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Barkasi Z., Zagorodniuk I.

THE TAXONOMY OF RODENTS OF THE EASTERN CARPATHIANS

The present paper deals with information on current composition of the rodent fauna in the Eastern Carpathians and adjacent lowland and piedmont areas in the light of modern views on the taxonomy and nomenclature of this group of mammals. The taxonomic richness of rodents (order Muriformes, seu Rodentia auct.) in the discussed region is shown. The presence and conservation statuses of species are indicated. The annotated list of species is presented with special attention on peculiarities of their distribution and current evaluations of population density. In addition to scientific names, the currently accepted Ukrainian and English names of taxonomic groups are given as well. The rating of the rodent families according to the rarity index was analyzed to determine the most vulnerable taxonomic groups.

Key words: rodents, the Eastern Carpathians, taxonomy, biodiversity.

According to taxonomic composition, the order of rodents is the richest systematic group of mammals. They have a considerable role in functioning of natural ecosystems and in evaluations of the mammalian fauna's diversity. The rodents are important components of the Carpathians' biodiversity and they occur in all types of ecosystems in all altitudinal zones. In most localities rodents are not only quite abundant, but also constant members of biological communities because they do not migrate and the vast majority of them (except hamsters, dormice and birch mice) have year-round activity.

The Carpathian rodents have several life forms such as subterranean, burrowing, dendrophilous and semi-aquatic. Among them we can find clearly exanthropic and synanthropic species. Many rodent species are common in the lowland and intermountain valleys, although the montane species form the unique part of the local fauna. The rodents are represented in the Eastern Carpathians by typical both aborigine and alien species. Species listed in several red data bases such as the Bern Convention on the Conservation of European Wildlife and Natural Habitats [65], Red Data Book of Ukraine [76], Red Data Book of the Carpathians [87] and the Red Data Book of the Ukrainian Carpathians [77] represent a valuable part of the Carpathian rodent fauna.

The very first summation concerning the mammalian fauna of the Eastern Carpathians [64] now mainly has historical importance. There have been significant changes in views on the Eastern European mammal fauna's taxonomy since its publication. Concepts of zoologist on the Eastern Carpathian mammal fauna's composition have undergone considerable changes as well. Such circumstances required a compilation of a mammal fauna checklist, which was published in 1997 as "Theriofauna of the Carpathian Biosphere Reserve" [27]. The checklist met the concepts on the systematics and fauna composition of the region generally accepted at that time and it was based on the taxonomic scheme presented by Pavlinov & Rossolimo [50] with appropriate adjustments described in particular in some of our original contributions [15, 27, 34, 39, 81].

Nonetheless, during the last two decades that have elapsed since the checklist's publication views on the species composition of several taxonomic groups of mammals has slightly changed. It requires revising and improving of those groups' checklists according to modern and real state of the mammalian fauna.

The order of rodents (Ordo Muriformes, seu Rodentia auct.) is one of those groups that need revising. The main goal of the present work is to analyze the modern taxonomic richness of rodents in the region of the Eastern Carpathians and to arrange an annotated list of species.

Methodological remarks

Geographical reference. The division of the Carpathian mountain system into several regions is quite diverse and it depends on the purpose of separate research, so there is no consolidated view on the system of the Carpathian's division. Despite the fact that various division schemes are similar in general, they often differ essentially in details, so the established "limits" of separate regions remain conditional.

Therefore, in the present work the authors under the name of "*Eastern Carpathians*" understand the part of the Carpathian Mountain situated mostly on the territory of Ukraine and Romania, and partly on the territory of Slovakia and Poland (fig. 1).

According to geomorphological data, practically all schemes divide the Eastern Carpathians into two large parts: 1) the Outer Eastern Carpathians (flysch belt, zone 4 on fig. 1); 2) the Inner Eastern Carpathians (volcano crystal belt, zone 5 on fig. 1). There are also some detailed divisions of the Eastern Carpathians (e.g. [90, 93]).

The authors accept the following division of the region: 1) the *Northeastern Carpathians* (from the Topľa river's valley in Slovakia to Máramaros in the border region of Ukraine and Romania): • Lower Beskids, • Eastern Beskids (or Wooded Carpathians), • Vihorlat–Gutin Volcanic Ridge; 2) the *Eastern Carpathians* [in strict meaning] (from Máramaros to the Braşov Depression and the Prahova river's valley): • Máramaros–Bucovina Carpathians, • Moldavian–Transylvanian Carpathians, • Carpathian curve.

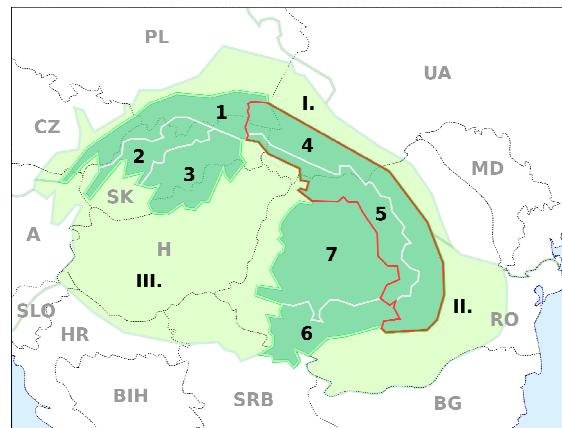


Fig. 1. The general division of the Carpathian Basin.

