

RECONSTRUCTION OF ORGANIC CARBON SOURCES IN THE PALAEOENVIRONMENT OF A LAKE: AN OPTICAL APPROACH

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The type of organic carbon (OC) plays a key role in the functioning of an ecosystem. In an aquatic ecosystem OC can be produced inside a water body (also called endogenous or autochthonous or authigenic) or transported from its catchment (exogenous or allochthonous or pedogenic). Organic matter (OM) formed in a lake is characterised by a lower molecular weight and predominantly aliphatic nature, while in terrestrially derived OM substances with higher molecular weight and aromatic structures prevail. Recently, due to human activity the main source of OM has altered in many water bodies: endogenous OM has become preponderant as a result of the enrichment of aquatic systems with mineral nutrients, which favours the thriving of planktonic algae.

The molecular structure and quantity of OM can be roughly detected from its optical properties. In this study we demonstrate the applicability of spectroscopic methods for revealing quantitative and qualitative changes of OC in a lake retrospectively. As settling and post-sedimentation processes in water bodies with different deepness and size can vary, lakes with different morphology were selected. Fluorescence and absorption spectra of pore water from chemically untreated sediment samples were recorded. Several spectral indices proposed as a measure of aromaticity degree of OM in lake water (De Haan and De Boer, 1987; Peuravuori and Pihlaja, 1997; McKnight *et al.*, 2001) were considered. Shift in the type of OM was visualized by plotting a quantitative optical measure versus an aromaticity index and assembling the graph so that readings of both OM attributes (absorption and fluorescence) were present (Stewart and Wetzel, 1980). The information obtained from these graphs (Fig. 1, left) was verified by the distribution of remains of primary (microalgae) and secondary (cladocerans) in-lake producers of carbon and compared with the molecular weight of OM in pore water (Fig. 1, right). In addition, the sensitivity of the 'optical' diagrams to manifest changes in OM was evaluated by comparing them with the pollution history and limnological monitoring data.

The study demonstrated that such approach is a very sensitive tool to reveal the historical break point in the replacement of allochthonous OC by autochthonous OC in small lakes (Fig. 1). In the case of a large lake studied the shift was less conspicuous when the graphical way of presentation with combining pairs of absorbance and fluorescence characteristics of pore water was used. Aromaticity indices applied in this work distinguished changes of OM temporally somewhat differently; however, the variance does not exceed a time span of 10 years and is comparable with the response of various biological species to environmental changes. The optical approach provides not only a simple way to restore the origin of OM in great detail but also helps to distinguish decisive periods in OC cycling of the lake ecosystem in the past.

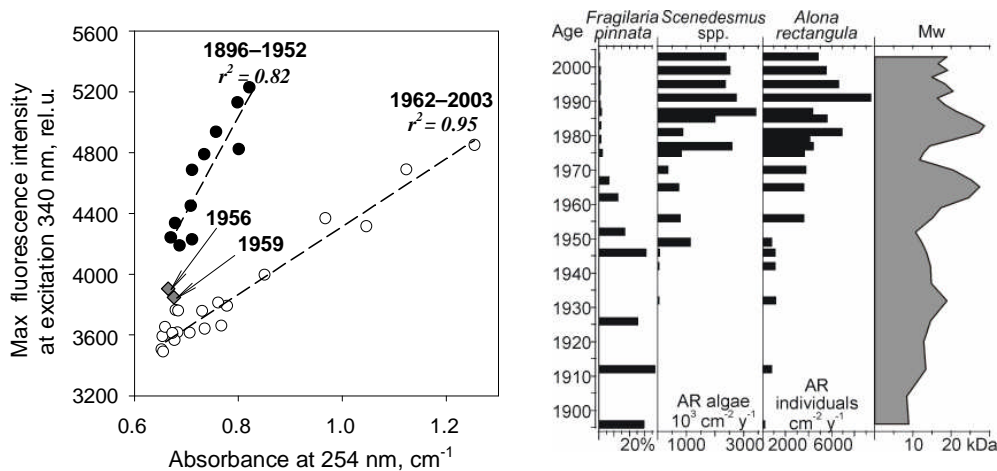


Figure 1. An example of the ‘optical’ diagrams of sediment pore-water DOM (left) demonstrating occurrence of two different types of OM in accumulated material and a transition in the 1950s. Age related changes in microalgal (*Fragilaria*, *Scenedesmus*) and cladoceran assemblages in sediments of a small shallow lake (Lake Harku, Estonia) indicating intensification of microalgal blooms at the same time (right). For comparison the stratigraphic change of weight-averaged molecular weight (Mw) of pore-water DOM is shown. Numbers in bold indicate years and in italic the correlation coefficient between the optical measures for the referred period is given. The percentage of *Fragilaria pinnata* is calculated from the total abundance of diatoms; AR=accumulation rate.

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