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A HISTORY OF RODENT RESEARCH IN THE UKRAINIAN CARPATHIANS

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A history of rodent research in the Ukrainian Carpathians. — Barkaszi Z. *— The paper presents a survey on the history of rodent research in the region of the Ukrainian Carpathians from the very first known publications to modern days. The analysis of available sources showed that the study of mammals of the Ukrainian Carpathians has begun in the middle of the 19th century when the very first fauna checklists were published. The rodent fauna of the region had been studied the most actively after World War II by well-known university and academic scientists. This is the time of the most active enrichment of scientific collections of zoological and natural history museums by specimens and their series collected in the Ukrainian Carpathians. Since the 1990s, a decrease in activity of rodent research has been observed in the region.*
Key words: *research history, rodents, Carpathians, history of science, scientific heritage.*
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Історія дослідження гризунів Українських Карпат. — Баркасі З. *— Стаття присвячена огляду історії дослідження гризунів регіону Українських Карпат з найперших відомих публікацій до сьогодення. Аналіз доступних джерел показав, що дослідження ссавців Українських Карпат почалися з середини XIX ст. з перших фауністичних зведень. Родентофауна регіону найбільш активно вивчалася відразу після Другої світової війни багатьма відомими науковцями університетів та академічних установ. У цей період поповнюються наукові фондові колекції зоологічних музеїв зразками та серіями видів з Українських Карпат. З 1990-х років спостерігається зменшення активності наукових досліджень гризунів у регіоні.*
Ключові слова: *історія досліджень, гризуни, Карпати, історія науки, наукова спадщина.*
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Introduction

The Carpathians are one of the main part of the European Alpide belt (Ozenda 1985) and one of the richest biogeographic regions of Europe in terms of biotic diversity (Baquero, Tellería 2001). The high biodiversity in the region is related mostly to the cumulative effect of such factors as geographical location, isolation, area, geomorphology, ladscape heterogeneity, relatively well-preserved habitats (from the lowland to the alpine zone), as well as the limited effect of Pleistocene glaciations (Mráz, Ronikier 2016).

Being situated in Central Europe, the formation of the biota of the Carpathians was affected by the flora and fauna of the Alpine, Arkto-Alpine, Mediterranean, and Asian regions (Finnie et al. 2007; Varga 2011). At the same time, the Carpathians form a system of insular biotopes on high massifs separated from one another. Such conditions facilitate the evolution of autochtonous components of the biota with endemic elements. All these factors determine the Carpathians as a biodiversity hotspot of exceptional importance in Europe (Mráz, Ronikier 2016).

The Ukrainian Carpathians are part of the Eastern Carpathians and within Ukraine are located in the territory of Zakarpattia, Lviv, Ivano-Frankivsk, and Chernivtsi Oblasts. In the majority of scientific works, including zoological studies, the Ukrainian Carpathians are considered as a single biogeographic unit including not only mountain ridges, but also adjacent piedmont and lowland areas of the regions Transcarpathia, Ciscarpathia, and Bukovina (Szcherbak 1988; Novikoff, Hurdu 2015) (see Fig. 1).

Until 1945, the region had been part of different countries. Being located in the periphery of those countries, the region had been paid relatively little attention in most spheres of life, including scientific research. Therefore, biodiversity of the Ukrainian Carpathians had not been studied in detail for a long time, and the very first expeditions to the region were organised only in the late 19th century.

The beginning of modern biology can be rightly associated with 1735, when the first edition of *Systema Naturae* by Carl Linné was published giving rise to floristic and faunal studies in

European countries according to a unified systematics. From the second half of the 18th century, naturalists prepared and published monographic surveys with the first sytematised fauna checklists. A number of such works were also published in Hungary, including the book *Tentamen Zoologiae Hungaricae* (Severinus 1779), four issues of the series *Universa Historia Physica Regni Hungarieae* on "quadrupeds", "birds", "fishes/amphibians", and "insects" (Grossinger 1793a, 1793b, 1794a, 1794b), a natural history of animals according to the Linnean system (Földi 1804), a doctoral thesis on animals having pharmacological importance (Feichtinger, 1840), a review of mammals of Hungary (Petényi 1844), as well as the first full-fledged monographs on birds (Chernel 1899) and bats of Hungary (Méhely 1900).

