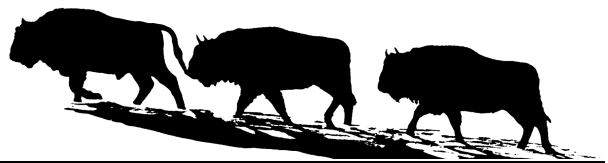


РЕГІОНАЛЬНІ АСПЕКТИ
ФЛОРИСТИЧНИХ І ФАУНІСТИЧНИХ ДОСЛІДЖЕНЬ

REGIONAL ASPECTS
OF FLORISTIC AND FAUNISTIC RESEARCH



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SPATIAL DISTRIBUTION OF THE MICROMAMMAL FAUNA IN THE UKRAINIAN CARPATHIANS

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Introduction

The Carpathian mountain range is a unique biogeographic phenomenon and an isolation factor of Pannonia and the Balkans from the East European Plain. In the same time, it is a specific ecocorridor for distribution of montane-boreal species to East and South [10; 21; 32]. The Ukrainian part of the Carpathians being situated in the NE part of the Carpathian mountain range is a connective band between the N and S parts of this mountain system. This gives rise to communities with unique species composition. The peculiarities of the geography, climate and vegetation not only on various heights, but also in differently situated megaslopes lead to nascence of faunal assemblages with special taxonomic structure. It is proved by the specifics and even more by the differences between the species composition of the mammal fauna from the side of Zakarpattia and Prykarpattia and Bukovina.

Amassed during the last century materials allow to state about a quite high level of investigation of the region's mammal fauna. K. Tatarynov's work «Mammals of the Western Regions of Ukraine» [31] is the first systemized data on the region's mammal fauna. Only separate groups of mammals (e. g., bats – Yu. Krochko; game mammals – I. Turianyn; insectivores – N. Kuruts; rodents – O. Korchynsky) and territorial parts of the region (Carpathian NNP and Carpathian BR – M. Rudyshyn, O. Kyseliuk, V. Pokynchereda, Ya. Dovganych, I. Zagorodniuk; Skole Beskids – N. Stetsula, B. Khoietsky) concerned by later fauna investigations.

Nevertheless, some groups of mammals remain poorly investigated and even well researched groups should be revised periodically. Besides, there are significant changes in the region's ecosystems, also in the abundance and distribution of a number of species (rare, synanthropic, alien). Fundamental research on the distribution of mammal species and composition of faunal assemblages in the entire region of the Ukrainian Carpathians almost were not held during the past 20 years. Consequently, now there is a lack of data needed in evaluating the mammal fauna's current state and its long-term changes, as well as in solving of the region's biodiversity problems.

Undoubtedly, the distribution of animals is closely related to the vegetation features of each region. Hence, the landscape features and floristic zonation of the investigated area should be considered in its dividing into different spatial units with the aim to study the species distribution and faunal assemblages' composition. One of the most powerful factors of the fauna differentiation in the space is the expressiveness of altitudinal vegetation zones. It determines the prevalence of the majority of habitat types, except only certain variants of riverine locations. Such differentiation identified and more or less thoroughly investigated in case of many groups of animals, not only vertebrates [5; 28; 29; 31; 34], but also invertebrates [22; 23; 27]. Among the brightest objects of studying of the fauna's spatial distribution are the mammals, especially small mammals that have repeatedly been subjected to analysis [1; 9; 16; 17].

The present work aims to initiate a new phase of investigation of the mammals' distribution in the Ukrainian Carpathians region in various facets of spatial distribution. It is also intended to give a preliminary analysis of distribution of the most numerous group of mammals, namely the small mammals or micromammals. Another task was to determine the peculiarities of the taxonomic structure of montane micromammal assemblage.

Methodological remarks

The term «micromammal fauna» is usually denotes the part of fauna that includes small-sized mammals. It is generally defined as an accounting group of small mammals, the taxonomic composition of which depends on regional peculiarities but mostly it represents the family Soricidae, superfamily Muroidea, and sometimes also includes ground squirrels and small mustelids [11].

Since this work refers to the taxonomic analysis of faunal assemblages, in particular montane ones, we consider it necessary to modify the term «micromammals» to taxonomic scope and expand it to all the following orders: Leporiformes (Lagomorpha), Muriformes (Rodentia) and Soriciformes (Insectivora auct.).

The mammal fauna's analysis is based on the annotated list of mammals of the Eastern Carpathians published by us earlier [13], and also on materials contained in the work «Mammals of the Transcarpathian Region (Ukraine)» [2] with some refinements, according to the recent mammals' taxonomy survey of Ukraine [12].

