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Hibernacula of *Barbastella barbastellus* in Ukraine: distribution and some ecological aspects

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Abstract. The paper presents a study regarding the winter aggregations of the barbastelle bat (*Barbastella barbastellus*) in western Ukraine, based on data collected in natural underground spaces and artificial structures (abandoned mines, ancient monuments, military fortifications, etc.). Some parameters including the size and dynamics of winter aggregations, as well as microclimate conditions of hibernacula were investigated. The most numerous barbastelle hibernaculum has been found in the Tarakaniv fortress (Rivne region); the largest aggregation of the species consisted of ca. 950 individuals. The numbers of barbastelles in Ukraine seem stable or even increasing. In Central Europe the species is not threatened as seriously as it is in Western Europe.

Distribution, **hibernation**, **winter aggregations**, **conservation**

Introduction

The barbastelle bat, *Barbastella barbastellus* (Schreber, 1774), is a Palearctic bat species. Its range stretches from the northern Morocco to Iran and from southern Scandinavia and Latvia to Greece (Wołoszyn & Bashta 2009). In Ukraine, the barbastelle is found from the western borders to the Dnieper river. The majority of records come from the western part of Ukraine and the Crimean Mts. (Kovalyova & Taraborkin 2001, Bashta & Potish 2007, Bashta 2009).

The last assessment of the barbastelle status and distribution in Ukraine, including a review of its records was made in 2001 (Kovalyova & Taraborkin 2001). Since then, a lot of new records and observations have appeared. Therefore the aim of this paper is to summarize and evaluate the information, including the new data on distribution and localization of roosts, and to determine population trends of the species in the eastern part of its range within the borders of Ukraine with a special attention to the Tarakaniv fortress as the largest hibernaculum of the species in Ukraine.

Study Area and Methods

The western part of Ukraine, where the study was conducted, includes very different type of landscapes. It covers several physiographic regions, including Polissâ and the Volynska upland (northern part), Podillâ (central part) and the Carpathian region (southern part). Broadleaved forests (incl. beech stands) of Central Europe, forests (incl. oak woods) of the forest-steppe areas of eastern Europe, mixed coniferous-broadleaved forests of northern Europe and meadow-steppe vegetation of southern areas as well as agricultural areas are represented here. The study area includes the Ukrainian Carpathians, which make up about 10% of the whole Carpathian Mts. The mountains are characterized by very varied landscape, limestone areas rich in caves and a temperate continental climate. Karst areas are most evident in the southern part of the Ukrainian Carpathians. The altitude of the investigated area ranges between 105 and about 2000 m a. s. l. (Marynych & Shyshchenko 2005).

The presence of large hibernacula of the barbastelle in underground fortifications of the neighbouring Central-European countries has stimulated us to search for such hibernacula in the territory of Ukraine. Inspection of potential hibernation roosts, mainly large cellars and other underground spaces was carried out in winter season, mainly during the second half of January and February. The checks were sometimes conducted also in late November, December and March. Monitoring of barbastelle numbers in Western Ukraine has been carried out since

1996, but many important roosts have been discovered only recently. The sites varied in respect of the years in which hibernating bats were counted.

Since the identification of the barbastelle in winter roosts is easy, based on its specific external morphological characters , the specimens were not handled (except for several individuals), taking care to minimize disturbance, so the information on sex is mostly not available. Individuals and small clusters of individuals were counted directly. Number of individuals in the larger aggregations was estimated by multiplying the number of bats counted in a unit area of a certain dimension by the total area covered by the aggregation, or mainly at home by counting the bats directly on the photographs that were taken. The latter method was preferable and proved to be more accurate and also has the advantage that it greatly reduces observation time, while diminishing bat disturbance caused by prolonged exposure to light.

All known museum collections of the main museums of Ukraine were analysed. The majority of barbastelle records are from the Zoological Museum of the Užgorod National University (ZMUzNU), as well as the State Museum of Natural History in Kyiv (NNPM) and the State Natural History Museum in Lviv (DPM) (Bashta & Shydlovsky 2001, Shevchenko & Zolotukhina 2005, Bashta 2007).

Results and Discussion

Current distribution

The barbastelle bat is distributed mainly in the forest and forest-steppe zones, in the mountains and foothills of the Crimean and Carpathian Mts. in Ukraine (Bashta 2009). Kovalyova & Taraborkin (2001) reported on about 20 winter observation records of the species in Ukraine. Nowadays we have more than 40 localities of the barbastelle winter roosts. The records are distributed unevenly, depending on the intensity of research effort in different parts of the country.

The first record of the species in western Ukraine was described by Pietruski (1853), who noted that the barbastelle had settled mostly in towers and old churches of cities. This author caught two specimens in the attic of a house in Lviv in 1832. This is probably the first published observation of the barbastelle in Ukraine.

Large hibernacula of the barbastelle are known from underground fortifications of several Central-European countries (e. g. Modlinski forts, forts near Torun, Osoviec in Poland, Brest fortress in Belarus or Kaunas forts in Lithuania – Fuszara & Fuszara 2002, Kasprzyk et al. 2002, Lesiński 2001, Demianchik & Demianchik 2002, Pauža & Paužiene 2002) and other countries and they are key sites for hibernation of many other bat species. It is characteristic that underground cavities of anthropogenic origin, in particular fortifications, are the most important wintering places for this species (Table 1).

Some parts of the country (e.g., the Polissâ and Volynska upland) are characterised by the absence of large underground cavities of natural origin. Therefore different artificial underground spaces became important shelters for bats there. During the study, in 2006, we found the country's largest hibernaculum of the barbastelle bat which is situated in an abandoned fortification (so called Tarakaniv fort) in the Rivne region (western part of the country).

Polissâ and the Volynska Upland

Records. Volyn' Region: **Šac'k**, 29 October 1953 – 1♂ (DPM, leg. Malchevska); **Olyka**, **castle** (Kiverci Dist.), 8 February 2009: 3 inds. (Bashta 2009). – Rivne Region: **Tarakaniv, fort** (Dubno Dist.), 3 January 2009: ca. 400 inds.; 4 March 2009: ca. 740 inds.; 20 November 2010: 300 inds.; 20 February 2011: ca. 730 inds.; 26 February 2012: 950 inds.; 25 March 2012: 162 inds. (Bashta & Ivashkiv in press); **Dubno, castle**, 20 February 2010: 3 inds.; 5 March 2011: 5 inds.; 26 February 2011: 1 ind.; **Klevan', castle** (Rivne Dist.), 7 February 2009: 1 ind. (Bashta 2009); **Novomalyn**, **castle** (Ostrih Distr.), 6 March 2011: 4 inds.

The barbastelle bat was observed only in the western and central parts of the Polissâ area (because its area of distribution is restricted eastwards by the Dnipro river in central Ukraine). The first

Table 1. Localisation and qualitative parameters of the main barbastelle hibernacula in Europe

site	country	number	reference
Nietoperek	Poland	ca. 30 000	Urbańczyk 1989
Dielik tunnel	Slovakia	ca. 6000	Uhrin 1995
Brest fortress	Belarus	ca. 3000	Demianchik & Demianchik 2001
Poznań fort I	Poland	1816	Jurczszyn et al. 2003
Szachownica cave	Poland	1477	Kowalski & Lesinski 1991
Tarakaniv forts	Ukraine	ca. 950	Bashta & Ivashkiv, in press
Modlin forts	Poland	ca. 600	Lesinski 1988
Mamerki/Gierłoż	Poland	555	Lesiński et al. 2005
Ivankivci mines	Ukraine	ca. 400	Drebet & Martyniuk 2009
Osowiec fort	Poland	344	Lesiński 2001
Kaunas forts	Lithuania	ca. 300	Pauža & Paužiene 2002
Konewka bunker	Poland	248	Fuszara & Fuszara 2002

record of this species (from the Poliskyi Dist., Žytomyr Region) was made by Abelentsev et al. (1956). The Polissâ area is characterized mainly by the absence of large underground cavities which are usually used by the barbastelle. However, probability of barbastelle wintering in this area is confirmed by the finding of one specimen in the Šac'k settlement in late October (DPM).

