Zoodiversity, **56**(3): 203–232, 2022
DOI 10.15407/zoo2022.03.203

UDC 599.4(477)

BATS OF CENTRAL UKRAINE: A SYNOPSIS

L. Godlevska[1*], S. Rebrov[2], P. Vorobei[1], M. Savchenko[1], P. Panchenko[2]

[1]*Schmalhausen Institute of Zoology NAS of Ukraine,*
vul. B. Khmelnytskogo, 15, Kyiv, 01030 Ukraine
[2]*Ukrainian Centre for Bat protection*
[*]*Corrersponding author*
E-mail: lgodlevska@izan.kiev.ua

L. Godlevska (https://orcid.org/0000-0001-6792-6543)
S. Rebrov (https://orcid.org/0000-0002-6780-5386)
P. Vorobei (https://orcid.org/0000-0002-8230-6374)
M. Savchenko (https://orcid.org/0000-0001-5929-5024)
P. Panchenko (https://orcid.org/0000-0003-3602-0831)

Bats of Central Ukraine: a Synopsis. **Godlevska, L., Rebrov, S., Vorobei, P., Savchenko, M., Panchenko, P. —** Here, we represent the first review of the bat fauna of the large territory of Central Ukraine (to the west from Dnipro River). The review is based on results of the original survey in 1999–2021 and data from all available sources (publications, museum collections). Fauna of the region includes 24 bat species: *Eptesicus*, 2 species; *Barbastella*, 1; *Myotis*, 10; *Nyctalus*, 3; *Pipistrellus*, 4; *Plecotus*, 2; *Vespertilio*, 1; *Rhinolophus*, 1. For each species there is a short description of its distribution (illustrated by a map), used roosts, seasonality of presence and reproductive status within the study area. The bat fauna composition is analysed by three distinguished subregions, from north to south: of mixed forests, the forest-steppe, and the Dniester River. The estimation of prevalence and comparative abundance of the species in the region is given. The general review of bat roosts, by their types (under- and overground), seasonality of usage, and sheltered species is presented. The paper is supplemented with the extensive array of original, earlier unpublished, primary data on bat records in the region.
Key words: bats, distribution, seasonality, reproductive status, abundance, roosts, Central Ukraine.

Introduction

All 28 bat species of Ukrainian fauna are legally protected: by the national laws of Ukraine and international treaties (EUROBATS Agreement, CMS, Bern Convention). Vulnerability of bats, tasks of their protection and conservation determine a critical need for clarifying their distribution, abundance and ecological preferences, both at national and regional levels (Fenton, 1997; Frick et al., 2020). Recognised role of bats as bioindicators, challenges for the bat conservation associated with the anthropogenic transformation of the environment and climate changes determine the necessity of conducting long-time monitoring of their ranges, abundance, status, etc. (Jones et al., 2009; Sherwin et al., 2013; Voigt & Kingston, 2016), that all require the primary data for assigning the starting point in observations.

By the end of the 20th century, data on bats of the vast territory of Central Ukraine had been quite scanty and patchy. Inside this region, there were only two plots comparatively well studied regarding the bat fauna: Kyiv with its vicinities and the territory in the Middle Dnipro River Region; in the first case, due to the presence of the research node in the city of Kyiv; in the second, as a result of qualitative dissertation research in late 1960, early1970s (see below).

In 1999–2021, we carried out extensive field research in different parts of Central Ukraine, which was supplemented with records done in the course of the work of the bat contact centres (kept by the authors). As a result, a big array of completely new data on bats in the region was gathered.

The current work aims to describe the bat fauna of Central Ukraine (to the west from the Dnipro River) with a focus on the distribution and status of each species and ecological traits of bats in the region (prevalence, seasonality of occurrence, reproductive status, comparative abundance, and roosts). In addition, one of the tasks of this work is to present the array of original, earlier unpublished, primary data on bat records in the region.

Study area

Central Ukraine, in the paper, is considered in the meaning of the socio-economic region, with adjacent territories (Shabliy, 1994). We excluded from the current review the part of Central Ukraine to the east from the Dnipro River as this area was considered in another review (Godlevska & Rebrov, 2018).

The study area is stretched in the meridian direction along the Dnipro. In the north, it is limited by the administrative border of Ukraine; in the south, by the border of Ukraine and the northern border of the steppe zone; in the east, by the Dnipro riverbed; in the west, roughly by the border of the forest-steppe zone. The area falls into eight administrative regions of Ukraine: Kyiv, Cherkasy, Kirovohrad (with Kropyvnytskyi as the regional centre), Mykolayiv, Odesa, Vinnytsya, Khmelnytskyi, and Zhytomyr (fig. 1). The total area of the study region is 123,000 km^2.

According to the classification of physiographic regions, the study area includes part of the zone of mixed forests (Kyiv and Zhytomyr Polissia) and part of the forest-steppe zone (Marynych & Shyschenko, 2006). Within the part, corresponding to the forest-steppe zone, we distinguish the subregion of the Dniester River, based on its landscape features, climatic conditions, and the presence of a significant number of, mainly limestone, mines (with a length, often, > 1 km). The high density of mines allows considering this subregion as the "cave" one, in contrast to the other (not-cave) parts of the study area, where underground cavities are presented by man-made structures like cellars, basements, fortifications, drainage tunnels, etc. Most of them have a small length (< 0.5 km) and volume; with the exception of the extended complex of drainage-mine systems of Kyiv (Godlevskaya, 2007).

Thus, in the borders of the study area, there are three identified subregions, from north to south: 1) mixed forests, ZMF, or Polissia; 2) forest-steppe, ZFS; 3) the Dniester River, DRS (fig. 1).

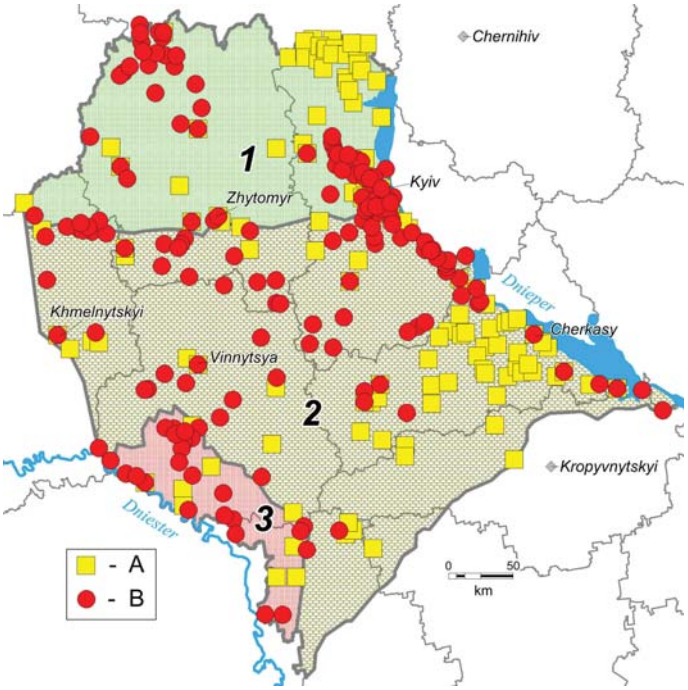


Fig. 1. Study area and localities (n_{loc} = 265). A — data of other authors, 1848–2020 (n_{loc} = 134); B — own data, 1999–2021 (n_{loc} = 168). Subregions, here and further: 1, mixed forests, or Polissia (ZMF); 2, forest-steppe (ZFS); 3, the Dniester River (DRS); see text.

Material and methods

Bat records, considered and analysed in the current review, concern two categories: A) data of other authors (publications, museum collections); B) own data, collected by the authors of the paper on their own or with their immediate participation. Some of the own data were already published but an extensive array of them is firstly presented by this paper. Annex (https://bit.ly/3ORCzGl) provides full details on earlier unpublished own bat records. (Referring below in the text to Annex corresponds to referring to earlier unpublished original data of the current paper's authors.) Yet, the Annex contains the complete reference list of sources (publications and museums) providing data about bat records in the study region (in Ukrainian).

The own data were collected in 1999–2021 in different seasons of the year: 1) during over 55 field expeditions and excursions; 2) during the bat survey in the city of Kyiv; and 3) in the course of the work of the bat contact centres. In total, the own data come from 168 study localities in eight administrative regions of Ukraine (fig. 1).

In the fieldwork, we applied the set of methods and approaches (the detailed description in: Godlevska & Rebrov, 2018). Acoustic surveys were done with bat detectors: Pettersson Electronik D 200, D 240, and Wildlife Acoustics Echo Meter Touch 2 Pro. Bat sound records were analysed using Pettersson Elektronik BatSound and Wildlife Acoustics Kaleidoscope Pro. Netting was done mainly with mist-nets (3–12 m long; Chinese; Polish, Ecotone). Nets were set up near bat roosts, at their commuting paths, feeding and watering places. Examination of bats was carried out during the short time after capture. The bats were released at the capture site immediately after their examination. Bat roosts' search was carried out using various methodical approaches (by the presence of faeces, social vocalisation of bats, swarming, etc.); all accessible underground cavities were examined. Where possible, the exact localisation of a roost and its description were done (allocation, type and structure of a roost, bat species, number of bats, the character of usage, etc.). Collecting faunistic data by calls to the bat contact centres was done by the scheme given in details in: Godlevska, 2012.

In the paper, particularly for assessing distribution and prevalence of species, we use the term "study locality", which is the conditional territorial unit which covers record(s') point(s) located inside or at some distance to a certain settlement. In some cases, when the bat survey was done very remotely of settlements, additional localities were distinguished.

Bat records inside the built-up districts of Kyiv, the western part of which lies in the borders of the study area, are not considered in detail. In the analysis of data, e. g. species prevalence, Kyiv is given as one study locality except for a few large nature protected areas inside the city administrative borders; they are considered as separate localities.

Year periods, in regard to bat life-cycle, were accepted as: the breeding period, from 15th May to 15th August; the warm period of the year, from 16th March to 20th October; the winter period, from 21st October to 15th March.

In the preparation of the current review, the own bat database was used (Godlevska, 2018). To outline the contribution of the original data in the general review's data set, we used the different symbols at species maps. The diagram of fig. 2 indicates the origins of bat observations considered in the review. In the assessment of species prevalence, their comparative abundance, and used roosts the original data are marked accordingly.

Abbreviations of bat species names, alphabetically: BBAR — *Barbastella barbastellus*; ENIL — *Eptesicus nilssonii*; ESER — *E. serotinus*; MBEC — *Myotis bechsteinii*; MBLY — *M. blythii*; MDAS — *M. dasycneme*; MDAU — *M. daubentonii*; MMYO — *M. myotis*, MMYS_gr — species of *M. mystacinus* morphogroup, MNAT — *M. nattereri*; NLAS — *Nyctalus lasiopterus*; NLEI — *N. leisleri*; NNOC — *N. noctula*; PAUR — *Plecotus auritus*; PAUS — *P. austriacus*; PKUH — *Pipistrellus kuhlii*; PNAT — *P. nathusii*; PPIP — *P. pipistrellus*; PPYG — *P. pygmaeus*; RHIP — *Rhinolophus hipposideros*; VMUR — *Vespertilio murinus*.

The history of the bat fauna survey in Central Ukraine

The first data about the bat fauna of the region refer to the middle of the 19th century (Kessler, 1851). The over half-century period after, in the history of the bat survey of Central Ukraine, is presented only by some collected specimens in museums. Further, in 1910–1941, Kyiv researchers first collected the significant data set on bats in Central Ukraine (Charlemagne, 1914, 1915, 1933; Popov, 1936, 1939; Abelentsev & Popov, 1956; see also in: Godlevska, 2013 b). First of all, the new data concerned Kyiv and vicinities, but also, records in some other terrains of the region were done. Among others, during these years, the researchers applied the method of fauna inventory by owl pellets' survey. It enabled to widen data on the fauna of Ukraine, including those on bats of the region (e. g. Izotiv, 1932; Popov, 1932; Pidoplichka, 1932, 1937).

Data from a few decades after World War II are mainly based on labelled specimens in museum collections. At this time, the work on bat banding, initiated in 1939 by B. Popov, was continued as well, partly at the territory of the study region (Abelentsev et al., 1968; 1969; 1970).

The significant array of bat data was collected on the Middle Dnipro Region (Cherkasy and Kirovohrad Regions) in the late 1960s and early 1970s by Sologor (1973), during her dissertation research. Data on bat records in this region in the following years are available in publications by Ruzhilenko, Tsvelykh (Ruzhilenko & Tsvelykh, 1992; Ruzhilenko et al., 1998). Recently, the bat survey here was carried out by Bilushenko (e. g.: 2009; 2013; 2014).

Results of the bat survey in Kyiv and Kyiv Region in the late 1980s are available in the publication by Likhotop et al. (1990). Bat records in this and other regions of the study area were published by Zagorodniuk

and colleagues (e. g. Zagorodniuk & Tyschenko-Tyshkovets, 2001; Zagorodniuk & Godlevska, 2003; Zagorodniuk & Kalinichenko, 2008).

In 1999, Godlevska initiated the systematic survey of bats in Kyiv and, in particularly, in underground structures of Kyiv and suburbs (Godlevskaya, 2007).

In 1999, at the Kyiv Zoo, the bat rehabilitation centre was established by V. Tyshchenko and colleagues. Among other things, in the course of the centre's work, *P. kuhlii* was first recorded in Kyiv, a regular wintering of *V. murinus* and *N. noctula* was also revealed in Kyiv (Godlevsky et al., 2000; Tyshchenko, Godlevska, 2008).

Recently, comprehensive bat surveys were done in two Kyiv protected areas: central and northern parts of the Holosiyivskyi National Nature Park (Vlaschenko et al., 2012; Vorobei et al., 2021), and Feofania Park (Bilushenko, 2016).

Much attention was devoted to inventory of bat underground sites in the region. In addition to the mentioned bat survey in underground structures of Kyiv Region, in 2006, Godlevska and colleagues started the first large-scale focused survey of bats' underground sites in Podolian Upland and the Middle Dniester River region, which partly refer to the territory of Central Ukraine (Godlevska, 2010; 2012). Later, the inventory of underground shelters of bats in the so-called not-cave regions of Ukraine (without natural caves or mines, including the study region) was conducted (Godlevska et al., 2016; Annex).

In 2009–2015, in the course of the work of the bat contact centre kept by Godlevska (2012; 2015) a lot of data on occurrence of bats all over Ukraine and, among others, in the study region were collected. After 2015, two contact centres were kept with the participation of all authors of the review, in Kyiv and Odesa Regions.

The intensive bat survey had been carried out in the Chernobyl Exclusion Zone (Gashchak et al., 2009; 2013). Data about bats of the western part of the study region are available in papers by Tyshchenko with colleagues (Tyshchenko, 2002; Tyshchenko et al., 2005) and Drebet with colleagues (Drebet, 2018; Drebet et al., 2020).

Some more data on bat observations are also available in other papers of mentioned authors and, as well, of other researchers (Kryshtal, 1947; Golub, 1996; Vasiliev & Andreev, 1998; Zhyla et al., 2001; Smirnov & Smirnov, 2007; Zykov, 2011; Gaschak, 2018; and others: see Reference section in Annex).

In 2001, Godlevska started the bat field research aiming to obtain data on the bat fauna from all parts of the study region (besides Kyiv and suburbs). Further, in 2014–2019, all authors of the current review jointly carried out the bat survey in all eight administrative regions of the study area. Most of the obtained data firstly presented by this paper (Annex).

