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Mark-recapture results and changes in bat abundance at the cave of Na Turoldu, Czech Republic

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A b s t r a c t . Between 1958-2000, 3,148 records of hibernating bats were made in a natural limestone cave, 92 % of them concerning *Rhinolophus hipposideros.* Other species included *Myotis myotis*, *M. mystacinus*, *M. brandtii*, *M. emarginatus*, *M. nattereri*, *M. daubentonii*, *Plecotus auritus*, *P. austriacus* and *Myotis blythii* (which was not recorded after 1973). The abundance of *R. hipposideros* (and of all bats combined) decreased between 1958-1963, probably due to the impact of mark-recapture work, and between 1970-1974 due to the devastation of the cave. After the cave was put under protection and the marking of bats was stopped, the hibernating assemblage recovered so that, between 1984-2000, numbers of bats showed significant increases resulting in numbers more than twice those at the beginning of the monitoring period. Between 1991-2000, 517 bats were netted and banded from spring until autumn in front of the cave. Nettings of species not found in winter (*Myotis bechsteinii*, *Eptesicus serotinus*, *Vespertilio murinus*, *Nyctalus noctula* and *Barbastella barbastellus*) increased the total number of species to 15. In *N. noctula* and *V. murinus* echolocation signals were also detected and, in the latter a display flight with mating calls was recorded. Samples of netted bats were compared with samples of bats observed in the same winter, and significant differences were found in species composition, diversity and in the dominance values of individual species. It is suggested that considerable numbers of bats other than *R. hipposideros* occur at the locality in winter, but have remained undetected due to their hidden hibernation. We analysed 1,038 individuals marked at Turold and 237 recaptured, plus 10 of bats marked elsewhere and recaptured at Turold. The longest movement recorded (66 km) was in a female *M. blythii*, the highest age (19.5 years) was in a male *R. hipposideros.*

Key words: hibernating bats, fluctuation in numbers, summer bat community, results of banding

Introduction

The cave of Na Turoldu is the largest known bat hibernaculum in the territory of the Pálava UNESCO Biosphere Reserve, and a previous study (G a i s l e r et al. 1996) has shown bats to represent the most diverse community among the reserve's small mammals. While this study reported data collected between 1989–1993, bats in the Na Turoldu Cave have been monitored from 1958 up to the present day. This 42 year period represents the third longest continuous bat monitoring record from any site in either the Czech Republic or the former Czechoslovakia, and is exceeded only by certain localities south of Prague (44 years) and in the Moravian Karst (43 years) (Ř e h á k 1997, Ř e h á k & G a i s l e r 1999). Although the cave in question has not been visited every year, the sample is large enough to be analysed with respect to shifts in numbers of hibernating bats - one of the goals of this paper. However, the previous study also showed that certain species, although common in the territory of the

reserve, were found in the cave only rarely or not at all. Therefore, the second goal of this paper was to compare species composition and diversity, as well as the dominance values of individual species, between samples obtained both inside and outside the cave. By this we intend to demonstrate just how many bat species can occur within a very small territory (i.e. <1 ha - the cave interior plus its surroundings).

Material and Methods

Bats hibernating inside the cave have been monitored from 1958 - 2000. The cave was visited once a year in January or February except in 1963 (when it was checked in March) and in 1960-1962, 1964-1967 and 1983 (no surveys made). Until 1980 bats were banded and those found with a band were recaptured. To avoid any confusion when comparing papers about bat-banding and bird-ringing we make it clear that, for bats, the terms "banding" and "ringing" are synonymous. The bands used to mark bats were very similar to the rings applied to passerine birds (for methodological details see H a n á k et al. (1962) and R o e r (1995)). From 1981 until the present day, bats found in the cave were censused without marking or disturbance, and only those banded previously, when found, were examined closely to check the band number (B a u e r o v á et al. 1989). Ten species were recorded, the numbers of individuals in each sample are specified in the paragraph "Winter census", and total numbers are given in Table 1.

Table 1. Total number of records (N) and mean number of bats (Mean) per one winter check in the Na Turoldu Cave, 1958-2000; n = 35 checks.