It is obsious that in most works the region what is now known as "Ukrainian Carpathians" is merely considered or not mentioned at all. The first more or less full checklist of animals of Galicia was published in 1840 (Zawadzki 1840), while for the former counties of Transcarpathia (modern Zakarpattia Oblast) notably later: in 1876 for Máramaros (Kardos 1876) and in 1881 for Bereg (Lehoczky 1881). Systematic and planned studies of the region's fauna, including rodents, started only about a half-century later.

A review of studies of muroids in mountain ecosystems of the Ukrainian Carpathians was published earlier by N.O. Stetsula (Stetsula 2011). The aim of this survey is to study and generalise the main periods of rodent research carried out in the entire region of the Ukrainian Carpathians from the very first available publications until modern days.

Periods in the history of rodent research in the Ukrainian Carpathians

The research of mammals and particularly of rodents of the region of the Ukrainian Carpathians can be traced from the mid-19th century. The entire period of fauna research can be divided into three stages: 1) a time of unsystematised amassment of faunal data in different parts of the region (1840–1945); 2) a period of transition from faunal studies to research into ecology, morphology, and biogeography (1945–1990); and 3) a time of local studies mainly within protected areas (since the 1990s). The timeframes of these stages are conditional and practically conincide with periods of domination of different systematic views on the mammal fauna.

For a better comprehension, a guide to the names of geographic regions and admisitrative units used in the paper is presented in Figs 1–2.

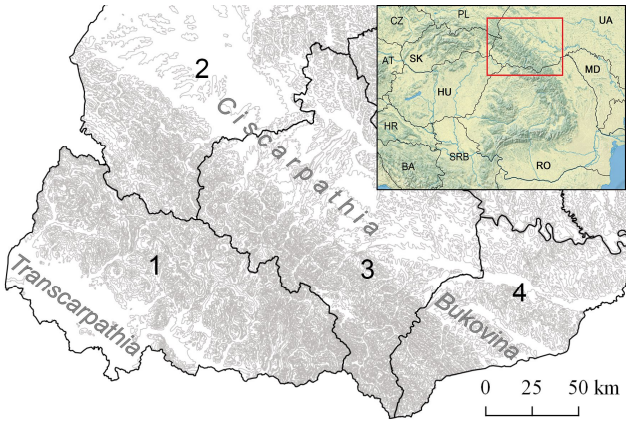


Fig. 1. A map of the region considered with topographic names used in the text. The numbers denote different administrative units (Oblasts) of Ukraine: 1–Zakarpattia, 2–Lviv, 3–Ivano-Frankivsk, 4–Chernivtsi

Рис. 2. Мапа дослідженого регіону з топографічними назвами, що вжито у тексі. Цифрами позначено різні адміністративні одиниці (області) України: 1–Закарпатська, 2–Львівська, 3–Івано-Франківська, 4–Чернівецька

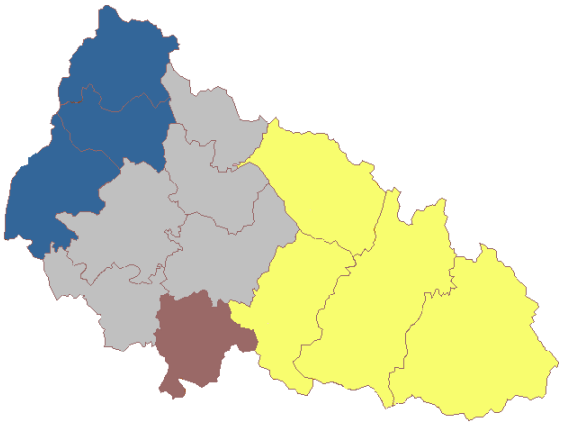


Fig. 2. A map of Zakarpattia Oblast, Ukraine, with former administrative units (counties) used until 1945: blue – Ung, grey – Bereg, brown – Ugocsa, yellow – Máramaros (after Shmurak, Wikipedia)

