

SMALL MAMMALS OF UZHANSKYI NATIONAL PARK (UKRAINIAN CARPATHIANS) AND ITS VICINITIES: A PRELIMINARY ANALYSIS

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Small mammals of Uzhanskyi National Park (Ukrainian Carpathians) and its vicinities: a preliminary analysis. — Z. Barkaszi, N. Koval. — A preliminary analysis of species composition, abundance and habitat preferences of small mammals in the territory of Uzhansky National Nature Park and its vicinities was conducted. Since the creation of the park in 1999, detailed studies on small mammals have not been conducted in the area. Thus, the present research is a first attempt to clarify the species composition and some ecological features of small mammals in the region. In September–October 2017, trappings of small mammals were conducted by traditional methods using Hero traps and live traps. Five key habitats were investigated: ‘mixed forest’, ‘forest edge’, ‘windfall’, ‘meadow’, and ‘shrubs’. The total number of trap days was 705 during which 101 specimens of 7 species were collected. One species — *M. agrestis* — was recorded first in Uzhansky National Park. The part of females in the general sample was higher than the part of males (58.4 % vs. 41.6 %, respectively). Among the studied habitats, the highest species richness was revealed in ‘meadow’, where all 7 species occurred. The most abundant but, at the same time, the poorest habitats were ‘mixed forest’ (34.4 specimens / 100 trap-days, 2 species) and ‘forest edge’ (20.0 specimens, 2 species). Among the 7 species revealed in the park and its vicinities, only one is considered abundant (*S. tauricus*). According to Shannon and Simpson diversity indices, the highest species diversity was revealed in ‘meadow’ ($H = 0.746$, $D = 4.741$), ‘windfall’ ($H = 0.436$, $D = 2.579$), and ‘shrubs’ ($H = 0.430$, $D = 2.528$), while ‘mixed forest’ and ‘forest edge’ showed the lowest diversity. By the level of habitat preference, the most eurytopic species were *S. tauricus* and *M. glareolus*. The yellow-necked field mouse preferred ‘mixed forest’ the most ($F_{ij} = 0.57$) and clearly avoided ‘meadow’ and waterside ‘shrubs’. The shrews (*Sorex*) and voles (*Microtus*) under conditions of Uzhansky Park were stenotopic species occurring only in ‘meadow’ ($F_{ij} = 1.00$). Habitats having the highest level of species diversity deserve special conservation attention. The current revised taxonomic list of orders Soriciformes and Muriformes includes 14 species. The presence of 2 species previously mentioned for the region have not been confirmed yet by actual records.

Key words: insectivores, rodents, abundance, habitat preference, protected areas.

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Introduction

Uzhansky National Nature Park is located in the Ukrainian Carpathians, in the upper part of the Uzh River’s basin in the northwest part of Zakarpattia Oblast, Ukraine (Transcarpathia). The national park was created in 1999 based on former reserves ‘Stuzhytsia’ and ‘Tykhyi’ (which existed yet in the early 20th century in order to protect primeval forests) and of adjoined territories of the Uzh River’s basin. The area of Uzhansky Park is 391.6 km² and is part of the trilateral (Poland, Slovakia, and Ukraine) biosphere reserve ‘Eastern Carpathians’. Primeval and old-growth forests of Uzhansky National Park are part of UNESCO World Heritage¹.

During the 20 years since the creation of the Park, many groups of organisms have yet remained poorly investigated. Nevertheless, the flora of Uzhansky Park is studied quite in detail, which is represented by 2 160 species of plants and fungi (Chronicle..., 2018). Primeval beech forests of the Park are studied thoroughly (Zayats, 2009), as well as lichens on some mountain meadows (Pirogov et al., 2014).

¹ Data from the official website of Uzhansky National Nature Park, page ‘History of Establishment’. Accessed on 05 February 2019 from <https://unpp.uz.ua/home/istoriya-stvorenniya/>

Among invertebrates of the Park, several groups of arthropods are relatively well studied, particularly the species composition of epigeal spiders represented here by 79 species, 3 of which were first recorded in the Ukrainian Carpathians (Hirna et al., 2015).

Insects of Uzhansky National Park are also studied in detail, especially their diversity and the distribution and ecology of rare and vulnerable species (Koval et al., 2011; Kanarskyi et al., 2012; Geryak et al., 2013; Koval, Kanarskyi, 2013).