Species	N	Mean
Rhinolophus hipposideros	2894	82.7
Myotis myotis	13	0.4
Myotis blythii	40	1.1
Myotis mystacinus	1	<0.1
Myotis brandtii	1	<0.1
Myotis emarginatus	133	3.8
Myotis nattereri	33	0.9
Myotis daubentonii	12	0.3
Plecotus auritus	7	0.2
Plecotus austriacus	11	0.3
indetermined	3	0.1
Total	3148	89.9

From 1991–2000, netting was performed outside the cave, up to 20 m from its entrance. This entrance, however, is closed by a solid gate which does not allow the bats to fly in and out (see the locality description). Bats were netted irregularly from April until November each year, a period termed "summer" for the sake of simplicity. Usually three 10-12 m long nets were set one hour before sunset and lifted shortly after midnight. Netted individuals were banded and released. Thirteen species were netted (the numbers of individuals in each sample will be presented elsewhere) and the total number of banded bats can be seen in Table 2 and those of recaptures in Table 3. The cave was not visited at each netting but, when visited, no bats were seen inside. When the two samples (winter and summer) were combined, the total number of species recorded was 15, and the total number of records 3,741. In addition to the above data, a few ultrasound records of *Nyctalus noctula* and *Vespertilio murinus* were made with a Skye bat detector.

The following abbreviations of bat species names are used in the list of records from the winter census: *Rhip = Rhinolophus hipposideros*, *Mmyo = Myotis myotis*, *Mbly = M. blythii*, *Mmys = M. mystacinus*, *Mbra = M. brandtii*, *Mema = M. emarginatus*, *Mnat = M. nattereri*, *Mdau = M. daubentonii*, *Paur = Plecotus auritus*, *Paus = P. austriacus.* Calendar dates are given with date first, followed by month and year, e.g. 10-2-72 = 10 February 1972. Further explanation of symbols used in the paper: m = male, f = female, T = Turold, both inside and outside the cave, O = other localities, B = banding (ringing), R = recapture, T/T = banded and recaptured at Turold, T/O = banded at Turold, recaptured elsewhere (analogously O/T), W = winter, inside the cave, S = summer, outside the cave (netting), W/1W = banded in winter, recaptured the next winter (analogously /2W, /3W = recaptured the second, the third winter after banding; S/ = banded in summer).

Study Area

The cave of Na Turoldu (= at Turold) is a natural limestone cave which consists of a complicated system of corridors and small domes forming three storeys situated at elevations between 295 - 250 m a.s.l. The total length of known underground caverns is 1,100 m. There are numerous crevices in the ceiling, the walls and in the bases of underground corridors and domes. Some of the crevices open to the surface and obviously allow bats to move in and out, but the exact locations of these bat passages are unknown. Winter air temperatures in the cave vary between 4.5 - 9.5 °C (n = 16). The cave is named after the 385 m high hill "Turold", situated on the periphery of the small town of Mikulov (population = 8,000). Between 1873-1934, Turold was affected by the output of Ernstbrunn dolomitic limestone. During the last 66 years, however, this limestone quarry has not operated and it has become overgrown - mostly by natural vegetation. The locality has been protected since 1946 and became a nature reserve in 1992. The quarry forms part of the Pálava Biosphere Reserve, which is situated in southern Moravia, close to the Czech-Austrian border. The Pálava Reserve (area = 83 km^2) consists of a core Upper Jurassic limestone ridge 12 km long and 3-4 km wide, with maximum elevation of 550 m (for further details see G a i s l e r et al. (1996) and Č t y r o k ý et al. (1998)).

