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Discovering underground bat hibernacula in lowland eastern Europe

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Abstract: The importance of underground hibernacula for the conservation of bats and monitoring their populations is well-recognized. However, the lowland territory of Belarus, with absent natural caves and suitable for bats mines, was one of the least surveyed European regions in terms of underground bat sites, and especially hibernacula. To address this knowledge gap, in 2020, we conducted a broad-scale one winter bat survey, exploring 90 underground sites (basements, cellars, church crypts, fortifications, and facilities of abandoned Soviet missile bases) in various parts of Belarus. To our knowledge, none of these sites had been examined for bats before. In 56 of the 90 underground sites, we discovered hibernating bats (a total of 1054 ind.) of six species: *Barbastella barbastellus* (78.5% of all bats), *Myotis daubentonii* (7.4%), *Plecotus auritus* (5.1%), *Eptesicus nilssonii* (4.9%), *Myotis brandtii* and *Eptesicus serotinus* (in sum, 2%). The distribution of bats among the hibernacula was highly uneven (with $N_{Me} = 3$; $N_{av} = 19$ ind.). In 76% of the hibernacula, the number of bats was between 1 and 10 individuals per site, which accounted for approximately 10% of all bats recorded during the survey. Only in five sites we found over 50 bats. One to four species were present in each site, with one species found in 58% of the hibernacula. We suppose that the small number of species and relatively small number of bats per hibernaculum is characteristic of the study region. This supports the idea that selecting key underground bat sites for their conservation and monitoring should be done regionally and only after obtaining primary data about bat species and their numbers in a sufficient number of sites. Our data significantly expands knowledge about underground bat hibernacula in the large lowland territory of eastern Europe and may serve as a starting point for further monitoring.

Key words: Bats, underground hibernacula, lowland regions, Belarus, eastern Europe

1. Introduction

Underground roosts are very important for many bat species worldwide, in particular for those which are year-round or seasonal troglophilous. In temperate regions, with the severe winters, such roosts are essential for hibernation of bats as they provide protected microclimate environment making bat wintering possible or not so risky relative to natural overground cavities such as hollow trees (Hutson et al., 2001; Mitchell-Jones et al., 2007; Furey and Racey, 2016).

Underground bat roosts also provide an opportunity for surveyors to make a census of animals which are not very visible and/or dispersed in the space due to their lifestyle and high mobility (Hayes et al., 2009; Battersby, 2010). Surveying underground bat roosts enables the characterization of the distribution and status of troglophilous species (Nagy and Postawa, 2011), and long-term regular counts of bats in these roosts allow for estimating population trends and assessing the results of bat conservation efforts, both regionally and globally (Van der Meij et al., 2015).

The importance of underground roosts for conservation and monitoring of bats was recognised and internationally adopted, in particular by the Resolutions 2.4 and 4.3 of the EUROBATS Agreement (EUROBATS, 1998; 2003). That was further followed by the compiling the database of internationally important bat underground sites of Europe.[1]

However, neither conservation nor monitoring of underground bat shelters are possible without the basic inventory (including the initial search and examination) of them. In many European regions, this was done decades ago. There, regular counts of bats in their underground roosts have been conducted for many years (Battersby, 2010). In others, the initial inventory of underground bat sites and identification of the most significant of them has started only quite recently.

1EUROBATS (2016). Conservation of Key Underground sites: the database (2016). Website https://www.eurobats.org/activities/intersessional_working_groups/underground_sites [accessed 08 March 2023].

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The lowland territory of Belarus, which does not have natural caves, is one of the least surveyed regions in Europe with regards to knowledge about underground bat sites. The bat species list of this region includes 19 species (Shpak et al., 2022), 9 of which are known to be cave-dwelling, at least during part of the year. However, little is known about their underground roosts and, in particular, their hibernacula.

The book by Kurskov (1981), summarizing decades of his work with bats of Belarus, mentions that he searched for bats in all possible potential roosts, including "basements, cellars, vegetable stores, and bunkers". According to Kurskov, the maximum number of hibernating bats observed per one underground site was 10 and 14 individuals. Later, Kurskov (1993) reported the discovery of newly-found underground hibernacula of *Barbastella barbastellus* in a large vegetable store in the middle of Bielaviežskaja Pušča Forest, where he observed 300–320 individuals of this species each winter from 1983 to 1986.

Demyanchik and Demyanchik (1999) reported about mass bat hibernation in buildings of the Brest Fortress where they recorded eight bat species of over 5000 individuals in total (with ca. 88% of *B. barbastellus*). These authors also confirmed the existence of the large hibernacula revealed by Kurskov, and reported about one more underground bat hibernacula of few tens of bats in Bielaviežskaja Pušča National Park.

The abovementioned sites, all located in southwestern Belarus, were the only underground bat hibernacula that have been described in publications for the territory of the country.

In 2019–2020, we conducted a comprehensive survey to search and inventory underground bat sites across various regions of Belarus. This paper aims to present the data collected during the survey, which enables to describe for the first time the underground bat hibernacula and bat communities wintering in them across a significant area of Eastern Europe.

2. Study area, methods

The territory of Belarus is lowland region with the average height is 160 m a. s. l.; the highest point, 345 m a. s. l. (Nature of Belarus, 2009). There are no natural caves or suitable for bats mines. The climate is temperate continental with the average year temperatures from +7 °C at the SW to +4.5 °C at the NE; the average January temperature, from –4.5 °C in the SW to –8 °C in the NE (Nature of Belarus, 2010).

In this study, we use the term "underground site" or simply "site" to refer to any underground unit that was examined during the study.

Before the fieldwork, we conducted an extensive search for information on underground sites that could potentially serve as bat shelters. In June and July 2019, we examined 70 underground sites in situ and found only a few solitary bats (*Plecotus auritus*) in them (Shpak et al., 2022). During the summer exploration, we also evaluated the sites' potential to serve as bat hibernacula, by their size and insulation from external temperatures. In February 2020, we explored 90 underground sites, including 27 from the summer list and an additional 63. The examined underground sites are located in all six administrative provinces of Belarus (Figure 1). We surveyed all sites for bats, to our knowledge, for the first time.

