probably dug in upper Quaternary in the same time with the formation of the 20-25 m terrace upstream and downstream of the Olteț gorges. It is a large cave formed of a main gallery oriented NW-SE, with many lateral ramifications where three sectors can be distinguished: south-eastern sector, which begins with "The downstream entrance", approximately 10 m wide and 2-8 m high and hosts in the Touristic Gallery; the central and north-western sectors with galleries and halls. The cave has two openings: the main one, downstream "Downstream Entry" of 8/8 m and another one upstream "Upstream Entry" (Fig. 1).

Although the first chiropterological reports in Oltenia area appear in the work of MEHELY, 1900, this draws the attention of the specialists from the "Emil Racoviță" Institute of Speleology in 1950. In the reference paper belonging to DUMITRESCU et al., 1963 "Răspândirea chiropterelor în R.P. Română", there is rendered information about the area, but only from a cave near Polovragi, Muierii Cave from Baia de Fier. The first chiropterological reports from Polovragi cave are made by BAZILESCU, 1974 who signals the species *Rhinolophus ferrumequinum* (SCHREBER, 1774) and in 1982, for the first and last time the species *Pipistrellus pipistrellus* (SCHREBER, 1774), (BAZILESCU, 1982).

The cave gets back in the chiropterologists' attention in 2001, when *Rhinolophus hipposideros* (BECHSTEIN 1800) species is mentioned in the work "Contribution to the knowledge of Chiroptera Distribution from the Romanian sector of the Carpathian Mountains" (GHEORGHIU et al., 2001).

In 2002, occasional visits within the framework of the research projects "Survey of Romania's underground bat habitats (Status and distribution of cave dwelling bats) 2002-2004", NAGY et al. (2003), reconfirms the existence of *Rhinolophus ferrumequinum* species in the Tourist Gallery.

In the absence of a comprehensive study of chiropters found in the Polovragi cave, in 2002, Focul Viu Speleological Association begins systematic visits to monitor bats throughout the whole cave, both Tourist Gallery and the galleries and halls upstream. In the visits conducted until 2009 throughout the year, there have been made detailed comments on the specific composition of the existing colonies, it has been followed the bats' dynamics during hibernation in the cave galleries and there have been made measurements of microclimatic factors.

