

MICRO- AND MACRO- BIOFACIES OF A LATE QUATERNARY SEDIMENT CORE RECOVERED FROM THE SE AEGEAN SEA

Drinia H., Koskeridou, E., Giamali, Ch.

University of Athens, Faculty of Geology and Geoenvironment, Department of Hist. Geology - Palaeontology, 157 84 Athens, Greece, cntrinia@geol.uoa.gr

Abstract

The basal part of a piston core 270 cm long, retrieved from the SE Aegean Sea (360 m in water depth) is used for benthic foraminifera and molluscs analysis. The bottom of the core is estimated at cal. 26 kyrs BP. Based on the faunal counts, benthic foraminiferal numbers (BFN), the percentage of planktonic species in the total foraminiferal association (%P) and the percentage occurrence of the well established redox fauna front dwelling taxa were calculated. The faunal parameters pattern of benthic foraminifera all show variability in the upper Quaternary core that appear related to the prevailing paleoceanographic conditions. The strong decrease of BFN and the increase of the benthic foraminifera deep infauna in the lower part of the core suggests extremely low oxygen values on the sea bottom.

Bathyal micromorphic bivalves and pteropods were also detected from this part of the core. Their episodic occurrences probably related to changing conditions. The mesopelagic/epipelagic pteropod ratio was used to check the paleoceanographic conditions. Abundance maxima of mesopelagic pteropods show relatively less stressed deposition periods. Downcore distribution of mollusc assemblages suggests that the depositional trend is getting shallower towards the top.

Keywords: Foraminifera, molluscs, pteropods, paleoceanography.

1. Introduction

The biotic components of the marine sediments have been used extensively for reconstructing paleoecology and paleoceanography. In recent years, there has been a growing interest among the micro and macropaleontologists to study distribution pattern of various micro and macrofaunal groups in order to have thorough knowledge on the relationship between their distribution and environmental conditions.

Foraminifera (single-celled protists that secrete a shell-like test) are among the most abundant organisms in the deep sea (the largest habitat on Earth), and are highly sensitive to environmental changes due to both natural and man-induced factors in marine and transitional environments. In particular, the potential of benthic foraminifera has long been recognized for their use in marine paleoenvironmental studies.

Additionally, molluscan tolerances are also largely used to discern the paleoenvironmental changes induced by sea level fluctuations, oxygen depletion, climate variation, hydrologic setting and process. Particularly, the documentation of pteropods (holoplanktonic gastropods, Mollusca) is important for paleoecological considerations because their distribution is influenced by environmental parameters such as water temperature, salinity, depth, oxygen contents etc.

This study presents the results of benthic micro and macrofaunal analyses of a marine core record from about 360 m water depth in the SE Aegean Sea, dated at 26 cal kyrs (Fig. 1). The main aim is to describe the impact of the environmental changes on the marine ecosystem through the study of proxies related to the benthic environment. The present investigation was carried out mainly on the selected calcareous microfaunal groups representing major portion of the biogenic components of the sediments.

2. Material and Methods

The core, named M22-18, 270 cm long in total, was drilled at 360 m water depth and 39 samples (1 cm thick) were taken from selected intervals (Fig. 1). For the present study nineteen samples were selected from the middle-basal part of the core. Samples were soaked in 10%

hydrogen peroxide for about twelve hours, wet sieved over 63 μm screen, dried and re-sieved over 125 μm screen.

For qualitative and quantitative microfaunal analyses, dried samples (>125 μm fraction) were split into subsamples to obtain suitable aliquots consisting of sufficient number foraminiferal specimens. In cases where foraminifera are rare, whole sample was analyzed. Microfaunal abundance was estimated for 1 gr dry sediment >125 μm .