Data on vertebrates are rather fragmented. Amphibians are the only group the taxonomic and species composition of which was fully clarified (Kurtyak, Krulko, 2010). Nevertheless, much attention was paid to mammals, which, according to current estimates, are represented by 63 species. The most thoroughly studied group of mammals are bats represented by 21 species, among which the presence of 19 species was confirmed by actual records (Bashta, Koval, 2014; Koval et al., 2018). Regarding other groups of mammals, separate studies were devoted to the population of the rare wildcat, the abundance of which has been showing a positive dynamic since 2007 (Koval, 2017), and to investigations into ecological conditions of the Park as a potentially suitable territory for breeding and restoration of the European bison (Perzanowski, Olech, 2007; Khoyetskyi et al., 2014). Considerable attention was paid to studies into the ecology of large carnivores of Uzhansky Park as well (Shkvyria et al., 2014).

Special studies on small mammals of Uzhansky Park have not been conducted before. Many of the easily recognizable species (e.g., *Sciurus vulgaris*, *Castor fiber*, *Apodemus agrarius* etc.) were included into the very first checklists of species, while the presence of small-sized species was confirmed mainly based on single records or was not confirmed at all. Among rodents, only the Eurasian beaver is well studied, which is represented here by a mountain population and continues to expand its distribution range (Koval, 2015).

Therefore, the aim of the present research was to clarify the species composition, diversity, and habitat preferences of small mammals in Uzhansky National Park and to revise the current checklist of shrews and rodents.

Material and Methods

Field studies were conducted from 15 September to 14 October 2017 in the territory of Uzhansky National Park and adjacent areas (Fig. 1).

Trappings took place in 5 types of habitats using Hero traps (outside the park) and live traps (both within and outside the park) according to a standard methodology (e.g., Zagorodniuk, 2002; Numerov et al., 2010). Animals collected by live traps were marked before release to avoid their recensus in case of their recapture. Trappings in each habitat lasted for 2 days (or 3 days in case of unfavourable weather conditions). The total number of trap-days was 705.

The following types of habitats were investigated (Fig. 2):

- 1) mixed forest (49.043455, 22.583172) — relatively young-growth beech–hornbeam–oak forest,
- 2) forest edge (49.042251, 22.578786) — at the boundary of a meadow and a beech-hornbeam forest,
- 3) windfall (48.883814, 22.470153) — cleared, in a beech–hornbeam forest,
- 4) meadow (49.043615, 22.581042; 48.940980, 22.476291) — moderately moist meadows,
- 5) shrubs (48.948434, 22.472967) — common hazel, blackberry and black elder along a mountain stream.

Indices of species richness and species diversity (Shannon and Simpson indices) were calculated, as well as the level of dominance, relative abundance (Zagorodniuk et al., 2002) and habitat preferences of species (Pesenko, 1982; Naglov, Zagorodniuk, 2006).

The revised checklist of small mammals of Uzhansky National Park follows the latest taxonomic scheme of the mammal fauna of Ukraine (Zagorodniuk, Emelynov, 2012).

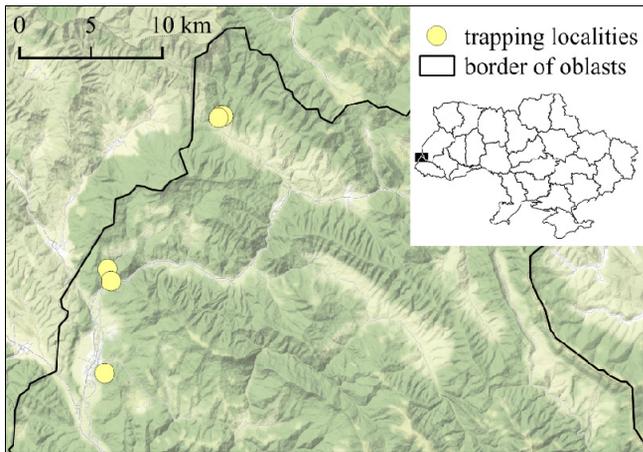


Fig. 1. Trapping localities of small mammals in Uzhansky National Park and its vicinities (Velykyi Bereznyi Raion, Zakarpattia Oblast).

Рис. 1. Місця відлову дрібних ссавців в Ужанському національному парку та його околицях (Великобerezнянський район, Закарпатська область).



