THE IMPACT OF SEDIMENT OXYGEN-CONTENT, CHEMICAL AND PHYSICAL WATER COLUMN PROPERTIES ON THE LIVING STANDING STOCKS OF BENTHIC FORAMINIFERA IN THE SE LEVANTINE BASIN (OFF THE ISRAELI COAST)

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Abstract

Standing stocks of living benthic foraminifera, and oxygen contents in the sediment were studied in the SE Levantine Basin off the Israeli coast. Box cores, CTD-profiles, nutrients and chlorophyll-a concentrations were taken, every two months during a two-year period, along a depth transect (40-700 m). Here, we discuss the data obtained at our 40 m station during the first year (June '96 - February '97). Standing stocks as well as the benthic foraminiferal species distribution patterns in the 0-1 cm sediment layer show strong variation throughout the seasons. Over that period also oxygen penetration depth varied considerably. Analysis of the results indicate that the seasonal variation in the benthic foraminifera assemblage and the fluctuations in standing stock, do not seem to be induced by primary production fluctuations, but probably are due to variation in oxygen penetration in the sediment column.

Key-words : Foraminifera, Levantine Basin, nutrients, oxygen

Introduction

The Levantine Basin, off the Israeli coast, is an area where deep pycno- and nutriclines, in combination with an extremely deep photic zone, create a highly stable benthic environment. The extremely low phosphate and nitrate concentrations lead to ultra-oligotrophic conditions during most of the year (1, 2, 3). Such conditions are ideal to study the ecology, microhabitat-structure and population dynamics of benthic foraminifera, since the relatively stable oligotrophic conditions imply that physical and chemical factors regulating benthic foraminiferal distribution have minor effects on the population, certainly if compared to highly unstable environments, as for instance the northern Adriatic Sea, where population dynamics are presumed to be driven by seasonality and large fluctuations in food supply.

Material and methods

To establish population time series and patterns of microhabitat occupation, box cores were taken during a period of 2 years on board of the R/V *Shikmona*. Along a depth transect from 40 to 700 m, 9 permanent stations (Fig. 1) were sampled on a two-monthly basis. In each of the stations continuous profiles of temperature, salinity and oxygen were measured with a Sea-Bird electronics CTD. Water samples for the measurement of nutrients (nitrate, nitrite, ammonia, o-phosphate, silicic acid and chlorophyll-a (chl-a)) were collected with Niskin bottles mounted on a General Oceanic Rosette. Water samples for chl-a analyses were filtered at sea using glass fiber filters after pre-filtration through 60 µm sieve. Chl-a was determined using the procedure developed by Holm-Hansen *et al.* (4). Nutrients were determined in the laboratory using a segmented flow technicon Autoanalyser II system by the methods described by Krom *et al.* (2). The box cores were subsampled and subsequently sliced into 0.5 cm or 1 cm slices and stored in a Rose Bengal-ethanol solution. Rose Bengal stained benthic foraminifera from the 63-150 µm and the 150-595 µm size fractions were picked and counted. The oxygen content in the box core sediments was measured immediately upon arrival on board, with oxygen needle-electrodes attached to a micromanipulator.

This study focuses on the benthic foraminiferal assemblages (63-595 µm) occurring at Station 1 (40 m) during the period June 1996 - February 1997.

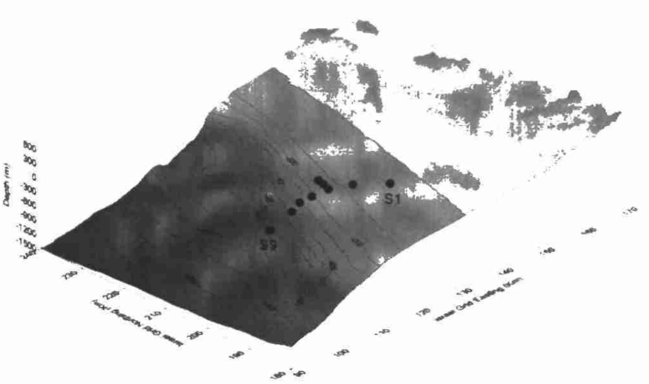

Fig. 1: Positions of the 9 permanent sampling stations (S1-S9).

Results and discussion

Chemical and physical structure of the water column

The nine stations cover the complete range from the Levantine surface water, through the Atlantic water mass, the Levantine intermediate water mass and down to the Deep water mass. Surface water temperatures show high seasonal variations and ranges between 18.2°C during winter and 28.4°C during summer. Generally, during winter the water column is well mixed in the upper 50 m and becomes stratified during the remainder of the year, with a upper mixed layer of about 25 m thickness bounded below by a sharp halocline and thermocline.

The concentrations of o-PO_4 in surface waters is close or below the detection limit (0.01 µM) increasing to 0.27 µM in deep waters. Nitrate concentration show a similar trend with values between detection limit and 4.94 µM. Chlorophyll-a concentrations were between 0.003 and 0.339 µg/l, similar to chl-a concentrations of the open sea in the Levantine basin (3, 5). Generally the distribution profile of chl-a concentrations show a deep chlorophyll maximum (DCM) between 80-120 m water depth. The DCM is associated with maximum oxygen concentrations. The depth integrative values of chl-a were found to be seasonally depended with values ranging between 10 and 30 mg m^{-2} in the upper 120 m (Fig. 2) and between 28 and 39 mg m^{-2} in the upper 400 m.

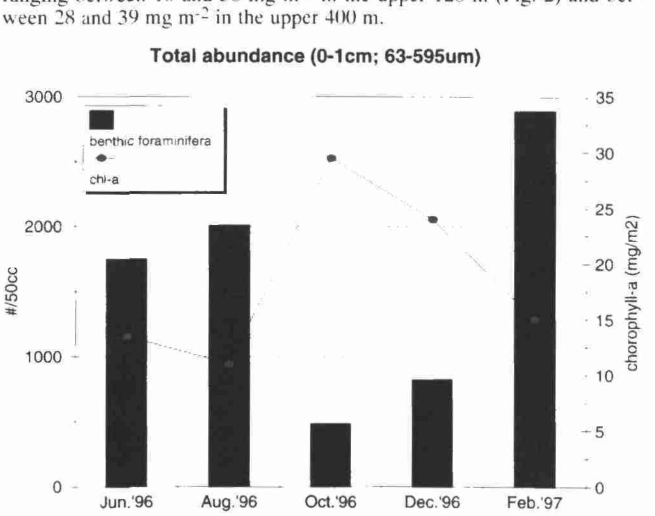

Fig. 2:Chorophyll-a (mg/m2) and standings stocks (numbers/50cc).

Benthic foraminifera

The faunal distribution patterns in the 0-1 cm sediment layer of Station 1 (40 m) display strong variation throughout the season. Surprisingly, the numbers of benthic foraminifera per 50cc (Fig. 2) in the oligotrophic Levantine Basin are considerably higher than the numbers of benthic foraminifera (per 50cc) in the highly eutrophic northern Adriatic Sea (6). Standing stocks do not seem to respond to primary productivity changes: no clear correlation is visible with chlorophyll-a profiles. One reason for this lack of correlation could be a phase shift, *i.e.* that the benthic associations show a retarded response to primary productivity. However, a time lag of the observed magnitude (4 months) does not seem feasible for the shallow water environment where sampling took place. Gooday (7) found