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Editorial

Introduction: Cold-Water Coral communities in the Mediterranean Sea

The scleractians species *Lophelia pertusa* and *Madrepora oculata* are considered two of the main components of the Cold-Water Coral communities (CWCs), well distributed in all deep oceans (see Freiwald and Roberts 2005 for a complete discussion). The scientific literature of the 1980s (Zibrowius, 1980 among others) indicates the current presence of these two species at different locations in the Mediterranean, even though referring almost exclusively to dead colonies and, in sporadic circumstances, to living ones, but with reduced vitality. The fortunate recovery by fishermen of large living colonies off Santa Maria di Leuca, southern Puglia, Ionian Sea (i.e. Tursi et al., 2004; Taviani et al., 2005) prompted the creation of the multidisciplinary research project APLABES (Apulian Plateau Bank Ecosystem Study), funded by the FIRB program of the Italian Ministry of Education, University and Research. The project, which involved researchers from different Italian Universities (Milano-Bicocca, Bari, Parthenope-Napoli, Catania) and research Institutes (ISMAR-Bologna, INGV-Roma) and associated European researchers, aimed at assessing the real presence, extension and importance of these deep coral banks along with the environmental factors favouring their development in the area.

The Mediterranean Sea represents the last remain of the Tethyan Sea, which underwent dramatic changes in its geographical, morphological and oceanographic configurations during the Oligocene and Miocene (18.5–5.3 million years ago) epochs. During this time span, the strong tectonic and climatic transformations significantly impacted also the fauna and flora of the basin. Such changes reached their acme during the Messinian age (6–5.3 million years ago), when a strong and catastrophic sequence of events (CIESM, 2008) lead to the almost complete desiccation of the basin (Fig. 1a and b), thus eliminating the Mediterranean marine ecosystem. In particular the surface zooxantellate hermatypic corals, which disappeared from the basin during the Messinian are subsequently represented by only a few small colonial species (see Bosellini and Perrin, 2008 and references herein): this is related to a restricted water exchange with the Atlantic Ocean and the progressive deterioration in surface temperature. A different story applies to the Cold-Water Coral communities, whose presence in the Mediterranean area was continuous for the last 5 million years, as documented by paleontologists since the 18th and 19th centuries (Seguenza, 1863; see Taviani et al., 2005 for revision).

Pliocene. At the beginning of the Pliocene, ~5.3 million years ago, the Mediterranean water masses were characterized by a circulation system and temperatures different from the modern ones (Fig. 1c, see also Benson, 1971), as demonstrated by Pliocene marine fossils. Compared with the present day, the microfossil-based paleotemperature reconstruction throughout the water column shows an early Pliocene Mediterranean connected to the Atlantic Ocean through an opening deeper and wider than the present-day Gibraltar Strait and with a different circulation pattern (estuarine circulation). The shallow Mediterranean fauna and flora show a tropical affinity, but without reef development, while the deep fauna (ostracods and benthic foraminifera) has Atlantic (cold) characteristics and documents, at least for the western Mediterranean, the presence of a "psicrosphere" (water mass with temperature $<10\,^{\circ}C$) with no evidence of a present-day-like thermohaline circulation.

Pleistocene to Holocene. During the Pleistocene, the Mediterranean Sea became more similar to its present-day tectonic configuration and probably underwent a transition in its general circulation system, leading to the modern antiestuarine circulation pattern. The latter is due to a strong hydrological deficit in the eastern part of the basin during periods of strong insolation, which determines "thermospheric" waters (with temperature $>10\,^{\circ}C$, i.e. Fig. 1d and e) and a deep mixing with the formation of deep-water masses which ensure bottom water oxygenation.

The Pleistocene paleontological record documents, for the deep Mediterranean, cyclical variations in biodiversity, with minima typically associated to interglacial stages. This biodiversity loss is evident within all taxonomic groups and is well documented in particular by the deep corals (Fig. 2). It is related to both the warming of bathyal and abyssal water masses and to a different circulation pattern at the Gibraltar Strait, whose relatively shallow sill prevents the entrance of "psicrospheric" waters from the North Atlantic Ocean, even in the presence of a potential estuarine circulation.

In contrast, during glacial stages, the existence of a strong thermohaline circulation in the Mediterranean, with the formation of cold deep waters in both the western and eastern basin, would have decreased bottom water temperatures to values lower than today (Corselli and Bernocchi, 1990; Corselli, 2000, Fig. 1), even in the absence of a deep Atlantic water inflow from a shallower Gibraltar Strait. Thus different bottom water temperatures in the glacial and interglacial stages would have impacted the components of the Mediterranean Cold-Water Coral communities.