Results

W i n t e r c e n s u s

List of records: 8-2-58 – *Rhip* 51 m, 33 f; *Mbly* 2 m, 3 f; *Mema* 11 m, 12 f; *Paus* 1 m. 21-2-59 – *Rhip* 31 m, 13 f; *Mmyo* 2 f; *Mbly* 5 m, 9 f; *Mema* 1 m; *Paus* 1 f. 5-3-63 – *Rhip* 40; *Mema* 2. 20-2-68 – *Rhip* 40, *Mbly* 2 m, 5 f; *Mema* 3 m, 1 f. 10-2-69 – *Rhip* 55 m, 27 f; *Mbly* 2 m, 4 f; *Mema* 6 m, 4 f. 2-2-70 – *Rhip* 51 m, 16 f; *Mmyo* 1 m, 1 f; *Mbly* 3 f; *Mema* 3 m, 7 f. 18-2-71 – *Rhip* 31 m, 19 f; *Mmyo* 1 f; *Mbly* 2 m, 2 f; *Mema* 1 f. 10-2-72 – *Rhip* 4 m, 2 f; *Mema* 5 f; *Paus* 1 m. 14-2-73 – *Rhip* 8 m, 7 f; *Mbly* 1 f; *Mema* 2 m; *Mnat* 1 m; *Mdau* 1 f; *Paus* 1 m. 5-2-74 – *Rhip* 1 f; *Mema* 2 f; *Paus* 1 f. 6-2-75 – *Rhip* 3 m, 1 f; *Paur* 1 m, 1 f; *Paus* 1 f. 4-2-76 – *Rhip* 21 m, 11 f; *Mnat* 1 m; *Paus* 1 m. 16-2-77 – *Rhip* 17 m, 12 f; *Mema* 2 m, 3 f; *Mbra* 1 m. 7-2-78 – *Rhip* 11 m, 3 f; *Mmyo* 1 m; *Mema* 1 f. 16-2-79 – *Rhip* 16 m, 4 f; *Paus* 2 m. 9-2-80 – *R hip* 16 m, 16 f. 22-2-81 – *Rhip* 23; *Mema* 1 f. 16-1-82 – *Rhip* 21; *Mema* 1 m. 28-2-84 – *Rhip* 53; *Mema* 5; *Mnat* 1; *Paus* 1. 4-2-85 – *Rhip* 41. 8-1-86 – *Rhip* 36; *Mmyo* 1; *Mnat* 9; *Mdau* 4; *Paur* 2. 24-1-87 – *Rhip* 48; *Mmyo* 1; *Mema* 3; *Mnat* 1. 15-1-88 – *Rhip* 62; *Mema*

2. 16-1-89 – *Rhip* 116; *Mema* 1. 16-1-90 – *Rhip* 97; *Mema* 4; *Mnat* 3; *Mdau* 1. 14-1-91 – *Rhip* 123; *Mdau* 1. 29-1-92 – *Rhip* 132. 19-1-93 – *Rhip* 142; *Mema* 1. 20-1-94 – *Rhip* 172; *Mmyo* 1; *Mema* 6; *Mdau* 1. 17-1-95 – *Rhip* 208; *Mmyo* 2; *Mema* 11; *Mnat* 1; *Mmys* 1; *Myotis* sp. 3. 16-1-96 – *Rhip* 243; *Mmyo* 1; *Mema* 4; *Mnat* 7; *Mdau* 1. 9-1-97 – *Rhip* 202; *Mema* 3; *Mnat* 3; *Mdau* 1; *Paus* 1. 16-1-98 – *Rhip* 201; *Mema* 8; *Mnat* 5; *Mdau* 2; *Paur* 2. 12-1-99 – *Rhip* 200; *Mema* 13, *Mnat* 1; *Paur* 1. 19-1-2000 – *Rhip* 214; *Mema* 6.

Rhinolophus hipposideros was the most common bat recorded hibernating in the cave, with a mean of 83 individuals per survey for the whole monitoring period (Table 1). *Myotis emarginatus* was the second commonest, with an average of only four individuals per survey. With regard to other species, the biggest difference between early and subsequent years was the decline and disappearance of *M. blythii*. Up to 14 *M. blythii* per survey were recorded between 1958-1969, and up to four between 1970-1973. After 1973 the species could no longer be found in the cave. The remaining species were recorded in low numbers (average ≤ one individual per survey, see Table 1).

Changes in abundance

The fluctuations in numbers of *R. hipposideros* and of all other bats combined (Fig. 1) are characterised by the following trends: (1) a decrease from 1958–1963, (2) a decrease from 1969–1974, and (3) an increase after 1983 until the end of monitoring. The first two decreasing trends are statistically insignificant due to small sample sizes (n = 3 and 6 years, respectively). In contrast, the increasing trend during the final years of monitoring is highly significant ($p < 0.001$). However, in species other than *R. hipposideros* numbers are too small to show any trends.

