

# DISTRIBUTION PATTERNS OF MONOSACCHARIDES AND POLYSACCHARIDES IN THE NORTHERN ADRIATIC

Marijan Ahel\*, Senka Terzic and Ivana Jelacic

Centre for Marine and Environmental Research, Ruder Boskovic Institute, Zagreb, Croatia

## Abstract

Distribution of carbohydrates (CHO) was studied in the northern Adriatic during major phytoplankton blooms from October 1993 to September 1994. Total carbohydrates (TCHO) and monosaccharides (MCHO) were determined directly, using the MBTH-method, while the concentration of polysaccharides (PCHO) was calculated as their difference. Phytoplankton biomass was characterised by determining chlorophyll and carotenoid pigments using an HPLC technique. The TCHO concentration varied from 70  $\mu\text{g C/l}$  to 1300  $\mu\text{g C/l}$  with significantly enhanced values in the surface layer. Carbohydrates were found mainly in the form of PCHO (up to 92% of TCHO), and their spatial distribution suggested a link to the crop and physiological status of phytoplankton.

**Key-words:** organic matter, phytoplankton, pigments, Adriatic Sea

## Introduction

Carbohydrates (CHO) represent one of the most important pools of organic matter in the sea. Recent studies by Pakulski and Benner [1] showed that carbohydrates comprised 21 ( $\pm 7\%$ ) of DOC in surface waters of the world oceans. The importance of carbohydrates in estuarine and coastal waters is expected to be even greater, however, there are only few reports dealing with the CHO distribution in such ecosystems [2]. Large temporal and spatial variations of carbohydrates were observed along the salinity gradients in a small estuary [2] with maximum concentrations (up to 1080  $\mu\text{g C/l}$ ) during periods of enhanced phytoplankton activity. Studies performed in the North Sea [3] showed that large amounts of carbohydrates were released into seawater towards the end of a diatom bloom. A considerable percentage of the released CHO was in the combined form. Moreover, it was suggested that diatoms could have been an important source of carbohydrates that eventually led to hypertrophic formation of gelatinous aggregates observed in the northern Adriatic [4]. However, very little is known about their occurrence and distribution in the northern Adriatic, especially about their relationship with phytoplankton. A weak but statistically significant correlation between the number of diatom cells and concentration of the total carbohydrates was noticed in a preliminary study which was conducted in the northern Adriatic during 1992 [5]. Moreover, enhanced concentrations of particulate carbohydrates ( $>100 \mu\text{g/l}$ ) were found in the period characterised by macroaggregate formation, while in normal situations their contribution to the total particulate organic carbon was below 10% [6]. The aim of this paper was to determine concentration levels and spatial distribution of TCHO, MCHO and PCHO in the northern Adriatic during major phytoplankton blooms.

## Experimental part

**Study area and sampling.** The northern Adriatic is a shallow semi-enclosed basin (maximum depth of 35 m) which receives large fresh-water inputs from the Po River and other north Italian rivers. Samples for the carbohydrate and pigment analyses were collected at several stations along the Po River mouth-Rovinj transect (Fig. 1) which is generally accepted as representative of eutrophication gradients the

northern Adriatic, especially during summer stratification [7]. Sampling was performed in the period from October 1993 to September 1994 from the research vessel *Vila Velebita* at 5-6 depths (0, 5, 10, 20, 30 m and near bottom) using 5 l Niskin bottles.

**Determination of carbohydrates.** Dissolved and particulate CHO were determined in nonfiltered seawater samples using the MBTH method. Determination of MCHO followed the original procedure by Burney and Sieburth [8], while TCHO were determined after HCl hydrolysis, using a method modified from Senior and Chevillot [2]. Concentration of PCHO was determined as the difference between the concentrations of TCHO and MCHO. Samples were analysed in duplicate and quantification was performed using glucose as a standard. The reproducibility of the carbohydrate determination was  $< 5\%$  for the higher concentration range ( $> 200 \mu\text{g C/l}$ ) and  $< 12\%$  for the lowest concentrations. The limit of detection was 30  $\mu\text{g C/l}$ . All concentrations are expressed in glucose carbon equivalents by multiplying the weight glucose equivalents by 0.4, because glucose is 40% carbon by weight.

**Determination of biomarker pigments and break-down products of chlorophyll a.** Chlorophylls and carotenoids were determined using a reversed-phase HPLC method [9]. Qualitative identification and quantitative determination of individual pigments was performed as described elsewhere [10]. The reproducibility of pigment determination was around 5%, while the detection limits varied from 1-5 ng/l, depending on the pigment extinction coefficients at 440 nm.

## Results and discussion

Distribution of TCHO in the water column of the northern Adriatic is illustrated in Fig. 2. Two stations, representing western (SJ108) and eastern (SJ107) parts of the basin (Fig. 1), show rather different distri-

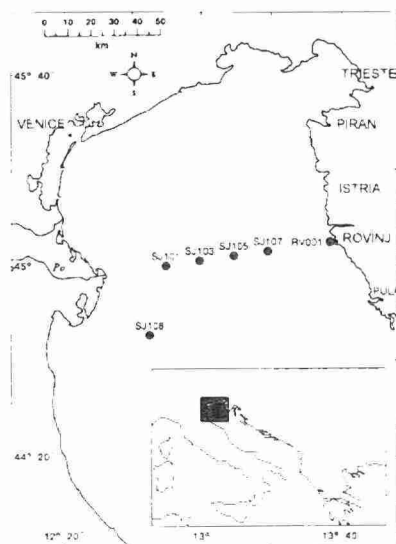


Fig. 1. Map of the northern Adriatic with sampling stations on the Po River mouth-Rovinj transect.

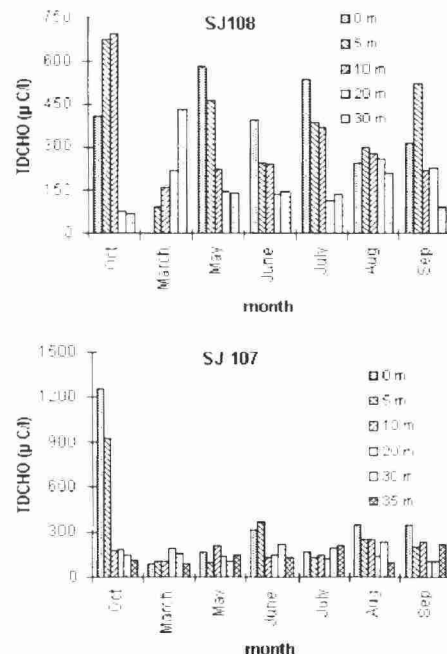


Fig. 2. Distribution of the total carbohydrates (TCHO) in the water column of the northern Adriatic during the major phytoplankton blooms in the period from October 1993 to September 1994.