The Eastern Carpathians outlined in red.

1. Outer Western Carpathians,
2. Central Western Carpathians,
3. Inner Western Carpathians,
4. Outer Eastern Carpathians, 5. Inner Eastern Carpathians,
6. Southern Carpathians, 7. Western Romanian Mountains and Transylvanian Plateau.

- I. Subcarpathian depressions,
- II. Romanian Lowlands,
- III. Pannonian Basin [86].

"*The region of the Eastern Carpathians*" in the understanding of the authors includes not only the mountain ridges named above, but also the adjacent lowland and piedmont areas. The reason for this is that many rodent species common in those lowland regions along the river valleys or other special corridors (e.g., roads, webs of human settlements, electric power lines and gas pipelines) get into the piedmonts or deep into the mountains and in fact become members of local communities. Examples could be the shrews, ground squirrels, hamsters, common voles etc.

Taxonomical basis. In the basis of the presented overview is the "Taxonomy of mammals of the Eastern Carpathian region" checklist published in the work "Theriofauna of the Carpathian Biosphere Reserve" [27]. The checklist was amended according to later fauna revisions published by Ukrainian and foreign zoologists.

Nomenclature. In the presented fauna checklist, the scientific, English and Ukrainian names of species are indicated, as well as common synonyms, also comments on the taxonomy and presence of the species in the fauna of the Eastern Carpathian region. Available to the authors special publications with descriptions of a species, genus or family are also cited. For reasons of consistency and harmonization, the systematic order, scientific and Ukrainian names of taxa are agreed with the "Taxonomy and nomenclature of mammals of Ukraine" [39], a fundamental publication on this issue. The English names of species are agreed with the database of the European Mammal Society [96].

Species statuses. In the annotated list of species we use two main species statuses: 1) the presence status (PS) indicated according to ACFOR categories (+ phantom): "abundant", "common", "frequent", "occasional", "rare", "phantom"; 2) the conservation status (CS) of species agreed with the publication "Fauna of Ukraine: conservation categories" [5]; in particular the authors indicate the conservation status according to the three following lists: the IUCN Red List of Threatened Species (IUCN), Bern Convention on the Conservation of European Wildlife and Natural Habitats (BC, Appendix II and III) and the Red Data Book of Ukraine (RDBU).

It is noticeable that RDBU categories slightly differ from those in the red list of IUCN. Therefore, the translation of RDBU categories into English is based on the harmonization published in [33]. Thus, the RDBU categories used in this work are the following: "EN" – endangered (зникаючий); "VU" – vulnerable (вразливий); "NT" – near threatened (рідкісний); "LC" – least concern (неоцінений); "DD" – data deficient (недостатньо відомий). The used here IUCN categories are the following: "VU" – vulnerable; "NT" – near threatened; "LC" – least concern; "DD" – data deficient.

Important to mention that because of huge amount of literature more attention was paid on publications of last decades and mainly on research carried out in the Ukrainian part of the Eastern Carpathians.

The taxonomy of Eastern Carpathian rodents

The order Muriformes (Rodentia auct.) is the most abundant order of mammals represented in the region of the Eastern Carpathians by 32 species of eight families (tab. 1).

There were described sibling species among a number of groups and views on the taxonomy and nomenclature of many "common" species have changed as well during the last few years. Investigations of morphologically close rodent species of the Eastern Carpathians concerned mainly the following groups: "wood mice" ("*Apodemus sylvaticus*" auct.), "house mice" ("*Mus musculus*" auct.), "common pine voles" ("*Pitymys subterraneus*" auct.) and "water voles" ("*Arvicola terrestris*" auct.) [21, 32, 35]. As it turned out later, each of these former species are represented actually by two sibling species in the Carpathian fauna. In the same time, a number of former "big" species, which were also divided into 2-3 "small" species and proved to be represented in the region's fauna only by the nominative forms that allowed to keep taxonomy and nomenclature unchanged. This concerns "birch mice" ("*Sicista subtilis* s. l. = s. str.) and "common voles" ("*Microtus arvalis* s. l. = s. str.). In some other cases, changes have affected the nomenclature but not the number of recorded in the region's fauna species (for instance, *Spermophilus suslicus* → *odessanus*, *Sylvaemus flavicollis* → *tauricus*, *microps* → *uralensis*).