Рис. 2. Мапа Закарпатської області з позначенням адміністро-територіальних одиниць (комітати, жупи) до 1945 р.: синій – Ужанський, сірий – Березький, бурий – Угочанський, жовтий – Мармароський (за: Shmurak, Wikipedia)

The first period (1840–1945): a time of fragmentary knowledge

This is the stage of gradual and unsystematised amassment of primary faunal data, mainly as checklists of species with brief notes on their occurence and only occasionally with detailed faunal descriptions. The first important zoological work providing data on mammals of the region of the Ukrainian Carpathians and particularly on rodents is the book *Fauna der Galizisch-Bukowinischen Wirbelthiere* (Zawadzki 1840), in which the author indicates 56 mammal species for Galicia and Bukovina, including 15 rodents. The checklist is accompanied with notes on morphology, occurrence, and biology of species. Later, the book by S. Pietruski *Historia naturalna zwierząt ssących dzikich galicyjskich* was published (Pietruski 1853) presenting brief descriptions of the biology and distribution of rodents in Galicia.

Data on the mammal fauna of Transcarpathia for this period are less solid, since animals of this region were studied mainly by science teachers of local gymnasiums and seminaries. Fragmentary information can be found in works of Hungarian zoologists in the context of the fauna of the Hungarian Kingdom (Petényi 1844; Hanák 1853), Austria-Hungary (Mojsisovich 1887; Paszlavszky 1918), or separate counties such as Máramaros (Frivaldszky 1875; Kardos 1876) and Bereg (Lehoczky 1881) that cover the area of several districts of modern Zakarpattia Oblast (see Fig. 2). Among these works, Kardos (1976) noted 42 mammal species for Máramaros, including eight rodents: *Sciurus vulgaris*, *Glis vulgaris*, *Arctomys marmota*, *Mus musculus*, *Mus sylvaticus*, *Mus rattus*, *Mus decumanus*, and *Hypudaeus arvalis*.

A certain stasis took place in mammal research at the beginning of the 20th century, which was obviously related to the military and political situation unfolding in the region at that time. Works on the mammal fauna appeared again the 1930s. In 1934, O. Štěpánek reported on records of the mound-building mouse *Mus spicilegus* from Ugocsa County (Štěpánek 1934), although a revision of specimens later revealed that they belong to *M. musculus* (Macholán 1995). O.E. Niezabitowski published an updated checklist of mammals of Galicia (Niezabitowski 1933) and I. Pidoplichko, based on analysis of owl pellets for 1924–1935, presented a checklist of rodents of the Eastern Carpathians (Pidoplichko 1937). Later, L. Sagan published data on rodents of the Chornohora massif (Sagan 1939).

The second period (1945–1990): a time of intense studies

This period is notable by a transition from faunistics to studies on distribution, and then on ecology and morphology of mammals. The establishment of the University of Uzhhorod in 1945 and particularly its Department of Zoology and Zoological Museum had a siginificant impact on the activisation of research in the region. However, not only members of the university staff carried out research in the region during this period, but also scientists from other institutions including the universities and zoological museums of Lviv, Chernivtsi, and Kyiv.

A major contribution to the study of rodents of the Ukrainian Carpathians was made, too, by zoologists of the Ukrainian Academy of Sciences, particularly of Schmalhausen Insitute of Zoology (Kyiv), the National Museum of Natural History (Kyiv), and the State Museum of Natural History (Lviv). Most of the museum specimens housed in zoological collections were gathered in the region during this very time (Barkaszi 2014), whereas the most active enrichment of these collections took place immidiately after World War II (Fig. 3).

For the about 60 years of this second period of research, over 50 mammalogists from academic institutions and universities had been working in the region of the Ukrainian Carpathians. The first contribution of this period was a survey on mammals of Transcarpathia published by M.G. Yanushevych, in which the author indicated 27 mammal species (Yanushevych 1947).