Relatively more winter records of the barbastelle come from the Volynska upland. Majority of them were found in the underground parts of big old buildings. Thus, a large number of hibernacula is located in the cellars of old castles, houses and fortifications, such as the castle in the Olyka (Kiverci Dist., Volyn' Region), castles in Dubno, castle in Novomalyn (Ostrih Dist.), fort near the Tarakaniv village (Dubno Dist.), etc., in the Rivne Region.

Podillâ

Records. Černivci Region: **Hryniačka**, **limestone mines** (Hotyn Dist.), 17 March 1985: 5 inds.; 15 March 1986: 2 inds.; 8 March 1988: 3 inds. (Vikyrchak & Zahorodniuk 2010). – Hmelnyckyj Region: **Gumenci**, **limestone mines** (Kamianec-Podilskyj Dist.), 17–18 February 2001 (Tyshchenko et al. 2005); 21–22 August 2001: 7♂♂, 4♀♀ (Tyshchenko et al. 2005); 9 March 2003: 10 inds. (Bashta 2009); 13 February 2010, 17 March 2010: 35 inds. (Matveev et al. 2010); **Ivankivci**, **limestone mines** (Sataniv Dist.), 2008–2009: 350–400 inds. (Drebet & Martyniuk 2009). – Lviv Region: **Lviv**, 17 November 1947, garret, under tile cover (Tatarynov 1956); 17 February 1949, 23 March 1949 (Tatarynov 1952); 1 April 1949, 8 December 1949, 8 February 1950 (Tatarynov 1952); 30 January 2009: military bunker "Loŝyna", 14 inds., 23 January 2010: 16 inds. (Bashta 2010); 5 December 2010: 1♀, 2 inds.; 19 February 2011: 10 inds. (I. Ivashkiv, pers. comm.); **Pidgirci, Pidgoreckyi castle** (Zoločiv Dist.), 5 March 2004: 1♀; 6 March 2009: 5 inds. (Bashta 2009); 19 February 2010: 6 inds.; 12 February 2011: 4 inds.; 9 March 2012: 7 inds.; **Mykolaiv**, **artificial grottoes**, 11 February 2006: 2 inds.; 10 January 2009: 2 inds. (Bashta 2009); 15 January 2011: 1 ind.; 5 February 2011: 3 inds.; **Iliv**, **cave** (Mykolaiv Dist.), 10 January 2009: 5 inds. (Bashta 2009); **Staryi Rozdil**, **cave** (Mykolaiv Dist.), 21 January 2012: 1 ind.; **Svirž, Sviržskyi castle** (Peremyšliany Dist.), 9 March 2012: 2 inds.; **Stradč, Stradčans'ka cave** (Âvoriv distr.), 7 March 1950: 10 inds. (Tatarynov 1952); 27 January 1951: 8 inds., 25 January 1953: 5 inds. (K. Tatarynov, pers. comm.); 1981–1984 (Polushyna & Borovets 1988), 25 February 1985: 2♂♂ (Tkach 1987); 12 November 1985, 7 January 1986 (Yu. Borovets, pers. comm.); 4 December 1996: 1 ind.; 16 January 1997: grotto, 1 ind.; 17 Novenber 1998: 3 inds.; 18 January 1999: grotto, 1 ind.; 17 November 1999: 3 inds.; 24 December 1999: 4 inds. (our data); 27 December 2000: 2 inds. (T. Guziy, pers. comm.); 27 January 2001: 1♂; 4 March 2001: grotto, 1 ind.; 29 March 2001: 2 inds.; 26 November 2001: 1 ind.; 20 January 2002: 1 ind.; 9 November 2002: 1♂; 22 December 2012: grotto, 1 ind. (our data); winter 2010/2011: grotto, 3 inds. (Bashta et al. in press); **Ivano-Frankove, Lysâča Nora cave** (Âvoriv Dist.), 27 December 2000: 1 ind. (T. Guziy, pers. comm.); 20 January 2002: 2 inds.; 22 December 2012:

1 ind. (our data); winters 2008–2012: 1–5 ex. (Bashta et al. in press); **Lviv, Medova cave**, December 1948: 17 inds. (Tatarynov 1956); 17 February 1949: 19 inds. (Tatarynov 1952); 9 March 1949: 10 inds. (Tatarynov 1952); 1 April 1949: 1 ind.; 8 December 1949: ♂+♀ (DPM); 28 December 1949: 20 inds. (Abelentsev et al. 1969); 6 January 1950: 6♂♂, 5♀♀ (Tatarynov 1952); 8 February 1950: 1♀; 7 March 1950: 1♂, 1 ind. (DPM); 5 December 1950: 1♂, 2♀♀; 25 December 1950 (Tatarynov 1952); 7 January 1951: 3♂♂, 5♀♀; 23 December 1951: ♂; 25 February 1952: 2♂♂, 1♀ (DPM); 28 December 1952: 3♀♀; 8 March 1953: 1♂ (Abelentsev et al. 1969); 30–31 January 1954: 3♂♂, 1♀; 6 March 1955: 2♀♀; 12 January 1957: 1♀ (DPM, leg. Tatarynov); 17 January 1997: 2 inds.; 24 December 1997: 4 inds.; 30 January 1998: 3 inds.; 14 December 1998: 2 inds.; 20 January 1999: 1 ind. (Bashta 2010); 10 February 2002: 1 ind.; 13 November 2002: 1 ind.; 23 November 2007: 1 ind.; 29 November 2007: 3 inds.; 29 December 2007: 3 inds.; 21 January 2008: 5 inds. (Dyky et al. 2008). – Ternopil Region: **Korolovka, Lysiačyi Hid cave** (Borŝiv Dist.), 11 March 2003: 1 ind. (Godlevska et al. 2005); **Nyžnie Kryvče, Kryštaleva cave** (Borŝiv Dist.), 11 March 2003 (Godlevska et al. 2005).

Despite the fact that the Podillâ area is characterized by numerous underground spaces of natural and artificial origin, the number of recent winter observations is not so high as expected. The main number of winter records comes from the caves of the southern part of the region. In particular, barbastelles were found in the Kryvčan’ska cave in the Ternopil Region (Tatarynov 1962), lime- stone mines near the Gumenci in the Hmelnyckyj Region (Tyshchenko et al. 2005, Matveev et al. 2010). We suppose that because of a large number of different underground spaces, the barbastelle, which often prefers small crevices, remained outside researchers’ attention.

