

# Community structure of meiofauna and macrofauna in Mediterranean Deep-Hyper-saline Anoxic Basins (DHAB's)

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## INTRODUCTION

DHAB are extreme habitats, associated with tectonically active zones in the deep sea. They are characterized by oxygen depletion, extremely high salinity and elevated methane and hydrogen sulphide concentrations. This reduced environment has the potential to sustain chemosynthetically based communities and thus presents a unique opportunity to study the community structure, diversity and adaptations of its meiofaunal and macrofaunal benthic components, as well as to compare protozoan and metazoan abundance and diversity.

To date, several cold-seep areas that harbor also various benthic communities have been found mainly in the Atlantic and in the Eastern and Western Pacific oceans. Investigations in the neighboring mud volcanoes of the Mediterranean Ridge complex have likewise revealed the existence of cold seep communities characterized by the presence of species dependent on methane rich emissions (Corselli and Basso 1996; Sibuet and Olu 1998). The mega- and macrofauna and the bacterial communities of these biotopes have been used in most cases for intensive investigations (Levin *et al.*, 2000). In contrast, the intermediate sized meiofauna have received less attention.

## DHAB's IN THE MEDITERRANEAN

Recently, five deep hypersaline anoxic basins (DHAB's) were discovered in the Mediterranean Sea, all below a depth of 3000m. These were the Bannock, the Urania, the Discovery, the L'Atalante and the Tyro basins (Figure 1). They represent unique deep-sea environments which originate from the dissolution of buried salt deposits (evaporates), that are the remains of hypersaline waters of the Miocene period (5.5. M.y. before present). The DHAB's are characterized by a total salinity above 30‰, absence of light, elevated pressure, variable pH values and ionic compositions and are sharply separated by the overlying normal sea-water. Some basins exhibit other environmental peculiarities (e.g. Urania basin has the highest concentration of sulfide among the Earth aquatic environments; Discovery basin has hydrocarbon seeps; Urania west basin has a mean temperature of 45°C at the brine/sediment interface). The sharp normal sea water/ brines transition interface (Figure 2), operates as a barrier to particles, which contain organic matter and pollutants, settling from the sea surface through the water column.

During this first leg (Aug - Sep. 2001) of the BIODEEP project (BIOTEchnologies from the DEEP) an intensive sampling effort was focused on the meiofaunal and foraminiferal assemblages of DHABs from sediments taken both within and outside the influence of brine pools. Benthic Meiofauna and Foraminifera were chosen as a target group because they not only consist a major element of deep-sea communities but are also considered to have a spatial distribution influenced by pore-water oxygen

and methane (Rathburn *et al.*, 2000). Furthermore these organisms are known to be abundant and diverse in habitats, which are subjected to considerable natural, physical and chemical stress and where very few if any macrofauna species remain. Substantially, investigations from deep-waters has shown that these extreme habitats are toxic to mega- and macrofauna and that if they support any life it consists mainly of protistan and metazoan meiofaunal communities, most members of which harbour prokaryotic symbionts (Bernhard *et al.*, 2000). Previous work has also shown that some foraminiferal species thrive in organically enriched – oxygen depleted environments and have often been found to outnumber metazoans (both meiofaunal and macrofaunal) at bathyal depths (Gooday *et al.*, 2000).

## SEDIMENT CHARACTERISTICS

The physicochemical environmental parameters analysed revealed pronounced differences between the DHAB and the adjacent stations outside the influence of brines. Negative Eh values were recorded at all stations in the brine areas of all four DHABs indicative of heavy organic loading and anoxia. In contrast, Eh profiles out of the brines were characterized by positive values down to 20cm depth and were representative of typical deep-sea conditions.

The concentrations of phytoplankton pigments on the sea floor of the four DHAB's were measured to obtain a general idea of sedimentation patterns of plankton derived organic material. In all non-brine sediments outside the DHAB's, the concentrations of CPE were very low, ranging from 0.58 (Bannock basin) to 1.14  $\mu\text{g g}^{-1}$  (L' Atalante basin). In contrast, strikingly high values were recorded in the brines of the Discovery, L'Atalante and Bannock basins (2.68-4.83  $\mu\text{g g}^{-1}$ ), whereas the Urania brine sediments showed similar values to those from the adjacent area (on average 0.93  $\mu\text{g g}^{-1}$ ). Similarly, all brine sediments showed significantly higher organic carbon values compared to those found in the adjacent areas (Figure 3).

