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CONTRIBUTION TO ECOLOGY OF BRANDT'S BAT, *MYOTIS BRANDTII* (CHIROPTERA, VESPERTILIONIDAE), IN THE NORTH-EASTERN UKRAINE: COMPARISON OF LOCAL SUMMER AND WINTER BAT ASSEMBLAGES

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Contribution to Ecology of Brandt's Bat, *Myotis brandtii* (Chiroptera, Vespertilionidae), in the North-Eastern Ukraine: Comparison of Local Summer and Winter Bat Assamblages. Vlaschenko, A., Hukov, V., Naglov, A., Prylutska, A., Kravchenko, K., Rodenko, O. — The Brandt's Bat (*Myotis brandtii* Eversmann, 1845) is one of the rarest bat species in Ukraine. There are only a few known locations of this species in summer and less known hibernacula in the whole country. Moreover, for territory of the north-eastern Ukraine are known only two underground bat hibernation sites with aggregation more than several tens of individuals. We undertook population surveys of winter aggregations in newly discovered and dug up abandoned sandstone mines in the Chuguev district of the Kharkiv Region (49°54ʹ N, 36°43ʹ E) from 2007 through 2015. We also surveyed summer bat assemblages in the forests surrounding these mines in 2012. The mines' microclimate conditions were as follows: temperature +6 °C – +10 °C and humidity 60–80 %. *M. brandtii*, *M. daubentonii* (Kuhl, 1817) and *Plecotus auritus* (Linnaeus, 1758) hibernate in the mines; the first species is most abundant by number of individuals. In midsummer 9 bat species were recorded including the three previously mentioned. *M. daubentonii* and *P. auritus* breed in surrounding forest, but *M. brandtii* does not. One recaptured individual of *M. brandtii* was minimum 6 years old, providing us the first recorded information on longevity of this species for Ukraine. The total number of bats hibernating in these mines is estimated to be up to 100 individuals; a hibernaculum with several tens of *M. brandtii* could be classified as more numerous for this species in Ukraine. For this reason, the system of mines in the Kharkiv region needs species protection status and an action plan for monitoring and management.

Key words: Brandt's Bat, *Myotis brandtii*, underground hibernaculum, summer bat assemblage, bat winter aggregation, north-eastern Ukraine.

Introduction

The Brandt's Bat (*Myotis brandtii* Eversmann, 1845) is one of the rarest bat species in Ukraine (Tyshchenko, 2009), it was first recorded in Ukraine in 1990 (Pokin'chreda, 1999). There were only few individuals of this species recorded in the western (Tyshchenko, 2003; Zagorodniuk, Dykyy, 2009; Buchko et al., 2011) and northern (Gachshak et al., 2013) parts of Ukraine in summer time till 2014. Also the single records of *M. brandtii* were observed in winter in different kinds of hibernacula (Godlevska et al., 2010; Godlevskaya et al., 2011; Godlevska et al., 2016). However, in summer bat assemblages in oak forests in parts of north-east Ukraine this species is not so rare accounting for 0.5 to 2.5 % of species relative abundance (Vlaschenko, 2006; Vlaschenko, Gukasova, 2009; Vlaschenko, Gukasova, 2010; Vlaschenko, 2012). *M. brandtii* was also recorded in one location during the autumn swarming activity in eastern Ukraine (Vlaschenko, Naglov, 2005; Vlaschenko, 2006). However, the winter roosts of this species in north-eastern Ukraine (Vlaschenko, Naglov, 2006; Zagorodniuk, Korobchenko, 2008) and the nearest regions of Russia (Il'in et al., 2002; Vlaschenko et al., 2012) were previously unknown.

Underground hibernacula with mass bat aggregations are quite rare in plain areas of north-eastern and eastern Ukraine, and the published data name only one in the Kharkiv Region (Vlaschenko, Naglov, 2006) and another group of mines in the Donetsk Region (Godlevskaya, Ghazali, 2009). The new system of abandoned mines in the Kharkiv Region was discovered by members of a Non-government Speleostological Organization "Dety pidzemellya" in 2007 near Tetlega Village, in the Chuguev District (Kovalev, 2014; Vlaschenko et al., 2014). Completely collapsed mines with only narrow entrances similar to those of burrows were dug out by people from NGO “Dety pidzemellya”. The first expedition to estimate the extent to which these underground sites are used as bat roosting place was conducted in the same year.

We identified these mines as important bat hibernaculum after several years of observations. One of the numerous bat species in this hibernaculum was *M. brandtii*. It was the first numerous wintering aggregation of the species in Ukraine and one of the biggest sample size of captured individuals. Due to these reasons two objectives of this paper are: to present data on winter bat aggregations in these mines, and to give short characteristics of forearm length and body mass of local *M. brandtii*. Furthermore, in July 2012 we did mist-netting survey in forest plot in vicinity of Tetlega mines. Little is known about summer and winter bat assemblages for one locality. Our results of summer bat mist-netting and winter bat census allow us to present two others subjects: data on summer bat assemblage in the areas surrounding the mines, and sex and age structure of the local bat population.

