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Holocene micromammal complexes of Belarus: A model of faunal development during Interglacial epochs

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Abstract. The changes identified in the Holocene fauna of Belarus were caused by changes in the relationship between tundra, steppe, forest and intrasonal biomes. These changes were also affected by migrations. Stages in the evolution of the micromammal fauna are identified herein. These may serve as a model for reconstructing the development of interglacial faunas of older periods of the Pleistocene.

Key words: Micromammals, Holocene, evolution, paleoecology, eastern Europe, Belarus.

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I. INTRODUCTION

Belarus is situated in the western part of the east European plain, between 56°10' and 51°16' north latitude and 23°11' and 32°47' east longitude. It covers a total of 207600 km^2. The relief is predominantly flat throughout. During the Pleistocene the ice sheets strongly influenced the formation of this terrain. Glaciers affected not only the relief, but also the structure and dynamics of the organic world. During the glacial periods the autochthonous fauna and flora disappeared from Belarus, to reappear in the interglacial periods.

These cycles are reflected in the development of the Holocene fauna. The history of the Holocene fauna of Belarus has been much studied, the advancement of which is related to the development of stable Pleistocene stratigraphic and paleogeographic reconstructions contributing to an understanding of modern ecological problems (LITVINUK 1985; BOGDEL 1984; ZIMENKOV 1987; ZHERNITSKAYA 1991). However, in spite of these studies, due attention has not been paid to the small mammal fauna.

Recent investigations (IVANOV 1992) have shown that data on the evolution of Holocene small mammals can be used for many purposes, and especially as a model for the development of Pleistocene interglacial faunas. During investigations of this problem the chronological scheme of the Holocene developed by BLITTER-SERNANDER was used, with modofications for Belarus (ELOVICHEVA et al. 1982). The data used in these investigations come from 20 localities (Fig. 1, Table I). The age of the fossil faunas is a composite of geology, paleobotany, radiocarbon, mollusc stratigraphy and other information.

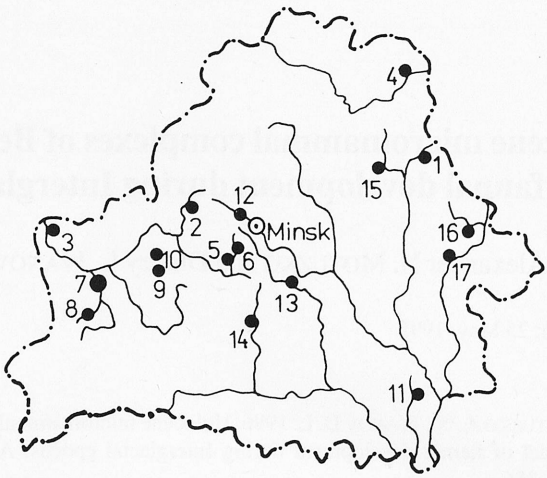

Fig. 1. Location of Holocene fossil small mammal faunas of Belarus. Legend: 1 – Buroje, 2 – Brod, 3 – Plaskovtsi, 4 – Sloboda Dvinskaya, 5 – Semenovichi 1, 6 – Semenovichi 2, 7 – Peski 1-4, 8 – Zelva, 9 – Voroncha, 10 – Novie Rutkovichi, 11 – Yastrebka, 12 – Drosdi, 13 – Kuharovka, 14 – Kirovo, 15 – Zabolotye, 16 – Lopatino, 17 – Chericov.

II. THE MATERIAL

Analysis of Holocene micromammal complexes in Belarus has shown that the core of the Recent small mammal fauna was formed out of the Late Pleistocene micromammal complexes.

The main processes in the evolution of the Holocene communities were the migration of species from neighbouring areas and the complex combination of ecological groups for very long periods of time (MOTUZKO 1983). The three main stages in the development of the small mammal faunas of Belarus are: Early Holocene, Middle Holocene, Late Holocene (Fig. 2).