All examined sites were man-made and can be classified into the following categories.

1. *Basements* (of former manor houses, a castle, and a monastery): cavities below buildings; of different size, brick/stoned, sometimes plastered (n = 14). *Cellars:* small, underground, standing alone facilities, brick, and concrete (n = 2).
2. *Crypts* of abandoned churches: cavities below the overground part of these buildings, covering their entire area; brick, partly plastered (n = 4).
3. *Fortifications*. Include: brick reduits and a bastion of the Babrujsk fortress (of the 19th cent.) abandoned and accessible for public (n = 7); fire groups of the Mazyr fortified area (built in 1930s): groups of pillboxes connected by the underground concrete galleries with chambers (n = 2).
4. *Facilities of the abandoned Soviet missile bases*. Each base included facilities for storing missiles, their maintenance, assembly, transportation, launching, defence, as well as housing and sheltering personnel; etc. We examined the facilities of 12 ground-launched missile bases and one large base for storing nuclear missile ammunition; all located at a distance from settlements. The facilities varied in terms of volume, size, and condition, with most being made of concrete, somewhere plastered inside. They were either underground, banked half-overground, or banked overground (n = 61).

The examined sites, in majority, were quite short by length. The longest two had the length about ca. 300 m. All sites were abandoned or not in active use. The level of public access to the sites varied and was, obviously, determined mostly by access restrictions and remoteness of settlements. In one missile base, we found signs of their usage as a strike ball polygon. None of the examined sites have a nature conservation status.

The sites were inspected, and bat counts were conducted by visually examining. In sites with high ceilings, binoculars and zooming photo-cameras were also used. *Myotis brandtii* was identified based on a set of external characters following Dietz and von Helversen (2004). The final count only included visible bats.

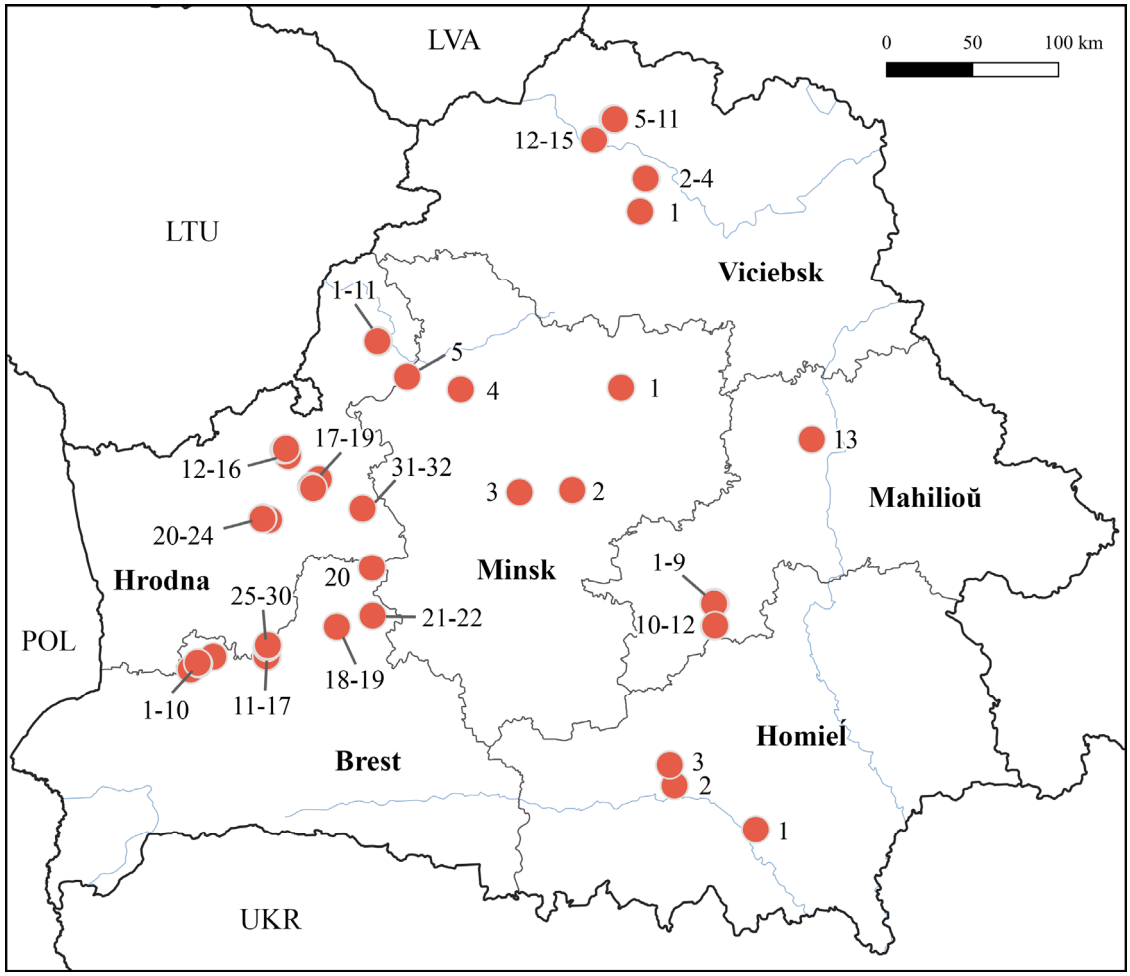

Figure 1. Location of the examined underground sites. *Numbers correspond to those in the list of Annex 1.*

3. Results

During the winter survey, we revealed bats in 56 (62%) of 90 examined sites (Annex 1). The total number of accounted hibernating bats was 1054 individuals. Six species were found in the examined sites: *Barbastella barbastellus* (Schreber, 1774), *Eptesicus nilssonii* (von Keyserling & Blasius, 1839), *Eptesicus serotinus* (Schreber, 1774), *Myotis brandtii* (Eversmann, 1845), *Myotis daubentonii* (Kuhl, 1817), and *Plecotus auritus* (Linnaeus, 1758) (Annex 2).

