Eastern European mammoth distribution and environments during the Middle Valdai Briansk Interstade (33,000-24,000 BP)

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SUMMARY: One of the most remarkable intervals within the Valdai Glaciation was a time of significant warming – the Briansk Interstade (33,000-24,000 yr. BP); there are abundant palaeotheriologic and palaeobotanic data, including mammoth finds, available for this interval. The principal goal of this study was an integrated analysis of the extensive database with respect to main features of mammoth environments during this Interstade. For this purpose we used mathematical as well as traditional research methods. Information on mammal and plant species composition, geology and geographical position of the sections as well as absolute and relative ages of localities has been included into databases. All data were organized in PARADOX software and then moved to ARC/VIEW GIS; the latter formed the basis for construction of electronic maps of indicator mammal and plant ranges and recognition of the principal biomes.

1. Material

1.1 Mammal data

45 Briansk mammal sites have been included into this study; most of them belong to cultural layers of Palaeolithic sites and are dated by radiocarbon. One site corresponds to molecourses of the Briansk soil, another to fluvial deposits. Mammals from five sites have been studied by one of the authors (Markova 1982; Markova *et al.* 1995). A few primary literature sources were also used, such as papers by Alexeeva (1990); Vereshchagin and Baryshnikov (1980), Guslitser and Kanivets (1965), Kalinovski (1983); Rekovets (1985), Rogachev *et al.* (1981), Tatarinov (1977) and others.

1.2 Mammoth finds

Briansk mammoth remains are widely spread over the East European Plain, from the Kama drainage basin (~60°N) in the north to the lower Dniester drainage basin (~ 48°N). They were found in the middle courses of the Dnieper and Don (~ 50 – 52°N), in the Kama basin (~ 55 –60°N) and in others regions (Fig. 1). It is possible that mammoth lived farther north, but we have not enough information for Arctic and Subarctic zones at present. No site of this age is known in the Crimea either. In the early Valdai time the range of mammoth was wider and included the Crimean Peninsula.

1.3 Paleobotanical data

During the last decades, a number of researchers, among them. Artushenko (1973), Bolikhovskaya (1995), Gurtovaya (1985), Spiridonova (1991) and others, published detailed palynological materials for the Briansk Interstade on the Russian Plain; they are supported by radiocarbon dates and by geological data.

52 plant remain localities of the Briansk time

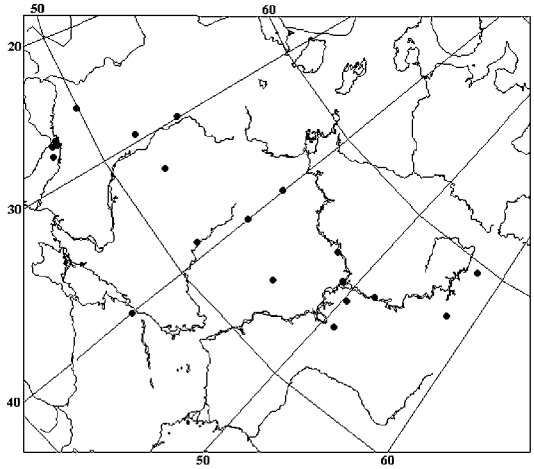

Fig.1 - The sites with *Mammuthus primigenius* remains (33 – 24 ka).

have been studied (Simakova & Kozharinov 1995). The palynological data reveal a complicated vegetation and climatic history during the Briansk Interstade.

2. Methods of the environment reconstruction

The principal goal of this study was to reconstruct the mammoth environment using all available data. The integrated analysis of mammal and plant data permitted to elucidate the biogeographical situation on the Russian Plain during the Briansk Interstade warming. The lots of theriological and botanical data of the Briansk Interstade were jointly analyzed. Mathematical methods have been used for these aims (Markova *et al.* in press). At the first stage of analysis the localities were classified by mammal and plant composition. The initial theriological materials were presented as matrix of "presence - absence" of 46 genera (58 species) of mammals which have been recovered from the Briansk deposits. The squared dissimilarity matrix was calculated (using the Jakar distance) for 45 mammalian sites located in 19 geographical points. The cases in which both species were absent have been ignored during the matrix calculation. Then we analyzed this matrix for reproducing the distances, based on several underlying dimensions. The lists of mammals have been established for every class of localities. The results of this classification were analyzed both in artificial MDS dimension space, and in geographical physical space according to the coordinates (latitude, longitude). The palaeofloristic data were classified analogously, but on the basis of Euclidian distance matrix. The distances between the sites were calculated for logarithm spectrum. The distinguished classes were characterized by mean values of pollen spectra. The results of pollen analysis reflect their relative appearance (maximum value for a sample, in %) for 20 most widespread species, genera and also taxa of higher order. At the second phase the limits of biomes were defined using results of integrated analyses of these classifications, obtained for mammals and plants, and with particular reference to geographic position of all distinguished groups of sites.