Especially important and thorough studies were published by I.T. Sokur, I.I. Turyanin, F.I. Strautman, K.A. Tatarinov, E.G. Reshetnyk, M.P. Rudyshin, N.A. Polushina, B.R. Pyliavsky, I.D. Shnarevych, O.V. Korchynsky, I.V. Zagorodniuk, and others (Fig. 4). However, most of these studies were restricted to separate parts of the Carpathian region or to different ecological or taxonomic groups of rodents.

K.A. Tatarinov's works have a special place in the research history of rodents of the Ukrainian Carpathians. He paid particular attention to representatives of the family Arvicolidae and was the first to study the distribution patterns and biology of the snow vole (Tatarinov 1954b) and of the common vole in the Eastern Carpathians (Tatarinov 1954a). In a broader geographical scope, i.e. together with adjacent regions of western Ukraine, the author studied the ecology of various mammals, including rodents, with a focus on their role as pests (Tatarinov 1956a, 1956b). The author's report of new record localities of two

boreal rodent species—the field vole and the tundra vole—in Ukraine, including the Carpathian region, is of particular importance (Tatarinov 1951).

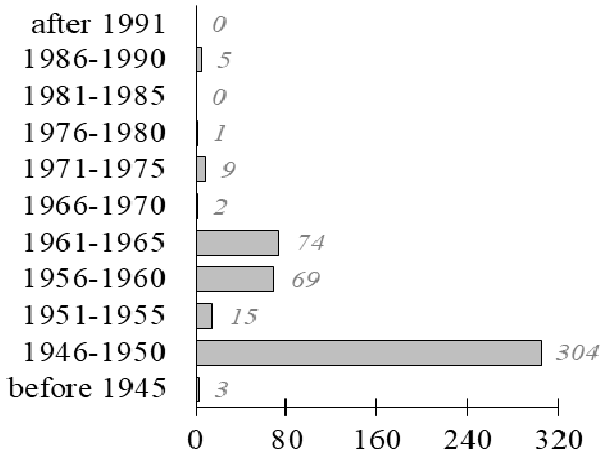
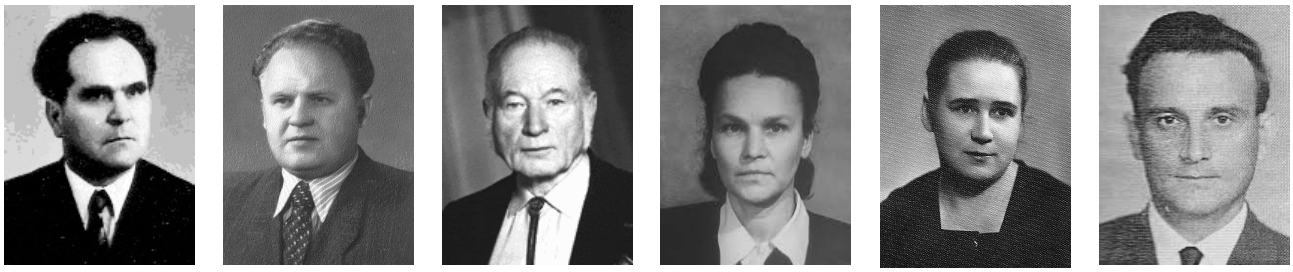


Fig. 3. The dynamics of amassment of museum specimens of Muridae housed in zoological collections of the National Museum of Natural History NAS of Ukraine and Zoological Museum of Taras Shevchenko National University of Kyiv

Рис. 3. Динаміка накопичення колекційних зразків гризунів родини Muridae у зоологічних колекціях Національного науково-природничого музею НАН України і Зоологічного музею Київського національного університету імені Тараса Шевченка



a *b* *c* *d* *e* *f*

Fig. 4. Some of the most prominent researchers of rodents of the region in the 20th century: *a* - Ivan Turyanin; *b* - Fedir Strautman; *c* - Kostiantyn Tatarinov; *d* - Evdokia Reshetnyk; *e* - Nadia Polushyna; *f* - Bohdan Pyliavsky (photo sources: https://bit.ly/2CAGaIV, https://bit.ly/2CowCAY, https://bit.ly/2OLfsQh, Korobchenko 2016, https://bit.ly/3fP81DN, Zagorodniuk, 2016)