Carpathians

Records. Transcarpathian Region: **Beregove**, town, 19 February 1948: 1♂; Zolota cave, 12 February 1949: 1♂ (NNPM); **Nyžnie Solotvyno, Borsuča cave** (Užgorod Dist.), 26 February 1962: 1♂; 26 December 1962: 1♂ (ZMUzNU); **Mužieve, mines** (Beregove Dist.), 12 March 2008: 1 ind. (Bashta 2009); **Galârska Dira mine** (Užgorod Dist.), 12 March 2006: 1 ind. (Bashta & Potish 2007); **Dilove** (Rahiv Dist.), 25 November 1984: grotto, 4♀♀ (Tkach 1987); **Kolonij cave** (Čerlenyj Kamin’ massif, Tiačiv Dist.), February 1995: 1 ind.; February 1996: 1 ind. (Zhdanovych 2000); **Sokolec cave** (Perečyn Dist.), winter 1998: 3 inds. (Vargovich 2000); **Prosoryh Stin cave** (Tâčiv Dist.), 27 December 2004: 1 ind. (V. Pokynchereda, pers. comm.); **Onokivci, Onokivska cave** (Užgorod Dist.), 12 March 2005: 1 ind. (Bashta & Potish 2007); **Stužycâ , Zahorb mine** (Velykobereznianskyj Dist.), 18 March 2011: 1 ind.; 30 November 2011: 5 inds. (Bashta & Koval 2012); **Hlyboke, mines** (Užgorod Dist.), 18 January 1953: 3♀♀, 18 February 1953: 2♂♂, 13 December 1954: 1♂ (ZMUzNU); 11 December 1955: 2♀♀ (Abelentsev et al. 1969); 1 April 1957: 1♀, 11 February 1965: 4♂♂, 1♀, 22 February 1965: 1♀, 23 February 1965: 3♀♀, 3 December 1965: 2♀♀, 6 December 1965: 1 ind., 4 January 1966: 1 ind., 13 December 1972: 2♀♀, 29 November 1975: 4♀♀ (ZMUzNU); 22 February 1982: 17 inds., 19 December 1983: 7 inds., 26 February 1985: 6 inds., 2 January 1986: 5 inds. (Tkach 1987); 7 March 2004: 5 inds., 19 March 2005: 1 ind., 12 March 2006: 4 inds. (Bashta & Potish 2007); **Mala Uholka, Družba cave** (Tiačiv distr.), 1990: 4 inds., 1992: 5 inds., 1993: 2 inds., 1994: 6 inds., 1996: 7 inds. (Vargovich 2000); 12 February 1997: 4 inds. (Pokynchereda & Pokynchereda 1997); 1997: 7 inds. (Vargovich 2000); 11–19 February 1998: 5 inds. (Krochko 1992); 1998: 5 inds. (Vargovich 2000); 28 December 2004: 2 inds.; 18 March 2006: 1 ind. (V. Pokynchereda, pers. comm.); **Mala Uholka, Moločnyi Kamin’ cave** (Tiačiv Dist.), 11 February 1997: 1 ind. (Pokynchereda & Pokynchereda 1997); 30@December 1995: 2 inds. (V. Pokynchereda, pers. comm.); 11–19 February 1998: 1 ind. (Krochko 1992); **Dilove, Čeremšyna cave** (Rahiv Dist.), 11–19 february 1998: 4 inds. (Krochko 1992); **Mala Uholka, Hrebin’ cave** (Tiačiv Dist.), 1997: 2 inds. (Vargovich 2000); **Velyke Grabovyŝe, Arpad forts** (Volovec Dist.), 4 March 2011: 19 inds. – Lviv Region: **Dubyna, caves at the Kluč Mt**. (Skole Dist.), 12 March 1998: 5 inds.; **Dubyna vill**. (Skole Dist.), 14 March 1999: cellar, 1 ind. (Bashta 2000); **Âmelnycâ, grotto** (Skole Dist.), 26 November 2011: 1 ind. (V. Pogranyčnyi, pers. comm).

The Carpathian region is represented by probably the largest number of barbastelle records. In the Transcarpathian part of this region the barbastelles were found both in the plains, foothills

Fig. 1. Localisation of the barbastelle hibernacula in Ukraine. Legend to the size: small ring = <10 inds., large black ring = 10–100 inds., large red ring = >100 inds. in hibernaculum

and mountain areas which is a result of the existence of a large number of different underground spaces. The pre-Carpathian part (lower north-eastern part of the Carpathian region) is characterized by a much smaller number of the barbastelle records.

Prydniprovska Upland

Records. Kyiv Region: **Kyiv**, **Golosieve**, 16 March 1938: 1 ind.; 11 November 1939: caves of Lavra, hydrostructures; 30 November 1939: Golosieve, 13 inds.; January 1940: Kytaeve; February 1940: Kytaeve; 24 March 1940: Golosieve, 1♂, 4♀♀ (Abelentsev et al. 1956); January 1941: 1♂; 12 January 1941: Cerkivŝyna hamlet, 2♀♀ (Likhotop et al. 1980); 24 February 1948 (Abelentsev et al. 1956); 24 November 1948: Kytaeve, 2 inds. (1♀); 28 November 1948: Kytaivska cave, 2♀♀ (NNPM); 12 April 1949: Kytaivska cave, 5♂♂, 5♀♀ (Abelentsev et al. 1956); **Lisnyky** (Kyevo-Sviatošyns'kyj Dist.), 2 April 1983: 1♂ (Likhotop et al. 1980). – Čerkasy Region: **Tahan'ča** (Kaniv Dist.), 26 December 1970:

crack in a wooden ceiling, 1♂ (NNPM); **Kanivskyj Nature Reserve** (Kaniv Dist.), 6 November 1990: building, 1♀; 7 March 1992, at the precipice at the Mariin Âr site (Ruzhilenko et al. 1998); **Cave**, **"Holodnyj Âr" Nature Reserve**, 9 March 1996: ca. 50 inds. (Golub 1996).
Majority of the records were related to the city of Kyiv and to the Kanivskyj Nature Reserve which probably reflects rather the concentration of scientists in the area than the real spatial distribution of the barbastelle population.

Crimea
Records. **Kyzyl-Koba cave** (Simferopol Dist.), January 1961: 2♂♂ (Konstantinov et al. 1976); 7 November 1982: 1♀ (NNPM); 20 February 2004: 1 ind. (Denisova 2004); **Bešujski kopi mines** (Bahčysarajskyj Dist.), January 1961: 1♂, 1♀ (Konstantinov et al. 1976); **Čatyr-Dag plateau** (Crimean Mts.), January 1972: 1 ind. (Konstantinov et al. 1976); 16 November 1975: 1 ind. (Denisova 2004); 3 March 1983: Vialov mine, 1♂, 1♀ (NNPM); winter 1983: Obvalna cave, 5 inds. (Stenko & Dulitsky 1988); 15 December 1985: Emine-Bair-Koba cave, 1♀ (NNPM); **Karadag Nature Reserve** (Crimean Mts.), 8 December 2003: 1 ind. (NNPM); **MAN cave** (Demerdži Mt., Crimean Mts.): 3 December 2003: 2 inds. (Denisova 2004); **Mar-Hosar cave** (Crimean Mts.), 16 March 2004: 1 ind. (Denisova 2004).

The earliest information about the observation of barbastelle bats in Crimea was mentioned by Nordman (1840). The author noted that the species is "quite common" at the southern coast of Crimea. Nikolskiy (1891) noted that the species is distributed throughout the mountain part of Crimea. Data on the species were also found in the publication by Sharleman (1920).

Roost preference in winter period
The roosts of barbastelle bats are associated mainly with underground cavities in winter period. They are mainly underground spaces, cellars, tunnels etc. as well as cracks in rocks. The species often hibernates in large underground shelters in Central and Eastern Europe (Bogdanowicz 1983, Lesiński 1986, Richarz 1989, Urbańczyk 1989, Uhrin 1995, Fuszara et al. 1996, Matveev et al. 2010, Demianchik & Demianchik 2002, Bashta & Ivashkiv in press). Numerous suitable hibernation roosts (mostly military structures or mines) are known in Ukraine.

