Nova Acta Leopoldina NF *117*, Nr. 399, 191–194 (2014)

A Multiproxy Reconstruction of the Last Interglacial Environmental Conditions in Northern Russia

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With 2 Figures

The Arctic generally lacks sound and continuous records of the last interglacial paleoenvironmental evolution. A high-resolution investigation of the 4.5 m thick sequence of Eemian marine beds directly overlying Saalian till in Bychye section (Pyoza River, NE White Sea Region) now allows for detailed reconstruction of past events on the basis of obvious changes in lithology, microfossils (foraminifers, ostracods, spores and pollen, aquatic palynomorphs), and benthic foraminiferal isotope data ($\delta^{18}O$, $\delta^{13}C$).

The early stage of inundation features an accumulation of marine clays overlying the till and stands out as a period of harsh, fluvially-affected environmental conditions with cold turbid waters and heavy seasonal sea-ice cover. This is suggested by the predominance of opportunistic species *Elphidium clavatum* and river-proximal species among foraminifers, and heterotrophic cryophilic species *Islandinium minutum* among extremely poor dinocyst assemblage. Low $\delta^{18}O$ and $\delta^{13}C$ values likely result from strong water stratification due to considerable influence of melt water. The main trend in the evolution of vegetation is the gradual supplanting of late Saalian – earliest Eemian arctic-type periglacial treeless vegetation by birch and light-coniferous forests during the early Eemian.

Further climate amelioration and increasing influence of open-sea waters correspond to accumulation of silts and sands of the middle part of the section. These are evidenced by increasing total abundance and diversity of microfossils, a high percentage of foraminifers characteristic of the Arctic shelves with high seasonal productivity (*Islandiella* spp., *Nonion labradoricum*), occurrence of relatively deep-water Arctic species among foraminifers (*Melonis barleeanus*) and ostracods (*Krithe glacialis*), a sharp increase in $\delta^{18}O$ values, and growing representation of broad-leaved species (*Quercus*, *Ulmus*, *Corylus*, *Carpinus*) in pollen spectra. The highest content of spruce, alder and other mixed forest halophytes supplemented by hazel maximum and single *Tilia cordata* pollen grains in the 200–120 cm sediment interval characterize the warmest and most humid period.

