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Some Data Bearing on the Recent Ecosystem Formation in the Middle and South Trans-Urals

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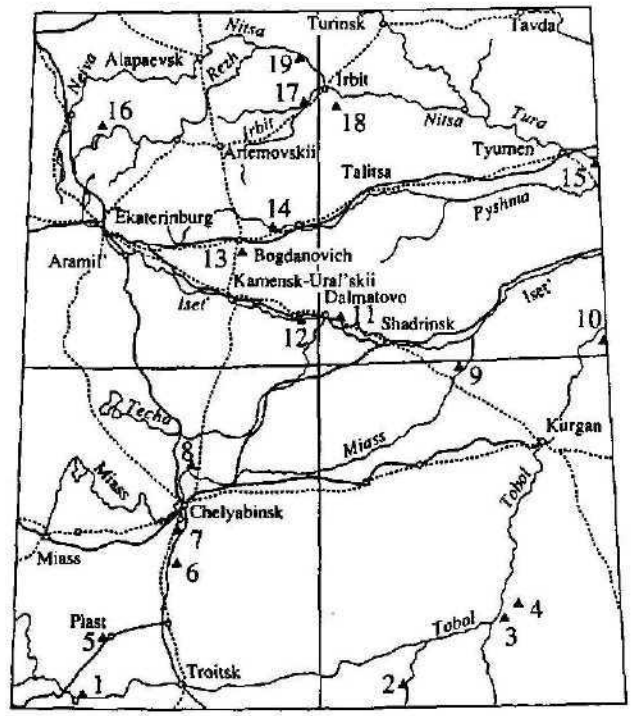
Abstract—Studies of species composition of extinct and contemporary small mammals faunas in combination with spore and pollen analysis, and data on malacofaunas and ostracods, shed light on the origins of contemporary ecosystems of the Middle and South Trans-Urals. Differences between the two regional ecosystems, of the beginning of the Late Pliocene in the South Trans-Urals, and the late Middle Pleistocene in the Middle Trans-Urals are defined, although they were less substantial than that of the modern ecosystems. Autochthonous and allochthonous components of modern fauna of these regions are recognized.

Paleontological data are traditionally used to construct models of ecosystem evolution and to find clues to the origin of contemporary communities. The data interpretation are often complicated by ambiguous geological reconstructions of the regions studied.

Uninterrupted development of terrestrial ecosystems of the Trans-Urals, since the area from the beginning of the Eocene has been free from sea transgressions or glaciation, provides an advantage for ecological studies of this region in comparison with the remaining major part of the West-Siberian Plain. Analysis of the species composition of fossil faunas of small mammals is a method of such paleoecological reconstructions.

Applicability of these studies has been demonstrated on recent materials, e.g., Shvarts and Pavlinin (1960) conducted zoogeographical zonation of the Urals based on studies of the small mammals fauna species composition. We employed the design of the study as the basis for our own analysis on the fossil faunas of the Trans-Urals. The study also incorporated spore and pollen analysis and analyses of malacofauna and ostracods (corresponding reports submitted to the Urals Geological Committee). All the localities studied are situated in the modern northern district of the West-Siberian Forest-Steppe Area (further in the text referred to as the South Trans-Urals) and middle sub-district of the East-European Taiga District of the West-Taiga Area (further in the text referred to as the Middle Trans-Urals) (figure). The fauna of the modern South Trans-Urals forest-steppe, as a transitive landscape fauna, comprises elements of forest and steppe faunas. The Middle Trans-Urals fauna consists mainly of forest species, penetration of steppe elements is only observed along its southern border (table).

Phylogeny schemes were worked out for practically all small mammals inhabiting the modern Trans-Urals, that make possible a consideration of the Pliocene taxa as ancestral to modern species (Chaline, 1972; Rabe-



Fossil Localities (from Maleeva (1988), with additions). (1) Streletskoe, (2) Vvedenka, (3) Zverinogolovskoe, (4) Verkhnyaya Alabuga, (5) Kochkar', (6) Baturino, (7) Korkino, (8) Bol'shoe Balandino, (9) Dolgovskoe, (10) Suer', (11) Dalmatovo, (12) Katalka, (13) Bainy, (14) Merkushino, (15) Parenkino, (16) Bol'shoi Sap, (17) Rechkalovka, (18) Nikitino, (19) Nitsinskoe.

