SEASONAL DYNAMICS OF BAT FAUNA IN COMARNIC CAVE, ROMANIA

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Abstract. Our study aimed to provide information about the population of bats present in Comarnic Cave, Romania about which little information was previously known. We found an important hibernating colony of *Rhinolophus ferrumequinum*, which is the dominating species in terms of numbers, as well as other five species, of which three were accidental and two were constant in the population (*Myotis myotis/oxygnathus* and *Rhinolophus hipposideros*). We measured microclimate parameters (air temperature, rock temperature and relative humidity) and evaluated site preferences in relation to them. For an easier analysis we used GIS, which allowed us to graphically interpret population data.

Keywords: bats, Comarnic Cave, hibernacula, Romania.

Rezumat. Dinamica sezonieră a faunei de lilieci din Peștera Comarnic, România. Studiul nostru a intenționat să furnizeze informații privind populația de chiroptere prezentă în Peștera Comarnic, România, despre care se cunoșteau foarte puține informații. Am identificat o colonie importantă de *Rhinolophus ferrumequinum*, specie dominantă din punct de vedere al efectivelor, precum și alte cinci specii din care trei au fost întâlnite accidental, iar două în mod constant (*Myotis myotis/oxygnathus* și *Rhinolophus hipposideros*). Am măsurat parametrii microclimatului și am evaluat preferințele chiropterelor în relație cu aceștia. Pentru o analiză mai simplă am folosit GIS, care ne-a permis să evaluăm grafic datele privind populația.

Cuvinte cheie: lilieci, Peștera Comarnic, hibernacul, România.

INTRODUCTION

The present study has been conducted in Comarnic Cave, situated in southwestern Romania, Caraş – Severin County, Banat area. The cave is part of The Semenic – Cheile Caraşului National Park and is a natural reservation, IUCN category IV, class B. It is one of the largest natural cavities in southwestern Romania, with a total length of 6,201m and an unevenness of -101m. The cave has seven entrances and is structured on three levels: fossil, subfossil and active. Tourist activity is known to be happening for at least 100 years. Presently, the cave is open to guided tours, for a length of 1,750m (BLEAHU et al., 1976; GORAN et. al., 1982) (Fig. 1). The touristic impact on the cave and the fauna is minimal due to the very small number of tourists every year and the minimum modifications brought to the cave, which are limited to a few ropes for tourists to grab onto and stairs which are dug into clay.

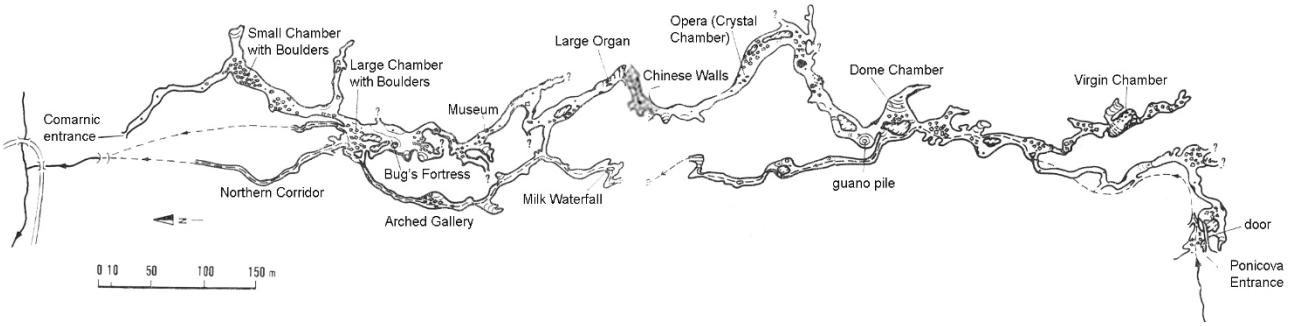

Figure 1. Comarnic Cave map (after Bleahu et al., 1976, modified).

