IMPORTANCE OF UNDERGROUND HIBERNACULA FOR *BARBASTELLA BARBASTELLUS* (SCHREBER, 1774) (*CHIROPTERA*, *VESPERTILIONIDAE*) IN THE NON-HIBERNATION SEASON

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Use of hibernation shelters and neighboring areas by Barbastelle bat in the non-hibernation season has been investigated in the Tarakaniv fortress (Rivne region, Ukraine) during 2010-2013. Feeding habitats, daily or mating roosts are possible functions of this place, besides of hibernation. Daily and seasonal aspects of this shelter using have been characterized. Such sites are very important for the conservation of the Barbastelle population; they have to be protected by high nature-conservation status.

Key words: *Barbastella barbastellus*, hibernation shelters, non-hibernation season, Ukraine

Bats use usually underground shelters mainly as hibernation sites in the temperate zone. Only exceptionally they create the nursery roosts there (Altringham, 1996). Underground sites are used mainly by males and non-breeding females and their numbers should be relatively low from spring to autumn, usually up to few individuals (Horáček, Zima, 1978).

Studies concerning the use of underground sites by bats in the non-hibernation period have been carried out for a series of places (e.g., Furmankiewicz, Górniak, 2002; Gaisler et al., 2003; Gottfried, 2009). However, there is still lack of information about this phenomenon in some species life cycle in the western part of Ukraine, especially for *Barbastella barbastellus* (Schreber, 1774).

Study area and methods

The investigations have been carried out in the Tarakaniv fortress, which was situated at the southern border of the Volynska Upland, near the village of Tarakaniv (Dubno district, Rivne region, Ukraine; Fig. 1). Forest-steppe landscape dominanted by oak-hornbeam forests and meadow steppe in the past and agricultural lands now is typical for this area. The fortress is situated within Povchanska Subprovince which lies between the Styr and the Ikva Rivers (Pryroda..., 1976).

Climate is relatively wet and warm here. Winter is light; summer is warm with enough precipitation. Winter starts on November 15-17, when daily temperature decreases below 0 °C. The coldest period begins in the middle of December and continues about 60 days. Vegetation period starts on April 5-9 and continues till November. Average annual temperature is relatively stable and consists 7-7,5 °C (Pryroda..., 1976).

Fig. 1. Map of the investigation area. Tarakaniv fortress is indicated by black point.

Tarakaniv fortress is an unique monument of military architecture of XIX century. It is a ground-concrete fortification made with bricks and strengthened by metal elements. Fortress lost its importance after the World War I.

Temperature and humidity fluctuations are relatively low in the deep underground cavities of the fortress that creates favorable conditions for the hibernation of some bat species.

The investigations were conducted during non-hibernation seasons of 2010-2013. Bats were mist-netted by three nets placed at the entrances to underground sites, in the inner part of the fort and at the outside entrance. The numbers of individuals caught in different seasons were used as indicators of activity. All bats were released on site immediately after processing (identification of sex and age, measurements of the series of parameters).

Another research method was investigation of territory using the time-expansion ultrasound detectors D-240x (Pettersson Elektronik AB, Sweden) and Tranquility Transect (UK). Bats call records were conducted by stereophonic (Sony WM-D6C) or digital (ZOOM H-2) recorders. The analysis of bat calls records was carried out with the program "BatSound". The characteristics of *B. barbastellus* calls with their specific rhythm and sounding were taken into account for the bat species investigations.

Results and discussion

Some regions, including Polissya, are characterized by the plain area and absence both of the natural (e.g., caves or grottoes) and artificial industrial undergrounds (e.g., mines, catacombs). Therefore, different artificial undergrounds (large cellars in old buildings, military fortresses) are very important for the bat species both sedentary and migratory. From this point of view we investigated the abandoned fortress which is important hibernacula for the series of bat species. This fortress is the largest known *B. barbastellus* hibernacula in Ukraine and one of the largest in the distribution range of this rare species (Bashta, 2012).

Use of the Tarakaniv fortress by *B. barbastellus* during the hibernating season. Visually estimated number of hibernating *B. barbastellus* fluctuated from 300 to 950 in the Tarakaniv fortress, consisting here the majority in wintering bat assemblage (93,3-97,6%, in average 96,1%; Bashta, Ivashkiv, 2012). Such part of *B. barbastellus* number is typical for assemblages in fortresses of the Eastern Poland (Godawa, 1994; Kowalski, Lesiński, 1997). Revealing that undergrounds of anthropogenic origin (especially, fortifications) are the most important hibernation places of *B. barbastellus* in this part of distribution range.

