

Short Communication:

Proportion faunal assemblage of rodents in geocological districts of Mordovia, Russia

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Manuscript received: 26 March 2016. Revision accepted: 6 August 2020.

Abstract. *Andreychev A. 2020. Short Communication: Proportion faunal assemblage of rodents in geocological districts of Mordovia, Russia. Biodiversitas 21: 3961-3968.* In one natural area, animals may have different distribution. They inhabit some areas, while they do not exist. Scientists have been working on this issue for a long time. This study reports that the species composition and species distribution varies depending on geocological districts. Twenty-eight rodent species have been recorded in the territory of Mordovia, Russia. In the region, the largest number of species belongs to coniferous and broad-leaved forests (42.9%). Species widely distributed in several natural areas (28.5%) ranked second place in terms of their representation. They are slightly inferior to the steppe animal species (25%). The taiga fauna is represented by only 3.6% of the total number of registered species. For each geocological district, the features of the rodent fauna are given, and rare species are identified. The forest-steppe region of Mordovia is compared in rodent fauna with other regions of Russia with different typical faunal assemblages.

Keywords: Habitat, population, rodents, Russia, species

INTRODUCTION

A review of the literature on small mammals, mostly rodents, suggests that average population density is highly determined by a balance of the positive effects of resources and the negative effects of enemies and the fact that the strengths of these effects vary depending on habitats. But there is also the density-independent population regulation. Seasonal patterns of population dynamics occur each year because of seasonal breeding and variations in mortality rates. Differences among years occur because of shifts in weather, resources, and enemies (Mapelli et al. 2012; Saetnan et al. 2012; Santos-Filho et al. 2012; Leon et al. 2013; Lobo and Millar 2013; Batzli 2014; Gasperini et al. 2016; Pitelka and Batzli 2018). Understanding the spatial species' distribution sheds light on the group's biogeographical history, offers clues to the diversity drivers, and helps to guide conservation strategies (Maestri and Patterson 2016). However, the abundance and species composition of rodents depend highly on the landscape zone. Therefore, in this paper, we adhere to the term faunal assemblage (Stroud et al. 2015). They propose that the clearest and most comprehensive definition of assemblage should be «a taxonomically related group of species that occur together in space and time» (Stroud et al. 2015).

In Mordovia, studies of mammalian fauna are associated with the period of expedition research of academician Peter Simon Pallas in 1768-1774. For the first time, P.S. Pallas reported on the speckled ground squirrel (*Spermophilus suslicus*) found in Mordovia. In the 2nd part of the message of the Academy of Sciences «Travels to

different provinces of the Russian state», the scientist described in details the habitat of this species: «Gophers are found everywhere along the rivers Pyana and Sura, but not so often; from there, the further South and East, more often». In the initial review work on birds and mammals of the middle and lower Volga valley, M. N. Bogdanov (1871) gave the first mention of 35 species of mammals from the modern territory of Mordovia. Before the formation of the Mordovian Autonomous region (1930), data on some new mammal species for this region were reported for the territories of four provinces: Tambov, Nizhny Novgorod, Penza, and Simbirsk, some of which were part of modern Mordovia. Subsequently, the mammal fauna of the region was updated with information about new species.

In this paper, we present new information on the rodent fauna of the Mordovia, identify the distribution of these species along with the geocological districts in the study area.

MATERIALS AND METHODS

Republic of Mordovia is located in the center of the European part of the Russian Federation. Its extreme borders are defined by geographical coordinates 42° 11'-46° 45' E and 53° 38'-55° 11' N (Figure 1). The maximum distance from west to east is 298 km and the distance from north to south is between 57 and 140 km. The area of the Republic of Mordovia is 26.200 km². Features of the geological structure of Mordovia are determined by its location in the central part of the Russian plain and the north-western slopes of the Volga Upland. In the western

part of the Republic of Mordovia, the Volga Upland reaches the Oka-Don Lowland.

The climate of the region is moderately continental with pronounced seasons throughout the year. The average annual air temperature varies from 3.5 to 4.0°C. The average temperature of the coldest month (January) is between -11.5 and -12.3 °C. Temperature declines to -47 °C are occurred. The average temperature of the warmest month (July), is between +18.9 and +19.8 °C. Extreme summer temperature values reach 37 °C. In Mordovia, the average annual precipitation is 480 mm. Flora of the Republic of Mordovia is represented by 1448 species including 1411 angiosperms, 18 ferns, 7 horsetails, 6 lycophytes, 6 conifers (Silaeva et al. 2010, 2019).

