



Ecosystem responses during Late Glacial period recorded in the sediments of Lake Łukie (East Poland)

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The main objectives of this study was to reconstruct climate impact on the functioning of Lake Łukie and its catchment (Łęczna Włodawa Lake District, East European Plain) during Late Glacial period. In order to reconstruct climatic fluctuations and corresponding ecosystem responses, we analysed lake sediments for pollen, microfossil Cladocera, plant macrofossils and chemical composition of the sediment. Of these, plant macrofossils and Cladocera were used to infer minimum and mean July temperatures and ordination analysis was used to examine biotic community shifts.

Multiproxy analyses of late-glacial sediments of Lake Łukie clearly show that the main driver of aquatic and terrestrial ecosystems as well as geomorphological processes in the catchment was climate variation. The history of the lake initiated during the Older Dryas. In that period, Łęczna Włodawa Lake District was covered by open habitats dominated by grasses (Poaceae), humid sites were occupied by tundra plant communities with less clubmoss (*Selaginella selaginoides*), dry sites by dominated by steppe-like vegetation with light-demanding species such as *Helianthemum*, *Artemisia*, *Chenopodiaceae*, and juniper bushes (*Juniperus*). Cold climate limited the growth and development of organisms in the lake, Cladocera community species composition was poor, with only few species present there all the time. During this time period, permafrost was still present in the ground limiting infiltration of rainwater and causing high erosion in the catchment area. Surface runoff is confirmed by the presence of sclerotia of *Cenococcum geophilum* and high terrigenous silica content.

The warming of the early Allerød caused a remarkable change in the natural environment of this area. This is in accordance with the temperature rise reconstructed with the use of plant macrofossils though the Cladocera reconstruction did not recorded the rise than. This temperature increase resulted in turnover of vegetation in the catchment of Lake Łukie, pioneer birch-pine forests dominated, later replaced by pine-birch forests. Consequently this limited the erosion. The results of all proxy suggest the water-level rise in lake Łukie. The Younger Dryas cooling in the region began about 12 630 14C years BP and recorded in significant drop in temperature reconstructed with plant macrofossils and Cladocera. The cooling resulted in a decline of forest communities and development of open habitats with grasses (Poaceae), *Artemisia*, and *Chenopodiaceae*), as well as juniper thickets (*Juniperus*)

At the end of the Younger Dryas, plant communities changed, the non-arborescent pollen declined, while pollen of trees (especially *Pinus*) became more abundant. This change was more abruptly reflected in Cladocera and aquatic pollen results and is probably related to gradual climate warming.

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