Among the accounted bats, *B. barbastellus* prevailed significantly by the number of individuals. This species also prevailed by the number of sites it was found hibernating in. The less distributed species was *M. brandtii*. The species with the smallest total number was *E. serotinus* (Figure 2).

The most inhabited by bats sites among explored were fortifications and basements/cellars: wintering bats were found in 78% and 75% of them, correspondingly. The checked facilities of missile bases were inhabited less: bats were recorded in 57% of them. However, in sites of this category, we recorded the biggest portion of all accounted bats (76%) in total; as well as the largest aggregations were found in the facilities of missile bases (Annex 1). The number of church crypts inspected was only four with bats revealed in two of them (Figure 3).

The distribution of bats among the examined hibernacula was highly uneven (with $N_{Me} = 3$ and $N_{av} = 19$ individuals). In 76% of the hibernacula, the number of bats found was between 1 and 10 individuals per site, accounting for approximately 10% of all bats recorded during the survey. Only five sites had aggregations of over 50 bat individuals, accounting for over 60% of all bats recorded during the survey (Figure 4). Two sites with the largest aggregations (Mh10 and Mh12; see Annex 1), with a total number of 42% of all accounted bats, are located nearby and represent, in fact, a single bat hibernacula complex.

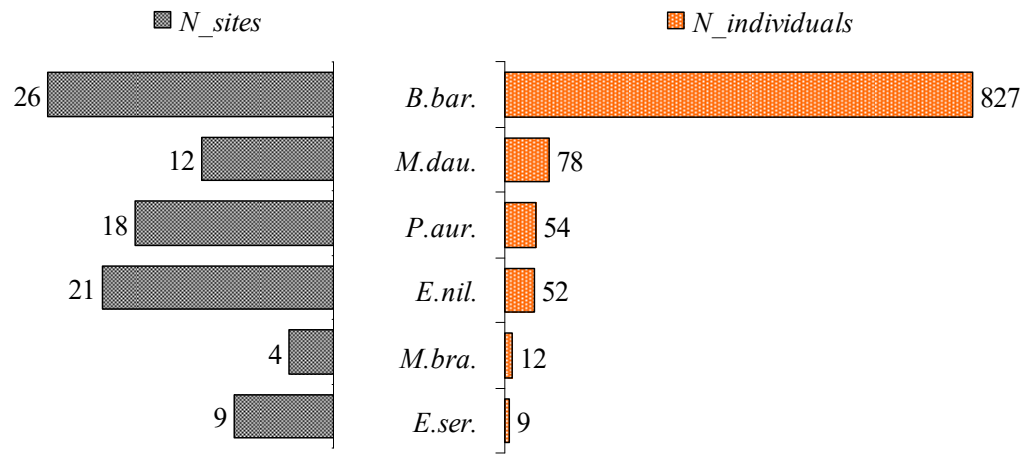

Figure 2. Bat species by the total number of individuals (right) and the number of sites in which they were recorded (left).

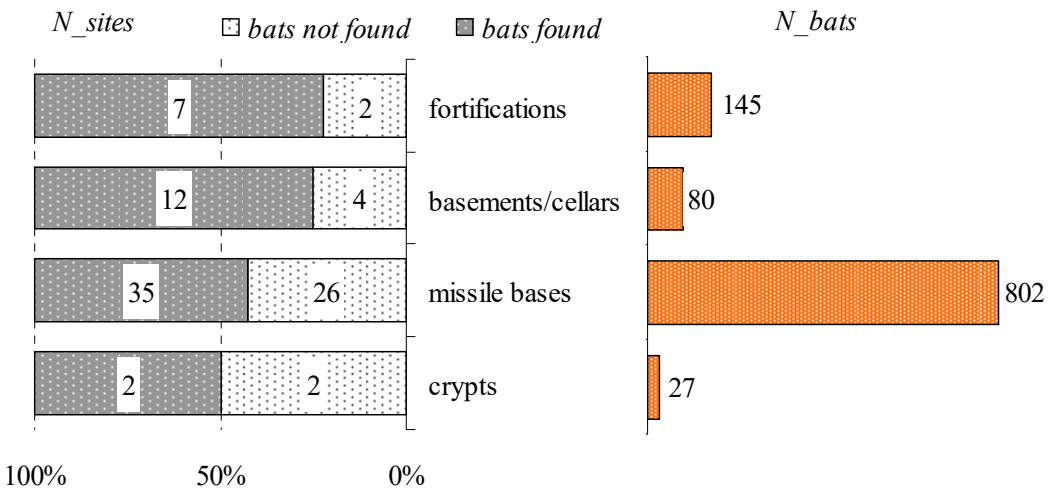

Figure 3. Presence and total numbers of bats in different types of the examined underground sites.

Note. We presume that the actual number of hibernating bats in some examined sites may be higher than recorded. For example, in the site with the highest number of bats (Mh10), there were extensive construction (ventilation) channels that were inaccessible for examination.

The number of bat species found hibernating in the examined sites ranged from one to four per site. In the majority of the examined hibernacula (58%), only one species was observed (Figure 5). However, the total number of bats in such monospecific hibernacula accounted for approximately 50% of all bats recorded during the survey.

