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Seasonal variation of organic compounds in a eutrophic oxbow lake

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Introduction

In many lakes, high planktonic biomass generates such large quantities that bottom waters become anoxic (Baranovic et al. 1993, Bárdosi et al. 2000, Dévai et al. 2002, Padisák et al. 2003), and massive organic-mineral aggregates occur in the water column, depending on meteorological and biochemical conditions in the water column (Stachowitsch et al. 1990; Degobbis et al. 1995). Chemical and physical speciation of dissolved organic carbon (DOC) impact the formation of aggregates in marine environment, but few studies have addressed the speciation of DOC in lacustrine ecosystems (V-Balogh et al. 2003). This study reports seasonal variability of DOC, total dissolved carbohydrates (TDCHO), total dissolved free amino acids (TDFAA), and colloidal organic carbon (COC > 1 kDa) in a eutrophic oxbow lake.

Key words: dissolved organic matter; carbohydrates; amino acids;

Materials and methods

The investigations were made in a small (A_0=5 ha, d_{max}= 3.5 m, d_{avg}= 2 m) oxbow at Endrőd-Középső-Holt Körös, Körös area, Békés county, in southeast Hungary (N 46°57′14.96″, E 2°49′18.63″). Between June 2002 and June 2003, water samples were collected biweekly. Phytoplankton samples were preserved with Lugol's solution in the field. Biomass was estimated by cell volume. The concentration of chlorophyll-*a* (Chl-*a*) was measured according to standard methods (APHA 1989). DOC of Millipore/0.22 filtered water was assayed by high temperature catalytic oxidation with Shimadzu TOC-5000A analyser. The concentration of carbon was determined against potassium hydrogen phthalate standards and corrected for total blank (ion-exchanged water). TDCHO, including mono-, oligo- and polysaccharides, were analyzed by the MBTH method (Mopper et al. 1992). TDFAA were analysed according to Cowie & Hedges (1992). Tangential flow ultrafiltration (UF) system (Amicon DC10LA) was applied to investigate the molecular weight distribution of the dissolved organic matter (DOM; Guo & Santschi 1996).

Results and discussion

TDCHO concentrations were strongly related to DOC (Fig. 1, 2.). TDCHO accounted for 15–20% of total DOC on average, while TDFAA accounted for about 1% of DOC (Fig. 3). A large fraction (60–65%) of the total DOC pool was colloidal, while truly dissolved compounds (< 1 kDa) accounted approximately for 35–40% of the total DOC (Fig. 4). DOC and TDCHO concentrations were higher in summer than winter (Fig. 1, 2, 3). Seasonal changes in the concentration of DOM and Chl-*a* of particulate matter indicated that phytoplanktonic or-

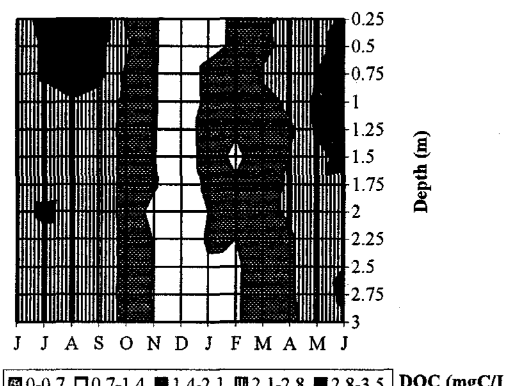

Fig. 1. Seasonal changes of DOC in the studied oxbow lake.

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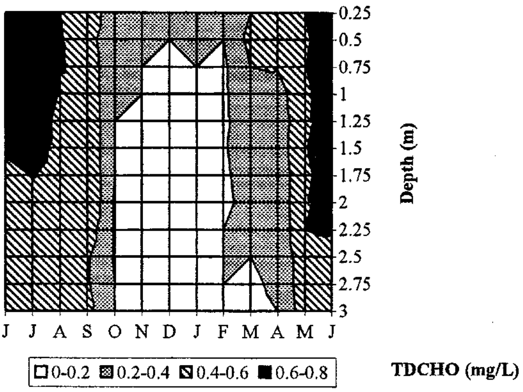

Fig. 2. Seasonal changes of dissolved carbohydrate carbon in studied oxbow.

ganic matter impact the concentration of DOC. Excreted organic materials during the photosynthesis processes of algae was another source of DOM.