3. The results of classification of theriological and floristic data

Two groups of localities with palynological materials have been distinguished as a result of classification (I, II). Each of these groups includes two sub-groups. Their ordination in the space of MDS axis could be interpreted as follows: sites of the first group (I, sub-groups 1 and 2) feature relatively high proportion of

cold-loving and moisture-loving forest taxa; sites of the second group (II, sub-groups 3 and 4) include high amount of xerophytic steppe and semi-desert taxa and also some broad-leaved trees (sub-group 4).

Five groups of mammal localities have been distinguished as a result of classification. The first group includes the most isolated sites. The second and forth groups are the most remote from the first one. The third group lies closely to the forth one but very far from the second group. The fifth group occupies an intermediate position in relation to all the rest groups.

4. Principal Biomes during Briansk Interstade

The following biomes could be reconstructed from north to south based on the described above procedures (Fig. 2). Mammoth *Mammuthus primigenius* lived in most of them:

4.1 Forest-tundra

A combination of tundra and steppe plant communities with "islands" of *Pinus-Betula* open forest and with the assemblage of sub-arctic mammals (reindeer, polar fox, pied and true lemmings, and narrow-sculled voles). Mammoth was very rare here. Possibly, the biomass in the north of Eastern Europe was not sufficient for subsistence of this large herbivore.

4.2. Periglacial forest-tundra-steppe

A mosaic of plant communities, including *Betula-Pinus* and *Picea* forested "islands", meadow and halophytes steppes, and tundra vegetation patches. Mammal assemblages consisted of tundra and forest-steppe species (woolly mammoth, primitive bison, wild ox, reindeer, red deer, roe deer, horse, saiga, wolverine, polar fox, ground squirrel, common hamster, pied and true lemmings, narrow-sculled, red-backed and field voles and others).

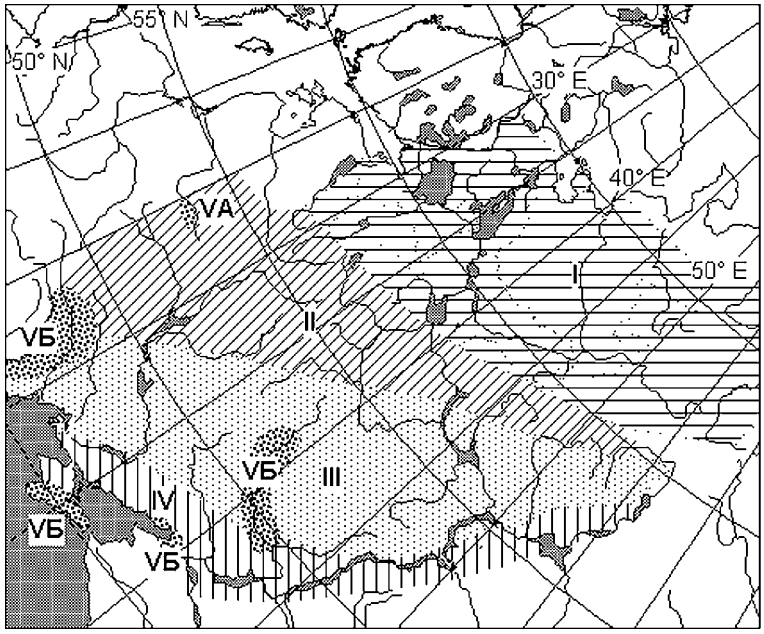

Fig.2 - Biogeographical provinces on the Russian Plain and the Crimea during the Briansk Interstade after botanical and mammal data.
I. Forest-tundra, II. Periglacial forest-tundra-steppe, III. Periglacial forest-steppe, IV. Periglacial steppe, V. Forest-steppe of plains (A), and highlands and mountains (B).

The environments with sufficient quantity of biomass favored the mammoth and other large herbivore existence in this zone.

4.3 Periglacial forest-steppe

Meadow-steppes with *Pinus-Betula* forested "islands", with scarce broadleaved trees, and with forest-steppe assemblage of mammals (woolly mammoth, woolly rhinoceros, primitive bison, wild ox, reindeer, red deer, roe deer, horse, saiga, cave carnivores, bobac marmot, ground squirrels, great jerboa, steppe lemming, narrow-sculled and field voles, and others). The environment of this biome was beneficent for *Mammuthus primigenius*. Mostly open landscapes with high biomass were favorable for mammoth, primitive bison, woolly rhinoceros and other large herbivores. The density of mammoth sites is the highest in this area. The mammal species richness is also highest among the plain regions of Eastern Europe.

