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SMALL MAMMALS IN THE UPPER BELTS OF THE URAL MOUNTAINS[1]

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SUMMARY.- Distribution of rodents in the upper belts of the Ural mountains in comparison with that in the lower belts and the adjacents plains is reviewed based on the many year data obtained by the authors and taken from the literature.

RESUMEN.- Se revisa la distribución de los roedores en los pisos superiores de los Urales en comparación con la de los cinturones inferiores y las llanuras adyacentes. Los resultados se basan en los datos obtenidos por los autores después de muchos años y en la información que aporta la bibliografía.

RESUMÉ.- On revoit la distribution des rongeurs dans les étages superieurs des monts Ourals en comparasion avec la distribution dans les étages inférieurs et les plaines adjacentes. Les résultats se sont appuyés dans les données obtenus par les auteurs après de beaucoup d'années de travail et dans l'information qu'apporte la bibliographie.

Key words: *Rodents, spatial distribution, altitudinal belts, Ural mountains.*

The Ural chain, that extends for over 2000 km through a variety of zones from tundra in the north to steppe in the south (Fig. 1), is an interesting object for research into the peculiarities of animal distribution in landscape zones and the corresponding altitudinal belts. According to B. A. BYKOV (1954), altitudinal belts, always connected with landscape zonality, can be normally recognized only in latitudinally orientated chains, like the Urals.

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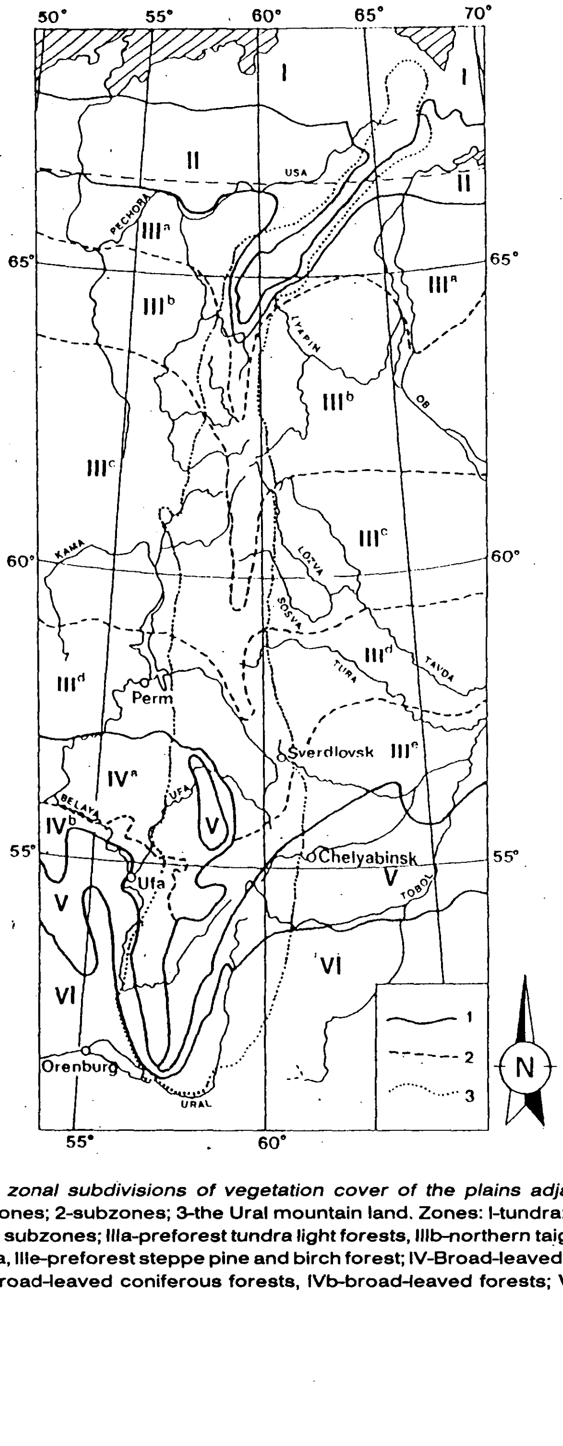

Fig. 1. *The main zonal subdivisions of vegetation cover of the plains adjacent to the Urals.* Boudaries of: 1-zones; 2-subzones; 3-the Ural mountain land. Zones: I-tundra; II-forest-tundra; III-boreal forest with subzones; IIIa-preforest tundra light forests, IIIb-northern taiga, IIIc-middle taiga, IIId-southern taiga, IIIe-preforest steppe pine and birch forest; IV-Broad-leaved forests with subzones; IVa-mixed broad-leaved coniferous forests, IVb-broad-leaved forests; V-forest steppe; VI-steppe.