Рис. 4. Відомі дослідники гризунів регіону в XX ст.: *a* - Іван Турянин; *b* - Федір Страутман; *c* - Костянтин Татаринов; *d* - Євдокія Решетник; *e* - Надія Полушина; *f* - Богдан Пилявський (джерела фотографій: https://bit.ly/2CAGaIV, https://bit.ly/2CowCAY, https://bit.ly/2OLfsQh, Korobchenko 2016, https://bit.ly/3fP81DN, Zagorodniuk 2016)

K.A. Tatarinov significantly contributed to the study of Carpathian water voles of the genus *Arvicola*, which have remained a taxonomically discrepant group of rodents not only in the Carpathian region (Zagorodniuk 1993a, 1993b; Zagorodniuk, Zatushevskyi 2012), but also in other parts of the genus's range (Abramson et al. 2009; Kryštufek et al. 2015). The author studied the ecology and economic importance of water voles in the upper Dniester basin (Tatarinov 1954c, Tatarinov, Opalatenko 1954), and the negative impact of the montane water vole's burrowing activity on polonynas and subalpine meadows (Tatarinov 1960, 1961). K.A. Tatarinov also paid particular attention to pest rodents and methods over their control (Tatarinov 1953), as well as investigated the prospects of economic use of the muskrat (Tatarinov 1950, 1952, 1954d).

K.A. Tatarinov first proposed a zoogeographical division of western Ukraine based on the distribution of mammals (Tatarinov 1954e), and later, together with F.I. Strautman, developed

the zoogeographical division of western oblasts of Ukraine according to the distributin of all vertebrate groups (Strautman, Tatarinov 1957). The author also studied small mammals by the pellet method investigating the feeding of the barn owl (*Tyto alba*) in the lowlands adjacent to the Ukrainian Carpathians (Tatarinov 1965).

From the 1950s, K.A. Tatarinov's scientific interest included not only small, but also other mammals, and later all vertebreates of western Ukraine. Among his most important works of this period are those devoted to the altitudinal distribution of mammals (Tatarinov 1955) and to the distribution of vertebrates in the subalpine belt of the Eastern Carpathians (Tatarinov, Vladyshevsky 1960).

Important scientific contributions are K.A. Tatarinov's monographic works on mammals (Tatarinov 1956c) and vertebrates of the west of Ukraine (Tatarinov 1973), in which he indicated 24 rodent species for the Ukrainian Carpathians. These works present detailed descriptions of species, part of which are currently outdated, although remain the most comprehensive for many rare species.

Noteworthy are F.I. Strautman's works on the ecology of vertebrates and separate mammal groups, particularly those in montane communities of the Ukrainian Carpathians. The author mainly focused on issues of population dynamics (Strautman, Yanushevych 1948; Strautman 1950), and distribution of rodents (Strautman 1954; Strautman, Benedyuk 1954) and other vertebrates in the krummholz zone (Strautman, Tatarinov 1949, 1959).

I.T. Sokur studied the mammal fauna of the Ukrainian Carpathians practically simultaneously with K.A. Tatarinov and F.I. Strautman. He noted 54 mammal species for the fauna of Transcarpathia, including 17 rodents (Sokur 1949), as well as authored the very first publication on the mammal fauna of the Ukrainian Carpathians as an integral region indicating 22 rodent species (Sokur 1952a). His later works mainly concerned mammals in the context of economic importance of species (Sokur 1952b, 1963a, 1963b). Besides, I.T. Sokur developed the zoological characteristics of the Ukrainian Carpathians based on biogeographical features of the local mammal fauna (Sokur 1951).