Table 1

**The taxonomic composition of the order Muriformes
in the Eastern Carpathian region**

Family	Genus	Species
Sciuromorpha Sciuridae Fischer, 1817	<i>Sciurus</i> Linnaeus, 1758 <i>Spermophilus</i> Cuvier, 1825	<i>vulgaris</i> Linnaeus, 1758 <i>citellus</i> (Linnaeus, 1766) <i>odessanus</i> Nordmann, 1842
Gliridae Muirhead, 1819	<i>Marmota</i> Blumenbach, 1779 <i>Glis</i> Brisson, 1762 <i>Muscardinus</i> Kaup, 1829 <i>Dryomys</i> Thomas, 1906 <i>Eliomys</i> Wagner, 1843	<i>marmota</i> (Linnaeus, 1758) <i>glis</i> (Linnaeus, 1766) <i>avellanarius</i> (Linnaeus, 1758) <i>nitedula</i> (Pallas, 1779) <i>quercinus</i> (Linnaeus, 1766)
Castorimorpha Castoridae Hemprich, 1820	<i>Castor</i> Linnaeus, 1758	<i>fiber</i> Linnaeus, 1758
Murimorpha Sicistidae Allen, 1901	<i>Sicista</i> Gray, 1829	<i>betulina</i> (Pallas, 1779) <i>loriger</i> (Nathusius, 1840)
Spalacidae Gray, 1821	<i>Spalax</i> Gueldenstaedt, 1770 <i>Nannospalax</i> Palmer, 1903	<i>graeacus</i> Nehring, 1898 <i>leucodon</i> (Nordmann, 1840)
Muridae Illiger, 1811	<i>Micromys</i> Dehne, 1841 <i>Apodemus</i> Kaup, 1829 <i>Sylvaemus</i> Ognev, 1924	<i>minutus</i> (Pallas, 1771) <i>agrarius</i> (Pallas, 1771) <i>tauricus</i> (Pallas, 1811) <i>sylvaticus</i> (Linnaeus, 1758) <i>uralensis</i> (Pallas, 1811)
Cricetidae Fischer, 1817 Arvicolidae Gray, 1821	<i>Mus</i> Linnaeus, 1758 <i>Rattus</i> Fischer, 1803 <i>Cricetus</i> Leske, 1779 <i>Ondatra</i> Link, 1795 <i>Myodes</i> Pallas, 1811 <i>Chionomys</i> Miller, 1908 <i>Arvicola</i> Lacépède, 1799 <i>Terricola</i> Fatio, 1867 <i>Microtus</i> Schrank, 1789	<i>musculus</i> Linnaeus, 1758 <i>spicilegus</i> Petenyi, 1882 <i>norvegicus</i> (Berkenhout, 1769) <i>cricetus</i> (Linnaeus, 1758) <i>zibethicus</i> (Linnaeus, 1766) <i>glareolus</i> (Schreber, 1780) <i>nivalis</i> (Martins, 1842) <i>amphibius</i> (Linnaeus, 1758) <i>scherman</i> (Shaw, 1801) <i>subterraneus</i> (Sélys-Long., 1836) <i>tatricus</i> (Kratochvil, 1952) <i>agrestis</i> (Linnaeus, 1761) <i>arvalis</i> (Pallas, 1779) <i>levis</i> Miller, 1908
Total	23 genera	32 species

Quite a few publications were dedicated to the taxonomic revision of Carpathian rodents, including special contributions (e.g. [11, 12, 16, 40-44]) and also surveys (e.g. [2, 27, 47]).

Non-native species. The present checklist includes all species that regularly present in the region during at least one season (i.e. including synanthropic species, which in summertime occupy natural or semi-natural habitats). This limits the added below fauna checklist by typical natural inhabitants of the studied area. Although humans, dogs, horses,

cats, ships etc. occur within natural and sometimes within protected ecosystems as well for a long time and significantly affect them are not considered. However, it does not mean the authors completely neglected by the adventive part of fauna – the appropriate sections of this review include data on distribution and abundance of *Mus*, *Rattus*, *Ondatra* etc. because they are regularly recorded as part of natural or conditionally natural communities.

Suborder 1. Sciuromorpha (вивірковиді)

Family Sciuridae Fischer, 1817 (squirrels, вивіркові)

Only the red squirrel is a typical species in the Carpathians, while the ground squirrels or sousliks are common mainly in the piedmonts. Numerous propositions and attempts on the alpine marmot's reintroduction in the Ukrainian part of the Carpathians were unsuccessful [8, 9, 75].

Sciurus vulgaris Linnaeus, 1758 (red squirrel, вивірка звичайна) – a common species in the region with a quite high variability¹. The species has three color phases²: red, black and dark. The taxonomic status of these phases is quite controversial and needs detailed further research. In particular, the black phase of the squirrel is considered to be the subspecies *S. v. carpathicus* Pietruski, 1853 [41], which is an endemic form in the region [28]. On the other hand, the dark phase is often equated with the subspecies *S. v. fuscoater* Altmann, 1855, while the red phase with *S. v. vulgaris*. Nevertheless, such identification of color phases as separate subspecies was made based on their spatial (in particular, altitudinal) distribution, yet craniometric differences between these forms were not revealed [114]. Summing it all up, we stand behind the view that the squirrel is represented in the region by a Carpathian subspecies *S. v. carpathicus* characterized by high variability of fur coloration. Besides, genetic analyses suggest the absence of breeding isolation and a constant gene exchange between the black and red phases [3].

