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Bat species composition and abundance in two underground hibernaculae in Vilnius before and after fencing

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Species composition and abundance of hibernating bats were investigated in Šeškinė bunkers and the Paneriai tunnel in Vilnius (Lithuania). Before fencing the Šeškinė hibernaculum against human disturbance, Barbastelle Bat (*Barbastella barbastellus*) was abundant but Daubenton's Bat (*Myotis daubentonii*) was rare. After blocking the Šeškinė bunkers their microclimate changed and Barbastelle Bats disappeared, but the number of Daubenton's Bats increased. In the Paneriai tunnel, the microclimate changed insignificantly because of incomplete fencing. This resulted only in minor changes in the behaviour of bats, *i.e*. the numbers of both dominating bat species, Daubenton's Bat and Pond Bat, continued growing. In addition, a new bat species, Brandt Bat (*Myotis brandtii*), was found in the Paneriai tunnel after fencing. Blocking of entrances to bat hibernaculae can change the microclimate in them. Therefore actions meant to close the entrances should be carried out with caution, because these activities can change the species composition and/or abundance of hibernating bats.

Key words: bats, *Barbastella barbastellus*, *Myotis dasycneme*, hibernating, Vilnius, Lithuania

INTRODUCTION

In Lithuania, the following eight bat species are known to hibernate: Daubenton's Bat *Myotis daubentonii*, Pond Bat *Myotis dasycneme*, Brandt's Bat *Myotis brandtii*, Natterer's Bat *Myotis nattereri*, Brown Long-eared Bat *Plecotus auritus*, Barbastelle Bat *Barbastella barbastellus*, Serotine Bat *Eptesicus serotinus* and Northern Bat *Eptesicus nilssonii* (Lietuvos..., 1988). In Lithuania, bats hibernate in various man-made underground and aboveground constructions. On rare occasions hibernating bats were found in hollows of old trees. Large natural underground sites suitable for bat hibernation are missing in Lithuania, therefore, the existence of bats in Lithuania during a cold season largely depends on man-made structures.

The largest bat hibernation sites in Lithuania are found mainly in the most urbanized areas of the country – in the cities of Vilnius and Kaunas (Prūsaitė, 1972, 1988; Masing & Buša, 1983; Lietuvos..., 1992; Pauža & Paužienė, 1996, 1998; Balčiauskas et al., 1997, 1999; Baranauskas, 2003; Makavičius et al., 2004; Baranauskas et al., 2005). Very often bats find suitable conditions for hibernation in old military fortifications like bunkers and tunnels. Such constructions were usually established in the environs of cities. Because towns grow, today many of the old fortifications appear close to city centres. At present, underground constructions, particularly military fortifications, are of great interest to society. People frequently visiting these sites disturb the animals (Stebbings, 1988; Randsome, 1990; Fenton, 1998; Randsome & Hutson, 2000). Therefore, to protect hibernating bats against human disturbance, various types of gates were proposed and constructed to cover the entrances of tunnels, mines and caves (Voûte & Lina, 1986; Stebbings, 1988; Masing, 1990; Randsome, 1990; Racey, 1992; Richardson, 1994; Fenton, 1998; McAney, 1998; Keely & McCabe, 1999). Special grilles are designed, allowing free access to the bats and hindering unauthorised human access. Protecting underground sites using grilles or other means is not without problems. Grilles may deter some species of bat from using the site (Novikov et al., 1970; Randsome & Hutson, 2000; Postawa, 2001).

In Vilnius, the following six bat hibernation sites are known at present: 1) Paneriai tunnel, 2) Šilas system of bunkers, 3) Verkiai cellar, 4) Rasos system of bunkers, 5) Pavilnis system of bunkers, and 6) Šeškinė system of bunkers. Of the eight bat species found in Lithuania during the cold season, the following seven species have been found hibernating in the Vilnius city area: *Myotis daubentonii*, *Myotis dasycneme*, *Myotis*

brandtii, *Plecotus auritus*, *Barbastella barbastellus*, *Eptesicus serotinus* and *Eptesicus nilssonii.* Two of them (*Barbastella barbastellus* and *Myotis dasycneme*), listed under the EU Habitats Directive (Council Directive 92/43/EEC of May 1992: On the conservation of natural habitats and wild fauna and flora) are considered mammals of European importance. In the above-mentioned bat hibernation sites in Vilnius, approximately 20 to 600 individuals hibernate each winter. In bat hibernation sites at Verkiai and Šeškinė, bat monitoring (counting) has been carried out since 1997 (Baranauskas, 2001, 2003; Baranauskas et al., 2005). Except the Verkiai cellar, all are often visited by people during winter. To decrease the disturbance of hibernating bats by people in Vilnius, two hibernation sites (Paneriai tunnel and Šeškinė) system of bunkers were closed for people in 2004.

