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Occupancy of bat boxes in the Dolní Morava Biosphere Reserve (southern Moravia, Czech Republic)

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Abstract. Altogether 37 (33 small, 4 big) bat boxes were installed in the area of the Dolní Morava Biosphere Reserve (southern Moravia, Czech Republic) during February–March 1998. A half of them (19) were situated in the thermophilous oak/hornbeam Milovice forest, 12 in a floodplain forest, 4 in the Děvín National Nature Reserve and 2 nearby a small fishpond. All boxes were checked annually until the autumn 2007, three of them until 2010. In total, 13 small bat boxes were used at least once by five bat species (*Pipistrellus pygmaeus*, *P. nathusii*, *Nyctalus noctula*, *Barbastella barbastellus*, *Myotis* sp.), eight of them regularly, most often by maternity colonies of *Pipistrellus pygmaeus*. Of the total of 47 nursery colonies recorded, 42 were of *P. pygmaeus*. The remaining records are related to individual specimens or exceptional maternity colonies of *Nyctalus noctula* and *Barbastella barbastellus*. None of the big bat boxes was used by bats.

Bat boxes, occupancy, *Pipistrellus pygmaeus*, Lower Morava

Introduction

Bat boxes are one of possible ways how to provide additional roosts to bats, but contrary to birds they are not considered an important tool in bat conservation. The percentage of boxes occupied by bats is usually quite low (Takke & Hildenhagen 1989, Kasprzyk & Ruczyński 2001, Ciechanowski 2005). Bat boxes can help to study the life of bats in different ways, from interesting records (Schmidt 1985, Haensel 1987, Bachman & Pröhl 1990, Dieterich et al. 1998, Schmidt 2003, Richter 2012) through species distribution (Heise 1983, Nagel & Nagel 1993, König & König 1995, Gaisler et al. 2002, Sachanowicz 2003), conservation tools (Bartonička 2005), population ecology (Boyd & Stebbings 1989, Dieterich 1998, Schmidt 2000, Horn 2005a, 2009), roosting and wintering ecology (Dieterich 2004, Horn 2006, Bartonička et al. 2008, Ohlendorf et al. 2010) to specific studies such as the influence of microclimate or bug invasion on roost switching (Bartonička & Řehák 2007, Bartonička 2008, Bartonička & Růžičková 2013). Numerous studies were focused on the appropriate design of bat boxes (Tupinier 1981, Gerell 1985, Stebbings & Walsh 1985, Mainer 1995, Haensel & Tismer 1999, Kasprzyk & Ruczyński 2001, Lourenco & Palmeirim 2004, Horn 2006). In the former Czechoslovakia, Gaisler (1975) published results of bat census in 100 bird and 10 bat boxes in the Pod Trlinou Nature Reserve near Zábřeh. His study, however, was aimed mainly at the results of winter census of bats hibernating in caves and mines. In general, there are only few modern literature sources related to bat boxes, majority of them deal with interesting species records in boxes. Low interest of researchers concerning bat boxes can be documented both at the international (Horáček & Benda 2010) and national levels (Horáček & Uhrin 2010) – there is no publication concerning bat boxes, among several hundreds of different bat studies. Only a small remark concerning possible use of bat boxes in bat monitoring is mentioned in EUROBATS guidelines (Battersby 2010).