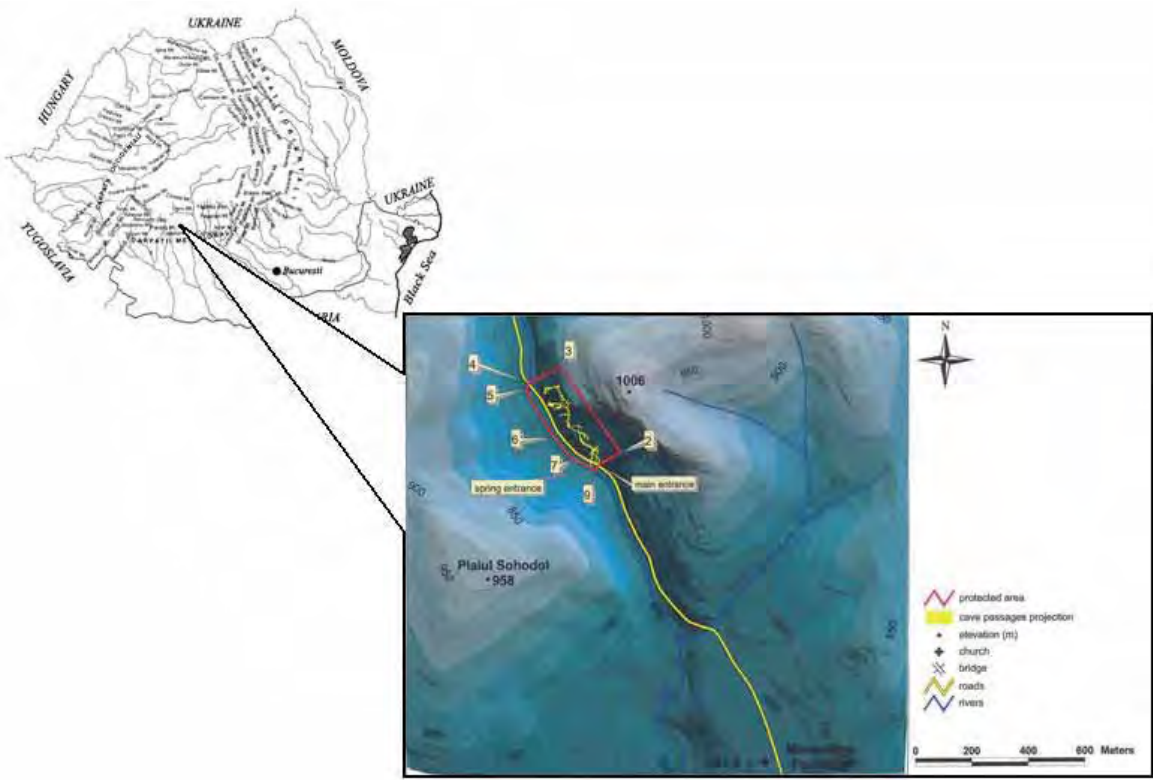

Figure 1. The location of the cave.
Figura 1. Localizarea peşterii.

MATERIAL AND METHODS

The materials used in the field were a thermo-hygrometer and a photo camera. Species were determined using identification keys (VALENCIUC, 2002; MURARIU et al., 2003) and morphometrical measurements.

The cave was divided into seven sectors from the downstream to the upstream entry to make observations in fixed points, as it follows: 1. Tourist Gallery, 2. Downstream access Gallery, 3. Gour's Hall, 4. Wonder Room, 5. Gallery 27, 6. Great Hall, 7. Upstream Access Gallery (Fig. 4). As we studied colonies of bats during hibernation, this was done with minimal trouble, and only a few specimens were handled.

This paper presents information obtained between 2002 and 2009, on the occasion of the 11 field trips: the 30th of November 2002, the 1st of March 2003, the 12th of March 2004, the 1st of May 2004, the 30th of October 2004, the 30th of November 2004, the 12th of March 2005, the 1st of December 2007, the 26th of January 2008, the 1st of February 2009, the 1st of March 2009.

RESULTS AND DISCUSIONS

Specific composition and population estimates. The cave has three colonies of bats, differentiated both from an ecological point of view and by their position in the habitat: two colonies for hibernation and one colony of birth.

The colonies are mixed, consisting of the following species: *Myotis myotis* (BORKHAUSEN 1797), *M. blythii* (TOMES 1857), *M. emarginatus* (GEOFFROY SAINT-HILAIRE 1806), *M. bechsteinii* (KUHL 1817), *Rhinolophus ferrumequinum* and *R. hipposideros* (Fig. 3).

The first colony is located in the visitable sector, Tourist Gallery. We observed the largest number of bats on the 12th of March 2005, 380 individuals (Fig. 6). The dominant species in this sector is *Rhinolophus ferrumequinum*. Species are found both in the form of colony, small groups of individuals, but also isolated specimens of *Myotis myotis* / *Myotis blythii* and *Rhinolophus hipposideros*. They are found on the ceiling at heights varying between 2 and 8 m.

The second colony is situated in the protected upstream sector - in the area called by us Gour's's Hall, because of this speleothem, with a diameter of 1m. This includes 155 individuals observed on the 26th of January 2008 belonging to the species *Myotis myotis* / *M. blythii* and is located on the ceiling at a height of 4 m (Fig. 5). The colony is not mentioned in literature, because that part of the cave was not discovered when the research was done in the 50`s, and according to the discussions with the present experts, who visited the cave, no one knows this gallery, found after the 70`s. The colony is more sensitive to human presence; individuals react very quickly to stress factors, compared with the colony from the Tourist Gallery, which hibernates under reflectors and in the middle of tourist path.