The climate in the area is a moderate, temperate-continental, Banat subtype with sub-Mediterranean influences. This type of climate is characterized by annual precipitations which are higher than the national average, frequent warm periods during winter and early springs. The cave climate is characterized by a unidirectional ventilation, with air temperatures of 3 to 10°C, water temperatures of 2 to 9°C and soil temperatures of 0.2 to 9°C. Relative humidity varies between 75 and 100%, depending on the level of rainfall and the functioning of the hydrogeological system.

Even though it is one of the largest caves in southwestern Romania and certainly the most accessible large cave, there is scarce data regarding bat fauna and no study dedicated to the way the cave is being occupied by bats. DUMITRESCU et al. (1963) mentions the presence of isolated *Rhinolophus hipposideros* in June 1952, without giving information about the number of individuals. NEGREA & NEGREA (1971) have a study on the guano synusia in the Banat area, which includes Comarnic Cave and provide us with multiple observations over a period of eight years. In July 1961, they mention individuals of *Rhinolophus ferrumequinum* and in October 1961, a colony of 500 *R. ferrumequinum*, isolated individuals of the same species and also *R. hipposideros* and *Myotis oxygnathus*. Observations in July 1963 showed isolated individuals of *Myotis myotis*. No numeric data is presented for any of these observations. In September 1965, a group of 20 *R. ferrumequinum* is recorded and in June 1968 no bats are found. Data for October 1969 show the presence of a colony of 200 *R. ferrumequinum*.

NEGREA & NEGREA (1983) give us the location for the colony observed in 1961 and 1969, which is Sala Domului (Dome Chamber). The presence of colonies in the past in the Dome Chamber was confirmed by cavers. The four species are also referenced in a review upon bat fauna of the Romanian Carpathians (GHEORGHIU et al., 2001). A study upon the mammals from the south-western part of Romania (including Semenic – Caraşului Gorges National Park) identifies 17 bat species (MURARIU, 2002), of which 4 species were found by us in Comarnic Cave. The size and multiannual stability of *R. ferrumequinum* colonies offer this cave the possibility of introduction in EUROBATS management and protection programs (HUTSON et al., 2015; MITCHELL-JONES et al., 2007).

MATERIAL AND METHODS

The study was conducted from December 2006 to December 2007, period over which six observation visits were made to the cave, in order to evaluate the status as a bat shelter, species and individual numbers, and also microhabitat conditions, which determine inhabitancy of the cave. We chose to include two hibernation periods because from the previous data it was clear that Comarnic Cave is primarily a hibernacula for *R. ferrumequinum.* In the case of the two sibling species, *M. myotis* and *M. oxygnathus*, when observations were made without capturing the individuals, they were treated as a group in order to avoid confusions, which may arise from their similar morphological characters (we will generically name *M. myotis*). Individuals in colonies were counted directly and not estimated, because the topology of the cave and the disposition of the colonies permitted it. The identification key used was SCHOBER & GRIMMBERGER (1993) and DIETZ & HELVERSEN (2004).

An anemometer was used in order to measure air currents, but no air currents were found to pass 1m/s, which was the minimum measurable value. Air temperature, rock temperature and relative humidity measurements were made in 17 station points chosen inside the cave and one outside the cave entrance for reference. During the first two visits, air and rock temperatures were taken using a digital Cole Parmer probe thermometer (Digi-Sense). Air temperatures and relative humidity measurements were taken during the next four visits, using a digital thermohygrometer (TFA-HygroLogger). During two visits, minimum-maximum thermometers were place in the vicinity of the identified colonies, in order to investigate temperature variations over a longer period of time.

In order to evaluate the microclimate parameters and correlations with the occupancy observations made we developed a method of graphical data interpretation by using a Geographical Information System. We created a georeferenced digital map of the cave starting from the map published in GORAN (1982). The advantage of this method is that data can be introduced graphically as points, but each point has a database behind it and based on that it can be illustrated in different shapes, sizes and colours. By clicking on a data point the information behind it can be quickly accessed. We created separate layers for each observation period and for bat observations and measurements.