All eleven geoeological districts of Mordovia belong to three types of landscapes (Yamashkin 2001). Landscapes of broadleaf forests and forest-steppes of erosion-denudation plains include Insarskiy, Vostochniy, and Yugo-Vostochniy geoeological districts. The landscape is

characterized by a strongly eroded elevated terrain, where the arc-shaped watershed of rivers Sura and Alatyr is clearly distinguished. A typical feature of the terrain is the spread of steep slopes. Landscapes of broadleaf forests and forest-steppes of secondary morainic plains of the Volga upland include Yuzhniy, Moksha-Vadskiy, Issa-Sivinsky-Rudninsky and Menya-P'yanskiy geoeological districts. A characteristic feature of this landscape is a well-defined slope change of natural territorial assemblage from watersheds to the valleys of medium-size rivers. Landscapes of mixed forests of water-glacial plains of the Oka-Don lowland and valleys of large rivers include Mokshinskiy, Vadskiy, Prialatyrskiy, and Surskiy geoeological districts. Water-glacial plains composed of sand with thin layers of loam. Groundwaters have a sporadic distribution. They are located at different depths. It causes a large mosaic in the degree of moisture content of natural assemblage. Features of the zonal position determine the presence of steppe and taiga elements here.

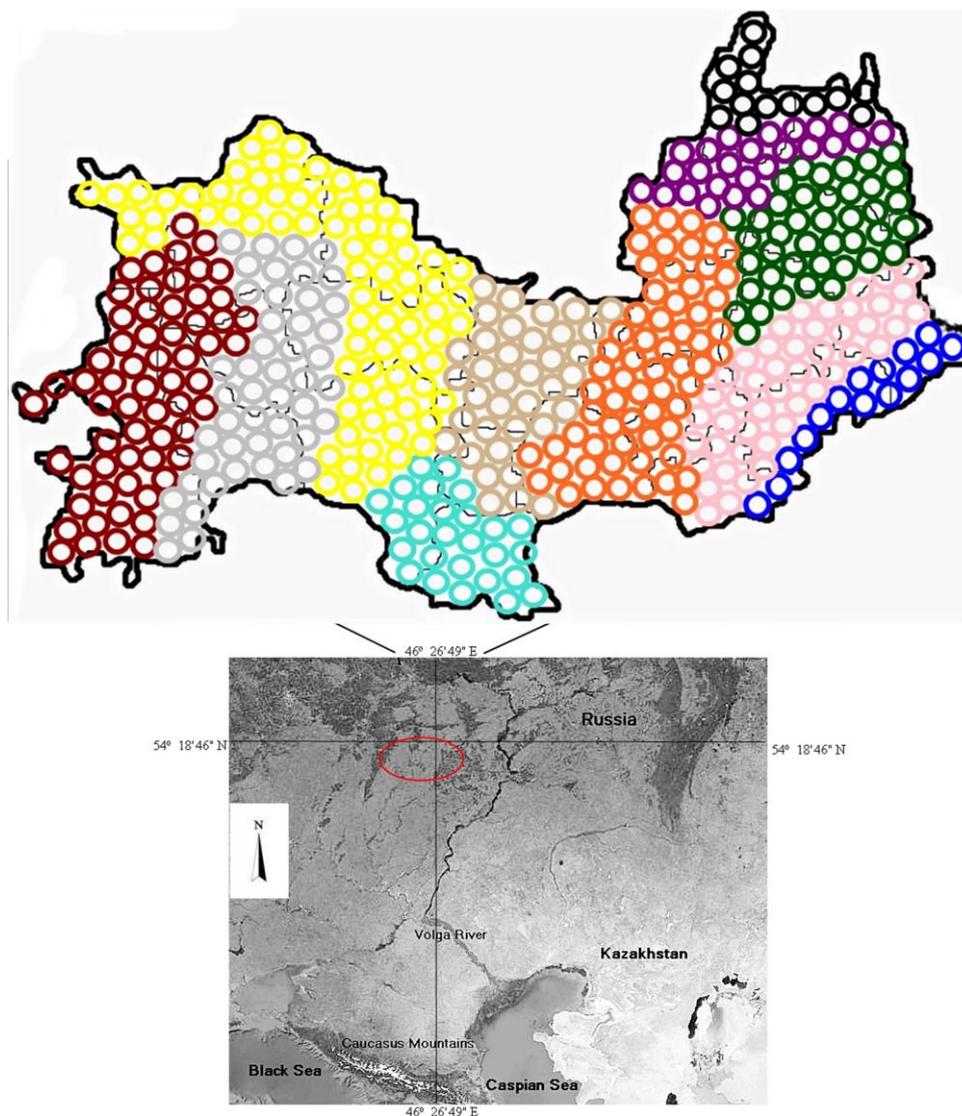


Figure 1. Location of geoeological districts in Mordovia, Russia (red oval: where animals were trapped). Note: red circle: Vadskiy district, yellow circle: Mokshinskiy district, grey circle: Moksha-Vadskiy district, blue circle: Yuzhniy district, brown circle: Issa-Sivinsko-Rudninskiy district, orange circle: Insarskiy district, purple circle: Prialatyrskiy district, green circle: Vostochniy district, pink circle: Yugo-vostochniy district, dark blue circle: Surskiy district, black circle: Menya-P'yanskiy district

The material for this study was registered using the captures and visual registrations of rodents, as well as the collection of pellets of bird of prey (*Bubo bubo*, 585 pellets, *Strix uralensis*, 146 pellets, *Aquila heliaca*, 74 pellets) in the Republic of Mordovia. The material was collected during expedition and stationary research in different districts of Mordovia in 2006-2019. In the geoecological districts, for the highest coverage of the species composition, the following habitats were selected to study: (i) mixed forest; (ii) oak wood; (iii) aspen forest; (iv) meadow; (v) agricultural field; (vi) swamp; (vii) human construction.

The rodent species were identified using E.A. Schwartz (1989) (Table 1). Latin names of species are given according to Wilson and Reeder (2005). Based on these studies, taking into account the ranges of rodent species, the representation of various faunal assemblages along the geoecological districts of Mordovia was determined.

RESULTS AND DISCUSSION