Table 1. Small Mammals Taphonomic Composition in the Fauna of the Middle Trans-Urals

Species	Age and Region											
	A	B	C	D	E	F	G	H	I	K	L	M
1	2	3	4	5	6	7	8	9	10	11	12	13
Desmana sp.		+										
S. moschata L., 1758			+									
Talpa europaea L., 1758											+	
Sorex sp.		+					+	+				
S. drepanosorex Kretzoi, 1965			+									
S. araneus L., 1758			+		+							
S. arcticus Kerr, 1792					+							
S. caecutiens Laxm., 1788					+							
S. macropygmaeus Mill., 1901											+	
S. minutus L., 1766			+		+						+	
S. munutissimus Zimm., 1780					+							+
Neomys fodiens Penn., 1771											+	
Pliolagus sp.	+											
Pliolagomys kujalnikensis Topacevski et Scorik, 1977	+											
Lepus sp.					+	+						
L. timidus L., 1758											+	
L. europaeus Pall., 1778												+
Ochotonidae gen. et sp. indet.		+										
Ochotonoides compliudens Boulte et Teilhard, 1928	+	+										
Ochotona sp.		+			+			+	+			
O. pusilla Pall., 1768				+	+	+		+				
Pteromys volans L., 1758											+	+
Sciurus vulgaris L., 1758											+	+
Eutamias sibiricus Laxm., 1769											+	+
Spermophilus sp.	+	+	+	+	+	+		+	+			
Sp. pygmaeus Pall., 1778						+						
Sp. major Pall., 1778												+
Marmota sp.	+	+										
Marmota bobac Müll., 1776						+						
Castor sp.		+										
Sicista sp.	+	+							+			
S. subtilis Pall., 1773												+
S. betulina Pall., 1778											+	+
S. vinogradovi Top., 1965			+									
Allactaga sp.			+			+						
A. jaculus Pall., 1778			+			+						
Alactagulus sp.						+						
Pliscirtorida sp.	+											
Apodemus silvaticus L., 1758											+	+
A. agrarius Pall., 1771											+	
Mus musculus L., 1758											+	+
Micromys minutus Pall., 1771.											+	+
Rattus norvegicus Berk., 1969											+	
Ellobius sp.									+			
E. talpinus Pall., 1770												+
E. tancrei Blasius, 1884					+							
Cricetidae gen. et sp. indet.		+										
Cricetulus sp.	+											
Cricetulus migratorius Pall., 1773					+							
Cricetus sp.		+			+							
C. cricetus L., 1758			+								+	
C. eversmanni Brandt, 1859												+
Ondatra zubethica L., 1766											+	

Table 1. (Contd.)

1	2	3	4	5	6	7	8	9	10	11	12	13
Pliomys sp.	+											
Clethrionomys sp.		+	+	+		+						
Cl. socolovi Top., 1965		+	+									
Cl. rufocanus Sundev., 1846									+		+	
Cl. glareolus Schreb., 1780					+						+	+
Cl. rutilus Pall., 1779												+
Lagurini gen. et sp. indet.		+										
Prolagurus sp.		+										
P. praepannonicus Top., 1965		+										
P. pannonicus Korm., 1930		+	+									
Lagurus sp.			+									
L. transiens Janos., 1962			+									
L. lagurus Pall., 1773				+	+	+	+	+	+	+		+
Eolagurus sp.			+			+			+			
E. luteus Eversm., 1840				+	+	+						
Dicrostonyx sp.					+		+	+				
D. guilielmi Sanf., 1869								+				
D. torquatus Pall., 1779									+			
Lemmini gen. et sp. indet.		+										
Lemmus sp.				+								
L. sibiricus Kerr, 1792					+							
Cromeromys sp.		+										
Borsodia sp.		+										
B. steklovi Zazh., 1980	+											
B. fejervari Korm., 1934		+										
Prominomys gracilis Kretzoi, 1959	+											
Mimomys sp.	+	+	+			+						
M. polonicus Kowals., 1960	+											
M. pliocaenicus Major, 1902	+	+	+									
M. reidi Hint., 1910	+	+										
M. pusillus Mehel., 1914			+									
M. intermedius Newt., 1881	+	+	+									
M. hihtoni Feifar, 1961	+											
Arvicola sp.				+		+						
A. mosbachensis Schmidt, 1911				+								
A. chosaricus Alex., 1976					+							
A. terrestris L., 1758					+	+	+			+		
Allophajomys sp.		+	+									
A. pliocaenicus Korm., 1932		+	+									
Putymys sp.			+									
P. hintoni Kretzoi, 1941			+									
Microtus sp.			+	+		+		+				
M. gregalis Pall., 1779				+	+	+	+	+	+	+	+	
M. oeconomus Pall., 1776			+	+	+	+		+			+	
M. agrestis L., 1761			+								+	+
M. arvalis Pall., 1779											+	