Material and methods

Study area and Study site. Kharkiv Region is located in north-eastern Ukraine; it borders the Russian Federation to the north and has a total area of 31.4 thousand km^2. The border between forest steppe (to the North) and steppe (to the South) nature zones crosses the region through the middle of the southern half. The terrain of the Kharkiv Region is undulating plains with a maximal elevation of 236 m above sea level in the north and minimal elevation of 90 m in the south-east. The mean annual temperature in the region is 8.1 °C, the mean January and July temperatures are — 7 °C and +21 °C respectively, and annual precipitation does not exceed 540 mm. There are oak, pines and mixed forests covering 12 % of the region (Golikov et al., 2011). In this paper we use both calendar and phenological year-round division (Boot, 1971; Golikov et al., 2011).

The Tetlega mines (49°54' N, 36°43' E) are located in the center of the Kharkiv Region 2 km from Tetlega Village. The mines were excavated in a bed of sandstone on the bank of a shallow valley. The mines are located in an old oak forest (about 8000 ha) on the left bank of the small river Tetlega. The mines were established in XVIII century, as sources of stone for millstone. Mines were abandoned probably no more than one hundred years ago. In 2007 the expedition of NGO “Dety pidzemellya” dug up three mine galleries and named them “Nedetskaya”, “Osinaya” and “Pobeda”. We used schematic maps of these mines designed by specialists from NGO “Dety pidzemellya”.

Mine Nedetskaya is located on the plat part on 30–50 m from the edge of the valley; total length, ca. 87 m; height of adits, 0.5–1.6 m. At present, it has only one entrance (0.8 x 0.5 m), that was dug in 2007. This mine had no external entrances before excavation.

Mine Osinaya is located on the slope of the valley; total length of ca. 15 m; the corridor is narrow (maximum of 0.8 m wide) with one branch. The entrance to the mine is temporarily unavailable.

Mine Pobeda is located on the slope of the valley; total length, ca. 220 m; height of adits, 0.5 to 1.7 m. At present, it has only one man-accessible entrance, a tight horizontal tunnel (0.6 x 0.4 m) located on the slope of the valley. The entrance was filled by ground from 2010 to 2012 and our 2013 expedition discovered that it became too narrow to access. The entrance was excavated again in November 2013.

There are many crevices in the walls, bays and ceilings in all three mines. There are two main types of crevices in the mines. The first are shallow crevices in clay found mostly in the ceilings. The second type is deep cracks in beds of sandstone; these can reach up to a few meters deep.

Data collecting. The temperature inside the mines was measured 20–30 centimeters above ground level by digital thermo-hygrometer (TFA 301020, manufactured in China) with an accuracy 0.1 °C. We left thermometers for 5–10 minutes at designated points to minimize the influence of human body temperature on the measurements. Results of temperature measurements were recorded making a total of more than 100 measurements. The humidity was measured with an accuracy of 5 %.

Both Nedetskaya and Pobeda mine were surveyed 9 times and Osinaya was surveyed once in different months from October 2007 to August 2015. During each visit a full inspection was performed.

In winter bats were not disturbed, we recorded locations of individuals on schematic maps of the mines. We also noted the wall or ceiling position, whether roosting openly or inside a crevice, and number of bats in an aggregation. Only active bats (flying inside the mines) were handled and measured during winter months. Manipulations with bats were made in August–October or in the second half of March.

We caught bats by ultrathin Chinese mist-nets, 6 x 3.5 m and 4 x 3.5 m in front of the mine entrances, and 12 x 4 m in the forest. We operated mist-nets from the sunset till 2 hours after it or the whole night at the mine entrances. The structure of summer bat assemblage was studied in July 2012 according to the well-established methodological approach (Vlaschenko, Gukasova, 2009; Gukasova, Vlaschenko, 2011). Nine mist-netting points were designated in surrounding forests (1 point at a lake in the forest, 2 points at lakes on the forests border, 2 points at roads and glade-lines, and 4 points at borders of openings and clear cuttings).