Fig. 2. Some of the studied habitats: a meadow within Uzhansky National Park (a) and a cleared windfall near Velykyi Bereznyi (b).

Рис. 2. Деякі з досліджених біотопів: лука на території Ужанського національного парку (a), очищений вітровал біля Великого Березного (b).

Results and discussion

Species composition and relative abundance

Based on trapping results, the presence of 7 small mammal species was revealed or confirmed in the territory of Uzhansky National Park (Table 2). Among them, 2 species (*S. araneus* and *S. minutus*) represent the order Soriciformes (seu Insectivora) and 5 belong to the order Muriformes (seu Rodentia).

In total, 101 specimens were trapped, most of which belong to *S. tauricus*. Two species — *S. minutus* and *M. arvalis* — have the least number of specimens in the general sample. In addition, all species are represented in the sample by a larger number of females than males (Fig. 3) except for *A. agrarius*, which is represented by an equal number of specimens of different sexes. The portion of females in the general sample is 58.4 %, while the portion of males is 41.6 %.

Among the studied habitats, the highest species richness was revealed in ‘meadow’, where all 7 species occurred. The highest abundance, although the lowest number of species, was revealed in ‘mixed forest’ (34.4 specimens, 2 species) and ‘forest edge’ (20.0 specimens, 2 species).

The lowest abundance of micromammals was revealed in ‘windfall’ (3.9 specimens), while ‘meadow’, which was the richest habitat by the number of species, had also a relatively low abundance of animals (8.4 specimens) due to the low number of specimens trapped in this habitat. The general relative abundance of micromammals in the studied area was 14.3 specimens.

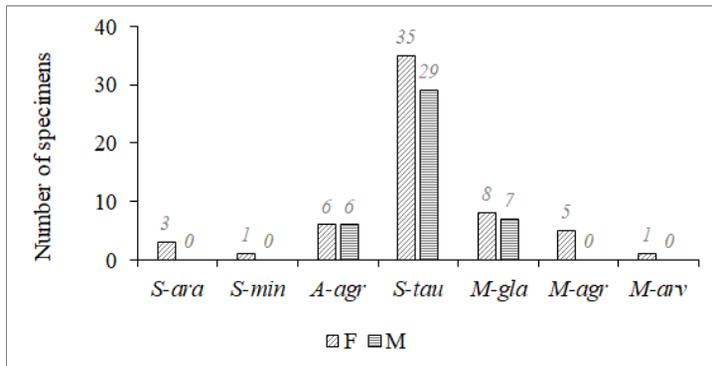


Fig. 3. The number of specimens of different sexes in the sample.

Рис. 3. Число екземплярів різної статі у вибірці.

Table 1. Results of trappings of small mammals in Uzhansky National Park and its vicinities

Таблиця 1. Результати відловів дрібних ссавців в Ужанському національному парку та його околицях

Species	Habitat					Total
	mixed forest	forest edge	windfall	meadow	shrubs	
<i>Sorex araneus (S-ara)</i>	0	0	0	3	0	3
<i>Sorex minutus (S-min)</i>	0	0	0	1	0	1
<i>Apodemus agrarius (A-agr)</i>	0	0	1	4	7	12
<i>Sylvaemus tauricus (S-tau)</i>	52	6	3	1	2	64
<i>Myodes glareolus (M-gla)</i>	3	2	3	1	6	15
<i>Microtus agrestis (M-agr)</i>	0	0	0	5	0	5
<i>Microtus arvalis (M-arv)</i>	0	0	0	1	0	1
Total specimens	55	8	7	16	15	101
Total trap-days	160	40	180	190	135	705
Specimens / 100 trap-days	34.4	20.0	3.9	8.4	11.1	14.3
Total species	2	2	3	7	3	7

Table 2. Scores of abundance of small mammal species in Uzhansky National Park and its vicinities

Таблиця 2. Бали рясноти видів дрібних ссавців в Ужанському парку та його околицях

Species	Females	Males	Total	%	Category of presence*	Score of abundance
<i>Sorex araneus (S-ara)</i>	3	0	3	3.0	frequent	3
<i>Sorex minutus (S-min)</i>	1	0	1	1.0	occasional	2
<i>Apodemus agrarius (A-agr)</i>	6	6	12	11.9	common	4
<i>Sylvaemus tauricus (S-tau)</i>	35	29	64	63.4	abundant	5
<i>Myodes glareolus (M-gla)</i>	8	7	15	14.9	common	4
<i>Microtus agrestis (M-agr)</i>	5	0	5	5.0	frequent	3
<i>Microtus arvalis (M-arv)</i>	1	0	1	1.0	occasional	2
Total	59	42	101	100.0	—	—

* Note: for translation of categories proposed by Zagorodniuk et al., 2002 we used the ACFOR scale.

