Short communication

ISSN 2658-3518
LIMNOLOGY FRESHWATER BIOLOGY
www.limnolfwbiol.com

C/N and δC^{13} patterns in lake sediments as a source of palaeoenvironmental information for the Mologa-Sheksna region (NW Russia)

Sadokov D.O.[1,2]*, Knoblauch C.[3], Melles M.[4], Mantke N.[4], Lendt R.[3]

[1] *Darwin State Nature Biosphere Reserve, Pobedy Pr., 6, Cherepovets, 162606, Russia*
[2] *St. Petersburg State University, Universitetskaya Emb., 7/9, St. Petersburg, 199034, Russia*
[3] *Universität Hamburg, Institute of Soil Science, Allende-Platz 2, Hamburg, 20146, Germany*
[4] *Universität zu Köln, Institute of Geology and Mineralogy, Zülpicher Str., 49a, Köln, 50674, Germany*

ABSTRACT. Organic geochemical proxies (δC^{13} and C/N) are used to infer changes of plant fossils sources in the sediments of relict mire lakes in Russia. The Pleistocene-Holocene transition is described by δC^{13} and C/N used jointly. Shifts of C/N and δC^{13} give ideas for the lakes water level and composition of plant remains changes as a consequence of the regional climate alterations. Pre-Holocene cool period (Younger Drias) and preceding warm phase (Allerød) are supposedly traced in the lake sediments for the north of the Mologa-Sheksna Lowland.

Keywords: lacustrine sedimentation, organic geochemistry, C/N ratios, δC^{13} signatures

1. Introduction

Late Glacial chronology for the Mologa-Sheksna Lowland (NW Russia, Vologda region) and late-Valdai (Würm) glaciations limits were largely derived only from geomorphological observations and borehole data (lithology and pollen) (Mokrienko et al., 1976), while there are none precise deposits age determinations for the northern part of the Lowland. Particularly it concerns the stratigraphy from the Last Glacial Termination up to nowadays, which can be traced in organic matter (OM) of lake and peat deposits widespread across the terrain.

2. Material and methods

Sediments of two relict lakes in the north of the Mologa-Sheksna Lowland were sampled by Russian peat corer in March 2018: Lake Beloye (N 59.379˚, E 35,626˚, area 1.26 km^2, depth 1.5 m) and Lake Pogoskoye (N 59,6975˚, E 36,8532˚, area 0.14 km^2, depth 2.1 m).

Total nitrogen and total carbon were measured in the sediments sub-sampled by every 2 cm at the University of Cologne using Vario MICRO cube (Elementar Analysensysteme GmbH). Organic muds were used for age determination at the Laboratory of the Radiocarbon Dating and Electronic Microscopy (Institute of Geography RAS, Russia) using accelerated mass-spectrometry method (AMS^{14}C) for three samples, one from each lake. Stable isotope ^{13}C content (δC^{13}) measurements were performed on the mass-spectrometer Thermo Scientific Delta V using an elemental analyzer Thermo Scientific Flash 2000 at the Institute of Soil Science (University of Hamburg, Germany). δC^{13} values are given relatively to the standart Vienne Pee Dee Belemnite (VPDB).

3. Results and discussion

Enhanced acceleration of OM with the onset of the Holocene, which is seen in lithological columns of both lakes, unambiguously indicates changes of climatic and hydrological conditions. Joint use of C/N and δC^{13} proxies (Fig. 1) enables to determine terrestrial or aquatic sources of OM accumulated in lakes (Meyers and Ishiwatari, 1995).

C/N proxy plotted for the sediments indicates mixed composition of plant fossils with terrestrial plants prevailing in all investigated lakes. In the sediments of lake Beloye C/N proxy values gradually increase upcore, while in the lowermost (late-glacial) part of the sequence mostly aquatic plant fossils (plankton) with a share of tundra plants are observed. By the Pleistocene-Holocene transition, near 11 600 cal. yr (δC^{13} peak at 473 cm), a short period of C_4-photosynthetic plants distribution is noticed, - probably tundra grasses. During the Holocene remains of C_3 terrestrial plants (deciduous) and lacustrine C_3-plankton were dominant in the sediments (Meyers and Ishiwatari, 1995).

*Corresponding author.
E-mail address: dmitriisadokov@gmail.com (D.O. Sadokov)

© Author(s) 2020. This work is distributed under the Creative Commons Attribution 4.0 License.