Species, sex and age of captured bats were identified; forearm length (by a caliper, accurate to 0.1 mm) and body mass (by digital weigh-scales, accurate to 0.1 gram) were measured also. We used current bat identification keys (Dietz, von Helversen, 2004; Dietz et al., 2009); Whiskered *Myotis* species group identification were made by wing membrane inserted at the foot, the teeth characteristics (checked by a loupe) and penis form (for males). There are no records of other species of Whiskered Myotis group on the territory of Kharkiv Region except

M. brandtii yet (Vlaschenko, 2011). We classified bats in two age groups: ad — adult (specimens older than 10 months), sad — subadult (specimens younger than 10 months) (Borisenko, 2000). In July the individuals with cartilaginous gaps on joints of the 5th finger were identified as subadult bats. In autumn, winter and spring age identification was more difficult, and we used a combination of characteristics for exact identification. Females of *M. brandtii* with puffed nipples were ranked to adult and those with flat and pink nipples were ranked to subadult. For *Myotis daubentonii* (Kuhl, 1817) chin-spot presence was used as an additional sign of age classification (Richardson, 1994). Adult males were identified by big testes and whirl up epididymides, the epididymides were white with black endings and/or black edge (Encarnação et al., 2003). Subadult males were identified as those with invisible testis and epididymides that looks like a black triangle. Specimens with unclear or combined age characteristics were classified as uncertain (un).

The majority of bats were banded with chiropterological identifying rings (Aranea, Poland) (Vlaschenko, 2012).

All animals after biometrical processing were released at the site of capture either immediately or the next evening (in June–August). All methods of bat capturing, keeping and handling were ethical according to international rules of animal welfare and conservation of protected species (Gannon et al., 2007).

The full list of recorded bats is presented in the Appendix. In total, we caught and recorded more than 300 individuals in mines and 328 in the surrounding forest area. Nine bat species were caught in total *M. daubentonii*, *M. brandtii*, *Myotis dasycneme* (Boie, 1825), *Eptesicus serotinus* (Schreber, 1774), *Nyctalus leisleri* (Kuhl, 1817), *Nyctalus noctula* (Schreber, 1774), *Pipistrellus nathusii* (Keyserling & Blasius, 1839), *Pipistrellus pygmaeus* (Leach, 1825) and *Plecotus auritus* (Linnaeus, 1758).

We recorded the tracks and signs of others animals in the mines, mainly mammals, and also the frequency of visits by people.

Statistic analysis. The statistical calculations were carried out by R software (www.r-project.org; version R i386 3.0.2, R Development Core Team, 2013). The binomial test was used for comparison of sex ratios (in samples which contained more than 10 specimens). The non-parametric Chi-squared test was used for comparison of allocation of individuals of *M. brandtii* and *M. daubentonii* inside the mines. The Mann-Whitney U test was used for comparison of forearm and body mass of *M. brandtii* between sex groups and phenological periods.

Results

Microclimate characteristics in Tetlega mines. The microclimate conditions were estimated for two mines: Pobeda and Nedetskaya. In Pobeda mine the mean temperature varied from +8.7 °C (n = 16, 22–02–2014) and +8.8 °C (n = 17, 07–02–2015) in February to +9.4 °C (n = 7, 02–11–2013) and +9.5 °C (n = 15, 01–11–2014) in November. In April the mean temperature was +8.9 °C (n = 16, 07–04–2014) (n — number of measurements). The maximum temperature inside the mine was +10.3 °C in a deep part of the underground, and the minimum (at a fixed point a few meters from the entrance) was +7.4 °C (07–02–2015 with outdoor temperature –7.0 °C). The temperature in Pobeda mine never falls below zero; the narrow entrance protects the mine from frost. In Nedetskaya mine the mean temperature varies from +8.7 °C (n = 8, 22–02–2014) and +8.1 °C (n = 9, 07–02–2015) in February to +9.9 °C (n = 8, 01–11–2014) in November. In April the mean temperature was +8.0 °C (n = 8, 07–04–2014). The maximum temperature inside the mine was +10.6 °C in a deep part of the underground, and the minimum was +6.5 °C (07–02–2015). The humidity in both mines varies from 60 % to 80 %.

Bat species composition in winter and in summer. Three species were recorded during hibernation in the mines, with *M. brandtii* being most abundant (table 1). The majority of hibernating bats and all three species were found in Pobeda mine. In Nedetskaya mine only few individuals (of *M. brandtii* and *M. daubentonii*) were recorded (Appendix). Both census methods, winter surveys inside the mines and mist-netting events in spring departure time, give similar results in terms of species relative abundance, however the occurrence of *M. daubentonii* starts to increase in spring.

In midsummer in surrounding forests the most abundant species was *N. noctula*, and the ratio of the three species hibernating in the mines (*M. brandtii*, *M. daubentonii* and *P. auritus*) together was only 8 % (table 1). In this period, the biggest bat species number was recorded, with the majority being long-distance migrant tree-dwelling species (besides *N. noctula*, the other ones were *N. leisleri*, *P. nathusii* and *P. pygmaeus*). During the period of autumn swarming (August) *M. daubentonii* was the most abundant species (table 1).