The chronology of getting the faunistic bat data in the study region is illustrated by fig. 2. In total, by 1999 (the starting point of the authors' research), the number of bat species (according to their current taxonomic status) known in the region was 13: *Barbastella*, 1; *Eptesicus,* 1; *Myotis*, 3; *Nyctalus,* 3; *Plecotus,* 1; *Pipistrellus,* 2; *Vespertilio*, 1; *Rhinolophus,* 1 (by publications and museum collections).

Species accounts

At present, there are data on the occurrence of 24 bat species (of two families: Vespertilionidae and Rhinolophidae) in the region: *Barbastella*, 1 species; *Eptesicus,* 2; *Myotis*, 10; *Nyctalus,* 3; *Plecotus,* 2; *Pipistrellus,* 4; *Vespertilio*, 1; *Rhinolophus,* 1 (fig. 2). We recorded 23 of them (all except *Nyctalus lasiopterus*).

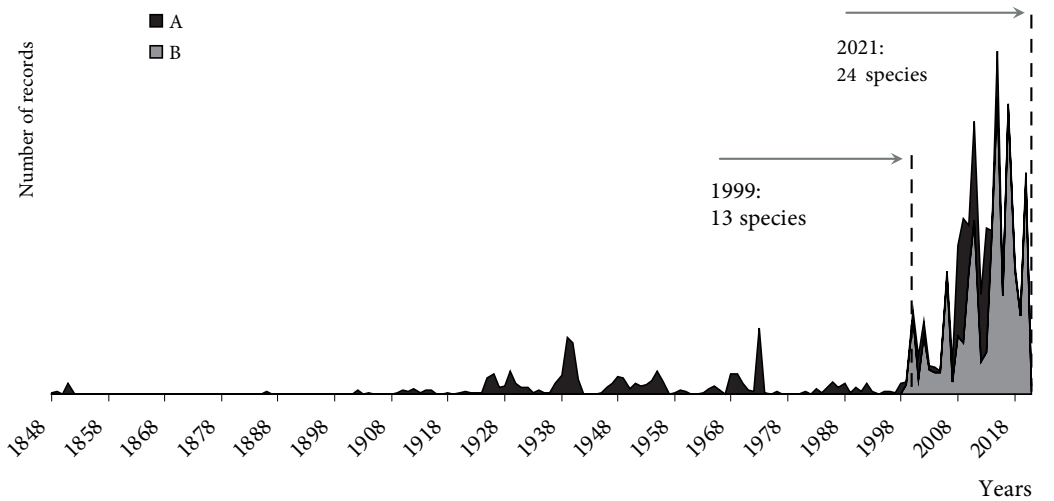


Fig. 2. Number of bat records considered in the current review by years. A — data of other authors; B — own data.

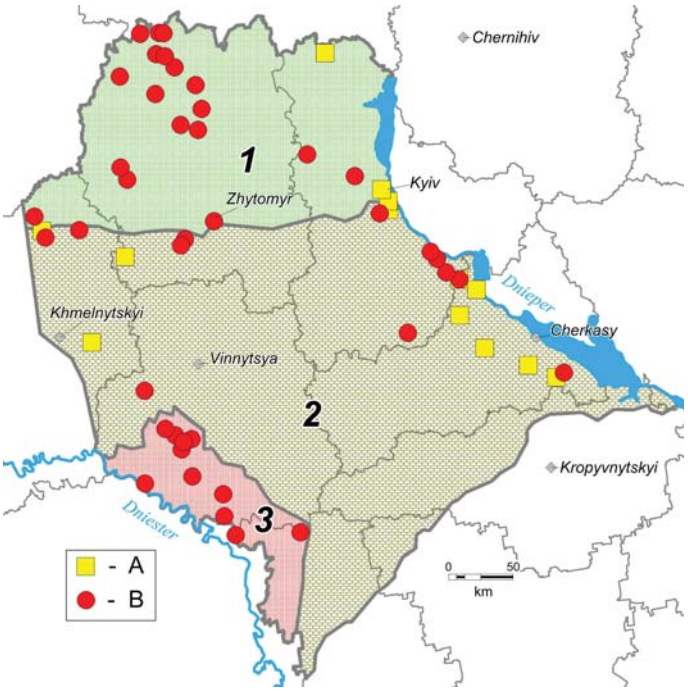


Fig. 3. Record localities of *Barbastella barbastellus.* Here and further, if no other description is given: A — data of other authors, 1848–2020; B — own data, 1999–2021.

Barbastella barbastellus (Schreber, 1774)

Within the study region, the species has quite patchy distribution (fig. 3). At present, it is rather frequently found in the northwestern part of the region and in the Dniester subregion. The Dnipro distribution patch of the species is relatively isolated from its other record localities. In Kyiv and outskirts, the species was regularly found in the middle of the 20th century (Abelentsev & Popov, 1956; Abelentsev et al., 1969; Godlevska, 2013 b). However, during the last two decades, the species was recorded only in two localities in the vicinities of Kyiv (Annex).

The breeding was recently first revealed in nine study localities (Annex). Maternity roosts are not known. During the breeding period, males were netted at entrances and inside abandoned banked military structures, up to 20 individuals per object (Annex). That allows considering such structures as roosts for the barbastelle males in the warm season of the year.

In winter, the species was recorded hibernating in underground cavities: mines, military objects, cellars, drainage tunnels; earlier, in monastery artificial caves (e. g. Abelentsev & Popov, 1956; Sologor, 1973; Godlevska et al., 2010; 2012; 2016; Annex). The exception is two winter records of single individuals in overground parts of buildings: in a cavity of a stable ceiling and in a greenhouse (Sologor, 1973; Ruzhilenko et al., 1998).

The number of hibernating individuals per one object is, usually, up to 10 individuals. There are only few hibernacula, where more barbastelles were recorded, with a maximum of 194 individuals (Annex).

Eptesicus nilssonii (Keyserling & Blasius, 1939)

Within the study region, the species is rare. We recorded it just in two localities in the northwestern part of the region in 2015 and 2017 (fig. 4). The only record of the species in the winter season in Kyiv (Zykov, 2011) may be considered as accidental.

The breeding was not recorded. No roosts are known.

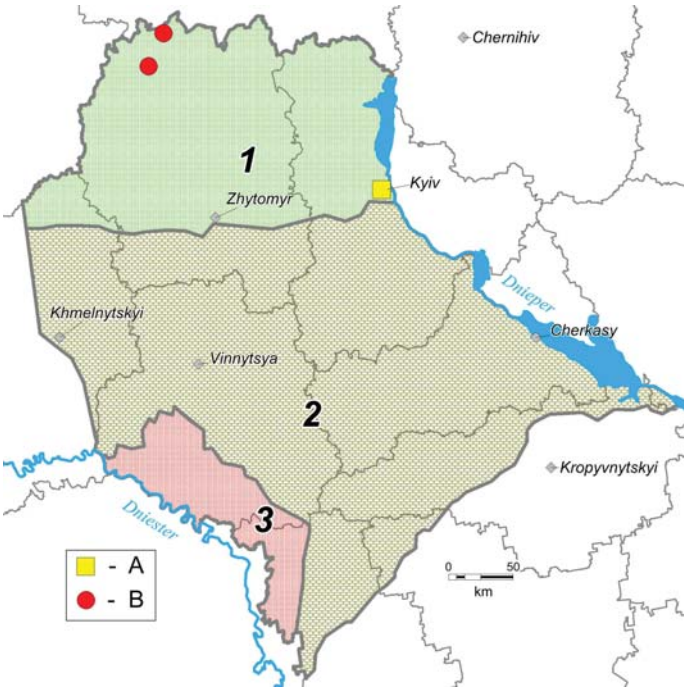


Fig. 4. Record localities of *Eptesicus nilssonii*.

Eptesicus serotinus (Schreber, 1774)

Widely distributed and one of the most common, all year round occurring species in the region (fig. 5).

Summer roosts are overground sections of man-made structures and, rarer, underground cavities. The study area entirely falls within the species breeding range. In total, breeding was found in 28 localities; we recorded it in 26 study localities in different parts of the study region.

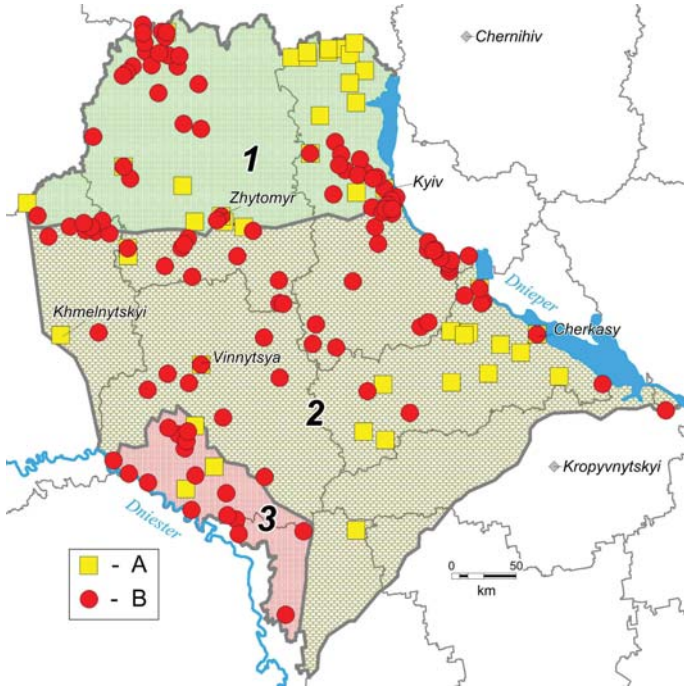


Fig. 5. Record localities of *Eptesicus serotinus*.

Maternity roosts have been localised in attic cavities of public (used) buildings, cavities in overground sections of abandoned buildings (Sologor, 1973; Annex).

In winter time, the species is regularly recorded in buildings (in inner rooms, at balconies, between window frames, etc.) and at the ground within built-up areas of settlements (Godlevska, 2012; 2015 b; Annex). Notably, old winter records of the species in the region (the earliest is dated by 1928) came from the territory of settlements; and the places of revealing of serotine bats were the same as those at present (collected specimens in the NMNH NASU). The species is also recorded hibernating in underground shelters (Abelentsev & Popov, 1956; Godlevska et al., 2010; 2012; 2016). Usually, its number per one underground hibernaculum does not exceed few individuals. However, there is a known big winter aggregation of the species (> 100 individuals) in one of the limestone mines in the Dniester subregion (Godlevska et al., 2010).

Myotis bechsteinii (Kuhl, 1817)

The species is rare. It was revealed recently in seven localities in the southern part of the study region (fig. 6); first, in 2006 (Godlevska et al., 2010). The extreme eastern records (southeast of the Podolian Upland, in the north of Odesa Region) correspond to the eastern boundary of species distribution range in Ukraine and in Europe as a whole (Wright et al., 2018).

The species was recorded hibernating in limestone mines (with the maximum number of 3 individuals per site) and during autumn swarming at the same underground objects. The breeding was first recently confirmed in the region, in two eastern points (Annex).

Myotis blythii (Tomes, 1857)

Like the previous species, *M. blythii* was revealed only within the Dniester subregion (fig. 7) in six study localities; first, in 2006 (Godlevska et al., 2010). The species was recorded both in winter and in the warm period of the year. The maximum number during hibernation per one site was 27 individuals. Maternity colonies are not known. However, in one locality (the north of Odesa Region), a single breeding female was netted at the mine entrance (Godlevska et al., 2010).

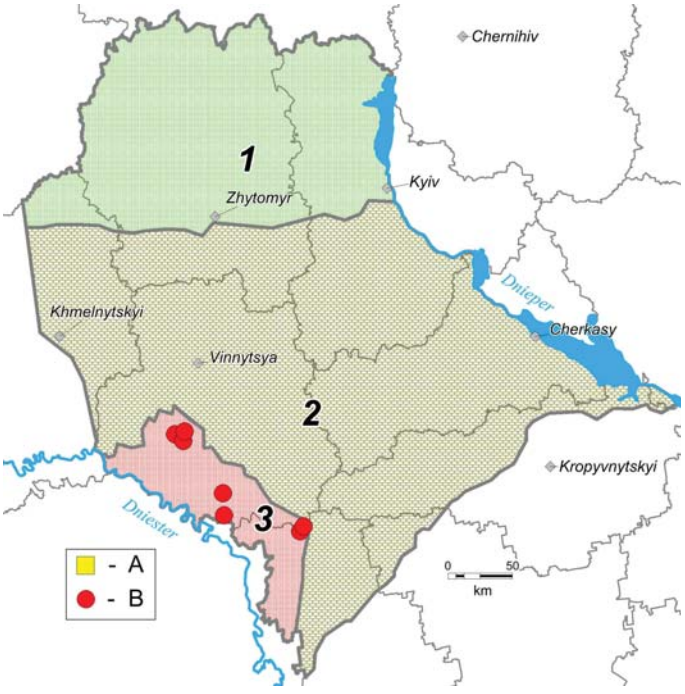


Fig. 6. Record localities of *Myotis bechsteinii.*

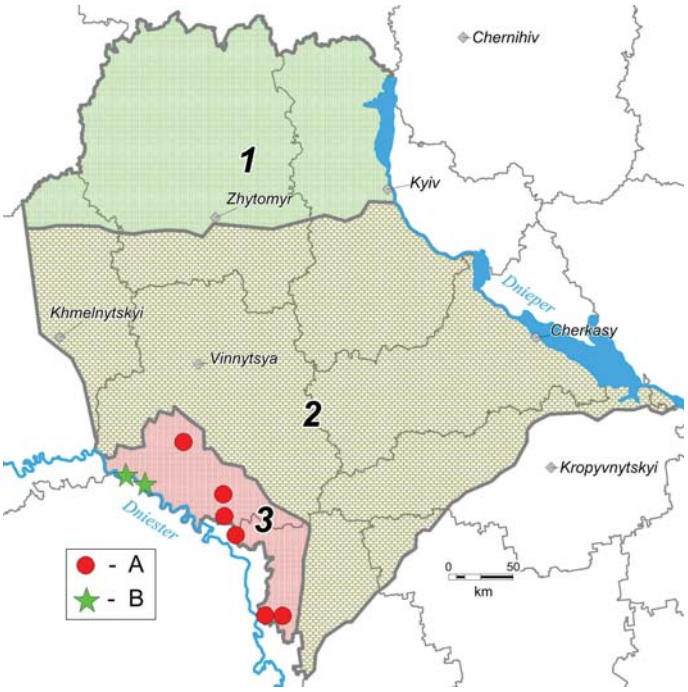


Fig. 7. Record localities of *Myotis blythii* (A) and *Myotis myotis* (B); original data.

Myotis dasycneme (Boie, 1825)

Although the species was found in all three subregions, its distribution there is highly patchy (fig. 8).

