

Cladocera remains in reconstructions of past ecological conditions of the Yamal Peninsula

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ABSTRACT. The aim of this study is to explore the Cladocera community from the bottom sediments of small unnamed lake (21-Ya-02B) whilst attempt to reconstruct the ecological and climatic conditions for the Yamal Peninsula. In total, remains of 37 taxa were identified in bottom sediments of the lake. Cladocera community in the lower layers at the column is represented by low taxonomic abundance and typical northern species. On the depth of 65-40 cm the maximum number of taxa was identified, which allows it to be considered the temperature optimum zone of Cladocera. Changes in the upper layers of the column may indicate climate warming in the study area and, as a consequence, thawing of permafrost.

Keywords: Cladocera, bottom sediments, Holocene, Yamal Peninsula, thawing of permafrost

1. Introduction

Recent decades have been characterized by noticeable climate change occurring in the Arctic faster and on a larger scale than in the rest of the world (Nigamatzyanova et al., 2021; Fefilova et al., 2022). Warming occurs synchronously for the Western Arctic region with short-term fluctuations, with both increasing and decreasing average annual temperatures observed. Climate warming is accompanied by an increase in annual precipitation (Shirokov and Vasiliev, 2019). Studies of lakes bottom sediments are of particular importance for reconstructing the ecological and climatic conditions of the past, whilst also assessing the current state of lakes (Smol et al., 2005). Algal and invertebrate remains (Chironomidae and Cladocera) are among the most common paleo indicators in lake sediments that provide reliable records of changes in water quality, habitat and catchment processes (Smol et al., 2005; Frolova et al., 2016; Ibragimova et al., 2020). The aim of this study is to explore the Cladocera community from the bottom sediments of small unnamed lake (21-Ya-02B), which is close to Lake Tabortato, whilst attempt to reconstruct the ecological and climatic conditions for the Yamal Peninsula.

2. Materials and methods

The Yamal Peninsula is located above the Arctic Circle, between the Kara Sea to the north and West, Baidaratskaya Bay in the southwest, and Obskaya Bay in the east. The territory is generally flat, hilly in the north, and elevated in the central part, elongated in the meridional direction, with elevations up to 100 m above sea level. The surface is cut in varying degrees by river and ravine network, heavily marshy and waterlogged. The Yamal Peninsula is located in a permafrost zone, a zone of tundra that changes from south to north from a narrow strip of forest tundra to arctic tundra. The climate of the peninsula is harsh, winter lasts 8-9.5 months (Atlas..., 2004). The study lake is located in the southwest of the Yamal peninsula (N 68°09'53.8", E 68°57'36.1"). The lake is round and small, coastal vegetation includes small bushes, moss and grass. The bottom of the lake is muddy. In July 2021, specialists of Kazan Federal University collected a column of bottom sediments of the lake using Gravity corer. The depth of sampling of the bottom sediment column was 4.3 m, the length of the column was 67 cm. For Cladocera analysis, bottom sediment samples were sliced in 1 cm increments. Thus, for Cladocera analysis

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35 samples of the bottom sediments were selected using a method of sample preparation improved by Korhola and Rautio (2001). In each sample 200 specimens were identified at minimum. The maximum number of headshields, carapaces or postabdomens of a single taxon was used to calculate the total number of specimens in the sample. Identification of the Cladocera remains was carried out using an Olympus BX41 (Olympus Corporation, Japan) (magnification x100-400) light microscope along with specialized keys for identification subfossil (Szeroczyńska and Sarmaja-Korjonen, 2007) and modern Cladocera (Kotov et al., 2013). Statistically significant stratigraphic zones were identified using CONISS cluster analysis of the Tilia/TiliaGraph software.