Investigating the species distribution, we introduced the term of «spatial units». They are separate parts of the studied region, mainly selected according to its physiographical and floristic features. Therefore, note that the selected by us spatial units should not be equated with the units of biogeographic division (neither geobotanical nor zoogeographical). For instance, Ya. Didukh and Yu. Sheliakh-Sosonko divide the Ukrainian Carpathians into two geobotanical districts [7]: Verkhovynsko-Beskidskyi (with larch and spruce forests, mountain meadows, fragments of pedunculate oak, sessile oak and beech forests) and Marmarosko-Chornohirsko-Svydovetskyi (beech, spruce, larch and oak forests, subalpine and alpine vegetation). According to the authors, the boundary of these districts runs along the rivers Rika and Svicha. The differences between the districts is primarily the following: the latter includes highlands with subalpine and alpine zones, while in the Verkhovynsko-Beskidskyi district the subalpine zone occurs only on certain tops and covers much smaller area. Another author, L. Tasenkevich developed the full regional phytogeographical division of the Carpathians [30]; however, this author's system is too complex to be used in faunal research.

Thus, the proposed by us division of the region based on a certain combination of its zoogeographical [33], geobotanical [4] and physiographical [20] division.

Results and their Discussion

General ideas on the region's mammal fauna

As of today, there are 82 mammal species known in the fauna of the Ukrainian Carpathians. Among them 78 referred in the survey from 1997 [13] and other three species such as the European beaver, the raccoon dog [26] and the golden jackal [25] appeared in the last few years. Besides, not long ago the garden dormouse was also mentioned for the region, but based on an old collection specimen [6; 15], so this species we consider in «phantom» status.

Thus, the mammal fauna of the Ukrainian part of the Carpathians

includes 82 species that represent 6 orders. The group's taxonomic richness showed in table 1. We can conclude that the highest taxonomic richness has the order Muriformes represented by 28 species (34 % of all mammal species). The second place takes the order Vespertilioniformes (22 species, 27 %) and the third – order Caniformes (17 species, 21 %). Order Leporiformes is represented by a single species.

Volume of the group of micromammals

The group of micromammals includes 38 species. Apart from bats as a highly specialized and also rich on species composition group of mammals, the micromammals are dominant (63 %) among all mammals of the region's fauna.

The micromammals are common in all altitudinal zones and they are important components of montane ecosystems as well. They are tied to the system of existing habitats tougher than large- and

Table 1

Taxonomic richness of class Mammalia in the Ukrainian Carpathians region

Orders	Families	Genera	Species
Leporiformes (Lagomorpha auct.)	1	1	1
Muriformes (Rodentia auct.)	8	21	28
Soriciformes (Soricimorpha auct., seu Insectivora s. l.)	3	5	9
Vespertilioniformes (Chiroptera auct.)	3	9	22
Caniformes (Carnivora auct.)	4	11	17
Cerviformes (Artiodactyla auct.)	3	4	5
Total	22	51	82

medium-sized species and their distribution is often limited only within the same group of habitat. Being determined by features of vegetation, hydrography and soils, such biotopes significantly differ in the space, particularly in vertical section, which affects the distribution of small mammals. For example, increased solar radiation, high air ionization, abrupt changes in moisture and temperature, low pressure and low oxygen partial pressure are the main climatic factors to influence on the animal's organism in mountain biotopes [3].

Spatial units

Patterns of the animals' distribution in the space defined by the variety of conditions of the habitat that are very different in both horizontal (according to geographical latitude and longitude) and vertical (according to altitudinal zonation in mountain areas) dimensions. Consequently, the analysis of fauna and faunal assemblages should be conducted accordingly to those spatial differences, because they determine the set of specific for the region species and the composition of their communities.

It is known that each faunal assemblage is a totality of species formed in the same period of time on the same territory in terms of the same landscape. Therefore, the assemblage members are characterized by common origin center and history, basic environmental needs and biocenotic relations as well [19]. Thus, obviously the most interest deals with those faunal assemblages that define the uniqueness of the region's fauna. In case of the Ukrainian Carpathians among the existing communities the boreal and subalpine ones are the most unique.