The present-day patterns of water masses and the main current distribution in the Mediterranean Sea are described in Pinardi and Masetti (2000).

The results of the APLABES project provide new data concerning the history of the Mediterranean CWC communities in the Ionian Sea and describe the different aspects of the marine ecosystems in the Apulian Plateau Bank.

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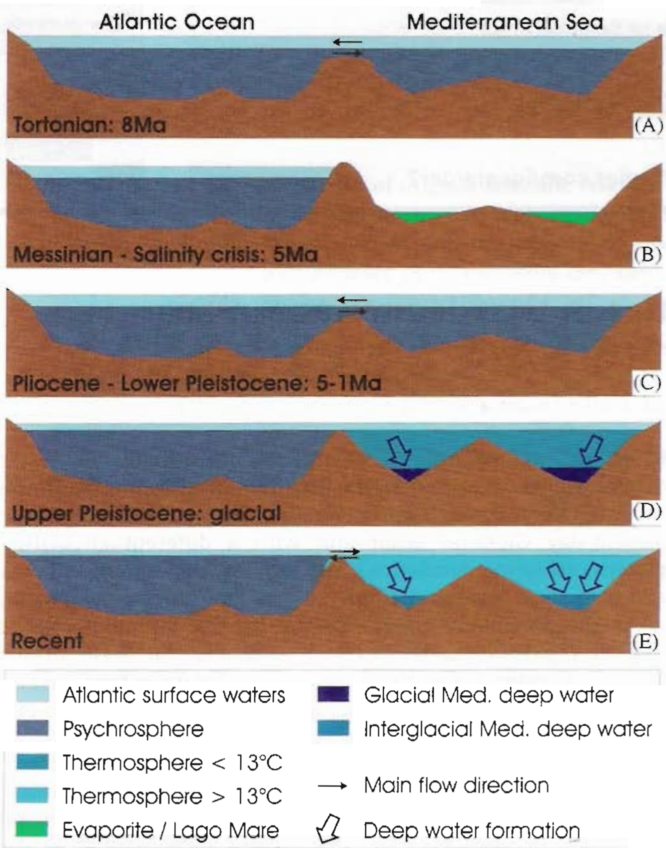

Fig. 1. Schematic reconstruction of the changing tectonic configuration of the Mediterranean basin through the geologic time, from the Tortonian (a) to the present day (e). The different water masses and associated temperature are shown, in relation to the reconstructed circulation pattern.

Biological analyses document that the SML coral banks represent an important hot spot of biodiversity in the bathyal Mediterranean Sea, with 221 living species (Mastrototaro et al., 2010). One hundred and thirty-five species are new for the SML bank, 31 of which represent new records for the north-western Ionian Sea (2 Porifera, 17 Cnidaria, 1 Mollusca, 3 Annelida, 2 Crustacea, 4 Bryozoa and 4 Echinodermata).

The greater densities and biomasses of some nektonic and benthic macrofauna (D'Onghia et al., 2010) were obtained inside the coral area. The fish size spectra and size distributions indicate a greater abundance of large fish inside the coral habitat, suggesting the role of the SML bank as a nursery area for these deep-water species, which find suitable environmental conditions in their early life stages and refuge from fishing.

The CWC community of SML is a Mediterranean expression of the world-wide CWCs with its peculiar characteristics also on the carbonate biodegradation processes of the deep-water corals as suggested by Beuk et al. (2010) which confirm a reduced ichnodiversity in Ionian Sea bathyal corals in comparison to the present ichnocoenosis of the Atlantic Ocean.

Vertino et al. (2010) provide the characterization of the habitats in the area, through a detailed analysis on the base of multibeam, side-scan sonar, video and sampling data including the accurate assessment of the video survey performed on two selected sites in the area.

The correlation of the cold-water coral occurences with the morphology and acoustic stratigraphy of the investigated area (Savini and Corselli, 2010) extended for about 800 square kilometres, evidences the nature and type of the substrates and documents that the CWCs are mainly found along a depth belt between 500 and 900 m: within the most prominent mass-movements and mass-transport deposition areas, on debris deposits along the western flank of the central ridge and on hard substrata outcropping at the top of the anticlines that characterise the western part of the investigated area.