On the rest of sectors, such as Downstream Access Gallery, Wonder Room, Gallery 27, Great Hall, Upstream Access Gallery, there were found isolated specimens of *Rhinolophus hipposideros* and *R. ferrumequinum*. Only in the Great Hall, *Myotis myotis* is encountered, the species preferring wide spaces. Their number does not exceed 10 individuals (the 1st of March 2009) (Fig. 2).

The third colony, the nursery one, is situated in the Bat Gallery, near the "Downstream entry". We avoided visiting this gallery, because the stress of the visits endangers too much the life of the new born bat babies.

The new species listed during this study are: *Myotis bechsteinii* (det. Oana Chachula / the 30th of November 2002) and *M. emarginatus* (det. Oana Chachula & Victor Gheorghiu / the 30th of November 2004). So, for *M. bechsteinii*, male specimen, we considered it necessary to take some biometric data as forearm length (La) = 61.42 mm, ear length (Lu) = 20.11 mm, and for *M. emarginatus*, male specimen, the length of the forearm (At) = 37.29 mm, ear length (Lu) = 12.95 mm. Both species were found on the Tourist Gallery and Downstream Access Gallery.

The fewest individuals were noticed on the 1st of May 2004, when the outside temperature already exceeded 20ºC and along the entire length of the cave we encountered a maximum of 10 isolated individuals or groups of 2-3 individuals.

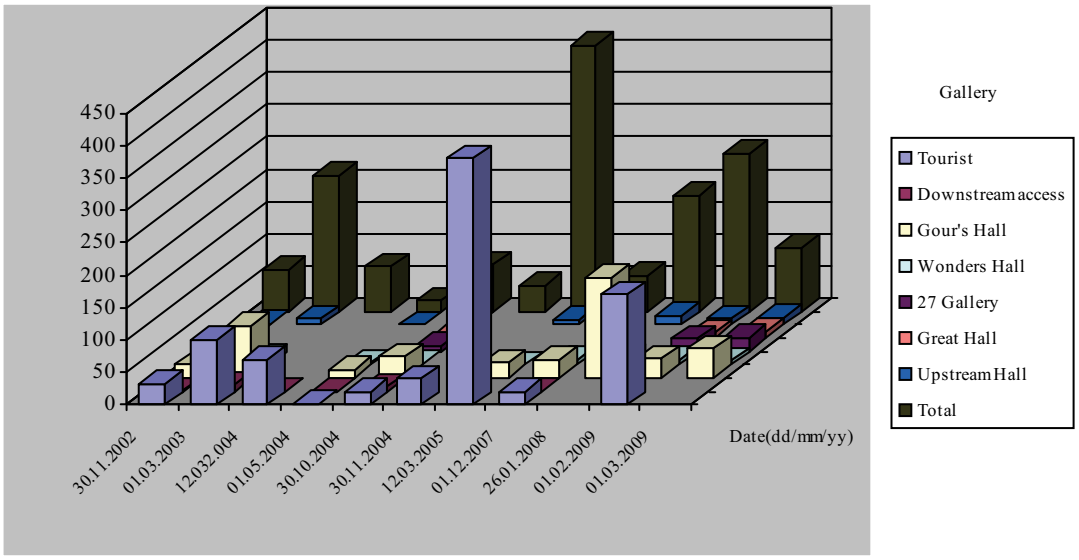

Figure 2. Seasonal dynamics of Chiroptera inside Polovragi cave between 2002 and 2009.
Figura 2. Dinamica sezonieră a chiropterelor pe sectoarele peşterii Polovragi între 2002-2009.