PS: *common*; CS: IUCN – *LC*.

Spermophilus citellus (Linnaeus, 1766) (European souslik, ховрах європейський) – during the last half-century the species has become rare in many European countries and since the late 1980s a number of attempts on its reintroduction have been made [101]. Such actions have had success in some countries of Central Europe, in particular in Slovakia [79]. In the region of the Ukrainian part of the Carpathians, colonies of the species are known from Transcarpathia and Bukovina, but exceptionally from lowland areas [57]. In Transcarpathia the species' geographical range includes the border areas with Slovakia and Hungary, where the souslik's further existence is impossible without creating nature conservation reserves with an appropriate level of grazing load [36]. The species is also

¹ To explain the high variability of the species a hypothesis was proposed based on the concept of adaptive polymorphism. According to hypothesis, the red squirrel changes its coloration gradually dependently from increasing the height above the sea level, and the coloration is considered as cryptic in a certain extent. Besides, according to another hypothesis, the black phase of the squirrel is expanding its range displacing in the same time the red phase from the mountains, and also is penetrating the lowland natural and urban habitats. The dark phase occurs in localities where the black and red phases are cohabitating [40].

² It was proved that the black phase of the squirrel predominates in number the other ones. It is more typical for the mountain areas, while the red and dark phases (but together with the black one) for the lowland. The black phase significantly predominates over the height of 400 m [114]. Despite this, in urban conditions all three phases cohabit [40].

quite rare in the Romanian part of the Eastern Carpathians, where the abundance of separate populations is more significant within the protected areas [102].

PS: *occasional*; CS: IUCN – *VU*, BE – *III*, RDBU – *EN*.

Spermophilus odessanus Nordmann, 1840 (Podolian souslik, ховрах подільський) – only recently recognized as a separate species from the group of *Spermophilus "suslicus"* [30]. Records of the species are known from Prykarpattia. The Eastern Carpathians are the southwest boarder of the species' range [24]. Based on analysis of old sources and specimens the Podolian souslik is considered to be a recent immigrant within adjacent to the Carpathians lowlands, in particular in Podolia, where it significantly pressed the European souslik, inter alia, by introgressive hybridization [37].

PS: *occasional*; CS: IUCN – not included, RDBU – *LC*.

Marmota marmota (Linnaeus, 1758) (alpine marmot, бабак гірський) – the species was widely spread after the Würm glaciation from the Carpathians to the Pyrenees, but during the Quaternary Period its abundance decreased because of climatic change and other factors [97]. An endemic population in the region of the Carpathians has remained only in the Tatras [80]. In Romania a reintroduced in 1973 population near Pietrosul Rodnei within the Rodnei Mountains National Park increased its abundance [108].

PS: *rare*; CS: IUCN – *LC*.

Family Gliridae Muirhead, 1819 (dormice, вовчкові).

Detailed research of the family within the region were not conducted, however former fauna surveys state that four dormice species of four genera occur in the region, although one of them we consider being a *phantom* species. The family is often mentioned as Myoxidae Gray, 1825.

Glis glis (Linnaeus, 1766) (edible or fat dormouse, вовчок сірий) – the species' geographical range basically coincides with the zone of deciduous forests in the western Palearctic. In the forest-steppe zone of Ukraine, Moldova and Russia the range is mosaic. The elevational range of the species is to the upper tree line of deciduous and mixed forests [95]. The edible dormouse in the region of the Eastern Carpathians is a relatively common representative of the rodent fauna. Prone to synanthropy. Common synonym – *Myoxus glis* [27].

PS: *common*; CS: IUCN – *LC*, BC – *III*.

Muscardinus avellanarius (Linnaeus, 1758) (common dormouse, ліскулька руда) – a typical woodland species, inhabiting mostly in deciduous and mixed forests with a well-developed understorey. In different parts of its geographical range the forest composition may be different, according to geographical latitude, but the species prefers forests with oak [92]. In the Eastern Carpathians, the common dormouse is a typical resident of oak, beech and hornbeam forests [67]. The species is not that abundant, it was found mostly on clearings and forest edge habitats [27].

PS: *common*; CS: IUCN – *LC*, BC – *III*.

Dryomys nitedula (Pallas, 1779) (forest dormouse, соня лісова) – a typical resident of dense deciduous, coniferous and mixed forests with well-developed understorey [1]. In the region of the Eastern Carpathians, it was revealed only in mountain areas. A relatively rare species, its abundance has never been high [1, 27].

PS: *rare*; CS: IUCN – *LC*, BC – *III*.

Eliomys quercinus (Linnaeus, 1766) (garden dormouse, жолудниця європейська) – the Carpathian mountain range is a marginal fragment of the species' distributional range [91]. The garden dormouse in the region of the Eastern Carpathians is considered as a very rare species. The latest (and only) known specimen was collected in 1957 in the Rakhiv district (Transcarpathia) [7]; thus, in the composition of the region's current rodent fauna the garden dormouse should be considered as a phantom species.