Rhinolophus hipposideros hibernates either singly or in groups termed colonies. Fluctuations in total numbers are reflected in fluctuations within the largest winter colony. If present, this assemblage has invariably been situated at the same place in the so-called "Bat

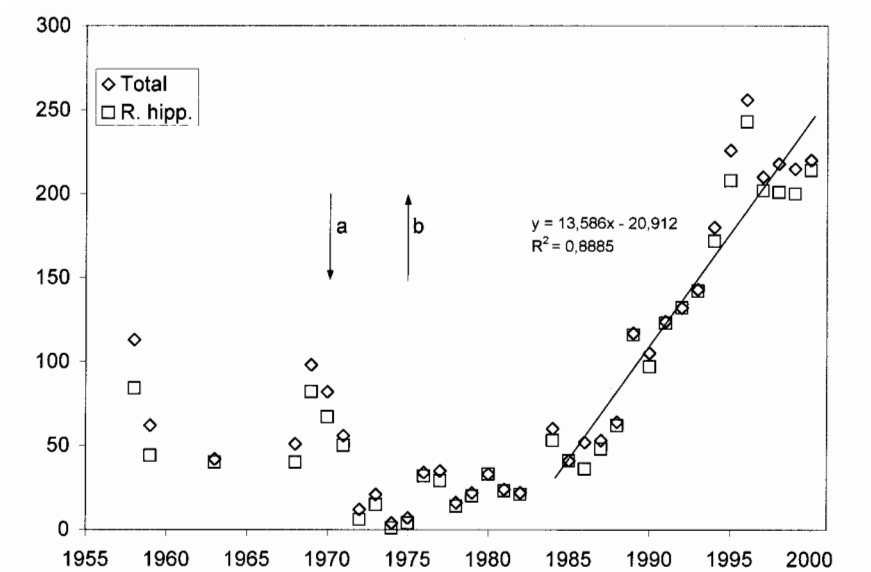

Fig. 1. Fluctuations in the numbers of hibernating bats recorded in the Na Turoldu Cave, 1958-2000 (y axis = number of bats, x axis = year). The arrow pointing downwards denotes the year the gate closing the cave was broken down, the arrow pointing upwards represents the year a new gate was installed, thus closing the cave once more.

Dome". At the beginning of research (in February 1958) the colony consisted of 40 individuals (see Gaisler et al. 1990: plate 1). The colony disappeared in the early 1970s and was relocated in 1976. In 1989 it consisted of 61 individuals and continued to increase to 200 individuals by 1996. During the last survey (in January 2000) we counted 170 individuals. Possible reasons for the shifts in numbers observed, such as the breaking down of the gate closing the entrance to the cave in 1970 (Fig. 1) will be discussed.

Summer netting and comparison with winter census

During 31 netting sessions we banded 517 individuals from 13 species. In addition, netting resulted in 69 (13.4 %) recaptures of eight species. Three species were recorded at the locality only by netting, i.e. *M. bechsteinii*, *E. serotinus* and *B. barbastellus*, and two more, *V. murinus* and *N. noctula*, were detected by bat detector. During the netting on 16-10-98, both a display flight and the mating calls of *V. murinus* were recorded. The bat, obviously a male, flew in circles from 19.00 till 19.05 h (Central European Time) and uttered loud calls at about 15 kHz in a regular sequence.

Since bats were only netted between 1991-2000, the sample of comparable winter records was limited (Table 2). The differences between the winter and the summer samples included both data on species composition and data on the quantitative representation of each species recorded. The differences between the numbers of individuals of the eight species common to both were significant (χ^2 Goodness-of-fit test, $p < 0.001$). While about ten times more bats were recorded per one winter survey than per one summer netting, the overall species diversity was eight times higher in the summer than in winter. The winter sample was dominated by one superabundant species, *R. hipposideros*, which accounted for 95.5% of all records. In contrast, the quantitative representation of species was more balanced in summer, with *M. nattereri*, *M. daubentonii*, *R. hipposideros* and *P. auritus* each accounting for >10% of all records. The ranks of species according to their dominance values are completely different when the two samples are compared (Table 2).