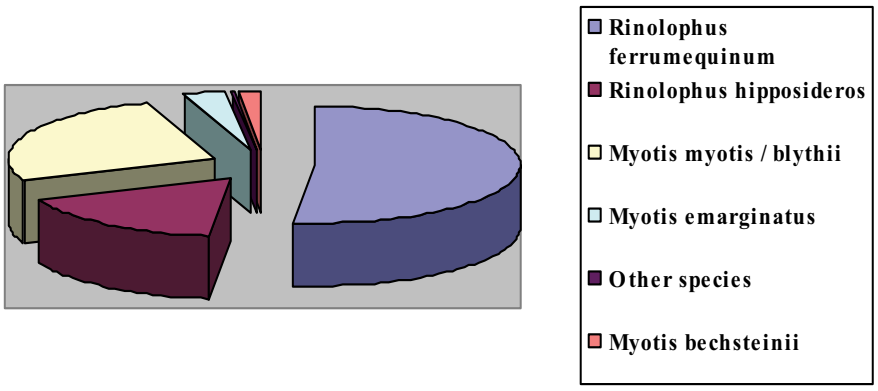

Figure 3. The specific composition of the hibernation colony from Polovragi cave.
Figura 3. Compoziţia specifică a coloniei de hibernare din Peştera Polovragi.

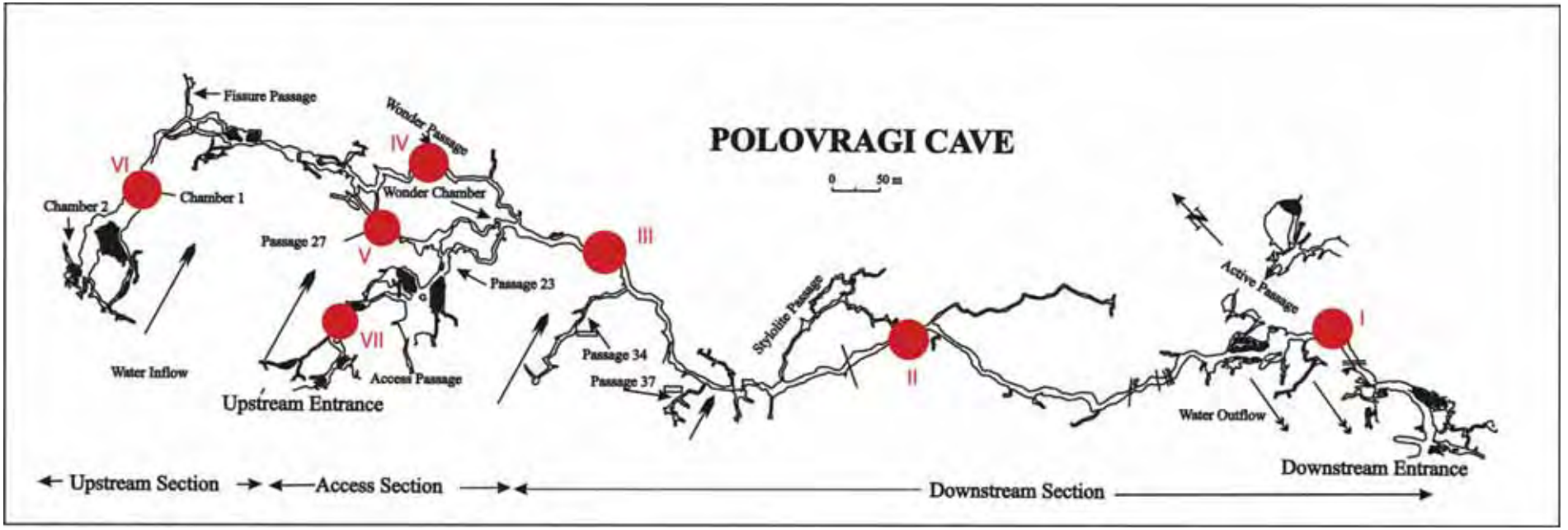

Figure 4. The map of the cave and representation of the observation points
(mapped by Focul Viu Speleological Association).
Figura 4. Harta peșterii cu reprezentările locurilor de observații
(cartare de Asociația speologică Focul Viu).

