Short communication

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The dynamics of macrophytes in Lake Vitalievskoye (Valaam Island, Russia) after level changes of Lake Ladoga during the Late Holocene

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ABSTRACT. Aquatic vegetation is a sensitive indicator of lake structural rearrangements, water level changes, overgrowth and waterlogging processes. Although macrophyte pollen may not be well preserved in lake sediments, it is a valuable source of information about an evolution of lakes. Continuing our previous researches on the use of macrophyte pollen analysis in paleolimnological studies, we have explored the sediments sequence of Lake Vitalievskoye on the Valaam Island (northern part of Lake Ladoga), that was isolated at the Ladoga regression for the Late Holocene. We have used pollen analysis of the sediments sequence with focus on the dynamics of aquatic vegetation. Based on our results, the macrophyte dynamics at every stage of the Lake Vitalievskoye development and relationship with the Lake Ladoga level changes in the Late Holocene were reconstructed.

Keywords: Lake Ladoga, Late Holocene, lake sediments, macrophytes, pollen analysis

1. Introduction

Lake Vitalievskoye is located on the Valaam Island (northern part of Lake Ladoga). It is a small lake surrounded by pine forest with spruce and birch with an area of 0.005 km^2 and a depth of up to 1.9 m. The lake was a part of Lake Ladoga at an early stage of its development and isolated from it in the Late Holocene due to the Ladoga's regression.

This article is a logical continuation of our previous researches of a role of macrophytes pollen in paleolimnological studies (Gazizova et al., 2020; Gazizova and Sapelko, 2020; 2021). There are many studies about aquatic vegetation including paleoenvironmental reconstructions (Taavitsainen et al., 1994; Saarnisto and Vuorela, 1998), however, we tried to explore potential use of macrophyte pollen in the reconstruction of the lake evolutionary history and the lake level changes. The macrophyte pollen in sediment sequences of some other lakes on the Valaam Island have been already studied (Vuorela et al., 2001; Saarnisto, 2012), and we have compared our results with existing data.

2. Materials and methods

Lake Vitalievskoye (10.8 m a.s.l.) were studied during paleolimnological field works of the Institute of Limnology RAS in summer 2019 and 2021. The lake sediments sequence was taken using a Russian corer (Sapelko et al., 2020). In addition, the modern aquatic vegetation of Lake Vitalievskoye was described and the surface samples of lake sediments were taken using a Voronkov's sampler. Received materials were studied using pollen analysis with focus on the macrophyte pollen.

3. Results and discussion

Based on pollen analysis and the existing studies of level changes of Lake Vitalievskoye (Saarnisto, 2012; Sapelko et al., 2018), we have reconstructed three stages of its Late Holocene development (Fig.). At the first stage (the Late Atlantic – Early Subboreal), Lake Vitalievskoye was part of Lake Ladoga, its poor aquatic vegetation was represented by *Potamogeton* spp. and *Sparganium* spp. At the second stage (end of the Subboreal), the lake was isolated from Lake Ladoga. At the first, the level of Lake Ladoga had decreased and it was a cause of the destabilization of this ecosystem. This process was accompanied by the disappearance of macrophytes pollen from pollen spectra. A similar absence of aquatic vegetation pollen is observed in the sediments sequence of other lakes in the Ladoga region (Delusin and Donner, 1995; Vuorela et al., 2001; Saarnisto, 2012; Sapelko et al., 2014; Gazizova

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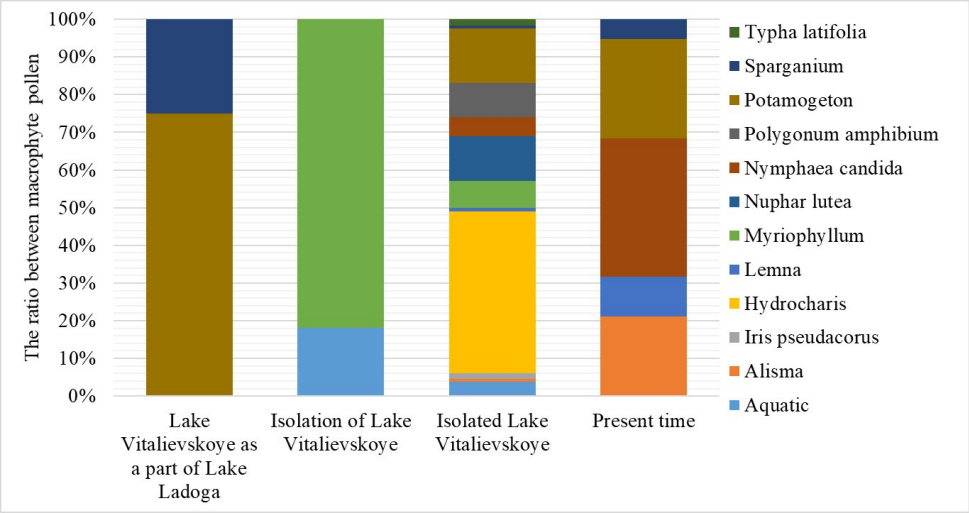

Fig. The representation of macrophytes pollen at the different stages of the Lake Vitalievskoye development.

et al., 2020; Gazizova and Sapelko, 2020; 2021). The following gradual loss of a connection with Lake Ladoga led to formation of the lagoon sedimentation in Lake Vitalievskoye. *Myriophyllum* spp. was the pioneer species for Lake Vitalievskoye aquatic vegetation when the lake ecosystem slow stabilized.

At the third stage (the Subatlantic) Lake Vitalievskoye has finally lost its connection with Lake Ladoga and the isolation process was finished. Fully isolated Lake Vitalievskoye was gradually populated with aquatic vegetation. *Myriophyllum* spp. was the only represented species for a long time, however, *Hydrocharis* spp., *Polygonum amphibium* and *Potamogeton* spp. Also appeared. *Nuphar lutea* latterly spread. The role of *Myriophyllum* spp. reduced and completely disappeared while *N. lutea* was appearance. Then *Nymphaea candida* spread and *Hydrocharis* spp. was a dominant; *N. lutea*, *Potamogeton* spp. and *P. amphibium* were prevailing species, too.

In the present time Lake Vitalievskoye is a small overgrown and overlogged lake with appropriate aquatic vegetation, which is represented by *Alisma* spp., *Lemna* spp., *N. candida*, *Potamogeton* spp. and *Sparganium* spp. according to pollen analysis of the surface samples of lake sediments. Additionally, the field description of modern aquatic vegetation showed the presence of *Hydrocharis morsus-ranae* and *N/lutea*.

4. Conclusions

The macrophyte dynamics at every stage of the Lake Vitalievskoye development was reconstructed. The obtained data helped us to reconstruct the Late Holocene history of the lake and describe its isolation process from Lake Ladoga.

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Conflicts of interest

The authors declare no conflicts of interest.

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