Mainly records of isolated barbastelle bats are known from the winter roosts of the Carpathian region. They are situated mainly in the Ugolsko-Šyrokolužanskyj massif of the Carpathian Biosphere Reserve (Krochko 1992, Pokynchereda & Pokynchereda 1997, Vargovich 2000, Zhdanovych 2000), but also in other parts of the region. Mainly isolated individuals were found there, but in some cases there were clusters of 4–7 inds. like in the mines near the Hlyboke vill. in the Transcarpathian region, where the numbers have reached several individuals both in the past (Abelentsev et al. 1956, Tkach 1987, Krochko 1992) and nowadays (Bashta & Potish 2007). The most numerous barbastelle hibernaculum located in a mine in the Ukrainian Carpathians numbered no more than 25 inds. (V. Pokynchereda, pers. comm.). The largest number of barbastelles in the Prydniprovska upland area was found in the Kytaivska cave (Kyiv region; Abelentsev et al. 1956). Relatively large winter aggregations of barbastelles were noted in large mines, mostly limestone ones, located in the Podillâ area. In particular, 35 individuals were counted in the Gumenecki mines (Hmelnyckyj region; Matveev et al. 2010). The largest number (350–400 inds.) was found in the Ivankovecki mines in 2008–2009 (Drebet & Martyniuk 2009). Number of this species was significantly smaller in the natural underground spaces – caves and grottoes. The largest known number of barbastelles was counted in the Stradčanska cave (Lviv region) – 10 inds., Medova cave (Lviv region) – 20 inds. (Tatarynov 1952), cave in Holodnyi Âr (Čerkasy region) – ca. 50 inds. (Golub 1996).

The Tarakaniv fortress is situated in the Volynska upland and it seems to be the largest hibernaculum of barbastelles in Ukraine and one of the largest in Central and Eastern Europe. Winter aggregations ranged here from 300 to 950 individuals in different seasons (2008–2009 – ca. 740 inds., 2009–2010 – ca. 300 inds., 2010–2011 – ca. 730 inds., 2011–2012 – ca. 950 inds.; indicated the highest number of bats found during certain seasons). Such large fluctuations in the number of winter aggregations during a relatively short time interval of 2009–2012 impede deeper interpretation of their dynamics and analysis of population trends. A significant increase in the number of wintering individuals was noted in the winter 2011/2012. The reasons of such fluctuation are still unknown. Actually, the total amount of aggregations could increase. However, it may be caused by redistribution of wintering individuals within the fort, so that more individuals were observable. It is also possible that this phenomenon was a result of bat immigration from other wintering sites. The main reason for such movements may be changes of microclimatic conditions due to frequent visits of the roosts by people (Kowalski & Lesiński 1991, Řehák 1997, etc.).

The lowest number of bats in this hibernaculum was found in November 2010 with ca. 300 individuals only. One of the possible reasons of such low number could be a relatively high temperature in the roost (mean t=8.7 °C) in this period. Moreover, it could have been caused by disturbance due to tourists visiting the fortress during the period of formation of winter aggregations and a subsequent movement of some individuals into inaccessible cavities.

Spatial distribution and microclimatic characteristics of hibernation roosts

The barbastelle is a rather cold-resistant species and it uses relatively cold part of the shelters, where the temperatures are close to 0 °C, to spend the winter season (Rydell & Bogdanowicz 1997). Cavities in the Tarakaniv fortress are characterized mainly by rather cold microclimatic conditions, which is confirmed by the presence of the barbastelle and other relatively cold-resistant bat species (*E. serotinus*, *P. auritus*). Other fortifications may have a much wider amplitude of microclimatic conditions that attract species with different ecological preferences. In this case a wider range of bat species can use the roosts, which provide favourable conditions for hibernation. For example, in the Miedzyrzecki forts (Poland), *Myotis myotis* and *Myotis daubentonii* were the most numerous species (Urbańczyk & Gólski 1994), indicating a relatively warmer temperatures than in the Tarakaniv fortress. The winter temperatures in the Tarakaniv fortress varied between –0.9 and +3.0 °C and depended on outside temperatures, while the relative humidity varied between 65 and 100%.

In warmer underground spaces, barbastelles usually occupied parts close to the entrance, where the temperature is relatively low. In the Gumenecki mines they have been found only at sites with the temperature of +3 to +5 °C (Matveev et al. 2010). In the winter of 2009/2010 with the outside temperature of –25 °C, the temperature in corridors of underground bunkers near the city of Lviv was –3.3 °C, but it was +0.3 °C in the cleft with wintering barbastelles.

Wintering barbastelles in the Tarakaniv fortress can be divided into three spatial groups: (a) isolated individuals or small groups distributed freely on walls, ceilings or in small cracks, (b) individuals situated in long narrow cracks at the ceilings of corridors, (c) large aggregations in ventilation ducts. In addition, the fourth group of individuals can be identified, hiding in inaccessible cavities. Individuals belonging to the first group could be placed open (on walls or ceilings) or occupy very different microshelters, such as different cracks or fissures. The minimum height from the floor was 1.5 m. Generally a few percent of bats were found at the height of up to 3.5 m and they occupied mainly deep fissures and cavities in the walls. It was caused by disturbance from visitors. The proportion of bats belonging to the first group was 5–10% only. Location of wintering barbastelles in the narrow cracks of corridor ceilings (second group) was evidently caused by the necessity to minimize energy costs during the winter. Crack width allowed fitting of one or two individuals, while the length of these cracks was up to 20 meters and, accordingly, such aggregations of bats had a “linear” structure. The third group of barbastelles showed clear tendency to create aggregations, which were situated in vertical ventilation ducts located in the ceiling of the underground casemates and included 76–82% of the wintering bats. Some of these ducts were blocked up with stones or concrete pieces and the bats grouped by attaching to them. Some bats were situated on inner walls of the ventilation ducts, creating groups of various sizes (from 6 to over 250 inds.). Supposedly, those ducts were blocked up too (although it was not visible), because the test did not detect air movement inside them.

Generally two or three bat aggregations were noted in different ventilation ducts with the mean number of 203 inds. They were usually located at the bottom of the ducts, near their entrance in the ceiling. During the winter of 2011/2012, the bats created 12 such aggregations, which, however, consisted mainly of a relatively small number of individuals, on average 38.6 (n=12; S_{max}=140) and were dispersed along the vertical length of the ducts. The aggregations are probably formed in order to reduce energy expenses during hibernation. In mines in the Podillâ area, particularly in the Gumenecki mines, the barbastelles were found to hang mostly alone (71.1%) and very rarely in groups of up to 10 inds. (Matveev et al. 2010). Temperature in those mines reached 3–5 °C, allowing the bats to avoid creation of such aggregations.

Large aggregations of barbastelles were usually monospecific. However, formation of multispecies groups (*B. barbastellus* + *E. serotinus*) were noted rarely, where the number of individuals did not exceed 2–5 (1+1; 3+1; 2+3) and only one aggregation included 17 *B. barbastellus* and 5 *E. serotinus* individuals.

The large number of barbastelles in the Tarakaniv fortress caused its absolute dominance in this underground space. Dominance rates fluctuated within 93.3–97.6% (mean 96.1%) in different years. A similar percentage of barbastelles was discovered in the forts of Eastern Poland (Kowalski & Lesiński 1997 etc.). Taking into consideration that underground spaces in the Tarakaniv fortress are not well isolated from external influences, fluctuations in barbastelle numbers may be significantly affected by climatic conditions of the region. Such fluctuations are also known from other studies (see Fuszara & Fuszara 2002, Fuszara et al. 2002).