For this reason to determine the taxonomic composition of the micromammals' montane assemblage basing on the entire amount of available data the preliminary assessment of the species distribution was conducted considering the various ecological and geographical conditions and landscapes, in particular the floristic features of the northern and southern megaslopes. Seven spatial units were determined:

«LOW» – the lowland part of Zakarpattia and partly the valleys of large rivers that have similar to lowland physiographic and floristic conditions;

«PDM» – zone of piedmont deciduous forests (oak, oak-hornbeam) from the side of Zakarpattia;

«MIX» – beech, coniferous and mixed forests of the southern megaslope;

«KRU» – the upper timberline and zone of krummholz-type vegetation;

«ALP» – the subalpine zone;

«CON» – coniferous forests of the northern megaslope (from the side of Prykarpattia);

«CCA» – piedmont parts of Prykarpattia and Bukovina.

The small mammals' spatial distribution

Results of the analysis of small mammal species distribution showed in table 2. The symbols used for different spatial units are the following:

+++ – very common and abundant species;

++ – common and comparatively abundant species;

+ – species occurs;

(+) – species occurs on and off;

* – species with very low abundance or its existence needs to be confirmed;

– – species does not occur or uncommon;

? – no reliable information on the species presence.

During the analysis of the species distribution within different spatial units there was introduced an «observing point» (Z) – the sum of the number of spatial units within which the species occurs.

Analyzing the prevalence of species within different spatial units, the occurrence point draws attention. Among 38 species of small mammals, there are 12 relatively widespread ($Z=5-6$), while 4 occur in all spatial units ($Z=7$): *A. agrarius* (note, that according to the literature [13; 18] the species riches the subalpine zone only within Borzhava polonyna*), *T. subterraneus*, *T. europaea*, *S. minutus*.

* «Local name for a segment of the upper belt of the Carpathians and various mountain ranges on the Balkan Peninsula that has a moderately hilly surface with a flat top and is covered by mountain meadows. A *polonyna* is usually used as a summer mountain pasture» (<http://goo.gl/6i6AZg>).

In addition, there are 4 unique species ($Z=1$) for certain spatial units: *S. citellus* (common only in the lowland part of Zakarpattia), *S. graecus* (known only from Bukovina), *E. quercinus* (phantom species referred for Zakarpattia).

Table 2

The small mammals' distribution in basic spatial units determined for the Ukrainian Carpathians

Species	LOW	PDM	MIX	KRU	ALP	CON	CCA	Z
Leporidae Fischer, 1817								
<i>Lepus europaeus</i> Pallas, 1778	++	+	+	+	-	+	++	6
Sciuridae Fischer, 1817								
<i>Sciurus vulgaris</i> Linnaeus, 1758	+	++	+	(+)	-	+	++	6
<i>Spermophilus citellus</i> (Linnaeus, 1766)	+	-	-	-	-	-	-	1
<i>Spermophilus odessanus</i> Nordmann, 1842	-	-	-	-	-	-	+	1
Gliridae Muirhead, 1819								
<i>Glis glis</i> (Linnaeus, 1766)	+	++	++	+	-	+	+	6
<i>Muscardinus avellanarius</i> (Linnaeus, 1758)	+	+	+	++	?	+	+	6
<i>Dryomys nitedula</i> (Pallas, 1779)	(+)	+	+	+	-	+	+	6
<i>Eliomys quercinus</i> (Linnaeus, 1766)	+	-	-	-	-	-	-	1
Castoridae Hemprich, 1820								
<i>Castor fiber</i> Linnaeus, 1758	++	+	*	-	-	-	?	2
Sicistidae Allen, 1901								
<i>Sicista betulina</i> (Pallas, 1779)	-	-	(+)	+	++	+	-	4
Spalacidae Gray, 1821								
<i>Spalax graecus</i> Nehring, 1898	-	-	-	-	-	-	+	1
Muridae Illiger, 1811								
<i>Micromys minutus</i> (Pallas, 1771)	+	(+)	+	+	-	+	+	6
<i>Apodemus agrarius</i> (Pallas, 1771)	+	+	+	+	(+)	+	++	7
<i>Sylvaemus tauricus</i> (Pallas, 1811)	+	+++	+++	+	-	++	++	6
<i>Sylvaemus sylvaticus</i> (Linnaeus, 1758)	++	+	(+)	-	-	+	+	5
<i>Sylvaemus uralensis</i> (Pallas, 1811)	+	(+)	-	-	+	-	+	4
<i>Mus musculus</i> Linnaeus, 1758	+++	+	+	-	-	-	+	4
<i>Mus spicilegus</i> Petenyi, 1882	(+)	-	-	-	-	-	(+)	2
<i>Rattus norvegicus</i> (Berkenhout, 1769)	++	+	+	-	-	-	+	4
Cricetidae Fischer, 1817								
<i>Cricetus cricetus</i> (Linnaeus, 1758)	++	+	-	-	-	-	+	3
Arvicolidae Gray, 1821								
<i>Ondatra zibethicus</i> (Linnaeus, 1766)	++	+	(+)	-	-	-	+	4
<i>Myodes glareolus</i> (Schreber, 1780)	+	+++	+++	++	-	-	+	5
<i>Chionomys nivalis</i> (Martins, 1842)	-	-	-	+	++	-	-	2
<i>Arvicola amphibius</i> (Linnaeus, 1758)	++	(+)	-	-	-	-	+	3
<i>Arvicola scherman</i> (Shaw, 1801)	-	+	(+)	+	++	+	-	5
<i>Terricola subterraneus</i> (Selys-Long., 1830)	+	+	+	++	+	+	+	7
<i>Terricola tatricus</i> (Kratochvil, 1952)	-	+	+	(+)	-	+	-	4
<i>Microtus agrestis</i> (Linnaeus, 1761)	*	*	(+)	++	+	+	*	4
<i>Microtus arvalis</i> (Pallas, 1779)	+++	++	+	-	-	-	-	3
Erinaceidae Fischer, 1814								
<i>Erinaceus roumanicus</i> Barrett-Hamilton, 1900	++	+	+	-	-	-	+	4
Talpidae Fischer, 1814								
<i>Talpa europaea</i> Linnaeus, 1758	+	+	++	+	(+)	++	+	7
Soricidae Fischer, 1814								
<i>Crociodura suaveolens</i> (Pallas, 1811)	++	+	+	-	-	-	+	4
<i>Crociodura leucodon</i> (Hermann, 1780)	+	*	-	-	-	-	+	2
<i>Neomys fodiens</i> (Pallas, 1771)	+	+	+	-	-	-	+	4
<i>Neomys anomalus</i> Cabrera, 1907	-	+	+	+	+	+	-	5
<i>Sorex alpinus</i> Schinz, 1837	-	+	+	+	-	+	-	4
<i>Sorex minutus</i> Linnaeus, 1766	+	+	+	+	(+)	+	+	7
<i>Sorex araneus</i> Linnaeus, 1758	+	++	++	++	-	++	+	6