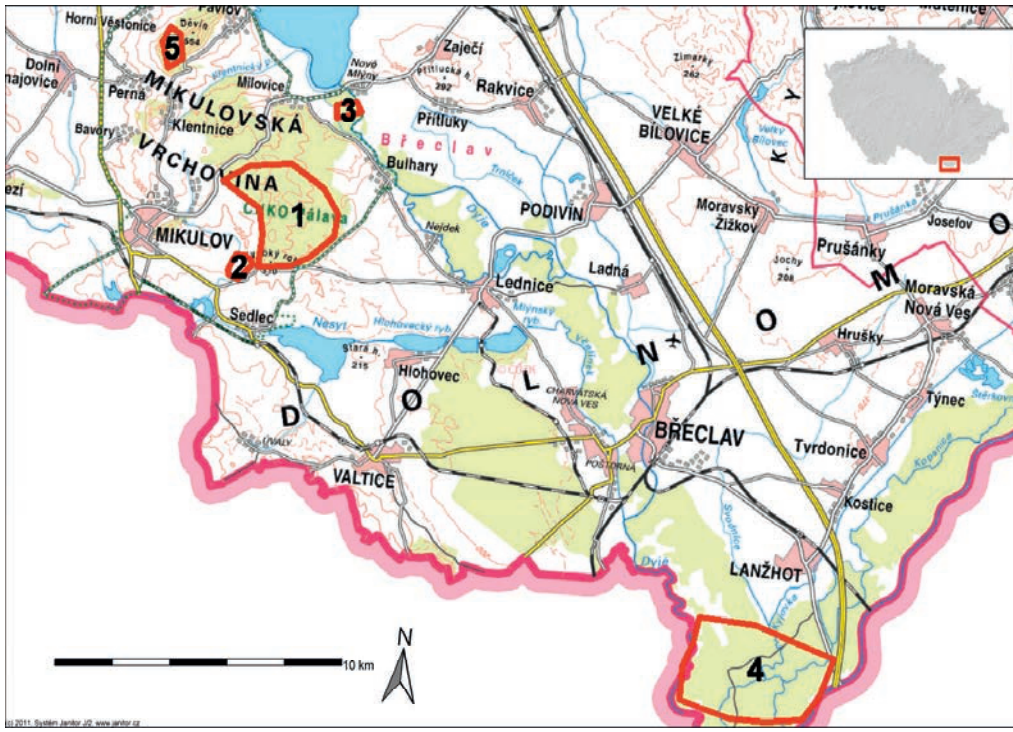

Fig. 1. The polygons of areas with installed bat boxes.

In the late 1990s, the Administration of the Pálava Protected Landscape Area (and Biosphere Reserve at that time) was offered by the Agency for Nature Conservation and Landscape Protection of the Czech Republic to put up 37 bat boxes within the area they managed. We decided to expose majority of them in the habitat with a lack of natural roosts and little knowledge on bat occurrence, in the Milovice forest. We were obliged to check the boxes at least once a year and to repair them if necessary.

Material and Methods

Altogether 37 bat boxes were installed in the area of the Dolní Morava Biosphere Reserve (south-eastern corner of the Czech Republic; Fig. 1) during February – March 1998. Thirty three of them were small simple plain wood boxes made from rough boards 20 mm thick (Fig. 3). The inner space was 680×240×40 mm with the entrance at the bottom. The back side of the box was 50 mm longer to ensure safe landing of bats. These boxes were thus designed very similarly as the Stratmann FS1 type (cf. Gerell 1985). All of the boxes were put up 4–6 metres above ground in five different habitats – see below. Four big bat boxes (inner measurements 700×500×280 mm, divided vertically into five separate spaces of the same size, also opened downwards) were placed inside big feeding racks; two of them in the Milovice forest and two in a floodplain forest. These boxes were designed according to the Issel type (cf. Tuttle & Hensley 1993). Exact location of bat boxes was discussed with the staff of forest management. All of them were placed nearby water bodies.

All boxes were checked using a strong torch from the ground, in the case of bat presence the individuals were caught and ringed. The boxes were checked twice a year; during the breeding period (May–July) and during the swarming activity

(August–September) in 1998–2007, since 2008 only occasionally with the exception of three boxes at Křivé jezero. All statistics deal only with the period 1998–2007.

Study Area

Milovice forest (Fig. 1: 1)

A thermophilous oak/hornbeam forest, majority of the area with stands of small trees because of low soil quality. The area is managed as a game preserve for fallow deer and mouflons. There are numerous clearings and small water sources in the area.

Altogether 17 small boxes were put up in the area at the elevations of 250–300 m a. s. l.; eight of them were placed on artificial equipment of the game preserve (four at feeding racks, three at hunting lodges), the remaining ones on trees (Fig. 3). Two big boxes were installed inside and outside of big feeding racks at the edge of the forest and a clearing.