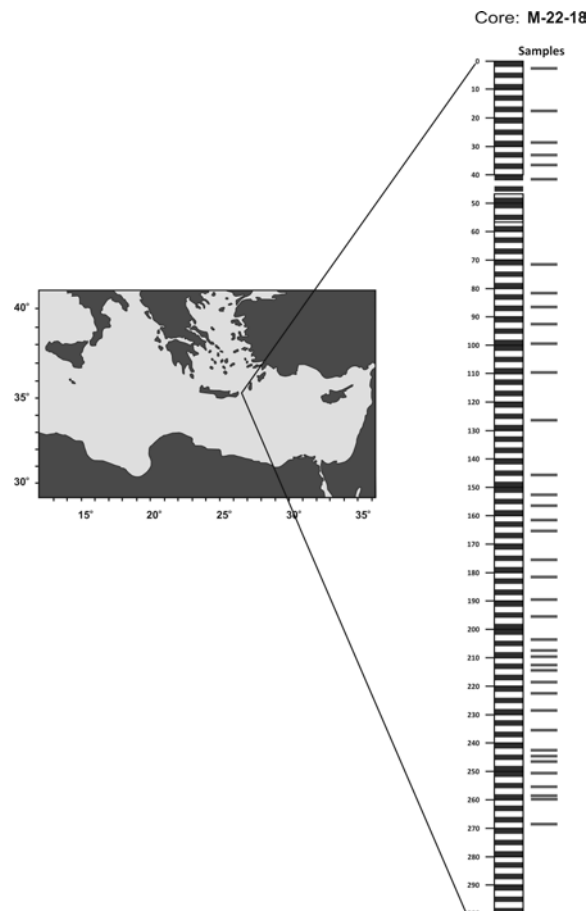


Fig. 1: Map showing the location of the core M22-18, together with the lithostratigraphical column of the studied core

Based on the faunal counts, benthic foraminiferal numbers (BFN; number of specimens per gram dry sediment) were calculated. This number gives information on the taphonomy of the original living assemblage, the oxygen level, the energy level in which the sediments were deposited and to a minor extent the productivity or organic flux.

The percentage of planktonic species in the total foraminiferal association (%P) was calculated as $100 \cdot P / (P+B)$.

Raw data were transformed into percentages over the total abundance of benthic foraminifera. Reconstruction of bottom water conditions concerning oxygen content was based on the presence of the dysoxic indicators in the assemblage. For this purpose, the percentage

occurrence of the well established redox fauna front dwelling taxa (*Bulimina*, *Uvigerina*, *Fursenkoina*, *Globobulimina* spp. and *Bolivina spathulata/dilatata*) which, according to Rogerson et al. (2006), is related to disturbance and/or environmental stress was calculated.

As for the molluscs, after drying, fossils were picked, isolated from each residue, and were identified to genus or species level. More than 40 species of bivalves and gastropods were identified. Chitons and brachiopods have been also recognized. Upon identification, ecological information was extracted in order to the environmental changes on the marine ecosystem. The ecological information was based on the following references (Pérès & Picard, 1964; Herman & Rosenberg, 1969; Sorensen, 1984; Poppe & Goto 1991; Onen & Douán, 2007; Høisæter, 2010). Paleocommunity reconstructions were based on the classification of the mediterranean biocoenoses (Pérès & Picard, 1964).

Quantitative analysis of benthic molluscs and pteropods yielded curves of absolute abundance. In order to give broad indications of relative faunal abundance, the following categories were used: rare (1–10 specimens), present (11–20), common (21–50), abundant (>51).

3. Results

In the studied samples, benthic foraminiferal preservation is generally moderate to good, but varies strongly between samples.

BFN remains relatively stable exhibiting low values apart from the basal part of the record where BFN shows an abrupt increase. Planktonic percentage varies between 16 and 80% of the total foraminiferal assemblage.

The group of the redox fauna shows high percentages from the bottom to 240 cm, but its abundance strongly decreases between 213 and 90 cm. The strong decrease of BFN and the increase of the benthic foraminifera deep infauna in the lower part of the core suggests extremely low oxygen values on the sea bottom (Van der Zwaan, 1980; Mullineaux and Lohmann, 1981; Katz and Thunell, 1984; Nolet and Corliss, 1990; Rohling et al., 1993, 1997; Jorissen, 1999; Mercone et al., 2001; Casford et al., 2003).

Pteropods present peaks at 222 – 223cm, 228 – 229cm and 242 – 243cm of the studied core (Fig. 3), with assemblages being dominated by the mesopelagic species *Limacina inflata* which indicates a temperature range from 8.5 to 28°C and a salinity range from 33.5‰ to 37.0‰ S. Also, in pteropod peaks, the species *Peraclis apicifulva*, *Clio cuspidata*, *Creseis* sp. occur. In these three samples benthic molluscan assemblages are dominated by the suspension feeder bivalve *Kelliella miliaris*. This species occurs in muds of the bathyal zone and lives just beneath the sediment – water interface.

