

Small Mammals (Rodentia, Lagomorpha, Carnivora) of the Southern Trans-Urals in the Atlantic Period of the Holocene

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Abstract—Studies of 5800 samples of bone and tooth fossils of rodents, lagomorphs, and carnivores collected from loose deposits of Chernyshevskaya-III Cave (52°38' N, 58°53' E; Kizil district, Chelyabinsk oblast, Russia) have allowed for the composition and structure of small mammal communities that inhabited the Southern Trans-Urals in the final stage of the Atlantic period (5210 ± 90 years BP, Ki-15500) of the Holocene to be described. The communities included 30 taxa belonging to three orders: Carnivora, Lagomorpha, and Rodentia, with six, two, and 22 species, respectively. The narrow-skulled vole (49%) dominated in the species structure of herbivorous small mammal communities. Codominants were the steppe lemming and the common vole (about 11% each). Steppe (19%) and meadow (18%) groups of species were widespread at that time. Forest and riverside species were also present (about 4% in each group). The existence of the zonal steppe type of small mammal communities with significant participation of mesophilic (mainly meadow) elements is reconstructed for the Southern Trans-Urals for that time. The data obtained reveal humid conditions in the study area during the final stage of the Atlantic phase of the Holocene period.

Keywords: small mammals, Atlantic period, Southern Trans-Urals, Middle Holocene

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INTRODUCTION

The Atlantic period of the Holocene (8–4.8 ka BP) is characterized by an increase in the mean global temperatures by 0.7°C compared to the present (*Klimaty...*, 2010). The climatic optimum of the Holocene falls on the final stage of the Atlantic period (AT3), during which, for example, the tundra zone was absent in Eastern Europe, the forest–steppe moved significantly southward, and the steppe zone underwent a reduction (Markova et al., 2003). For the territory of the Southern Trans-Urals, according to the data of spore–pollen analysis, several stages of aridization are recorded for the entire Atlantic period (Lavrushin and Spiridonova, 1999).

The study area is the steppe part of the Southern Trans-Urals, adjacent to the eastern slope of the Southern Ural Mountains. In terms of geomorphological zoning, this area is located on the border of the southeastern Ural and Southern Trans-Ural provinces. The relief is ridged, ridge-hilly, and strongly leveled. The climate of the region studied is characterized by significant dryness (up to 350–400 mm of precipitation per year), the height of the snow cover does not exceed 0.3–0.4 m. The average annual temperature ranges from +1 to +3°C. The temperature range per year is 70–75°C, and the duration of the frost-free

period is 200 days. Forest–steppe and steppe vegetation is widespread (*Ural ...*, 1968).

Until the present studies, there was no characterization of small mammal communities for the Atlantic period of the Holocene of the Southern Trans-Urals (Smirnov and Kuzmina, 2005, etc.). The purpose of this study is based on fossil materials from Chernyshevskaya-III cave (layer 3, 5210 ± 90 years BP, Ki-15500) to characterize the composition and structure of communities of small mammals (Rodentia, Lagomorpha, Carnivora) inhabiting the territory of the Southern Trans-Urals in the final stage of the Atlantic Holocene period.

MATERIALS AND METHODS

Chernyshevskaya-III cave (52°38' N, 58°53' E) is located in the Kizilskii district of Chelyabinsk oblast on the left bank of the Khudolaz River. The cave is an inclined crevice, 7 m long. The entrance orientation is southern; its width is 2.5 m, and its height is 2 m. The total thickness of the removed loose deposits is 55 cm. Two main layers are distinguished: layer 1 contains light gray humus sandy loam with a large inclusion of rubble, and layer 3 has light brown sandy loam with a small inclusion of rubble. Layer 2 is intermediate. For layer 3, an uncalibrated radiocarbon date of

5210 ± 90 years BP (Ki-15 500) was obtained from collagen isolated from bone debris, this layer belongs to the middle subhorizon of the Agidel Horizon of the Holocene (Danukalova, 2010) in the stratigraphic subdivision of the Upper Quaternary deposits of the Southern Urals region or to the end of the Atlantic period (according to the Blitt–Sernander scale) of the Middle Holocene (Walker et al., 2012).