P. L. GORCHAKOVSKY (1975) distinguishes the following altitudinal belts of vegetation in the Urals: montane-steppe, montane-forest-steppe, montane-forest, subgoltsy, montane tundra (goltsy) and cold goltsy desert.

The following phytogeographical zones and subzones are distinct in the plains adjacent to the Urals and the analogous altitudinal belts-in mountain regions (Fig. 2):

1. Tundra zone. The analogue of plain tundras in the mountains is montane tundras lying far southwards int the highest part of the chain.
2. Forest-tundra zone. Some phytocoenoses of the subgoltsy belt are similar to plain forest-tundra.
3. Boreal forest zone. Montane-forest belt analogous with the boreal forest zone is all along the slopes of the Ural chain, from 52 to 62° North.

3a. Subzone of preforest-tundra light forests. Its analogue in the mountains is forest in the lower part of the slopes of the prepolar and northern Urals: spruce forests on the western slope, larch and spruce-larch ones on the eastern side.

3b. Northern taiga subzone. Swamp light dwarf forests. In the mountains forests such as plain northern taiga extend far southwards. They are represented by spruce, fir, siberian pine and less frequently- by pine forests.

3c. Subzones of the middle and southern taiga. Forests are more dense, with diverse components. The forests of this subzone are analogous with mountain pine and birch forests and merge with them.

4. Broad-leaved forest zone. Broad-leaved or mixed coniferous-broad-leaved forests of the European type predominate. In the mountains similar forests can be found only on the western macroslope of the southern Urals.
5. Forest-steppe zone. The analogue of plain forest-steppe in the mountains is montane forest-steppe.
6. Steppe zone. Original steppe vegetation is almost completely destroyed in the plains of the Preurals and Transurals due to soil cultivation. In the mountains similar steppe communities are few and can be found only in the southern extremity, the Irendyk chain.

Although small mammals of the Urals are considered to have been well studied, they were actually investigated mostly in plain regions or in the lower belts.

In the last 20 years a great deal of research into small mammals in the mountain regions of the Urals has been undertaken by zoologists from the Institute of Plant and Animal Ecology, Ural Division of the Academy of sciences of the USSR. Special expeditions and studies at research stations all along the range permitted detailed analysis of the spatial distribution of animals over an altitudinal gradient, their ecology, adaptations to specific environmental conditions, etc.