Table 2. Comparison of results of the winter census and summer netting, 1991-2000. N = number of bats seen or netted; D = species dominance (%); Mean = mean number of bats per one census or netting (n = 10 winter checks, 31 summer nettings); H' = species diversity.

Species	Winter			Summer		
	N	D	Mean	N	D	Mean
R. hipposideros	1837	95.5	170.8	65	12.6	2.1
M. myotis	4	0.2	0.3	25	4.8	0.8
M. mystacinus	1	0.1	0.1	12	2.3	0.4
M. emarginatus	52	2.7	4.8	40	7.7	1.3
M. nattereri	17	0.9	1.7	159	30.8	5.1
M. bechsteinii	0	0.0	0.0	15	2.9	0.5
M. daubentonii	6	0.3	0.6	83	16.1	2.7
E. serotinus	0	0.0	0.0	28	5.4	0.9
V. murinus	0	0.0	0.0	1	0.2	<0.1
N. noctula	0	0.0	0.0	2	0.4	<0.1
P. auritus	3	0.1	0.2	60	11.6	1.9
P. austriacus	1	0.1	0.1	26	5.0	0.8
B. barbastellus	0	0.0	0.0	1	0.2	<0.1
Total	1921	100.0	178.8	517	100.0	16.7
H'		0.351			2.948	

Mark - recapture analysis

During the entire time span 1958-2000, 1,038 bats of 15 species were banded at Turold (Table 3). Males were more commonly banded in all species with the exceptions of *M. myotis* and *M. blythii*. In the former, the two sexes were equally represented, but females dominated in the latter. Altogether, 237 recaptures were obtained, representing 22.8% of the total bats banded. Of these 161 (68%) were made in winter and 76 (32%) in summer. At least one recapture was obtained for nine species and 151 marked individuals. The recovery rate is higher for winter bats (30.9 %) than summer (14.7 %). There are 36 records of bat movements (15.2 % of all recaptures), including 26 concerning bats banded at Turold and recaptured outside this locality (15 *R. hipposideros*, 10 *M. emarginatus*, 1 *M. blythii*) and 10 of bats banded elsewhere and recaptured at Turold (6 *R. hipposideros*, 2 *M. myotis*, 1 *M. blythii*, 1 *M. nattereri*). Recapture data with respect to individual species are given below.

Table 3. Survey of the number of all banded bats and of all recaptures, 1958-2000. In the last column, the number of summer recaptures is in brackets.

Species / Sex	Winter		Summer		Total	Recaptures
	males	females	males	females	banded	
R. hipposideros	206	133	54	11	404	149 (23)
M. myotis	4	6	13	12	35	2 (1)
M. blythii	10	18	0	0	28	13
M. mystacinus	0	0	9	3	12	0
M. brandtii	1	0	0	0	1	0
M. emarginatus	33	27	33	7	100	18 (15)
M. nattereri	34	5	108	51	198	23 (15)
M. bechsteinii	8	1	14	1	24	0
M. daubentonii	11	3	55	28	97	5 (4)
E. serotinus	0	1	19	9	29	1 (1)
V. murinus	0	0	0	1	1	0
N. noctula	0	0	2	0	2	0
P. auritus	3	0	43	17	63	15 (13)
P. austriacus	14	3	17	9	43	11 (4)
B. barbastellus	0	0	1	0	1	0
Total	324	197	368	149	1038	237 (76)

Rhinolophus hipposideros

T/T recaptures: m – W/1W 43 x, W/2W 14 x, W/4W 4 x, W/5W 2 x, W/6W 1 x, W/11W 1 x, W/12W 1 x, S/1W 12 x, S/2W 6 x, S/3W 5 x, S/4W 2 x, S/2S 1 x, S/3S 1 x; f – W/1W 11 x, W/2W 6 x, W/3W 2 x, W/4W 1 x, W/7W 1 x, W/8W 1 x, W/12W 1 x, S/1W 5 x, S/2W 2 x, S/3W 1 x, S/4W 2 x, S/8W 1 x.