Most of our surveyed underground roosts may be significantly affected by human disturbance. It may be also able to reduce the individual movements and changes of their shelters, particularly to the inaccessible ones, which may have caused underestimation of the bats during censuses. February is the best period for winter counts of barbastelles, when the greatest number of individuals was detected. It can be caused by two factors. Firstly, winter aggregations are relatively stable already and, secondly, the mean number of wintering bats increased during the winter.

Population status and its changes in Ukraine

The barbastelle is considered as one of the most threatened species of bats in Europe. This species was assigned a relatively high conservation category: it is included in the IUCN Red List in the category NT "near threatened" (Hutson et al. 2008), in the Bern Convention (Appendix II), Bonn Convention (Annex II), Eurobats (Appendix I), Annexes II and IV of the Habitats Directive as well as in the Red Data Book of Ukraine (2009) as "disappearing".

Based on fragmentary data from previous years, we may outline some population trends in the western part of Ukraine. Negative dynamics of the barbastelle were noted for the Stradčans'ka and Medova caves (Lviv region) since the middle of the 20th century (Abelentsev et al. 1956, Tatarynov 1974, Dyky et al. 2008, Bashta 2010) (Table 2). Negative trends in both caves were caused by direct human impact. Some authors suggest that the number of the Crimean population used to be larger (Dulitsky 2001).

Table 2. Dynamics of barbastelle aggregations in some caves of the Lviv Region

	Abelentsev et al.	Tatarynov			Bashta	Dyky et al.
	(1969)	(1974)			(2010)	(2008)
	till 1950	1951–52	1960–62	1971–73	1996–2002	2002–2008
Stradčans’ka cave	10	5–8	till 5	0	1–4	0
Medova cave	29	30–40	2–3	0	1–5	1–5

caused by direct human impact. Some authors suggest that the number of the Crimean population used to be larger (Dulitsky 2001).

Our studies suggest that the barbastelle population is at least stable in Ukraine today. In general, its size and number of records have been increasing. However, it may be caused most likely by increasing research intensity and surveying new areas and roosts. In the countries of Northern, Central and Eastern Europe, populations are stable or increasing (Slovakia, Uhrin et al. 2010; Austria, Spitzenberger & Mayer 2003; and Germany, Rudolph et al. 2003, Schober 2003 etc.). Positive trends were observed in some hibernacula of Central Europe (Poland, Lesiński et al. 2005; Lithuania, Pauža & Paužiene 2002; Czech Republic, Řehák & Gaisler 1999, Horáček et al. 2005). In contrast, the barbastelle populations from the Western and Southern European countries indicate decline in numbers, particularly in Belgium (Fairon & Busch 2003), Switzerland (Theiler 2003) and the Balkan Peninsula (Paunović et al. 2003), and even disappearance from the Netherlands (Hutson et al. 2008). Significant decline of the barbastelle population took place in Slovakia in the 1970s (Gaisler 1975, Gaisler et al. 1981) as well as in some hibernacula in the 1990s (Uhrin et al. 2002).

Threats affecting barbastelle populations are largely unknown. However, due to some species peculiarities, namely trophic specialization (feeding on nocturnal butterflies) and usually the use cavities or dead bark of old deciduous trees, this species is probably especially vulnerable to intensive forest activities (Sierro & Arlettaz 1997, Russo et al. 2004), which often consist ofremoving dead and damaged trees. Bats have only few natural enemies. However, human activity is the greatest danger for them. Bats are very sensitive not only to changes in the microclimate in hibernacula, but also to some disturbance factors such as light or noise. The major threat for barbastelle could be destruction of roosts, which may include changes of wall structure in the corridors, making fire in the corridors and storage of toxic waste there. In extreme cases the underground spaces may be exploded by special devices. Small roosts can be destroyed or devastated, or even filled up with garbage. Like all bat species, the barbastelle is very vulnerable to disturbance during hibernation. Threats in this period include frightening, and rarely even killing of animals. Frequent awakening of bats causes depletion of their fat reserves. We assume that the barbastelle population in Ukraine, like in almost all Central and Eastern European countries is not as decreasing as in the Western European countries. More detailed studies have resulted in the change of conservation status of this species in the IUCN Red List from vulnerable (1996) to near threatened (2008; Hutson et al. 2008).

Importance of anthropogenic underground cavities for barbastelle conservation in Ukraine

Our results show that large underground cavities of anthropogenic origin may be important for the survival of barbastelle populations not only in Ukraine, but throughout Central and Eastern Europe. These structures are used in different seasons and seem to be vital places to maintain the population of this species with disjunctive distribution range. The role of these cavities for the species outside the hibernation season is as important as in winter. They are the places of formation of so called coupling-migratory colonies and aggregations during the autumn accumulation of fat reserves. Preliminary studies suggested that the species composition in these sites in late summer and the first half of autumn is no smaller than in winter.

Therefore, such places that attract large numbers of bats from the surrounding areas should be protected by law. This is particularly important for the bat species like the barbastelle, which has a high level of philopatry. Bats generally show a very high degree of connection to concrete wintering sites

(Glover & Altringham 2008). In recent years, tourism and recreation development has caused deterioration of the conditions for bats in different fortresses. Regular and uncontrolled visits by tourists affect directly the bat fauna (a factor of disturbance) and change substantially the microclimate conditions in the roosts. Such influence is a significant negative factor for bats, because it can lead to premature determination of hibernation. Strong anthropogenic influence may cause a significant reduction of the size of bat winter aggregations. Therefore, these hibernacula must be secured by active protection; first of all by closing the entrances to underground spaces or other restrictions of unauthorised access, especially during the period from November to April.

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References

Abelentsev V. I., Pidoplichko I. H. & Popov B. M., 1956: *Komahoidni Insectivora i kažany Chiroptera. Fauna Ukrainy. Tom 1*(*1*) [*Insectivors Insectivora and Bats Chiroptera. Fauna of Ukraine, Volume 1*(*1*)]. AN USSR, Kyiv, 448 pp (in Ukrainian).

Abelentsev V. I., Kolushev I. I., Krochko Yu. I. & Tatarynov K. A., 1969: Rezultaty kolcevania rukokrylyh v Ukrainie v 1939–1967. Povidomlennia 2 [Results of bat ringing in Ukraine 1939–1967. Report 2]. *Vestnik Zoologii*, **2**: 20–24 (in Russian).

BashtaA.-T., 2000: Znahidky ridkisnyh vydiv rukokrylyh (Mammalia, Chiroptera) v Beskydah (Ukrainski Karpaty) [Records of rare bat species in the Beskids (Ukrainian Carpathians)]. *Vestnik Zoologii*, **34**(3): 66 (in Ukrainian).

BashtaA.-T., 2007: Kažany v kolekcii Zoologičnogo Museû Užgorodskogo Universytetu: opys i zagalnyij analiz [Bats in the collection of the Zoological Museum of the Užgorod University: description and general analysis]. *Naukovi Zapysky Užgorodskogo Nacionalnogo Universytetu*, **20**: 120–127 (in Ukrainian, with a summary in English).

BashtaA.-T., 2009: Survey of current state and distribution of bats (Chiroptera) in Ukraine. *Studia Chiropterologica*, **6**: 43–80.

BashtaA.-T., 2010: Harakterystyka ugrupovannia kažaniv mista Lvova: vydova riznomanitnist, prostorovyj i sezonnyj rozpodil [Characteristics of bat community of the Lviv city: species composition, spatial and seasonal distribution]. *Studia Biologica*, **4**(3): 109–124 (in Ukrainian, with a summary in English).