The bone material of Rodentia, Lagomorpha, and Carnivora from the layers of Chernyshevskaya-III cave was obtained by washing the sediments on sieves with a mesh size of 1 × 1 mm. Usually, cave loose deposits contain decomposed remains of the vital activity of birds of prey and mammals, which have accumulated over time and have formed a kind of chronicle of the history of biogeocenoses and ecosystems (Knyazev, 1979).

The determination of fossil material was carried out using the reference collections of the Laboratory of Paleoecology and the Museum of the Institute of Plant and Animal Ecology, Ural Branch, Russian Academy of Sciences. For the group of rodents and pikas, we used keys (Gromov and Erbaeva, 1995; Borodin, 2009). For some groups of rodents, measurement systems were used: hamsters (Smirnov, 1990), voles from the common-field group (Markova, 2003), and forest voles (Borodin et al., 2005). When identifying mice, their morphological features were taken into account (Zykov et al., 2010).

RESULTS

In total, about 5800 dental and bone remains of Rodentia, Lagomorpha, and Carnivora, which characterize communities of small mammals of the end of the Atlantic period of the Holocene for the territory of the Southern Trans-Urals, were analyzed (Table 1). The most abundant material was obtained for small rodents and pikas.

The presence of 30 taxa belonging to three orders was recorded, of which there were six taxa of the order Carnivora, two species of Lagomorpha, and 22 taxa of Rodentia.

In the group of small rodents and lagomorphs, the narrow-headed vole dominated (49%). The steppe lemming and the common vole were equal codominants (the share of each species is about 11%). The group of common species (1.0–9.9%) included the common mole, the common hamster, the northern birch mouse, the root vole, the water vole, and the voles from the red-bank group. Rare taxa (0.2–0.9%) were the small suslik, the gray hamster, the steppe pika, the field mouse, the red and bank voles, the mice from the group small forest–field, and Eversmann’s hamster. The group of very rare species (less than 0.2%) consisted of the field vole, the big suslik, the small forest mouse, and the yellow steppe lemming.

In combining small herbivorous mammals according to the type of habitat, five groups of taxa were distinguished (Table 2). The steppe species group included the steppe pika, susliks, hamsters, the mole vole, and the steppe lemming. The group of meadow species consisted of the common hamster, the common vole, and the field mouse. Forest species included all voles of the genus *Clethrionomys*, the small forest mouse, and the field vole. Riverside species are the root vole and the water vole. The group of semiarid species was composed by the yellow steppe lemming. Not included in any of the groups are the birch mouse, mice from the small forest–field group, and the polyzonal species of the narrow-headed vole. The dominance of steppe species has been established. The proportion of meadow species is large. The shares of forest and riverside species are approximately equal at about 4%. The semiarid group was very rare.

Two groups have been identified in relation to one of the leading ecological factors for semiarid ecosystems, the factor of humidity. These are the groups of xerophilic (steppe, semiarid) and mesophilic (meadow, forest, riverside) species (Table 2). The dominance of mesophilic species has been established.

DISCUSSION

The Holocene climatic optimum, which fell on the final stage of the Atlantic period (Markova et al., 2003), affected the composition, but to a greater extent, the structure of communities of small mammals (Rodentia, Lagomorpha, Carnivora) in the Southern Trans-Urals. The dominant species in the structure of the communities of rodents and pikas at that time was the narrow-headed vole (49%). This species, being polyzonal, lived on the territory of the Southern Trans-Urals during the entire Holocene. It is included in the core of communities as a dominant, and since remains of this species are close to the modern southern subspecies *L. (S.) g. gregalis* (Smirnov et al., 2007), then the zonal type of communities can be defined as steppe.

At the end of the Atlantic period of the Holocene, steppe (19%) and meadow (18%) groups of rodent and pika species were widespread, while forest and riverside species were represented in approximately equal proportions (4%). The presence of marten at the end of the Atlantic indicates the presence of significant areas of woody and shrub vegetation in the valley of the Khudolaz River. The presence of marten in the fauna of the period under consideration was noted in the Southern Urals (Kosintsev and Gasilin, 2008). The semiarid group was very rare at less than 0.1%; it included only one species, the yellow lemming.