The aim of the present study was to evaluate the diversity and abundance of hibernating bats in the Šeškinė system of bunkers and the Paneriai tunnel after fencing these large wintering sites.

MATERIALS AND METHODS

Detailed descriptions of the study sites (Šeškinė system of bunkers and Paneriai tunnel) have been elsewhere (Baranauskas, 2001, 2003), together with the bat counting results in these sites.

Hibernating bats were indentified according to their morphological features (Corbet & Harris, 1991; Macdonald & Barret, 1993; Dietz & Helversen, 2004). Bats were found and identified using a hand torch (Lutsar et al., 2000; Masing, 2004). The light was shown on them briefly, and the bats were not touched white counting them. The proportion of hibernating bats found by us at each site is estimated to comprise about 90% of the total colony. During the season of 1997 bats were counted on 10th March, while during the seasons 1998–2005 they were counted in January (Tables 1 and 3).

Two bat hibernation sites in Vilnius are briefly described below.

Šeškinė system of bunkers. The system is part of a military fortification erected in the first decades of the 20th century. It is situated at the foot of a hill in the western part of Vilnius. There are five buildings and ten bunkers in total. In two bunkers the former entrances serve as free flyways for bats, whereas all the other bunkers can be entered by bats only through narrow ventilation holes. All bunkers are 4 × 4 m (16 m^2) rooms connected by passages. These rooms have complex ventilation systems. For safety reasons, quickly growing trees were planted at the entrances just after construction. At the beginning of the 20th century the bunkers were situated in the environs of the city. Now, after the enlargement of the city, the Šeškinė fortification is close to the city centre. The Šeškinė fortification, like all old military fortifications, is very much attractive to people. By the decision of the Resources Fund of the Vilnius City, all entrances of the fortification were blocked in December 2004, except few small openings left for bats to fly in and out.

Before blocking the entrances of the Šeškinė bunkers, these sites were dry and cold in winter (2–4 ˚C). After blocking of the entrances with bricks, the premises of the bunkers became warmer (5–7 ˚C) and more humid.

Paneriai tunnel. It is situated in the southeastern part of the Vilnius city. The tunnel is arch-shaped, 6.4 m high, 8 m wide and 430 m long (Matulis, 1971). The tunnel is partly ruined in two places and completely ruined in one place, thus there are three sections incompletely separated from each other (Baranauskas, 2003). The first section (A) is about 50 m long and is the coldest during the winter period. It is dry in summer and damp in winter. As a result of water dripping from the ceiling and vapour erupting from the tunnel, many 0.5–1 metre-long stalactites and stalagmites have formed. At the beginning of the section the temperature is close to the exterior temperature throughout the year. Section A is less isolated from the outside, and in autumn it contains the largest number of bats. During winter frosts most bats leave this site. In mid-winter, section A is the coldest part of the tunnel.

The third section (C) has the same lenght as section A (about 50 m). It is the warmest section of the tunnel. During bat hibernation time the temperature here is fluctuating between 8 and 11 ˚C. The second section (B) is about 250 m long. Here the temperature fluctuates between 5 and 8 ˚C. This section is very wet, because water penetrates the ceiling throughout the seasons of hibernation. The section is very humid all year round. The ceiling is partly destroyed as bricks or even blocks of bricks have fallen down. Hibernating bats may be found here also in heaps of bricks on the ground. There are many deep cracks everywhere in the tunnel, and many bats hibernating in them cannot be either found or indentified exactly, particularly in section B.

The Paneriai tunnel is protected by law as an engineering monument. It is the largest bat hibernation site in the Vilnius city.

In September 2004 the Paneriai tunnel was blocked against human visitors by a 3 m high wall.