Horní Mušlovský fishpond (Fig. 1: 2)

Three small bat boxes were exposed on willow trees at the bank of a 6 ha fishpond at the edge of the Milovice forest and surrounding fields, at 220 m a. s. l.

Křivé jezero National Nature Reserve (Fig. 1: 3)

A mature floodplain forest (116 ha, 165 m a. s. l.) with many different pools and channels, smaller clearings. Four small boxes were put up at the banks of the pools; three on trees, one on a hunting lodge (Fig. 2).

Figs. 2, 3 (left) – bat box No. 26 on hunting lodge at the Křivé jezero lake, regularly used by a maternity colony of *Pipistrellus pygmaeus*. 3 (right) – bat box No. 13 in the Milovice forest. Often used by treecreepers, once with a maternity colony of *Barbastella barbastellus*.

Soutok area (Fig. 1: 4)

A mature floodplain forest (5000 ha, 600 ha of meadows; 152 m a. s. l.; the largest complex of this woodland type in the Czech Republic) with many different pools and channels, big clearings. Three small boxes were placed on old trees at the banks of big pools, one at a hay shed at the edge of a pine forest (Fig. 4). Two big boxes were exposed inside big hay sheds.

Děvín National Nature Reserve (Fig. 1: 5)

The reserve (380 ha) consists of a wide range of habitats from warm rocky steppes with hairy oak shrubs to supra-colline forest communities with colder mesoclimate. Five small boxes were placed on trees at pool banks in an oak/hornbeam forest. While the other boxes were put up mostly at low elevations of 150–300 m a. s. l., those at Děvín were situated at 350–450 a. s. l.

Results

In the period 1998–2007, thirteen small bat boxes (40% of all installed boxes) were used at least once by bats. Already 3 months after installation, two maternity colonies of *Pipistrelus pygmaeus* were found in two boxes. Altogether five bat species were recorded: *Pipistrellus pygmaeus* in eight boxes, *P. nathusii* in two boxes, *Nyctalus noctula* in four boxes, *Barbastella barbastellus* in one box and *Myotis* sp. (a small-sized species) in one box. Maternity colonies were recorded in 10 boxes: *P. pygmaeus* in eight boxes, *N. noctula* in three boxes and *B. barbastellus* in one box. Altogether 47 maternity colonies were found; 42 of *P. pygmaeus*, four of *N. noctula* and one of *B. barbastellus* – see Table 1.

The numbers of females in *P. pygmaeus* nursery colonies varied between 10–50 adults, most often between 20–30 (13 cases), in the period 1998–2007. In one case, an exceptionally high

Fig. 4. Bat box No. 4 at the Soutok area, regularly used by a maternity colony of *Pipistrellus pygmaeus*.

Table 1. The occupancy of bat boxes in different years. Legend: *Bbar* = *Barbastella barbastellus*; *Nnoc* = *Nyctalus noctula*; *Pip* sp. = *Pipistrellus* sp.; *Pnat* = *Pipistrellus nathusii*; *Ppyg* = *Pipistrellus pygmaeus*; BB = bumble bee nest; F = female; H = hornet nest; M = male; MAT = maternity colony; MC = moth caterpillars; N = nest; SAT = cocoon of giant moth *Saturnia pyri*; W = wasps