Table 1. Bat species relative abundance in the Tetlega mines and surrounding forest area in different seasons of a year

Species	Summer, mn* (July)	Autumn, mn swarming (August)	Hibernation, c** (15 November–20 March)	Spring departure, mn&c (21 March–April)
M. brandtii	0.3 % (n = 1)	22.5 % (n = 42)	54.3 % (n = 25)	40.0 % (n = 32)
M. daubentonii	3.7 % (n = 12)	73.8 % (n = 138)	43.5 % (n = 20)	55.0 % (n = 44)
M. dasycneme	—	0.5 % (n = 1)	—	—
N. noctula	82.0 % (n = 269)	1.6 % (n = 3)	—	—
N. leisleri	4.6 % (n = 15)	0.5 % (n = 1)	—	—
E. serotinus	1.8 % (n = 6)	—	—	—
P. nathusii	2.4 % (n = 8)	0.5 % (n = 1)	—	—
P. pygmaeus	1.2 % (n = 4)	0.5 % (n = 1)	—	—
P. auritus	4.0 % (n = 13)	—	2.2 % (n = 1)	5.0 % (n = 4)
Total (bats)	328	187	46	80

*mn — mist-netting; **c — census inside the mines.

Sex ratio and breeding status of the local bat poulation. In the summer (July) bat assemblage the females and subadult individuals were predominant among the most abundant species (Appendix). Only a single adult male was sampled and identified as *M. brandtii* in the summer survey; this was also the only species of those sampled that does not breed in the area. For *M. daubentonii* only subadult individuals were present in July with equal sex ratio (7 ♀ and 5 ♂, binomial test, $p = 0.77$). In the swarming period (August) for both age groups of *M. brandtii* males were predominant (5 ♀ and 34 ♂, binomial test, $p < 0.01$). For *M. daubentonii* among adult individuals males were predominant too (32 ♀ and 59 ♂, binomial test, $p < 0.01$). For subadult individuals of *M. daubentonii* there was equal sex ratio (18 ♀ and 29 ♂, binomial test, $p = 0.14$). In winter only few individuals were identified by sex resulting in a sample size insufficient for analysis (Appendix). In April there were more *M. brandtii* males than females recorded inside the mines (6 ♀ and 17 ♂, binomial test, $p = 0.03$), but among individuals mist-netted near the entrances there were more females than males (8 ♀ and 1 ♂). Among *M. daubentonii* recorded inside the hibernacula in April (3 ♀ and 6 ♂) males were predominant, among mist-netted individuals (15 ♀ and 20 ♂, binomial test, $p = 0.49$) there was equal sex ratio. Among *P. auritus* captured in spring departure period all were males, but in midsummer we caught adult females and subadult individuals of both sexes (Appendix).

We got one recapture of a ringed bat, a female *M. brandtii* ringed on 20–02–2008 in Pobeda mine with ring number B028527 and recaptured 07–04–2014 in the same mine. This individual was identified as adult in 2008, consequently it was minimum 6 years old at the time of recapture.

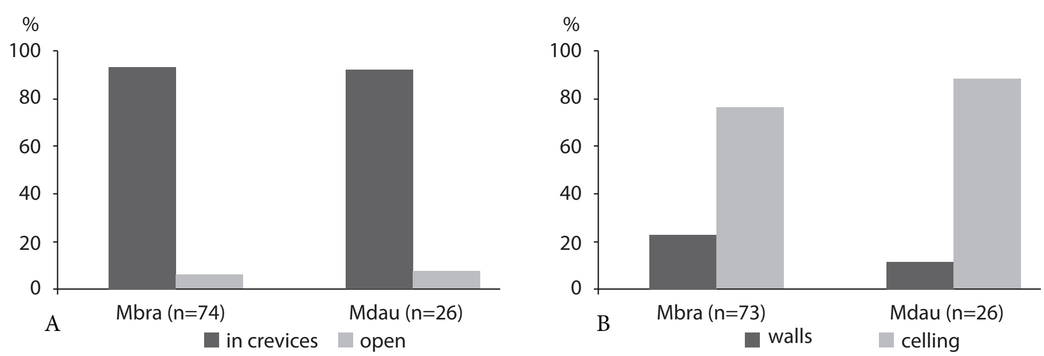

Fig. 1. Allocation of *M. brandtii* (Mbra) and *M. daubentonii* (Mdau) inside the Tetlega mines from November to April (n — number of counted bats); A — in crevices or open, B — on walls or ceiling.