RESULTS

During the study period we have identified a total of six species (Table 1), of which only three had a constant presence. The dominating species in terms of individual numbers is *R. ferrumequinum*, which forms large hibernating colonies. The other two species with a constant presence in Comarnic Cave are *M. myotis* and *R. hipposideros.*

Table 1. Bat species in Comarnic Cave (only during winter period).

No.	Species	Mean (min. - max.) number of individuals	Period of counting
1	*Rhinolophus ferrumequinum* Schreber	264 (123 – 477)	01.12.2006 – 27.12.2007
2	*R. hipposideros* Bechstein	10 (2 – 23)	01.12.2006 – 27.12.2007
3	*Myotis myotis* Borkhausen	44 (13 – 86)	01.12.2006 – 27.12.2007
4	*M. dasycneme* Boie	2	31.12.2006
5	*M. daubentonii* Kuhl	1	21.02.2007
6	*Plecotus austriacus* Fischer	1	21.02.2007

The first observations (December 1, 2006) were done in the context of higher than average outside temperatures for this time of the year (4.9°C – Fig. 2). Therefore, the bats were still found in the period of pre-hibernation cave colonization. Individuals were still active with the presence of isolated individuals, small groups and also a colony of 194 *R. ferrumequinum* found at the "Bug's Fortress" area (about 480m from the main entrance to the cave) in the fossil area of the cave. The distribution was not compact, with individuals forming small groups of 10-20 bats, situated 30-40cm from each other. A minimum-maximum thermometer was placed in the vicinity of the colony and was retrieved on February 21, 2007. The temperature variation for this entire period was only 0.2°C.

The next observations (December 31, 2006) found the hibernating colony of *R. ferrumequinum* in a different place, at the intersection of the Arched Gallery and the Northern Corridor, just at the start of the active sector of the cave. Outside temperatures had fallen below 0°C (Table 2) and there was a layer of snow. The colony contained only 174 *R. ferrumequinum* individuals, which formed a single group, most of which had entered torpor and were wrapped in their patagium. The overall number of bats found in the cave was higher, but we found a smaller number of *R. ferrumequinum* than at the previous visit,

but a higher number of *M. myotis* and *R. hipposideros* (Fig. 3), as well as two *M. dasycneme* individuals. A minimum-maximum thermometer was placed close to the hibernating colony and was later picked up on February 21, 2007. The temperature variation recorded over this short period was 1.1°C, higher than the one recorded at the previous colony site. This could show that temperature stability may not be as important in choosing a hibernation site as other factors, such as relative humidity, which should be higher in this active part of the cave.

