

THE STRUCTURE AND THE DYNAMICS OF A HIBERNATION MIXED COLONY OF BATS (CHIROPTERA) FROM AN OLD GALLERY MINE (RARĂU MOUNTAINS – ROMANIA)

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Abstract. Mine No. 1 is a winter shelter for 11 species of bats: *Myotis myotis*, *Myotis blythii*, *Myotis bechsteinii*, *Myotis brandtii*, *Myotis mystacinus*, *Myotis daubentonii*, *Plecotus auritus*, *Plecotus austriacus*, *Barbastella barbastellus*, *Eptesicus nilssonii* and *Eptesicus serotinus* (Nmax = 109). During 4 years (2004-2008) there were tracked: microclimate changes, the number of bats dynamics (in the shelter, seasonal and annual), as well as annual differences about the specific compositions of the bats. Mine No. 1 offers helpful information about the bats fauna specific to the mountains, but also of some rare species like: *Eptesicus nilssonii*, *Barbastella barbastellus*, *Myotis bechsteinii*.

Keywords: old-mine, hibernation, Chiroptera, *Eptesicus nilssonii*, Rarău mountains.

Rezumat. Structura și dinamica unei colonii mixte de hibernare dintr-o galerie veche de mină (Munții Rarău - România). Mina nr. 1 este adăpost de iarnă pentru 11 specii de chiroptere: *Myotis myotis*, *Myotis blythii*, *Myotis bechsteinii*, *Myotis brandtii*, *Myotis mystacinus*, *Myotis daubentonii*, *Plecotus auritus*, *Plecotus austriacus*, *Barbastella barbastellus*, *Eptesicus nilssonii* și *Eptesicus serotinus* (Nmax = 109). În decursul a 4 ani (2004-2008) s-au urmărit: schimbări ale microclimatului, dinamica numărului de chiroptere (în adăpost, sezonieră și anuală), precum și diferențele anuale privind compoziția specifică a chiropterelor. Mina nr. 1 oferă informații valoroase privind chiropterofauna specifică zonei de munte dar și a unor specii rare precum: *Eptesicus nilssonii*, *Barbastella barbastellus*, *Myotis bechsteinii*.

Cuvinte cheie: galerie de mină, hibernare, Chiroptera, *Eptesicus nilssonii*, Munții Rarău.

Introduction

The mine gallery has been researched, for bats, from 1999 to 2001 by the Speleology Club “SpeoBucovina”. Visits to the mine also took place before, but not for bats studying; The Speleology Club “SpeoBucovina”, from 1983, have named the mine “Peștera-Laborator” (Laboratory-Cave) because it’s an underground favorable for the initiation of young speologists.

Pieces of information referring to the ecology of the bats from the caves in Moldavian Carpathians are few. Valenciuc (1969, 1972), starting from 1963, has studied the dynamics and the microclimate conditions from 2 caves: Peștera Liliecilor from Rarău (the Bats’ Cave) and Peștera Toșorog (the Toșorog Cave) from the county of Neamț. Some errata information are about two caves from Ceahlău Mountains, in the winter: Avenul Mare and Peștera Groapa cu Var (Irina Pocora and Bogdan Vornicu, pers.com.). Here there were listed 6 species of bats: *Myotis blythii*, *Myotis daubentonii*, *Plecotus austriacus*, *Eptesicus nilssonii*, *Eptesicus serotinus* and *Rhinolophus hipposideros*.

In Rarău Mountains, up to the altitude of 1492 m, there are more old mine galleries, made in limestone. Mine No. 1 is a winter shelter. The colony inside the cave represents a pattern of the chiropterofauna living in the area, which was very poorly studied until now. Because of that the cave entered into the National Monitoring Program. Another gallery mine which was inventoried before by Chachula (2002) is Mina lui Mantz (Mantz’s Mine) on Putna Valley, which has a length of 180 m. We inventoried here a small winter colony of ~20 individuals, mostly *Myotis myotis* (17 ex.), *M. daubentonii* and

M. mystacinus (20.12.2004). Another mine inventoried also by Oana Chachula is Mina din Abruptul Rarăului (Mine from abruptement of Rarău). Chachula listed here four bat species: *Myotis myotis*, *Myotis mystacinus*, *Myotis daubentonii* and *Eptesicus nilssonii* (Nmax = 32).