During the Early Holocene (Preboreal-Boreal) there were significant changes in the structure of the micromammal complexes. Little by little, tundra species disappeared and were succeeded by species of taiga and mixed forest. Taking into consideration the correlation between ecologic groups, the Early Holocene complex can be divided into three substages. In the Preboreal (localities Buroje and Plaskovtsi) the number of species of tundra and steppe groups declined sharply in comparison with faunas of the Late Pleistocene. *Lemmus sibiricus*, *Dicrostonyx* sp., *Microtus gregalis*, *Ochotona* cf. *pusilla* and *Spermophilus* ex gr. *major-superciliosus* make up 4-15% of the faunas of this period. Intrazonal species such as *Sorex araneus*, *Arvicola terrestris*, *Microtus oeconomus* etc. are dominant, and the number of taiga species increases as well (e. g., *Clethrionomys glareolus*, *Microtus arvalis*, *M. agrestis*, *Sorex isodon*). The micromammal faunas of that period can be seen as mainly forest (northern taiga) with some tundra species (Fig. 2:1a).

At the boundary of the Preboreal and Boreal (localities Lopatino, Peski 4, Brod and Chericov) there was further reduction in the proportion of periglacial species, which now constitute only 1-3% of the fauna. Judging by the fact that remnants of tundra-steppe species are found in distinct regions, the conclusion can be drawn that their ranges were separated into several isolated districts. The most common species are *Lemmus sibiricus* and *Dicrostonyx* sp. Simultaneously, new species appear: *Apodemus sylvaticus*, *Neomys fodiens* etc. The structure of the forest communities becomes

Table I

Theriofauna structure of Holocene locations in Belarus

Species \ Location	Early Holocene												Middle Holocene							L. Hol.
	Buroje	Plaskovtsi	Lopatino	Peski 4	Brod	Chericov	Sloboda Dv.	Drosdi	Kuharovka	Zabolotye	Peski 1	Peski 2	Zelva	Peski 3	Semenovichi 2	Voroncha	Kirovo	Semenovichi 1	N.Rutkovichi	Yastrebka
Insectivora																				
Erinaceus sp.	3																			
E. aff. *europaeus* L.																8				
Talpa europaea L.			1					1								27				
Desmana moschata L.	6																			
Soricidae gen.	68												8						20	
Sorex sp.			1		1							1	1			200				
S. minutus L.	7					2							1		1	9				
S. isodon TUR.	5		4																	
S. coecutiens LAXM.																26				
S. araneus L.	16			3		2		1		2			8		4	63	4	1		
Neomys fodiens PEN.			1					1	1						1		1			
N. cf. *anomalus* CABR.	8															2				
Crocidura suaveolens PALL.																1				
Chiroptera																				
Plecotus auritus L.																1				
Lagomorpha																				
Ochotona cf. *pusilla* PALL.	5																			
Rodentia																				
Castor fiber L.			1																	
Spermophilus ex gr. *superciliosus* KAUP	3																			
Glis glis L.																62				
Muscardinus sp.																5				
Dryomys cf. *nitedula* PALL.																7				
Sicista sp.	1																			
Sicista betulina PALL.																16				
Mus musculus L.			5			7		3	1	2							3		1	
Apodemus agrarius PALL.			1							1										
A. sylvaticus L.	3	1				1			1							2				
A. flavicollis MELCH.			1	11		3							24	2	19	65				
Rattus norvegicus BER.			2																	
Cricetus cricetus L.	6																			
Arvicola terrestris L.	46	5	38	23	48	17	10	41	3	13	47	29	8	5	78	42	10	73	60	+
Microtinae gen.	147												31						4	
Microtus sp.	563	8	25	23	37	15	5	38	1	12	53	40	54	3	26	318		27	73	+
M. oeconomus PALL.	53	1	2	3	4	1		4	1		7	7		1	2	5		7	2	
M. agrestis L.	107		10	3	3	1		9		4	5	5	12	1	10	25	1?	2	8	
M. arvalis PALL.	23				4	2	2			1	4	6	5	2	3			3	6	+
M. gregalis PALL.	3	6				1														
M. subterraneus SEL.													4	1	1?	37	1		6	
Cl. glareolus SCHREB.	91	5	22	10	77	22	26	13	2	5	57	38	434	14	45	331	9	29	71	+
Lemmus sp.					1															
Lemmus sibiricus KERR.	16		1	1																
Dicrostonyx sp.	16				2															
D. cf. *torquatus* PALL.				1																
Carnivora																				
Meles meles L.																	1			
Lutra lutra L.			1								1									
Martes martes L.													1							
Artiodactyla																				
Sus scrofa L.			1																1	
Cervidae gen.																			5	
Cervus elaphus L.		5	1								5	1								
Capreolus capreolus L.																	1			
Bos sp.																	1			