## MEIOFAUNAL ABUNDANCES

Meiofaunal density from the non-brine sites of all four basins was very low ranging from 12 (Urania basin) to 43 ind.  $10\text{cm}^{-2}$  (Discovery basin). The brine samples of the Atalante and Discovery basins displayed higher densities compared to those from the non-brine sites (41-45 and 191 ind.  $10\text{cm}^{-2}$  respectively). However, at Urania and Bannock basins the opposite trend was observed (Figure 4).

In the normal non-brine sediment and at all basins, the meiobenthic community structure was typical, with nematodes being the most abundant taxon comprising up to 64.4% of the total. In contrast, community structure in the brine sediments differed considerably among the four basins (Figure 5). At Discovery basin meiobenthos was dominated by copepods and foraminifera (mostly planktonic species) comprising together 75% of the total, followed by juvenile bivalves, nematodes, allogromiid foraminifera and other crustacean.

Atalante basin was characterised by various meiofaunal taxa; nematodes, foraminifera, copepods, juvenile molluscs (unid. bivalves and gastropods).

At Urania basin juvenile bivalves (unid.sp.) dominated the community (61.5%) followed by copepods, foraminifera and other crustacean taxa.

At Bannock basin juvenile gastropods (unid.sp.) were the most abundant taxon (45%) at station MCBANN01, followed by the above-mentioned bivalves, nematodes, planktonic copepods and foraminifera. At station MCBANN02, the meiobenthic

community was comprised of various taxa such as nematodes, foraminifera, crustacean and juvenile molluscs. Figure 6 gives an overview of the different forms encountered at the brine sediments of the four basins.

## MACROFAUNAL ABUNDANCE AND BIOMASS

Macrofaunal abundance values obtained from the non-brine sites of the Discovery and Urania basins ranged from 60 to 88 ind m<sup>-2</sup> and were normal for deep-sea environments. In contrast to this, abundance at the only brine site (Urania basin) available was much lower (24 ind. m<sup>-2</sup>). The same trend was observed for biomass, with values ranging from 0.003-0.005 g m<sup>-2</sup> outside the brines, dropping to 0.001 inside (Urania basin).

Macrofaunal community structure was drastically different between the non-brine and brine sites. Polychaeta abundance and biomass was dominant outside the brine sediments with values ranging from 62-73% and 59-90% respectively, while crustacean was the second most dominant group with abundance and biomass values ranging from 20-38% and 6-39% respectively. In contrast, the brine site (Urania basin) was dominated by crustacean (67% and 95% of the total abundance and biomass respectively).

## SYNTHESIS

Up to now, sampling of meiofauna at brine areas has been undertaken rarely (Jensen 1986; Sibuet and Olu 1998; Thiermann *et al.*, 1994) and the results are somehow contradicting. In some cases, no differences in meiofaunal abundance between brine and control sites are found (Shirayama and Ohta 1990), whereas in others the abundance was found to be up to two orders of magnitude higher than those recorded from the surrounding area (Olu *et al.*, 1997). Two hypotheses may explain these enhanced faunal abundances: the local enrichment in the sediment by chemosynthetic production which may be due (1) to free living chemoautotrophic bacteria or (2) detrital organic matter from clusters of symbiotic fauna (Sibuet and Olu 1998).

However, the presence of a fauna living in such environments, and particular the metazoan component, is rather unexpected since both the absence of oxygen and the presence of hydrogen sulphide, either of which, alone, has been considered a lethal condition for all free-living metazoans (Fenchel and Riedl 1970). The presence of the fauna implies that adaptations, which provide a long-term tolerance, exist and must be of two types. Either the animals in question can exclude the sulphide at the body wall and thereby avoid the toxicity problem or, if sulphide penetrates the body wall, they must detoxify it, something that is usually achieved with “bacterial metabolic help” (Giere 1993).

Our results so far indicate that all four DHABs support, to a different extent, meiofaunal communities which could possibly harbour prokaryotic symbionts. Many of these taxa, including the prokaryotic symbionts are expected to be new for science.

The macrofaunal community was sampled only marginally and therefore much remains to be done during the next BIODEEP cruises and before sound conclusions are drawn.

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## Capture to Figures

Figure 1. Map of the eastern Mediterranean showing the locations of the anoxic basins and the bathymetric profile along the Discovery basin.

Figure 2. The vertical profile of salinity showing the sharp normal sea water/ brines transition interface.

Figure 3. Distribution of mean organic carbon values within and outside the brine areas.

Figure 4. Mean meiofaunal abundance (indv./10cm<sup>2</sup>) at the four anoxic basins.

Figure 5. Meiofaunal community structure within the anoxic sediments of the four anoxic basins.

Figure 6. Different forms found in anoxic brine sediments, below 3000 m depth in the eastern Mediterranean.