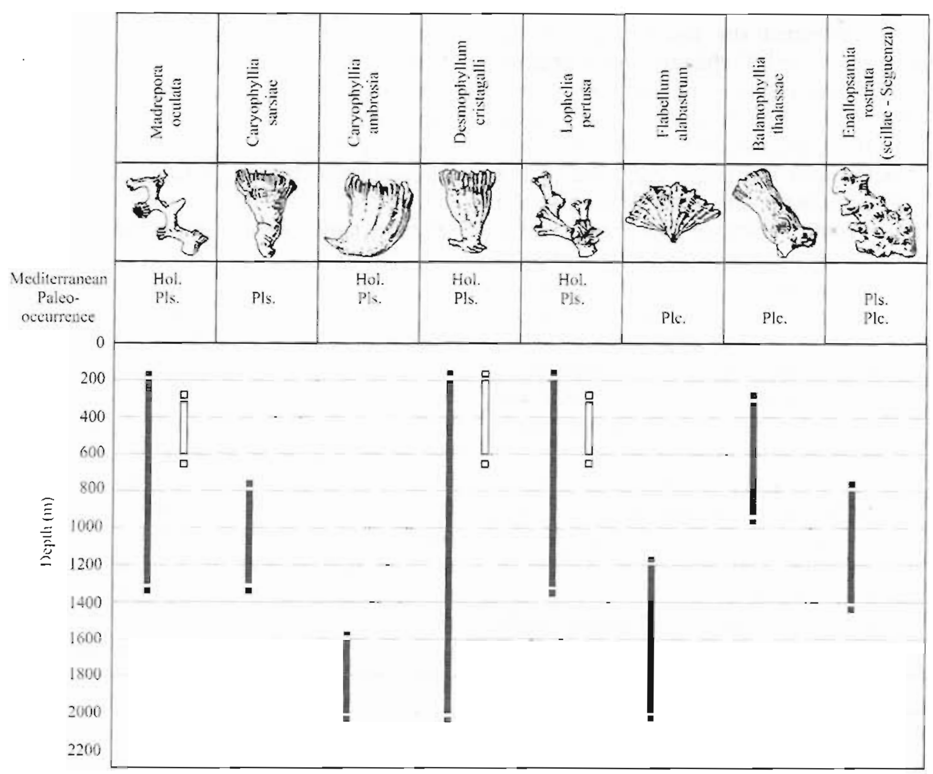

Fig. 2. Mediterranean paleo-occurrence (Hol. = Holocene; Pls. = Pleistocene; Pli. = Pliocene) and bathymetric distribution of scleractinaires in the present Atlantic Ocean (black bars) and the Mediterranean Sea (white bars) (modified after Zibrowius, 1987).

Budillon et al. (2010) characterize the water masses distribution in the area, showing their provenance and importance for the development of the coral colonies in the form of enhanced bottom currents which are able to prevent corals from burial. The core of ADW (Adriatic Deep Water) is located between 500 and 1000 m: such flow carries nutrient-rich waters that provide a crucial source for the biological activity of the deep layers of this region.

Etiope et al. (2010) provide the results on the presence/absence of gas emissions in the area. No significant occurrence of methane was detected, either in seawater or in the underlying sediments, excluding a potential evidence of chemiosynthetic activity for the growth and development of white corals.

Rosso et al. (2010) recognize the presence of six different thanatofacies in the SML area. These thanatofacies are easily distinguishable and appear to be largely corresponding and overlapping with related living facies. The described facies have good correspondences in already known fossil facies and assemblages although further facies have been described from Pleistocene submerged and on-land outcrops. Thanatofacies are formed *in situ* and the entire and fragmented skeletons almost completely account for recent sediment production. The SML mound province represents an active temperate-water carbonate factory in the present-day Mediterranean Sea.

The bottom sediments of the area are late Pleistocene to Holocene in age and fall biostratigraphically within the *Emiliania huxleyi* acme nannofossil zone (Malinverno et al., 2010). Radiometric dating on corals and one bivalve recovered along the sediment succession, coupled with micropaleontological analyses at some sites allow to propose a sequence of coral colonization phases. The temporal succession of the coral species and morphotypes seems to reflect the climatic history of the area at the transition from the last glacial to the present interglacial stage.

Lopéz-Correa et al. (2010) on the basis of the stable isotope and trace element composition of recent Cold-Water Corals (*L. pertusa* and *Desmophyllum dianthus*) and a Late-Glacial bivalve (*Pseudamussium septemradiatum*) confirm for the latter period lower bottom water temperatures with a different salinity than today and a significantly more eutrophic nutrient regime.

Di Geronimo (2010) testifies the differences between the recent and the past (Late Pleistocene) records of CWCs on the basis of the reduction of deep-water cirripedians. Although these results could be biased by the lack of samples for the present-day Mediterranean, the documented reduction may reflect environmental changes.

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