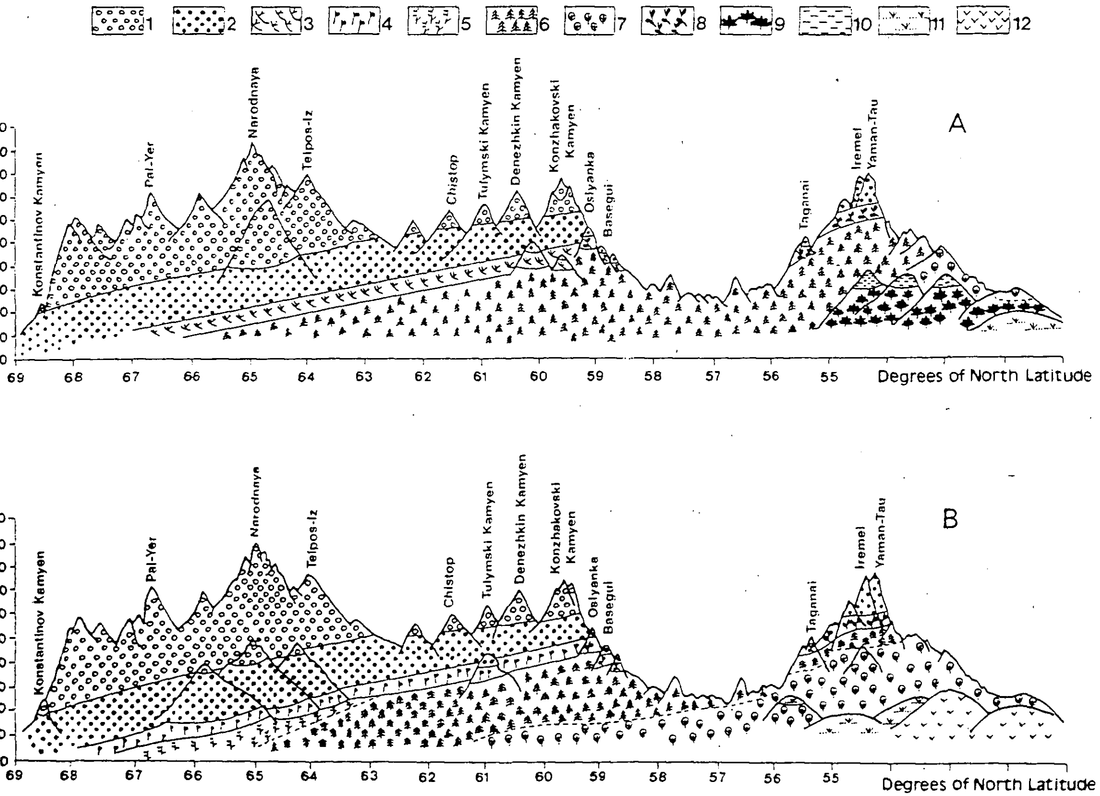

Fig. 2. *Distribution of vegetation in altitudinal belts.* A-eastern, B-western slopes of the Ural mountains. 1. cold goltsy deserts; 2. montane tundras; 3. open crook-stem birch woodlands with forest meadows; 4. subgoltsy larch open woodlands; 5. mountain larcha woodlands of the preforest tundra type; e. mountain spruce forests; 7. mountain pine forests; 8. subgoltsy fir-spruce parklands with forest meadows; 9. mountain broad-leaved (oak, lime, maple) forests; 10. subgoltsy open crook-stem oak woodlands with forest meadows; 11. mountain forest steppe; 12. mountain steppe.

The distinguishing feature of the mountain part of the Ural region, compared to the adjacent plains, is the penetration of faunistic groups elements from composition of rodents. Thus, of 38 species found in the Ural region 31 were from the mountain area. It is advisable to compare distribution of rodents in the whole mountain area with that in the upper belts and stone fields to better understand their spatial distribution (Table 1). The table gives only terrestrial mice-like rodents. The numbers characterize relative abundance of each species according to MARVIN (1969): common species, 4; rare, 3; very rare, 2; single, 1; absent, 0. Based on these estimates (abundance in the whole area versus elevated biotopes) all species may be subdivided into the following groups in their relation to elevated biotopes:

Group 1: species belonging to those ecological forms for which conditions of the upper belts are unsuitable and which were not met: synanthropic (Norway rat, house mouse); meadow-field plain species of the forest-steppe zone (*Apodemus agrarius, Sicista subtilis,* a nominal subspecies of *Microtus gregalis, Apodemus flavicollis,* the inhabitant of broad-leaved forests; *Ondatra zibethica* confined to slow waters; *Ellobius talpinus,* a specialized excavator).

Group 2: species of different ecological requirements, seldom occuring in elevated biotopes and much more frequently in the lower belts of the Urals (*Arvicola terrestris;* "the southerners" *Cricetus cricetus, Micromys minutus, Apodemus sylvaticus;* the inhabitants of zonal tundras: *Discrostonyx torquatus* and *Lemmus sibiricus.* Representatives of these species are not residents of the investigated habitats. Of this group is *Myopus schisticolor* rare in the Urals and restricted to swampy moss habitats and therefore not appearing at high altitudes (except a local population recorded in Iremel).

Group 3: species rare both in the whole mountain area and in the upper belts, although rather numerous in some locations. They are *Microtus middendorffi* recorded only in the goltsy belt tundras; *Sicista betulina* and *Microtus arvalis* unconfined to any particular biotope.

Group 4: *Microtus agrestis* and *Microtus oeconomus,* both typical of the Ural mountains but less dense in the upper belts.

At first sight, this is because grass-feeding *Microtus* are short of suitable food at high altitudes. This suggestion is supported by multiple observations of field voles in high-forb meadows of the subgoltsy belt of the prepolar Urals. However, some facts indicate that other explanations are possible.