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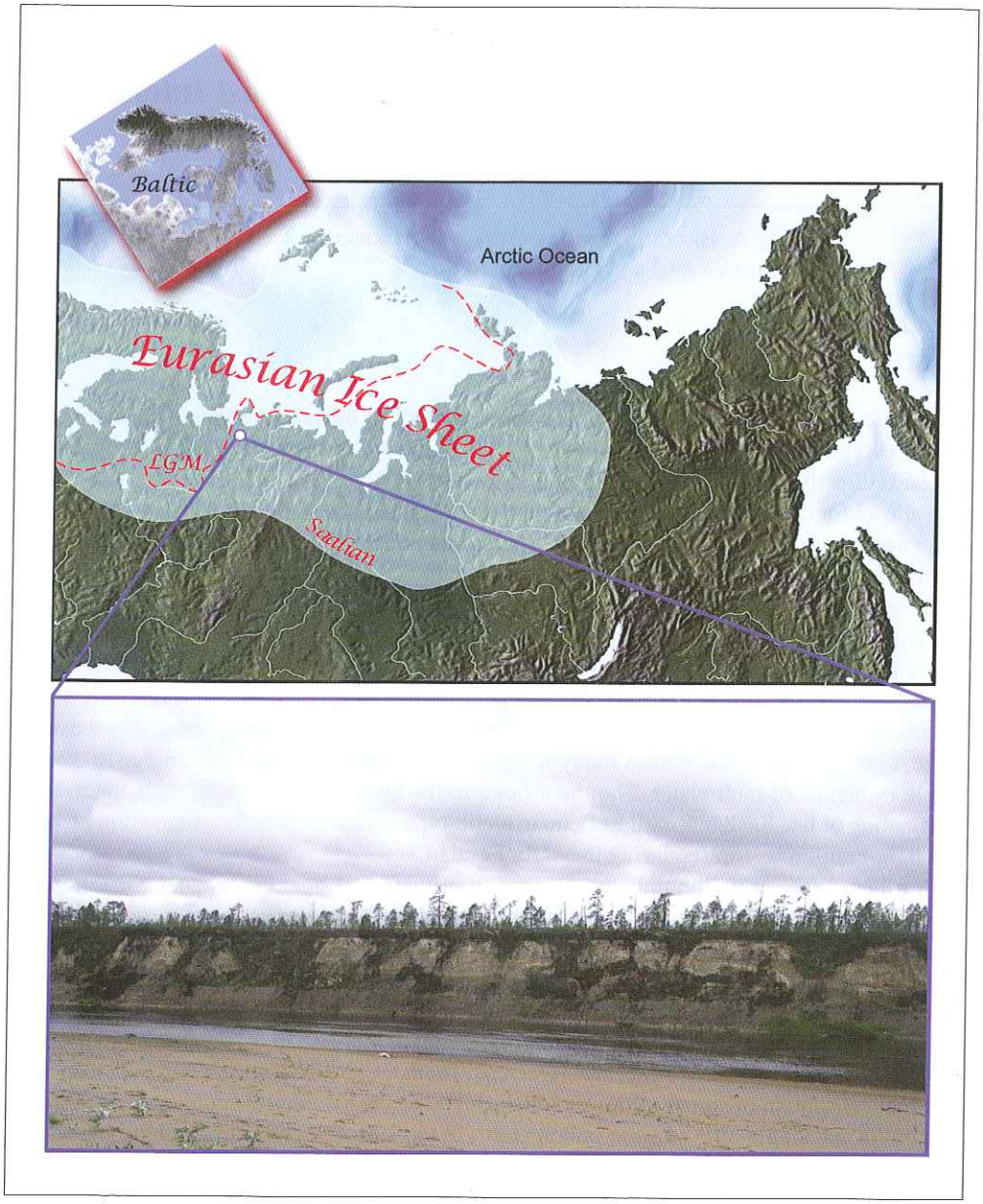

Fig. 1 Maximum Eurasian ice sheet configuration during the penultimate glaciation (Saalian) in comparison with the maximum extent during the Last Glacial Maximum (LGM) c. 20,000 years ago (*top*). For some time during the Eemian warm period, the interglacial phase which followed directly upon the Saalian, there was a seaway connection across the Baltic Sea, between the North Sea and the White Sea (*top small inset*). That situation led to a deposition of marine sediments found today at various localities, especially in areas outside the erosional reach of the last glacial ice sheets. The bottom panel shows such an example from the northern banks of the Pyoza River in N. Russia (Fig. in parts modified from BAUCH 2013).

