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PALEOECOLOGICAL EVIDENCES FOR THE LATE PLEISTOCENE LAKE VEGETATION IN THE SOUTH OF THE VALDAI HILLS (BASED ON PLANT MACROFOSSILS DATA)

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The complex study of sections of the Upper Pleistocene lacustrine sediments located in the marginal parts of the last ice sheet provides paleocological records that contribute to an increased understanding of long-term environmental changes during the Late Pleistocene. These investigations contribute also to the reconstruction of the boundaries and dynamics of the Valdai (Weichselian) glaciation. Buried lake-swamp sediments rich in organic matter make it possible to use both paleobotanical and radiometric methods to determine their choronostratigraphic position.

The present paper is focused on paleobotanical, especially paleocarpological, study of the Upper Pleistocene buried lacustrine-palustrine sediments located in the Central Forest State Natural Biosphere Reserve. The study area is situated 360 km west of Moscow (the Tver' region) in the south of the Valdai Hills. The boundary of the Valdai ice cover was situated 15–20 km to the north of the Natural Reserve (Chebotareva, Makarycheva, 1974; Velichko et al., 2004). Geological and geomorphological studies have shown that buried lacustine and palustrine deposits were common in the Natural Reserve. They accumulated in isolated depressions on the moraine of the Moscow stage of the Dnieper glaciation epoch (Puzachenko, Kozlov, 2007).

The most complete Upper Pleistocene section was investigated earlier by N. N. Sokolov. Palynological analysis showed that the section contains Mikulino (Eemian) and Early Valdai (Early Weichselian) deposits (Sokolov, 1948). However, Minaeva et al. (2005) supposed that the buried organogenic sediments of the Natural Reserve are of Middle Valdai age on the basis radiocarbon dating and analysis of macroscopic plant remains from the upper part of the buried peat. Recently, scientists of the Institute of Geography RAS and Severtsov Institute of Ecology and Evolution RAS accomplished an additional complex study of four sections of buried lacustrine and palustrine deposits in the Natural Reserve (Fig. 1).

Section Natural Reserve-1 ("Sokolov borehole") is situated at a steplike part of a slope of a Moscow moraine range in the southern part of the Natural Reserve. Drilling revealed (from bottom to top): carbonate clays with gruss (moraine), fluvioglacial, lacustrine and palustrine deposits about 680 cm thick. They are overlain by loesslike loam, heavy loam and Holocene peat (Fig. 1). Section Natural Reserve-2 resembles section Natural Reserve-1 by it's geomorphological position. It is also situated on a steplike part of a moraine slope. The thickness of buried organogenic deposits (peat and organic-

rich clays) slightly exceeds 2 m. It should be noted, that section Natural Reserve-3 does not contain buried lake deposits so it is not considered in this paper. Section Natural Reserve-4 is situated in a small depression, on a watershed. Buried lacustrine deposits are thin there, represented (from bottom to the top) by lacustrine clays, sand, and organic-rich clay (Fig. 1).

In spite of differences between the compositions of the local fossil assemblages from the studied sites two generalized carpological assemblages can be distinguished for the region under consideration. They include local assemblages of the studied sections with the similar composition or occurrence of particular plant taxa.

Carpological assemblage 1 includes local assemblages from the peaty deposits in the sections Natural Reserve-1 and Natural Reserve-2. Their common feature is the presence of species characteristic of s. c. "*Brasenia* assemblage". It includes the remains of thermophilic species of aquatic and wetland plants. The numerous seeds of the extinct species *Brasenia holsatica* were identified in studied sections. Fossil fruits of *Dulichium arundinaceum*, which currently grows only in North America, were found in local carpological assemblages from the section Natural Reserve-2. Numerous remains of various aquatic plants such as *Aldrovanda vesiculosa*, *Salvinia natans*, *Trapa natans*, *Najas marina*, *Potamogeton acutifolius* were identified. Most of these species occur in the modern flora of Europe, but to the west and south from the region under consideration. Some of them, such as *Aldrovanda vesiculosa* and *Najas marina*, also occur in some isolated northern localities.

The wetland herbaceous plants were represented by numerous remains of *Typha* sp., *Carex* sp. div., *Eleocharis palustris*, *E. ovata* and *Scirpus sylvaticus*. The role of palustrine plants, such as *Chamaedaphne calyculata, Andromeda polifolia, Menyanthes trifoliata, Rhynchospora alba,* increased in the upper part of peaty deposits in studied sections. While the remains of aquatic and wetland plants predominated in carpological assemblage under consideration, some fruits and seeds of arboreous plants (*Carpinus betulus*, *Acer* sp., *Alnus glutinosa*, *Picea* sp.) were identified.

In general, assemblage 1 reflects local vegetation of shallow organic-rich water bodies, so-called lake-swamps, which existed under conditions of warm and mild climate. The abundance of palustrine plant macroremains in upper parts of studied peaty deposits was due to the paludification of water bodies.

Assemblage 1 is comparable by its composition to Mikulino carpological assemblages of adjacent areas of the Tver Region and the basin of Zapadnaya Dvina River (Velichkevich, 1982). The comparison with palynological data from the same sites in Natural Reserve (Novenko et al., 2008) showed that assemblage 1 corresponds to pollen zones M2–M6 of the Mikulino Interglacial and, in particular, to its climatic optimum.

Carpological assemblage 2 includes similar in composition local assemblages of sections Natural Reserve-1, Natural Reserve-2 and Natural Reserve-4 and is restricted to organic-rich clays. The assemblage is characterized by a sharp domination of fruits of *Batrachium* sp., prominent amount of megaspores of *Selaginella selaginoides*, and the presence of the extinct species *Potamogeton dorofeevii*. Species that are tolerant to climatic conditions are present, and thermophilic elements are absent. The prominent role of the microthermic species *Selaginella selaginoides*, which probably grew in wet meadows along coasts of water bodies, reflects the progressive climatic cooling.