4. Discussion

The results of the census provided the addition to the knowledge about bat species occurrence in Belarus. The most significant contribution was the discovery of *B. barbastellus* in almost half of the examined hibernacula (in five provinces of Belarus) with the highest total number among all the hibernating species. Till 2015, in Belarus, this species was known only in the southwest of the country (Kurskov, 1981; Demjanchik and Demjanchik, 2000). Later, Dombrovski et al. (2017) recorded it ca. 250 km to the east, in S Belarus. In 2019, the species was first

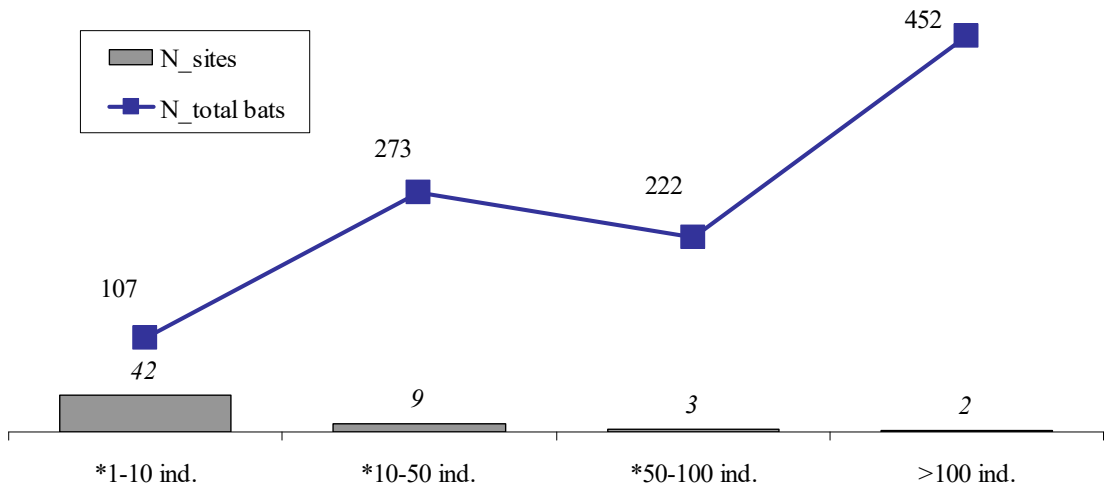

Figure 4. The quantitative distribution of bats among the bat inhabited sites.

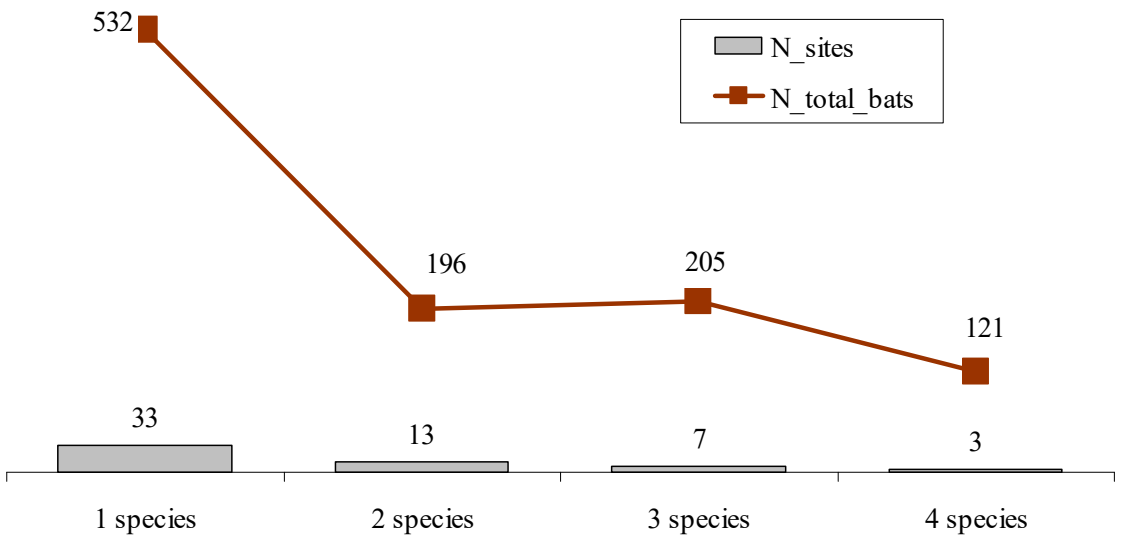

Figure 5. The number of species and the total number of bats in the inhabited sites.

recorded in central Belarus, in Minsk (Shpak et al., 2022). Our data shows the presence of the big population of this species inside the study region and enable to outline its distribution more accurate, both regionally and globally. Notably, this species was the least recorded during the summer bat survey in Belarus (Shpak et al., 2022). That evidences the importance of applying multiple methods during the bat fauna inventory, and that the results of underground bat shelters' survey may significantly supplement other data.

Of 19 bat species of the Belarusian fauna, all species in the genera *Myotis* (n = 6), *Plecotus* (n = 2), and *Barbastella* (n = 1) can be classified as troglophilous, totalling 9 species. These species are sedentary or do not migrate long distances (Hutterer et al., 2005), and are primarily known to hibernate in underground cavities (Dietz et al., 2009), which is particularly relevant for regions with cold winters, like Belarus. Two *Eptesicus* species are also regularly found in underground hibernacula throughout their range (Dietz et al., 2009), but in small numbers, suggesting that

underground shelters may not be their primary type of wintering and could be considered "semitroglophilous."

During our survey, we recorded only six species, including four troglophilous species (2, *Myotis*; 1, *Plecotus;* 1, *Barbastella*) and two semitroglophilous species (*Eptesicus*). In comparison, eight species were found in underground hibernacula in the southwest of Belarus (Demjanchik and Demjanchik, 1999; Haarsma et al., 2010). In adjacent regions of northern Ukraine, eight species were recorded hibernating in underground shelters (Godlevska et al., 2016); in adjacent territories of Poland, eight species were recorded (nine with *M. mystacinus*) (Fuszara et al., 1996; Lesiński et al., 2004); in Lithuania, in Kaunas fortress (located approximately 100 km to the north of the northwest border of Belarus), eight species were recorded (Pauza and Pauziene, 1998; Masing et al., 2009); and in Latvia, seven species were recorded (eight with *M. mystacinus*) (Vintulis and Pētersons, 2014).