In both males and females, the longest period between banding and recapture was 12 years and the individuals concerned were found in the cave (type W/W). While in type S/W the longest period was eight years in a female, and three years for an S/S type male, no recaptures of type W/S were made. There were 15 recaptures of type T/O - 10 of them W/S. The bats were recaptured in the summer of the same or subsequent year, mostly at Lednice or Břeclav, up to 25 km east of the banding site. One record is exceptional: f, B 16-2-77, was repeatedly found hibernating in the cave on 7-2-78, 9-2-80 and 16-1-89; on 3-6-88 it was pregnant and recaptured in a breeding colony in the loft of a building at Bulhary, Panenský mlýn, (7 km NE). Another record represents the only recapture abroad: f, B 4-2-

76, R Rabensburg, Austria, 2-5-75 (27 km SE). The following recaptures of bats banded at Turold in summer are also worth mentioning: m, B 20-4-93, R artificial cave, Lednice, 17-1-95 (13 km E); f, B, 24-9-97, R in a cellar at Janohrad, Lednice, 20-1-98 (14 km E); f, B 16-9-91, R in a cellar at Insel, Mikulov, 29-1-95 (4.5 km SES); m, B 30-8-96, R game reserve feeding trough, Klentnice, 30-4-97 (3 km NE).

Four recaptures of type O/T represent records showing the connection between the caves of the Moravian Karst and Turold: 2 m, B Jedovnické propadání Cave, 26-1-58, R Na Turoldu Cave, 18-2-71 (58 km S); m, B Jedovnické propadání Cave, 26-1-58, R Na Turoldu Cave, 16-2-77 (same distance, but after 19 years); f, B Ochozská jeskyně Cave, 15-4-71, R Na Turoldu Cave, 17-2-73 (49 km S). Two O/T recaptures are of females who moved from breeding colonies to hibernacula: f, B Lednice, castle loft, 20-6-56, R Na Turoldu Cave, 8-2-58 (13 km W); f, B Lednice, castle loft, 10-7-59, R Na Turoldu Cave, 5-3-63 (same).

The highest numbers of *R. hipposideros* were marked during winter checks in 1969 and 1970. On the former, 54 m and 27 f were banded, and 21 m and 12 f on the latter date. There were 30 recaptures (56%) of males banded in 1969 and recaptured in 1970, but only four (15%) of the females treated at the same time. This species has the second highest overall recovery rate (36.9%) – i.e. 149 recaptures of 404 bats banded (Table 3).

Myotis myotis

Two recaptures of the O/T type: m, B Býčí skála Cave, Moravian Karst, 15-2-58, R Na Turoldu Cave, 21-2-59 (53 km S); m, B Bulhary, netted in Milovice Forest, 20-7-97, R Turold, netted, 28-8-97 (6 km W). As the second animal was recaptured only five weeks later (i.e. within the same season) the two localities probably belonged within its foraging range. The recovery rate was low (5.7%) for this species.

Myotis blythii

T/T recaptures: m – W/3W 1 x, W/10W 2 x, W/11W 1 x, W/12W 1 x; f – W/1W 3 x, W/2W 2 x, W/3W 1 x, W/9W 1 x, W/11W 1 x.

The last three records of males and the last two of females concern only one animal each. The male was banded in 1959 and recaptured in 1969, 1970 and 1971 in the cave Na Turoldu, but it was also recaptured in Kateřinská Cave, Moravian Karst, 13-2-73 (63 km N). The female was banded in 1959 and recaptured in 1968 and 1970 at the same place. There is one record of type O/T: f, B Erichova Cave, Moravian Karst, 10-2-59, R Na Turoldu Cave, 20-2-68 (66 km S). *Myotis blythii* had the highest recovery rate (46.4%).

Myotis emarginatus

T/T recaptures: m – W/1W 1 x, S/1S 1 x, S/2S 1 x, S/3S 1 x, S/7S 1 x, S/2W 1 x; f – W/1W 1 x, S/2S 1 x.

