

DIVERSITY AND BIOTOPIC DISTRIBUTION OF BAT SPECIES (MAMMALIA: CHIROPTERA) IN CHIȘINĂU, REPUBLIC OF MOLDOVA

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Abstract. The studies were performed in 2018-2023 in the habitats of Chisinau. The bat fauna of Chisinau is quite well represented, which indicates the adaptation of animals to anthropogenic disturbances in urban habitats. Out of 21 species of bats reported on the territory of the Republic of Moldova, 13 species are present in the city habitats. The dominant species in the city is *Nyctalus noctula*, the most synanthropic species that is present in most of old or damaged buildings and even use the cracks and ventilation pipes of new buildings for roosting. In urban habitats the species *N. noctula*, *E. serotinus*, *P. pipistrellus/pygmaeus*, *P. austriacus* predominate and have been recorded both in green areas and in buildings. The rarest species were *R. hipposideros*, *M. daubentonii*, *M. dasycneme*, *M. bechsteinii*. Most of the registered species are listed in the Red Book of the Republic of Moldova as critically endangered (*M. bechsteinii*, *V. murinus*), endangered (*Rh. hipposideros*, *M. dasycneme*, *P. auritus*) and vulnerable (*M. daubentoni*, *M. mystacinus*, *P. kuhli*, *P. austriacus*).

Keywords: chiropterans, diversity, Chișinău city, urban habitats, adaptation, rare species.

Rezumat. Diversitatea și distribuția biotopică a speciilor de lilieci (Mamifere: Chiroptera) în orașul Chișinău, Republica Moldova. Studiile au fost efectuate în perioada 2018-2023 în habitatele orașului Chișinău. Fauna de lilieci din Chișinău este destul de bine reprezentată, ceea ce indică adaptarea animalelor la perturbările antropice în habitatele urbane. Din 21 de specii de lilieci raportate pe teritoriul Republicii Moldova, 13 specii sunt prezente în habitatele orașului. Specia dominantă în oraș este *Nyctalus noctula*, cea mai sinantropică specie care este prezentă în majoritatea clădirilor vechi sau deteriorate și chiar folosește fisurile și țevile de ventilație ale clădirilor noi pentru adăpostire. În habitatele urbane predomină speciile *N. noctula*, *E. serotinus*, *P. pipistrellus/pygmaeus*, *P. austriacus* care au fost înregistrate atât în spațiile verzi, cât și în clădiri. Cele mai rare specii au fost *R. hipposideros*, *M. daubentonii*, *M. dasycneme*, *M. bechsteinii*. Majoritatea speciilor înregistrate sunt incluse în Cartea Roșie a Republicii Moldova ca critic periclitate (*M. bechsteinii*, *V. murinus*), periclitate (*Rh. hipposideros*, *M. dasycneme*, *P. auritus*) și vulnerabile (*M. daubentoni*, *M. mystacinus*, *P. kuhli*, *P. austriacus*).

Cuvinte cheie: chiroptere, diversitate, orașul Chișinău, habitatele urbane, adaptare, specii rare.

INTRODUCTION

In Chișinău, the presence of natural and artificial water pools, parks and recreation areas creates micro-ecosystems, in which bats find favorable conditions for shelter, food and reproduction. Anthropogenic habitat creates specific conditions for the interaction between organisms in this system. An important aspect in the field of chiropterology is the study of the biological and ecological features of bats in order to establish the mechanisms of their interaction with the man-made environment. The conditions created by human activity (microclimate, waste) represent a favorable environment for the reproduction of a large number of insects that accompany anthropogenic activities, which serve as a trophic source. Various types of human constructions with many closed spaces serve as source of shelter and offer an advantage for the existence of bats in urban conditions. In the last decades, the urban sectors are constantly expanding. Under these conditions, bats as one of the most numerous groups of mammals, which gradually adapt to these changes.