3. Results

In total, remains of 37 taxa belonging to 5 families of Cladocera (Chydoridae, Bosminidae, Daphniidae, Sididae, Macrothricidae) were identified in bottom sediments of the unnamed lake. The species diversity is mainly represented by the remains of the family Chydoridae. According to the stratigraphic diagram of Cladocera taxa distribution in bottom sediments of the studied lake, 4 faunistic zones can be distinguished. In the lower part of the column (Zone I, 70-65 cm) the least number of taxa - 15 taxa - was identified. *Alonella nana* - 34.49 %, *Chydorus* cf. *sphaericus* - 24.45 %, *Eubosmina* (*Bosmina*) cf. *longispina* - 17.35 % are subdominants. Cladocera community in this zone is represented by typical northern species. Zone II (65-40 cm) shows the greatest species diversity, where remains of 32 taxa were identified. The greatest number of remains belongs to *A. nana* - 27.73 %, *C.* cf. *sphaericus* - 26.96 %, *E. (B.)* cf. *longispina* (18.41 %) remains. The increase in taxonomic diversity is due to the development of the littoral complex. In zones I-II the remains of *Sida crystallina*, *Rhynchotalona latens*, *Camptocercus fennicus* are found, which are associated with cold climate and low content of organic matter. In zone III, significant changes in the ratio of identified taxa are observed: the role of dominant in the Cladocera community is played by *E. (B.)* cf. *longispina* (73.87 %). The share of *C.* cf. *sphaericus* (14.83 %), *Acroperus* sp., *Alona guttata tuberculata/ Alona rectangula pulchra*, *A. nana* (0.41 %) decreases. In zone IV, a decrease in taxonomic diversity was observed - 18 taxa were identified. The dominance of *E. (B.)* cf. *longispina* (50.3 %) is noted, *C.* cf. *sphaericus* (27.49 %) is subdominant. The proportion of representatives of *Alona* s.lat. increases, while the remains of representatives of the genus *Alonella* are not found in Zone IV.

4. Discussion

Low taxonomic diversity of the lower part of the bottom sediment column is common for lakes of glaciogenic origin (Frolova and Ibragimova, 2015). Zone I is represented by remains of typical northern species associated with low temperatures. There is an increase in taxonomic diversity in the upper layers.

The Cladocera community of this zone indicates the cold climate during this period. The maximum number of remains of *A. nana*, classified as a subarctic taxon, is noted here. However, this species is also strongly associated with vegetation and has a pronounced ecological preference for dystrophic lakes with sphagnum mosses (Fryer, 1968). The presence of higher aquatic vegetation and oligotrophic conditions in the reservoir is indicated by the remains of *S. crystallina* (Flössner, 2000). The maximum number of taxa was identified in zone II, which allows it to be considered the temperature optimum zone of Cladocera, although the remains of northern species (*C. fennicus*, *R. latens*, *A. harpae*, *A. nana*) testify to low temperatures in the study region. The increase in taxonomic diversity is due to the appearance of taxa inhabiting overgrown areas of water bodies. In zone III the dominant communities change, a significant increase in the proportion of pelagic *E. (B.)* cf. *longispina* may indicate a change in temperature regime in the study area and, as a consequence, thawing of permafrost. There is a decrease in the proportion of littoral species and species associated with vegetation. Northern species reduce their abundance in favor of warm-water forms: *C. fennicus* is replaced by *C. rectirostris*. In zone IV, taxonomic diversity continues to decrease, indicating changing conditions in the watershed and in the lake. The increase in the proportion of *C.* cf. *sphaericus* at the present stage of the lakes is often associated with eutrophication (Flössner, 2000), as well as with the release of organic matter during permafrost thawing. The increase in the proportion of *B. longirostris* in the surface sediments is also classified as a sign of an increase in the trophic status of the lake. Similarly, to those observed in previous investigations in other tundra lakes within Russia (Frolova and Ibragimova, 2015; Frolova et al., 2016; Ibragimova et al., 2020)

5. Conclusions

Significant changes in subfossil Cladocera community of the studied unnamed lake on the Yamal Peninsula are noted from a depth of 40 cm of the bottom sediments: there is a change in the dominant complex, an increase in the proportion of pelagic taxa and taxa associated with eutrophication. The above may be a consequence of climate change and thawing of permafrost in the study area.

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Conflict of interest

The authors declare no conflict of interest.

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