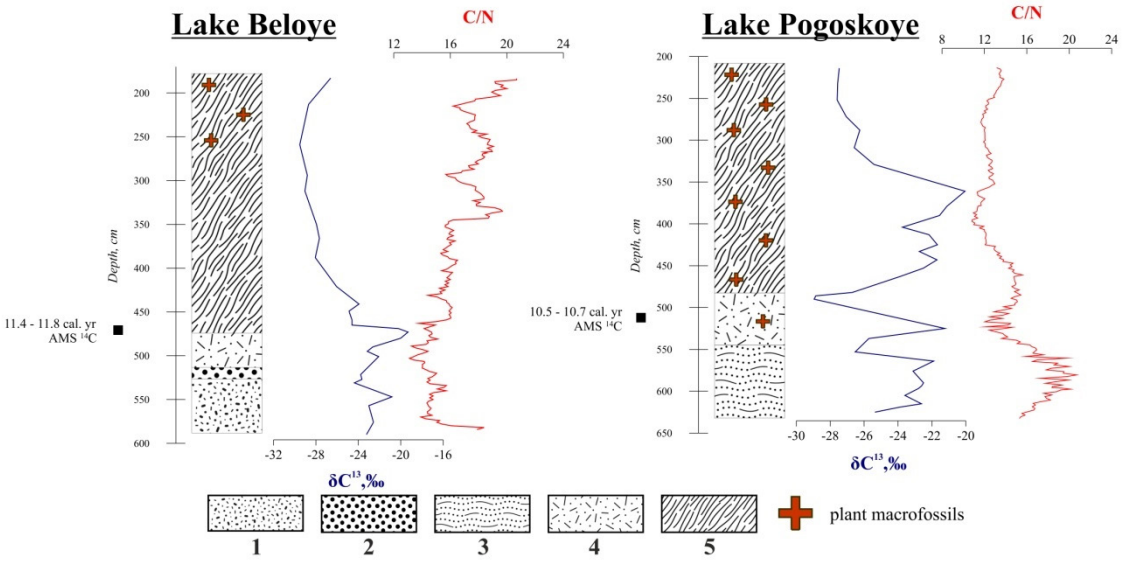

Fig.1. Lithology and vertical distribution of C/N and δC1^3 in the sediments of lakes Beloye, and Pogoskoye. Keys: 1 – laminated sandy silt, 2 – sandy silt with OM, 3 – rhythmically laminated silt with OM, 4 – silt with OM, 5 – organic gyttja

In the lowermost layers of sediments (634-560 cm) in lake Pogoskoye C/N and δC^{13} proxies show predominance of periglacial tundra grasses remains, which had been widespread at the lake surroundings during late-glacial time. An increase of the reservoir depth is indicated at the interval 564-537 cm (according to the δC^{13} values shift towards lacustrine plankton and C/N shift to aquatic plant remains) (Meyers and Ishiwatari, 1995). Geomorphological and lithological observations confirm these ideas (Mokrienko et al., 1976). Through the Holocene mixed plant fossils deposited in the lake with algae dominance; composition of terrestrial remains changed from xerophytic (C_4- or CAM-photosynthetic plants) to C_3-plants.

Hypothetically on the basis of C/N and δC^{13} plotted patterns and known datings in each lake Allerød warm period was suggested to be associated with the level 535-528 cm in lake Beloye and 580-540 cm in lake Pogoskoye, and the presumed Younger Drias cooling event follows upcore, expressed by an increase of δC^{13}. These patterns finely correlate with inorganic geochemical indicators discussed by Sadokov et al. (2019).

The study was funded by RFBR, project number 19-35-90026.

References

Meyers P.A., Ishiwatari R. 1995. Organic Matter Accumulation Records in Lake Sediments. In: Lerman et al. (Eds), Physics and Chemistry of Lakes. New York. pp. 279-328.

Mokrienko Z.M. et al. 1976. Report on the complex geological survey in scale 1: 200 000 of the r. Suda basin,Vologda region, vol. 1, book 1, USSR. Leningrad. (in Russian)

Sadokov D.O., Sapelko T.V., Mantke N. et al. 2019. Inorganic elements content in the sediments of the Mologa-Sheksna Lowland lakes as an indicator of Holocene climate change. In: Ecosystems Dynamics in the Holocene. Proceedings of the V Russian Scientific Conference with Int. Participation. Moscow. pp. 292-294. (in Russian)