PS: *phantom*; CS: IUCN – *NT*, BC – *III*.

Suborder 2. Castorimorpha (бобровиді)

Family Castoridae Hemprich, 1820 (beavers, боброві)

The family is represented by a single semi-aquatic species.

Castor fiber Linnaeus, 1758 (Eurasian beaver, бобер європейський) – first reports on the Eurasian beaver's reappearance in the Ukrainian part of the Carpathians were published in the early 2000s. As it is considered, the species immigrated to the region from Poland, Slovakia and Hungary where works on its reintroduction have been carried out. Since there is a rapid expansion of the species not only in lowland areas, but also at significant heights in the mountains [2, 45].

PS: *common*; CS: IUCN – *LC*, BC – *III*.

Suborder 3. Murimorpha (seu Myomorpha auct.) (мишовиді)

According to taxonomic richness indexes the Murimorpha suborder is the amplest group of mammals in the Eastern Carpathians represented by 5 families of 2 superfamilies, such as the superfamily Dipodoidea (includes Sicistidae) and the superfamily Muroidea (includes Spalacidae, Muridae, Cricetidae, Arvicolidae).

Superfamily Dipodoidea (стрибакуваті)

Family Sicistidae Allen, 1901 (birch mice, мишівкові)

The family is represented by two species.

Sicista betulina (Pallas, 1779) (northern birch mouse, мишівка лісова) – a rare species, common mainly at high altitudes and in the eastern macroslopes. The northern birch mouse is relatively abundant in the subalpine zone [60] and almost unknown from the southern macroslope of the Carpathians [27]. The Carpathians are the southern border of distribution of this generally northern species [49].

PS: *occasional*; CS: IUCN – *LC*, BC – *II*, RDBU – *NT*.

Sicita loriger (Nathusius, 1840) (Nordmann birch mouse, мишівка Нордмана)³ – in old sources the species described as *S. loriger* and *S. nordmanni*, however in publications from the second half of the 20th century it was considered as *S. subtilis* s. l. [34]. The species status of the 26-chromosome *S. subtilis* was predicted by us in 2000 [29] and accepted in 2009 [34]. The Nordmann birch mouse was not recorded in the Eastern Carpathians, but there are several records of "*S. subtilis*" from the Romanian part of the Carpathians and from Transylvania as well, although those records some authors consider as a separate subspecies *S. subtilis trizona* [89]. Consequently, the Nordmann birch mouse is not mentioned in most red lists, so the species' statuses are the same as for *S. subtilis*.

PS: *rare*; CS: IUCN – *NT*, BC – *II*, RDBU – *EN*.

³ Because of different views on the taxonomy and nomenclature of birch mice species, we propose the English and Ukrainian names of *S. loriger*.

Superfamily Muroidea (мишуваті)

The superfamily Muroidea includes 4 families: Spalacidae (2), Muridae (8), Cricetidae (1) and Arvicolidae (10 species). Comments and remarks on statuses and the presence of separate species are given below in the descriptions of families and species.

Family Spalacidae Gray, 1821 (spalacids or mole rats, сліпакові)

This group of classic grassland and forest–steppe species is not typical for the Carpathians in general, but in the region of the Eastern Carpathians there are two mole rat species. Important to mention that in the mountains mole rats are absent [27].

Spalax graecus Nehring, 1898 (Balkan mole rat, сліпак буковинський) – in Ukraine and Romania the species is known only from the right bank of the Prut river [46, 78]. The Balkan mole rat is supposed to be a derivative of *S. zemni* Erxleben, 1777, which survived in isolated conditions in piedmont and meadow steppe communities [46]. In addition, *S. antiquus* Méhely, 1909 is recognized as a separate from *graecus* Nehring, 1898 endemic species in Romania, local population of which was found in Transylvania [103].

PS: *occasional*; CS: IUCN – *NT*, BC – *II*, RDBU – *DD*.

Nannospalax leucodon (Nordmann, 1840) (lesser mole rat, сліпець понтичний) – in the region of the Eastern Carpathians this species occurs only in Transylvania as a local population with unique karyotype $2n = 50$ [105]. In the other side of the Carpathians the species (karyotype $2n = 56$) is common in the lowland part of Bukovina between the Prut and Dniester rivers [46].

PS: *occasional*; CS: IUCN – *DD*, RDBU – *DD*.

Family Muridae Illiger, 1811 (murids or mice, мишеві)

One of the taxonomically most diverse groups – 8 species of five genera, including sibling species from the group of "wood mice" (*Sylvaemus*) not long ago considered as part of the *Apodemus* genus and often described as one polymorphic species "*flavicollis*" [48, 111]. Carpathian rats and house mice are typical commensals, however *Rattus rattus* in the modern fauna's composition was not recorded [4, 25].

Micromys minutus (Pallas, 1771) (harvest mouse, мишка лучна) – a relatively common species in lowland and piedmont habitats [1]. Within the area of the Carpathian Biosphere Reserve the species is rare and in the mountains (above 400-500 m) was not recorded [27].