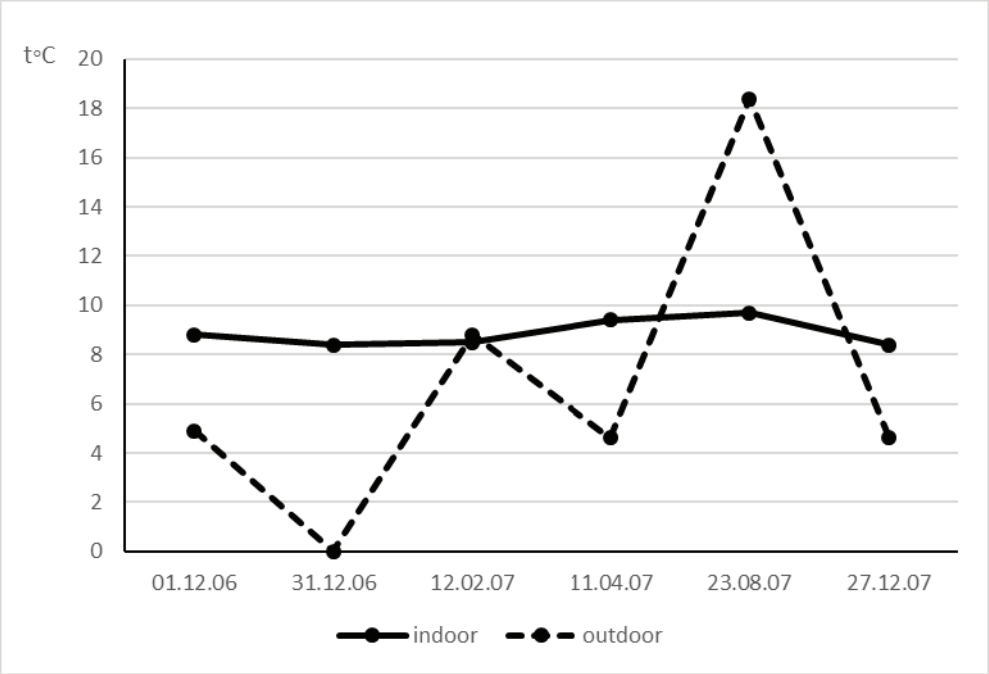

Figure 2. Temperature dynamics indoor and outdoor at Comarnic Cave.

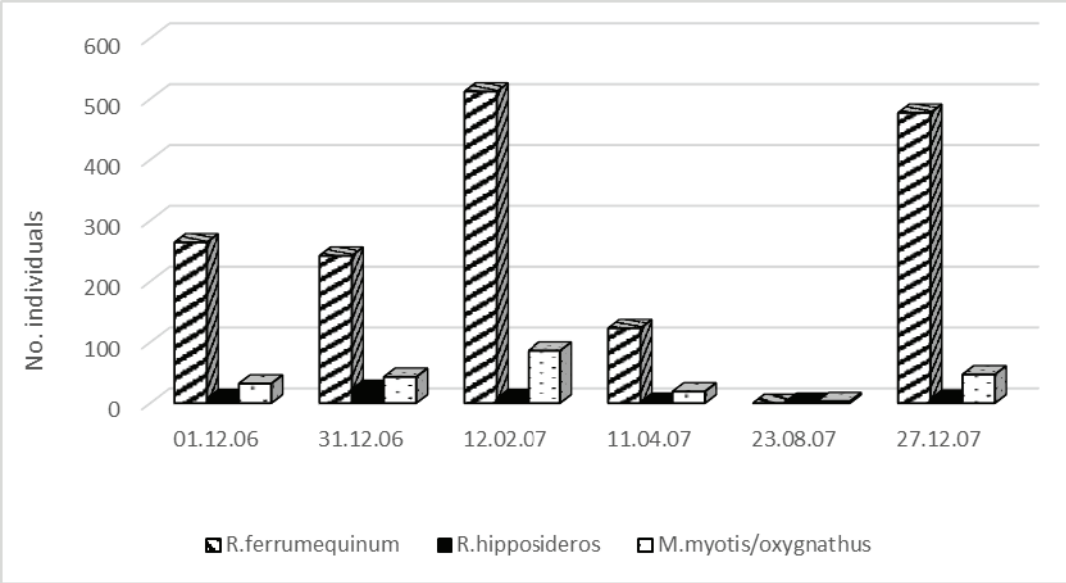

Figure 3. The number of bat individuals for the main three species identified in the colonies.

The third observations, on February 12, 2007, were done in the conditions of an early spring, with an outside temperature of 8.8°C and visible insect activity. We found a much larger hibernating colony of *R. ferrumequinum*, with a total number of 482 individuals. The colony was loosely distributed in small groups and had moved about 20m compared to the site they were found before. They had exited torpor and were slightly active. Most other bat species were found in the northern quarter of the cave, closer to the main entrance than previously, suggesting they were preparing to leave the cave. The number of *M. myotis* was higher than previously and *R. hipposideros* was lower (Fig. 3).

A very small number of bats that had not left the cave yet was found on April 11, 2007 (Fig. 3), but all signs pointed that they were preparing to leave. Outside temperatures were lower than the average for this period (Fig. 2). Most bats were found 150-200m to the main entrance of the cave. At this point it is safe to say that this is the preferred access way into the cave. We found a colony of 114 active *R. ferrumequinum* in the Small Chamber with Boulders, 150m from the entrance.