The species occurs year-round. During our survey, we first confirmed the breeding of the species in the region, in four study localities (Vorobei et al., 2021; Annex). Between 1999 and 2021, in the study region, only one maternity roost was found: a ceiling crevice

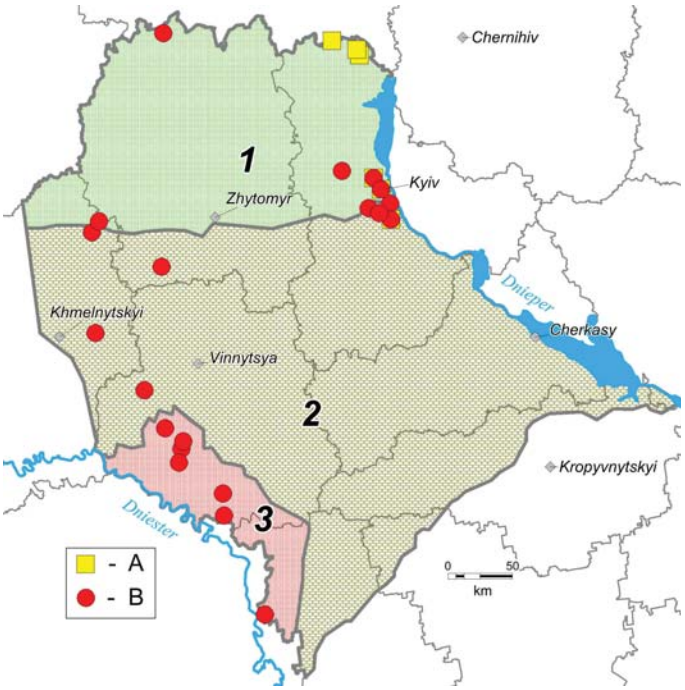


Fig. 8. Record localities of *Myotis dasycneme*.

in the overground section of an abandoned building in Kyiv Region (Vorobei et al., 2021). Another potential maternity roost is in an abandoned building in Khmelnytskyi Region, where breeding females (together with adult males) were netted (Annex).

In summer, *M. dasycneme* was recorded in tree cavities as well (Charlemagne, 1915; Abelentsev & Popov, 1956; museum specimens in: Zagorodniuk & Godlevska, 2001), and was netted at underground sites during late summer swarming (Godlevskaya, 2007; Godlevska et al., 2010; 2016).

Winter roosts are underground; the maximum counted number of pond bats per hibernaculum was 12 individuals, but, in most cases, 1–4 individuals.

Among animals netted during the breeding period, the percentage of pond bats was only 0.7 % (fig. 24). During the autumn swarming, pond bats were netted at entrances to underground sites; however, their quantity was low; e. g. in Kyiv, 0.2 % in 2003–2005 (Godlevskaya, 2007). All together enables to conclude that the population size of the species in the region is small.

Myotis daubentonii (Kuhl, 1817)

It is one of the most regularly occurring and common species in the study region. Here it was recorded all year round, in many study localities (fig. 9).

Summer roosts: bridges, overground sections of abandoned buildings, tree cavities, underground cavities. The breeding range includes, obviously, the whole territory of the study region. In total, breeding was confirmed in three subregions in 24 study localities. We first revealed maternity roosts of the species in the region: five, in abandoned buildings; one, in a tree hollow (Annex).

Winter shelters are various underground cavities (e. g. Abelentsev & Popov, 1956; Sologor, 1973; Likhotop et al., 1990; Godlevska et al., 2010; 2012; 2016; Annex). In the not-cave part of the study region (ZMF- and ZFS-subregions), the species dominates by number of individuals over other species in underground hibernacula; in the Dniester subregion, codominates (fig. 25). The maximum number of *M. daubentonii* per one underground hibernaculum in the region was 353 individuals (Kyiv, DMS 47-P1-2: winter 2016/2017; Annex).

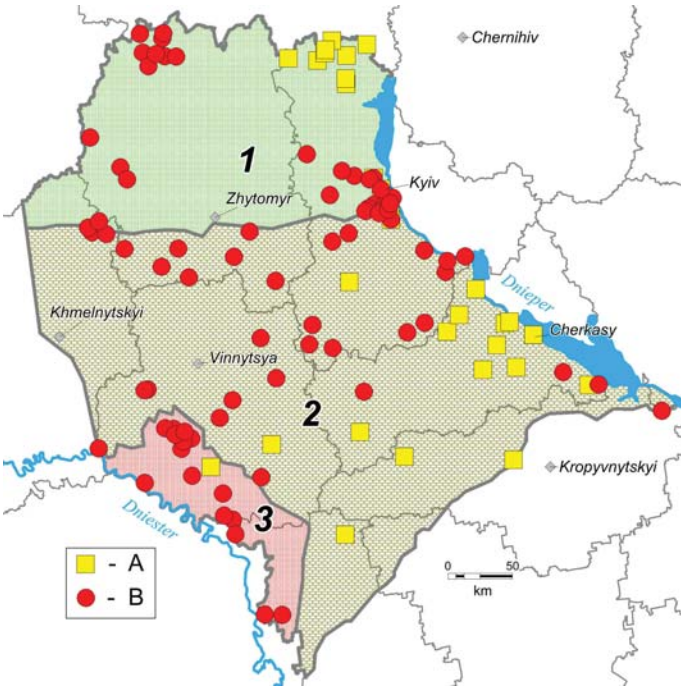


Fig. 9. Record localities of *Myotis daubentonii*.

Myotis myotis (Borkhausen, 1797)

The species was revealed only in western part of the Dniester subregion, in two study localities (fig. 7); first, in 2010 (Godlevska et al., 2012). Record localities are underground sites. There, single specimens were revealed, both in the warm and winter seasons. The breeding was not confirmed.

***Myotis mystacinus* morphogroup**

Among European bat species, the group of whiskered bats is one of the most complicated both for systematics and field identification (e. g. Benda & Tsytsulina, 2000; Çoraman et al., 2020).

We distinguished species of this group by morphological characters (using description from: Dietz & von Helversen, 2004). Part of specimens was identified only to the group of four or three species, in particular those found during winter counts in hibernacula.

In the study region, we identified the occurrence of four bat species from the *M. mystacinus* morphogroup: *M. brandtii*, *M. mystacinus*, *M. aurascens, M. alcathoe* (fig. 10, 11).

All four species were first recorded in the study region only in the last decades. In the ZMF- and ZFS-subregions, records of species of the group are, generally, very rare (Zagorodniuk & Godlevska, 2003; Godlevskaya, 2007; Gashchak et al., 2009; 2013; Annex). In the DRS-subregion, whiskered bats are recorded regularly; here, we first identified all four species.

In general, clarification of the distribution and status of *M. mystacinus* morphogroup species in the study region, like in other regions of Ukraine, requires further research with applying genetic methods.

— ***Myotis brandtii*** (Eversmann, 1845). In the ZMF- and ZFS-subregions, it is very rare. Single individuals of this species were found there only in six study localities (fig. 10). In the DRS-subregion, its abundance, at present, cannot be estimated correctly: most records of whiskered bats refer to the winter season and are identified only to the group *M. brandtii* / *M. mystacinus* s. l.

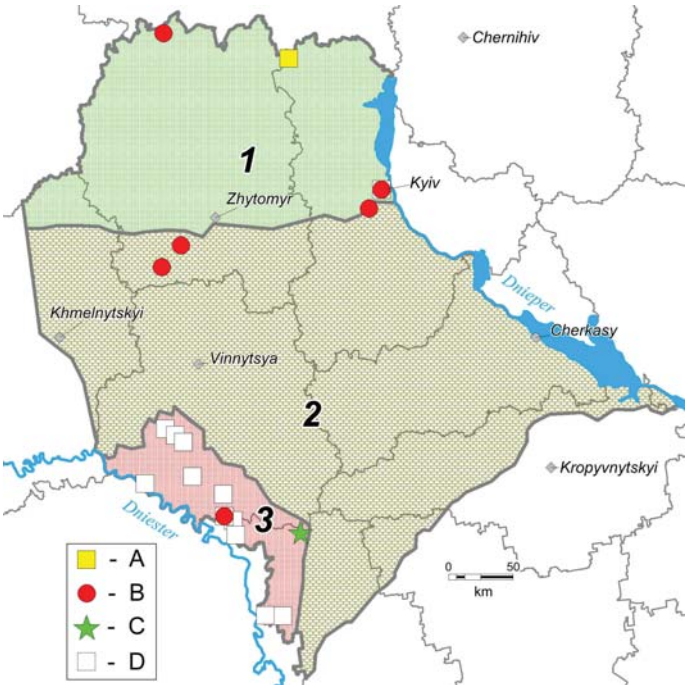


Fig. 10. Record localities of *Myotis brandtii* (A, B), *Myotis alcathoe* (C), and not identidied specimens of *Myotis mystacinus* morphogroup (D).

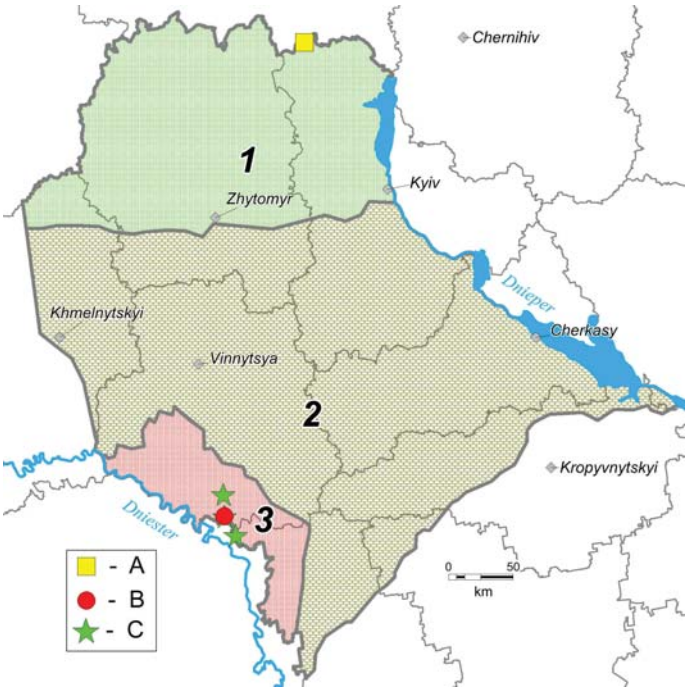


Fig. 11. Record localities of *Myotis mystacinus* morphogroup species: *M. mystacinus* s. s. (A, B), *Myotis aurascens* (C).

The breeding of the species in the study region was confirmed only in one locality, in Zhytomyr Region, where one juvenile female was netted in the middle of July (Annex). As for now, there is no information about summer roosts. Only one winter shelter of this species was verified: in a drainage mine in Kyiv, where a single individual was found (Annex).

— ***Myotis alcathoe*** von Helversen & Heller, 2001. One juvenile specimen of a small whiskered bat (ra = 31.5 mm), identified as *M. alcathoe,* was netted in the DRS-subregion, in Odesa Region, in 2014 (Annex). Any other records are so far absent (fig. 10).

— ***Myotis aurascens*** Kuzyakin, 1935. Bats identified as *M. aurascens* were recorded in the Dniester subregion, in three localities (fig. 11): in two of them, in underground sites during the autumn swarming season; in one, by skeleton remains, found in a rock crevice (Annex).

— ***Myotis mystacinus*** (Kuhl, 1817) s. s. was recorded in two localities. We identified *M. mystacinus* s. s. in one underground site in the Dniester subregion during autumn swarming (Annex). In the ZMF-subregion, in summer 2009, an adult male, identified as *M. mystacinus* s. s. was netted at the territory of the Chernobyl Exclusion Zone (Gashchak et al., 2009). The latter record, however, stands alone among other records of whiskered bats in this part of Ukraine. All other records of identified to species whiskered bats here are presented by *M. brandtii* (Godlevska et al., 2016 b; 2020; this paper). In adjacent territories of southern Belarus, only *M. brandtii* was recorded (Shpak, 2010; Dombrovski, 2018).

Number of whiskered bats (*M. bra.* + *M. mys.* s. l.) comprised ca. 6 % of all counted bat individuals in underground hibernacula of the DRS-subregion (fig. 25, B). However, during winter counts, when no contact examination of bats is possible, the determination of species of this group was not done. Nevertheless, taking into account that all four species were identified in the Dniester subregion, and that whiskered bats in Europe are considered to be sedentary (Hutterer et al., 2005), we presume that all these species winter in the DRS-subregion.

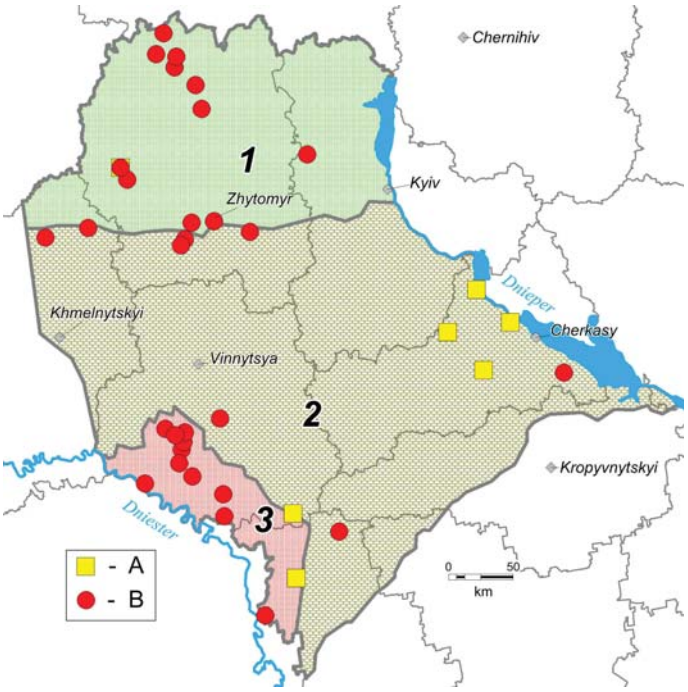


Fig. 12. Record localities of *Myotis nattereri*.

Myotis nattereri (Kuhl, 1817)

The species was revealed in three subregions. However, its distribution is irregular. Points of records may be combined in three rather separate patches: southern, in the Dniester subregion and adjacent territories; eastern, in the Central Dnipro zone; and northern, in Polissia (fig. 12).

The species was found in all seasons of the year. The breeding was revealed in three subregions in seven localities (Sologor, 1973; Biletskaya et al, 1990; Godlevska et al., 2012; Annex). In the course of the authors' study, no maternity roosts were found. During the breeding season, juvenile individuals were netted in an abandoned building and at an underground site entrance (Annex); however, animals' shelters were not localised. Earlier, breeding females with juveniles were found in a tree cavity and in a bird box, within the eastern distribution plot of the species in the study region (Sologor, 1973; Biletskaya et al., 1990). Solitary males and non-breeding females were found or netted inside overground sections of abandoned buildings, and in underground or semi-underground objects (Annex).

Known winter roosts are only underground. The counted number per one hibernaculum was, commonly, 1–6 individuals. Bigger aggregations were found only in four sites. The maximum counted number of *M. nattereri* in a hibernaculum was 68 ind.; in the ZMF-subregion (Godlevska et al., 2016 a).

Nyctalus lasiopterus (Schreber, 1780)

The species is extremely rare. It was recorded in the warm period of the year in eight localities with only 10 records in total (fig. 13). Most records refer to the middle of the 20th century (Abelentsev & Popov, 1956; Zagorodniuk & Godlevska, 2001; Godlevska, 2013 b). Recently it was found only twice, at the territory of the Chernobyl Exclusion Zone (Gashchak et al., 2009; 2013). During our study, the species was not recorded.

Two recent records in 2009 and 2013 (in the Chernobyl Exclusion Zone) were presented by an immature male and a female, both netted in the 3rd decade of July (Gashchak et al., 2009; 2013). These individuals comprise only 0.06 % of the general number of bats, examined by Gaschak with colleagues in 2007–2013. However, the records may prove the species breeding in the ZMF-subregion.