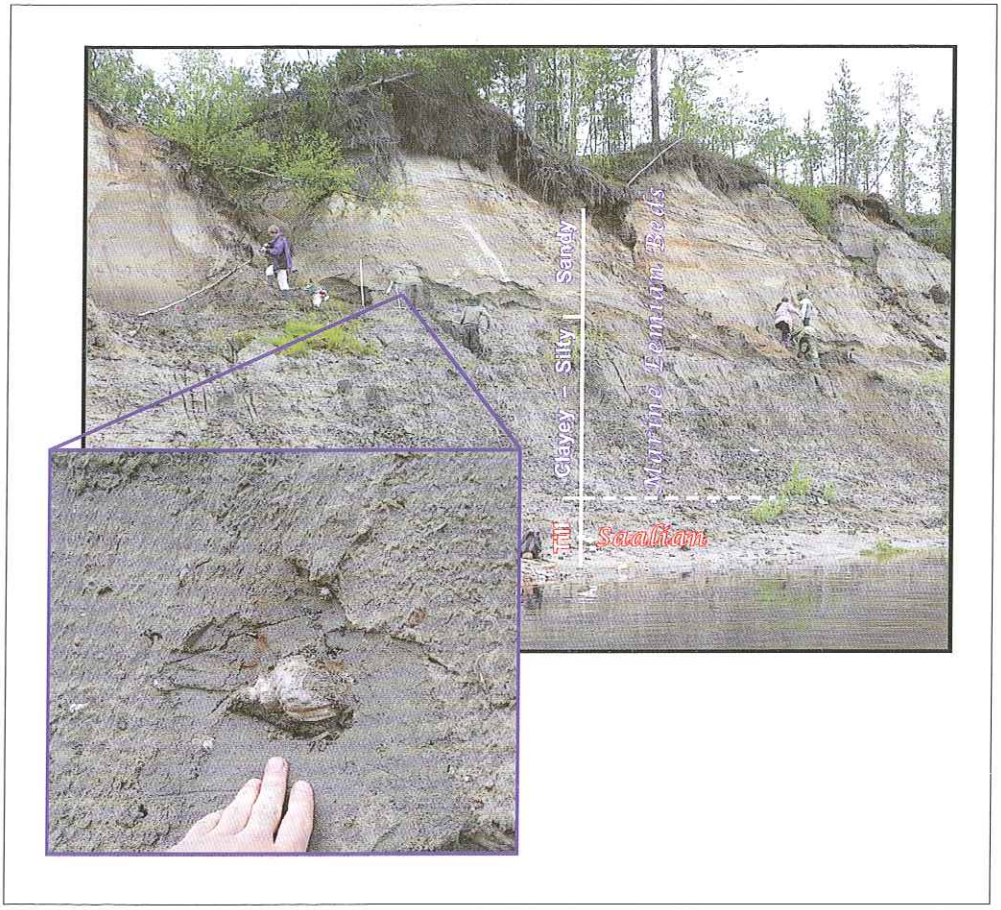

Fig. 2 Lithostratigraphical units of the Pyoza River in N. Russia showing marine Eemian sediments with upward-grading of sediment grain sizes (clay to cross-bedded sands) above till material of Saalian age. Besides microfossils (e.g., foraminifers, ostracods, dinoflagellate cysts, and pollen), the marine sediments also contain a wealth of macrofossils, such as bivalves and gastropods (close-up photograph).

The final regressive stage, caused by isostatic crustal rebound, witnessed the accumulation of sands, gradually decreasing taxonomic diversity and abundance of microfossils, and a growing proportion of relatively warm-water and shallow-water species especially among ostracods (*Finmarchinella finmarchica*, *Patagonicythere dubia*, *Cythere lutea*, *Hemicytherura clathrata*, *H. villosa*, *Semicytherura undata*). However, these warm-water elements co-occur with typical Arctic shelf species among both ostracods (*Sarsicytheridea bradii*, *S. punctillata*, *Robertinoides tuberculatus*, *Elofsonella concinna*, *Palmenella limicola*) and foraminifers (*Elphidium clavatum*, *E. incertum*, *Cassidulina reniforme*, *Islandiella* spp., *Cibicides lobatulus*, *Buccella frigida*, *Astrononion gallowayi*, *Haynesina orbiculare*). Most likely the warm-water species were restricted to the shallowest parts of the former bay with the highest summer warming and strongest freshwater influence. There are no direct indicators of Atlantic water penetration in the species composition of microfossils, and the presence of subarctic ostracods and bivalves

as well as single dynocysts of autotrophic species *Penthapharsodinium dalei*, *Spiniferites* cf. *pachydermus* and *Nematosphaeropsis labyrintus* in the upper part of the section could be due to shallowing and surface water warming. Gradual climatic deterioration towards the end of the record is manifested by birch prevalence over pine and hornbeam and disappearance of spruce, alder, and other mesophilous representatives.

Reference

BAUCH, H. A.: Interglacial climates and the Atlantic meridional overturning circulation: Is there an Arctic controversy? Quaternary Science Reviews doi:10.1016/j.quascirev.2012.11.023 (2013)

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