In addition to recaptures at the same locality, there are 10 cases of movements (T/O) - all of them concerning females banded in winter inside the cave and recaptured at summer breeding colonies at Lednice. The breeding colonies were situated in three different lofts of the central Lednice Castle, as well as in lofts of two smaller hunting castles up to 13 km away (Rybniční and Tři Grácie). One animal was checked six times: f, B 2-2-70, R Lednice, loft, 5-6-70, 28-6-71, 14-6-72, 26-6-73, 19-8-74. It was immature in 1970 and either pregnant or lactating on subsequent recaptures. The overall recovery rate was 18 % in this species.

Myotis nattereri

T/T recaptures: m – S/S (same season) 1 x, S/1S 8 x, S/2S 4 x, S/3S 1 x, S/4S 2 x, S/1W 2 x, S/2W 2 x, S/3W 1 x; f – S/5W 1 x.

One movement (O/T) was documented between a forest habitat and a hibernaculum: m, B Pavlov, netted at Soutěska, 9-9-91, R Na Turoldu Cave, 17-1-95 (5.5 km S). *Myotis nattereri* had a low recovery rate (11.6%), but there were large differences between the sexes: in males the recovery rate was 15.5%, but only one female was recaptured (1.8%).

Myotis daubentonii

T/T recaptures: m – S/S (same season) 1 x, S/1W 1 x, S/1S 2 x; f – S/1W 1 x.

The lack of data is related to the very low recovery rate (5.1%).

Eptesicus serotinus

T/T recapture: f - S/2S 1 x.

With only one recapture, the recovery rate for this species (3.4%) was the lowest recorded.

Plecotus spp.

T/T recaptures: *P. auritus*: m – W/1S 1 x, S/1S 5 x, S/2S 3 x, S/4S 2 x, S/5S 1 x, S/2W 2 x; f – S/3S 1 x. *P. austriacus*: m – S/S (same season) 1 x, S/5S 1 x, S/6S 1 x, S/1W 4 x, S/5W 1 x; f – W/2W 1 x, W/3W 1 x, S/1S 1 x.

The recovery rates were high: 23.8% in *P. auritus* and 25.6% in *P. austriacus.*

Discussion

The results of our checks show that Na Turoldu Cave hosts large numbers of *R. hipposideros* but negligible numbers of bats of other species. This resembles, for example, Hermannshöhle in Austria (B a a r et al. 1986) and certain caves in northern Moravia (Ř e h á k & G a i s l e r 1999). Due to its exposed hibernation, *R. hipposideros* can be found relatively easily so that numbers ascertained at a hibernaculum are close to reality (B e z e m et al. 1964). As the species is sedentary (R o e r 1995, S c h o b e r & G r i m m b e r g e r 1998) changes observed in its abundance at large hibernacula may reflect changes in the population density of the local population. This, however, does not seem to be the case for the decrease recorded at the beginning of our research. It seems most likely that the decreases from 1958–1963 were the result of disturbance to the bats associated with banding (R e i t e r 1998). On the other hand, the decrease between 1970 - 1975 was the result of disturbance by unauthorised human activity. In summer 1971, the gate closing the entrance to the cave was broken down and, during subsequent visits by intruders, the cave was devastated. The finding of only one *R. hipposideros* and a total of four bats in 1974 undoubtedly reflect this impact. The cave was closed and again put under protection in autumn 1975. The period 1975-1982 (and probably until 1983, although there was no survey that year) can be viewed as representing the recovery of the hibernating assemblage, when the number of bats started to grow (Fig. 1). The absence of banding and other negative impacts upon hibernating bats seems to be only one reason for this positive trend. Even more obvious than the increase in the total numbers of *R. hipposideros* recorded in the cave, is the increase in the size of the winter colony from 40 in 1959 to 200 in 1996, i.e. five fold. This corresponds with data from certain other hibernacula situated close to the species' northern border in Europe. After a general decrease in *R. hipposideros* numbers in the 1960s and 1970s (D a a n et al. 1980, O h l e n d o r f 1995) numbers stabilised and started to increase (M c A n e y 1994, Ř e h á k 1997, Ř e h á k & G a i s l e r 1999). This increase may reflect the successful breeding of local lesser horseshoe bat populations over the last fifteen years or so.