The "missing" species, according to the list of troglophilous bats in Belarus and species recorded to hibernate underground in adjacent territories, are: *Myotis dasycneme* (Boie, 1825), *Myotis myotis* (Borkhausen, 1797), *M. nattereri* (Kuhl, 1817), *Myotis mystacinus* (Kuhl, 1817), and *Plecotus austriacus* (Fischer, 1829).

M. dasycneme has been recorded in five of the six administrative provinces of Belarus, including two maternity colonies, and its distribution range overlaps with our study area. However, it appears to be a generally rare species in Belarus based on previous records (Kurskov, 1981; Demjanchik and Demjanchik, 2000; Shpak et al., 2022).

M. myotis appears to be a relatively elusive species in the Belarusian fauna (Shpak et al., 2022). Its main distribution range lies to the east and south of our study area (Sachanowicz et al., 2006; Red book of Ukraine, 2009), where it has also been observed in underground hibernacula in Poland (Fuszara et al., 1996; Lesinski et al., 2004) and Ukraine (Godlevska et al., 2016). We suppose that four documented records of this species in Belarus (Kurskov, 1981) can be considered accidental.

Occurrence of *M. nattereri* in Belarus has only been confirmed in the SW part of the country (Demjanchik and Demjanchik, 2000; Haarsma et al., 2010; Dombrovski et al., 2017; Shpak et al., 2022). Therefore, the absence of this species in the bat hibernacula examined by us may be due to its general distribution pattern.

M. mystacinus sensu sticto was included in the list of bat species found in Belarus based on an inventory of collected museum specimens conducted by Strelkov (1983): both this species and *M. brandtii* were identified in the Bielaviežskaja Pušča Forest. However, the distribution of *M. mystacinus* s. s. in Belarus, as in many other regions, requires further survey. All recent records of whiskered bats in Belarus have been attributed to *M. brandtii* in surveys conducted by Shpak (2010), Dombrovski (2017; 2018), and Larchanka et al. (2020). During our winter counts, we identified "whiskered bats" based on external morphological characteristics that corresponded to those of *M. brandtii*.

P. austriacus was first recorded in Belarus in the early 1990s, in the SW (Demjanchik and Demjanchik, 2000). Its discovery there, according to the data, is related to the ongoing expansion of the species range and is consistent with recent discoveries in adjacent regions of Poland (Sachanowicz et al., 2006). However, to date, this species has not been found outside the SW region of Belarus (Shpak et al., 2022).

It is possible that more troglophilous bat species hibernating in underground sites will be discovered in the study area in the future, in particular those that are known to occur here in the summer (such as *M. dasycneme*). However, we presume that we recorded the basic species suite which is compiled by the revealed, six, species.

The number of species per examined site was quite small, with only four species being revealed in three sites, and one to three species in the rest. In only five sites did the total number of bats exceed 50 individuals; in the majority of sites, we found 1–10 bats. These results are consistent with the data of Kurskov (1981), who also did not find aggregations of bats wintering underground.

Considering the wide geographical range, the large number of examined sites, and their diversity, we suggest that the small number of species and the relatively small number of bats per hibernaculum may be a characteristic of the study region. This supports the idea that the selection of key underground bat sites should be developed regionally and only after obtaining primary data about bat species and their numbers in such shelters in a specific region (Mitchell-Jones et al., 2000).

We discovered the largest aggregations of hibernating bats in the facilities of abandoned Soviet missile bases, where we recorded 76% of all bats and found the five largest hibernacula (with N_{total} > 50 ind.). This highlights the importance of such sites for bat conservation in Belarus. Notably, no large bat hibernacula are known in similar missile bases in Latvia and Ukraine (Vintulis, 2013; Godlevska and Vorobei, own data).

The collected data significantly expand the knowledge about underground bat hibernacula at the large territory of the lowland eastern Europe and may serve as the starting point for further monitoring of bat populations in the region.

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References

Battersby J. (2010). Guidelines for surveillance and monitoring of European bats. EUROBATS Publication Series. No. 5. Bonn, Germany: UNEP/EUROBATS Secretariat. https://doi.org/10.13140/RG.2.1.1747.8802

Demjanchik VT, Demjanchik MG (2000). Bats of Belarus: handbook – field guide. Brest, Belarus: S. Lavrov Publishers (in Russian).

Demyanchik MG, Demyanchik VT (1999). Comparative-ecological aspect of mass hibernation groups of bats in the engineering structures of Brest and the State National Park "Belovezhskaya Pushcha". In: Belovezhskaya Pushcha at the Turn of the Third Millennium; Minsk, Belarus. p. 273-275 (in Russian).

Dietz C, Nill D (2009). Bats of Britain, Europe and Northwest Africa. London: A & C Black.

Dietz C, von Helversen O (2004). Illustrated identification key to the bats of Europe. Electronic publication v. 1.0: 1-72. https://doi.org/10.13140/RG.2.1.3908.5606

Dombrovski V (2018). Maternity colonies of *Myotis brandtii* in the Polesie State Radiation-Ecological Reserve. Theriologia Ukrainica 16: 91-94. https://doi.org/10.15407/pts2018.16.091

Dombrovski V, Fenchuk V, Zhurauliou D (2017). The bat fauna (Mammalia, Chiroptera) of Stary Zhaden zakaznik, Southern Belarus. Proceedings of the Theriological School 15: 3-9. https://doi.org/10.15407/ptt2017.15.003

EUROBATS (1998). Resolution 2.4. Transboundary Programme: Habitat Proposals.

EUROBATS (2003). Resolution 4.3. Guidelines for the Protection and Management of Important Underground Habitats.

Furey NM, Racey PA (2016). Conservation ecology of cave bats. In: Voigt CC, Kingston T (editors). Bats in the Anthropocene: Conservation of bats in a changing world. 1st ed. Springer, pp. 463-500.