Previously for the territory of the Southern Trans-Urals for the entire Atlantic period, several stages of aridization were recorded (Lavrushin and Spiridonova, 1999). The data on the composition and structure

Table 1. Species composition, the number of remains, and the minimum number of individuals of Carnivora, Lagomorpha, and Rodentia characterizing the end of the Atlantic Holocene period in the Southern Trans-Urals (according to data from Chernyshevskaya-III Cave, layer 3; 5210 ± 90 years ago)

No.	Taxon	Remains/minimum number of individuals
Carnivora		
1	<i>Mustela nivalis</i> , least weasel	4/3
2	<i>Mustela ermine</i> , ermine	5/2
3	<i>Mustela (Putorius)</i> sp., ferret	4/2
4	<i>Martes</i> sp., marten	1/1
5	<i>Vulpes vulpes</i> , common fox	7/3
6	<i>Vulpes corsac</i> , corsac fox	4/1
Lagomorpha		
7	<i>Lepus timidus</i> , white hare	10/2
8	<i>Ochotona pusilla</i> , steppe pika	59/9
Rodentia		
9	<i>Spermophilus</i> cf. <i>pygmaeus</i> , small suslik	41/10
10	<i>S.</i> cf. <i>major</i> , big suslik	1/1
11	<i>Marmota bobak</i> , steppe marmot	1/1
12	<i>Sicista</i> sp., northern birch mouse	255/67
13	<i>Apodemus agrarius</i> , field mouse	7/3
14	<i>Sylvaemus uralensis</i> , small forest mouse	2/2
15	ex gr. <i>S. uralensis</i> – <i>A. agrarius</i> , mice from the small forest–field group	7/3
16	<i>Cricetulus migratorius</i> , grey hamster	8/6
17	<i>Allocricetulus eversmanni</i> , Eversmann's hamster	5/3
18	<i>Cricetus cricetus</i> , common hamster	374/79
19	<i>Ellobius talpinus</i> , common mole vole	339/67
20	<i>Clethrionomys glareolus</i> , bank vole	24/7
21	<i>C. rutilus</i> , red vole	23/10
22	<i>C.</i> ex gr. <i>glareolus</i> – <i>rutilus</i> , forest voles from red-bank group	52/20
23	<i>Lagurus lagurus</i> , steppe lemming	587/127
24	<i>Eolagurus luteus</i> , yellow steppe lemming	2/1
25	<i>Arvicola terrestris</i> , water vole	88/20
26	<i>Lasiopodomys (Stenocranius) gregalis</i> , narrow-headed vole	631/575
27	<i>Microtus oeconomus</i> , root vole	30/29
28	<i>M. agrestis</i> , field vole	3/2
29	<i>M. arvalis</i> sl, common vole	133/126
30	<i>Microtus</i> sp.	3124/–
Total fossil remains of small mammals:		5831/1182

of communities of small mammals confidently indicate that at the end of the Atlantic period, i.e., about 5200 years ago, mesophilic species of small mammals dominated in the southern Trans-Urals (26%) and species confined to dry habitats were in a subordinate position (19%). The revealed dynamics of the increase in the proportions of mesophilic species of small mammals in the Southern Trans-Urals in the time studied lies within the framework established by

L.G. Dinesman (1977, 1999) of the trend of increasing mesophytization of steppe ecosystems in the Holocene. In particular, on the Russian Plain, in the Middle Holocene, the accumulation rate of the remains of the steppe group of animals noticeably decreased, which indicates a prolonged depression in the abundance of these species caused by an increase in the mesophyticity (Dinesman and Savinetsky, 2000) of the grass cover of steppe ecosystems.

Table 2. Ratio of groups of taxa of herbivorous small mammals by habitat type and relation to the moisture factor (according to data from Chernyshevskaya-III Cave, layer 3; 5210 ± 90 years ago)

No.	Groups of taxa	%
By type of habitat		
1	Steppe	19.11
2	Meadow	17.82
3	Forest	3.51
4	Riverside	4.2
5	Semiarid	0.09
In relation to moisture factor		
1	Xerophilic species	19.2
2	Mesophilic species	25.53

The data obtained reconstruct the habitat in the Southern Trans-Urals zonal steppe communities of small mammals with a significant participation of mesophilic (mainly meadow) elements at the end of the Atlantic Holocene period and restore the existence of humid conditions at this time.

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COMPLIANCE WITH ETHICAL STANDARDS

The authors declare that they have no conflict of interest. This article does not contain any studies involving animals or human participants performed by any of the authors.

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