The accumulation of dissolved organic matter in summer presumably involves an enrichment in biorefractory compounds discharged by agriculture area around the oxbow lake and an inability of bacteria/Cyanobacteria/algae to consume all the DOC produced. Increases in biological productivity and freshwater residence time, and strong water stratification favoured the accumulation of DOM.

DOM is the main fraction (80–90%) of total organic matter in marine environments (KEPKAY 1994) and is involved in the functioning of the ecosystem. The data set provided on TDCHO is, to the best of our knowledge, the first available for a eutrophic freshwater ecosystem. In this study the carbohydrates accounted for 20–30% of DOC and were important constituents of DOM. In summer, concentrations of DOC and TDCHO were found to be higher in surface than bottom waters, while DFAA did not show any significant variation in the water columns. In winter, all the investigated vari-

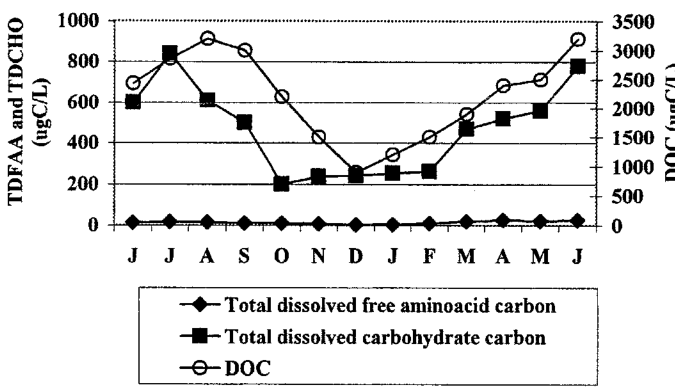

Fig. 3. Seasonal changes of DOC, dissolved carbohydrate carbon (TDCHO) and total dissolved free aminoacid carbon (TDFAA) at 0.5 m in studied oxbow.

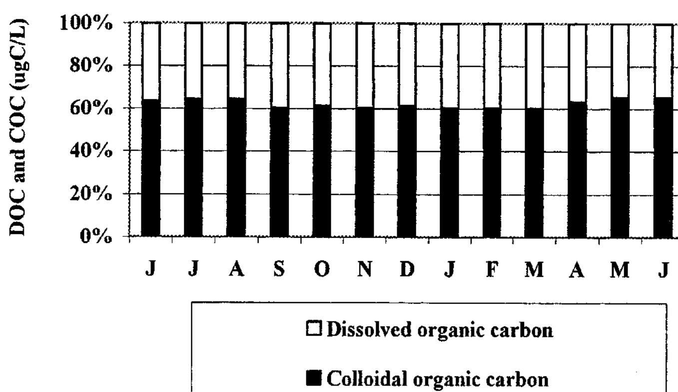

Fig. 4. Seasonal changes of dissolved organic carbon (DOC) and colloidal carbon (COC) at 0.5 m in studied oxbow.

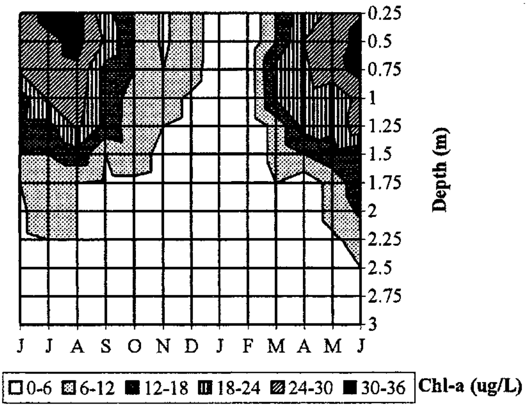

Fig. 5. Seasonal changes of chlorophyll-*a* in studied oxbow.

ables showed reasonably uniform profiles since the water column was completely mixed.

Bioreactivity of organic matter and the carbon circulation through the trophic food chain are strongly influenced by chemical composition and molecular size classes of the DOM pool (AMON & BENNER 1996). High concentrations of carbohydrates and high molecular mass colloidal particles favour the formation of aggregates. The dynamics of aggregates are also influenced by biological processes and by wind-induced mixing of the water column (RIEBESELL 1992). The observed accumulation of DOM in summer along with an increased role of carbohydrates and colloidal matter, may be critical factors for the formation of mucilaginous aggregates.

Although our results about TDCHO and COC increase the understanding of processes, more studies are needed on DOM composition and variability of DOC, COC, TDCHO and DFAA in order to better characterize the role of DOM.

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