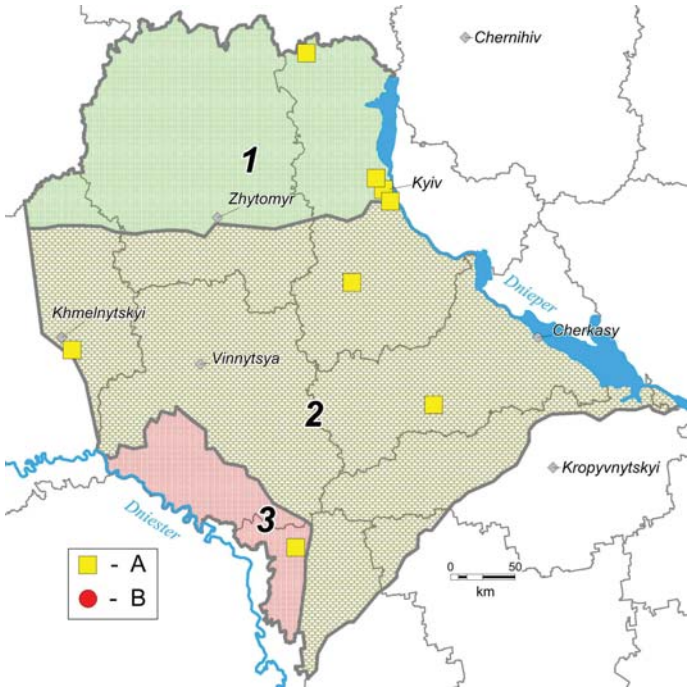


Fig. 13. Record localities of *Nyctalus lasiopterus.*

Nyctalus leisleri (Kuhl, 1817)

The species was recorded in different parts of the study region during the warm period of the year (fig. 14). Records mostly come from forest and park patches.

The region seems to be entirely within the breeding zone of the species: the breeding was recorded in all three subregions, in 24 localities (during our survey, in 21 study

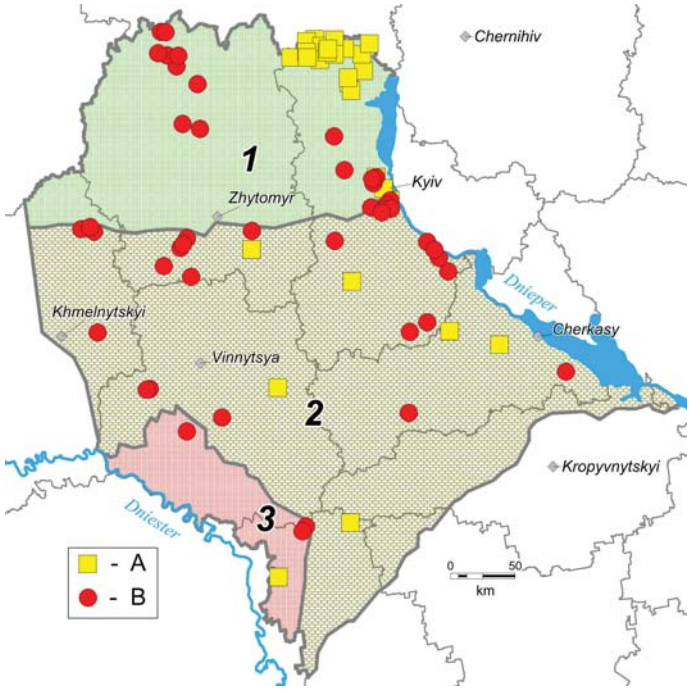


Fig. 14. Record localities of *Nyctalus leisleri.*

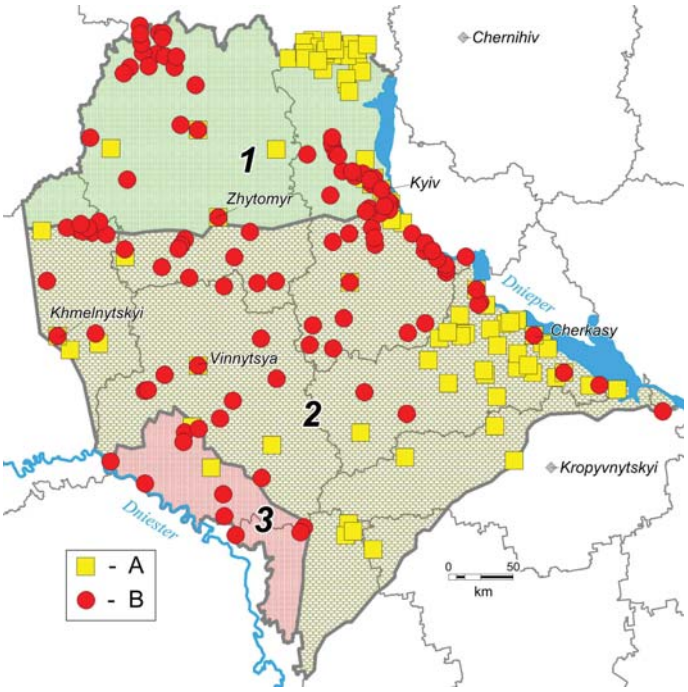


Fig. 15. Record localities of *Nyctalus noctula.*

localities). Known roosts were located in hollow trees and one, in a bird box, in which the maternity colony of 46 individuals, including juveniles was found (Biletskaya et al., 1990). Winter records are not known.

Nyctalus noctula (Schreber, 1774)

The species is common and widespread in the region (fig. 15). We recorded it in the majority of study localities.

The breeding zone includes all the territory of the study region. In total, the breeding was marked in all three subregions, in 51 study localities (we've found in 43). Known earlier and recently found summer roosts were almost exceptionally in hollow trees (tens of roosts). Maternity colonies were found only in hollow trees. Known records in buildings during summer are not numerous and concern the migration season; thus, such roosts are, obviously, transit. E. g. we recorded a colony of common noctules, in which all four sex-age groups were presented (MMad, MMjuv, FFad, FFjuv) in an abandoned concrete hangar in Cherkasy Region in late August, 2018 (Annex).

At present, Central Ukraine is entirely within the species winter range due to its recent expansion northward (Godlevska, 2015 a). The first winter records of the species in the region came from Kyiv in the early 2000s. Since then, it is regularly found there in winter. All known records in winter refer to the territory of settlements, and all localised by us winter roosts were in buildings, mostly multi-storey. Identified roosts were: different structural cavities, ventilation channels, cavities inside balconies' facing, etc. The number of individuals in one winter colony is estimated to reach a few thousand (Godlevska, 2015 a; L. Godlevska, comm.). Recently, Bilushenko (2015) reported his observation of *N. noctula* colonies in hollow trees in winter in Cherkasy and Kyiv.

Pipistrellus kuhlii (Kuhl, 1817)

During the last half a century, the species expanded into many regions of Europe (e. g. Strelkov, 2004; Ancillotto et al., 2016; Lučan et al., 2020). For Central Ukraine, it is new as well. Here, its occurrence was first recorded in Kyiv in 1999 (Godlevsky et al., 2000). At

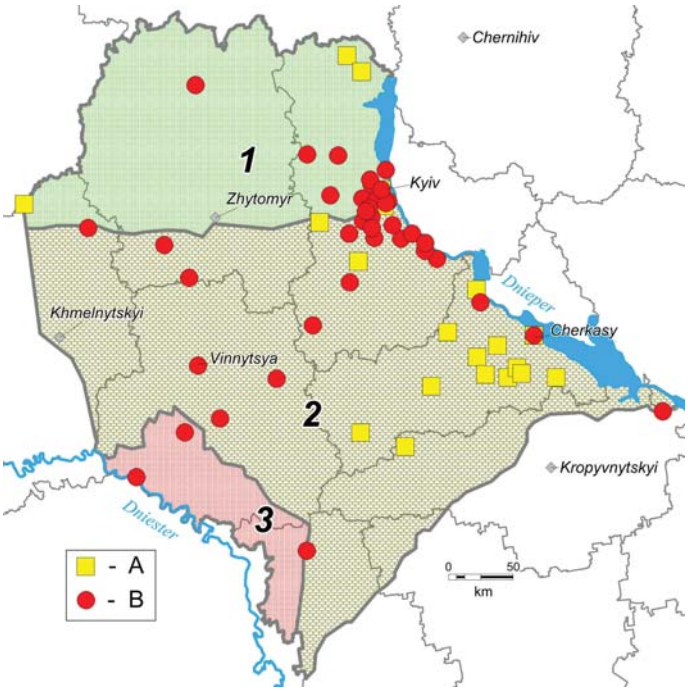


Fig. 16. Record localities of *Pipistrellus kuhlii*.

present, the species is distributed throughout the study region, although in the northwest it occurs rarer than in other parts (fig. 16).

The species is recorded year-round. All known roosts, including maternity ones, were found out only in overground sections of buildings (in different cavities). Three biggest maternity colonies counted were from ca. 50 to over 100 individuals, with juveniles (Bilushenko, 2013; Annex).

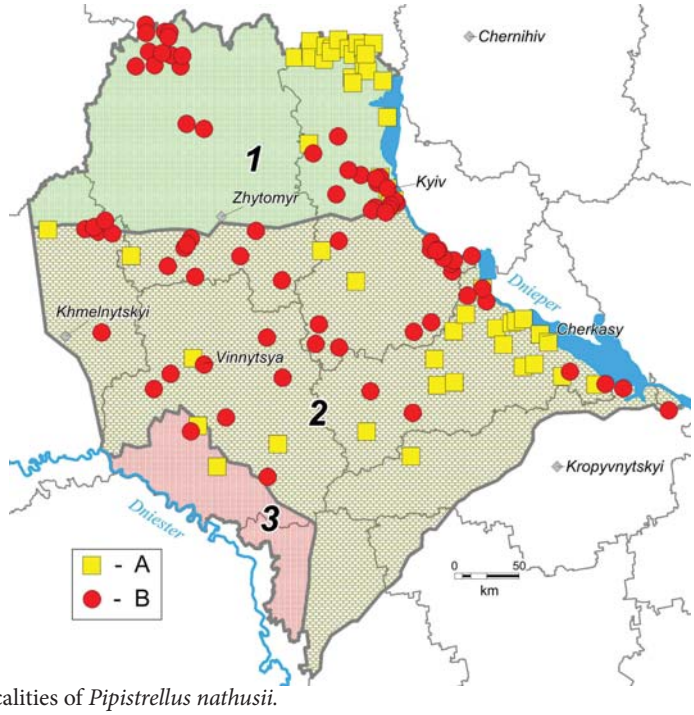


Fig. 17. Record localities of *Pipistrellus nathusii*.

Known hibernation roosts are in buildings (all localised ones were in cavities beside window frames). Wintering groups and colonies were recorded during repair works (Godlevska, 2015 b; Hukov et al., 2020). The maximum colony size in winter for Central Ukraine was 138 individuals (Hukov et al., 2020).

Pipistrellus nathusii (Keyserling & Blasius, 1839)

The species was recorded all over the study region (fig. 17).

Winter records within the study region are absent. The earliest date of a record in the warm period is 05.04 (1954); the latest, 10.10 (2013) (Abelentsev & Popov, 1956; Bilushenko, 2014).

In the warm period of the year, it is one of the common bat species (fig. 24). Roosts are: cavities in buildings, both used and abandoned, hollow trees. Maternity colonies are sometimes mixed with *P. pygmaeus*. The breeding was revealed in the ZMF- and ZFS-subregions, in 40 localities, in total. The biggest of counted maternity colonies was of > = 90 adult individuals (Vorobei et al., 2021).

Pipistrellus pipistrellus (Schreber, 1774)

Note. *P. pipistrellus* and *P. pygmaeus* were recognised as separate species in late 1990s (Barratt et al., 1997; Mayer & von Helversen, 2001). Correspondingly, in the publications on bats of Ukraine before 2000, this pair of species was mentioned as *P. pipistrellus* (fig. 18, D). We identified species of this pair of pipistrelles by morphological characters (on Dietz & von Helversen, 2004). In some cases the identification was verified by recording echolocation signals during bats' release. In the case with *P. pygmaeus*, acoustic observations were taken into consideration (this method is not reliable enough for *P. pipistrellus* s. s. because of the significant overlapping of its echolocation signals with those in *P. nathusii* и *P. kuhlii*).

The occurrence of *P. pipistrellus* s. s. was confirmed recently only in the south of the study area, in the DRS-subregion (fig. 18). There, the breeding of the species was confirmed (Annex), and its hibernation (in mines) was recorded (Godlevska et al., 2012). In the rest of the study area, only *P. pygmaeus* was recorded.

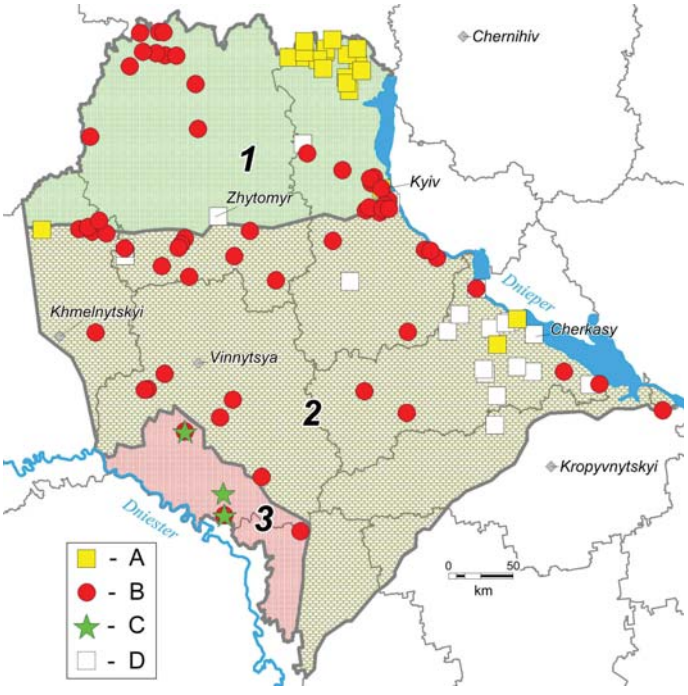


Fig. 18. Record localities of *Pipistrellus pygmaeus* (A, B), *P. pipistrellus* s. s. (C), and *P. pipistrellus* s. l. (D).

Pipistrellus pygmaeus (Leach, 1825)

The species was first mentioned as the species for the region only in 2001 (Zagorodniuk, Tyschenko-Tyshkovets, 2021; see Note to *P. pipistrellus*). Further, the species was revealed in many localities all over the study region (fig. 18).

Winter records are absent. In total, during the last two decades, the breeding of *P. pygmaeus* was recorded in all three subregions in 35 study localities. Roosts are hollow trees, different cavities in overground sections of buildings, both abandoned and used (Vlaschenko et al., 2012; Godlevska et al., 2021; Annex). All checked by us colony roosts (9 of 18 found) were maternity. The largest counted colony was > = 177 individuals (Annex). Mixed maternity colonies with *P. nathusii* are known (Vlaschenko et al., 2012; Annex).

Taking into account the data on the current distribution of *P. pygmaeus* and *P. pipisrellus* s. s. in the region, we presume that all old records of *P. pipistrellus* s. l. in the ZMF- and ZFS-subregions (fig. 18, D) may be reffered to *P. pygmaeus*.

Plecotus auritus (Linnaeus, 1758)

Note. Till late 1990s, in publications of Ukrainian zoologists, long-eared bats (*P. auritus* and *P. austriacus*) were considered as one species (fig. 19, C). Therefore, to estimate the distribution of these two species in the past only by publications is not possible. However, in museum collections, there are 34 specimens collected within the study region (in ZMF- and ZFS-subregions) in 1912–1969. All of them are *P. auritus* s. s. (Zagorodniuk & Godlevska, 2001; Godlevska, 2013 b).