The first data on bats from Chișinău can be found in the 1950-1960s, where 4 species (*Plecotus auritus*, *Eptesicus serotinus*, *Nyctalus noctula* and *Vespertilio murinus*) are mentioned for urban area, found in cellars and basement, in attics, various cracks and empty spaces of large buildings (SAENCO, 1959; AVERIN & LOZAN, 1961; DOROSHENKO, 1975). Data on bats from underground shelters, mainly limestone mines located near Chișinău – Cricova and Mileștii Mici, can be found in one paper (DOROSHENKO, 1975). There is only one paper dedicated to urban fauna in the past century, where 11 species of bats found in Chișinău habitats are mentioned (ANISIMOV & COJUHARI, 1978). The studies on urban fauna of terrestrial vertebrates performed in 2012-2013 in Chișinău municipality revealed the presence of 9 bat species (VASILASCU et al., 2013).

Since 2013 extensive studies of bat fauna have started in various sites of anthropogenic origin and in the urban habitats of Chișinău city. Thus, the first publication on bats fauna from Chișinău city revealed a diversity of 10 species (NISTREANU et al., 2017). The studies performed in the Chișinău airport and adjacent territories revealed the presence of 7 bat species (NISTREANU & LARION, 2022). In the last years intense rehabilitation activities within city habitats have started (NISTREANU et al., 2022).

The aim of the paper is to elucidate the diversity and actual status of the bat fauna in Chișinău and to reveal the urban biotopes used by chiropterans for their biological activities.

MATERIALS AND METHODS

Chișinău is located at an altitude of 60-90 m, coordinates 4702 N and 28050 E, at the edge of the southeast slope of the Central Plateau of the Republic of Moldova, in the forest-steppe zone. The city has a relatively large area of

123 km² and in each district there are parks with water basins and rich woody vegetation, which favours the presence of bats and their distribution throughout the municipality.

Chişinău is a combination of habitats of different types, to which a large number of bat species are adapted. In these habitats, conditions are created for shelter, shelter or hunting.

1. Natural habitats in the vicinity of Chişinău municipality include a wide range of forest habitats, represented by the remnants of the once extensive forests of Durleşti, Băcioi, Condrița, Vadul-lui-Vodă. All forest habitats are of natural origin, formed by plant associations with the predominance of oak, followed by ash, elm, hornbeam, lime, maple. The shrub is rich and abundant, represented by horn, hawthorn, rosehip, pigeons, honeycomb, bellflower, soft bead, itchy wood. Forest biotopes included the following types: forest interior, forest edge. Recreational areas have been recorded closer to the edge of the forest, where research has also been carried out.

2. Aquatic and marsh habitats occupy the basins of rivers, lakes, reservoirs, ponds and adjacent territories.

3. Man-made agricultural habitats are represented by curtains and forest plantations, as well as various types of agrocoenoses: cereals (wheat, barley, corn), processed and abandoned orchards (apple, plum, cherry, walnut), vineyards, fodder crops (alfalfa) and roaches.

4. Urban habitats are represented by municipal parks: Botanical Garden, Zoo, Morilor Valley, Rose Valley, Râșcani-Ciocană forest area, Alunelul park, Dendrariul, blocks of flats, neighborhoods with houses, old and abandoned buildings, surroundings recreational sectors in the suburbs (Vadul-lui-Vodă, Durleşti, Cricova, Dumbrava, etc.), gardens.

The monitoring of bats in the urban area was carried out during 2018-2023 through direct observations, captures, with the ultrasonic detector, as well as following the notifications of the population regarding the presence of bats in buildings. The research was performed in the post-hibernation, reproductive and post-reproductive period, when the activity of the bats is at its peak. Chiropteran species in the city were identified during the trophic activity between 18:00 and 23:00. Trails of 2-5 km were performed at a speed of 2 km/h, during which the number of individuals was recorded by ultrasound frequency, according to the methodology developed for monitoring bat species in Europe (BUTTERSBY, 2010).

In order to establish the diversity and the number of bats in the studied area, individuals of different species were captured from buildings, blocks of flats, houses. The benefit of this method of direct determination is that it is possible to measure, identify, observe the condition of the animal, and put a ring with a special number.

Out of the methods of indirect observations the ultrasonic detector or acoustic detection (Pettersson D220) was used. The technique of using sound detectors along with the flight characteristics of bat species in a particular habitat, as well as some behavioral characteristics lead to a fairly accurate identification of existing species in a particular area. This method was performed in parks, fields, and open places where the bats are hunting. Unlike the capture method, when the animal is handled, acoustic detection is a non-invasive method that does not affect bat species in any way. With the help of the ultrasound detection equipment, we were able to record the signals emitted by the bats, without interfering with their normal activity. However, a reliable determination of the species is not always possible, and the information collected cannot provide us with data on age, sex, or reproductive condition of individuals (NISTREANU et al., 2021).