Fuszara E, Kowalski M, Lesinski G, Cygan JP (1996). Hibernation of bats in underground shelters of central and northeastern Poland. Bonner zoologische Beiträge 46: 349-358.

Godlevska L, Buzunko P, Rebrov S, Ghazali M (2016). Underground bat sites of "not-cave" region of Ukraine, on results of 2002–2015. Visnyk of the Lviv University. Series Biology 71: 178-189 (in Ukrainian with an abstract in English).

Haarsma AJ, Jansen E, Bongers F (2010). Report of a visit of the region of Brest, February 24 – March 03.

Hayes JP, Ober HK, Sherwin RE (2009). Survey and Monitoring of bats. In: Kunz TH, Parsons S (editors). Ecological and Behavioral Methods for the Study of Bats. Baltimore: Johns Hopkins University Press, pp. 112-129.

Hutson AM, Mickleburgh SP, Racey PA (2001). Global status survey and conservation action plan Microchiropteran bats. Gland, Switzerland and Cambridge, UK: International Union for the Conservation of Nature.

Hutterer R, Ivanova T, Meyer-Cords C, Rodrigues L (2005). Bat migrations in Europe: A review of literature and analysis of banding data. Naturschutz und Biologische Vielfalt 28: 1-176.

Kurskov AN (1981). Bats of Belarus. Minsk, Belarus: Navuka i technika (in Russian).

Kurskov AN (1993). Rare species of bats listed in the second edition of the Red Data Book of Belarus. Protected animals of Belarus 3: 49-51 (in Russian).

Larchanka AI, Velihurau PA, Semyonova AA, Valnisty AA, Solovej IA (2020). New data on bats species diversity in National Park Narochansky (Belarus). Proceedings of the National Academy of Sciences of Belarus, Biological Series 65 (4): 454-461 (in Russian). https://doi.org/10.29235/1029-8940-2020-65-4-454-461

Lesiński G, Kowalski M, Domański J, Dzięciołowski R, Laskowska-Dzięciołowska K et al. (2004). The importance of small cellars to bat hibernation in Poland. Mammalia 68 (4): 345-352. https://doi.org/10.1515/mamm.2004.034

Masing M, Baranauskas K, Siivonen Y, Wermundsen T (2009). Bats hibernating in Kaunas Fortress, Lithuania. Estonian Journal of Ecology 58 (3): 192-204. https://doi.org/10.3176/eco.2009.3.04

Mitchell-Jones T, Bihari Z, Masing M, Rodrigues L (2007). Protecting and managing underground sites for bats. Publication Series. No. 2. Bonn, Germany: UNEP/EUROBATS Secretariat.

Mitchell-Jones T, Bihari Z, Rodrigues L, Masing M (2000). Guidelines for the implementation of Resolution No. 4 adopted by the 2nd Session of the Meeting of Parties Transboundary Programme–Habitats: Data compilation.

Nagy ZL, Postawa T (2011). Seasonal and geographical distribution of cave - dwelling bats in Romania: implications for conservation. Animal Conservation 14 (1): 74-86. https://doi.org/10.1111/j.1469-1795.2010.00392.x

Nature of Belarus: encyclopedia. Climate and water (2010). Volume 2. Minsk, Belarus: Belarusian Encyclopaedia named after Petrus Brovka (in Russian).

Nature of Belarus: encyclopedia. Earth and subsoil (2009). Volume 1. Minsk, Belarus: Belarusian Encyclopaedia named after Petrus Brovka (in Russian).

Pauza DH, Pauziene N (1998). Bats of Lithuania: distribution, status and protection. Mammal Review 28 (2): 53-68. https://doi.org/10.1046/j.1365-2907.1998.00025.x

Red book of Ukraine. Animal World (2009). Kyiv, Ukraine: Globalkonsalting (in Ukrainian).

Sachanowicz K, Ciechanowski M, Piksa K (2006). Distribution patterns, species richness and status of bats in Poland. Vespertilio 9 (10): 151-173.

Shpak A (2010). First record of *Myotis brandtii* (Mammalia, Vespertilionidae) in the Central Polesie of Belarus. Vestnik zoologii 44 (3): 252.

Shpak A, Godlevska L, Larchanka A, Savchenko M, Vorobei P et al. (2022). Data on the summer bat fauna of Belarus in 2017–2020. Theriologia Ukrainica 23: 20-30. https://doi.org/10.15407/TU2305

Strelkov PP (1983). Records of *Myotis brandti* Eversmann, 1845 and *Myotis mystacinus* Kuhl, 1819 (Chiroptera, Vespertilionidae) based on materials from the museums of the USSR. Proceedings of the Zoological Institute of the Academy of Sciences of the USSR, 119: 38-42 (in Russian).

Van der Meij T, Van Strien AJ, Haysom KA, Dekker J, Russ J et al. (2015). Return of the bats? A prototype indicator of trends in European bat populations in underground hibernacula. Mammalian Biology 80: 170-177. https://doi.org/10.1016/j.mambio.2014.09.004

Vintulis V (2013). Sikspārņu pazemes mītņu nozīme un populāciju ilglaicīga dinamika Latvijā. Promocijas darbs Doktora grāda iegūšanai bioloģijas nozarē, Latvijas Universitāte, Rīga, Latvia (in Latvian).

Vintulis V, Pētersons G (2014). Root cellars are important winter roosts for brown long-eared bats (*Plecotus auritus*) and northern bats (*Eptesicus nilssonii*) in Latvia. Mammalia 78 (1): 85-91. https://doi.org/10.1515/mammalia-2012-0104

Annex 1. Inventory of underground bat hibernacula in Belarus.