P. auritus was recorded in three subregions (fig. 19), all year round.

The breeding was confirmed in three subregions (in total, in 23 localities). Revealed maternity roosts were in underground cavities, n = 3; and in overground sections of (abandoned) buildings, n = 4 (Godlevska et al, 2016 a; Annex). In the breeding roosts, adult males were recorded together with females and juveniles. The maximum number of the summer colony, found in a big abandoned factory cellar, was about 60 individuals, with 1M, 7Fad-repr, 1Mjuv examined (Annex).

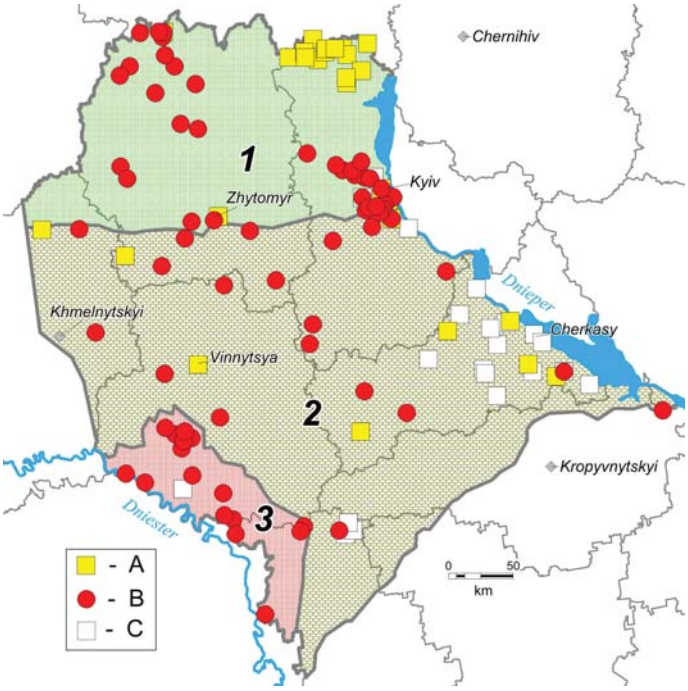


Fig. 19. Record localities of *Plecotus auritus* (A, B), *Plecotus* spp. (C).

Known hibernacula are underground. The maximum hibernation number per site, counted in one of the mines in the Dniester region (VRB-1 mine, Vinnytsya Region), was 55 individuals (Godlevska et al., 2012). However, in most hibernacula, the counted number of *P. auritus* was 1–12 individuals.

Plecotus austriacus (Fischer, 1829)

The current distribution of the species in the region (fig. 20) seems to be the consequence of the recent and continued nowadays range expansion in northern, north-eastern and eastern directions. The records of the species in the ZMF- and ZFS-subregions were previously absent; see Note to *P. auritus*. The occurrence of the species there was first reported by Bilushenko (2009), in the ZFS-subregion. Until recently, the northernmost record locality of *P. austriacus* was at the border of the ZFS and ZMF-subregions in Kyiv (Godlevska et al., 2016 a). However, in winter 2020/2021 the species was first recorded in the ZMF-subregion (Annex). Notably, all record points of the species in these subregions concern anthropogenic objects or habitats (mostly in different man-made structures).

The bat fauna of the DRS-subregion was studied much less than in two other regions; focused bat studies were carried out only recently. Thus, it is not possible to estimate how new the species is for the subregion. During the two last decades, the species in the DRS-subregion was recorded in almost the same number of localities as *P. auritus* (14 and 16 correspondingly). However, in comparison with *P. auritus*, an abundance of *P. austriacus* seems to be lower. In particular, the total number of *P. austriacus* in the underground hibernacula of the DRS-subregion was 32 individuals against 96 in *P. auritus* (fig. 25).

In the study region, *P. austriacus* is recorded in all seasons of the year. Breeding females and/or juvenile individuals were found in seven localities of ZFS- and DRS-subregions (Godlevska et al., 2010; 2021; Annex). Revealed maternity roosts were underground (mines) or in overground sections of (abandoned) buildings (ibid).

Known hibernation roosts are underground; the number per one hibernacula was up to 9 individuals (Godlevska et al., 2012).

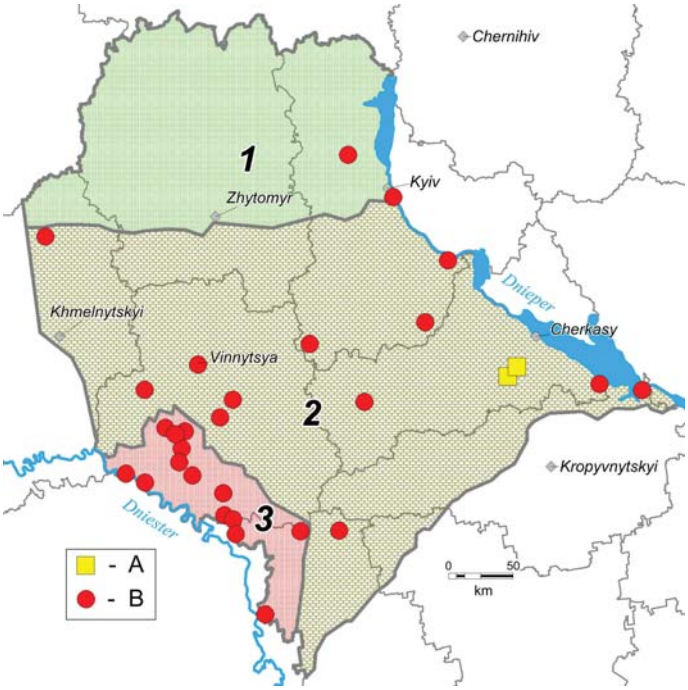


Fig. 20. Record localities of *Plecotus austriacus*.

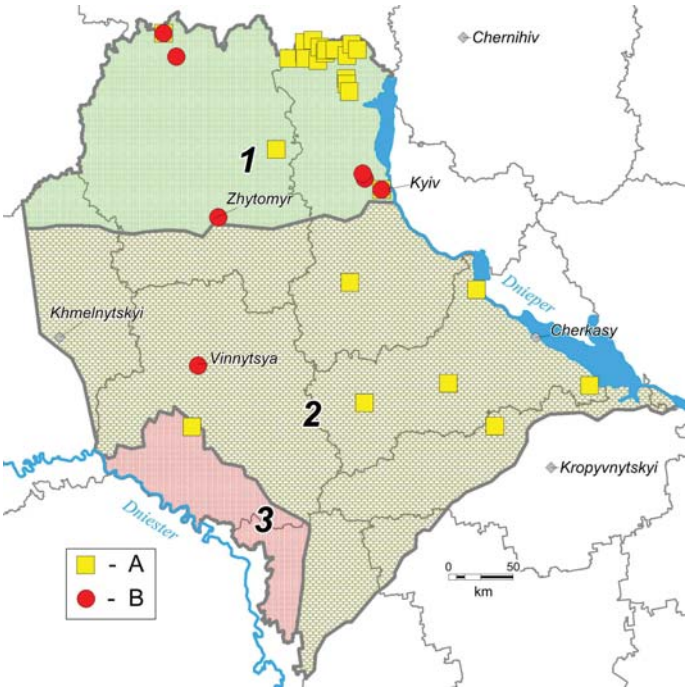


Fig. 21. Record localities of *Vespertilio murinus.*

Vespertilio murinus Linnaeus, 1758

The species was recorded in all three subregions (fig. 21). However, its occurrence within the study region is characterized by evident seasonal dynamics.

We found breeding of the species only in two localities in the northwest of the study region with one localised maternity roost in the attic space (Annex). In the northeast of the region, in the Chernobyl Exclusion Zone, Gaschak et al. (2009; 2013) regularly recorded *V. murinus* during the breeding season, in 2007–2013: individuals of this species there comprised 5 % of all netted bats. In other parts of the study region, during the breeding season, the species is almost absent. Summer, exactly dated, observations of the species, there, are presented by single specimens with no breeding females or juveniles among them (e. g. Bilushenko, 2016; Ruzhilenko et al., 1998; Godlevska, 2012; 2015).

In previous publications, there are mentions of maternity colonies in two localities of the ZFS-subregion: one, in a hollow oak in southern vicinities of Kyiv (Charlemagne, 1933); the second, two colonies in hollow trees in Cherkasy Region (Sologor, 1973). Taking into account the absence of any other records of maternity colonies in the ZFS- and Dniester subregions, both in past and present, we presume that mentioned records might concern colonies of *Nyctalus leisleri,* the species which is similar by size with *V. murinus* and which, in Ukraine, typically roosts in trees (e. g. Vlaschenko, 2009; Godlevska & Rebrov, 2018; Annex). Misidentification between these two species occurs even now (L. Godlevska, comm.).

Since 1998, *V. murinus* is recorded regularly in autumn and winter in large settlements, mostly in districts of multi-storey buildings, where parti-coloured bats are regularly found in inner rooms, at the outside surface of buildings or on the ground, in particular in Kyiv. Inside such districts, the autumn display song of males of *V. murinus* is recorded as well (Godlevska, 2013 a; 2015; Annex). The current regular winter occurrence of *V. murinus* in the region evidently indicates another case of expansion of the bat winter range (Godlevska, 2013 a).

Noteworthy that the described seasonal dynamics of the species occurrence is similar to that at the adjacent territories to the east from the Dnipro River (Godlevska, Rebrov, 2018): the breeding is known only in the northernmost part, summer records are single, and in winter parti-coloured bats are found in settlements.

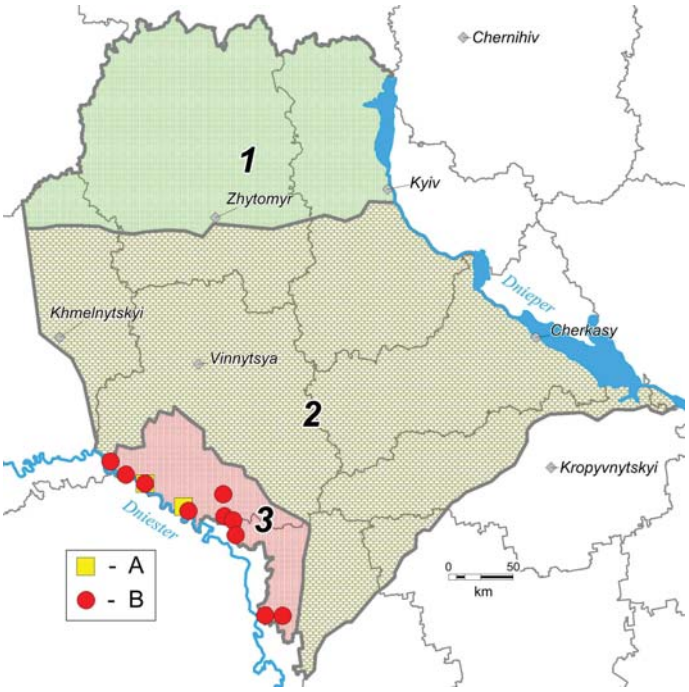


Fig. 22. Record localities of *Rhinolophus hipposideros*.

Rhinolophus hipposideros (Borkhausen, 1797)

The distribution of the species within the region is restricted to its southern part, to the Dniester subregion (fig. 22), where it was recorded in 10 study localities in different seasons of the year. All found roosts, both winter and summer, were underground. The maximum counted number per one hibernaculum was 167 individuals (Godlevska et al., 2010). Maternity colonies were revealed in three underground sites; the largest counted ca. 50 adult females (ibid; Annex).

Chiropterofauna of subregions, seasonality of species occurrence, their reproductive status

The summary on bat species' occurrence by subregions, seasons, and their reproductive status is presented in table 1.

In total, in the ZMF-subregion, 17 bat species were recorded; in the ZFS-subregion, 15. The difference concerns two species: *E. nilssonii* and *M. mystacinus* s. s. The former is known by records in few study localities of the ZMF-subregion; the latter was found there only once. *P. austriacus* is the new species for the ZMF-subregion. *N. lasiopterus* is an extremely rare species, which was recorded only twice in the ZMF-subregion during the last two decades. In the rest, species composition and reproductive status of species of these subregions are pretty similar.

The highest number of species (in total, 23) was recorded in the Dniester subregion, which is the smallest by area. Here, so-called cave species (*R. hipposideros*, *M. blythii*, *M. myotis*) and *M. bechsteinii,* species of *M. mystacinus* morphogroup, *P. pipistrellus* s. s. were found.

Winter occurrence of 17 species in the region was established with direct observations. Occurrence, in winter, of three species of *M. mystacinus* morphogroup: *M. alcathoe*, *M. aurascens* and *M. mystacinus* s. s. is presumed. Winter records for four, known to be long-distance migrants (Hutterer et al., 2005), species (*P. nathusii, P. pygmaeus, N. leisleri, N. lasiopterus*) are not known in the study region; it is presumed to be out of their winter range.

During the last two decades (and in general), reproduction was confirmed for 20 bat species in the study region. So far, there are no data on breeding of four species (*E. nilssonii*, *M. myotis, M. aurascens, M. mystacinus*) in the region. In the case of the

Table 1. Bat species by three subregions of Central Ukraine: mixed forests (ZMF), forest-steppe (ZFS), and Dniester River (DRS), in the warm period of year (S) and in winter (W)

Species	ZMF-S	ZMF-W	ZFS-S	ZFS-W	DRS-S	DRS-W
B. barbastellus	+ repr	+	+ repr	+	+	+
E. nilssonii *	+	+	–	–	–	–
E. serotinus	+ repr	+	+ repr	+	+ repr	+
M. alcathoe *	–	–	–	–	+ repr	(+)
M. aurascens *	–	–	–	–	+	(+)
M. bechs teinii *	–	–	–	–	+ repr	+
M. blythii *	–	–	–	–	+ repr	+
M. brandtii *	+	+	+ repr	–	+	(+)
M. dasycneme	+ repr	+	+ repr	+	+	+
M. daubentonii	+ repr	+	+ repr	+	+ repr	+
M. myotis *	–	–	–	–	+	+
M. mystacinus *	+?	–	–	–	+	(+)
M. nattereri	+ repr	+	+ [repr]	+	+ repr	+
N. lasiopterus	+ repr	–	[+]	–	[+]	–
N. leisleri	+ repr	–	+ repr	–	+ repr	–
N. noctula	+ repr	+	+ repr	+	+ repr	–
P. auritus	+ repr	+	+ repr	+	+ repr	+
P. austriacus *	(+)	+	+ repr	+	+ repr	+
P. kuhlii *	+ repr	+	+ repr	+	+ repr	(+)
P. nathusii	+ repr	–	+ repr	–	+	–
P. pipistrellus *	–	–	–	–	+ repr	+
P. pygmaeus	+ repr	–	+ repr	–	+ repr	–
R. hipposideros	–	–	–	–	+ repr	+
V. murinus	+ repr	+	+ [repr?]	+	[+]	(+)
Total, species	16 (17)	12	15	10	23	12 (18)
	17		15		23	

* The species first found in the region during the last two decades (old records of *P. pipistrellus* s. l. were assigned to *P. pygmaeus*); repr — breeding of a species was confirmed by records of breeding females and / or juvenile individuals in the breeding period; [+] / [repr] — species occurrence / breeding was recorded before 1999; [repr?] — breeding was mentioned in publications, but reliability of species identification is questionable; (+) — species occurrence is presumed.

first two species, the region seems to be on the edge of their main distribution ranges. In *M. aurascens* and *M. mystacinus* the breeding in the region is presumed; given their sedentary.