In Mordovia, 28 rodent species were recorded (Andreychev et al. 2014, 2016; Andreychev and Lapshin 2017). Of these, in the region, the highest number of species is found in coniferous and broad-leaved forests (42.9%). In the second place in terms of representation are species widely distributed in several natural areas (28.5%). In terms of number of species, they are slightly inferior to steppe species (25%). The taiga type of fauna is represented by only 3.6% of the total number of registered species. In geoecological districts, the distribution of species is not even (Figure 2).

In the Insarskiy geoecological district, the analysis of the rodent species composition for belonging to the fauna types showed a considerable number of representatives of widespread in several natural zones of the steppe faunal assemblage (42.9%). Species of coniferous and broad-leaved forests (35.7%) and steppe faunal assemblages (21.4%) were less represented. Among the representatives of the steppe faunal complex, three species (*Marmota bobak*, *Spermophilus suslicus*, *Spalax microphthalmus*) are rare (Figure 3) not only in the district, but also in the whole of Mordovia (Andreychev et al. 2015; Andreychev 2018, 2019). Only in this area, the settlements of the blind mole rat *S. microphthalmus* are concentrated. Here its population has a vulnerable state, as in other parts of its range (Zagorodniuk et al. 2018). The Eurasian harvest mouse has the highest number of locations in this district compared to other ones.

In Vostochniy geoecological district, the dominants in terms of faunal types are species widely distributed in several natural zones (50%). The second position in terms of number is occupied by species preferring coniferous and broad-leaved forest (41.7%). The least represented species are assigned to the steppe faunal complex (8.3%). This district has habitats suitable for steppe species such as the bobak marmot, speckled ground squirrel, and great jerboa. For the bobak marmot, grazing impact is important, as it

was shown in Ukraine (Rashevskaya and Semeniuk 2015; Tokarskiy 2015; Savchenko and Ronkin 2018).

In the Yugo-Vostochniy geoecological district, the rodent species composition was characterized by a relatively high number of representatives of the steppe faunal complex (24.9%). These are the following species: bobak marmot, speckled ground squirrel, great jerboa, common hamster. This district has the highest concentration of settlements and the largest population of bobak marmot in Mordovia. Species widely distributed in several natural zones (43.8%) are predominated over species of coniferous-deciduous forests (31.3%).

In Yuzhniy and Moksha-Vadskiy geoecological districts, we found an equal ratio of species groups widely distributed in several natural zones (50%) and living in coniferous and broad-leaved forests (50%). Steppe and taiga species are not found here.