In the summer observations (August 23, 2007), there were identified only three individuals, one *M. myotis* and two *R. hipposideros*. We also had an unplanned trip to the cave on July 27, 2007, time at which we did not identify any individuals present. Even though the cave is not used as a nursery, it is possibly used as an autumn temporary shelter.

Observations on December 27, 2007 were done in the conditions of a much earlier winter than the previous year, with ice formations present for the first 50m of the cave. Due to this, the total number of observed individuals was a lot higher than the previous year, with a total of 531 recorded individuals (Table 3). What is most interesting is that there was a colony of 461 *R. ferrumequinum* and 23 *M. myotis* in the same point they were found in April 2007; The Small Chamber with Boulders, in an area strongly influenced by outside temperatures. The air temperature measured only a few meters away from the colony was only 4.6°C, very unusual for hibernating *R. ferrumequinum.* It is possible that due to collective thermoregulation the temperature inside the colony was higher. The bats had entered torpor and no individuals were active. The distribution of the colony was in four larger compact groups, surrounded by smaller compact groups and groups of 2-5 individuals of *M. myotis.* Until this time there is no record (written or oral) of a hibernating colony found so close to the main cave entrance. Most of the individuals were located in this area with only 30 other individuals scattered throughout the cave.

DISCUSSIONS

We have observed a lack of fidelity when it comes to the site of the hibernating colonies, with a tendency over the years for the colony to be sited in the more northern areas. NEGREA & NEGREA (1971) place the colony at the Dome Chamber, in the southern sector of the cave. In the same place, a hibernating colony was observed in 2004, while in 2005, there was no hibernating colony present (personal, unpublished observations). It is possible that changes in microclimate have taken place inside the cave, since in 2004 a new gate was placed, which reduced airflow, due to a solid area, with bars only on top, to allow bat access, while the previous gate was completely made of bars. CURRIE (2000) showed that placing gates, even bat-friendly ones can lead to the abandonment of shelters, because of the way they can drastically change microclimate.

By graphically overlapping all layers of information available for the study period, using ArcView, we have observed a clear preference for bat inhabitation of the first northern quarter of the cave, with most observations made in this area and also most of the population concentrated in it. This area is also most influenced by outside temperature. It is possible that this area offers the most advantageous microclimate conditions for hibernation, while also providing waking bats to evaluate outside conditions. Since we believe there has been a reduction in airflow in this area, it is possible that due to lower evaporation, good hibernating conditions have been created here (RANSOME, 1990).

Using the data collected on December 1, 2006 and December 31, 2006, we tried to see if there is a linear correlation between air temperature, rock temperature and the number of *R. ferrumequinum* by using the Pearson product-moment correlation coefficient (*r*). All obtained values were close to 0, which translated into no linear correlation. It is possible that there is a non-linear correlation between these variables. Data analysis has shown that 99% of total bats were found in areas where rock temperature was between 7 and 9°C and 95% of total bats were found in area where air temperature is between 7.8 and 9°C. Most bats were found in area where air temperature is close to rock temperature or higher. This leads to the conclusions that air temperature is a more important microclimate parameter because of the higher contact area.

CONCLUSIONS

Taking into consideration available data as well as observations made in this study we can say that Comarnic Cave is only used as a hibernacula and is also holds the largest known hibernating colony of *R. ferrumequinum* in the Semenic – Cheile Carașului National Park. The bat species dynamics is consistent with known data from the past, which takes us to the conclusion that the colonies are stable in terms of intraseasonal and multiannual dynamics. We believe that the winter dynamics of bats is determined, at least in part, by the sub-Mediterranean climate in which Comarnic Cave is located. It is possible that there are changes in the way that the cave is being used a shelter, but also due to lack of data it may be well within the normal limits. Because more data is required and also because it is one of the most important bat roosts in the area, further studies should be conducted. Using GIS has made it a lot easier to interpret data from several visits and also the relation between microclimate and bats.

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