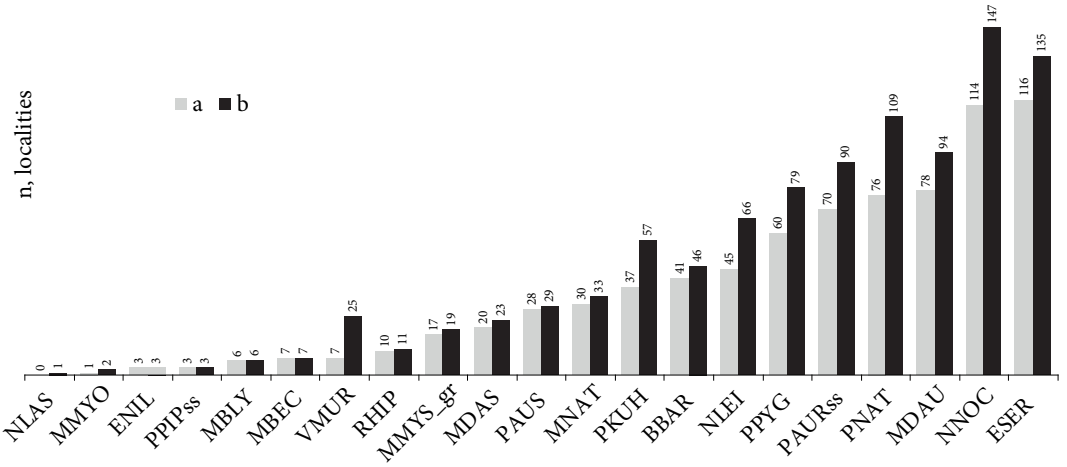


Fig. 23. Bat species of Central Ukraine by number of localities in 1999–2021, according to: a, own data; b, sum of all available geographically attributed data for the time period.

Distribution of species, their prevalence and abundance

In total, by results of 1999–2021 study, the most common, by the number of localities, species are: *E. serotinus, N. noctula, M. daubentonii, P. nathusii, P. auritus* and *P. pygmaeus*. Other species were found in a fewer number of localities. The species *N. lasiopterus, M. myotis, E. nilssonii, P. pipistrellus* s. s.*, M. blythii, M. bechsteinii* have the restricted distribution (see Species accounts). They are known from the least (among other species) number of localities (fig. 23).

In general, our own results on the prevalence of species (fig. 23, a) correspond to the broader array of data (fig. 23, b). The only species with a considerable difference in a number of localities (by own *vs.* sum of all data) is *V. murinus*. The majority of known localities of this species are in the Chernobyl Exclusion Zone. There, the species is regularly found in summer (Gashchak et al., 2009; 2013) in contrast to the biggest part of the study region (see *V. murinus* species account).

The most prevalent species have, in general, the highest abundance. In particular, the quantitative representativeness of these species among netted bats during the breeding season was high in all three subregions (fig. 24).

Bat roosts

In total, in the course of our study within the region, we revealed and/or examined 108 underground bat shelters; with the length of a few meters to over 10 km each (Godlevskaya, 2007; Godlevska et al., 2010; 2012; 2016; Annex). Data on two underground bat roosts for the same time period are available in publications of other authors (Smirnov & Smirnov, 2007; Bugaichenko, 2019).

During 1999–2021, in underground shelters of two not-cave subregions (ZMF and ZFS), we revealed eight bat species: *B. barbastellus, E. serotinus, M. brandtii, M. dasycneme, M. daubentonii, M. nattereri, P. auritus, and P. austriacus*. They exhaust the full list of bat species been recorded in underground sites of the not-cave (NC) subregions.

In summer, in underground sites of this, not-cave, part of the region, we found bats in comparatively low numbers. Maternity colonies in underground structures of the NC subregions were observed only in one species, *P. auritus*, in two objects (Godlevska et al., 2016; Annex). Also breeding females of *M. daubentonii* were caught at the entrance to one semiunderground object (Annex).

In the NC part of the region, in 1999–2021, we examined 50 underground hibernacula: in the ZMF-subregion, 34; in the ZFS-subregion, 16. The maximum bats' number per one underground hibernaculum in the NC subregions was 356 individuals: in DMS 47-P1-2, Kyiv (Annex). However, the median value of bats' number per one underground hibernaculum was 4 individuals (N_{av} = 42 ind.). In winter aggregations in underground hibernacula of the NC subregions, *M. daubentonii* predominated considerably (fig. 25, A).

Notably, the biggest portions (96 %) of counted hibernating bats in the NC subregions were revealed in less than a half of underground hibernacula (43 %). The largest complex of underground hibernacula in the NC subregions is represented by the drainage mine systems (DMS) in Kyiv. The general number of bats counted in DMSs (18 objects in different years) amounts ca. 76 % of all bats in underground hibernacula in not-cave subregions. About 20 % of counted bats hibernating underground in the not-cave part of the region were found in four other objects in the ZMF-region (tree, military; one, a tunnel of unclear purpose). And only 4 % of bats were counted in the rest (56 %) of the examined underground hibernacula of this, not cave, part of the study region.

More bat species were revealed in underground sites of the Dniester, cave, subregion, where there are many extended underground objects, diverse by structure and microclimate (Godlevska et al., 2010; 2012). There, *R. hipposideros*, *M. blythii*, *M. myotis*, *M. bechsteinii*, and species of *M. mystacinus* morphogroup and *P. pipistrellus* s. s. are added to the list of species roosting underground (fig. 25, B).

In summer, in examined underground cavities of the Dniester subregion, maternity colonies of *R. hipposideros* (four sites) and *P. austriacus* (three sites) were recorded. As well,

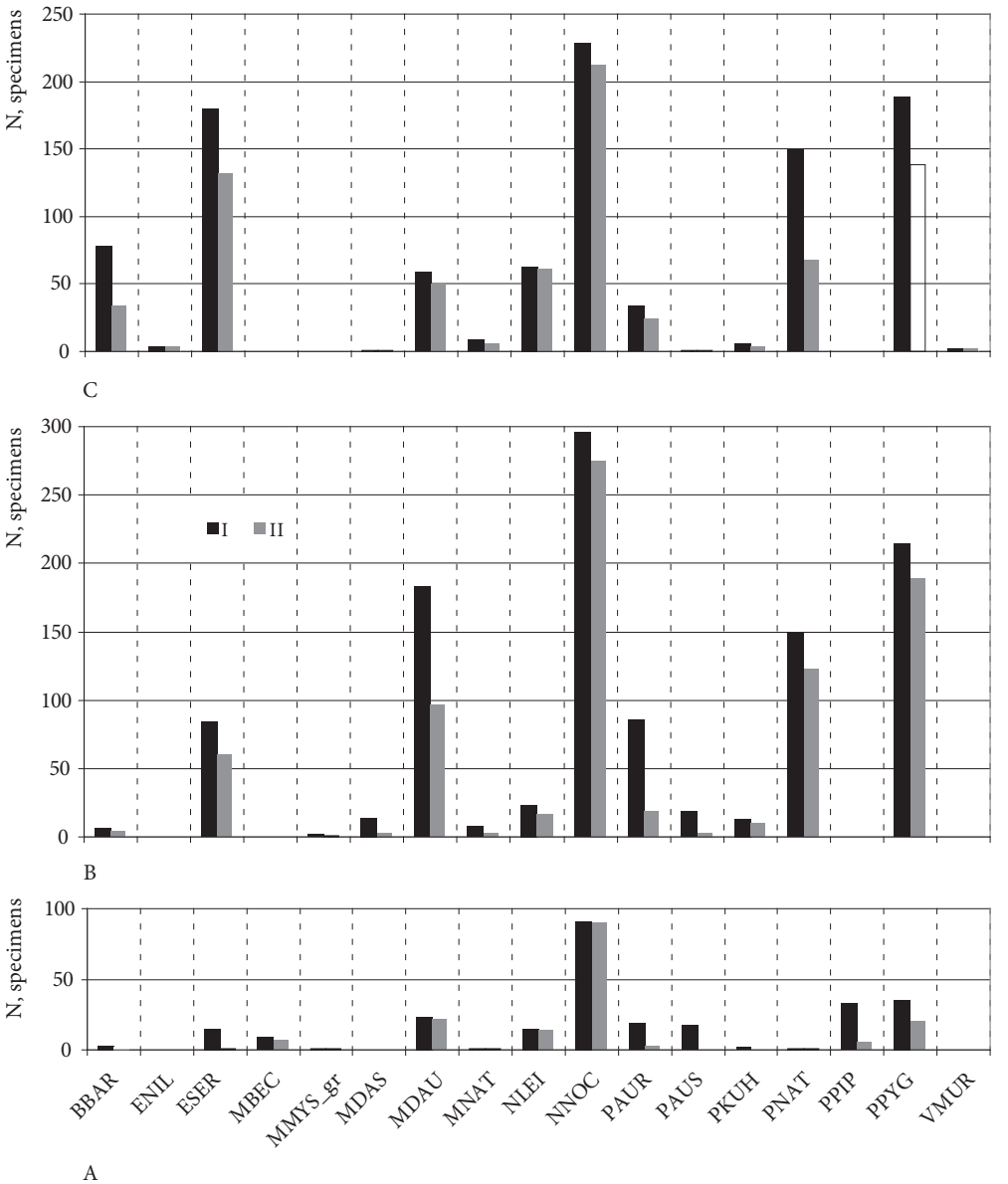


Fig. 24. Quantitative representativeness of species among netted bats during breeding season in 1999–2021 in subregions: A, Dniester River, DRS (n_{ind} = 265); B, forest-steppe, ZFS (n_{ind} = 1097); C, mixed forests, ZMF (n_{ind} = 1007). I — all netted specimens; II — bats netted remotely of identified roosts. Results of catchings at underground sites in the DRS were not included. Only own data were used.

breeding females of *M. blythii* and *P. auritus* were netted at the entrances to mines, that indirectly indicates the using such objects by these species as maternity.

In winter, in the DRS-subregion, 26 underground hibernacula were inspected. The maximum number of bats per one underground hibernaculum was 371 individuals: in VRB1-mine, Vinnytsya Region (Godlevska et al., 2012). In comparison with the not-cave subregions, the median value of bats' number per one underground hibernaculum was higher: 30 individuals (with N_{av} = 68 ind.). Dominant species (by the number of individuals) were *R. hipposideros* and *M. daubentonii*. However, the distribution of counted individuals by species in the Dniester region is less sharp than in not-cave subregions (fig. 25, B).

Overground bat roosts in the study region include various cavities in man-made structures, trees, and, probably, in rock and soil outcrops.

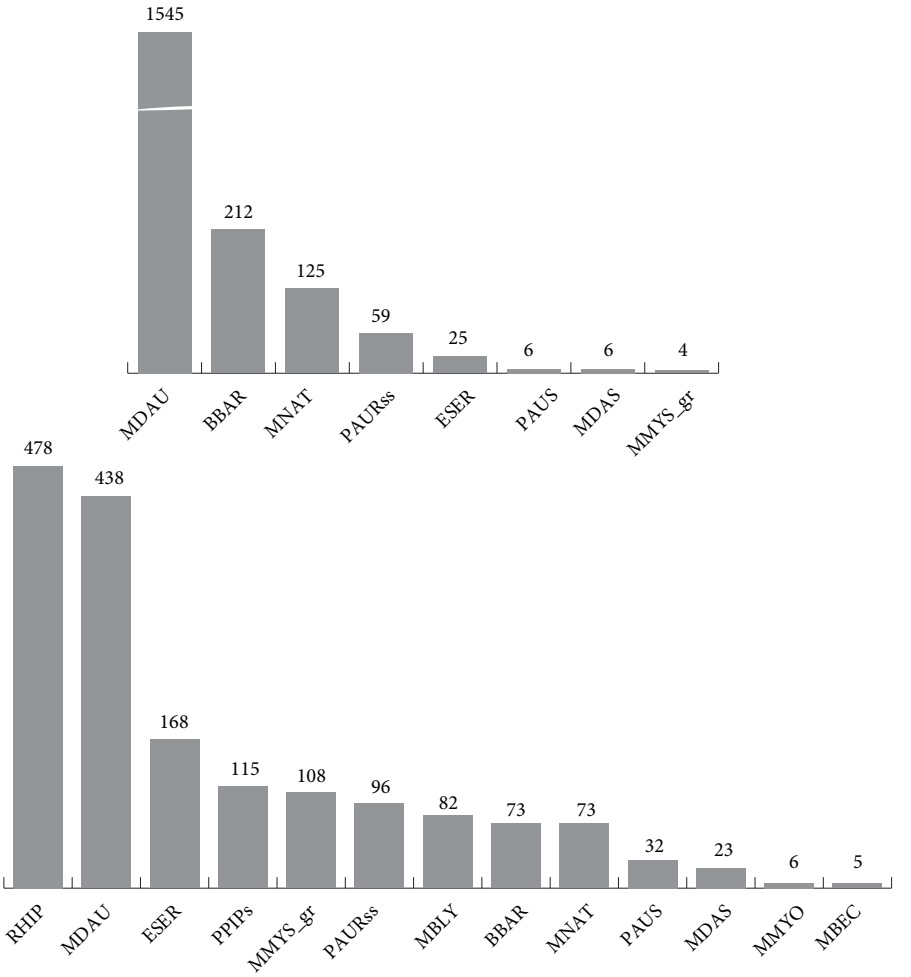
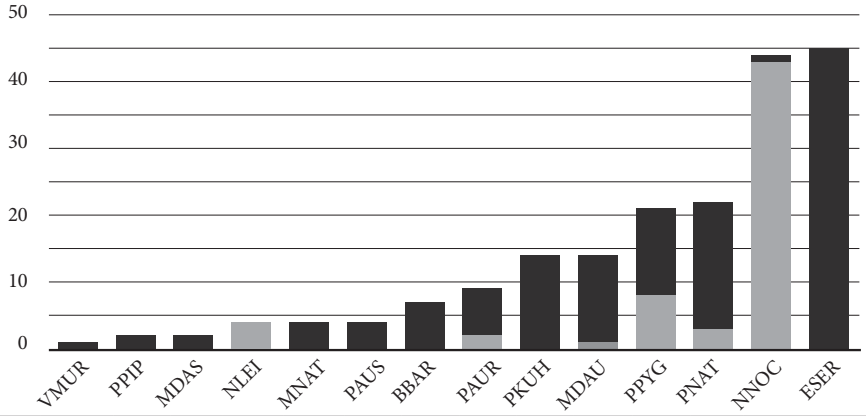


Fig. 25. Quantitative representativeness of bat species in underground hibernacula of the study area (by own data of 1999–2021). A, ZMF- and ZFS-subregions (34 and 16 objects; 1931 and 51 identified ind., correspondingly); B, DRS-subregion (26 objects, 1697 identified ind.). By: Godlevskaya, 2007; Godlevska et al., 2010, 2012; this paper. In case of numerous counts, maximal numbers were taken.

In the warm period of the year, we revealed 162 overground bat roosts (67, in trees; 95, in man-made structures). For 135 of them, at least one species of sheltered bats was identified; for 27, the species of sheltered bats was not identified or identified only to a genus (e. g. *Nyctalus*, *P. nathusii/P. kuhlii*; etc.). In total, roosts of 14 species were localised (fig. 26). In general, these species are the all ones with localised summer overground roosts during the last two decades of the bat survey in the region.

The largest number of such roosts, in the warm period of the year, was found for four species: *E. serotinus*, *N. noctula*, *P. nathusii, P. pygmaeus*, which are among the most frequent and abundant species in the region (see above). Roosts of six species (*M. daubentonii, N. noctula, N. leisleri, P. auritus, P. pygmaeus, P. nathusii*) were found in tree cavities. *N. leisleri* was found roosting only in trees; *N. noctula*, almost solely. In overground sections of various man-made structures, roosts of 13 species were revealed. Among them, eight species were revealed roosting only in the man-made structures (fig. 26).