According to the rodent fauna structure, Issa-Sivinsky-Rudninsky geoecological district is distinguished by the predominance of widespread species in several natural zones (50%) and species of coniferous and broad-leaved forests (42.5%). One of the rare representatives preferring coniferous-deciduous forests in this district area is the hazel dormouse. The species of the steppe faunal complex accounted for about 7.5%.

In relation to the faunal assemblage, Menya-P'yanskiy district is represented by two predominant groups of species widely distributed in several natural zones (45%) and living in coniferous-deciduous forests (37%). The steppe fauna type contains 18% species. Here, on the border with the Nizhniy Novgorod oblast, the bobak marmot is known.

The analysis of rodent species registered in the Mokshinskiy district, belonging to the fauna types, showed their heterogeneity. Rodents of coniferous and broad-leaved forests (50%) were represented by the highest number of species. The proportions of representatives of the other three fauna types are distributed as follows: widespread species (31.8%), steppe (13.6%), and taiga (4.6%). In this region, the taiga fauna is represented by the red vole, which is a quite rare species. The high species diversity of rodents (22 species) in this district is caused by the presence of a high number of Protected Areas. First of them is the Mordovia State Nature Reserve where the following rare species are registered: forest dormouse, edible dormouse, garden dormouse, grey hamster, steppe lemming, Northern birch mouse, harvest mouse, Eurasian beaver.

The Vadskiy geoecological district is dominated by widespread species (46.6%) and coniferous-deciduous forests (46.6%). The district area is almost completely covered with forest. For this reason, there is a high number of species such as the bank vole, yellow-necked mouse, Ural field mouse, and red squirrel. Due to the dense network of forest rivers and lakes, a high number of Eurasian beaver populations is known here (Andreychev 2017). Due to the almost complete absence of biotopes preferred by steppe species, their representation here is minimal (6.8%).

Table 1. The species composition of rodents in Mordovia, Russia belonging to faunal assemblages

Taiga	Faunal assemblage		
	Coniferous and broadleaf forests	Steppe	Widely distributed in several natural areas
<i>Clethrionomys rutilus</i> (Pallas, 1779), northern red-backed vole	<i>Clethrionomys glareolus</i> (Schreber, 1780), bank vole	<i>Spermophilus suslicus</i> (Güldenstaedt, 1770), Speckled ground squirrel	<i>Sciurus vulgaris</i> (Linnaeus, 1758), Eurasian red squirrel
	<i>Microtus arvalis</i> (Pallas, 1779), common vole	<i>Spalax microphthalmus</i> (Güldenstaedt, 1770) greater mole rat	<i>Arvicola terrestris</i> (Linnaeus, 1758), European water vole
	<i>Microtus agrestis</i> (Linnaeus, 1761), field vole	<i>Marmota bobak</i> (Müller, 1776), bobak marmot	<i>Microtus oeconomus</i> (Pallas, 1776), root vole
	<i>Pitymys subterraneus</i> (de Selys-Longchamps, 1836), European pine vole	<i>Lagurus lagurus</i> (Pallas, 1773), steppe lemming	<i>Ondatra zibethicus</i> (Linnaeus, 1766), muskrat
	<i>Castor fiber</i> (Linnaeus, 1758), Eurasian beaver	<i>Cricetulus migratorius</i> (Pallas, 1773), grey hamster	<i>Mus musculus</i> (Linnaeus, 1758), house mouse
	<i>Dryomys nitedula</i> (Pallas, 1779), forest dormouse	<i>Cricetus cricetus</i> (Linnaeus, 1758), common hamster	<i>Micromys minutus</i> (Pallas, 1771), Eurasian harvest mouse
	<i>Eliomys quercinus</i> (Linnaeus, 1766), garden dormouse	<i>Allactaga major</i> (Kerr, 1792), great jerboa	<i>Apodemus agrarius</i> (Pallas, 1771), striped field mouse
	<i>Muscardinus avellanarius</i> (Linnaeus, 1758), hazel dormouse		<i>Rattus norvegicus</i> (Berkenhout, 1769), brown rat
	<i>Glis glis</i> (Linnaeus, 1766), edible dormouse		
	<i>Sicista betulina</i> (Pallas, 1779), northern birch mouse		
	<i>Apodemus uralensis</i> (Pallas, 1811) Ural field mouse		
	<i>Apodemus flavicollis</i> (Melchior, 1834), yellow-necked mouse		