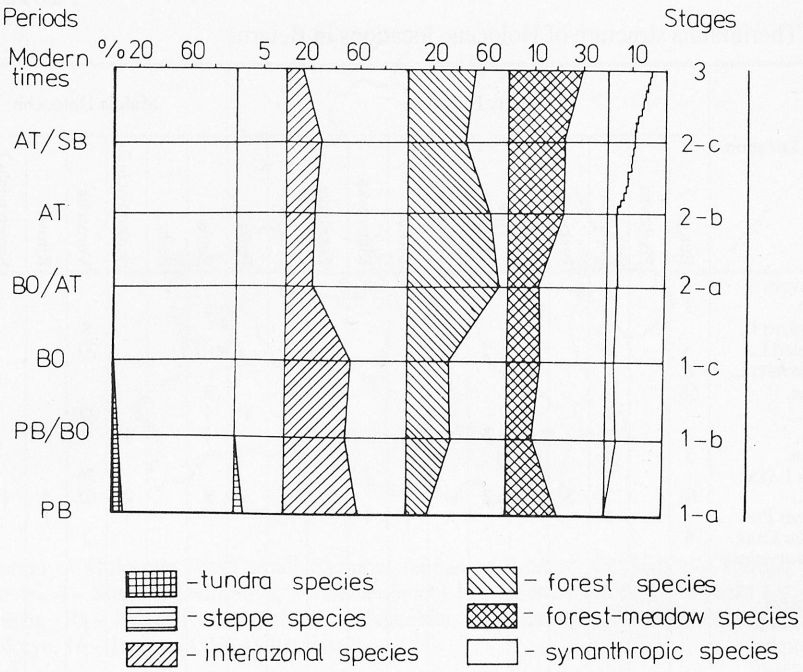

Fig. 2. Correlation of ecological groups in the structure of micromammal communities of the Holocene of Belarus.

more complex, with dominance of intrazonal faunal associations (Fig. 2:1b). The micromammal complexes of the period belong to the middle-south taiga forest type. During this period *Mus musculus* and *Rattus norvegicus* enter the fauna.

In the Boreal period of the Early Holocene (localities Sloboda Dvinskaya, Drosdi, Kucharovka, Zabolotje and Peski 1, 2) representatives of tundra biotypes disappear completely from the fossil faunas. Their place is taken by forest communities of south taiga and mixed forest type, which rapidly become dominant (Fig. 2:1c).

The Middle Holocene period in the development of the micromammal fauna of Belarus is characterized by a preponderance of forest species. These are found not only in watersheds, but in river valleys as well (Fig. 2:2a-c).

At the end of the Boreal – beginning of the Atlantic period (localities Zelva, Peski 3 and Semenovichi 2) the number of fossils of riverine species is reduced by half and the same number of forest species take their place. *Clethrionomys glareolus* becomes dominant. *Microtus subterraneus* appears among forest species, and the frequency of *Apodemus flavicollis* increases. Such changes mark the beginning of the formation of pioneering zonal associations of small mammals of broadleafed and coniferous/broad-leafed forests. Balanced communities of near-river species and those of coniferous forests and mixed forests continued to exist (Fig. 2:2a).

The golden age of broad-leafed forest micromammal associations was the Atlantic period (locality Voroncha). These associations were dominant in forest communities, both in the diversity of species and in the number of individuals. At this time, Belarus was flooded by the migration of

great numbers of *Glis, Dryomys*, *Muscardinus* and *Sicista betulina*. The number of *Microtus subterraneus*, *Talpa europaea*, *Erinaceus europaeus* and *Sorex* s. str. also increases (Fig. 2:2b).

Toward the end of the Atlantic – beginning of the Subboreal period and in the Subboreal period of the Middle Holocene (localities Novije Rutkovichi, Kirovo and Semenovichi 1) a leading role in the structure of the micromammal communities is played by representatives of open areas (meadows, fields, forest meadows, edges of forests). These are represented by *Microtus arvalis*, and *Erinaceus europaeus*. This fact can be related to the influence of human activities. The percentage of the most specialised representatives of broad-leafed forests (e. g., *Microtus subterraneus*, *Glis glis*) is reduced, while animals from mixed and south-taiga forest play more a important role (Fig. 2:2c).