Legend:
1. Tourist gallery
2. Downstream access gallery
3. Gour's Hall
4. Wonders' Hall
5. Gallery 27
6. Great Hall
7. Upstream access gallery

Legendă:
1. Galeria turistică 2. Galeria de acces aval
3. Sala Gurului 4. Sala Minunilor
5. Galeria 27 6. Sala Mare
7. Galeria de acces amonte

Aspects of the cave microclimate and the influence on chiropters. The values from the access galleries and the relative humidity are influenced by the outside temperature fluctuations. Air temperature in Gour's Hall, where the second colony is situated, and in other deep areas of the cave, remains constant around 8°C in all periods. The highest temperature in the cave is registered in the Great Hall, where it reaches 9.2°C (the 1st of March 2009). Moreover, in these areas, the relative air humidity is almost 100%. As temperature increases outside during the spring months, fewer bats are found in the galleries of the cave; they wake up from the state of hibernation and leave the shelter. The majority is found in deep areas of the cave, the largest groups being observed here. Meanwhile, solitary individuals, mostly belonging to the species *Rhinolophus hipposideros* were encountered even at low temperatures of 2°C of the vestibular areas. Dynamics of the total number of Chiroptera and changes in the specific composition are, apparently, closely related to changes in the environmental temperature, and fluctuations in the number of bats from one year to another, is a natural phenomenon.

Table 1. The values of air temperature and relative humidity inside the cave during the study.
Tabel 1.Valorile temperaturii şi umidităţii relative a aerului din peşteră pe perioada studiului.

Date	T°C/U outside	T°C/U Tourist Gallery	T°C/U Downstream access Gallery	T°C/U Gour's's's Hall	T°C/U Gallery 27	T°C/U Great Hall
October 10, 2004	19.9°/ 63%	8.1°/ 95%	9.5°	7.9°	-	8.4°/92%
November 30, 2004	7°/ 59%	8°/ 90%	-	-	-	-
March 12, 2005	2.5°/ 69%	-	-	8.5°	-	-
December 1, 2007	3.6°/ 57%	-	3°(vestib.)/ 67%	-	-	-
January 26, 2008	-2°	-	7.6°	-	-	-
March 1, 2009	4,2°	-	6.1°	8.7°	8.9°	9.2°

Conservation and protection of the bats from Polovragi cave. To ensure effective protection, the buffer area of Polovragi Cave Speleology Reserve is represented by the upstream entrance in the cavity from the Olteţ gorges and the final electrified segment of Tourist Gallery.

Internal zoning is a function of the need of speleogenetic resource conservation, protecting wildlife and tourism activities, namely cave tourism:

• Area I, Protection and conservation: all galleries with public access, the access being made through the downstream entry, only with the cave guide, employed by the Gorj County Museum, the custodian of the visitable part of the cave, called Tourist Reserve.
• Area II, Speleological Reserve, Ecotourist route: Tourist Gallery, Main Gallery, Upstream Entry. The following activities are permitted: wildlife protection, speleogenetic conservation, scientific research, training, cave tourism.
• Area III, Speleological Reserve, Speleological tourist route: Sectors of galleries from the entrance in Wonder Gallery / Gallery 27 and the end of the cavity. "Crocodile" segment from Tourist Gallery to Hall Lake. The following activities are permitted: wildlife protection, speleogenetic conservation, scientific research, speleological education.

In the table below, we render the conservation status of the species present on this site, both European and national (TEMPLE & TERRY, 2007; MURARIU et al., 2005).

Table 2.The conservation status of the bat species recorded in Polovragi cave.
Tabel 2. Statutul de conservare a speciilor de lilieci existente în Peştera Polovragi.