year box No.	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	W	W	W					W		
2	MC				MC	*Certhia* N				MC
3			*Certhia* N		MC		*Nnoc* 2M 2F	*Certhia* N		
4	*Ppyg* MAT		*Ppyg* 1M		*Ppyg* MAT		*Ppyg* MAT	*Ppyg* MAT	*Ppyg* MAT	*Ppyg* MAT
5			W	W		*Nnoc* 4M	*Nnoc* MAT			
7	*Passer* N		lost							
8		*Ppyg* MAT	*Ppyg* MAT	*Ppyg* MAT		*Nnoc* 1	*Nnoc* 4 ex		*Nnoc* MAT	
9	MC		*Certhia* N		W		*Certhia* N	*Certhia* N		
11	*Ppyg* 1M			*Ppyg* MAT	*Ppyg* MAT	*Ppyg* MAT	*Ppyg* MAT	*Ppyg* MAT	*Ppyg* MAT	
12	*Ppyg* 1M		*Ppyg* MAT		*Ppyg* MAT			*Nnoc* MAT	*Nnoc* MAT	
13	MC				*Certhia* N	*Certhia* N	*Certhia* N	*Certhia* N	*Pnat* 1M	*Bbar* MAT
16					*Ppyg* MAT	*Ppyg* MAT	*Ppyg* MAT	*Ppyg* MAT	*Ppyg* MAT	*Ppyg* MAT
17					*Ppyg* MAT	*Ppyg* MAT	*Ppyg* MAT	*Ppyg* MAT	*Ppyg* MAT	*Ppyg* MAT
20								SAT		
21			BB							
22			W							
23			W		W					
25	*Pip* sp. 1					*Certhia* N				
26	*Ppyg* MAT	*Ppyg* MAT		*Ppyg* MAT	*Ppyg* MAT	*Ppyg* MAT	*Ppyg* MAT	*Ppyg* MAT	*Ppyg* MAT	*Ppyg* MAT
29			H	H		MC				
30	W					*Pnat* 2F			*Pnat* 1M 1F	*Pnat* 1M
34				*Ppyg* MAT	*Ppyg* MAT	*Ppyg* MAT		*Ppyg* MAT		

Table 2. The changes in numbers of bats during different checks of boxes at the Křivé jezero lake. Legend: *Nnoc* = *Nyctalus noctula*; *Ppyg* = *Pipistrellus pygmaeus*

box No.	sp.	check									
2008		30 Apr	21 May	10 Jun	25 Jun	8 Jul	21 Jul	8 Aug	26 Aug	11 Sep	26 Sep
12	*Nnoc*	8	0	0	25	10	20	0	0	0	4
26	*Ppyg*	1	0	1	?	?	0	20	20	3	1
16	*Ppyg*	30	10	8	?	?	50	3	7	0	0
2009		23 Apr	13 May	3 Jun	16 Jun	1 Jul	15 Jul	26 Aug			
26	*Ppyg*	0	50	80	30	50	50	10			
16	*Ppyg*	0	50	30	20	50	50	30			
2010		7 May	19 May	28 May	8 Jun	16 Jun	22 Jun	8 Jul	17 Jul	31 Jul	12 Aug
26	*Ppyg*	4	0	27	20	0	0	5	0	20	15
16	*Ppyg*	12	0	0	20	?	0	13	20+	8	15

number of 80 females was found in the box no. 26 in the Křivé jezero NNR (box on a hunting lodge) on 3 June 2009. A *N. noctula* maternity colony with 10–20 females occurred only in box no. 12, situated in an open space on a high hunting lodge. Also the *B. barbastellus* maternity colony occurred only in one box, placed inside the Milovice forest; before 2007 this box no. 13 was used mainly as a breeding place by treecreepers (*Certhia* sp.).

The presence of several hymenopteran species (wasps in six boxes 11 times, hornet twice in one box, bumble bee in one case), high number of gypsy moth caterpillars (seven times in five boxes) and even one interesting record from the view of nature conservation (presence of a cocoon of the giant peacock moth *Saturnia pyri*) were documented. The nests of *Certhia* sp. were found 11 times in five boxes, the nest of *Passer montanus* in one case.

Discussion

The bat boxes were installed in different habitats both from the view of forest type, providing different levels of roost opportunities (thermophilous oak/hornbeam forests × floodplain forests) as well as population density of bats. Both these characteristics have to be considered when assessing the bat box occupancy (Taake & Hildenhagen 1989, Ciechanowski 2005). The overall occupancy of bat boxes in the study area is one of the highest ever published. Usually the occupancy rate reaches single units, at least in Europe (e.g. Gaisler 1975: 4%; Taake & Hildenhagen 1989: 3%). On the other hand, an extremely high occupancy was published from the USA: Tuttle & Hansley (1993) mentioned even 73%, but this figure deals with only 11 boxes, similar to our "big" boxes – see above. While in our study, this type of boxes showed zero occupancy, in the USA it was frequently used, mainly by *Myotis lucifugus*. The same results from central Europe, i.e. zero occupancy of the biggest bat boxes, were mentioned by Kasprzyk & Ruczyński (2001), though from a different habitat type (pine forests).