Group 5: *Clethrionomys* common both in the whole mountain area and in the upper belts.

Thus, the upper belts are inhabited mainly by *Clethrionomys* and some *Microtus,* common through the forest zone, from forest-steppe to forest-tundra. Totally, 15 mice-like rodent species have been reported here (Table 1).

TABLE 1
Occurence of rodents in the whole mountain area and the upper belts of the Ural mountains.

	whole area	*upper belts*
Sicista subtilis	3	0
Sicista betulina	3	2
Rattus norvegicus	4	0
Mus musculus	4	0
Apodemus agrarius	4	0
Apodemus sylvaticus	4	2
Apodemus flavicollis	3	0
Micromys minutus	3	1
Cricetus cricetus	4	2
Myopus schisticolor	3	2
Lemmus sibiricus	3	1
Dicrostonyx torquatus	3	1
Clethrionomys glareolus	4	4
Clethrionomys rutilus	4	4
Clethrionomys rufocanus	4	4
Arvicola terrestris	3	1
Microtus arvalis	3	3
Microtus middendorffi	3	3
Microtus agrestis	4	3
Microtus oeconomus	4	3
Microtus gregalis	3	0
Ondatra zibethica	3	0
Ellobius talpinus	3	0

Nine species were recorded in habitats connected with stone-fields, seven in the stone-fields themselves. These habitats lacked the typical tundra species *(Dicrostonyx torquatus, Lemmus sibiricus, Microtus middendorffi)*, hydrophylous species *(Arvicola terrestris, Microtus oeconomus)* as well as *Micromys minutus, Sicista betulina* and *Myopus schisticolor*.

The inference from our research is that stone-fields in the southern parts of the chain are innabited by nearly the same number of species as the upper belts; in the northern parts they are occupied by only 2 species irrespective of the number of species in the upper belts. The Middle Urals is a transitional zone: of 6 species found in the upper belts 4 are inhabitants of stone-fields. Further analysis of the faunistic similarity and distinction in the upper belts and in stone-fields was made using the Ochiai similarity index (OCHIAI, 1957):

$$K = \frac{C}{a.b} \; . \; 100\;\%$$

where a and b -the number of species in the 2 compared faunas, C- the number of species occuring in both faunas.

This measure was chosen for its lesser dependence on differences in the number of species in each fauna than other measures based on the summation of elements in the compared lists (Measures of Kulchinsky, Jaccard, Sørensen). Besides, it has better resolution than measures dealing with maximal and minimal values of lists (Sympson's measure, measures of similarity) inclusion developed by ANDREYEV (1979a), SEMKIN (1979), PESENKO (1982).

	1	2	3	4	5	6	7	8
1	2 \ 2	2	2	1	0	0	0	0
2	1	4 \ 5	5	4	3	3	3	2
3	2	4	7 \ 8	5	5	4	5	3
4	0	2	3	3 \ 6	5	4	4	3
5	0	1	2	2	2 \ 7	4	6	3
6	0	2	3	3	2	3 \ 4	4	3
7	0	1	2	2	2	2	2 \ 9	5
8	0	1	2	2	2	2	2	2 \ 7

Fig. 3. *Matrix of comparison of the number of common species in different locations of the Urals.* 1st row and 1st column-numbers of locations: 1. Mugodgars, 2. Irendyk, 3. Kukshik (2,3-southern Urals), 4,5-middle Urals, 6. northern Urals, 7. prepolar Urals, 8. polar Urals. The upper right part: the number of species common of each pair of locations in the upper belts; the lower left part: that in lithomorphic habitats. The numbers in the diagonal squares are the number of species in each location in the upper belts (above the diagonal) and in lithomorphic habitats (below the diagonal).

Fig. 3 gives a matrix of the number of species common for each pair of the compared areas. From the data of this table a matrix of similarity measures was calculated ($K_{i,j}$) (Fig. 4).