Since this is the first planned study on small mammals of Uzhansky National Park, we consider converting the relative abundance of species into abundance scores and estimating the category of presence of species in the territory. Such estimation considering some chorological features contributes to the issue of determination of conservation categories of species, which is necessary for creating red lists of fauna of the Park and of the Carpathian region in general.

Considering the volume of available data, using the method of score-based estimation of abundance (Zagorodniuk et al., 2002) seems to be the most convenient and accurate approach. The con-

version of census data into abundance scores also allows the unification of abundance data and makes their comparison with data from other protected areas much easier (see: Table 2).

Therefore, among the 7 species recorded in the territory only one is ‘abundant’ (*S. tauricus*), two species are ‘common’ (*A. agrarius* and *M. glareolus*), and another two belong to the category ‘occasional’ (*S. minutus* and *M. arvalis*). The ‘occasionality’ of *M. arvalis* in the area can be explained by two conditions. First, the common vole in the region of the Ukrainian Carpathians is a lowland species, which can disperse into the mountains along valleys. Second, it is restricted mainly to agricultural lands, while field research were conducted exclusively in natural habitats. Thus, the presence of a sole specimen of *M. arvalis* in the sample, trapped in the meadow, is rather an example of the species’ intrusion into the mountains and into a natural habitat from the nearest farmlands

The field vole (*M. agrestis*) was recorded in the territory of Uzhansky National Park for the first time. The southern range edge of this boreal species runs along the Ukrainian Carpathians and its records from the area of Uzhansky Park were not available during the revision of the species’ range in the region (Barkaszi, 2017). Therefore, records of the field vole in the territory of the Park as well as further studies into the species’ distribution in the area are extremely important to clarify the field vole’s distribution patterns and ecological features in range edge populations

Species diversity and habitat preferences

Species diversity in each type of habitat was measured by both the Shannon (H) and Simpson indices (D). By both indices, the highest species diversity was revealed in such habitats as ‘meadow’ ($H = 0.746$, $D = 4.741$), ‘windfall’ ($H = 0.436$, $D = 2.579$) and ‘shrubs’ ($H = 0.430$, $D = 2.528$). At the same time, the lowest diversity is recorded for ‘mixed forest’ and ‘forest edge’, where the same two species — *S. tauricus* and *M. glareolus* — occurred (see: Tables 3–4).

Table 3. The Shannon index of diversity of small mammals in the studied biotopes

Таблиця 3. Показник різноманіття Шенона дрібних ссавців у досліджених біотопах

Species	mixed forest	forest edge	windfall	meadow	shrubs
<i>Sorex araneus</i> (<i>S-ara</i>)	—	—	—	0.136	—
<i>Sorex minutus</i> (<i>S-min</i>)	—	—	—	0.075	—
<i>Apodemus agrarius</i> (<i>A-agr</i>)	—	—	0.121	0.151	0.154
<i>Sylvaemus tauricus</i> (<i>S-tau</i>)	0.023	0.094	0.158	0.075	0.117
<i>Myodes glareolus</i> (<i>M-gla</i>)	0.069	0.151	0.158	0.075	0.159
<i>Microtus agrestis</i> (<i>M-agr</i>)	—	—	—	0.158	—
<i>Microtus arvalis</i> (<i>M-arv</i>)	—	—	—	0.075	—
Diversity, H	0.092	0.244	0.436	0.746	0.430
Evenness, J	0.305	0.811	0.914	0.882	0.902