No.	Species	Bern Convention	Bonn Convention	Red Book Romania	Eurobats	Habitats Directive
1.	*Myotis myotis*	Annex 3	Annex 2	T	+	Annex 2 & 4
2.	*Myotis blythii*	Annex 3	Annex 2	T	+	Annex 2 & 4
3.	*Myotis emarginatus*	Annex 3	Annex 2	T	+	Annex 2 & 4
4.	*Myotis bechsteinii*	Annex 3	Annex 2	T	+	Annex 2 & 4
5.	*Rhinolophus ferrumequinum*	Annex 2	Annex 2	V	+	Annex 2 & 4
6.	*Rhinolophus hipposideros*	Annex 2	Annex 2	V	+	Annex 2 & 4

Legend: T – threatened species; V – vulnerable species.
Legendă: T – specie ameninţată; V – specie vulnerabilă.

We observe that the all recorded bat species appear in the Annex II of the Bonn Convention (migratory species with poor conservation status in the European region), in the Annexes 2 and 3 of the Bern Convention (strictly protected and protect bat species in Europe) and in the Eurobats Agreement (London, 1991, till now, being adopted by 30 countries) that follows to develop and implement an integrate common strategy in order to preserve the diversity of the European bat species.

All the bat species identified in this site appear in the Habitats Directive, too - in the Annex 2, like species of community interest for which it is necessary to appoint special conservation areas and all in the Annex 4, being strictly protected species in the European Union.

In time, we tried to do wherever possible – to hold education campaigns, to increase the visitors' awareness-level through informative panels and presentations made locally and to protect the cave and its fauna by gates. For this purpose, three metal gates were installed by Focul Viu Speleological Association, one located between the Tourist Gallery and Downstream Access Gallery, one at the Upstream entry (Fig. 7) and the other one on the Upstream access Gallery (Fig. 8). Polovragi cave provides such important information on the spread of bats in the area, as well as of rare species of national importance.

Figure 5. *Myotis myotis* colony.
Figura 5. Colonie de *Myotis myotis.*

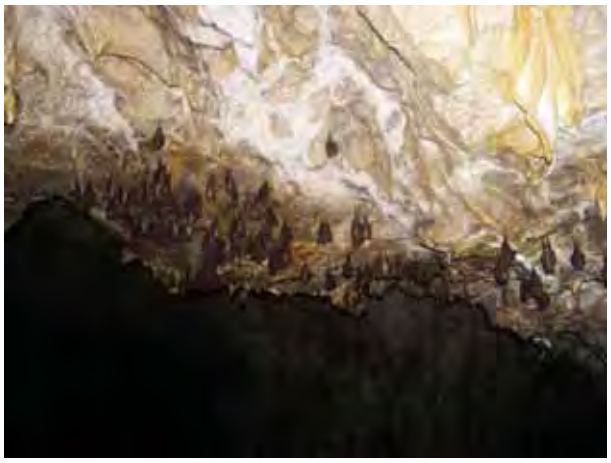

Figure 6. *Rhinolophus ferrumequinum* colony.
Figura 6. Colonie de *Rhinolophus ferrumequinum.*

Figure 7. Upstream entry.
Figura 7. Intrarea amonte.

Figure 8. Gate III on Upstream access Gallery.
Figura 8. Poarta III pe Galeria de acces amonte.

CONCLUSIONS

We achieved an eight year study in order to monitor the number of bats, to observe the ecological aspects of the population and the habitat during hibernation. Thus, we estimated the total number to approximately 700 bats, divided into two distinct colonies. They are located in different areas of the cave, one unknown by the specialists till now. Six species are found, among which we mention *Myotis bechsteinii*, *M. emarginatus* (new housing).

All bat species recorded in Polovragi cave are included in the Romanian Red Book of Vertebrates, being threatened species (the national effectives are estimated at about no more than 2,000 individuals) or vulnerable species (the national effectives are about 3,000 individuals maximum).

Starting with 2008, the Gorj County Museum closed the cave for tourist visits during bat hibernation, more specifically during December, January and February.

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