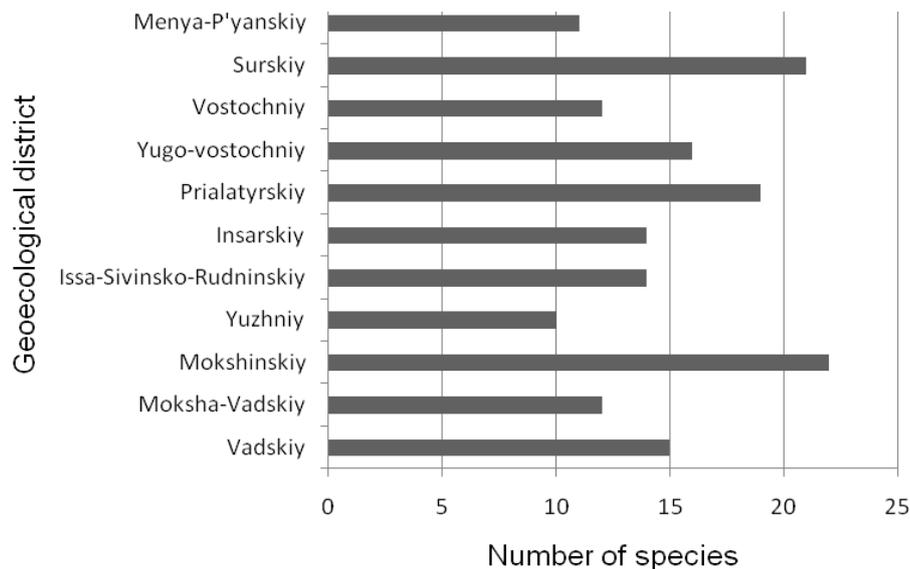
**Figure 2.** Number of rodent species in the geoeological districts of Mordovia, Russia



Figure 3. Photo of rare rodents in Mordovia, Russia. A. Edible dormouse (*Glis glis*); B. Greater mole rat (*Spalax microphthalmus*); C. Bobak marmot (*Marmota bobak*); D. Eurasian harvest mouse (*Micromys minutus*); E. Forest dormouse (*Dryomys nitedula*); F. Speckled ground squirrel (*Spermophilus suslicus*). (Photographs by A. Andreychev)

In the Prialatyrskiy district, the complex of coniferous-broadleaf forest species is of great importance for belonging to the faunal types (57.9%). This is the highest representation of this fauna type among all the geoeological districts in the Republic of Mordovia.

Species widespread in several natural zones account for 36.8%. The steppe faunal complex is represented by 5.3% of rodent species. The district is characterized by the presence of many rare rodent species. It is home to Northern birch mouse, forest dormouse, hazel dormouse,

edible dormouse, harvest mouse, Eurasian beaver. European pine vole (*Pitymys subterraneus*) was not registered in our catches. However, in 2019, it was captured for the first time in the Republic of Mordovia (Kirillova et al. 2019). We consider it appropriate to provide data on catches of this vole. One instance of an underground vole was captured on 4 May in an abandoned vegetable garden in the village Obrezki. This record testifies the easternmost occurrence of *M. subterraneus*. Previously, the underground vole was recorded in regions adjacent to Mordovia, namely in the vicinity of the village Zhelannoe in the Ryazan oblast and in the Zemetchinskiy district of the Penza oblast. This species is rare and included in many regional Red Data Books of Russia: Leningrad oblast (Red book 2002), Tver oblast (Viktorov and Istomin 2002), Penza oblast (Bystrakova 2019), Moscow oblast (Yemelyanova 2008), Pskov oblast (Istomin 2014), and Novgorod oblast (Doynikova 2015). The appearance of a species new for Mordovia can be explained by its range extension. This is confirmed by the registration of this new species in the Smolensk oblast, too (Belyaev 2020).

In the Surskiy geoeological district, coniferous and broad-leaved forest types predominate (42.9%). To a lesser extent, there are species that are widely distributed in several natural areas of the forest (33.3%) and the steppe faunal complex (23.8%). This, Surskiy, riverine district, as well as Mokshinskiy, Prialatyrskiy district, also have a high species diversity. There are 21 species of rodents. Here, such rare species are noted: forest dormouse (Andreychev and Boyarova 2020; Andreychev and Kiyaykina 2020), hazel dormouse, great jerboa, bobak marmot, speckled ground squirrel, steppe lemming, Eurasian beaver, pygmy field mouse, harvest mouse.

Thus, our analysis of the proportions of faunal assemblages showed the highest representation of rodents in the geoeological districts of the landscape of mixed forests of the water-glacial plains of the Oka-Don lowland and the valleys of large rivers.