B. barbastellus shows clear tendency to form hibernation aggregations usually in the ventilation ducts (76-82% of specimens), wall crevices and as well as free hanging on the walls. Censuses have been conducted in the vertical ventilation ducts (4-5 m); bat number in the ducts of other figurations remains unknown.

Inner part of fortress is characterized with rather cooler microclimatic conditions that prove the prevalence of relatively cool-tolerant bat species here (*B. barbastellus*, *Eptesicus serotinus* (Schreber, 1774), *Plecotus auritus* (Linnaeus, 1758)). Temperature in the hibernation shelters varied within -0,9 and +3,0 °C, and very slightly correlated with outside temperatures. Shelters of some *Myotis* spp. were situated in scarce warmer parts of the fortress (Bashta, Ivashkiv, 2012). Temperature regime in the hibernation shelters of *B. barbastellus* proved that this species is quite cold-resistant and used relatively cool places for surviving during the winter season.

Activity of *B. barbastellus* in the non-hibernating season. Our researches during the non-hibernation seasons suggests that the fortress plays significant role in the life cycle of *B. barbastellus*. Parameters of *B. barbastellus* nocturnal activity as well as mist-netting showed us the great importance of underground shelters during not only hibernation, but also in the summer and autumn, particularly in mating period. These data are similar to the results from the central Europe (Červený, 1982; Rydell, Bogdanovicz, 1997; Berková, Zukal, 2004).

Similar but not so numerous observations on *B. barbastellus* in the non-hibernation season are known for some undergrounds of Podillya area. Percentage of this species consisted only 3% here (Tyshchenko, 2004). The species was noted in the grottoes of place “Divochi skeli” in the National Nature Park “Kremenetski

Hory" (Tyshchenko, 2002), limestone mines near the village of Pryvorottia in Kamianets'-Podilskyi distr. (Tyshchenko, Matveev, Bovtunova, 2005), as well as from mines near the village of Hlyboke in the Transcarpathian region (Bashta, 2009).

After leaving their hibernacula in spring, *B. barbastellus* hanging on walls were not found again until November or exceptionally October. It was confirmed by surveys during daytime before each mist-netting night. However, they flew out the underground entrance at the late evening. Possibly, it means that in the non-hibernations period they use inaccessible shelters within undergrounds.

In the spring time we noted only the rare passes of *B. barbastellus*; which means that the area is used relatively rare by this species. Hibernaculum does not seem important during the spring and first half of summer. In contrast to this, all methods showed high bat activity in August and September.

Usually the *B. barbastellus* appears already about late July-early August in the Tarakaniv fortress. Bats activity was increased till the end of August. On 21.08.2011 we caught about 150 specimens of *B. barbastellus* during the 3 hours.

The specimens hunt in the fortress; it was easy visible in the torches light. Till the end of October the activity decreased significantly. The number of males caught was substantially greater than the females (10:7, $P<0.01$). However, the prevalence of males in the same frames was observed during both all late summer-autumn and hibernation periods. Probably, there are the individuals which stay here till the hibernation period.

Creation of so called migration-mating aggregations is typical rather for migration bat species. There are several hypotheses that explain the use of hibernacula and its vicinity during the non-hibernation season. The most common one suggests that hibernacula may be used as stop-over sites at the migration corridors (Horáček, Zima, 1978; Whitaker, 1998). The second group of hypotheses considers that hibernacula may be used as meeting and information exchange place. It was supported by a series of recent studies of bat swarming activities near the underground entrance during the last summer and early autumn (Parsons, Jones, Greenaway 2003; Parsons et al., 2003; Gottfried, Szkudlarek, 2007).

Autumn activity of bats is typical for many European underground cavities (Dudek, Paszkiewicz, Szkudlarek, 1999; Parsons, Jones, Greenaway 2003; Parsons et al., 2003 etc.). Their microclimatic conditions can be much more appropriate at that time than summer sites (Harmata, 1969). *B. barbastellus* appears much earlier here than at beginning of hibernation. Autumn season is very important for bat winter hibernation as they have to accumulate sufficient fat reserves to cover the relatively high energy consumption for mating period and hibernation. Thus, the appearance of numerous bat flocks at the fortress indicates a rich food supply in the area and its surrounding. Supposedly, it would be more appropriate for bats (from the point of view of energy saving) to accumulate and save the fat close to the future hibernation places. These investigation suggests that the number of autumn aggregations during the migration season here is not lower than during hibernation and that seems to be the same aggregation. This is supported indirectly by almost the same sex composition of bats during the migration-mating and hibernation periods.