Distribution patterns and economic significance of rodents and other vertebrates of the Ukrainian Carpathians was actively studied in this period by I.I. Kolyushev, who noted, at first, 20 rodent species for the region (Kolyushev 1953), and later 28 species (Kolyushev 1959), which was the largest number of rodents indicated for the region at that time. The author also studied the altitudinal distribution of mammals and diversity patterns of vertebrates in the region (Kolyushev 1957, 1964).

Knowledge on the mammal fauna of Bukovina as of the mid-20th century can be found in works of I.D. Shnarevych and K.I. Yanholenko. In particular, these are data on latitudinal and altitudinal migrations of the Carpathian form of the European squirrel (Shnarevych 1954) and surveys on mammals and vertebrates of Bukovina (Shnarevych, Nikitenko 1957; Shnarevych 1959). K.I. Yanholenko's works are devoted to ecology, distribution, and specifics of burrowing activity of mole-rats, which in the region of the Ukrainian Carpathians occur only in Bukovina (Yanholenko 1959, 1961, 1966). Among them, the Bukovina mole-rat (*Spalax graecus*), which geogrpahical range covers lowland regions of Bukovina adjacent to the Eastern Carpathians in both Ukraine and Romania, is the westernmost representative of the genus, and the Ukrainian Carpathians are part of the western boundary of both the species' and genus's range (Korobchenko, Zagorodniuk 2009; Chişamera et al. 2014).

Data on the ecology of montane populations of voles were published by B.R. Pyliavsky, who studied in detail the features of feeding, circadian and seasonal migration of the field vole (*Microtus agrestis*) and the European pine vole (*Terricola subterraneus*) in the krummholz and subalpine meadows of the Ukrainian Carpathians (Pyliavsky 1964, 1969, 1970a, 1970b, 1976). The ecology of the field vole and other muroids were also studied in Bukovina (Horbyk 1956; Nikitenko, Horbyk 1959).

N.A. Polushyna made a significant contribution to the study of mammals of the region. She carried out research on small mammals living at high altitude (Polushyna 1972, 1987) and in anthropogenic landscapes (Polushyna, Bodnar 1984). N.A. Polyshuna studied the abundance of common voles in Ciscarpathia and methods of its regulation (Polushyna, Bodnar 1987), distribution patterns of the montane water vole (Polushyna, Kushniruk 1960), and the abundance of mammals in the Ukrainian Carpathians (Polushyna 1965). Her work on the specifics of fruiting of forest-forming species and on the feeding of mammals on those fruits is unique and of great importance (Polushyna 1964), as well as her survey on mammal assemblages of different altitudinal zones and on biogeogprahical principles of conservation of the Carpathian mammal fauna (Polushyna 1977, 1981).

N.A. Polushyna also contributed to the taxonomic status of the montane water vole

(Polushyna, Kushniruk 1962) and she was the first to reveal the occurrence of the pygmy wood mouse (*Apodemus microps*) in the region of the Ukrainian Carpathians (Polushyna, Vozniuk 1980). Issues of the systematics and ecology of wood mice of the region were also investigated by other authors (e.g. Andreev, Horbyk 1954), and later two other records of the pygmy wood mouse were reported from Transcarpathia (Emelyanov et al. 1987).

E.G. Reshetnyk studied distribution patterns of the European ground squirrel in Transcarpathia. She was the first to investigate the occurrence of this species in the region not only providing detailed data on record localities, but also considering the taxonomic status of the ground squirrel (Reshetnyk 1948, 1965, 1967). E.G. Reshetnyk's publications had been the only source of information on the European ground squirrel in Transcarpathia for a long time.

An important contribution to the study of rodents of the Carpathian region was made by I.I. Turyanin. A large number of his works were devoted to ecological features of the common vole, the brown rat, the European pine vole, and other rodent species of the local fauna (Turyanin 1956a, 1956b, 1960, 1969a, 1986, 1987). The author's materials on different life forms of rodents of Transcarpathia and their altitudinal distribution have retained their relevance (Turyanin 1957a, 1957b).