RESULTS AND DISCUSSION

Šeškinė system of bunkers

During eight years (1997–2004), before blocking the entrances, Barbastelle Bats were dominating at Šeškinė. Pond Bats were not numerous, and Serotine Bats and Brown Long-eared Bats were rare. The last two species were detected in this hibernation site not every year. After the site was blocked from the visitors in 2005, the abundance of bats significantly changed (Table 1).

Before the partial blocking of the entrances in Šeškinė, Daubenton's Bats formed only about 11% of all

Table 1. **Diversity and abundance of hibernating bats in the Šeškynė hibernation site in 1997–2005**

Date	*Myotis dasycneme*		*Myotis daubentonii*		*Plecotus auritus*		*Eptesicus serotinus*		*Barbastella barbastellus*		Total
	n	%	n	%	n	%	n	%	n	%	
1997.03.10	–	–	1	4.1	1	4.1	–	–	22	91.8	24
1998.01.04	–	–	1	4.0	2	8.0	–	–	22	88.0	25
1999.01.15	–	–	1	3.7	2	7.4	1	3.7	23	85.2	27
2000.01.10	–	–	3	8.8	3	8.8	3	8.8	25	73.6	34
2001.01.16	–	–	3	17.6	–	–	–	–	14	82.4	17
2002.01.27	–	–	5	20.8	1	4.2	1	4.2	17	70.8	24
2003.01.08	–	–	4	18.2	1	4.5	1	4.5	16	72.8	22
2004.01.11	–	–	3	21.4	–	–	–	–	11	78.6	14
2005.01.16	1	3.0	28	84.9	–	–	1	3.0	3	9.1	33
Total	1	0.5	49	22.3	10	4.5	7	3.2	153	69.5	220

Table 2. **Diversity and abundance of hibernating bats in the Šeškynė hibernation site during different months of 2004–2005**

Date	*Myotis dasycneme*		*Myotis daubentonii*		*Barbastella barbastellus*		*Eptesicus serotinus*		Total
	n	%	n	%	n	%	n	%	
2004 09 17	1	33.3	2	67.7	–	–	–	–	3
2004 10 19	–	–	3	30.0	7	70.0	–	–	10
2004 11 19	–	–	3	30.0	7	70.0	–	–	10
2004 12 18	–	–	1	8.3	11	91.7	–	–	12
2005 01 16	–	–	3	60.0	2	40.0	–	–	5
2005 02 19	–	–	18	90.0	2	10.0	–	–	20
2005 03 12	1	3.0	28	84.9	3	9.1	1	3.0	33
2005 04 11	1	14.3	6	85.7	–	–	–	–	7
Total	3	3.0	64	64.0	32	32.0	1	1.0	100

hibernating bats, but after partial blocking of the site their proportion increased to 85%. According to the literature, bats respond very quickly to changes of microclimate at hibernation sites (Masing, 1981; Liiva & Masing, 1987; Richardson, 1994; Postawa, 2001). In December 2005, before the partial blocking of the entrances in Šeškinė, 7–11 Barbastelle Bats hibernated there, but after blocking the site only 2–3 Barbastelle Bats were found later in the same winter (Table 2).

Before blocking the entrances in Šeškinė (20 December 2004), Barbastelle Bats hibernated there in groups every year, beginning from October and November. The blocking of the entrances reduced aeration, and the site became warmer (5–7 ˚C) and wetter. As a result, nearly all Barbastelle Bats disappeared. Out of 11 Barbastelle Bats found at the site in mid-December, only 2–3 bats remained there by January. The latter bats continued hibernation till spring. Contrary to Barbastelles, the number of Daubenton's Bats considerably increased in Šeškinė during winter (from 3 bats in mid-January to remarkable 28 bats in mid-March). The latter change means that Daubenton's Batss have entered the site in great numbers during midwinter, a phenomenon thus far described in Northern Bats (Liiva & Masing, 1987) but not in Daubenton's Bats in our region (Table 2).

Some species such as Brown Long-eared Bat seem to be ecologically more plastic than the other bat species. Brown Long-eared Bats hibernate both in warm and cold hibernation sites (Kurskov, 1978). Barbastelle Bats usually hibernate in cold sites (Kurskov, 1978; Mitchell-Jones et al., 1999). Barbastelle Bats do not avoid the sites with temperature close to zero. In cold winters they even hibernate at below zero (Masing & Buša, 1983). Compared to Barbastelle Bats, Daubenton's Bats hibernate in warmer sites (Novikov ir kt., 1970; Kurskov, 1978; Masing & Buša, 1983; Corbet & Harris, 1991; Macdonald & Barret, 1993; Klys et al., 2002).