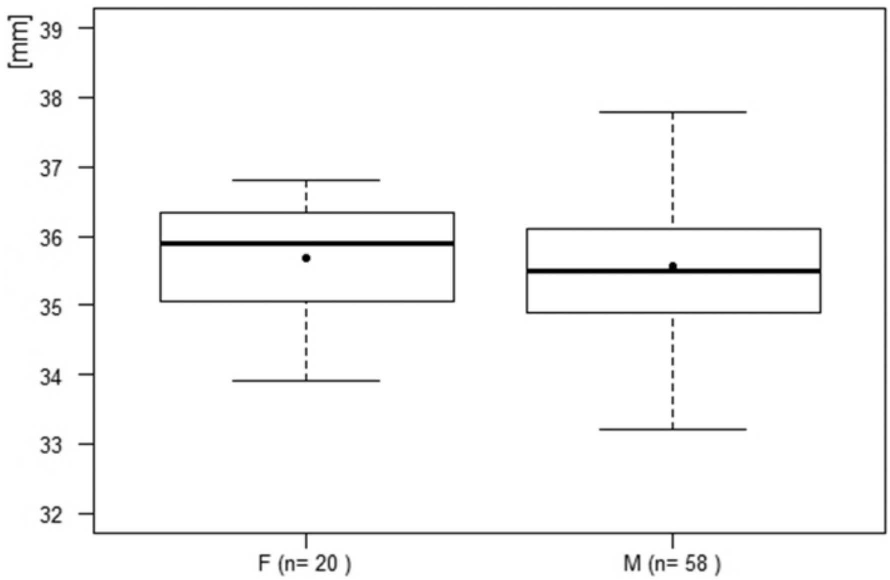

Fig. 2. Forearm length (mm) of females (F) and males (M) of *M. brandtii* from Tetlega mines (dot — mean value, line — median value, whiskers — min and max values).

B a t a l l o c a t i o n i n s i d e a h i b e r n a c u l u m. The preference of allocation inside the mines for *M. brandtii* and *M. daubentonii* is presented in fig. 1, A. and fig. 1, B. Inside the mines, both species prefer the deep crevices (fig. 1, A) in the ceiling (fig. 1, B). We did not observe a significant difference between the preferences in allocation of *M. brandtii* and *M. daubentonii* (crevices/open: X-squared = 0.0207, $p > 0.05$; wall/ceiling: X-squared = 1.6417, $p > 0.05$). The single *P. auritus* which was found in the Pobeda mine was hanging in an open position on the ceiling.

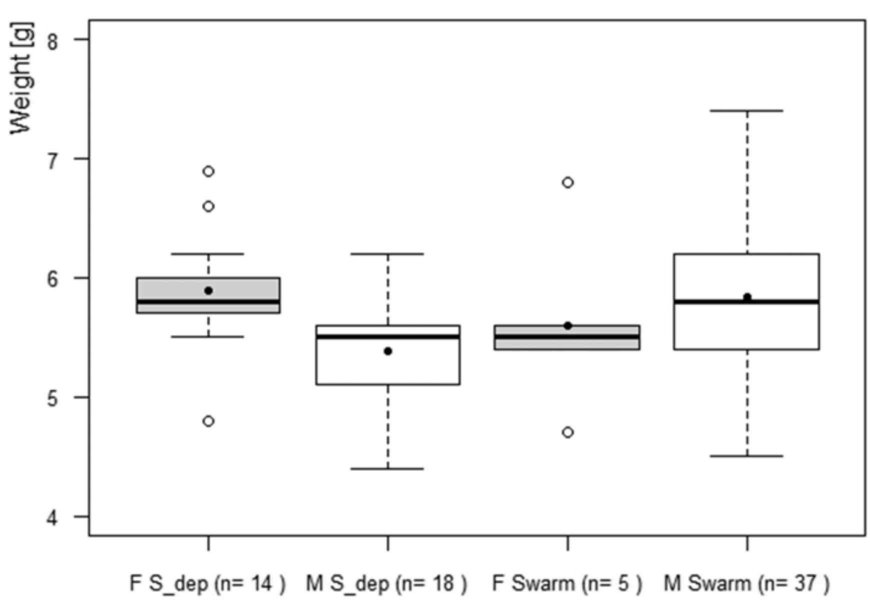

Fig. 3. Body mass (g) characteristic of females (F) and (M) of *M. brandtii* in periods of spring departure April (S_dep) and swarming August (Swarm) from the Tetlega mines (dot — mean value, line — median value, whiskers — min and max values, not filling circles — outliers).

Characteristic of forearm length and body mass of *M. brandtii*. The mean value of forearm length of *M. brandtii* affiliated with Tetlega mines for females is 35.6 mm and for males 35.5 mm (fig. 2). Forearm length did not differ significantly between females and males ($W = 637$, p-value > 0.05).

In the period of spring departure (April) the body mass of *M. brandtii* hibernating in Tetlega mines in females was 5.8 g and for males 5.3 g (fig. 3). In this period females had on average a significantly bigger body mass than males ($W = 206.5$, p-value < 0.05). In the period of swarming (August) the average body mass for females was 5.6 g and for males 5.8 g (fig. 3). There is no statistically significant difference in body mass between females and males during the swarming period ($W = 67$, p-value > 0.05).