PS: *occasional*; CS: IUCN – *LC*.

Apodemus agrarius (Pallas, 1771) (striped field mouse, житник пасистий) – a typical and abundant lowland-piedmont species, but sometimes it can be found at height about 1300 m (for instance, Borzhava polonina). The striped field mouse avoids continuous forests and prefers shrubs, meadows, fields, also occurs in forest edge habitats [1, 27, 69].

PS: *common*; CS: IUCN – *LC*.

Sylvaemus tauricus (Pallas, 1811) (yellow-necked mouse, мишак жовтогрудий) – an abundant species of wooded biotopes of piedmont and mountain areas; the most abundant mammal species in the region. Common synonym – *Apodemus flavicollis* Melchior [27]; *S. alpicola* in the Carpathians was not recorded [21].

PS: *abundant*; CS: IUCN – *LC*.

Sylvaemus sylvaticus (Linnaeus, 1758) (wood mouse, мишак європейський) – earlier it was mentioned as *A. sylvaticus*. The species is common and abundant in lowland biotopes but quite rare in the mountains. Data on the species' geographical, biotopic and altitudinal

distribution in the region need revision. Young individuals of *Sylvaemus tauricus* quite often are identified as *S. sylvaticus*, and the same happens in case of *S. uralensis* [18, 22].

PS: *common*; CS: IUCN – *LC*.

Sylvaemus uralensis (Pallas, 1811) (pygmy field mouse, мишак уральський) – common synonym: *Apodemus microps* Krat. et Ros., the species was known under this name until 1989-1993. The pygmy field mouse is a little-known species in the region with low abundance and represented by a lowland [11, 47, 56, 82] and an isolated from it subalpine [42] populations.

PS: *frequent*; CS: IUCN – *LC*.

Mus musculus Linnaeus, 1758 (eastern house mouse, миша хатня) – an adventive, typical commensal and synanthropic species, wild breeding populations of which in the Carpathian region were not revealed [26]. This species occurs near human settlements, in summer it has temporal colonies in the wild but close to human dwellings [27, 47].

PS: *common*; CS: IUCN – *LC*.

Mus spicilegus Petenyi, 1882 (steppe mouse, миша курганцева) – a typical lowland species inhabiting mainly on agricultural lands [109]. It is morphologically close to the house mouse but significantly differs ethologically [104]. The species distributional range includes adjacent to the Carpathians lowland areas [23, 26], in particular the eastern regions of Slovakia [84, 85] and Hungary [83, 88] as well as part of Transylvania [82]. There could be finds of the species in lowland areas of Transcarpathia and Forecarpathia. However, in 2005-2007 it was already reported about finds of about 30 "colonies" in the Uzhhorod district (Transcarpathia) [1], but such finds need to be confirmed by craniometric analysis.

PS: *frequent*; CS: IUCN – *LC*.

Rattus norvegicus (Barkenhout, 1769) (brown rat, пацюк мандрівний) – an adventive and rare in the wild species, a far invader [31]. Melanistic individuals of this species were identified earlier as *R. rattus*, which in fact was not recorded in the modern fauna of the Eastern Carpathians – populations of *R. rattus* disappeared probably at the end of the 19th century [25, 75].

PS: *common*; CS: IUCN – *LC*.

Family Cricetidae Fischer, 1817 (hamsters, хом'якові)

The family in the region, as well as in Ukraine in general, has become quite rare. Only one species (*Cricetus cricetus*) occurs in the Eastern Carpathians' fauna inhabiting mainly in piedmont areas. Another species (*Cricetulus migratorius*) of the family was mentioned from localities remote from the mountains (e.g. Khotyn upland), however, during the last decades on its modern records have not been reported [63].

Cricetus cricetus (Linnaeus, 1758) (common hamster, хом'як звичайний) – in the near past it was a common lowland and piedmont species that was not recorded in mountains and intermountain valleys [74]. Now it is considered as a rare species in lowland Transcarpathia [1], however in some localities is quite common (especially in the Uzhhorod district (V. Chumak, pers. comm.), also in Bukovina and the Skole district [106]. The common hamster is quite numerous in Transylvania, where its part in eagle-owl's pellets is 16.5 % of all identified vertebrate species [107].

PS: *occasional*; CS: IUCN – *LC*, BC – *II*, RDBU – *LC*.

Family Arvicolidae Gray, 1821 (voles, щурові)

The largest family of rodents represented in the region's fauna by 10 species of six genera. Among them, the *Myodes* genera is dominant or subdominant in the most of woodland rodent communities. The taxonomic heterogeneity of three groups considered earlier in the region's fauna as monotypic was discovered: *Terricola* (*Pitymys* auct.), *Arvicola* та *Microtus* s. str. (two species in each genus). The Arvicolidae family is among the most popular research objects. Common synonym of the family – Microtidae Cope [10, 14, 19, 72, 74]. There is an alien and two protected vole species in the region's fauna; their distribution is limited by mountain ridges.