Material and Methods

1. Study area

Mine No. 1 from Rarău is built in solid rock, no reinforcement being required other than in 2 small portions. The mine has a main gallery, between the 0 and 3 entrance, and 4 ramifications, from which 2 are closed at the end (Sec 1 and 2), and the other 2 (Sec 3 and 4) end in full versant, only with alpine access. Because the mine crosses the mountain, an air current is forming, with preponderance from entrances 2, 3 and 0. As a direct consequence, the main gallery, during the winter, is dry and has the temperature mostly around 0°C.

The ramifications which are closed to the end, because they are slightly oriented in the current direction, are influenced just in their beginning part, at their opposite extremity the temperature tends to stabilize at 4.5°C at the ceiling, and at 2 degrees at sol. Another phenomenon that can be signalized is the walls humidity, noticeable varying along the first 20-30 meters from the ramification: a clear humidity area begins from the ceiling and descends to the floor (Done, 2004) (Fig.1).

The galleries are quasihorizontal, and the floor is covered with sterile; only on the left ramification appear small slops in the area that were traversed for the hutches. The ceiling and the walls have numerous trails of holes, with the diameter of approximately 4 cm and deep up to 15 cm. During winter, in the main gallery appear ice formations.

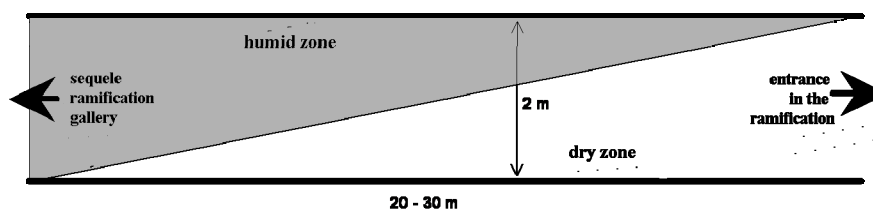


Figure 1. Outline representing the humidity of the ramification gallery (Sec 1 and 2) walls (Done 2004).

- Coordinates: E 25°34'09" / N 47°27'18" / 1504 m.a.
- The galleries have an almost quadratic section from 1.8 to 2 m and a total length of 995 m.
- Mine No. 1 is located in the middle of the coniferous forest, forest that occupies 70% of the total surface of the massif Rarău-Giumalău.

2. Collection data

The observation was conducted in the winter season from October to May in the years 2004 – 2007. 11 visits were totally made to the mine.

Data regarding the microclimate (temperature and humidity variations) were recorded by the aid of a termohygrometer (HANNA HI 9065).

The species were identified on the basis of determination keys (Grimmberger 1996; Valenciu 2002; Decu *et al.*, 2003; Dietz, von Helversen, 2004) as a result of the morphometric measurements (mainly of the length of the forearm) or, for confirmation, on the basis of photographs. The fewest specimens possible were manipulated, knowing the fact that bats should not be disturbed during their hibernation period. More rigid

determinations were made in autumn (October-November). The material used: sliding calipers, magnifying glass (x10), gloves, flashlight, digital camera.

The very similar species *M. myotis*/*M. blythii*, *M. mystacinus*/*M. brandtii* were distinguished only during several controls, by external features. If this was not possible, both species were classified together as *M. myotis*/*M. blythii*, *M. mystacinus*/*M. brandtii*.