I.I. Turyanin paid a great deal of attention to the study of population ecology of muroids, in particular to monitoring the dynamics of their abundance in Transcarpathia (Turyanin 1957b, 1958, 1983). A number of his works are devoted to changes in the abundance of rodents and to their ectoparasites (Turyanin 1965, 1966). The author's parasitological studies also include endoparasites, particularly helminths of rodents and other groups of mammals and vertebrates (Turyanin 1959a, 1969b). I.I. Turyanin obtained important results on the economic and epidemiological significance of rodents in the region (Turyanin 1955, 1959b), which are unique data since in-depth epizootic studies of rodents practically have not been carried out here since the mid-20th century.

M.P. Rudyshin's works are devoted to topics of population ecology and distribution patterns of rodents in the Ukrainian Carpathians. The author thoroughly studied the ecology of the field vole in the region including reproduction, fecundity, distribution and abundance in different types of landscape, specifics of burrow structure depending on substrate conditions, etc. (Rudyshin 1957, 1958a, 1958b). M. P. Rudyshin also investigated in detail the population structure and ecology of the field vole and European pine vole in different ecosystems of the Carpathians, particularly at high altitudes (Rudyshin, 1982a, 1984, 1987).

Regarding other spcies, the author studied the ecology of the brown rat and methods over its control (Rudyshin 1986a), the ecology and distribution of the yellow-necked wood mouse in western Ukraine (Rudyshin 1962), and the edible dormouse as a pest of forests (Rudyshin 1960a). Especially significant is the author's work on the northern birch mouse since it presents the largest number of known records of this rare species in the region (Rudyshin 1982b). M.P. Rudyshin also carried out complex research into the distribution of muroids in different types of landscapes and ecosystems of the Carpathian region (Rudyshin 1960b, 1960c, 1961), as well as into population ecology of rare species (Rudyshin 1986b).

New directions of research, particularly biochemical and morho-physiological, were initiated in the region by O.V. Korchynsky. His first publications were devoted to the possible use of results of serum protein electrophoresis in the systematics of rodents (Korchynsky 1983) and to the specifics of seasonal changes of fractional composition of proteins of mice, particularly in relation to altitudianal zonation (Korchynsky 1977, 1979a). The author also applied the method of morpho-physiological indicatiors in population studies of the striped field mouse and yellow-necked wood mouse under different conditions and revealed that changes of morpho-physiological parameters are related to seasonal, age-sex, and demographic features of populations (Korchynsky 1974, 1980, 1982a).

O.V. Korchynky's research into population ecology of rodents were focused on ecological and age-related structure as well as on population dynamics of the striped field mouse and yellow-necked wood mouse (Korchynsky 1979b, 1982b, 1984, 1986). Contributions to the morphological variation of voles and wood mice by the author have a notable scientific significance (Korchynsky 1987, 1988b, 1990), as well as his survey summarising results of rodent studies carried out in the Ukrainian Carpathians (Korchynsky 1988a). The latter practically became the basis for further revisions of species composition of rodents and source for population ecology data in subsequent fauna surveys.

A signicant scientific value have those few works devoted to the snow vole, a rare species occurring at high altitude. The first such contribution on the species' altitudinal distribution and abundance in the Eastern Carpathians was published in 1961, in which the author noted that

the snow vole in the region is a typical species of stone fields (Firchuk 1961). Later works presented data on new records of the species, specifics of its feeding and other aspects of ecology (Rudyshin 1975; Rohatko 1980, 1984a, 1984b).

At the end of the secod period in the research history of Carpathian rodents a report on finding of a new species for the region—the Tatra pine vole—appeared (Zagorodniuk 1988), which is also the sole endemic mammal species of the Carpathians (Mráz, Ronikier 2016; Barkaszi 2016a). The first cytogenetic study on chromosome sets of some Carpathian rodent species was also published at that time (Baskevich 1988).