Note. There are three different color forms of *Sciurus vulgaris* common in the region of the Ukrainian Carpathians: red and dark in the lowland and piedmont parts, and black in highlands [14].

To obtain information on taxonomic structure of micromammal assemblages within different spatial units (particularly in altitudinal zones) it is worth to pay attention to the variability of indexes of

The indexes of species richness of small mammals in different spatial units of the Ukrainian Carpathians

Index of species richness	Spatial units						
	LOW	PDM	MIX	KRU	ALP	CON	CCA
Total species	30	31	28	20	11	19	29
Species with index «+++»	2	2	2	0	0	0	0
Species with index «++»	9	4	3	5	3	3	4
Total «+++» and «++»	11	6	5	5	3	3	4

the communities' species richness in general, and on the other hand on the differences between them according to presence of dominant and abundant species (table 3).

According to data showed in table 3, we

can conclude that with increasing the altitude the number of species in the assemblages' composition gradually decreases (fig. 1). Therefore, the most number of species characterizes the lowland and piedmont biotopes of Zakarpattia and Prykarpattia. The number of species decreases sharply at the upper timberline, particularly in the transition zone between the mixed and coniferous forests and zone of krummholz-type vegetation ($\Delta=8$), and especially between the latter and the subalpine zone ($\Delta=9$).

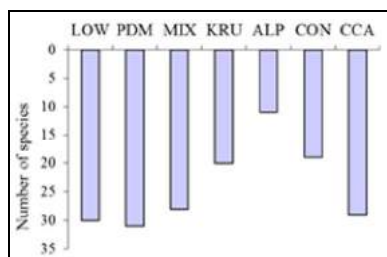


Fig. 1. Number of small mammal species in different spatial units of the Ukrainian Carpathians.

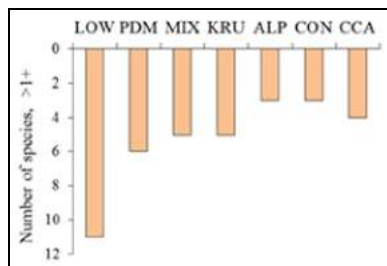


Fig. 2. Number of abundant small mammal species within different spatial units.