Benthic molluscs present peaks at the samples 92 – 93cm, 161 – 162cm, 222 – 223cm and 259 – 260cm (Fig. 3). In all of these samples, except sample 222 – 223cm, pteropods are rare or absent. Samples 92 – 93cm and 161 – 162cm consist of shallow water benthic fauna dominated by *Bittium* sp., *Alvania cancellata*, Trochidae, Rissoidae and fragments of sea urchins. The sample 259 – 260cm consists of different species of gastropods with low number of specimens in every species. There is predominance of the bathyal bivalve *K. miliaris* which is accompanied by the eurybathyal species *Aclis* cf. *verduini*, *Caecum trachea*, *Pusillina inconspicua*, *Marsallora adversa*. Sample 222-223cm is dominated by the bathyal bivalve *K. miliaris* and other bathyal species, such as *Limopsis minuta*, *Montacuta* cf. *substriata*, *Limatula* sp.

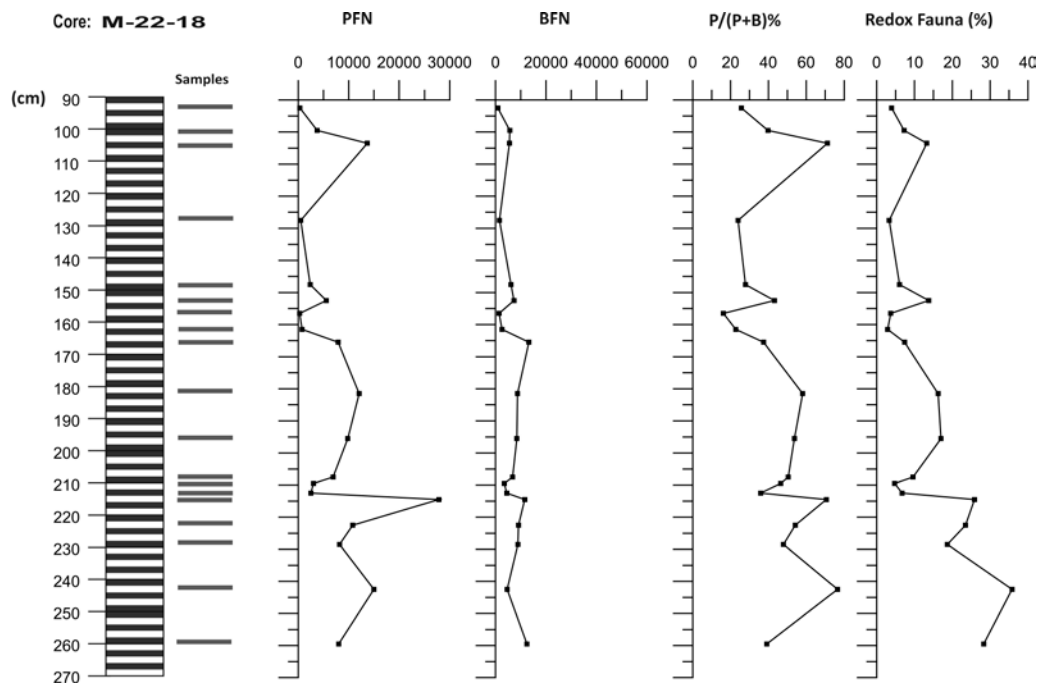


Fig. 2: Depth profile with Planktonic Foraminifera Number (PFN), Benthic Foraminifera Number (BFN), the percentage of planktonic species in the total foraminiferal association (P/P+B%) and the percentage occurrence of the well established redox fauna front dwelling taxa.

5. Discussion

As pointed out before, species belonging to the well established redox fauna are very frequent in the basal part of the core up to 213 cm. The relatively high abundance values of the well established redox fauna at the basal part of the record, allows the recognition of an episode of environmental stress expressed by the shallowing of the redox front. The shallowing of the redox front could be linked to the increase of food availability that leads to an increased consumption of oxygen (Jorissen et al., 1995).

Enhanced palaeoproductivity and limited availability of dissolved oxygen in bottom waters, temporarily establish dysoxic conditions. At the same levels, an oligotypic benthic foraminiferal assemblage prevails. The fauna is entirely composed of infaunal taxa.