Since the *B. barbastellus* is a sedentary species, the use of hibernacula during the "warm" seasons of the year may be caused by both information exchange and the energy saving reasons.

Role of undergrounds for conservation of *B. barbastellus.* In Ukraine, as in all European countries, bats are protected by law. *B. basrbastellus* is included into the Red Data Book of Ukraine (Red Data Book..., 2009). In addition, Ukraine joined the Agreement on the Conservation of Bats in Europe (EUROBATS), as well as the Bern and Bonn Conventions. *B. barbastellus* has a NT ("near threatened" category) according to the IUCN Red list (IUCN, 2013). In accordance with these documents all bat species should be protected.

Tarakaniv fortress is used widely by bats in autumn (coupling) and hibernation seasons. Therefore, it is a particularly vital place for viability and survival of bat population, including such rare and scattered species as *B. barbastellus*, which is characterized by a high level of philopatry. Generally bats show a high degree of connection to specific hibernation sites (Glover, Altringham, 2008). Thus this site, which attracts a great number of bats from large areas and therefore is very important for their conservation should be strictly protected.

Bats have a few natural enemies. However, the greatest threat for them is human activity. There are many publications concerning the influence of anthropogenic factors that caused a significant decline in bat populations during the last decades in Europe (Stebbings, 1988; Lesiński, 2006 et al.). Bats are very sensitive not only to change in the microclimate of hibernacula, but also to some disturbing factors (light or noise).

Recent years brought the tourism development and increase of recreational activity and the situation for bats at the fortress seems getting worse. Regular and uncontrolled visits of various tourists, the noise generated by them, influence directly the bat fauna (disturbance factor) and significantly changed microclimatic parameters of the shelter. Placing of the grilles would be the most appropriate measure for protection of bat population in this fortress.

Conclusions

1. *B. barbastellus* appears at the site of their hibernaculum in non-winter period that proves that it has a great importance for the *B. barbastellus* population mostly as mating and resting places.

2. *B. barbastellus* were noted there from the late July, but their numbers were the highest in late August. The numbers of males caught was significantly greater than the females' ones (10:7, $P<0.01$). Their activity became decreased significantly till the end of October.

3. The appearance of bat numerous flocks at the fortress indicates a rich food supply in the area and its surroundings. Supposedly, it would be more appropriate for bats (from the point of view of saving energy) to accumulate the fat in the area of future hibernation places.

4. Use of this fortress by bats in different seasons makes it a vital place for the conservation and survival of bat population, including the rare and disjunctive bat species *B. barbastellus*, which is characterized by a high level of philopatry.

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ЗНАЧЕННЯ ПІДЗЕМНИХ МІСЦЬ ГІБЕРНАЦІЇ ДЛЯ *BARBASTELLA BARBASTELLUS* (SCHREBER, 1774) (*CHIROPTERA*, *VESPERTILIONIDAE*) У ПОЗАЗИМУВАЛЬНИЙ ПЕРІОД

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Використання місць зимівлі та навколишніх біотопів широковухом європейським протягом позазимувального періоду досліджували в Тараканівському форті (Рівненська область, Україна) протягом 2010-2013 рр. Можливі функції цього об'єкту для рукокрилих, окрім гібернації – місця кормодобування, денного відпочинку або парування. Охарактеризовані добові та сезонні аспекти використання рукокрилими цього сховища. Такі місця поселень широковуха дуже важливі для збереження його популяції і повинні бути захищені природоохоронним статусом високого рівня.

Ключові слова: *Barbastella barbastellus*, місця зимівлі, позазимовий період, Україна

ЗНАЧЕНИЕ ПОДЗЕМНЫХ МЕСТ ГИБЕРНАЦИИ ДЛЯ *BARBASTELLA BARBASTELLUS* (SCHREBER, 1774) (*CHIROPTERA*, *VESPERTILIONIDAE*) ВО ВРЕМЯ НЕЗИМОВОЧНОГО СЕЗОНА

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Использование мест зимовки и прилегающих биотопов европейской широкоушкой на протяжении незимовочного периода 2010-2013 гг. исследовали в Таракановском форте (Ривненская область, Украина). Возможные функции этого объекта для рукокрылых, кроме гибернации – места добывания корма, дневного отдыха и спаривания. Проанализированы суточные и сезонные аспекты использования рукокрылыми этого укрытия. Такие местообитания очень важны для сохранения популяции широкоушки и должны быть защищены природоохранным статусом высокого уровня

Ключевые слова: *Barbastella barbastellus*, места зимовки, внезимний период, Украина

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