Paneriai tunnel

During earlier investigations (2000–2004) we ascertained hibernating Pond Bats, Daubenton's Batss and Brown Long-eared Bats in the Paneriai tunnel (Baranauskas, 2003; Baranauskas et al., 2005). Additionally, Barbastelle Bats and Serotine Bats were found at this site, too, but not every year (Table 3).

During five years (2000–2004), before partial blocking of the entrances of the Paneriai tunnel (third decade of September 2004), the most abundant bat species hibernating at this site was Daubenton's Bat forming 67–74% of the community. After partial blocking of the entrances the proportion of this species remained the same (about 70%). Before blocking of the entrances Pond Bats composed on average 15.6% of the bat community. After blocking of the entrances the number of Pond Bats also remained about the same (14.1%).

After partial blocking of the entrances of the Paneriai tunnel the number of hibernating bats continued to grow and doubled during one year, *i.e.*, compared to 251 hibernating bats found in mid-January 2004, 602

Table 3. **Diversity and abundance of hibernating bats in the Paneriai tunnel in 2000–2005**

Date	*Myotis dasycneme*		*Myotis daubentonii*		*Myotis brandtii*		*Plecotus auritus*		*Eptesicus serotinus*		*Barbastella barbastellus*		Indefinite		Total
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
2000 01 08	11	11.4	72	74.2	–	–	2	2.1	–	–	–	–	12	12.3	97
2001 01 16	17	13.0	93	71.0	–	–	2	1.5	–	–	–	–	19	14.5	131
2002 01 23	26	17.0	107	70.0	–	–	5	3.3	2	1.3	2	1.3	11	7.1	153
2003 01 25	13	9.6	101	74.3	–	–	4	2.9	2	1.5	3	2.2	13	9.5	136
2004 01 08	53	21.1	167	66.5	–	–	1	0.4	–	–	3	1.2	27	10.8	251
2005 01 19	85	14.1	413	68.6	4	0.7	2	0.3	–	–	1	0.2	97	16.1	602
Total	205	15.0	953	69.5	4	0.3	16	1.1	4	0.3	9	0.7	179	13.1	1370

Table 4. **Diversity and abundance of hibernating bats in the Paneriai tunnel during different months of 2004–2005**

Date	*Myotis dasycneme*		*Myotis daubentonii*		*Myotis brandtii*		*Plecotus auritus*		*Barbastella barbastellus*		Indefinite		Total
	n	%	n	%	n	%	n	%	n	%	n	%	
2004 09 17	5	11.4	19	43.2	2	4.5	–	–	–	–	18	40.9	44
2004 10 21	61	12.3	389	78.6	2	0.4	1	0.2	–	–	42	8.5	495
2004 11 24	83	13.9	432	72.6	8	1.3	2	0.3	–	–	71	11.9	596
2004 12 24	92	14.7	441	70.4	7	1.1	3	0.5	–	–	83	13.3	626
2005 01 19	85	14.2	413	68.6	4	0.7	2	0.3	1	0.1	97	16.1	602
2005 02 06	75	12.8	412	70.3	7	1.2	2	0.3	1	0.2	89	15.2	586
2005 03 17	43	10.0	302	70.1	11	2.6	1	0.1	1	0.1	73	17.1	431
2005 04	4	18.2	12	54.6	3	13.6	–	–	–	–	3	13.6	22
Total	448	13.2	2420	71.1	44	1.3	11	0.3	3	0.1	476	14.0	3402

bats were found in the tunnel in mid-January 2005, some months after partial fencing of the entrances. Additionally, a new bat species, Brandt's Bat *Myotis brandtii*, was found in the tunnel during the last season.

Before fencing of the Paneriai tunnel at the beginning of hibernation season, about 30 bats were present in section A (Baranauskas, 2003). During the winter months most of the bats hibernating in this section of the tunnel moved over to warmer parts (sections B and C) (Baranauskas, 2003). After fencing of the tunnel, about 70 bats hibernated in section A, which means that the bats did not move to sections B and C during winter as they did before fencing. After fencing, the tunnel became slightly warmer in all sections. As more bats were counted in section A after fencing, this probably indicates that section A became more suitable for hibernation compared with other sections.