There was no statistically significant difference in body mass of females between spring departure and swarming periods ($W = 52$, p-value > 0.05). On the contrary, males had a significantly higher body mass during the swarming period than they did during spring departure ($W = 181.5$, p-value < 0.05).

Other mammal species noted in the mines were mainly carnivores, namely foxes, badgers and stray dogs. In different years of observations foxes and badgers lived in Pobeda mine (mainly in the adits unsuitable for humans). There were a lot of droppings from these species near the entrances of the mine. In 2013 the entrance to Pobeda mine was covered from inside by soil from a fox burrow. At the same time people visited these mines very rarely. The mines are covered by forest and the entrances look more like burrows than underground mines. It is very unlikely that people visit the mines, except for visits organized by our team or by NGO "Dety pidzemellya".

Discussion

The Tetlega mines were backfilled by soil; Pobeda mine for example was only accessible by a narrow burrow like adit. The adit was just wide enough for bats to enter and obviously these mines were used by local bats before they were dug up. The main places of bat hibernation in the mines are deep crevices in sandstone. In August 2015 we observed bats flying into adits of Pobeda mine and hiding inside crevices. Observations of these mines bring up the question: can bats use burrows of carnivores for hibernation or do bats rather prefer to pass through the burrows and go to crevices in the sandstone or any other rock type? As far back as the middle of the XX century Strelkov (1958) noted a great disproportion between the minimal numbers of counted bats in hibernacula to the thousands of bats present in the same area in summer. This was noted for the Central Black Earth Region of Russia and for north-eastern Ukraine mainly, areas with a small number of rock mines and a lack of natural caves (Strelkov, 1958; Vlaschenko, Naglov, 2006). The main hypothesis explaining this disproportion was that bats use deep crevices in rock denudations for hibernation (Strelkov, 1958; Vlaschenko, Naglov, 2005; Vlaschenko, Naglov, 2006). Even one example of such a hibernaculum was described (Borisenko et al., 1999). However, the case with Tetlega mines lead us to another hypothesis that the undiscovered hibernacula (except human cellars: Lesiński et al., 2004; Vlaschenko et al., 2012) could be not only open rock denudation, but also burrows to the rocks, or even badger setts. Bats in hibernation are an easy prey for any ground predators from carnivores to insectivores (Il'in, 1988). For this reason badgers could eat bats if they are situated in the adits of a set, and therefore the hypothesis is of low-probability. Nonetheless, it could be tested in the future. The particularities of bat allocation in the Tetlega mines (mostly in crevice of ceiling, fig. 1, A; 2, B) could be explained as protection from predators. Bats choose more protected locations, where there is a low likelihood of being eaten by carnivores that live permanently in the mines.

Before the Tetlega mines were discovered, in Kharkiv Region only one mine system was known — Liptsy mines (40 km to the north-east from the Tetlega mines) (Vlaschenko, Naglov, 2006). In Liptsy mines the bat winter aggregation and seasonal dynamics of the aggregation have been sufficiently studied since 1999 (Vlaschenko, Naglov, 2006;

Vlaschenko et al., 2014). This mine system was classified as the most populated bat hibernation site in all of north-eastern Ukraine (Godlevska et al., 2016). We can compare the data presented in this paper with the data known for the Liptsy mines. The Tetlega mines are lower and full of ground adits compared to Liptsy mines (Vlaschenko, Naglov, 2006; Kovalev, 2014). The Liptsy mines are recent underground sites where mining activity continued up to the beginning of the XX century. The microclimate conditions of Tetlega mines or more specifically Pobeda mine is similar to that of "Liptsy 2" mine (+8 °C to +11 °C, Vlaschenko et al., 2014). Both of them have one narrow burrow for an entrance. Two other Liptsy mines ("Liptsy 1" and "Liptsy 3–4") have two entrances and a low temperature gradient in winter (Vlaschenko, Naglov, 2006; Vlaschenko et al., 2014). The humidity in the Liptsy mines is higher (up to 95–100 %) than in the Tetlega mines, but the accuracy of humidity measurements by available digital hygrometer is not enough for accurate assumption.