4.4 Periglacial steppe

Forb steppes with the steppe mammal assemblage (woolly mammoth, woolly rhinoceros, horse, saiga, bobac marmot, ground squirrels, great jerboa, greater mole rat, northern mole-vole, steppe and yellow lemmings, and others and others including reindeer). Drier conditions of this biome determined lower biomass with respect to the previous one. This accounts for lower quantity of mammoth localities in these regions.

4.5 Plain (A) and mountain (B) forest-steppe

Betula-Pinus forests areas with few broadleaved trees and mammal assemblage of south periglacial forest-steppe (woolly mammoth, woolly rhinoceros, primitive bison, wild ox, horse, saiga, giant and red deers, reindeer, wild boar, steppe and yellow lemmings, yellow-necked mouse, field and common voles; in the Crimea the assemblage lacks mammoth, but the Pleistocene wild ass and *Microtus obscurus* are present.

5. Conclusions

The reconstructed biomes reflect specific environmental and climatic conditions of the Briansk Interstade where mammoth found favorable habitats. The analogues of modern natural zones did not exist in this time on the Russian Plain. The reconstructed landscapes reflect moderate-cool climate of this period, when the majority of northern subarctic plant and mammal species extended their ranges considerably to the south and was distributed not only in the Northern, but also in the Central Russian Plain. At the same time, steppe species penetrated farther north and west, which suggests a destruction of continuous forest zone during the Briansk Interstade. Fragments of forests persisted in topographically diversified areas with many local habitats (in highlands, mountains, and river valleys). The Briansk biomes were similar to modern ecotones in their high diversity. Earlier Guthrie, Graham, Lundelius, Semken and others have noted similar features of periglacial biota in North America.

The differences between East European biogeographical provinces were smoothed during the Briansk time: subarctic plants and mammals were present practically in every of them. Forest species, more sensitive to warmth and humidity, were not abundant on the Russian Plain. However, the periglacial forest-steppe and forest-tundra steppe were more extensive during the Briansk time than at the Late Valdai Maximum. That indicates rather temperate climate of the Briansk Interstade.

The Briansk climate undoubtedly was more severe than recent one, with lower winter temperatures and low precipitation (Frenzel 1992). Several factors had the major effect: the existence of small ice sheet in Scandinavia; a significant marine glaciation (pack ice), which affected the moisture supply to the continent; wide distribution of permafrost; and also the decrease of air masses transfer from the West to the East (van Andel & Tzedakis 1996; Velichko 1973). Such climatic conditions influenced the appearance and wide distribution of different types of periglacial vegetation and "mixed"

mammal assemblages over the Russian Plain; many of them have no analogues in modern biota. Various types of open periglacial environments with great diversity of grass and bush vegetation were comfortable for large herbivores, including woolly mammoth. The palynological studies have been performed on stomach and bowels contents from the frozen mammoth bodies, found mostly in Siberia. It appeared that the animals mostly fed on the boreal and hypoarctic plants, including grasses, mosses, and also branches of trees, shrubs, and dwarf shrubs (*Betula, Alnus, Salix, Larix, Ericales*) (Ukraintseva 1992, 1996). Mammoths found the most suitable feed in wet habitats with high diversity of green grasses (Tomskaya 2000). The analysis of the mammoth distribution during the Briansk Interstade revealed the most favorable mammoth habitats. Those are: 1) periglacial forest-tundra-steppe communities situated between ~54° and 59°N (where a combination of *Betula-Pinus* and *Picea* forest "islands" with the meadow steppes, tundra associations and halophytic plant species was found); 2) periglacial forest-steppe with the meadow steppe associations and *Pinus-Betula* forest islands, with insignificant admixture of broadleaved plants. The latter plant community was located between ~ 48° and 60°N during the Briansk Interstade. Northern Subarctic regions and southern steppe areas characterized by lower biomass were not very favorable for the mammoth subsistence, because of the absence of essential diversity and quantity of forage. The lack of mammoths in the Crimea in the Briansk Interstade and the Late Valdai could be also attributed to a high activity of Paleolithic hunters in this region during the Early Valdai. Judging by the data from the Middle Paleolithic Crimean sites, mammoth was common enough there.

6. Acknowledgements

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