BashtaA.-T. & Ivashkiv I., in press: Struktura, dynamika čyselnosti ta prostorovyj rozpodil zymovoho ugrupovannia kažaniv (Chiroptera, Vespertilionidae) Tarakanivskogo fortu (Zahidna Ukraina) [Structure, quantitative dynamics and spatial distribution of the wintering bat community (Chiroptera, Vesper- tilionidae) in the Tarakaniv fortress (Western Ukraine)]. *Naukovi Zapysky Užgorodskogo Nacionalnogo Universytetu* (in Ukrainian, with a summary in English).

BashtaA.-T. & Koval N., 2012: Vydova riznomanitnist, osoblyvosti pošyrenniâ ta problemy ohorony rukokrylyh (Chiroptera) Užanskogo NPP [Species diversity, distribution and problems of conservation of bats (Chiroptera) in the Užansky NPP]. *Naukovi Zapysky Deržavnogo Pryrodoznavčogo Muzeû*, **28**: 85–108 (in Ukrainian).

BashtaA.-T. & Potish L., 2007: *Ssavci Zakarpats'koj oblasti* [*Mammals of the Transcarpathian Region* (*Ukraine*)]. National Academy of Sciences of Ukraine Publ., Lviv, 260 pp (in Ukrainian, with summaries in English).

BashtaA.-T. & ShydlovskyI., 2001: Rukokryli v kolekcii Zoologičnogo Muzeû Lvivskoho Universytetu [Collection of bats (Chiroptera) in the collection of the Zoological Museum of Lviv University]. *Naukovi Zapysky Deržavnogo Pryrodoznavčogo Muzeû*, **16**: 41–45 (in Ukrainian, with a summary in English).

BashtaA.-T., Kusnezh O. & Ivashkiv I., in press: Vydovyj sklad i prostorovyj rozpodil rukokrylyh (Chiroptera) pivdenno-shidnoi častyny Ukrainskoho Roztočâ [Species composition and spatial distribution of bats (Chiroptera) at south-eastern part of Ukrainian Roztoččâ (Western Ukraine)]. *Notes of Lviv University*, *Series Biologia* (in Ukrainian with English summary).

Bogdanowicz W., 1983: Community structure and interspecific interactions in bats hibernating in Poznań. *Acta Theriologica*, **28**: 357–370.

Demianchik V. T. & Demianchik M. G., 2001: *Rukokrylye Belorusii* [*Bats of Belarus*]. S. Lavrov Rubl., Brest, 216 pp (in Russian).

DenisovaE. V., 2004: Dodatkovi dani po pošyrennû i biologii šyrokovuha evropejskogo v Krymu [Additional data on the distribution and biology of the barbastelle in Crimea]. Pp.: 40–43. In: Mezhzherin V. V. (ed.): *Sučasni problemy zoologičnoji nauky* [*Current Problems of the Zoological Science*]. Kiev University Publ., Kyiv, 210 pp (in Ukrainian).

Drebet M. V. & Martyniuk V. Y., 2009: Znahidky ridkisnyh vydiv kažaniv v pidzemelliah Kamâneckoho Prydnistrovâ na zymivli [Records of rare bat species hibernating in the underground of Kamianecke Prydnistrovâ]. Pp.: 30–32. In: Derbak I. S. (ed.): *Materialy konferencii*, *prysviačenoi 20-riččiu stvorennâ NPP* "*Synevyr*" [*Proceedings of the Conference Devoted to the 20th Anniversary of the NP Synevyr Declaration*]. PP Danylo I.S., Synevyr, 148 pp (in Ukrainian).

DykyI., Kusnezh O. & Mysiuk V., 2008: Fauna kažaniv Medovoj pečery (Lvivŝčyna) i pytannâ ii ohorony [Bat fauna of the Medova cave (Lviv region) and its protection]. *Rarytetna Fauna ta ii Ohorona* [*Rare Fauna and its Protection*]. *Proceedings of the Theriologcal School*, **9**: 214–218 (in Ukrainian, with a summary in English).

DulickyA. I., 2001: *Mlekopitaûŝie*. *Istoria*, *sostoânie*, *ohrana*, *perspektivy* [*Mammals*. *History*, *Status*, *Protection*, *Perspectives*]. Sonat, Simferopol, 208 pp (in Russian).

Fairon J. & Busch E., 2003: Dynamique de la population de *Barbastella barbastellus* en Belgique. *Nyctalus* (*N. F.*), **8**: 521–527.

FuszaraE. & FuszaraM., 2002: Monitoring liczebności nietoperzy w kryjywkach zimowych w okolicach Tomaszowa Mazowieckiego w latach 1993–1999 [Monitoring of bats wintering in the area of Tomaszyw Mazowiecki in the period 1993 to 1999]. *Nietoperze*, **3**: 109–118 (in Polish, with a summary in English).

FuszaraE., Kowalski M., Lesiński G. & Cygan J. P., 1996: Hibernation of bats in underground shelters of central and northeastern Poland. *Bonner Zoologische Beiträge*, **46**: 349–358.

FuszaraE., FuszaraM. & Wojciechowski M., 2002: Monitoring liczebności nietoperzy w zimowiskach na Pojezierzu Mazurskim w latach 1992–1999 [Monitoring of bat numbers in winter shelters of the Masurian Lake District in the period 1992 to 1999]. *Nietoperze*, **3**: 65–75 (in Polish, with a summary in English).

GaislerJ., 1975: A quantitative study of some population of bats in Czechoslovakia (Mammalia, Chiroptera). *Acta Scientiarium Naturalium Academiae Scientiarum Bohemoslovacae*, *Brno*, **9**(5): 1–44.

GaislerJ., Hanák V. & Horáček I., 1981: Remarks on the current status of bat populations in Czechoslovakia. *Myotis*, **18–19**: 68–75.

GloverA. M. & Altringham J. D., 2008: Cave selection and use by swarming bat species. *Biological Conservation*, **141**: 1493–1504.

GodlevskaL., Petrushenko Yu., Tyshchenko V. & Zagorodniuk I., 2005: Zymovi skupčennia rukokrylyh v pečerah Centralnoho Podillâ (Ukraina) [Winter bat assemblages (Chiroptera) in the caves of Central Podillâ (Ukraine). *Vestnik Zoologii*, **39**(2): 37–45 (in Ukrainian).

Golub B. M., 1996: Zimovka evropejskoj šyrokoušky (*Barbastella narbastellus* Schreber) v zapovednike "Holodnyi Âr" (Čerkaskaâ obl.) [Wintering of the Eauropean barbastelle (*Barbastella barbastellus* Schreber) in the "Holodnyi Âr" Nature Reserve (Čerkasy region)]. *Vestnik Zoologii*, **31**(1–2): 72 (in Russian)

Horáček I., Hanák V. & GaislerJ., 2005: Dlouhodobé změny biodiverzity netopýrů: zpráva o nejrozsáhlejším monitorovacím programu 1969–2004 [Long-term changes in biodiversity of bats: a report on the most extensive monitoring program 1969–2004]. Pp.: 105–115+101B–122B. In: Vačkář D. (ed.): *Ukazatele změn biodiversity* [*Indicators of the Biodiversity Changes*]. Academia, Praha, 298 pp (in Czech, with a summary in English).

Hutson A. M., AulagnierS. & SpitzenbergerF., 2008: *Barbastella barbastellus*. In: IUCN (2012): *IUCN Red List of Threatened Species*. *Version 2012.2*. URL: www.iucnredlist.org.

Kasprzyk K., Ruczyńska I. & Wojciechowski M., 2002: Zimowe spisy nietoperzy na Pomorzu Nadwiślańskim w latach 1996–1999 [Winter bat census in Pomorze Nadwiślańskie in 1996–1999]. *Nietoperze*, **3**(1): 39–52 (in Polish, with a summary in English).