In winter, we localised overground bat roosts only in buildings (Godlevska, 2015 a; Annex; L. Godlevska, comm.) where four species (*N. noctula*, *P. kuhlii*, *E. serotinus*, *V. murinus*) were regularly found. These four species also predominate by the number of calls to contact centres, both within the study region and Ukraine overall (Godlevska, 2012 b,



	VMUR	PPIP	MDAS	NLEI	MNAT	PAUS	BBAR	PAUR	PKUH	MDAU	PPYG	PNAT	NNOC	ESER
Building	1	2	2	0	4	4	7	7	14	13	13	19	1	45
Trees	0	0	0	4	0	0	0	2	0	1	8	3	43	0

Fig. 26. Localised overground bat roosts and their types (natural / anthropogenic) in summer by species, Central Ukraine (by own data, 1999–2021).

2015 b; Prylutska & Vlaschenko, 2013; Panchenko & Godlevska, 2018). *N. noctula* is known as the species forming large hibernation colonies in hundreds of specimens in multi-storey buildings in settlements (Godlevska, 2015 a). *P. kuhlii* hibernate in cavities of overground sections of buildings in groups or colonies with a number up to 150 individuals (see *P. kuhlii* species account). Numerous and regular records of *E. serotinus* and *V. murinus* in inner rooms of buildings are the evidence of their wintering in cavities of these structures. Of the four species mentioned, three are "new" in winter in the region: *N. noctula*, *V. murinus*, due to the expansion of their winter range; *P. kuhlii*, due to the expansion of the general range.

In buildings, in the inner rooms of their overground sections, there were few records of single specimens of *P. austriacus* and *Plecotus* sp. (Ruzhilenko et al., 1998; Bilushenko, 2009; Annex). That may be considered as the evidence of roosting of long-eared bats in buildings in winter as well. There were also two records of single specimens of *B. barbastellus* in overground sections of buildings (see the species account).

Few records of solitary bats in hollow trees in the winter period concern, mainly, the autumn (October) or spring (March) seasons (Abelentsev & Popov, 1956; Sologor, 1973). These seasons in certain years may be characterised by rather high temperatures, and, correspondingly, such shelters may be transit or temporal. The only mention in publications of bats (*N. noctula*) in hollow trees during the main winter period in the region, namely in the cities of Kyiv and Cherkasy, concerns the last decade (Bilushenko, 2015). It can not be ruled out that the warming of winters allow bats, at present, to hibernate in trees in the regions (earlier) characterised by low temperatures and long periods of frosts (Babichenko et al., 2003). However, only further research will show whether the wintering of bats, particularly *N. noctula*, in trees is constant, or such shelters are satellite to those already known in buildings.

One more type of conditionally overground roosts in crevices of rock or soil outcrops is not studied enough. In the borders of the study region, there were two records of bats at the surface of outcrops in the late winter period: in the middle of March. In particular, on the 15th of March 2008, few specimens of *E. serotinus* were observed at ledges of granite rocks (Zagorodniuk & Kalinichenko, 2008). The single specimen of *B. barbastellus* was found at the loess wall of a ravine on the 7th of March 1992 (Ruzhilenko et al., 1998).

Discussion

The history of the bat fauna survey in Central Ukraine covers the period of over 170 years. However, the biggest portion of the available data on the bat fauna of this region refers to the period of the two last decades (fig. 2). During 1999–2021, the list of bat species

was significantly clarified, both for the region overall and for its subregions. In particular, the presences of 11 bat species were first identified in the region (table 1). At that, only *P. kuhlii* is the new species of the regional fauna; others seem to be discovered due to the intensification of the bat research activities.

The distribution ranges of all species were significantly clarified both for the study region and Ukraine overall. Among other, the distribution of recently separated species (*P. pipistrellus* and *P. pygmaeus*, *P. auritus* and *P. austriacus*) was determined.

Among the subregions, the Dniester subregion stands out by number of species both in winter and warm seasons of the year. Noteworthy that increase in the number of bat species known for the study region (from 13 to 24) occurred, to the large extent, due to observations first carried out in the DRS-region (Godlevska et al., 2010; 2012; this paper). Only here, six of nine "new" species were first recorded: *M. aurascens*, *M. alcathoe*, *M. bechsteinii*, *M. blythii*, *M. myotis*, and *P. pipistrellus* s. s. The high diversity of bat species in this subregion is, obviously, determined by its landscape diversity (Marynych & Shyschenko, 2006), microclimate and availability of the large number of underground shelters (see Study area). The total number of bat species of this subregion (namely 23) enables to identify it as one of the bat diversity hotspots in Ukraine; together with Carpathian and Crimean regions.

The available data allow specifying the seasonality of occurrence and outlining more precisely the breeding ranges of studied species. Most of the data on breeding of bat species in the region were collected just in the last two decades; and most of them were obtained in the course of authors' field surveys.

Availability of appropriate roosts is very important for any bat species. Recently received data enable to assess the distribution and significance of underground bat roosts in the region. In particular, we show an unequal distribution of bats among known underground hibernacula in the not-cave subregions where 96 % of wintering underground bats were counted less in a half of all inspected hibernacula. Moreover, 76 % of these bats were revealed in the complex of drainage mines of Kyiv City.

The distribution of hibernating bats among underground hibernacula in the Dniester subregion is more equal, in comparison with not-caves ones. As well, the distribution of counted individuals by species in the Dniester region is less sharp than in not-cave subregions (fig. 25). This is, obviously, caused by the diversity of underground sites (including their structure, volumes and microclimate) of the Dniester subregion.

With intensification and broadening research activities in future, the number of bats hibernating underground in the region may be defined more precisely. However, available data unambiguously indicates the importance of already known large hibernacula for bat conservation, especially in the not-cave part of the region.

During our surveys, we had collected a big array of data on overground bat roosts in the warm period of year (n = 162). We suppose that roosts in tree cavities (n = 67) were undercounted. Revealing and examining bat shelters in trees is a more methodologically complicated task, which often requires more time and effort than for roosts in man-made structures, which are more accessible for direct inspection. At the same time, the considerable number of revealed bat roosts in man-made structures (n = 95) shows the significance of such types of shelters for bats in the region and determines the necessity to draw special attention to their protection in the development and implementation of bat conservation measures, both at regional and national levels. The same is highly relevant for winter bat shelters in buildings. Almost all known overground roosts of bats in winter were localised in buildings.

In general, the data collected during the last two decades significantly broadened the knowledge about the bat fauna of the region and Ukraine as a whole. In fact, the current review represents the "picture" of the bat fauna for this period. We suppose that it may be used further as a checkpoint both for monitoring certain species, their communities and localities or roosts.

Conclusions

The bat fauna of Central Ukraine (to the west from the Dnipro River) includes 24 species: *Eptesicus*, 2 species; *Barbastella*, 1; *Myotis*, 10; *Nyctalus*, 3; *Pipistrellus*, 4; *Plecotus*, 2; *Vespertilio*, 1; and *Rhinolophus*, 1.

During 1999–2021, the breeding was confirmed in 20 species (all except *E. nilssonii*, *M. myotis, M. aurascens, M. mystacinus*). Winter records of four, known to be long-distance migrants, species (*P. nathusii, P. pygmaeus, N. leisleri, N. lasiopterus*) are not known in the region. Winter occurrence of three species of *M. mystacinus* morphogroup is presumed.

Species composition (and their reproductive status) in two subregions, of the mixed forests (ZMF) and forest steppe (ZFS), are pretty similar. In the ZMF-subregion, it total, 17 bat species were recorded; in the ZFS-subregion, 15. The highest number of species (23) was recorded in the Dniester subregion.

By results of 1999–2021 studies, the most common species (by the number of localities) were *E. serotinus, N. noctula, M. daubentonii, P. nathusii, P. auritus* and *P. pygmaeus*. Other species were found in a fewer number of localities. The species *N. lasiopterus, M. myotis, E. nilssonii, P. pipistrellus s. s., M. blythii, M. bechsteinii* have the restricted distribution. Their records come from the least (among other species) number of localities. The most common species have, in general, the highest abundance. The quantitative representativeness of these species among netted bats during the breeding season was high in all three subregions.

Eight species were recorded in underground sites of the not-cave part of the study area (ZMF- and ZFS-subregions). Maternity colonies in underground structures of the NC subregions were observed only in *P. auritus.* The maximum bats' number per one underground hibernaculum in the not-cave subregions was 356. In these subregions, the biggest portion of counted hibernating bats (96 %) was revealed in less than a half of inspected underground hibernacula. The dominant species among hibernating bats in underground sites of these subregions was *M. daubentonii*. In the Dniester subregion, 13 bat species were found in underground sites. At least two species (*R. hipposideros*, *P. austriacus*) use such sites as maternity roosts. The maximum number of bats per one underground hibernaculum was 371. The distribution of hibernating bats among underground hibernacula in the Dniester subregion is more even than in those of not-cave subregions (median values of bats' number per one underground hibernaculum: 30 vs. 4 individuals, correspondingly). The dominant species in winter aggregations (by number of counted individuals) were *R. hipposideros* and *M. daubentonii*.

During the two last decades, in the warm period of the year, overground roosts of 14 species were revealed. During our survey in the warm period of the year, we revealed 162 overground bat roosts, and for 135 of them at least one sheltered bat species was identified. The largest numbers of such roosts were found for four species, which are among the most common and abundant in the region: *E. serotinus*, *N. noctula*, *P. nathusii,* and *P. pygmaeus*. In the warm period of the year, six species were found roosting in tree cavities; and 13, in overground sections of various man-made structures (buildings, hangars, bridges, military structures).

In winter, almost all known overground bat roosts are in buildings. Species that are regularly found to hibernate in such shelters are *N. noctula*, *P. kuhlii*, *E. serotinus*, *V. murinus*.

We sincerely thank N. Atamas, I. Balashov, A. Bednarchuk, P. Buzunko, S. Davydenko, D. Demchenko, M. Ghazali, P. Gol'din, A. Grushko, A. Haleyeva, L. Kravchuk, O. Krokhmal, A. Larchenko, P. Lina, A. Marchevka, M. Maruschak, O. Mischenko, I. Parnikoza, I. Pobivantseva, T. Postawa, O. Proskura, Ju. Pryadko, M. Storozhuk, V. Tyshchenko, A. Plyha, Zh. Zynkevich, all who helped us in different years with the fieldwork. We thank L. Kravchuk, E. Zhuravleva, A. and B. Paschenko, M. Storozhuk, members of the Kyiv Animal Rescue Group, and O. Bubela, L. Bugaichenko, V. Frankova, O. Gulai, Ju. Kutsokon, O. Matviychuk, Ju. Nesin, V. Linkevich, Je. Rudenko, B. Popov, O. Vasyljuk, D. Vishnevskiy, S. Zhyla, for communications about bat findings; R. Ivanenko, O. Kovalenko, A. Plyha, A. Podobailo, S. Zhyla for assistance in organization of the fieldwork.

Part of the fieldwork was carried out with the financial support of: Stichting Zoogdierenwerkgroep Zuid-Holland, Bat Support Fund for Eastern Europe, Rufford Foundation, European Mammal Foundation, Bobryk Village Charity "Development and prosperity", Fund for the protection of biodiversity of Ukraine, and Fund of Dovkolabotanica's Friends.

We thank P. Gol'din, for the discussion of the manuscript; two anonymous reviewers, for the valuable critical comments and remarks.

References

Abelentsev, V. I., Popov, B. M. 1956. Order Chiroptera, or bats. *In:* Pidoplichko, I. G. *Fauna Ukrainy. Vol. 1: Mammals.* Vyd-vo AN URSR, Kyiv, 229–446 [In Ukrainian].

Abelentsev, V. I., Kolyushev, I. I., Krochko, J. I., Tatarinov, K. A. 1968. The results of ringing Chiroptera in the Ukrainian SSR for 1939–1967. Communication 1. *Vestnik Zoologii*, 6, 59–64 [In Russian].

Abelentsev, V. I., Kolyushev, I. I., Krochko, J. I., Tatarinov, K. A. 1969. The results of ringing Chiroptera in the Ukrainian SSR for 1939–1967. Communication 2. *Vestnik Zoologii*, 2, 20–24 [In Russian].

Abelentsev, V. I., Kolyushev, I. I., Krochko, J. I., Tatarinov, K. A. 1970. The results of ringing Chiroptera in the Ukrainian SSR for 1939–1967. Communication 3. *Vestnik Zoologii*, 1, 61–65 [In Russian].

Ancillotto, L., Santini, L., Ranc, N., Maiorano, L., Russo, D. 2016. Extraordinary range expansion in a common bat: the potential roles of climate change and urbanisation. *The Science of Nature*, **103** (3–4), 15.

Babichenko, V. M., Rudishyna, S. F., Nikolaeva, N. V. Gushchyna, l. M. 2003. Low air temperature. *In*: Lipinskyi, V. M, Dyachuk, V. A., Babichenko, V. M., eds. *Climate of Ukraine*. Rayevsky Publishing House, Kyiv, 141–145 [In Ukrainian].

Barratt, E. M., Deaville, R., Burland, T. M., Bruford, M. W., Jones, G., Racey, P. A., Wayne, R. K. 1997. DNA answers the call of pipistrelle bat species. *Nature*, **387** (6629), 138–139.

Benda, P., Tsytsulina, K. 2000. Taxonomic revision of *Myotis mystacinus* group (Mammalia: Chiroptera). *Acta Societatis Zoologicae Bohemicae*, **64**, 331–398.

Biletskaya, M. G., Likhotop, R. I., Sologor, E. A. 1990. The use of artificial shelters for attracting bats. *In*: *Materials on ecology and faunistic of some representatives of bats.* Institute of Zoology AS USSR, Kyiv, 5–9 [In Russian].

Bilushenko, A. A. 2009. The first finding of a Grey Long Eared Bat, *Plecotus austriacus* (Chiroptera), Vespertilionidae in Cherkassy region. *Vestnik Zoologii*, **43** (2), 120 [In Russian].

Bilushenko, A. A. 2013. The current status of Kuhl's pipistrelle *Pipistrellus kuhlii* (Chiroptera, Vespertilionidae) in the Central forest-steppe of Ukraine. *Vestnik Zoologii*, **47** (4), 343–349.

Bilushenko, A. A. 2014. Current faunal status of Nathusii pipistrelle, *Pipistrellus nathusii* (Chiroptera, Vespertilionidae) in Central Ukraine. *Problems of bioindications and ecology*, **19** (2), 150–161 [In Ukrainian].

Bilushenko, A. 2015. Usage of bats' roosts in the conditions of the Central Forest-Steppe of Ukraine. *Bulletin of the Taras Shevchenko National University of Kyiv. Biology*, **70**(2), 29–32 [In Ukrainian].

Bilushenko, A. A. 2016. Bats of Feofaniya park in Kyiv, Ukraine. *Plecotus et al.*, **19**, 19–26 [In Russian].

Bugaichenko, L. 2019. Barbastella barbastellus. Image ID ##135728-135729. In: UkrBIN: Ukrainian Biodiversity Information Network, Database on Biodiversity Information. Available from: http://www.ukrbin.com (Accessed: April 02, 2020).

Charlemagne, E. 1914. A description of Trukhanov (Alekseevskyi) island. *Proceedings of Dnepr biostation*, **1**, 15–35 [In Russian].