In addition to the general number of species, it is also important to pay attention to their distribution in different spatial units taking into account the relative abundance. To clarify this issue we can use the symbols proposed in table 2. Hence, there are two species with high abundance (3+) in three spatial units of the southern megaslope, from the lowland part to the upper timberline (LOW–MIX). Those species in LOW are the following: the synanthropic *M. musculus* (wild populations of this species have low abundance, but in the lowland anthropized biotopes and human settlements are situated more «closely» and they have much territory than in mountain areas) and a typical species in fields, *M. arvalis*. In PDM and MIX the species *M. glareolus* and *S. tauricus* have the highest abundance, however in the literature mentioned that the former species is more abundant in mixed and coniferous forests (MIX), while in deciduous forests (PDM) *S. tauricus* predominates *M. glareolus* [24].

If add the relatively less abundant but typical in certain spatial units species (2+) to the dominant ones we obtain a general picture of the core of each micromammal assemblage within different spatial units of the Ukrainian Carpathians (fig. 2).

The figure 2 shows that the highest number of typical species with relatively high abundance is observed in the lowland micromammal assemblage (11 species), but already in the next assemblage (piedmont) this number decreases

almost twice ($\Delta=5$). Zones of mixed forests (MIX), krummholz-type vegetation (KRU) and the units of the northern megaslope (CON, CCA) are characterized by almost the same number of dominants (3–5). The highland turned out as the poorest, where only three species have relatively high abundance.

Peculiarities of the montane micromammal assemblage

As it was shown above, there is a significant differentiation of micromammal assemblages in spatial-altitudinal units in conditions of the Ukrainian Carpathians. According to our estimates, the

montane micromammal assemblage includes 11 species that may occur in the subalpine and alpine zones. Among them 7 species are common for these locations, including 6 species of Muriformes (*S. betulina*, *S. uralensis*, *C. nivalis*, *A. scherman*, *T. subterraneus*, *M. agrestis*) and one species of Soriciformes (*N. anomalus*).

From this list, only three species of mouse-like rodents (*C. nivalis*, *S. betulina*, *A. scherman*) have relatively high abundance in the composition of highland assemblage and in the same time make its core. Other three species (*A. agrarius*, *T. europaea*, *S. minutus*) may occur in the composition of montane assemblage, yet they are spread only within certain macroslopes or they are uncommon with low abundance. Another feature of the montane small mammal assemblage is the absence of representatives of six families, namely Leporidae, Sciuridae, Castoridae, Spalacidae, Cricetidae and Erinaceidae.

All of these peculiarities of the montane assemblage are obviously connected not only with smaller capacity and less variety of both landscape and habitat conditions in highlands, but also with the principle of alternative diversity [8]. In the mountains, the latter is reflected in increasing the number of monotypic higher taxa and decreasing of the number of species in gradient from piedmont conditions to the highland zones [9].

Conclusions

1. The group of micromammals in the region of the Ukrainian Carpathians includes 38 species of three orders. It was revealed that the number of species in certain spatial units significantly decreases with increasing the altitude and only 12 species are relatively widespread.

2. Among small mammals, only three species are closely related to certain spatial units of the region: *Spermophilus citellus* occurs only in the lowland part of Zakarpattia, *S. odessanus* occurs only in Prykarpattia and *Spalax graecus* habits only in Bukovina. Unlike them, most species enter into mountains in their different parts to a considerable height.

3. The montane micromammal assemblage of the Ukrainian Carpathians region includes 7 species. The assemblage's core includes three species: *Chionomys nivalis*, *Sicista betulina*, *Arvicola scherman*. Another peculiarity of this assemblage is the absence of representatives of six families, namely Leporidae, Sciuridae, Castoridae, Spalacidae, Cricetidae and Erinaceidae.

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АДВЕНТИВНА ФРАКЦІЯ ФЛОРИ ЧИВЧИНО-ГРИНЯВСЬКИХ ГІР

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Чивчино-Гринявські гори як окремі флористичний район виділив В. І. Чопик [4; 5]. Вони розташовані в південній частині північно-східного макросхилу Українських Карпат, охоплюючи витоки річок Сірет і Сучава, басейн Білого Черемошу, значну частину басейну Чорного Черемошу і межують із Прикарпаттям та Чорногорою. Нами на основі показників коефіцієнтів подібності/відмінності між видовим складом флор, наявності великої групи диференційних видів, порівняння спектрів провідних родин і родів, властивого їм ендемізму, ступеня його вираженості доведено правомірність розглядати Чивчинські гори, Гринявські гори і Покутсько-Буковинські Карпати в ранзі окремих флористичних районів Українських Карпат [6] (рисунок).