The Tetlega mines have the second highest number of hibernated bats among underground hibernacula in Kharkiv Region. The structure of bat winter aggregation in Tetlega mines is different to the Liptsy mines. In case of the Liptsy mines *M. brandtii* is absent and *M. dasycneme* is present as rare species. *P. auritus* is the rarest species in the Tetlega mines but is the second most abundant in Liptsy mines. The most abundant species in Liptsy mines is *M. daubentonii*. Hibernation of *M. dasycneme* (by several individuals) in the Tetlega mines could also be possible, because this species was caught there in swarming time (Appendix). On the contrary *M. brandtii* has never been caught in Liptsy mines or at all in the northern part of Kharkiv Region. The record of *M. brandtii* in the vicinity of Tetlega Village is the northernmost recorded location of the species in the Kharkiv Region. All records of this species in the warm period of a year were made in the south and south-east, in forests on the banks of the Seversky Donets River (Vlaschenko, 2006; Vlaschenko, Gukasova, 2009; Vlaschenko, Gukasova, 2010). In these southern forests, reproductive females and subadult individuals were recorded, although in the forests near Tetlega mines *M. brandtii* do not breed. Are the summer micropopulations and winter aggregations formed by the same individuals or not is topic for future research. It is known that *M. brandtii* can travel 300 km (even 600 km) between summer and winter habitats (Hutterer et al., 2005).

The general characteristics of bat summer assemblage in the forest near the Tetlega mines are typical for oak forest of north-eastern Ukraine and the Central Black Earth Region of Russia (Vlaschenko, Gukasova, 2009; Vlaschenko, Gukasova, 2010; Prylutska, 2014). The dominant species are forest-dwelling and long-distance migrants, with highest abundance of *N. noctula*. In terms of sex-age structure, breeding females and subadult individuals are most frequently recorded for most species. From both winter and summer surveys for this location 9 species have been recorded of the 12 bat species known to occur in the whole Kharkiv Region (Vlaschenko, 2011).

The recapture of a ringed individual of *M. brandtii* gives the first longevity data for this species in Ukraine (Vlaschenko, 2012).

The values of forearm length of *M. brandtii* from Tetlega mines completely coincide with data from literature: means 35.4 mm (Strelkov, Buntova, 1982), 35.5 mm (Zagorodniuk, Dukuy, 2009), and range 33.0–38.2 mm (Dietz, Kiefer, 2014). The data on body mass and seasonal dynamic of this parameter is limited. Dietz and Kiefer (2014) gave a range of 5–7 g for body mass of *M. brandtii*; our data (fig. 3) has a wider range than presented in this book.

The Tetlega mines urgently need an Action Plan for future conservation. Without such a plan, these artificial underground sites will be backfilled within a few years. We need to protect entrances, otherwise in just one spring bats can be trapped within the mine walls resulting in extinction of the local population. An ecological trap for bats is created when a man-made structure becomes a key bat roosting site, but years later it could be damaged. The management of such underground sites for bat conservation is a key step for Europe's strategic protection of these animals (Mitchell-Jones et al., 2007). The other important subject that needs to be tested in a future study will be the estimation of predator pressure on the local bat population of Tetlega mines. Do the carnivores living in the mines hunt local bats, and what is the number of individuals eaten?

Conclusions

We discovered a new bat underground hibernaculum (Tetlega mines) in north-eastern Ukraine. It is a system of abandoned sandstone mines in Chuguev district of Kharkiv Region. Tens of individuals (it is possible up to 100) of three bat species hibernate in the mines and *M. brandtii* is one of the most numerous among them. Based on the large number and diversity of bats using the Tetlega mines, the site should be listed as a key hibernaculum of the national or even international importance (EUROBATS.AC5. Report.Annex3, Mitchell-Jones et al., 2007). The Tetlega mines are the second most used hibernaculum for bats in the Kharkiv Region and even among all underground hibernacula in north-eastern Ukraine.

In summer 8 bat species live in the forest surrounding the mines and the structure of bat assemblage is typical for oak forest of north-eastern Ukraine. The dominant species are forest-dwelling and long-distance migrants, with highest abundance of *N. noctula*. In terms of sex-age structure, breeding females and subadult individuals were recorded most often for most species, except for *M. brandtii* since they do not breed in the area. From winter and summer surveys of this location 9 bat species in total have been documented. The values of forearm length of local *M. brandtii* completely coincide with data from literature.

The Tetlega mines urgently need an Action Plan of future conservation according to European rules for bat underground hibernacula (Mitchell-Jones et al., 2007).

Appendix

List of recorded bats: A) inside the Tetlega mines (only including visits when bats were recorded), B) mist-netted near the mines entrances, C) mist-netted in surrounding forest area. Abbreviations: Date of record: 20(6/7)–02–08 — dd(dd/dd)–mm–yy; Mine names: P — Pobeda mine, N — Nedetskaya mine; Bat species acronyms: *Mdau— Myotis daubentonii*, *Mbra — Myotis brandtii*, *Mdas — Myotis dasycneme*, *Msp. — Myotis* sp.*;* *Eser — Eptesicus serotinus*, *Nnoc — Nyctalus noctula*, *Nles — Nyctalus leisleri*, *Pnat — Pipistrellus nathusii*, *Ppyg — Pipistrellus pygmaeus*, *Paur — Plecotus auritus*. Symbols of sex and acronyms of age: ♀ — female, ♂ — male; ad — adult individual, sad — subadult individual, un — sex and age were unidentified. For one individual we noted only one symbol of sex, for two and more individuals we noted the number before the sex symbols. We divided by commas sex-age groups of one species, by semicolons different species in one date, different mines in one date and/or mist-nets in one night are divided by dots.