A—Middle-Late Pleistocene (Akchagyl), South Trans-Urals, Zverinogolovskoe Locality; B—Eopleistocene, South Trans-Urals, localities Zverinogolovskoe, Kochkar', Baturino (Chumlyak Formation); C—Early Pleistocene, South Trans-Urals, Baturino Locality (Baturino Formation); D—beginning of the Middle Pleistocene, South Trans-Urals, localities Bainy, Suer', Baturino; E—end of the Middle Pleistocene, Middle Trans-Urals, Nitsinskoe Locality; F—beginning of the Late Pleistocene, South Trans-Urals, localities Verkhnyaya Alabuga, Streletskoe, Vvedenka, Dolgovskoe, Korkino; G—middle Late Pleistocene, Middle Trans-Urals, Nikitino Locality; H—middle Late Pleistocene, South Trans-Urals, localities Dalmatovo, Merkushino, Kataika, Bol'shoe Balandino; I—end of the Late Pleistocene, Middle Trans Urals, localities Rechkalovka, Bol'shoi Sap, Parenkino; K—end of the Late Pleistocene, South Trans-Urals, Streletskoe Locality; L—modern, Middle Trans-Urals; M—modern, South Trans-Urals.

Table 1. (Contd.)

1	2	3	4	5	6	7	8	9	10	11	12	13
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Cl. rufocanus Sundev., 1846									+		+	
Cl. glareolus Schreb., 1780					+						+	+
Cl. rutilus Pall., 1779												+
Lagurini gen. et sp. indet.		+										
Prolagurus sp.		+										
P. praepannonicus Top., 1965		+										
P. pannonicus Korm., 1930		+	+									
Lagurus sp.			+									
L. transiens Janos., 1962			+									
L. lagurus Pall., 1773				+	+	+	+	+	+	+		+
Eolagurus sp.			+			+			+			
E. luteus Eversm., 1840				+	+	+						
Dicrostonyx sp.					+		+	+				
D. guilielmi Sanf., 1869								+				
D. torquatus Pall., 1779									+			
Lemmini gen. et sp. indet.		+										
Lemmus sp.				+								
L. sibiricus Kerr, 1792					+							
Cromeromys sp.		+										
Borsodia sp.		+										
B. steklovi Zazh., 1980	+											
B. fejervari Korm., 1934		+										
Prominomys gracilis Kretzoi, 1959	+											
Mimomys sp.	+	+	+			+						
M. polonicus Kowals., 1960	+											
M. pliocaenicus Major, 1902	+	+	+									
M. reidi Hint., 1910	+	+										
M. pusillus Mehel., 1914			+									
M. intermedius Newt., 1881	+	+	+									
M. hihtoni Feifar, 1961	+											
Arvicola sp.				+		+						
A. mosbachensis Schmidt, 1911				+								
A. chosaricus Alex., 1976					+							
A. terrestris L., 1758					+	+	+			+		
Allophajomys sp.		+	+									
A. pliocaenicus Korm., 1932		+	+									
Putymys sp.			+									
P. hintoni Kretzoi, 1941			+									
Microtus sp.			+	+		+		+				
M. gregalis Pall., 1779				+	+	+	+	+	+	+	+	
M. oeconomus Pall., 1776			+	+	+	+		+			+	
M. agrestis L., 1761			+								+	+
M. arvalis Pall., 1779											+	

A—Middle-Late Pleistocene (Akchagyl), South Trans-Urals, Zverinogolovskoe Locality; B—Eopleistocene, South Trans-Urals, localities Zverinogolovskoe, Kochkar', Baturino (Chumlyak Formation); C—Early Pleistocene, South Trans-Urals, Baturino Locality (Baturino Formation); D—beginning of the Middle Pleistocene, South Trans-Urals, localities Bainy, Suer', Baturino; E—end of the Middle Pleistocene, Middle Trans-Urals, Nitsinskoe Locality; F—beginning of the Late Pleistocene, South Trans-Urals, localities Verkhnyaya Alabuga, Streletskoe, Vvedenka, Dolgovskoe, Korkino; G—middle Late Pleistocene, Middle Trans-Urals, Nikitino Locality; H—middle Late Pleistocene, South Trans-Urals, localities Dalmatovo, Merkushino, Kataika, Bol'shoe Balandino; I—end of the Late Pleistocene, Middle Trans Urals, localities Rechkalovka, Bol'shoi Sap, Parenkino; K—end of the Late Pleistocene, South Trans-Urals, Streletskoe Locality; L—modern, Middle Trans-Urals; M—modern, South Trans-Urals.

der, 1981; Agadjanian, 1992). This paper is an attempt to analyze certain stages of the history of modern ecosystems of the Middle and South Trans-Urals.

SOUTH TRANS-URALS

The oldest material on the territory studied was collected from the locality Zverinogolovskoye (South Trans-Urals) dated as Pliocene (Akchagyl). The fauna from this locality may be considered as forest-steppe, since it is represented by ancestral forms of modern steppe, forest-steppe and intrazonal species (table). The spore and pollen analyses data are fragmentary and indicate the presence of such thermophile elements as hemlock, oak, maple, and elm in the vegetation.