Is the superabundance of *R. hipposideros* observed in Na Turoldu and some other caves real or an artefact of the sampling method? We do not believe that the large numbers of bats (e.g. *M. nattereri*, *M. daubentonii* or *P. auritus*) caught in summer in front of the cave (Table 2) do not

hibernate at the locality. These, and some other species netted at Turold, tend to hide in protected places when hibernating, and so are difficult to find (Bezem et al. 1964, Schober & Grimmberger 1998). Baagoe et al. (1988) found that the number of *M. daubentonii* recorded departing from a Danish hibernaculum in spring was much greater than the number of hibernating individuals of the same species recorded by a visual census inside the same quarters in winter. Similar results were obtained in a study of *M. nattereri* and *M. daubentonii* wintering in a bunker in Poland (Jurczyszyn 1998). In both species the number of departing bats netted in late winter and spring was higher (nearly two times so in some years) than the number of bats seen inside. We therefore suspect that an unknown, yet considerable, number of bats netted outside the cave hibernate inside it. If this is the case, hibernation must occur either in protected places inaccessible to an observer, and/or they hibernate in deep slots in the rocks near to the outside the cave, which also makes them difficult to locate. If this is true, then the actual species diversity of the hibernating bat community must be greater (and the dominance of *R. hipposideros* lower) than that revealed from the winter samples. Irrespective of this rather speculative conclusion, the number of 15 species (nearly the half of European chiropterofauna) recorded at the locality is high and warrants Turold's the status as a nature reserve.

The results of marking and recapturing bats are generally in agreement with those from previous bat banding studies in the former Czechoslovakia (Hanák et al. 1962, Gaisler & Hanák 1969) - for example, the finding that *R. hipposideros* moves up to 27 km between summer and winter quarters. Similar movements between summer nursing quarters and a hibernaculum up to 13 km away have also been recorded in *M. emarginatus* (cf. Gaisler et al. 1989). New findings, however, are the movements between Turold and the Moravian Karst, i.e. between winter quarters up to 66 km, as recorded in *R. hipposideros*, *M. myotis* and *M. blythii.* A male *R. hipposideros*, banded in Moravian Karst area, was recaptured at Na Turoldu Cave after 19 years. As this individual must have been born in the summer prior to marking, its age at recapture was at least 19.5 years. Several recaptures of *R. hipposideros* and one in each *M. myotis* and *M. nattereri* document movements between a shelter and a foraging area or between two foraging areas at distances of up to 6 km.

The overall recovery rate for banded bats of 22.8% is high (Hanák et al. 1962 = 8.1%, Gaisler & Hanák 1969 = 9.1%, Hanák et al. 1996 = 9.7%). Recovery was higher in winter (30.9%) than in summer (14.7%) because of the much higher representation of *R. hipposideros* in the winter samples. If we omit *M. blythii*, the actual status of which is unclear (cf. Gaisler et al. 1988), *R. hipposideros* has the highest recovery rate of 36.9%. This results not only from its exposed hibernation, but also from its sedentary way of life. Sedentary *Plecotus* spp. also have high recovery rates. Reiter (1998) analysed recapture data at a locality where *R. hipposideros* was absent and found recovery rates of 20–25% in *Plecotus*, *Barbastella* and *Eptesicus*, while the recovery rates of *Myotis* spp. were lower. Masing et al. (1999) showed that second year recapture rates usually varied between 20–50% in sedentary bat species in Estonia, but that values were significantly lower in migratory species.

We have only few records of bats banded in winter and recaptured in summer (or vice versa) at Turold. This may (in part?) be due to the different times at which we banded bats: hibernating bats were only banded in 1958-1980, and bats netted outside the cave only in 1991-2000. Another source of error may be the potentially lower trapability of rhinolophids compared to vespertilionids in summer due to their echolocation differences. The bias makes it difficult to assess differences in interseasonal recovery rates for individual species, which might contribute to elucidating the problem of their real representation at the locality in different times of year.

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