Table 4. The Simpson index of diversity of small mammals in the studied biotopes

Таблиця 4. Показник різноманіття Сімпсона дрібних ссавців у досліджених біотопах

Species	mixed forest	forest edge	windfall	meadow	shrubs
<i>Sorex araneus</i> (<i>S-ara</i>)	—	—	—	0.0352	—
<i>Sorex minutus</i> (<i>S-min</i>)	—	—	—	0.0039	—
<i>Apodemus agrarius</i> (<i>A-agr</i>)	—	—	0.0204	0.0625	0.2178
<i>Sylvaemus tauricus</i> (<i>S-tau</i>)	0.8939	0.5625	0.1837	0.0039	0.0178
<i>Myodes glareolus</i> (<i>M-gla</i>)	0.0030	0.0625	0.1837	0.0039	0.1600
<i>Microtus agrestis</i> (<i>M-agr</i>)	—	—	—	0.0977	—
<i>Microtus arvalis</i> (<i>M-arv</i>)	—	—	—	0.0039	—
Diversity, D	1.115	1.600	2.579	4.741	2.528
Evenness, E	0.558	0.800	0.860	0.677	0.843

Table 5. Habitat preferences (F_{ij}) of small mammal species in Uzhansky National Park and its vicinitiesТаблиця 5. Біотопна приуроченість (F_{ij}) дрібних ссавців в Ужанському парку та його околицях

Species	habitat, %	mixed forest	forest edge	windfall	meadow	shrubs
<i>Sorex araneus</i> (<i>S-ara</i>)	20.0	—	—	—	1.00	—
<i>Sorex minutus</i> (<i>S-min</i>)	20.0	—	—	—	1.00	—
<i>Apodemus agrarius</i> (<i>A-agr</i>)	60.0	—	—	0.10	0.45	0.78
<i>Sylvaeus tauricus</i> (<i>S-tau</i>)	100.0	0.57	0.20	-0.20	-0.84	-0.69
<i>Myodes glareolus</i> (<i>M-gla</i>)	100.0	-0.65	0.79	0.54	-0.45	0.59
<i>Microtus agrestis</i> (<i>M-agr</i>)	20.0	—	—	—	1.00	—
<i>Microtus arvalis</i> (<i>M-arv</i>)	20.0	—	—	—	1.00	—
Species having $F_{ij} > 0.5$	—	1	1	1	4	2

Obviously, the means of diversity indices are related not only to the species richness and abundance in each habitat but also to different habitat preferences of species. The latter largely affects the patterns of distribution and occurrence of species. The more uniform are the conditions in a habitat the smaller number of species and the lower diversity characterize this habitat, which also lead to ‘monotypization’ of taxa and expressive domination of only a couple of species.

The obtained census data allow conducting a preliminary estimation of habitat preferences of species under conditions of Uzhansky National Park, which provides the opportunity to determine those habitats and micromammal communities that deserve priority conservation attention in order to preserve diversity in the Park (Table 5).

Results indicate that the most eurytopic species in the studied area are *S. tauricus* and *M. glareolus*. Though both species occur in each type of habitat, they demonstrate different levels of preference. For instance, the yellow-necked field mouse prefers the most ‘mixed forest’ ($F_{ij} = 0.57$) and clearly avoids ‘meadow’ and stream bank ‘shrubs’. In Uzhansky Park and its vicinities, ‘forest edge’, ‘shrubs’, and cleared ‘windfall’ are habitats most preferred by the bank vole ($F_{ij} = 0.54–0.79$), while the striped field mouse largely prefers ‘shrubs’ ($F_{ij} = 0.78$). On the other hand, shrews and meadow voles (*Sorex* and *Microtus*) under conditions of Uzhansky National Park are stenotopic species occurring only in ‘meadow’ ($F_{ij} = 1.00$).

Revised checklist of small mammals of Uzhansky National Park

During our studies, we confirmed the presence of 7 species of micromammals in the fauna of Uzhansky Park. The field vole (*M. agrestis*) was recorded in the area for the first time.

Considering all previously reported reliable and confirmed records and observations of species, we aim to present the current taxonomic list of orders Soriciformes and Muriformes of the Park and its vicinities based on our results, previously published data and reports on observation of relatively large and easily recognizable species. Thus, the current checklist based on data from field studies and literature sources (Koval, Berkovych, 2019) includes 14 species, 4 of which belong to shrews and 10 represent the order of rodents. Most of the species have been regularly observed during general fauna monitoring since their first record, while the presence of two species included into the fauna checklist earlier (*M. minutus* and *T. tatricus*) is yet to be confirmed.

The revised checklist of species with their conservation categories according to the Red Book of Ukraine, Red Book of the Ukrainian Carpathians, Red List of IUCN and Annexes of the Bern Convention are presented in Table 6.