RESULTS

During 2018-2023 in the habitats of Chişinău 13 species of bats were registered: *Rhinolophus hipposideros*, *Myotis daubentoni*, *M. dasycneme*, *M. mystacinus*, *M. bechsteinii*, *Nyctalus noctula*, *Pipistrellus pipistrellus/pygmaeus*, *P. kuhli*, *Plecotus auritus*, *P. austriacus*, *Eptesicus serotinus*, *Vespertilio murinus* (Fig. 1).

Rhinolophus hipposideros (Bechstein, 1800) - Lesser horseshoe Bat. The species of the genus *Rhinolophus* with a body mass 3,6-8g. Ultrasonic frequency: 102-114 kHz. Status in the Red Book of Moldova (2015) is EN.

Myotis daubentoni (Kuhl, 1817) – Daubenton's Bat. The species of the genus *Myotis* with a body mass 6-10 g. Ultrasonic frequency: 40-42 kHz. Status in the Red Book of Moldova (2015) is VU.

M. dasycneme (Boie, 1825) – Pond Bat. The species of the genus *Myotis* with a body mass 13-25 g. Ultrasonic frequency: 35 kHz. Status in the Red Book of Moldova (2015) is EN.

M. mystacinus (Kuhl, 1817) – Whiskered Bat. The species of the genus *Myotis* with a body mass 4,5-9 g. Ultrasonic frequency: 45-50(45-53) kHz. Status in the Red Book of Moldova (2015) is VU.

M. bechsteinii (Kuhl, 1817) – Bechstein's Bat. The species of the genus *Myotis* with a body mass 6-12 g. Ultrasonic frequency: 45-50 kHz. Status in the Red Book of Moldova (2015) is CR.

Nyctalus noctula (Schreber, 1774) – Noctule Bat. The species of the genus *Nyctalus* with a body mass 25-35 g. Ultrasonic frequency: 19-24 kHz. It is not included in the Red Book of Moldova and is considered a common species.

Pipistrellus pipistrellus (Schreber, 1774) – Common Pipistrelle Bat. The species of the genus *Pipistrellus* with a body mass 3-8 g. Ultrasonic frequency: 41-43(44-45) kHz. It is not included in the Red Book of Moldova and is considered a common species.

P. pygmaeus (Leach, 1825) – Soprano Pipistrelle Bat. The species of the genus *Pipistrellus* with a body mass with a body mass 3-8 g. Ultrasonic frequency: 52-58 kHz. It is not included in the Red Book of Moldova and is considered a common species.

P. kuhli (Kuhl, 1817) – Kuhl's Pipistrelle Bat. The species of the genus *Pipistrellus* with a body mass 5-10 g. Ultrasonic frequency: 35-40 kHz. Status in the Red Book of Moldova (2015) is VU.

Plecotus auritus (Fischer, 1829) –Brown Long-eared Bat. Species of the genus *Plecotus* with a body mass 5-11 g. Ultrasonic frequency: 26-29 kHz. Status in the Red Book of Moldova (2015) is EN.

P. austriacus (Linnaeus, 1758) – Grey Long-eared Bat. Species of the genus *Plecotus* with a body mass 5-11g. Ultrasonic frequency: 26-29 kHz. Status in the Red Book of Moldova (2015) is VU.

Eptesicus serotinus (Schreber, 1774). Serotine Bat. The species of the genus *Eptesicus* with a body mass 15-30 g. Ultrasonic frequency: 25-27 kHz. It is not included in the Red Book of Moldova and is considered a common species.

Vespertilio murinus (Linnaeus, 1758) – Parti-coloured Bat. The species of the genus *Vespertilio* with a body mass with a body mass 8-20 g. Ultrasonic frequency: 25-27 (22-25) kHz. Status in the Red Book of Moldova (2015) is CR.

Most species are listed in the Red Book of the Republic of Moldova as critically endangered (*M. bechsteinii*, *V. murinus*), endangered (*Rh. hipposideros*, *M. dasycneme*, *P. auritus*) and vulnerable (*M. daubentoni*, *M. mystacinus*, *P. kuhli*, *P. austriacus*).