In discussing the results, it is of great interest to compare the distribution of the identified rodent species by faunal types in Mordovia with other regions of different natural zones, particularly, Saratov oblast, which belongs to the steppes of the European part of Russia. Thirty-two rodent species have been recorded in this region (Shlyakhtin et al. 2008). Of these, the highest number of species belongs to the steppe fauna type (53.1%). The second type most represented by species are coniferous and broad-leaved forests (25%). They are slightly inferior to the species widely distributed in several natural zones (21.9%). Present diversity patterns of the studied steppe species suggest that they share a unique genetic signature; and distinct assemblages exist in each of the now isolated areas rich in steppe habitats (Kajtoch et al. 2016).

We compared the rodent fauna in Mordovia with the Vladimir oblast belonging to the zone of coniferous-broad-leaved (mixed) forests. Twenty rodent species have been recorded in this region (Kuzmin and Serbin 1998). Of them, the highest number of species is found in coniferous and broad-leaved forests (55%). Species widely distributed

in several natural areas (40%) are ranked second place in terms of representation. The steppe fauna type is represented by only 5% of the total number of registered species. This region is similar to Mordovia in terms of the predominance of two fauna types. The difference is caused by the low diversity of steppe fauna compared to the lack of taiga fauna species compared to Mordovia. A similar situation was noted in mountain forest ecosystems of the Beskydy Mountains (Suchomel et al. 2014). The highest diversity was observed in primeval forests.

We compared the rodent fauna of Mordovia with Karelia belonging to the taiga. Twenty-two rodent species have been recorded in this region (Ivanter 2008). Of them, the highest number of species belongs to two fauna types, including widespread in several natural zones (43%) and inhabiting coniferous and broad-leaved forests (38%). The taiga fauna type is represented by 19% of the total number of registered species. Karelia is also similar to Mordovia in terms of the predominance of two fauna types. However, in Mordovia, a considerable predominance of fauna of coniferous and broad-leaved forests over the fauna of species widely distributed in several natural zones was revealed. A notable difference between the rodent fauna of Karelia is a high proportion of taiga species, compared with Mordovia. In Karelia, the responses to concentrated cuttings include a decrease in total population size, transition to an arrhythmic population dynamics with drastic short-term rises and deep long depressions, formation of unstable mosaic spatial distribution, disturbances of the reproduction rates, and a decrease in reproduction intensity (Ivanter and Kurhinen 2016). In Mordovia, concentrated cuttings are not produced. So, the total population size of insectivorous mammals is relatively stable. The biogeographical history of *M. rutilus* differs from other boreal forest-associated species. Well-differentiated clades and the existence of secondary contact zones indicate prolonged isolation and persistence in Eurasian refugia (Kohli et al. 2015).

Thus, we want to emphasize the features of distinguishing Mordovia by the proportion of different assemblages. Firstly, this is the uniqueness of this region, where both steppe and taiga species are found. This is not related to many other regions. It is no coincidence that Mordovia is called a forest-steppe region. Secondly, it is a transitional zone between the steppe faunal assemblage and the faunal assemblage of coniferous and broadleaf forests. This is evidenced by the almost equal proportion of steppe species and species widely distributed in several natural areas.

In Mordovia, the proportion of rodent species of the total number of mammal species is 37%. This is the highest indicator among other animal groups. Insectivores (16%) (Andreychev 2020) are somewhat inferior to rodents. In comparison to Cisokan, Cianjur, West Java, Indonesia, the proportion of rodent species from other mammals is higher (Withaningsih et al. 2018; Husodo et al. 2019). This is a feature differing Mordovia of many other mammal faunas, where representatives of the other animal orders predominate (Wirdateti et al. 2013; Sulistyadi 2016; Medina et al. 2018; Shanidah et al. 2018). We assume that

the geographic latitude of the area inhabited by rodent species may be decisive in this difference. Indisputable influence is exerted by climatic conditions. Our research covers the northern sections (ca. 54° N), while in Indonesia these are the southern sections (ca. 6° S), and in Peru these are the southern sections (ca. 10° S). Thus, possible causes for the higher proportion of rodents in Mordovia are more severe living conditions, which are less suitable for bats.

ACKNOWLEDGEMENTS

I am grateful to E.A. Ilykaeva, A.V. Salaeva, E.O. Levtsova, S.A. Yutukova, M.N. Suharnikova for support in carrying out of field studies.

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