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Eastern Ionian Sea paleoceanographic conditions during the Plio - Pleistocene as revealed through the study of fish otoliths

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Fish otoliths from the SE Zakynthos and SW Kephallonia islands (Eastern Ionian Sea) provide new evidence for the reconstruction of the paleoceanographic conditions during the Late Pliocene – Early Pleistocene interval. The forty – six fish taxa identified in the sediments of the study areas are separated in tropical, subtropical, temperate and subpolar ecological groups occupying surface, intermediate and deep water layers, based on their modern geographic and bathymetric distributions.

During the Late Pliocene, the presence of Chlorophthalmus agassizi in the Eastern Ionian Sea probably denotes temperate oligotrophic conditions. At about 1.96 Ma B.P the high contribution of the bathypelagic Electrona risso, whose modern contribution is limited by the 10-15º C isotherms and productivity greater than 50gC/m2y (Whitehead et al., 1984), is combined with the increased presence of the deeper water species Maurolicus muelleri and Benthosema glaciale, which are mostly known from the high temperate – subpolar zones of today's oceans (Whitehead et al., 1984; Mytilineou et al., 2005). The nutrient-rich intermediate water layers at this time thus overlie colder deep waters, much like today (Malanotte-Rizzoli et al., 1997). In addition, the high abundance of representatives of the genus Diaphus could imply warmer surface conditions (Whitehead et al., 1984).

The situation around 1.93 Ma, throughout the water column, is much more homogenous, signified by the introduction of Hygophum hygomii in the deeper water layers, as well as the decrease in relative abundance of Benthosema glaciale, perhaps due to a certain increase in deep water temperate. However, the most dominant species by far in the assemblage remains Ceratoscopelus maderensis, a purely temperate meso-bahtypelagic species (D'Onghia et al., 2004).

At around 1.9Ma, there is a marked increase in the relative abundance of tropical taxa, namely Diaphus taaningi and Bregmaceros sp., which occupy the upper 500 meters of the water column. This increase in the tropical group of surface and intermediate waters, along with a decrease accordingly of both subtropical and temperate taxa, can be attributed to a climatic optimum at this time. However notable is the strong presence also of cold species Nansenia groenlandica and Benthosema glaciale in deeper water layers (mostly below 500 meters). Considering this event, it seems that warmer Atlantic water inflow in the Mediterranean, as a result of higher mean temperatures at this time, could be responsible for the upper part of the water column temperature increase. In addition, the formation of deeper water with lower temperatures than before could be attributed to increased river run off in the Adriatic Sea, which then inflows to the study areas.

The paleoceanographic conditions appear generally stable until the uppermost part of the Pliocene, with colder temperatures prevailing gradually with an increase in relative abundance of Maurolicus muelleri combined with a decrease of Electrona risso. In the uppermost Pliocene and lowermost Pleistocene (around 1.73 Ma) the relative abundance of Electrona risso increases again in both study areas. Finally, the conditions in the upper part of the stratigraphic sequences return to temperate, with notable the presence of Myctophum punctatum, typically associated with upwelling conditions (Whitehead et al., 1984).

Fish otoliths, as indicators of the paleoceanographic conditions throughout the water column, play a most

significant role in the reconstruction of the deep – sea conditions. The presented palaeoecologic analysis of the Teleost fauna reveals distinct phases in the evolution of climate and oceanography during the Late Pliocene – Early Pleistocene interval. Notwithstanding the general deterioration of climate progressing into the Pleistocene era, it appears that the Mediterranean paleocirculation in conjunction with regional topography were modulated by the constantly changing global climatic conditions, to produce a rather compex palaeoceanographic setting in the central part of the basin. In this respect, fish otoliths offer a unique opportunity to reconstruct the palaeoenvironmental conditions in the entire water column and through time.

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