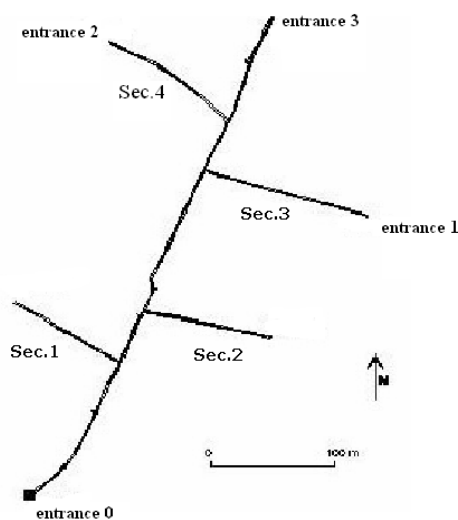


Figure 2. Outline Mine No. 1 (Done 2004).

3. Data analysis

The following ecological indices were used to describe the species composition of bat hibernating in No. 1 Mine: proportion (P %) and frequency (F %).

Results and Discussion

1. Species composition and number of bats hibernating in the old mine

It's not a large hibernating colony but it contains vulnerable or endangered species (*Myotis myotis*, *Myotis blythii*, *Barbastella barbastellus*, *Myotis bechsteinii*) or rare for the country bats fauna (*Eptesicus nilssonii*). *M. myotis*/*M. blythii* were the dominant species (44%, Nmax = 109), followed by *B. barbastellus* with 37%. *Eptesicus nilssonii* (11%) were also numerous (Fig. 3). Other species are represented by: *M. daubentonii*, *M. mystacinus*/*M. brandtii*, *P. auritus*/*P. austriacus*, *E. serotinus* and *M. bechsteinii*.

The maximum of bats met in the mine was N = 109 (4.01.2007).

The colony is mostly formed in October and at the end of April in the mine there are just few bats (N=9). During summer there is no bat in the mine. From the abundant species, the first species that come to the winter shelter and leave the last are: *M. myotis*, *M. blythii* and *E. nilssonii*; *B. barbastellus* comes the last (in November) to the mine and leaves the first (March) (Tab. 1).

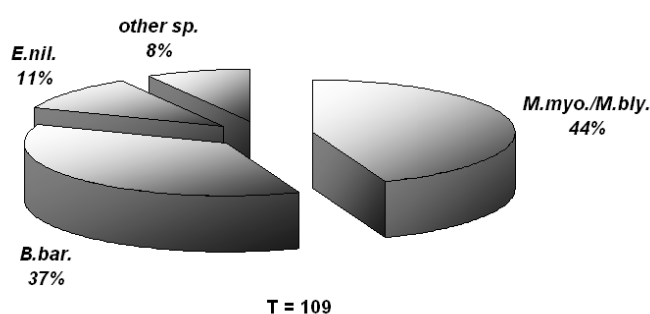
2. The number of bat species

11 bat species were observed during four winter seasons (2004-2008). The species are listed below from most to least numerous. The proportion and frequency of occurrence of different species are shown in the Tab. 2.

Lesser mouse-eared bat *Myotis blythii* (Tomes, 1857) and **Greater mouse-eared bat** *Myotis myotis* (Borkhausen, 1797)

Table 1. Specific composition of the bats in Mine No. 1 in the study period.

Date	<i>M.my./ M.bly.</i>	<i>B.bar.</i>	<i>M.dau.</i>	<i>M.mys./ M.bra.</i>	<i>E.nil.</i>	<i>P.aur./ P.aus.</i>	<i>E.ser.</i>	<i>M.bec.</i>	Total
19.12.04	49	47	1	-	5	3	-	-	105
26.02.04	53	27	1	1	4	1	-	-	87
23.10.05	41	-	1	1	8	1	-	-	52
26.11.05	42	30	3	1	6	-	-	-	82
12.03.06	47	25	1	2	4	1	-	-	80
29.04.06	6	-	-	1	2	-	-	-	9
24.11.06	47	34	2	3	7	2	-	1	96
4.01.07	48	40	2	3	12	1	3	-	109
2.03.07	48	43	2	4	6	2	1	-	106
4.10.07	24	-	1	2	6	1	-	-	34
3.01.08	51	40	1	4	11	-	-	-	106

**Figure 3.** Specific composition of the bats from Mine No. 1 (4.01.2007).

This two species were the most numerous. On a cave from Rarău Mountains, Peștera Liliecilor (Bats Cave), *M. blythii* was forming in the 60s a winter colony of ~7000 individuals (Valenciuc, 1969), now in the mentioned cave there are still ~3000 individuals. Bats Cave can be found at approximately the same altitude at 1 km away from the gallery mine.