Benthic Foraminiferal Number is often used as a proxy for surface water productivity since benthic foraminiferal densities correlate with C_{org} content in the sediment (Herguera & Berger, 1991). Moreover, benthic numbers are thought to be very sensitive to bottom water oxygen concentrations (Moodley et al., 1997; van der Zwaan & Jorissen, 1991). However, the relative high BFN together with high percentage values of the redox fauna in the very basal part of the core may be attributed to the general idea that with decreasing bottom water oxygen levels the total meiofaunal benthic biomass first increases due to decreased predation by, and competition with the declining macrofauna (Verhallen, 1991). At a certain critical oxygen content meiofauna start to rapidly diminish (Josefson & Widborn, 1988) but never disappear as many benthic foraminiferal species are very sensitive to prolonged anoxia (Alve & Bernhard, 1995; Bernhard & Alve, 1996).

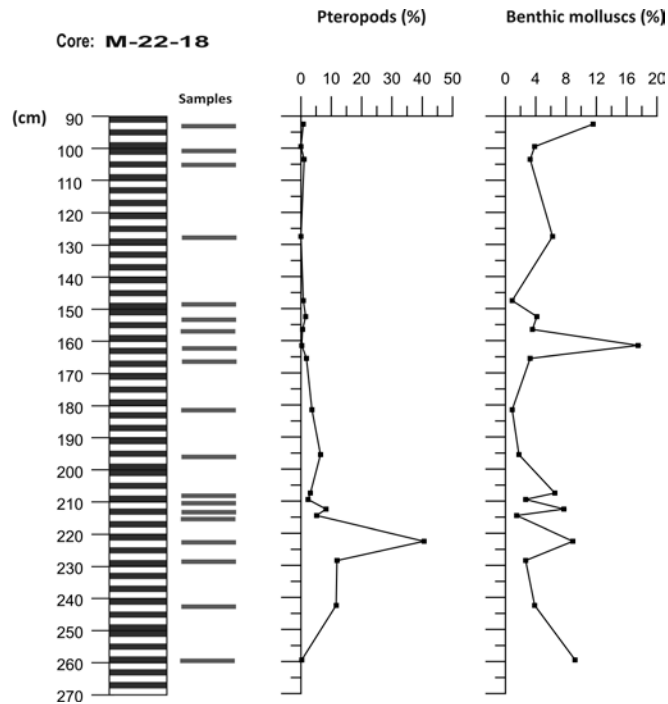


Fig. 3: Depth profile with the percentage occurrence of Pteropods and the percentage occurrence of the benthic molluscs.

Benthic molluscan assemblages are dominated by the outer shelf-epibathyal bivalve *Kelliella miliaris* with values ranging from 28.32 to 85.64%. The investigated paleocommunities are substantially represented by characteristic species of the biocoenoses VTC (coastal terrigenous muds, from circalittoral bottoms) and VP (bathyal muds), with particular regard to the dominant *Kelliella miliaris*. Partially, a modest influence from the circalittoral biocoenoses DC and particularly DE (detritic and muddy-detritic bottoms, respectively) was detected, as testified by the occurrence of preferential species such as *Limatula subauriculata* and *Montacuta cf. substriata*.

The rareness of molluscs at different parts of the core indicates stressed environment. The molluscs detected from the lower part, at 259-260cm, indicate transportation or a temporal improvement of the conditions.

The episodic occurrence of pteropods with high relative abundance of mesopelagic over epipelagic forms suggests a relatively well ventilated water column (Sijinkumar et al., 2010). These short-term events might be related to temporarily changing conditions (upwelling or increased runoff) and it requires further research. The accompanied glacial benthic assemblages are consistent with well aerated conditions and moderate organic fluxes as testified by the occurrence of molluscs such as *Kelliella miliaris*, *Alvania subsoluta*, *Limatula subauriculata*, *Montacuta* sp.

To the top of the core, a decreasing depth of the deposition is resulted by the dominance of an infralittoral to lower circalittoral stock, mainly consisted by *Alvania cancellata*, *Bittium* sp., Trochidae, Rissoidae.

6. Conclusions

The Late Quaternary sequence of the core M22-18 retrieved from the SE Aegean Sea offers an exceptional opportunity to investigate both the foraminiferal and molluscan records and their paleoenvironmental significance.

Benthic foraminiferal assemblages and abundance are related mainly to the sedimentary organic carbon and dissolved oxygen concentration.

The prominent increase in abundance of pteropod shells of mesopelagic forms together with the benthic molluscs indicates less intense surface productivity and intense deep sea ventilation.

The occurrence of pteropods combined with the reported benthic foraminifera indicates deposition in an open marine basin, in the bathyal zone.

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