Comparing the results of the analysis of fauna from the locality (Ivakina, 1995) and the data of spore and pollen analysis one may conclude that the forest-steppe and meadow landscapes were most developed in the Trans-Urals at that time. Later, the character of the fauna changed slightly but remained that of steppe and forest-steppe. A change of ratio among the species was most probably due to global climatic variations. This conclusion is supported by the observed changes in species composition of plant communities, mollusc and ostracod faunas.

In the early Eopleistocene, thermophile species almost disappear from the mollusc and ostracode faunas of the Uvelian Formation deposits. The spore and pollen spectra suggest reconstruction of forest-steppe landscapes: pine and birch forests against the background of goosefoot and sagebrush phytocenoses. The difference from the preceding stage is in the growth of the amount of intrazonal and forest forms. Most interesting is the appearance of remains of Lemmini on the faunistic list of species from the Kochkar' locality. We can not identify these scarce remains according to their morphological features, for their features are intermediate between the *Synaptomys* and *Lemmus*, more reminiscent of the latter.

In the second part of the Eopleistocene (the Chumlyakian Time) the small mammals fauna preserves its forest-steppe features (table). The spore and pollen spectra are of the forest-steppe type with the presence of frigophile bushes of Arctic birch and alder.

At the beginning of the Upper Pleistocene the fauna of small mammals is dominated by steppe and semi-desert-desert elements, jerboa reappearance is observed (table). The complex of species constitutes a typical biotype of steppe, meadow-steppe and near-water landscapes of warm and dry interglacial. The malacofaunas are numerous and taxonomically diversified, comprising thermophile species. Spore and pollen spectra are of meadow-steppe type, with a predominance of thermophile floral elements.

In the mid-Upper Pleistocene spore and pollen complexes are represented by steppe communities with a predominance of goosefoot and sagebrush assemblages. Mollusc assemblages comprise frigophile terrestrial species. The appearance of lemmings of the genus *Dicrostonyx* in the rodent fauna of the Dolmatovo locality (northern South Trans-Urals), within certain limits (Smirnov, 1992), may testify to a colder climate.

Paleontological data on Late Pleistocene and Holocene stages of ecosystem development of the region are not known. Presently, the vegetation and fauna of the South Trans-Urals are represented by typical forest-steppe forms.

MIDDLE TRANS-URALS

The territory of the Middle Trans-Urals is poorly characterized in terms of paleontology, this being especially true of the earlier stages of the ecosystem formation. The Nitsinskoye locality, the oldest in the territory, is dated end of the Middle Pleistocene. There is no modern analogy for the mammalian fauna. It comprises forest, steppe and tundra species (table). The malacofauna is rather diversified and comprises some thermophile elements. The spore and pollen spectra are forest-steppe type characterizing spruce-pine forests with fir and alder and meadow-steppe areas.

Nikitino is the next oldest locality of the Middle Trans-Urals, dated mid-Late Pleistocene. The "no-analogy" character of the fauna of small mammals is evident (table).

The most numerous material on the Middle Trans-Urals have been collected from localities dated end of the Late Pleistocene. The mammalian fauna is the "no-analogy" type. The spore and pollen spectra characterize forest-steppe landscapes of pine-birch forests among meadow-steppe phytocoenoses. It is noteworthy that when the microteriofauna is characterized as one of "no-analogy", elements of forest vegetation are always present. This is evidence of a fundamental difference between the Pleistocene ecosystems of the region and modern ones, the latter being typical of the taiga zone.

CONCLUSIONS

Some steppe species that once inhabited the Trans-Urals, such as haymakers and voles of the genus *Eolagurus*, are currently observed retreating to the south. Presently, the differences between the ecosystems of the Middle and South Trans-Urals are less significant than they were in the time discussed. The Middle Trans-Urals was evidently covered more densely by forests. Judging by the assemblage of all fossil finds, one can conclude that the open spaces in the Middle Trans-Urals in the past was better developed, when steppe elements, now lacking, where present, e.g., *Ochotona pusilla*, *Lagurus lagurus*, *Eolagurus luteus*. One should note the absence in all localities of the territory studied of finds of mice, rats, musk-rat, squirrel, chipmunk and mole. It is probable that mice came to the Trans-Urals from the European part of Eurasia after the last glaciation, since their remains are absent from

all known West-Siberian localities. Rats appeared in the Urals in connection with human activities (Vigorov, 1992) in the 19th century. The musk-rat was introduced to the Trans-Urals by man at the beginning of the 20th century. Absence of squirrels and chipmunks from the collections may be accounted for by the lack of large forests. Absence of moles from Pliocene-Pleistocene localities may be accounted for both by the lack of adequate biotopic conditions and by taphonomic peculiarities of accumulation of osteological material.

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