The highest number of *M. blythii* (Nmax = 36) was found on 26.02.2004. The number of individuals is twice as big as *M. myotis* species. In the mine, *M. myotis* species counts up to 18 individuals. The 2 species come to the mine probably in September and at the end of April there were 6 individuals left in the mine. The most of the individuals are staying in the secondary galleries (Sec 1 and Sec 2) where the temperature and humidity are higher and more stable, with priority the second half of the secondary galleries, where T = 4.5 -7°C and U = 80-90%. Klys *et al.* (2002), in Poland say that temperature range for the hibernating *M. myotis* was among 2.5 – 8,8°C. The individuals of the 2 species stay freely suspended on the walls at least 1.6m height or on the ceiling, and rarely in holes or bays.

They stay alone or in groups of at most 21 individuals on the gallery Sec 2 (12.03.2006), only on the humid wall. Rarely some solitary individuals have been met in the main gallery, but the temperature wasn't lower than 4°C.

Barbastelle *Barbastella barbastellus* (Schreber, 1774)

This is the second most abundant species recorded in the shelter (33,8%) and is an constant species (F=72,7%). There are few signals of the species in Romania (Decu *et al.*, 2003). In Europe such species with a limited distribution and high degree of behavioral specialization is considered most vulnerable to extinction (Haupt, 2005). In the west side of the country the species is more frequently met, being associated with the

mountains and hills area; but in Moldavia the species is rare and in Dobrogea and Danube Delta the species is missing.

In Moldavia the species was met before while hibernating only in 2 sub terrain shelters: Toșorog Cave - county Neamț (Valenciuc, 1972) and Grota Mare -county Iasi (Ifrim & Valenciuc, 2005), few individuals.

In Mine No. 1, Nmax=47 (19.12.2004), it comprised 37% of the total. The species is met in the main gallery and the secondary galleries 3 and 4 which are opened at the end, marked by low temperature during winter (Furmankiewicz & Furmankiewicz, 2002), where T = -2 and 5°C and U = 53 – 80%, with temperature oscillations and cold wind. The best conditions as an underground hibernaculum are a temperature of 1,6 – 4,8°C and humidity of 70 – 90% (Boye & Dietz, 2005). From the species from the shelter, *B. barbastellus* comes the latest (November) to the shelter and leaves the first (March). Some individuals can be met in the secondary galleries 1 and 2, but only at the entrance and on the dry wall at ½ - 1 m height. In the main gallery and the secondary galleries 3 and 4 they are met mostly in the holes shot in the ceiling, in groups of 1-4 individuals or on the wall, semi hidden, at 0.7-3 m height. It is the most sensible species to disturbing, even in the profound hibernation period. In March, the most of the remained individuals were staying in the gallery Sec 3, they probably leave the shelter through the cliff exit. Also in here we found on 12.03.2006 a dead individual.

Northern bat *Eptesicus nilssonii* (Keyserling et Blasius, 1839)

Though abundant in Scandinavia it occurs rarely and patchily in Central Europe. Occurrence of the northern bat in Central Europe is often associated with mountains (at elevation levels above 300 m) areas with coniferous forests of low insect density (Haupt, 2005). Previous studies provided contrasting views upon habitat use of *E. nilssonii*: whereas Jong (1994) emphasizes the outstanding importance of lake and forest habitats for the species, in a Scandinavian region dominated by coniferous forest, other studies (Rydell & Racey, 1995) described the northern bat as a typical street lamps bat.