Konstantinov A. I., Vshyvkov F. N. & DulitskyA. I., 1976: Sovremennoe sostoânie fauny rukokrylyh v Krymu [Current state of the bat fauna in Crimea]. *Zoologičeskij Žurnal*, **55**(6): 885–983 (in Russian).

KovalyovaI. & Taraborkin L., 2001: Sovremennyj status i rasprostranenie *Barbastella barbastellus* v Ukrainie [Current state and distribution of *Barbastella barbastellus* in Ukraine]. *Vestnik zoologii*, **35**(3): 79–84 (in Russian with English summary).

Kowalski M. & Lesiński G., 1991: Changes in numbers of bats in Szachownica cave (central Poland) during 10 years. *Myotis*, **29**: 35–38.

Kowalski M. & Lesiński G., 1997: Nietoperze w polskiej części twierdzy Brześć [Bats (Chiroptera) in the Polish part of the Brześć fortress]. *Kulon*, **2**: 84–86. (in Polish, with a summary in English).

Krochko Yu. I., 1992: *Rukokrylye Ukrainskih Karpat* [*Bats of the Ukrainian Carpathians*]. Unpubl. Dr.Sc. Thesis. Užgorod State University, Užgorod, 421 pp (in Russian).

Lesiński G., 1986: Ecology of bats hibernating underground in Central Poland. *Acta Theriologica*, **31**: 507–521.

Lesiński G., 1988: Skład gatunkowy i liczebność nietoperzy w fortach modlińskich w ciągu roku [Species composition and number of bats in the Modlin forts in one year]. *Przegląd Zoologiczny*, **32**: 576–587 (in Polish, with a summary in English).

Lesiński G., 2001: Nietoperze Chiroptera Kotliny Biebrzańskiej i terenów przygleglych [Bats Chiroptera of the Biebrza Basin and surrounding area]. *Parki Narodowe i Rezerwaty Przyrody*, **20**(2): 51–64 (in Polish).

Lesiński G., FuszaraE., FuszaraM., Jurczyszyn M. & Urbanczyk Z., 2005: Long-term changes in the numbers of the barbastelle *Barbastella barbastellus* in Poland. *Folia Zoologica*, **54**: 351–358.

LikhotopP. I., Tkach V. V. & Barvinski N. A., 1990: Rukokrylye goroda Kieva i Kievskoj oblasti [Bats of the Kiev city and region]. Pp.: 10–26. In: Kovtun M. (ed.): *Materialy po ekologii i faunistike nekotoryh predstavitelej rukokrylyh* [*Material on the Ecology and Fauna of Some Representatives of Bats*]. Institute of Zoology, Academy of Sciences, Kyiv, 27 pp (in Russian).

Marynych O. M. & Shyshchenko P. T., 2005: *Fizyčna geografâ Ukrainy* [*Physical Geography of Ukraine*]. Znannâ, Kyiv, 511 pp (in Ukrainian).

Matveev M. D., Drebet M. V., Sydorchuk Yu. V. & Tarasenko M. O., 2010: Zymova fauna kažaniv Gumeneckoji štolni (NPP "Podilski Tovtry") [Winter fauna of bats in the Humenecka mine (Podilski Tovtry NNP]. *Podilskij Pryrodnyčij Visnyk*, **1**: 124–149.

NikolskiyA. M., 1891: Pozvonočnye životnye Kryma [Vertebrate Animals of Crimea]. *Zapiski Imperatorskoj Akademii Nauk*, **68**(Priloženie): 1–484 (in Russian).

von Nordmann A., 1840: Observations sur la Faune Pontique. Mammalia. Pp.: 355–635. In: DemidoffA. (ed.): *Voyage dans la Russie meridionale et la Crimee par la Hongrie, la Valachie et la Moldavie*. Ernest Bourdin et Cie, Paris, 756 pp.

Paunović M., PandurskaR., IvanovaT. & Karapandža B., 2003: Present knowledge of distribution and status of *Barbastella barbastellus* (Schreber, 1774) (Chiroptera: Vespertilionidae) on the Balkan Peninsula. *Nyctalus* (*N. F.*), **8**: 633–638.

Pauža D. H. & Pažiene N., 2002: Bats of Lithuania: distribution, status and protection. *Mammal Review*, **28**: 53–68.

Pietruski S., 1853: *Historia naturalna zwierząt ssacych dzikich Galicyjskich* [*Natural History of the Wild Mammals of Galicia*]. Druk. Zakladu Narodowego im. Ossolińskich, Lwów, 98 pp (in Polish).

PokyncheredaV. F., 2007: Čyselnist' rukokrylyh u karstovyh pečerah i štolniah [Quantity of bats in karst caves and mines]. Pp.: 283–285. In: GamorF. D. (ed.): *Litopys pryrody Karpatskogo biosfernogo zapovidnyka* [*Chronicle of Nature of the Carpathian Biosphere Reserve*]. Carpathian Biosphere Reserve, Rahiv, 340 pp (in Ukrainian).

PokyncheredaV. F. & PokyncheredaV. V., 1997: Vydovyj sklad ta čyselnist' rukokrylyh na zymivli v pidzemnyh porožnyah Karpatskogo biosfernogo zapovidnyka [Species composition and quantity of bats in wintering underground shelters of the Carpathian Biosphere Reserve]. Pp.: 154–157. In: GamorF. D. (ed.): *Mižnarodni aspekty vyvčennia ta ohorony bioriznomanittia Karpat* [*International Aspects of Investigations and Conservation of the Carpathian Biodiversity*]. Carpathian Biosphere Reserve, Rahiv, 420 pp (in Ukrainian).

PolushynaN. A. & Borovets E. Yu., 1988: O zimovke rukokrylyh v Stradčanskoj peŝere [on the bat hibernation in the Stradčanska cave]. Pp.: 46–48. In: TopachevskyV. A. (ed.): *Izučennost teriofauny Ukrainy: jejo racionalnoe ispolzovanie i ohrana* [*The Knowledge of the Mammal Fauna of Ukraine*: *its Rational Use and Conservation*]. Naukova dumka, Kyiv, 152 pp (in Russian).

Řehák Z., 1997: Trendy ve vývoji početnosti netopýrů ve střední Evropě [Long-term changes in the numbers of bat populations in Central Europe]. *Vespertilio*, **2**: 81–176 (in Czech, with an abstract in English).

Řehák Z. & GaislerJ., 1999: Long-term changes in the number of bats in the largest man-made hibernaculum of the Czech Republic. *Acta Chiropterologica*, **1**: 113–123.

Richarz K., 1989: Ein neuer Wochenstubennachweis der Mopsfledermaus *Barbastella barbastellus* (Schreber, 1774) in Bayern mit Bemerkungen zu Wochenstubenfunden in der BRD und DDR sowie zu Winter vorkommen und Schutzmöglichkeiten. *Myotis*, **27**: 71–80.

Rudolph B.-U., HammerM. & Zahn A., 2003: Die Mopsfledermaus (*Barbastella barbastellus*) in Bayern. *Nyctalus* (*N. F.*), **8**: 564–580.

Russo D., Cistrone L., Jones G. & Mazzoleni S., 2004: Roost selection by barbastelle bats (*Barbastella barbastellus*, Chiroptera: Vespertilionidae) in beech woodlands of central Italy: consequences for conservation. *Biological Conservation*, **117**: 73–81.