Charlemagne, E. W. 1915. The mammals of the vicinity of Kiev. *In*: Artobolevskiy, V. M. *Materials to the study of fauna of southwestern Russia Vol. 1*. Kessler Ornithol. Society, Kyiv, 26–92 [In Russian].

Charlemagne, M. 1933. Materials on mammal fauna of Kyiv region. *Proceedings of the Zoological museum*, **12**, 57–73. [In Ukrainian].

Çoraman, E., Dundarova, H., Dietz, C., Mayer, F. 2020. Patterns of mtDNA introgression suggest population replacement in Palaearctic whiskered bat species. *Royal Society Open Science*, **7** (6), 191805.

Dietz, C., von Helversen, O. 2004. Illustrated identification key to the bats of Europe. Electronic publication, v. 1.0, 1–72. https://www.researchgate.net/publication/274838308_llustrated_Identification_key_to_the_Bats_of_Europe_–_complete_pdf (accessed 19 October 2021)

Dombrovski, V. C. 2018. Maternity colonies of *Myotis brandtii* in the Polesie State Radiation-Ecological Reserve. *Theriologia Ukrainica*, **16**, 91–94.

Drebet, M. 2018. Bat fauna monitoring in urban landscapes of Podillia (Ukraine) based on results of the work of bat contact centre. *Theriologia Ukrainica*, **16**, 145–148.

Drebet, M., Martyniuk, V., Vorobei, P. M. 2020. New records of bats at the territory of "Malyavanka" nature national park. In: *Records of protected animal, plant and fungi species in Ukraine*. TVORY, Vinnytsia, 205. (Series: "Conservation Biology in Ukraine", is. 19) [In Ukrainian].

Gashchak, S. P., Vlaschenko, A. S., Naglov, A. V. 2009. Results of the study of fauna and radioactive contamination of bats in Chernobyl Exclusion Zone in 2007–2009. *Problems of Chernobyl Exclusion Zone*, **9**, 102–124 [In Russian].

Gashchak, S. P., Vlaschenko, A. S., Naglov, A. V., Kravchenko, K. A., Gukasova, A. S. 2013. Bat fauna of the Exclusion Zone in concern of assessment of environmental value of its areas. *Problems of Chernobyl Exclusion Zone*, **11**, 56–79 [In Russian].

Godlevskaya, E. V. 2007. Use of Kyiv caves by bats (Chiroptera): hibernation and swarming. *Vestnik Zoologii*, **41** (5), 439–448.

Godlevska, L. V. 2012. Results of the work of the bat contact-centre (Ukraine). *Scientific notes of Taurida National V. I. Vernadsky University. Series: Biology, chemistry*, **25**(4), 12–20 [In Russian].

Godlevska, L. V. 2013 a. New *Vespertilio murinus* (Chiroptera) winter records. An indication of expansion of the species' winter range? *Vestnik Zoologii*, **47** (3), 239–244.
Godlevska, L. 2013 b. Recent bats in the collection of the paleontological museum of NMNH, NAS of Ukraine. *Proceedings of the Zoological museum*, **44**, 145–157.
Godlevska, L. 2015 a. Northward expansion of the winter range of *Nyctalus noctula* (Chiroptera: Vespertilionidae) in Eastern Europe. *Mammalia*, **79** (3), 315–324.
Godlevska, L. 2015 b. Results of the work of the Kyiv bat contact-centre in 2012–2015. *Proceedings of the Theriological School*, **13**, 11–19 [In Ukrainian].
Godlevska, L. V. 2018. Bats of Ukraine: what do we know? *In*: *1st International Conference "Bats of Eastern Europe: Challenges for Conservation". Abstracts.* Republic of Armenia, Yerevan, 25–27 October 2018.
Godlevsky, L., Tyshchenko, V., Negoda, V. 2000. First Records of *Pipistrellus kuhlii* from Kyiv. *Vestnik Zoologii*, **34** (3), 78.
Godlevska, O. V., Tyshchenko, V. M., Ghazali, M. A. 2010. A current status of cave-dwelling bats of Podillya and Middle Dniester River region (Ukraine). *Nature reserves in Ukraine*, **16** (1), 53–64 [In Ukrainian].
Godlevska, L., Ghazali, M. A., Tyshchenko, V. M. 2012. Results of the census of cave-dwelling bats in Podolia and Middle Dniester River region (Ukraine) in 2010–2011. *Proceedings of the Theriological School*, **11**, 89–97 [In Ukrainian].
Godlevska, L. V., Buzunko, P. A., Rebrov, S. V., Ghazali, M. A. 2016 a. 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].
Godlevska, L. V., Rebrov, S. V., Panchenko, P. S. 2016 b. New data on bat fauna of Rivne oblast (Ukraine). *Nature reserves*, **22** (1), 72–77 [In Ukrainian].
Godlevska, L., Rebrov, S. 2018. Bats of the Left-Bank Dnipro Region in the northern part of Ukraine. *Theriologia Ukrainica*, **16**, 25–50 [In Ukrainian].
Godlevska, L. V., Vorobei, P. M., Fedun, O. M. 2020. New data on bats of Volyn oblast. In *Records of protected animal, plant and fungi species in Ukraine*. TVORY, Vinnytsia, 117–121. (Series: "Conservation Biology in Ukraine", is. 19.) [In Ukrainian].
Godlevska, L. V., Vorobei, P. M., Savchenko, O. M. 2021. Bat fauna of the territory of Rzhyschiv CATC. In *Biodiversity of Rzhyshchiv city amalgamated territorial community*. Druk Art , Chernivtsi, 346–353. (Studies of "Hlyboki Balyky" Ecological research station, Is. 1) [In Ukrainian].
Golub, V. M. 1996. Wintering of the barbastelle bat (*Barbastella barbastellus* Schreber) in the "Kholodnyi Yar" reserve. *Vestnik Zoologii*, **30** (1–2), 72 [In Russian].
Hukov, V., Timofieieva, O., Prylutska, A., Rodenko, O., Moiseienko, M., Bohodist, V., Domanska, A., Vlaschenko, A. 2020. Wintering of an urban bat (*Pipistrellus kuhlii lepidus*) in recently occupied areas. *European Journal of Ecology*, **6** (1), 102–120.
Fenton, M. B. 1997. Science and the conservation of bats. *Journal of mammalogy*, **78** (1), 1–14.
Frick, W. F., Kingston, T., Flanders, J. 2020. A review of the major threats and challenges to global bat conservation. *Annals of the New York Academy of Sciences*, **1469** (1), 5–25.
Hutterer, R., Ivanova, T., Meyer-Cords, C., Rodrigues, L. 2005. *Bat migrations in Europe: a review of banding data and literature*. Federal Agency for Nature Conservation, Bonn, 1–162.
Izotiv, I. P. 1932. To the study of the relationship between barn owl and small rodents. *Materials to By-District Study of Small Mammals and Birds Fed on Them*, **1**, 93–100 [In Ukrainian].
Jones, G., Jacobs, D. S., Kunz, T. H., Willig, M. R., Racey, P. A. 2009. Carpe noctem: the importance of bats as bioindicators. *Endangered species research*, **8** (1–2), 93–115.
Kessler, K. F. 1851. Mammalian animals. In: *Proceedings of the Commission... for description of the provinces of the Kyiv educational district: Kyiv, Podolian, Volyn, Poltava, Chernigiv*, Kyiv, 1–88 [In Russian].
Kravchenko, K., Vlaschenko, A., Prylutska, A., Rodenko, O., Hukov, V., Shuvaev, V. 2017. Year-round monitoring of bat records in an urban area: Kharkiv (NE Ukraine), 2013, as a case study. *Turkish Journal of Zoology*, **41** (3), 530–548.
Kryshtal, O. P. 1947. Kaniv Biogeographical Reserve. Fauna. *Proceedings of the Kaniv Biogeographical Reserve*, **1** (1), 116–125 [In Ukrainian].
Likhotop, R. I., Tkach, V. V., Barvinskiy, N. I. 1990. Bats of Kiev and Kiev region. *In*: *Materials on the ecology and faunistic of some representatives of bats*. Institute of Zoology AS USSR, Kyiv, 10–27 [In Russian].
Marynych, O. M., Shyschenko, P. G. 2006. *Physical geography of Ukraine*. T-vo 'Znannya', Kyiv, 1–511 [In Ukrainian].
Mayer, F., von Helversen, O. 2001. Sympatric distribution of two cryptic bat species across Europe. *Biological Journal of the Linnean Society*, **74** (3), 365–374.
Panchenko, P., Godlevska, L. 2018. Data on the bat fauna of the Northern Black Sea Region based on results of the work of bat contact centres. *Theriologia Ukrainica*, **16**, 120–126 [In Ukrainian].
Pidoplichka, I. G. 1932. Analysis of pellets in 1925–1932 years. *Materials to By-District Study of Small Mammals and Birds Fed on Them*, **1**, 5–79 [In Ukrainian].
Pidoplichka, I. G. 1937. Results of pellets' examination in 1924–1935. *Proceedings of the Zoological museum*, **9**, 101–171 [In Ukrainian].
Popov, B. M. 1932. The barn owl (*Tyto alba guttata* Brhm.) and its food in "Koncha-Zaspa" Reserve. *Materials to By-District Study of Small Mammals and Birds Fed on Them*, **1**, 81–91 [In Ukrainian].

Popov, B. M. 1936. Mammological notes. About new sites of findings of the forest birch mouse in Ukraine. *Proceedings of the Zoological museum*, **21**, 193–196 [In Ukrainian].
Popov, B. M. 1939. To the question of the geographical distribution of some small mammals in the Ukrainian SSR. *Zoologicheskii Zhurnal*, **18** (2), 331–335 [In Russian].
Prylutska, A. S., Vlaschenko, A. S. 2013. Materials on the distribution of bats, based on the results of the work of the contact center in Kharkov (2008–2013). *Biological Systems*, **5** (4), 532–537 [In Russian].
Ruzhilenko, N. S., Tsvelykh, A. N. 1992. Records of the rare bat species in Kanev Reserve. *Vestnik zoologii*, **1**, 57 [In Russian] .
Ruzhilenko, N. S., Grischenko, V., Mezhzherin, V., Tsvelykh, A. N. 1998. Bat fauna of Kaniv Nature Reserve. *Proceedings of the Theriological School*, **1**, 76–79 [In Ukrainian].
Shabliy, O. I. 1994. *Socio-economic geography of Ukraine*. Svit, Lviv, 1–607 [In Ukrainian].
Sherwin, H. A., Montgomery, W. I., Lundy, M. G. 2013. The impact and implications of climate change for bats. *Mammal Review*, **43** (3), 171–182.
Shpak, A. V. 2010. First record of *Myotis brandtii* (Mammalia, Vespertilionidae) in the central Polesie of Belarus. *Vestnik Zoologii*, **44** (3), 252.
Smirnov, N. A., Smirnov, D. A. 2007. A record of the lesser horseshoe bat in Vinnytsya oblast. *Nature reserves in Ukraine*, **13** (1–2), 65–66 [In Ukrainian].
Sologor, E. A. 1973. *Eco-physiological traits of bats of the Middle Dnieper River Region*. Thesis for the scientific degree of candidate of biological sciences. Kyiv, 1–160 [In Russian].
Strelkov, P. P. 2004. Expanding of distribution areas of Palearctic Chiropera, Mammalia, as an example of invasion in anthropogenic biotopes. In: Alimov, A. F., Bogutskaya, N. G., eds. *Biological invasions in aquatic and terrestrial ecosystems*. KMK, Moscow, 202–207 [In Russian].
Tyshchenko, V. M. 2002. Modern state and ecological peculiarities of *Myotis daubentonii* in the Podillya territory (Ukraine). *Bulletin of Luhansk Taras Shevchenko National Pedagogical University*, **1**, 140–149 [In Ukrainian].
Tyshchenko, V., Matveev, M., Bovtunova, J. 2005. In addition to bat fauna (Chiroptera) of Khmelnitsky Region. *Scientific Bulletin of the Uzhgorod University (Series Biology)*, **17**, 173–183 [In Russian].
Tyshchenko, V. M., Godlevska, O. V. 2008. First winter records of *Vespertilio murinus* and *Nyctalus noctula* (Chiroptera) in Kyiv. *Vestnik Zoologii,* **42** (3), 280 [In Ukrainian].
Vasiliev, A. G., Andreev, S. P. 1998. The fauna of bats (Chiroptera) in the undergrounds of valley of the Middle Dniester. *In*: *The problems of biodiversity conservation of the Middle and Low flows of the Dniester River. Abstracts of International Conference (Chisinau, November 6–7, 1998)*. BIOTICA, Chisinau, 25–27 [In Russian].
Vlaschenko, A. 2009. Current status of Leisler's bat (Chiroptera) on the territory of Kharkov region. *Visnyk of Lviv University. Biology series*, **51**, 145–156 [In Ukrainian].
Vlaschenko, A. S., Godlevska, L. V., Kravchenko, K. O., Tyshchenko, V. M., Gukasova, A. S., Sudakova, M. V. 2012. Contribution to bat fauna of Holosiyivsky National Nature Park. *Nature Reserves in Ukraine*, **18** (1–2), 51–58 [In Russian].
Voigt, C. C., Kingston, T. 2016. Bats in the Anthropocene. *In*: Voigt, C. C., Kingston, T., eds. *Bats in the Anthropocene: conservation of bats in a changing world*. Springer Nature, 1–12.
Vorobei, P. M., Savchenko, M. O., Godlevska, L. V. 2021. Bat fauna of the Holosiivskyi National Nature Park, Northern part. *Cherkasy University Bulletin: Biological Sciences Series*, **1**, 12–25 [In Ukrainian].
Wright, P. G., Hamilton, P. B., Schofield, H., Glover, A., Damant, C., Davidson-Watts, I., Mathews, F. 2018. Genetic structure and diversity of a rare woodland bat, *Myotis bechsteinii*: comparison of continental Europe and Britain. *Conservation Genetics,* **19,** 777–787.
Zagorodniuk, I., Godlevska, L. 2001. Bats in collections of zoological museums of Ukraine: phenological review of data. *In*: Zagorodniuk, I., ed. *Migration Status of Bats in Ukraine*. Ukrainian Theriological Society, Kyiv, 122–156 [In Ukrainian].
Zagorodniuk, I., Godlevska, O. 2003. Bats of tribe Myotini (Mammalia) in the Middle Dnipro Region: species composition, distribution and abundance. *Vestnik Zoologii*, **37** (2), 31–39 [In Ukrainian].
Zagorodniuk, I. V., Tyschenko-Tyshkovets, M. V. 2001. *Pipistrellus pygmaeus* (55 kHz) in the Kyiv Region (Ukraine). *Vestnik Zoologii*, **35** (6), 52 [In Ukrainian].
Zagorodniuk, I. V., Kalinichenko, O. I. 2008. New Natural Site of Bat Hibernation (Chiroptera) in the Polissia. *Vestnik Zoologii*, **42** (3), 286 [In Ukrainian].
Zhyla, S., Shkvyrya, M., Negoda, V. 2001. Seasonal dynamics of bat populations in the Polissian Nature Reserve. In: Zagorodniuk, I., ed. *Migration Status of Bats in Ukraine*. Ukrainian Theriological Society, Kyiv, 95–97 [In Ukrainian].
Zykov, A. E. 2011. The northern bat (*Eptesicus nilssonii* (Keiserling Blasius 1839)) in Ukraine. *Theriofauna of Russia and Adjacent Territories. International Conference*. KMK, Moscow, 182.

Received 11 November 2021
Accepted 5 June 2022