Both before and after the fencing of the Paneriai tunnel, *Myotis dasycneme* was the dominating bat species hibernating there. It has been one of the most abundant species in the tunnel throughout the hibernation period (Table 4).

In the Paneriai tunnel, the number of Daubenton's Bat is increasing. The same tendency was noticed in other parts of its distribution range (Řehak, Gaisler, 1999; Racey, 1992). The number of Pond Bats has increased as well. During the last winters the biggest clusters of Pond Bat in Vilnius were found in the Paneriai tunnel. In the 2004–2005 hibernation season, the largest count of Pond Bat was made in December (92 specimens). During the same period only 3 specimens were found in other hibernation sites in Vilnius: two animals in the Rasos bunkers and one animal in the Šeškinė bunkers.

As both underground systems, the Paneriai tunnel and the Šeškinė bunkers, were fenced at the beginning of the hibernation season 2004/2005, human influence could have an impact on the number of bats hibernating in these systems during the same winter. Therefore, it is too early to tell at present how much the microclimate change caused by fencing has effected bat numbers in these hibernation sites. Further research can show this.

CONCLUSIONS

1. After heavy fencing of the Šeškinė bunkers, the microclimate changed, and the numbers of bat species prefering dry and cool hibernation sites (*Barbastella barbastellus*), decreased but the number of termophilous and hygrophilous species (*Myotis daubentonii*) increased.

2. After partial fencing of the Paneriai tunnel the microclimate changed not much. This resulted in minor changes in the behaviour of bats, *i.e.* the numbers of both dominating species, Daubenton's Bat and Pond Bat, continued to grow. In addition, a new bat species, Brandt's Bat (*Myotis brandtii*), was found in the Paneriai tunnel after fencing.

3. Blocking of entrances into bat hibernaculae can change their microclimate. Therefore, actions meant to close the entrances should be carried out with caution,

because these activities can change the species composition and/or the abundance of hibernating bats.

4. If the entrances of underground hibernation sites of bats are being planned to close against humans and predators like cats and martens, these actions should not make the microclimate unsuitable for bats.

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ŠIKŠNOSPARNIŲ RŪŠINĖ SUDĖTIS IR GAUSUMAS PRIEŠ UŽTVERIANT IR UŽTVĖRUS DVI VILNIAUS ŠIKŠNOSPARNIŲ ŽIEMAVIETES

S a n t r a u k a

Buvo stebimas šikšnosparnių rūšinės įvairovės ir gausumo kitimas Vilniaus miesto nuo lankytojų užtvertose Šeškinės ir Panerių tunelio žiemavietėse. Prieš užtveriant Šeškinės žiemavietę, joje gausiausiai apsistodavo europiniai plačiaausiai *Barbastella barbastellus*, o vandeniniai pelėausiai *Myotis daubentonii* būdavo reti. Po užtvėrimo (pasikeitus žiemavietėje mikroklimatui), situacija joje pasikeitė, žymiai pagausėjo vandeninių pelėausių, o beveik visi europiniai plačiaausiai iš jos pasitraukė. Užtvėrus Panerių tunelio žiemavietę (mikroklimatas joje mažai pakito), joje išliko tos pačios vyraujančios šikšnosparnių rūšys – vandeninis pelėausis, kūdrinis pelėausis *Myotis dasycneme* ir joje aptikta nauja žiemavietei rūšis – Branto pelėausis *M. brandtii*. Akcentuojama, kad šikšnosparnių žiemavietes užtvėrus nuo lankytojų, jose gali pasikeisti mikroklimatas. Nors užtvaromis žiemavietės ir yra apsaugomos nuo lankytojų ar plėšrūnų, bet dėl galimo mikroklimato pasikeitimo iškyla tam tikra rizika žvėrelių rūšinės įvairovės stabilumui jose. Ypač kruopščiai reikia parinkti apsaugos priemones nuo lankytojų tose šikšnosparnių žiemavietėse, kuriose apsistoja europinės svarbos žinduoliai – europiniai plačiaausiai ir kūdriniai pelėausiai.

Raktažodžiai: šikšnosparniai, *Barbastella barbastellus*, *Myotis dasycneme*, žiemojimas, Vilnius, Lietuva