The high occupancy of our boxes is surprising also when considering that wooden boxes were used; usually they are wood-concrete or concrete boxes that show higher occupancy in comparison with wooden ones (Taake & Hildenhagen 1989, Kasprzyk & Ruczyński 2001).

Surprisingly, no boxes were occupied in the area of the Soutok floodplain forests, where the population density of bats is very high; there are also numerous natural roosting possibilities in old trees, several buildings and in the abundant hunting equipment (high seats, feeding racks etc). The same habitat situation is found in the Křivé jezero NNR, where, however, the occupancy was very high – three of four boxes were nearly regularly used as maternity roosts (Table 1).

Irregular changes in the occupancy of boxes in the same year were recorded quite often (Table 2); which is quite a common phenomenon in some bat species. One of the reasons of this roost switching could be recolonization of roosts by bat bugs (Bartonička & Růžičková 2013). The latter study is based on data coming from the boxes in the Křivé jezero NNR. The record of 80 *Pipistrellus pygmaeus* females probably corresponds to the maximum capacity of this type of bat boxes.

The occurrence of other animals in bat boxes could also affect their occupancy by bats. There is a roost competition with birds, but this does not seem to be too important in the case of specially designed bat boxes; on the other hand, wasps and hornets could be the reason of bat absence (Gerell 1985). This situation was documented in our boxes, although at least twice there was an active wasp nest in one part of the box and only a few centimetres from it there was an active male and two females of *P. nathusii*. Also the presence of high numbers of gypsy moth caterpillars could cause the absence of bats in boxes.

The species composition of bats recorded in bat boxes varies among habitats and geographic areas. In Poland altogether 13 bat species were found in bat/bird nest boxes (Kowalski & Lesiński 1994), with the highest figures for *Myotis nattereri* (33.2%), *Plecotus auritus* (28.5%) and *Pipistrellus nathusii* (18.3%). The variations of bat species composition depends also on the type of the box (Taake & Hildenhagen 1989); boxes of the Schwegler type, designed as a woodpecker hole, were used mainly by *Myotis bechsteinii* and *Plecotus auritus*, while *Myotis brandtii* preferred the Stratman FS1 type. No differences were found for *Pipistrellus nathusii* and *Myotis nattereri*. In northern Moravia, Gaisler (1975) recorded *Plecotus auritus* as the most common species in both bird and bat boxes, *N. leisleri* was the second most frequent bat. Additional three species, *Nyctalus noctula*, *Myotis mystacinus* and *M. bechsteinii* were found always as a single individual per nest box. In his paper, however, Gaisler (l.c.) mentioned also a record of a *M. bechsteinii* maternity colony in a bird nest box at another locality, a forest near the Brno water reservoir. There are several thousands of bird boxes in the Soutok area; during their cleaning in autumn, *Plecotus auritus* is also the most common species in these boxes (Berka & Krause, pers. comm.).

Timing of checks is another factor affecting records of bats in boxes; these can be different in the period of reproduction, autumn swarming activity and migration and in winter. While Taake & Hildenhagen (1989) visited their bat boxes as late as in August – September (and due to this fact they did not record any nursery colonies), Kasprzyk & Ruczyński (2001) checked their boxes between 20 June – 16 July, which means that the possible autumn use of the boxes by calling males could not be revealed. The data concerning social organization of *Pipistrellus pipistrellus* were obtained in southern Sweden by regular checks of bat boxes during May – October (Gerell & Lundberg 1985).

Bat boxes are a useful tool how to increase roosting opportunities for bats and also to study their life. Bats use the boxes during the whole life cycle, contrary to birds, where the possibility to breed is by far the most important point (and also the most important reason why the boxes are installed). On the other hand, for bats the boxes can be important as alternative shelters during spring migration, reproduction and also in autumn as mating grounds. Bats use the boxes even in the habitats offering a high number of natural roosts.

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P.S.: I received the last comments concerning this article from Jiří Gaisler, my excellent teacher, tutor and unforgettable friend, just five days before his sudden death ...

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