Ondatra zibethicus (Linnaeus, 1766) (muskrat, ондатра мускусна) – an introduced species (near 1940-1950) which has now become an integral part of all shore ecosystems of various origin. The muskrat in some locations has a quite significant abundance [1, 27].

PS: *common*; CS: IUCN – *LC*.

Myodes glareolus (Schreber, 1780) (bank vole, нориця руда) – the only representative of the genus in Ukraine. It is an abundant species in all forest types in the lowland and the mountains as well. There are quite common synonyms of the genus such as *Evotomys* in older sources and *Clethrionomys* in the newer ones [27, 68]. The genetic heterogeneity of populations around the Carpathians was described. It is related to the existence of different refugia in the past not only in lowland areas (Eastern clade), but also at significant altitudes (Carpathian clade). A secondary contact zone between these populations formed in the northeast of Poland. Genetic investigations also proved that voles of the Carpathian refugium form a single clade [94, 110].

PS: *abundant*; CS: IUCN – *LC*.

Chionomys nivalis (Martins, 1842) (snow vole, снігурка альпійська) – a typical, though rare species that mainly occurs in open subalpine rocky habitats. The species is distributed in the Ukrainian Carpathians in the Chornohora and the Gorgany ranges where it was recorded in 8 localities [19]. A detailed mapping of its distributional range has not been carried out yet. The snow vole in older sources usually considered as part of the genus *Microtus* Schrank [58, 66].

PS: *rare*; CS: IUCN – *LC*, BC – *III*, RDBU – *VU*.

Arvicola amphibius (Linnaeus, 1758) (water vole, щур водяний) – a formerly abundant lowland species, closely related to wetland habitats. Common synonym – *A. terrestris* L. [43, 113]. The water vole is substituted by *Arvicola scherman* in piedmont and mountain areas; however, the boundaries between these species in most of the regions are not clear.

PS: *common*; CS: IUCN – *LC*.

Arvicola scherman (Shaw, 1801) (montane water vole, щур гірський) – a common species of the region considered earlier as a subspecies (mountain race) of the water vole [19, 20, 21, 55, 70]. The species is likely represented by only typical terrestrial form that constructs underground burrows. Quite often inhabits agricultural lands, especially potato fields. To north from the Carpathians the species enters far to the plains, in particular it can be found in the Kraków-Częstochowa Upland, in Roztocze and possibly in the West Polissia [38].

PS: *common*; CS: IUCN – *LC*.

Terricola subterraneus (Selys-Longchamps, 1836) (common pine vole, норик підземний) – a common species of forest edge and deforested habitats, also of alpine dock forbs [16, 53, 54, 61, 62]. The species is often considered in the composition of either

Microtus Schrank or *Pitymys* MacMurtrie genera (e.g. [73]). The Carpathian population is related to the 52-chromosome race *daci*us Miller [16].

PS: *frequent*; CS: IUCN – *LC*.

Terricola tatricus (Kratochvil, 1952) (Tatra vole, норик татринський) – a rare and endemic species of the Carpathians, often mentioned as *Microtus tatricus*. It was suggested that the species range is fragmented and it is reducing [99]. The Tatra vole is a typical species of mountain forests and morphologically close to the common pine vole. The species was first recorded in the fauna of the Eastern Carpathians only in the late 1980s [13, 17, 112]; most records are from the Chornohora [17] and Máramaros [99].

PS: *rare*; CS: IUCN – *LC*, BC – *II*, RDBU – *NT*.

Microtus agrestis (Linnaeus, 1761) (field vole, полівка темна) – the species is rare in the lowland, uncommon in the forest zone and quite numerous in the subalpine zone of the Carpathians [6, 51, 52, 59]. In general, it is a northern species; the Carpathians are the southernmost border of its distribution. The Carpathian population of the field vole is likely isolated from other populations distributed north of the Carpathians [19]. The authors suggest that the species could be identified earlier as *Microtus arvalis* (in Ukraine the field vole was first recorded in 1925 [19], and in the Carpathians only a few years later, in 1935 near Hoverla (Sagan, 1939 after [69])).

PS: *common*; CS: IUCN – *LC*.

Microtus arvalis (Pallas, 1779) (common vole, полівка європейська) – a common species of lowland and piedmont meadows representing in the Carpathians a group of sibling "common vole" species [27]. The species was repeatedly mentioned in the composition of mountain communities (e. g. [69]), but during further studies the species was not revealed in the mountains (particularly in the area of Chornohora) [17, 44]. Obviously, the common voles is also absent in most of (if not all of) the highland areas of the Carpathians.

PS: *common*; CS: IUCN – *LC*.

Microtus levis Miller, 1908 (sibling vole, полівка лучна) – a sibling species of *Microtus arvalis*. Records of this 54-chromosome species in the Carpathian region have been assumed since 1991 based on mapping of ranges of this group of sibling species [14]. By now, according to craniological data, the species' presence in western Ukraine was proved [71], as well as in several regions of Hungary, including neighboring ones with Transcarpathia [98]. The *levis* Miller, 1908 form, which name was accepted as valid for the 54-chromosome voles from the "*arvalis*" group was described from submountain areas of Romania (Prahova, Găgeni). The type specimen of "*levis*" by morphological features is identical to 54-chromosome "*arvalis*" (the former "*rossiaemeridionalis*") [100]. The sibling vole in the Eastern Carpathian Mountains has not been recorded yet.