In open spaces, above the surface of the lakes, mainly representatives of the genus *Myotis*: *Myotis daubentoni* (40 - 42 kHz), *Myotis dasycneme* (35 kHz), *Myotis bechsteinii* (45 - 50 kHz), *Myotis mystacinus* (45 - 50 kHz) were identified. In large parks, where forest vegetation prevails, for example, the Ciocană-Râșcani park, the common noctule bat (*Nyctalus noctula*) was frequently recorded (22 - 28 kHz), the same trend was observed in the central region of the city: the central park, the Cathedral park and the dendrological park.

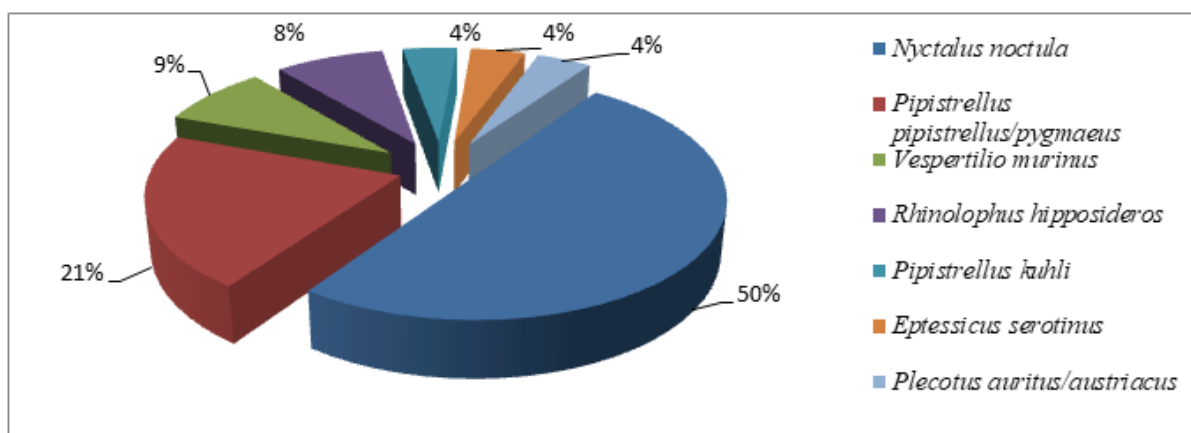


Figure 1. Structure of chiropteran communities in the summer period, registered by the method of ultrasonic determination.

Over the last few decades, several species of bats have "conquered" the environment offered by urban building. The response of bats to the urbanization process is highly specific: some species tolerate urban habitat or are even favored by its roosting or foraging opportunities, others are affected by the loss or fragmentation of their natural habitat. These are generally species whose original shelters were tree hollows or rock fissures: the common noctule bat *Nyctalus noctula*, the common pipistrelle bat *Pipistrellus pipistrellus*, the serotine bat *Eptesicus serotinus*, the party-coloured bat *Vespertilio murinus*, for which the cracks in the walls made from prefabricated elements, can provide a wide variety of roosts (Fig. 2). These, from an ecological point of view, are similar to the roosts occupied in natural habitats.