Important changes in the structure of the micromammal fauna of Belarus took place in the Late Holocene. Communities of coniferous forest and mixed forests, basically consisting of *Clethrionomys glareolus* and representatives of the genus *Apodemus* become predominant. *Glis glis*, *Muscardinus avellanarius* and *Eliomys quercinus* are very rare. Representatives of the genus *Crocidura*, as well as *Sicista betulina*, reach their modern percentage in the micromammal communities of the region. Their distributions are reduced and they are found only in the south of the country. The huge range of *Microtus subterraneus* is subdivided, with the areas numerous and isolated. Today, the species is very rare and can be found only in the Belovezhskaya Forest Preserve (Belovezhskaya Pushcha). The percentage of *Microtus* is reduced and only *Microtus arvalis* is numerous. This period is most favourable for the development of synanthropic species - representatives of the genera *Mus* and *Rattus* (Figs 2-3). Natural causes account for some of these changes, but they are mostly due to anthropogenic influences, which led to the decay of broad-leafed forest communities (IVANOV 1994) and fundamentally changed the composition and correlation of species within the communities.

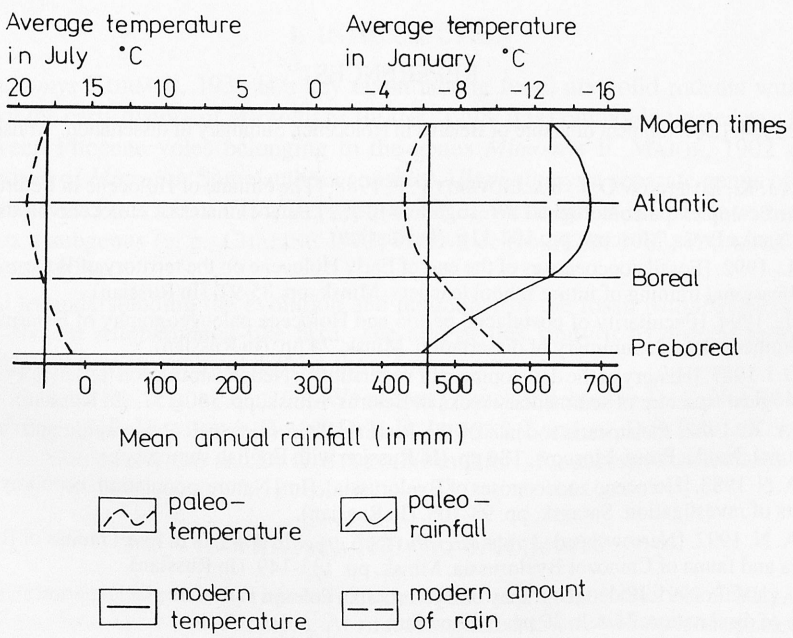

Fig. 3. Palaeoclimatic characteristics of the Holocene according to data from fossil micromammals.

III. PALEOCLIMATIC RECONSTRUCTIONS

Data on small mammals have made it possible to create paleoclimatic reconstructions for different periods of the Holocene (Fig. 3). With the aid of the arealogical method of climatograms (MARKOVA 1982) it was established that during the Preboreal period of the Holocene the climatic indices improved in comparison with those of the Late Pleistocene. The average temperature for July was 16°C to 17°C and for January -7°C to -10°C. Rainfall rose by 75 mm but didn't exceed 600 mm. During the Boreal period the indices were very close to the modern ones: average temperature for July was around +18°C and for January -7°C, with annual rainfall 600-625 mm. The most extreme indices were obtained for the Atlantic period of the Middle Holocene. Average temperatures for July were 1.5-2°C higher than the modern ones, corresponding to averages of 18°C to 20.5°C; the temperatures for January were 0.5-1°C than today, corresponding to -5.5°C to -6°C. The annual rainfall remained unchanged and ranged from 550 to 750 mm in different regions of the country. In the Late Holocene climatic situation become worse, with indices close to those of today.

IV. CONCLUSIONS

Data on normal changes in small mammal associations and climate let us state that older interglacial faunas of the Pleistocene hade a more closely integrated structure. When considering the development of small mammal faunas in interglacials one must distinguish between the beginning, optimum and final stages (MOTUZKO 1992). Detailed examination of stages in faunal development enables us not only to stratify sediments of the Pleistocene, but also to correlate the climatic conditions of the past over wide areas. It is quite possible that some general rules regarding the development of small mammal faunas of the Holocene may result from studies of older time periods. The most interesting point in the evolution of interglacial faunas is the correlation in time of ecologic groups of small mammals. Among other significant processes are those of the appearance of new species and the extinction of the most specialised species.

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