#	Name of a site	Type	Date	BBAR	ENIL	ESER	MBRA	MDAU	PAUR	My.sp	Pl.sp.	Unident.	N_ind / N_sp
Homieĺ Province (Ho)													
1	Juravičy, monastery	Basement	22.02.2020						2				2 / 1
2	Pcič, fire group	Fortification	22.02.2020	36		1			9		1	1	48 / 3
3	Pieršaja Slabodka, fire group	Fortification	22.02.2020	44		1			1			> 1	> 47 / 3
Mahilioŭ Province (Mh)													
1	Babrujsk Fortress-1	Fortification	23.02.2020					2					2 / 1
2	Babrujsk Fortress-2	Fortification	23.02.2020	2		1							3 / 2
3	Babrujsk Fortress-3	Fortification	23.02.2020										0 / 0
4	Babrujsk Fortress-4	Fortification	23.02.2020					39	1	1	2		43 / 2
5	Babrujsk Fortress-5	Fortification	23.02.2020										0 / 0
6	Babrujsk	Cellar	23.02.2020										0 / 0
7	Babrujsk, church	Crypt	23.02.2020					8					8 / 1
8	Babrujsk Fortress-6	Fortification	23.02.2020	1									1 / 1
9	Babrujsk Fortress-7	Fortification	23.02.2020						1				1 / 1
10	Kazakova, military-1	Missile	23.02.2020	329									329 / 1
11	Kazakova, military-2	Missile	23.02.2020	4									4 / 1
12	Kazakova, military-3	Missile	23.02.2020	123									123 / 1
13	Kniažycy, church	Crypt	24.02.2020										0 / 0
Viciebsk Province (Vi)													
1	Arechaŭna, church	Crypt	24.02.2020		8			5	5			1	19 / 3
2	Bieckaje, military-1	Missile	25.02.2020		1								1 / 1
3	Bieckaje, military-2	Missile	25.02.2020		1							1	2 / 1
4	Bieckaje, military-3	Missile	25.02.2020										0 / 0
5	Dziornavičy, military-1	Missile	25.02.2020		1								1 / 1
6	Dziornavičy, military-2	Missile	25.02.2020										0 / 0
7	Dziornavičy, military-3	Missile	25.02.2020										0 / 0
8	Dziornavičy, military-4	Missile	25.02.2020										0 / 0
9	Dziornavičy, military-5	Missile	25.02.2020										0 / 0
10	Dziornavičy, military-6	Missile	25.02.2020										0 / 0
11	Dziornavičy, military-7	Missile	25.02.2020		2								2 / 1
12	Zaborje, military-1	Missile	25.02.2020		2								2 / 1

Annex 1. Continued

#	Name of a site	Type	Date	BBAR	ENIL	ESER	MBRA	MDAU	PAUR	My.sp	Pl.sp.	Unident.	N_ind / N_sp
13	Zaborje, military-2	Missile	25.02.2020		2				1				3 / 2
14	Zaborje, military-3	Missile	25.02.2020										0 / 0
15	Zaborje, military-4	Missile	25.02.2020										0 / 0
Minsk Province (Mn)													
1	Stara-Barysaŭ, manor	Basement	24.02.2020										0 / 0
2	Smilavičy, manor	Basement	24.02.2020						1				1 / 1
3	Kalinina, manor	Basement	24.02.2020	1									1 / 1
4	Miasata, manor	Cellar	26.02.2020										0 / 0
5	Bienica, church	Crypt	26.02.2020										0 / 0
Hrodna Province (Hr)													
1	Asinaŭščyna, military-1	Missile	26.02.2020										0 / 0
2	Asinaŭščyna, military-2	Missile	26.02.2020	1	1								2 / 2
3	Asinaŭščyna, military-3	Missile	26.02.2020		5								5 / 1
4	Asinaŭščyna, military-4	Missile	26.02.2020		3								3 / 1
5	Asinaŭščyna, military-5	Missile	26.02.2020										0 / 0
6	Asinaŭščyna, military-6	Missile	26.02.2020										0 / 0
7	Asinaŭščyna, military-7	Missile	26.02.2020		3								3 / 1
8	Asinaŭščyna, military-8	Missile	26.02.2020										0 / 0
9	Asinaŭščyna, military-9	Missile	26.02.2020										0 / 0
10	Asinaŭščyna, military-10	Missile	26.02.2020		1								1 / 1
11	Asinaŭščyna, military-11	Missile	26.02.2020		1								1 / 1
12	Bierdaŭka, manor	Basement	27.02.2020					1					1 / 1
13	Cvermy, military-1	Missile	27.02.2020	1	2			1					4 / 3
14	Cvermy, military-2	Missile	27.02.2020	80	8				1	1			90 / 4
15	Cvermy, military-3	Missile	27.02.2020	1									1 / 1
16	Cvermy, military-4	Missile	27.02.2020		2								2 / 1
17	Bierdaŭka, military	Missile	27.02.2020										54 / 3
18	Hieniušy, military-1	Missile	27.02.2020	18									18 / 1
19	Hieniušy, military-2	Missile	27.02.2020										0 / 0
20	Naharodavičy, military-1	Missile	27.02.2020		2								2 / 1
21	Naharodavičy, military-2	Missile	27.02.2020	2	2								4 / 2

Annex 1. Inventory of underground bat hibernacula in Belarus.