In Bulgaria there is only one record of a dead individual of *E. nilssonii* found in the mountains in south-western Bulgaria. This is the southernmost record within its while distribution area (Benda *et al.*, 2003). Also Benda *et al.*, specifies that relatively closely is situated the record from Romanian Southern Carpathians (one finding from Piatra Arsa near Predeal; Rauschert, 1963). Preceding signals of the species in Romania (Mehely, 1900) are from another species and the informations from Dumitrescu *et al.*, 1962 are mistaken (Barti, 2002). Barti signalizes the species in Romania at Puciosu Mountain, one single individual found at 7 July 2001 in Ucigasa Cave (and other two individuals, pers.com.), at 1100 m altitude; also and based of the remains found in a pellet of *Strix aluco* on the date of 16th February 2002 in the church tower of Sâncraiu village. In 2001, Gheorghiu *et al.*, signalizes the specie in the Carpathians foothills in Romanian Banat (two records from Oravița and Carașova), this data are doubtful, because the authors didn't mentioned where the data come from.

The present data suggest that in the Balkans (Bulgaria, southern Romania, Croatia), the range of *E. nilssonii* is restricted into few islets of boreal forest habitats (Benda *et al.*, 2003).

In the summer of 2001, Valenciuc and Chachula have found one individual of *E. nilssonii* (new species for Moldova), in the ruiniform relief, next to Pietrele Doamnei (Rarău Mountains). The species was also found in December 2004 in Avenul Mare from Ceahlău (Neamț) (Bogdan Vornicu, pers.com.).

The highest number of *E. nilssonii* (Nmax = 12) was found on 4.01.2007 at Mine No. 1. It shows the widest distribution, like *M. myotis* and *M. blythii* (F=100%) at this shelter.

In October, in the shelter there were already present individuals of this species, and at the end of April there still were 2 individuals in the mine. As *B. barbastellus*, prefers the lower and oscillate temperatures, being met in the main and 3 and 4 secondary galleries, on the wall, semi hidden at 0.8-2.5 m height, rarely in the shot holes along with *B. barbastellus* or solo suspended on the ceiling.

During summer we observed the species hunting on the plateau at the light of a chalet, at 1500 m altitude, it was also observed hunting in clearings, on Rarău mountains.

Whiskered bat *Myotis mystacinus* (Kuhl, 1817) and **Brandt's bat** *Myotis brandtii* (Eversmann, 1845)

M. brandtii is a rare specie for Romania's bats fauna. During summer the species was captured in the net at the entrance of Liliecilor Cave (Ifrim & Valenciuc, 2006). In the mine, both species were found in holes, in the terminal part of the wall or on the ceiling, solitary, being met in 1st and 2nd secondary galleries. There were identified 3 individuals of *M. brandtii* and 1 of *M. mystacinus*.

Daubenton's bat *Myotis daubentonii* (Kuhl, 1817)

The species has hibernated mostly in the crack of rock and under the stone. They were observed, like the other *Myotis* species, in part of the gallery (Sec. 1 and 2) where the water occurs on the surface like Klys *et al.* (2002) observed. Rarely the species was met in the main gallery or in Sec 4.

Brown long-eared bat *Plecotus auritus* (Linnaeus, 1758) and **Grey long-eared bat** *Plecotus austriacus* (Fischer, 1829)

There were few specimens in the shelter. *P. auritus* was found at the end of Sec. 1 and 2, it prefer temperature around 7°C (Boye & Dietz, 2005) and *P. austriacus* was found on the main and Sec 3 gallery, were temperature was often below 0, the species can cope with air temperatures of -7°C (Boye & Dietz, 2005).

Serotine *Eptesicus serotinus* (Schreber, 1774)

The species is accidental for this shelter. 3 specimens were observed on 4.01.2007, at principal gallery, in holes at 1.8-2 m high. No records of hibernating serotine bats are more of three individuals (Boye & Dietz, 2005).