PS: *phantom* (?); CS: IUCN – *LC*.

The rating of rodent families in terms of species richness

The presented above checklist includes all recorded in the modern fauna of the Eastern Carpathians and adjacent lowland–piedmont areas rodent species. In total, the rodent fauna of the Eastern Carpathian region includes 32 species of 8 families. According to number of species, the family Arvicolidae is the richest (10 species), then Muridae (8), Gliridae (4), Sciuridae (4), Spalacidae (2), Sicistidae (2); families Castoridae and Cricetidae are represented in the region's fauna only by one species each (tab. 2).

The checklist contains 10 species (31%) included into the Red Data Book of Ukraine, 2009 [76]. In general, the part of protected species is proportional to the amount of species in the families. According to the rarity index, the most vulnerable families in the region are the following: Spalacidae, Sicistidae, Sciuridae, and Cricetidae. Each of them is represented by 1-2 protected species and the part of such species is not less than 50% of the total species richness. At the level of superfamilies the most vulnerable is the non-Muroidea group of families (5 species of 11, rarity index $I = 2.27$). The presence of such species indicates the level of the fauna's conservation. However, their loss would mean not only the loss of some species, but also three families that would significantly affect the estimates of the taxonomic diversity of the region's fauna.

According to the rarity index, the non-Muroidea species are 1.9 times rarer in comparison with muroid rodents (Muroidea) (see tab. 2).

Table 2

The rating of rodent families of the Eastern Carpathians according to the rarity index*

Family		Species total, absol.	Species in RDBU, absol. (a)	Part of RDBU species (b)	Rarity index, $I = ab$
1. Spalacidae	сліпакові	2	2	1,00	2,00
2. Sicistidae	мишішкові	2	2	1,00	2,00
3. Sciuridae	вивіркові	4	2	0,50	1,00
4. Cricetidae	хом'якові	1	1	1,00	1,00
5. Gliridae	вовчкові	4	1	0,75	0,75
6. Arvicolidae	щурові	10	2	0,20	0,40
7. Muridae	мишеві	8	0	0,00	0,00
8. Castoridae	боброві	1	0	0,00	0,00
Σ non-Muroidea	(1+2+3+4)	11	5	0,45	2,27
Σ Muroidea	(5+6+7+8)	21	5	0,24	1,19
Total		32	10	0,31	3,13

* These indexes were proposed in our previous review [27]. The position of each taxon in the table is given according to the value of the rarity index (last column).

The real fauna diversity indexes should be adjusted by further research. However, at the present our understanding of the region's rodent fauna composition can be considered as complete. Possible changes in taxonomic lists in the future would be related with removal (disappearance) of species. Irreversible changes in the environment lead to decrease the species number and reduction of their distributional range. Protected ecosystems more often remain the only and last centers of authentic fauna that rapidly changes in the whole region of the Carpathians because of intense economic development and anthropogenic transformation of natural ecosystems.

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Національний науково-природничий музей НАН України, Київ
e-mail: zoozag@ukr.net, zlbarkasi@ukr.net

Баркасі З., Загороднюк І.

Таксономія гризунів Східних Карпат

У праці подано відомості про сучасний склад родентофауни Східних Карпат та прилеглих рівнинно-передгірних територій у світлі сучасних поглядів на таксономію та номенклатуру цієї групи ссавців. Оцінено таксономічне багатство ряду Мишоподібні (*Muriformes*, seu *Rodentia auct.*) у регіоні. Подано анотований список видів з оглядом їхнього поширення та оцінками чисельності популяцій. Окрім наукових подано й нині прийняті українські та англійські назви таксонів, а також позначено статус присутності та категорії охорони кожного з видів. Проаналізовано рейтинг родин мишоподібних за видовим багатством, із визначенням найбільш вразливих таксономічних груп.

Ключові слова: гризуни, Східні Карпати, таксономія, біорізноманіття.

Баркаси З., Загороднюк І.

Таксономія гризунів Восточных Карпат

В работе представлены сведения о современном составе родентофауны Восточных Карпат и прилегающих равнинно-предгорных территорий в свете современных взглядов на таксономию и номенклатуру этой группы млекопитающих. Оценено таксономическое богатство отряда Мышевидные (*Muriformes*, seu *Rodentia auct.*) в регионе. Представлен аннотированный список видов с обзором их распространения и оценками численности популяций. Кроме научных поданы и ныне принятые украинские и английские названия таксономических групп. Проанализирован рейтинг семейств мышевидных по видовому богатству с определением наиболее уязвимых таксономических групп.

Ключевые слова: гризуны, Восточные Карпаты, таксономия, биоразнообразие.