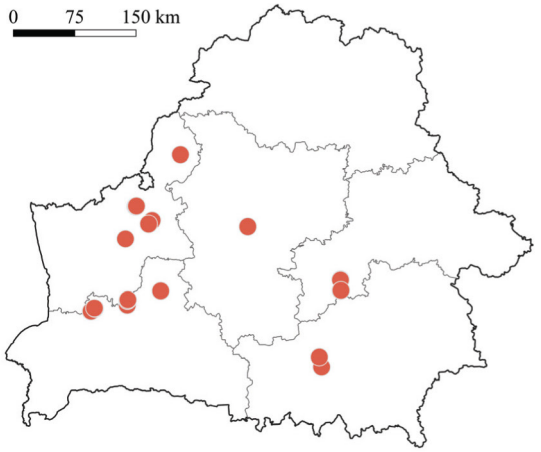
#	Name of a site	Type	Date	BBAR	ENIL	ESER	MBRA	MDAU	PAUR	My.sp	Pl.sp.	Unident.	N_ind / N_sp
22	Naharodavičy, military-3	Missile	27.02.2020		1	1							2 / 2
23	Naharodavičy, military-4	Missile	27.02.2020		2								2 / 1
24	Naharodavičy, military-5	Missile	27.02.2020										0 / 0
25	Zavodny Lies, military-1	Missile	29.02.2020	36					1				37 / 2
26	Zavodny Lies, military-2	Missile	29.02.2020										0 / 0
27	Zavodny Lies, military-3	Missile	29.02.2020										0 / 0
28	Zavodny Lies, military-4	Missile	29.02.2020										0 / 0
29	Zavodny Lies, military-5	Missile	29.02.2020										0 / 0
30	Zavodny Lies, military-6	Missile	29.02.2020										0 / 0
31	Ščorsy, manor	Cellar	29.02.2020					1		3			4 / 1
32	Ščorsy, manor	Basement	29.02.2020				1	3					4 / 2
Brest Province (Br)													
1	Ružany Palace-1	Basement	28.02.2020			1	4	6	4	1			16 / 4
2	Ružany Palace-2	Basement	28.02.2020				2	6	16	6			30 / 3
3	Libiarpoĺ, military-1.1	Missile	28.02.2020	1		1			1				3 / 3
4	Libiarpoĺ, military-1.2	Missile	28.02.2020	2									2 / 1
5	Libiarpoĺ, military-2.1	Missile	28.02.2020			1			2				3 / 2
6	Libiarpoĺ, military-2.2	Missile	28.02.2020	7					2				9 / 2
7	Libiarpoĺ, military-2.3	Missile	28.02.2020	77					1				78 / 2
8	Libiarpoĺ, military-2.4	Missile	28.02.2020	1									1 / 1
9	Libiarpoĺ, military-2.5	Missile	28.02.2020										0 / 0
10	Libiarpoĺ, military-2.6	Missile	28.02.2020										0 / 0
11	Manciuty, military-1	Missile	29.02.2020	4		1							5 / 2
12	Manciuty, military-2	Missile	29.02.2020	1									1 / 1
13	Manciuty, military-3	Missile	29.02.2020	2									2 / 1
14	Manciuty, military-4	Missile	29.02.2020						z				0 / 0
15	Manciuty, military-5	Missile	29.02.2020										0 / 0
16	Manciuty, military-6	Missile	29.02.2020										0 / 0
17	Manciuty, military-7	Missile	29.02.2020										0 / 0
18	Jastrambieĺ, manor	Basement	29.02.2020	1			5	5	3	1			15 / 4

Annex 1. Continued

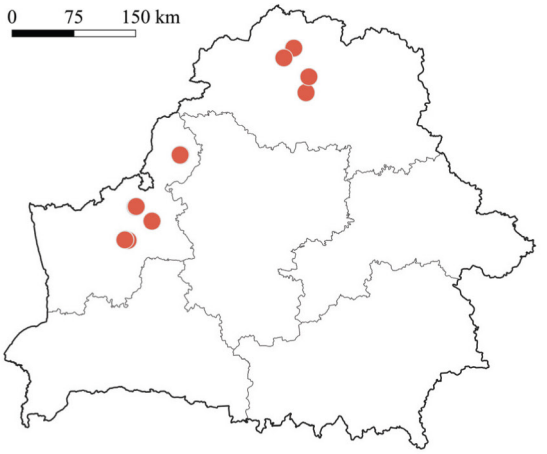
#	Name of a site	Type	Date	BBAR	ENIL	ESER	MBRA	MDAU	PAUR	My.sp	Pl.sp.	Unident.	N_ind / N_sp
19	Jastrambieĺ, manor	Basement	29.02.2020	1									1 / 1
20	Palaniečka, manor	Basement	29.02.2020					1	2				3 / 2
21	Flierjanova, manor	Cellar	29.02.2020										0 / 0
22	Flierjanova, manor	Basement	29.02.2020								2		2 / 1

* Sites' numbers correspond to those of Figure 1 of the article. Numbering of sites is separate within each administrative province. Abbreviation of the bat species names: BBAR, *B. barbastellus*; ENIL, *Eptesicus nilssonii*; ESER, *E. serotinus*; MBRA, *Myotis brandtii*; MDAU, *M. daubentonii*; PAUR, *Plecotus auritus*; My. sp., Myotis sp.; Pl. sp., *Plecotus* sp.; Unident., unidentified. N_ind, the total number of counted bats, N_sp, the number of revealed bat species (include all identified species; My.sp./Pl.sp. was added to the sum as equal to one species in cases when there were no identified *Myotis* or *Plecotus* species).

Annex 2. Records of bat species hibernating in the examined underground sites.

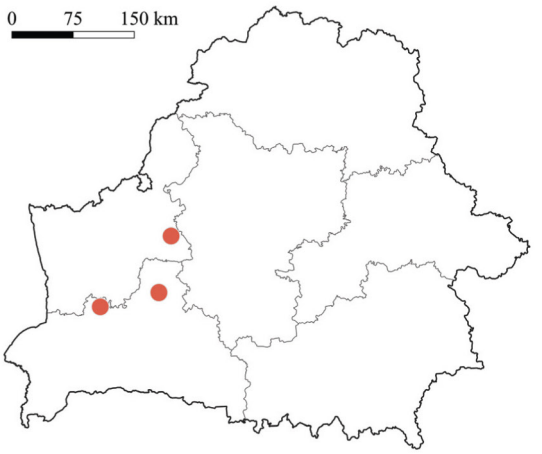


Barbastella barbastellus



Eptesicus nilssonii

Eptesicus serotinus



Myotis brandtii

Myotis daubentonii

Plecotus auritus