Bechstein's bat *Myotis bechsteinii* (Kuhl, 1818)

It is accidental for the shelter Mina nr. 1. Usually in mine Bechstein's bat is present alone (Boye & Dietz, 2005). One female was seen on 24.11.2006, at gallery Sec. 2. During summer the species was captured with the net at the entrance of Liliecilor Cave from Rarău (one specimen).

Table 2. Number (N), proportion (P%) and frequency (F%) of bats hibernating in Mine No. 1 in the years 2004-2007.

Species	N	P%	F%
<i>M. myotis/M. blythii</i>	456	52.7	100
<i>B. barbastellus</i>	286	33.1	72.7
<i>E. nilssonii</i>	71	8.2	100
<i>M. mystacinus/M. brandtii</i>	20	2.3	90.9
<i>M. daubentonii</i>	15	1.7	90.9
<i>P. auritus/P. austriacus</i>	12	1.4	72.7
<i>E. serotinus</i>	4	0.5	18.2
<i>M. bechsteinii</i>	1	0.1	9

3. The seasonal and in shelter dynamics of the bats from Mine No. 1

During winter hibernating bats choose places in the undergrounds specific climatic conditions. Each species prefer different hibernation temperature.

Table 3. The distribution of bats in the galleries from Mine No. 1 in the study period and the values of temperature and humidity.

Date	Galleries				Total	T.outside °C	T. inside °C	U. %
	Maine	Sec. 1	Sec. 2	Sec. 3				
19.12.04	34	18	35	18	105	-5	3.4	80
26.02.04	26	18	41	2	87	-7	3.6	75
23.10.05	7	17	26	2	52	8.5	7.8	90
26.11.05	21	19	30	12	82	1.2	4	85
12.03.06	16	18	50	6	80	-1	6.2	68
29.04.06	2	4	3	0	9	9	9.5	45
24.11.06	27	24	31	14	96	2.9	4.5	88
4.01.07	34	23	32	17	109	-5.2	3	62
2.03.07	25	21	38	20	106	5.4	4.3	82
4.10.07	10	10	12	2	34	12	7.7	76
3.01.08	37	25	34	8	106	-5	3.2	62.6

The gallery preferred by the bats is the secondary gallery no. 2, here the maximum number of bats was met in March (Fig. 4), the species of *Myotis* type prefers this gallery because of the temperature and higher humidity which are keeping constant. The medium temperature at the entrance of the galleries closed at the end (Sec. 1 and 2) is of 4.3°C and in the terminal part of 7°C and the medium humidity is of 78%.

On the main gallery and on Sec 3, the most bats were met in December and January (Fig. 5), those being preferred by the less pretentious species at temperature and humidity oscillations: *Barbastella barbastellus*, *Eptesicus nilssonii* and *Plecotus austriacus*. On the Sec 4 gallery there were never met more then 3 bats. On the main and Sec 3 and 4 galleries the medium temperature is of 2.7°C (-3 and 6°C) and the medium humidity of 73%.