Ruzhilenko N., Hryshchenko V., Mezhzherin V. & Tsvelykh O., 1998: Fauna kažaniv Kanivskogo pryrodnogo zapovidnyka [Bat fauna of the Kaniv Nature Reserve]. *Evropejs*'*ka nič kažaniv* '*98 v Ukraini* [*European Bat Night* '*98 in Ukraine*]. *Proceedings of the Theriological School*, **1**: 76–79 (in Ukrainian).

Rydell J. & Bogdanowicz W., 1997: *Barbastella barbastellus*. *Mammalian Species*, **557**: 1–8.

SchoberW., 2003: Zur Situation der Mopsfledermaus (*Barbastella barbastellus*) in Sachsen. *Nyctalus* (*N. F.*), **8**: 663–669.

Sharleman M., 1920: *Zviri Ukrainy*. *Korotkyj poradnyk do vyznačennâ*, *zbyrannâ i sposterihannâ ssavciv* (*Mammalia*) *Ukrainy* [*Mammals of Ukraine*. *Short Guidelines for Identification*, *Collecting and Conservation of Mammals* (*Mammalia*) *of Ukraine*]. Vseukrainskyj kooperatyvnyj vydavnyčyj soûz, Kyiv, 83 pp (in Ukrainian).

Shevchenko L. S. & ZolotukhinaS. I., 2005: *Katalog kollekcij Zoologičeskogo muzeâ NNPM NAN Ukrainy*. *Tom 2*: *Mlekopitaûŝie* [*Catalogue of Collections of the Zoological Museum of NNPM NAN Ukraine*. *Part 2*: *Mammals*]. Zoomuzej NNPM NAN Ukrainy, Kyiv, 238 pp (in Russian).

Sierro A. & Arlettaz R., 1997: Barbastelle bats (*Barbastella* spp.), specialize in the predation of moths: implications for foraging tactics and conservation. *Acta Oecologica*, **18**: 91–106.

SpitzenbergerF. & MayerA., 2003: Verbreitung und Status der Mopsfledermaus (*Barbastella barbastellus*) in Österreich. *Nyctalus* (*N. F.*), **8**: 674–680.

Stenko R. P. & DulitskyA. I., 1988: Gelmintofauna redkih i isčezaûŝih vidov rukokrylyh Kryma [Helmints of rare and threatened bats of Crimea]. Pp.: 49–51. In: TopachevskyV. A. (ed.): *Izučennost teriofauny Ukrainy: jejo racionalnoe ispolzovanie i ohrana* [*The Knowledge of the Mammal Fauna of Ukraine*: *its Rational Use and Conservation*]. Naukova dumka, Kyiv, 152 pp (in Russian).

Tatarynov K. A., 1952: Narys fauny ssavciv derevnyh nasadžen rajonu mista Lvova [Mammals of wood�lands in the Lviv city area]. *Naukovi zapysky Muzeju Agrobiologii Instytutu AN Ukrainy*, **2**: 64–92 (in Ukrainian).

Tatarynov K. A., 1956: *Ssavci zahidnyh oblastej Ukrainy* [*Mammals of the Western Regions of Ukraine*]. AN USSR, Kyiv, 188 pp (in Ukrainian).

Tatarynov K. A., 1962: Peŝery Podolii, ih fauna i ohrana [Caves of Podolâ, their fauna and protection]. *Ohrana Prirody i Zapoviednoe Delo v SSSR*, **7**: 88–101 (in Russian).

Tatarynov K. A., 1974: *Rukokrylye Podolii i Prikarpatia*. *Pokazateli ih čislennosti i puti ohrany* [*Bats of Podoliâ and Prikarpattiâ*. *Indicators of their quantity and methods of protection*]. Pp.: 58–60. In: Strelkov P. P. & Kuzyakin A. P. (eds.): *Materialy Pervogo Vsesoûznogo sovesŝania po rukokrylym* (*Chiroptera*) [*Proceedings of the First Pan-Union Bat Conference*]. Zoological Institute AS USSR, Leningrad, 182 pp (in Russian).

TheilerA., 2003: Übersicht über die Situation der Mopsfledermaus (*Barbastella barbastellus*) in der Schweiz. *Nyctalus* (*N. F.*), **8**: 686–688.

Tkach V. V., 1987: Novye nahodki rukokrylyh, zanesennyh v Krasnuû knigu USSR [New records of bats included into the Red Data Book of Ukraine]. *Vestnik Zoologii*, **5**: 86 (in Russian).

Tyshchenko V., Matveev M. & BovtunovaYu., 2005: Do fauny kažaniv (Chiroptera) Hmelnyččyny [On the bat fauna (Chiroptera) of the Hmelnytskyj region]. *Naukovi Zapysky Užgorodskogo Nacionalnogo Universytetu*, **17**: 173–183 (in Ukrainian, with a summary in English).

Uhrin M., 1995: The finding of a mass winter colony of *Barbastella barbastellus* and *Pipistrellus pipistrellus* in Slovakia. *Myotis*, **32–33**: 131–133.

Uhrin M., Hapl E., Andreas M., BendaP., Bobáková L., Hotový J., Matis Š., Obuch J., Pjenčák P. & ReiterA., 2002: Prehľad zimovísk netopierov Muránskej planiny [Overview of the bat hibernacula in the Muránska planina Mts]. *Vespertilio*, **6**: 103–130 (in Slovak).

Uhrin M., BendaP., Obuch J. & Urban P., 2010: Changes in abundance of hibernating bats in central Slovakia (1992–2009). *Biologia, Bratislava*, **65**: 349–361.

Urbańczyk Z., 1989: Results of the winter census of bats in Nietoperek 1985–1989. *Myotis*, **27**: 139–145.

Urbańczyk Z. & Gólski Z., 1994: Zimowe spisy nietoperzy na Ziemi Lubuskiej w latach 1988–1992 [Winter census of bats in Lubuska Land (Western Poland) between 1988 and 1992]. Pp.: 149–157. In: Wołoszyn B. W. (ed.): *Zimowe spisy nietoperzy w Polsce 1988–1992. Wyniki i ocena skuteczności* [*Results of the Winter Bat Census in Poland*: *1988–1992*]. CIC ISEZ PAN, Kraków, 230 pp (in Polish, with a summary in English).

Vargovich R., S. 2000: Hibernation of bats in Transcarpathian (West Ukraine) caves and adits 1988–1998. Pp.: 185–197. In: Mock A., Kováč L. & Fulín M. (eds.): *Fauna jaskýň*. *Zborník referátov zo seminára* [*Cave Fauna*. *Proceedings of the Workshop*]. Východoslovenské múzeum, Košice, 217 pp.

Vikyrchak O. K. & Zagorodniuk I. V., 2010: Novi znahidky ridkisnyh vydiv ssavciv na terytorii Černiveckoji oblasti [New records of rare mammal species on territory of the Černivtsi region]. Pp.: 152–156. In: SkilskyjI. V. & Smirnov N. A. (eds.): *Problemy vyvčennia ta ohorony tvarynnoho svitu v pryrodnyh i antropogennyh systemah* [*Problems of Investigations and Conservations of Animal World in Natural and Anthropogenical Systems*]. DrukArt, Černivtsi, 296 pp (in Ukrainian, with a summary in English).

Wołoszyn B. & BashtaA.-T., 2001: *Nietoperze Karpat*. Platan, Krakow-Lviv, 168 pp (in Polish and Ukrainian).

Zhdanovych V. M., 2000: Osoblyvosti periodu hibernacii kažaniv u pidzemnyh shovyŝčah Tiačivskogo rajonu [Peculiarities of bat hibernation period in the underground shelters of Tiačiv district]. *Naukovi Zapysky Užgorodskogo Nacionalnogo Universytetu*, **8**: 199–201 (in Ukrainian, with a summary in English).

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