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Late Quaternary micropalaeontological record of a semi-enclosed marine basin, North Evoikos, central Aegean Sea

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ABSTRACT

North Evoikos Gulf constitutes a deep (450 m) semi-enclosed basin in east-central Greece connected to the Aegean Sea via a 42-m sill to the north and a 40-m wide, 8-m deep channel to the south. Six gravity cores retrieved from different physiographic settings of the Gulf were analyzed for their benthic foraminiferal content, in order to reconstruct the local and regional palaeoenvironmental changes.

Species Correspondence Analysis separates the foraminifera into 4 clusters: Cluster 1 is composed of Agglutinated species, *Elphidium* spp. and *Ammonia beccarii*; Cluster 2 is exclusively composed of *Bulimina marginata*; Cluster 3 consists of *Bolivina spathulata* and *Bulimina costata* and finally Cluster 4 comprises the 10 remaining species: *Cibicides lobatulus*, *Cibicidoides pachyderma*, *Bulimina aculeata*, *Cancris oblonga*, *Melonis barleeanum*, *Chilostomella oolina*, *Cassidulina laevigata*, *Hyalinea balthica* and Miliolidae. These clusters represent four distinct foraminiferal biofacies and are interpreted as reflecting different ecological conditions: Biofacies p-H corresponds to the proximal part of the shelf and it is characterised by the absence of foraminifera, skeletal debris and abundant peloids. Its topmost part shows an erosional surface, aged 32.4 ka, characterised by shell debris, and the appearance of few shallow marine benthic foraminifera. Biofacies Ia and Ib consist of a low-diversity Holocene assemblage which is mainly dominated by *Textularia* spp. and *Elphidium* spp., reflecting a low-energy restricted lagoon and the deeper water assemblage of *B. marginata* and *H. balthica* (Biofacies Ib) as well as by a mollusc assemblage dominated by *Corbula gibba*. These biofacies are only present in the mid-shelf setting. Biofacies II (Cluster 3: *B. spathulata–B. costata*) shows a possible positive correlation with nutrient contents and it exhibits a complementary pattern of distribution with Biofacies III (Cluster 4: *B. marginata*).

Two main palaeoenvironmental settings were recognized: a) In the first setting dominated by Biofacies Ia and Ib, the succession of the benthic faunas is mainly controlled by the ongoing sea level rise; b) in the second setting, the species typical of shelf environment (*C. laevigata–H. balthica*) give way to opportunistic species (*B. spathulata*) and species that are more resistant to bottom water changes (*B. marginata*). This pattern is attributed to variations in the food chain and oxygenation.

North Evoikos Gulf during the Uppermost Quaternary reflects a passive response to a globally fluctuating sea level that was not significantly modified by dramatic tectonic processes. Therefore, its palaeoceanographic evolution is primarily driven by climatic (eustatic) processes and accurately depicts local conditions.

1. Introduction

North Evoikos Gulf is an elongated embayment in the central Aegean Sea (Eastern Mediterranean Sea), featuring a distinct NW–SE orientation and a total surface of approximately 390 km^2. It is connected to the central-west Aegean Sea through the narrow and shallow Oreos-Trikeri straits, with a maximum depth of approximately 42 m, and a mean width of 4 km, and with the Southern Evoikos basin through the human-maintained Euripus Channel (length 60 m, width 40 m, depth 8 m), (Fig. 1). According to Drinia and Anastasakis (2012), the presence of the Oreos-Trikeri straits played a major role in the palaeoceanographic evolution of the North Evoikos Gulf during the past sea level oscillations, sometimes seriously hampering deeper water masses from passage and ventilating the Evoikos sea floor, making its palaeogeographic

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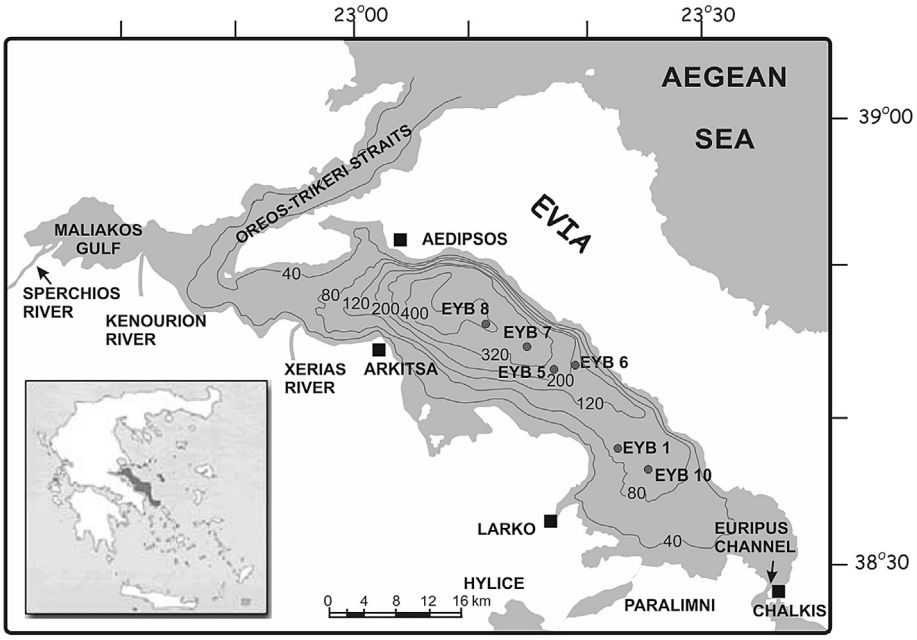