A) 20–02–08 P — *Mdau* 3un; *Mbra* ♀. 02–11–13 P — *Msp.* 1. N — *Mdau* ♂ ad. 22–02–14 P — *Mdau* 6 un; *Mbra* 15 un; *Msp.* 4; *Paur* 1un. N — *Mbra* 1un; *Msp.* 1. 07–04–14 P — *Mdau* 2 ♀ ad, 3 ♂ sad, ♂, 2un; *Mbra* ♀ ad, 3 ♀ sad, 2 ♀, 5 ♂ ad, ♂ sad, 11 ♂, 25 un; *Msp.* 1. 08–04–14 N — *Mdau* ♀ ad, ♂ ad, ♂ sad, 1un; *Mbra* 2 un; *Msp.* 1. 01–11–14 P — *Mdau* ♀ ad, 1un. N — *Mdau* 1un. 07–02–15 P — *Mdau* ♀ ad, ♂ ad, 2 ♂ sad, 7un; *Mbra* ♂, 5 un. N — *Mbra* ♂, 1un. 18–08–15 P — *Mbra* 3 ♂ ad; *Msp.* 8.

B) 06–10–07 P — *Mdau* ♂ sad. 18–03–09 P — *Paur* 3 ♂. 18/19–04–09 P — *Mdau* ♀ sad, 7 ♂ ad; *Mbra* ♀ ad; *Paur* ♂ sad. 19–04–09 P — *Mdau* 2 ♂ ad, ♂ sad; *Mbra* ♀. 7/8–04–14 P — *Mdau* 7 ♀ ad, 2 ♀ sad, 5 ♀, 9 ♂ ad; *Mbra* 2 ♀ ad, 3 ♀ sad, ♀, ♂ sad. N — *Mdau* ♂ ad. 16/17–08–15 P — *Mdau* 17 ♀ ad, 7 ♀ sad, 27 ♂ ad, 19 ♂ sad; *Mbra* ♀ ad, 3 ♀, 16 ♂ ad, 9 ♂; *Mdas* ♂ ad. N — *Mdau* 15 ♀ ad, 11 ♀ sad, 32 ♂ ad, 10 ♂ sad; *Mbra* ♀ sad, 7 ♂ ad, 2 ♂; *Nnoc* 2 ♂ sad, ♂; *Nles* ♀ sad; *Pnat* ♀ ad; *Ppyg* ♀ ad.

C) 05/06–07–12 — *Mdau* ♀ sad. *Mdau* 2 ♀ sad, 2 ♂ sad; *Eser* ♂ ad; *Nnoc* 14 ♀ ad, 18 ♀ sad, 9 ♂ ad, 19 ♂ sad; *Nles* 2 ♀ ad, 3 ♀ sad, 2 ♂ sad; *Pnat* ♂ ad, ♂ sad; *Ppyg* ♀ ad, ♀ sad; *Paur* ♀ sad. *Paur* 2 ♀ ad, ♀ sad, 4 ♂ sad. 06/07–07–12 — *Mbra* ♂ad; *Eser* 2 ♀ ad, ♂ sad; *Nnoc* 13 ♀ ad, 8 ♀ sad, 13 ♂ sad; *Nles* ♀ sad, 2 ♂ sad; *Paur* 2 ♀ ad. 07/08–07–12 — *Mdau* 3 ♀ sad, 3 ♂ sad; *Eser* ♀ ad; *Nnoc* 23 ♀ ad, 41 ♀ sad, 14 ♂ ad, 31 ♂ sad; *Nles* 2 ♀ sad, ♂ sad; *Pnat* 2 ♀ sad. *Mdau* ♀ sad; *Nnoc* 15 ♀ ad, 4 ♀ sad, 3 ♂ ad, 6 ♂ sad; *Nles* 2 ♀ ad; *Pnat* ♀ ad; *Ppyg* ♀ sad; *Paur* ♀ ad. 08/09–07–12 — *Eser* ♂ ad; *Pnat* 3 ♂ sad; *Ppyg* ♂ sad; *Paur* ♀ ad, ♀ sad. 09–07–12 — *Nnoc* ♀ sad, ♂ sad. *Nnoc* 5 ♀ ad, 15 ♀ sad, ♂ ad, 15 ♂ sad.

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