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Non-pollen palynomorphs from 78 surface sediment samples reveal spatial distribution of phytoplankton in Latvian lakes and ponds

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ABSTRACT

The aim of this study is to characterize the current spatial distribution of three main phyla of phytoplankton (Cyanobacteria, Charophyta and Chlorophyta) from 77 Latvian lakes and ponds, analysed from modern surface sediment samples through a non-pollen palynomorph approach. The Pearson cross-correlation and the principal component analysis were applied to test the potential correlation of phytoplankton with climate (mean winter and summer temperature), water (pH), environmental (land use – forest, agriculture and urban) and sediment (organic and carbonate matter) variables. The results show the dominance of Chlorophyta in Latvian lakes and ponds. Cyanobacteria were dominant in sites closer to human-populated and recreation centres, including urban and agricultural land-use areas. In more turbid and polluted environments, Chlorophyta thrive today. Charophyta dominated in forested areas. Although Chlorophyta dominate in present-day waterbodies, the rather high relative proportion of Cyanobacteria draws attention to a potential threat. As the cross-correlation results indicate a negative correlation between Cyanobacteria and mean winter temperatures, in warmer climates Cyanobacteria can overtake other phytoplankton. The results of this study can be further used in lake and pond management.

Introduction

Lakes are critical resources for water supplies and food security, as well as highly valued destinations for recreation and tourism. Extensive climate warming over the last few decades has affected lake water temperatures (O'Reilly et al. 2015). A striking consequence of climate change for aquatic ecosystems is that many are experiencing shorter periods of ice cover, as well as earlier and longer summer stratified seasons, which often result in a cascade of ecological and environmental consequence, such as warmer summer water temperatures, alterations in lake mixing and water levels, declines in dissolved oxygen, increased likelihood of cyanobacterial algal blooms, and the loss of habitat for native cold-water organisms (Smol 2008; Woolway et al. 2022).

Establishing the susceptibility and trophic changes in lake ecosystems is an important management issue on a local and regional scale. In this context, a palaeolimnological approach that employs the microfossil record of algae has been considered to be one of the most influential approaches for determining the ecological status of lakes (EC 2000). Lacustrine sedimentary environment is ideal for studying the status of a waterbody. Under limited oxygen conditions, phytoplankton survives for hundreds to thousands of years. There are more than 2300 lakes larger than 1 ha and even more than 10 000 lakes smaller than 1 ha in Latvia, comprising in total 1.6% of the country's territory (Apsīte and Kļaviņš 2023). Hence, monitoring the current status of lakes is a crucial aspect for maintaining water quality and resulting ecosystem services. In current Latvian legislation, lakes smaller than 50 ha are not distinguished as separate waterbodies. Only if future monitoring data shows that this is necessary to achieve environmental quality objectives, this decision will be reviewed. Nevertheless, the majority of small lakes and ponds are not currently monitored in Latvia and there is a lack of information on algal composition.