The prevalence of *Batrachium* on shoals indicates an increased water level under conditions of relatively cold and humid climate. Communities of charophytes formed underwater meadows in deeper areas of water bodies, that testifies to the increased concentration of carbonates in water. The comparison with palynological data from the same sites (Novenko et al., 2008) showed that assemblage 2 corresponds to the end of Mikulino Interglacial, transitional period and the beginning of the first post-Mikulino cooling.

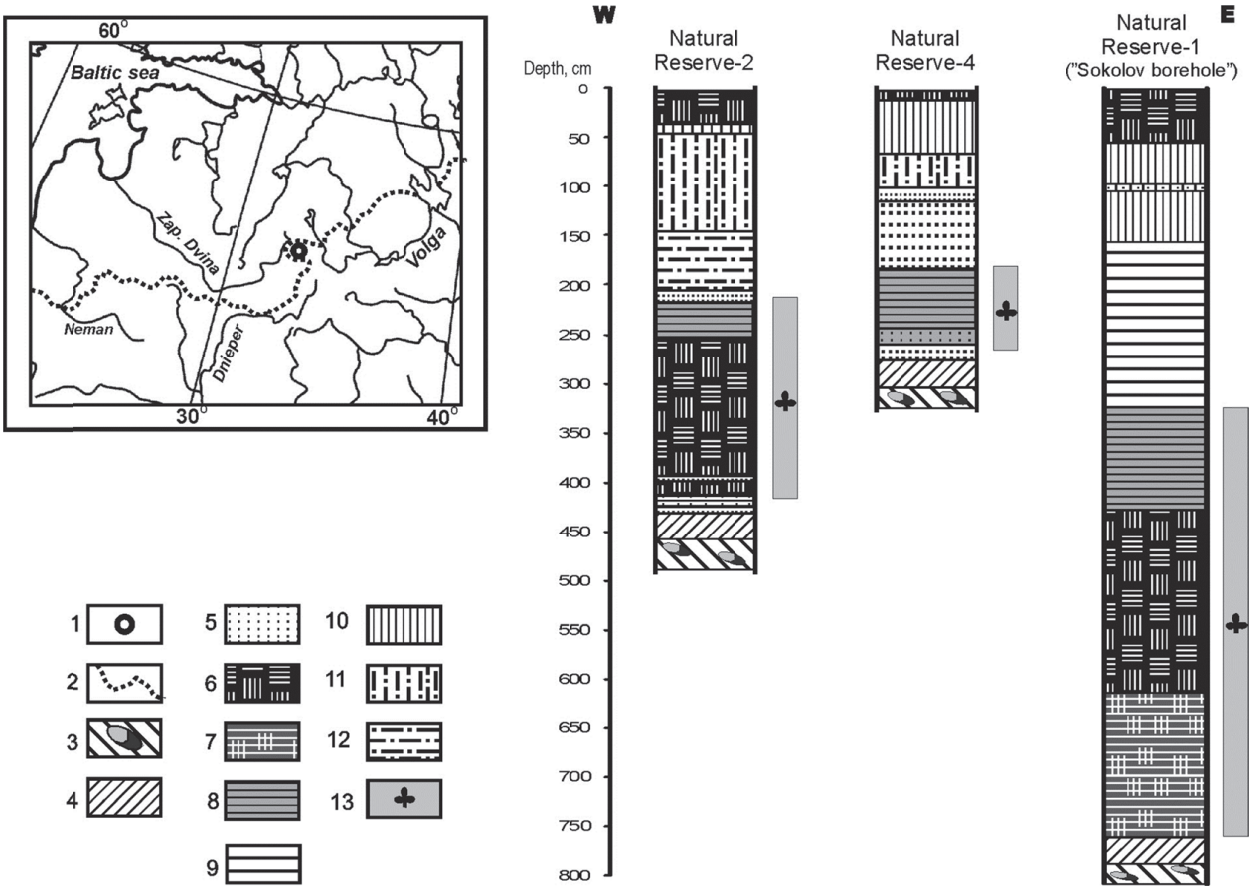

Fig. 1. The location and lithology of the sections studied in the Central Forest State Natural Biosphere Reserve. Legend: (1) the Central Forest State Nature Biosphere Reserve; (2) boundary of the ice cover (Velichko et al., 2004); (3) moraine (carbonaceous loam with gruss); (4) bluish-gray carbonaceous clay; (5) sand; (6) peat; (7) highly terrigenous peat; (8) clay with high content of organic matter; (9) clay; (10) loam; (11) loesslike loam; (12) sandy loam; (13) intervals studied using paleocarpological methods

Few East-European localities are known to contain data that are comparable with those obtained about carpological assemblage 2 of the Natural Reserve. Similar assemblages are known from Pryalitsa section in Tver' Region (Velichkevich, 1982) and Medininkai section in eastern Lithuania (Satkunas et al., 2003). These assemblages were obtained from sediments corresponding to the transitional stage between the Mikulino interglacial and Valdai glaciation.

The obtained data allowed us to reconstruct the dynamics of local lake-swamp vegetation and changes in conditions in small paleolakes in the south of the Valdai Hills. These paleolakes were characterized by shallow-water eutrophic conditions during the Mikulino interglacial. Thermophilic species, which now are alien to the flora of the region under consideration, were represented in water plant communities. The processes of paludification intensified in the second half of the climatic optimum of the Milulino Interglacial. Paleocarpological data for the end of Interglacial indicate an increase in the water level under conditions of the progressive climatic cooling.

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