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## Palaeoenvironmental Investigations and Reconstructions in Northern Russia Using Subfossil *Cladocera* (*Branchiopoda*, *Crustacea*)

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and Sebastian WETTERICH<sup>4</sup>

Climate change is emerging as the most far reaching and significant stressor on Arctic biodiversity (PETERSEN 2010). It is expected that climate warming will cause changes or even a decrease of areas of distribution of animals living in Arctic regions. Continued thawing of permafrost can lead to the drainage and eventual disappearance of lakes, as can erosion and lake coalescence (SAMCHYSHYNA et al. 2008).

Earlier melting of ice and snow, flowering of plants, and emergence of invertebrates can cause a mismatch between the timing of reproduction and food availability. Furthermore, recent climate warming is expected to support biological invasions by species originating from warmer regions (BIJ DE VAATE et al. 2002). Hence, biological observations based on the best available scientific methods are required to identify changes in biodiversity, to assess the implications of observed changes, and to develop adaptation strategies.

*Cladocera* (*Crustacea: Branchiopoda*) is a key component of aquatic ecosystems and their community structure reflects the combination of physical, chemical, and biological characteristics of the system they inhabit (JEPPESEN et al. 2003, DAVIDSON et al. 2007, FROLOVA 2013).

The period of open water and, respectively, the vegetation period for the majority of water organisms are limited in the Arctic by a short temporary interval of one or two months. Samples of zooplankton collected with standard hydrobiological methods once or twice a season, do not allow tracing presence of many species. Therefore, the real species richness of the water body in the Arctic region is unclear because of the unknown seasonal dynamics of the life cycles in the arctic water bodies. As in the lake sediments, the remains of animals for the entire vegetative period are deposited, and paleolimnological techniques can give a better understanding of a taxonomic diversity, at least for some selected families (*Chydoridae*, *Bosminidae*).

The aim of the present investigation is to examine the taxonomic and ecological diversity of cladoceran microfossil assemblages from the north-west of Yakutia, north-eastern Siberia, to determine their distribution within the region with regards to environmental gradients and to reveal the influence of environmental factors in structuring the cladoceran communities in the region with special regard to climate-dependant environmental parameters.

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We study subfossil remains of *Cladocera* (*Branchiopoda*, *Crustacea*) from lakes, located in different regions of Russia (Northern Karelia and north-eastern Siberia). According to the *Cladocera* abundance in lake sediments, they were divided into three groups: dominant taxa (> 50 % in each sample), subdominant (from 25–50 %), and seldom (< 25 %) taxa. We determined their biotopic and zoogeographic features, calculated indexes of species diversity, community evenness, and statistical analysis with identification of preferences of species for hydrological parameters. Our analysis allows us to obtain a more complete picture of the species composition of the cladoceran community in comparison to regular sampling over several vegetation seasons using standard hydrobiological methods.

The material for this study was surface sediment samples from 18 lakes in Bolshoy Lyakhovsky Island, Oyogos Yar, sediments from 24 lakes in Central Yakutia, and 5 lakes in the White Sea region. In general, most of the lakes are small and shallow, and were formed by thermokarst processes with maximal depths of about 4 m. Ion concentrations show that cation compositions for lake waters are dominated by  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$ . We found differences in hydrochemical composition. In Central Yakutia lakes had high salinity, while in the northern melt water ponds we observed lower salinity. Al ion content was higher in waters of the Bolshoy Lyakhovsky Island, compared to those in Central Yakutia. Reservoirs in Bolshoy Lyakhovsky Island also have high rates of Fe, compared to reservoirs in Central Yakutia.

Among the leading species, common for all sampling sites in the region of north-eastern Siberia, is *Chydorus sphaericus*, *Alona guttata*, *Bosmina longirostris*. The composition of the dominants was similar, but it was replenished in reservoirs of Central Yakutia with such species as: *Alonella nana*, *Bosmina longispina*. In taxonomic terms the highest species diversity of Cladocera was in the lakes of Central Yakutia (34 taxa), and in the waters along the coast of the Laptev Sea: 20 species in the lakes of the Bolshoy Lyakhovsky Island and 9 in Oyogos Yar.

According to zoogeographic zoning, the bulk of the cladocera community, typical of present-day conditions, were species characterized by universally geographical distribution, except for lakes from the White Sea region, where more northern species were found. The majority of the found species belonged to the littoral taxa, but in the lakes in the White Sea region more littoral-planktonic taxa were found.

The values of Shannon's Index (H) range from 0.90 to 2.75 in samples from the island of Bolshoy Lyakhovsky and from 2.64 to 2.7 in the waters of Central Yakutia, and for the lakes in the White Sea region: 2.04–2.97. This indicates the presence of a relatively diverse cladoceran community. The values of Pielou index ranged from 0.35 to 0.87 in samples from the Laptev Sea coast lakes, from 0.6 to 1.0 in samples from Central Yakutian waters, and from 0.41–0.91 for the lakes from the White Sea region, indicating an even distribution of species in the cladoceran communities.