Conclusions

During field studied, the presence of 7 species of small mammals was revealed or confirmed in the territory of Uzhansky National Park and its vicinities, such as *S. araneus*, *S. minutus*, *A. agrarius*, *S. tauricus*, *M. glareolus*, *M. agrestis*, *M. arvalis*. The field vole was recorded in the area for the first time.

Table 6. The revised checklist of small mammals of Uzhansky National Park and conservation categories of species according to several red lists*

Таблиця 6. Поточний список дрібних ссавців Ужанського національного парку та охоронні категорії видів за декількома червоними списками

No.	Taxa	Last confirmed record	RBU	RBUC	IUCN	BC
SORICIFORMES (Insectivora)						
Soricidae Fischer, 1814						
1.	<i>Crocidura leucodon</i> (Hermann, 1780)	Koval, Berkovych, 2019	DD	—	LC	III
2.	<i>Sorex alpinus</i> Schinz, 1837	Koval, Berkovych, 2019	R	NT	NT	III
3.	<i>Sorex minutus</i> Linnaeus, 1766	our field studies, 2017	—	—	LC	III
4.	<i>Sorex araneus</i> Linnaeus, 1758	our field studies, 2017	—	—	LC	III
MURIFORMES (Rodentia)						
Sciuridae Fischer, 1817						
5.	<i>Sciurus vulgaris</i> Linnaeus, 1758	observed during field studies, 2019	—	—	LC	III
Gliridae Muirhead, 1819						
6.	<i>Glis glis</i> (Linnaeus, 1766)	Koval, Berkovych, 2019	—	—	LC	III
7.	<i>Muscardinus avellanarius</i> (L., 1758)	Koval, Berkovych, 2019	—	—	LC	III
8.	<i>Dryomys nitedula</i> (Pallas, 1779)	observed by N. Koval, 2017	—	VU	LC	III
Castoridae Hemprich, 1820						
9.	<i>Castor fiber</i> Linnaeus, 1758	observed by N. Koval, 2019	—	LC	LC	III
Muridae Illiger, 1811						
10.	<i>Apodemus agrarius</i> (Pallas, 1771)	our field studies, 2017	—	—	LC	—
11.	<i>Sylvaemus tauricus</i> (Pallas, 1811)	our field studies, 2017	—	—	LC	—
Arvicolidae Gray, 1821						
12.	<i>Myodes glareolus</i> (Schreber, 1780)	our field studies, 2017	—	—	LC	—
13.	<i>Microtus agrestis</i> (Linnaeus, 1761)	our field studies, 2017	—	—	LC	—
14.	<i>Microtus arvalis</i> (Pallas, 1779)	our field studies, 2017	—	—	LC	—

* Note: RBU — Red Book of Ukraine (Akimov, 2009), RBUC — Red Book of the Ukrainian Carpathians (Mateshko, Potish, 2011), BC — Bern Convention, IUCN — Red List of the International Union for Conservation of Nature. DD — data deficient, R — rare, NT — near threatened, VU — vulnerable, LC — least concern.

In total, 101 specimens were trapped, among which the portion of females was 58.4 %, while the portion of males was 41.6 %. Among the studied habitats, the highest species richness was revealed in ‘meadow’, where all 7 species occurred. ‘Mixed forest’ and ‘forest edge’ were characterized by the highest abundance but the least number of species.

By the level of relative abundance, only one species is considered abundant in the territory (*S. tauricus*), two species are common (*A. agrarius* and *M. glareolus*), two species are frequent (*S. araneus* and *M. agrestis*), while another two occur occasionally (*S. minutus* and *M. arvalis*).

According to the Shannon and Simpson diversity indices, the highest species diversity was revealed in ‘meadow’ and ‘shrubs’, while the lowest in ‘mixed forest’ and ‘forest edge’.

By the level of habitat preferences, *S. tauricus* and *M. glareolus* are the most eurytopic species, while shrews and meadow voles (*Sorex* and *Microtus*) display stenotopy in the studied area. Habitats maintaining higher levels of diversity and of habitat preferences of species deserve prior conservation attention.

The current revised checklist of shrews and rodents of Uzhansky National Park based on data from field studies and literature sources includes 14 species. The presence of two species — *T. tauricus* and *M. minutus* — previously included into the fauna list of the Park based on literature sources (Kricsfalusy et al., 2001) is yet to be confirmed by actual records.

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