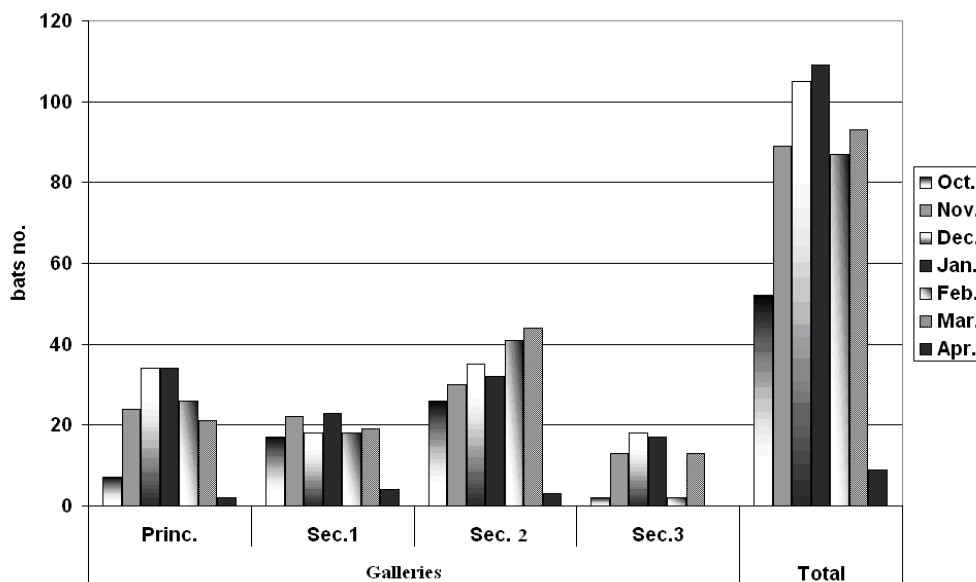


Figure 4. Bats distribution on the No. 1 Mine galleries.

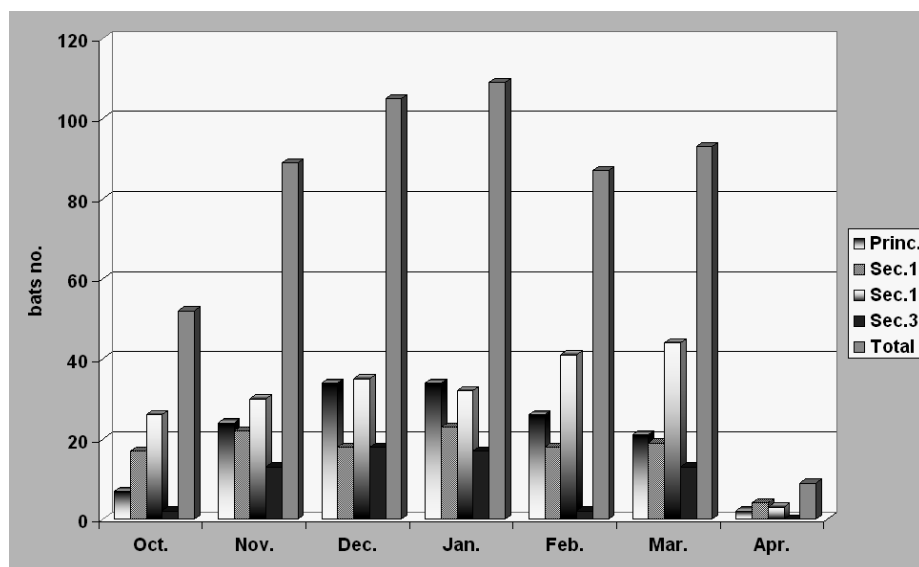


Figure 5. The seasonal dynamics in No. 1 Mine.

In what it concerns the seasonal dynamics, the bats come to the shelter in October and leave the shelter in April-May. In October, the main and Sec 3 galleries (ramification of the main gallery) are rarely visited by bats because the *Barbastella barbastellus* species is missing. In the rest of the months the bats distribution is approximately uniform in the specified galleries. The maximum number of bats was met in December and January (Fig. 5).

Conclusions

From the species identified in Mine No. 1, 4 species are present in Annex II of Habitats Directive: *Myotis myotis*, *Myotis blythii*, *Myotis bechsteinii* and *Barbastella barbastellus*. Mine No. 1 gives important information about the bats fauna specific to mountain area as well as for some rare species as: *Eptesicus nilssonii*, *Barbastella barbastellus*, *Myotis bechsteinii*. *M. myotis/M. blythii* are the dominant species (44%, Nmax = 109), followed by *B. barbastellus* with 37% and *E. nilssonii* (11%) also numerous.

Acknowledgements

We thank Farkas Szodoray-Paradi from APLR (Bat Asociation from Romania) for the equipment, Levente Barti for comments on the manuscript, Adrian Done from SpeoBucovina and Alexandra Ciuc for the support given.

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