Fig. 1. General bathymetry and coring locations in the North Evoikos Gulf.

evolution different from that of the Aegean Sea. The palaeoceanographic conditions in the North Evoikos Gulf show many similarities with those prevailing in the Sea of Marmara: according to Besiktepe et al. (1994), the oceanography of the Marmara Sea is characterized by the outflow of brackish water from the Black Sea with salinity of 18‰ and inflow of saline intermediate and bottom water (38‰) from the Aegean Sea. Water and suspended sediments are delivered to Marmara Sea from the Straits of Dardanelles and Bosporus.

The aim of this study is to reconstruct the palaeoenvironmental evolution of this restricted setting by means of the benthic foraminiferal record. Benthic foraminifera are one of the most numerous and most easily collectable fossils on which such studies can be based. They are especially suitable for monitoring rapid environmental changes because many species are opportunistic, rapidly responding to environmental change (e.g. Bernhard and Reimers, 1991; Corliss and Silva, 1993; Sen Gupta et al., 1996).

There is no previous work on the benthic foraminifera from the North Evoikos Gulf. The only previous paper referred to a unique outer shelf core EYB6 (Drinia and Anastasakis, 2012). These authors used benthic foraminiferal species abundance records, to determine changes in environmental conditions in the semi-enclosed North Evoikos outer shelf environment.

In this study, benthic foraminiferal faunal data of six gravity cores retrieved in different physiographic provinces of the Gulf (the shelf, the slope and the basinal setting), that penetrated Holocene marine sediments, are used to reconstruct the environmental changes that occurred in the last 9 ka. We studied the distribution of this benthic microfauna assuming that variations in the frequency of selected ecologically sensitive species may reflect overall changes in primary productivity and oxygen content.

2. Regional setting

The geodynamic regime of Central Greece which is characterized by active crustal extension during the Quaternary (e.g. Jackson, 1994) is responsible for the formation of the North Evoikos Gulf during the Pleistocene. The graben of North Evoikos Gulf is bound by a series of WNW–ESE to NW–SE fault zones which are active since early Miocene (e.g. Roberts and Jackson, 1991). The activity of these fault zones has strongly influenced the landscape evolution of the region, and is related with significant historical (e.g. Bousquet and Pechoux, 1977) and instrumentally recorded seismicity (e.g. Papanastassiou et al., 2001).

The basin is divided into two well-defined bathymetrical regions: a gradually sloping region, occupying both the western and southern parts of the Basin, ranging from 0 to approximately 200 m depth, and a distinct depression at the northeastern part, which occupies 1/5 of the overall area of the Basin and its greatest depth measures about 425 m. This depression is due to the structural setting of the region, featuring an active fault zone running along the adjacent coastline of the Evia Island (Van Andel and Perissoratis, 2006; Sakellariou et al., 2007). This fault zone is clearly visible in the steep topography of the eastern coast of the Basin and responsible for the characteristic SW–NE asymmetry of the Basin.

The North Evoikos Basin is surrounded by a variety of sedimentary, magmatic and metamorphic rocks, the weathering products of which are a major source of the sediments studied. At present, the major supplier of fresh water is the river Sperchios, which is 82 km long and has a drainage basin of 1158 km^2. Other significant fresh water input originates to the north through the Kenourion and Xerias rivers. To the south, major fresh water input originates from Lake Paralimni. River runoff causes the input of suspended clay, organic detritus and dissolved nutrients into the marine system. This can provoke strong primary production events, leading to eutrophic conditions in the water column and on the sea floor. Therefore, the runoff of the Sperchios delta is responsible for strong environmental changes into the Basin. Its influence is evident in the upper part of the water column, but also on the sea floor, where it strongly affects the distribution of the benthic foraminifera. However, seismic reflection data along the North Evoikos shelf do not