	1	2	3	4	5	6	7	8
1		63,2	50,0	28,9	0	0	0	0
2	35,4		79,0	73,0	50,7	67,1	44,7	33,8
3	53,4	75,6		72,6	66,8	70,7	58,9	40,1
4	0	57,7	65,4		77,2	81,6	54,4	46,3
5	0	35,4	53,4	81,6		75,6	75,6	42,8
6	0	57,7	65,5	100,0	81,6		66,7	42,8
7	0	35,4	53,4	81,6	100,0	81,6		63,0
8	0	35,4	53,4	81,6	100,0	81,6	100,0	

Fig. 4. *Matrix of measures of similarity ($K_{i,j}$) of rodent fauna in different locations of the Urals.* Numbers of locations like in Fig. 3.

($K_{i,j}$) is measure of similarity of areas i and j (i,j = 1, 2.... 8). It is seen from the matrix of similarity measures that the fauna of mice-like rodents in the southern extremity of the southern Urals (1) is maximally different from that in other regions, as might be expected from their geographical location.

Similarity in species composition in the upper belts is more pronounced in the neighbouring locations, it gradually decreases as the distance between the compared locations increases (K_{ij} values - in the squares adjacent to the diagonal).

In stone-fields the fauna of all regions northward of the Middle Urals are identical.

The analysis of the fauna has shown that stone-fields are interzonal habitats which provide stable ecological conditions. So, they are less dependent on zonal-climatic conditions than other biotopes of the upper belts.

This conclusion is supported by the analysis of the distribution of individual species in the stone-fields of the Urals.

As mentioned above, of fifteen species spread over the upper belts seven were found in the stone-fields. The species occuring in stone fields are distributed unequally along the Ural chain. *Sicista betulina* and *Microtus arvalis* live in the stone-fields of Mugodgars and south Urals, while other species occuring in the Ural stone fields are not observed here.

Microtus arvalis is probably resident of stone fields only in the Mogodgars, as it was present here in spring before the birth of the young at low population density, while in stone fields of the south Urals it was recorded in late summer and never more.

Apodemus sylvaticus is resident of Mugodgars stone fields and, perhaps, Irendyk, although in 1976 catches it was absent. Under similar conditions in the Tien Shan *Apodemus sylvaticus* constantly inhabits stone field margins in the forest-meadow-steppe zone (ZIMINA, 1962). In the Caucasus it is also common in stone fields (JASNY, 1978). In the southern and middle Urals *Apodemus sylvaticus,* and *Microtus arvalis* occupies other elevated biotopes.

Microtus agrestis can be found in stone fields only in the southern and middle Urals and only in some periods. In general, this species ranges over vast areas from southern to polar Urals.

Clethrionomys glareolus constantly occupies stone fields only in the southern and middle Urals, other upland habitats -from Irendyk to prepolar Urals. *Clethrionomys rutilus* is distributed both in stony and other biotopes from Kukshyk to the polar Urals; however, in the south Urals (and in some periods in the middle Urals) its populations in stone-fields are not resident.

Constantly and everywhere from the southern to polar Urals stone fields are inhabited by *Clethrionomys rufocanus.* Until recently the southern boundary of its range in the Urals was Beloretsk region, Bashkir ASSR, i.e. it did not pass the limits of the forest zone (BOLSHAKOV 1963, 1975).

It has been found lately that the species penetrates further southward at least 120 km, as far as Irendyk, i.e. the forest-steppe zone. It should be noted that the only biotope the species occupies here is stone-fields. In the other areas to the north the species can occur in other biotopes of the upper belts but only in some periods -evidence that *Clethrionomys rofocanus* is petrophilous in the Urals and occupies an ecological niche which is filled by specialized mountain species in other mountain lands. Thus, the fauna of stone-fields in the Urals is formed of wide-spread eurytopic *Clethrionomys* species (one of which, *Clethrionomys rufocanus,* is an ecological vicariant of specialized petrophilous species) and of not numerous representatives of some other species spread throughout the Urals and able to settle in the upper belts.

Plain tundra species that penetrate through montane tundras probably cannot survive in typical mountain stony habitats. In the Mugodgars, located in the semi-desert zone and isolated by a vast valley of the Ural river, stone fields are inhabited by more southern forms, *Microtus arvalis* and *Apodemus sylvaticus.*

More northern and fairly stable conditions in stony habitats (as in other biotopes of the upper belts) permit the northern species to penetrate along the Ural chain into unusual latitudinal climatic zones further south in accordance with the principle of station change (BEJ-BIENKO, 1966).

The extent of penetration is largely dependent on the ecological peculiarities of each species.

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