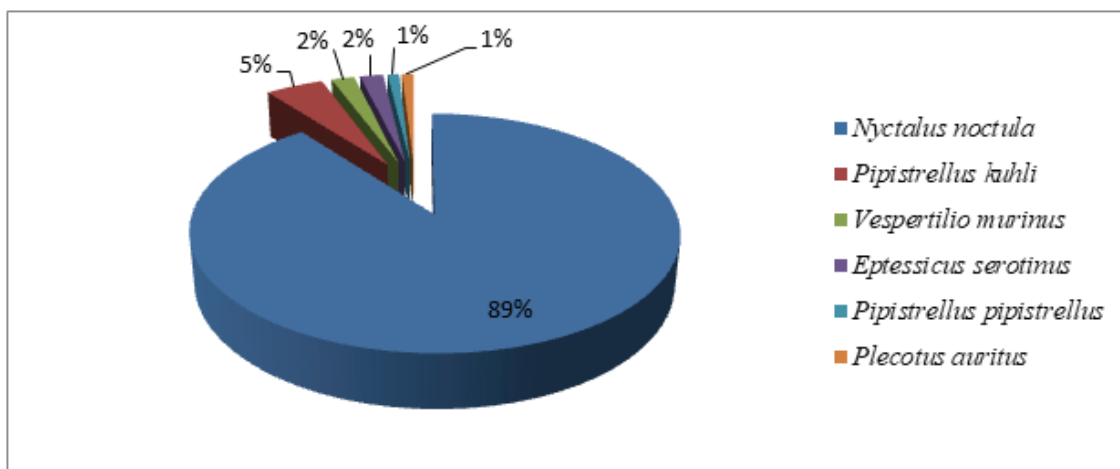


Figure 2. Relative abundance of the chiropteran species, registered by the method of capture in human constructions in 2021.

The individuals that were collected by the capture method offer concrete evidence about certain species space use in human constructions as various types of roost in different seasons. The collected individuals can be easily

identified according to morphological features and can provide valuable information on roost preferences, as well as the adaptive particularities to the urban environment in different species.

In urban habitats, the species *N. noctula*, *E. serotinus*, *P. pipistrellus/pygmaeus*, *P. austriacus* predominate and have been recorded both in green areas and in buildings. The rarest species in urban habitats were *R. hipposideros*, *M. daubentonii*, *M. dasycneme*, *M. bechsteinii*, registered in low number in forest biotopes and large parks and near water basins.

Upon notification from the population, 3 large colonies of *N. noctula* (about 200 individuals, 85 ind. and 88 ind.) were rescued from various buildings in two districts of the city. The individuals were released in a park with many tall old trees.

DISCUSSIONS

All bat species in Europe are listed in Annex II of the Habitats Directive as species of Community interest, whose conservation of which requires the designation of special areas of conservation, as well as in the Berne Convention on the Conservation of European Wildlife and Natural Habitats in Annex II (strictly protected fauna species), except *Pipistrellus pipistrellus*, which is listed in Annex III (protected fauna species). Bats are also included in the UN Convention on the Conservation of Migratory Species of Wild Animals (CMS), and the European Bat Conservation Agreement (Eurobats) that is dedicated exclusively to bats. In the second edition of the Red Book of Moldova (2001) 6 species of bats were listed, and in the third edition (2015), 16 species of bats are already included. Most species are listed as critically endangered (*M. bechsteinii*, *V. murinus*), endangered (*Rh. hipposideros*, *M. dasycneme*, *P. auritus*) and vulnerable (*M. daubentoni*, *M. mystacinus*, *P. kuhli*, *P. austriacus*).

The bat species diversity is higher in comparison to the previous studies, but several species mentioned for the city habitats were not recorded in the last years, such as *Myotis nattereri* and *Pipistrellus nathusii* (ANISIMOV & COJUHARI, 1978). *Plecotus austriacus* can be considered a new species for urban fauna as it wasn't mentioned for the territory of the republic until 1997 (ANDREEV & VASILIEV, 1997) and even was considered as *P. auritus* (AVERIN et al., 1979).

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CONCLUSIONS

The bat fauna of Chişinău is quite well represented, which indicates the adaptation of animals to anthropogenic disturbances in urban habitats. Out of 21 species of bats reported on the territory of the Republic of Moldova, 13 species are present in the city area.

On the territory of each city district in recreation areas with parks, various types of water sources and many abandoned buildings, a large number of different species of bats were recorded.

The dominant species in the city is *Nyctalus noctula*, the most synanthropic species that is present in most of old or damaged buildings and even uses the cracks and ventilation pipes of new buildings for roosting.

In urban habitats, the species *N. noctula*, *E. serotinus*, *P. pipistrellus/pygmaeus*, *P. austriacus* prevail and have been recorded both in green areas and in buildings. The rarest species were *R. hipposideros*, *M. daubentonii*, *M. dasycneme*, *M. bechsteinii*.

Most of the registered species are listed in the Red Book of the Republic of Moldova as critically endangered (*M. bechsteinii*, *V. murinus*), endangered (*Rh. hipposideros*, *M. dasycneme*, *P. auritus*) and vulnerable (*M. daubentoni*, *M. mystacinus*, *P. kuhli*, *P. austriacus*).

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