The third period (since 1990): a time of restricted research

This stage is characterised by mainly local (within protected areas) and situational (under grants and other projecs) faunal studies, particularly of small mammals. A decrease in activity of mammal research can be traced in the region from the 1980s. Studies supported by grants mainly focused on research and monitoring of bats and rare large carnivorans (wolf, bear, and lynx), so the interest to small mammals has notably fallen in this period, and only two doctoral theses were defended on rodents, both prepared within protected areas (Kyseliuk 1998; Stetsula 2010).

Among the very first publications of this period are the surveys on the mammal fauna of the Carpathian Biosphere Reserve (Dovhanych 1982, 1988) and the analysis of changes in abundance of rodents in Bukovina (Dremliuga et al. 1990). Later works presented analysis of species richness and taxonomic diversity of rodent communities in the Carpathians (Emelyanov, Zagorodniuk 1993) based on the newly developed concept of alternative diveristy in montane communities (Emelyanov, Zagorodniuk 1990, 1993).

In the early 1990s, works devoted to two poorly known rodent species were published. Among them were the confirmations of the Tatra pine vole's occurence in the fauna of the Eastern Carpathians using cytogenetic approaches (Zagorodniuk, Zima 1992) and a survey on its distribution and variation (Zagorodniuk et al. 1992), as well as a study on distribution, variation, and taxonomic status of voles of the genus *Arvicola* (Zagorodniuk 1993b; Zagorodniuk, Peskov 1994). A review of polytypic groups of Carpathian rodents dealing with the issue of cryptic diversity was published at this time too (Zagorodniuk, Peskov 1993), as well as a zoogeographical analysis and a survey on rare small mammals of the Ukrainian Carpathians (Korotkoruchko 1993a, 1993b).

In the 1990s, O.I. Kyseliuk studied the small mammal fauna of protected areas of the Ukrainian Carpathians. His works were devoted to distribution patterns and diversity of small mammals, particularly in different zones of protected areas (Kyseliuk 1993a, 1993b, 1998). A special discovery of this period was the finding of a pygmy wood mouse population at high altitude (Kyseliuk 1993c).

Important contributions in this period were the fauna surveys of protected areas based on current taxonomic views and considering the concept of cryptic diversity with recognition of sibling complexes in the composition of the local fauna and particularly among rodents. These are fauna surveys of the Carpathian Bioshpere Reserve (Zagorodniuk et al. 1997) and of Gorgany Nature Reserve (Kyseliuk, Hodovanets 2000).

In the early 2000s, studies on small mammals of the region were devoted mainly to issues of ecology of rodents, features of small-mammal communities and population dynamics at high altitude and in forest ecosystems of the Carpathians (Kyseliu, 1997, 2001a, 2001b, 2002).

Similar studies were later started in the Skole Beskids National Nature Park led by N.O. Stetsula. She studied population dynamics, demography, and altitudinal distribution of rodents (Stetsula 2007, 2008a; Barabash, Stetsula 2007), as well as rare species that occur in the territory of the park (Khoyetskyi, Stetsula 2008). Especially relevant are the data on distribution of the montane water vole in the Skole Beskids (Stetsula 2006, 2008b). Later, N.O. Stetsula analysed the taxonomic richness and diversity of rondents and of the entire mammal fauna of the park (Stetsula, Obukh 2011; Stetsula 2012a, 2014a), studied the importance of age in diagnostics of morphologically similar species, and biotopic preferences of rodents in the Skole Beskids (Stetsula 2012b, 2014b).

In the mid-2000s, the first studies on the distribution of rodents that appeared in the region due to range expansion (Eurasian beaver and mound-building mouse) were carried out and a monograph was published presenting generalised data on mammals of Transcarpathia (Potish, Bashta 2005; Bashta, Potish 2007, 2012).

The most recent studies have been devoted to the distribution (Barkaszi 2016b; 2017b; Barkaszi, Zagorodniuk 2018; Barkaszi 2019), diversity (Stetsula et al. 2016; Barkaszi, Koval 2019), and diagnostics (Barkaszi 2017a; 2018) of rodents, and to reviews of their taxonomy (Barkaszi, Zagorodniuk 2016), endemism (Barkaszi 2016a), and conservation issues (Zagorodniuk, Barkasi 2018).

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