We revealed significant differences in preferences of species for certain environmental conditions using an analysis of variance (ANOVA). The data for this analysis was an abundance of fossilized remains of each taxon that had been found in investigated waters from northeast of Yakutia. Using statistical analysis, we revealed significant differences in the abundance of certain species and values of hydrochemical parameters corresponding to the species-specific preferences for abiotic conditions.

Forward selection and Monte Carlo permutation tests (999 permutations), identified a minimal subset of four environmental variables that significantly ( $p \leq 0.05$ ) and most effectively explained variation in the species data:  $T_{\text{July}}$ , water depth,  $\text{SO}_4^{2-}$ ,  $\text{Si}_4^+$ RDA axis 1 ( $\lambda = 0.174$ )

and axis 2 ( $\lambda = 0.157$ ) were both significant ( $p \leq 0.05$ ) and explained 85.8% of the relationships between the cladoceran taxa and measured environmental variables.

From the four identified significant environmental variables,  $T_{\text{July}}$  featured the highest percentage of explained variance, as well as the highest  $\lambda_1/\lambda_2$  ratio (0.67). The latter measure, in particular, serves to indicate how effectively the variance in the species data is captured by a particular gradient (WECKSTRÖM et al. 1997, KORHOLA et al. 2000). The results suggest that the relationship between cladoceran distributions and  $T_{\text{July}}$  in this data-set is sufficiently strong and is promising for the future development of a regional transfer function that has the potential to be used to predict the mean July temperatures from the cladoceran data.

The investigation of cladoceran assemblages of north-western Yakutian lakes has demonstrated a high potential for this group of hydrobionts as an indicator of the ecological state of water bodies and of the changes taking place in an ecosystem caused by climate change (high level of correlation between the species composition and the air temperature). The obtained results encourage further work on making a regional cladoceran-based temperature model appropriate for the Arctic regions of Russia as a whole, and Yakutia in particular.

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### *References*

- BIJ DE VAATE, A., JAZDZEWSKI, K., KETELAARS, H. A. M., GOLLASCH, S., and VELDE, G.: Geographical patterns in range extension of Ponto-Caspian macroinvertebrates species in Europe. *Can. J. Fish Aquat. Sci.* 59, 1159–1174 (2002)
- DAVIDSON, T. A., SAYER, C. D., PERROW, M. R., BRAMM, M., and JEPPESEN, E.: Are the controls of species composition similar for contemporary and sub-fossil cladoceran assemblages? A study of 39 shallow lakes of contrasting trophic status. *J. Paleolimnol.* 38, H. 117–134 (doi: 10.1007/s10933-006-9066-x) (2007)
- FROLOVA, L. A., NAZAROVA, L. B., PESTRYAKOVA, L. A., and HERZSCHUH, U.: Analysis of the effects of climate-dependent factors on the formation of zooplankton communities that inhibit Arctic lakes in the Anabar River basin. *Contemp. Probl. Ecol.* 6, 1–11 (2013)
- JEPPESEN, E., JENSEN, J. P., LAURIDSEN, T. L., AMSINCK, S. L., CHRISTOFFERSEN, K., SØNDERGAARD, M., and MICHELL, S. F.: Sub-fossils of cladocerans in the surface sediment of 135 lakes as proxies for community structure of zooplankton, fish abundance and lake temperature. *Hydrobiologia* 491, 321–330. (doi: 10.1023/A:1024488525225) (2003)
- KORHOLA, A., OLANDER, H., and BLOM, T.: Cladoceran and chironomid assemblages as qualitative indicators of water depth in subarctic Fennoscandian lakes. *J. Paleolimnol.* 24, 43–54 (2000)
- PETERSEN, A.: Emerging issues and challenges. In: KURVITS, T., ALFTHAN, B., and MORK, E. (Eds.): *Arctic Biodiversity Trends 2010 – Selected Indicators of Change*; pp. 15–16. Akureyi, Iceland: CAFF International Secretariat 2010
- SAMCHYSHYNA, L., HANSSON, L.-A., and CHRISTOVERSEN, K.: Patterns in the distribution of Arctic freshwater zooplankton related to glaciation history. *Polar Biol.* 31, 1427–1435 (doi: 10.1007/s00300-008-0482-4) (2008)

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WECKSTRÖM, J., KORHOLA, A., and BLOM, T.: Diatoms as quantitative indicators of pH and water temperature in sub-arctic Fennoscandian lakes. *Hydrobiologia* 347, 171–184 (1997)

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