

Coastal Lagoons: Spatial Patterns of Benthic Assemblages and Bioindication

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Coastal lagoons are shallow basins connected to the sea by one or more inlets. The relationships among tidal regime, dimensions of the inlets and basin morphology strongly influence water exchange with the adjacent sea, internal circulation and suspended solid transport. These characteristics make coastal lagoons a peculiar environment among marine coastal ecosystems.

Coastal lagoon are sedimentary environments especially along the microtidal and nannotidal coasts of the Mediterranean (Nichols & Boon, 1994; Barnes, 1995). As tides penetrate the lagoon, their energy is dissipated and suspended solids deposited. Lighter suspended matter sinks and accumulates at the more internal areas, forming sediments characterised by fine particles and high organic content. Often rivers flow into coastal lagoons, where particles suspended in the freshwater flocs and aggregate by salt contact generating local accumulation zones.

Across a coastal lagoon, there is a gradual departure from the marine environment toward habitats characterised by a high variability of environmental parameters and increasing levels of stress, for organisms that live there, caused mainly by organic matter accumulation and reduced water exchange.

The divergence from marine conditions are tolerated by a progressively lower number of species so that the number of species present in lagoonal assemblages typically decreases along the sea-land axis (Cognetti & Maltagliati, 2000). This spatial pattern is more evident in large microtidal coastal lagoons that are less subjected to stochastic fluctuations (Guelorget & Perthuisot, 1983; Barnes, 1994).

Many benthic indices of environmental quality include species diversity in their formulation and assign a direct relationship between diversity and environmental quality (for a review see Diaz *et al.*, 2004). If a diversity-based index must be applied to a coastal lagoon, it should take into account careful consideration of the natural spatial pattern of diversity that characterises this class of environment.

A quality diversity-based index that does not take into account the “physiological” relationships between number of species, water exchange, organic matter content and sediment texture will inevitably assign low quality values even to the secluded habitats of coastal lagoons which are in pristine condition.

During this workshop, we presented an exercise addressed to identify the relationships between diversity of macrobenthic assemblages, water exchange with the sea and organic matter in one of the largest Mediterranean coastal lagoons, the Lagoon of Venice.

A total of 140 samples (5 replicates each) were analysed, taken during May-June 2002 from sampling stations which were evenly distributed over the whole Lagoon of Venice, on subtidal shallows which is the most common habitat. As a measure of water exchange with the sea, we calculated the water residence time for every station. The measure of organic matter content was obtained by loss of weight on ignition at 350°C (LOI@350). This measure was preferred to other LOI at different temperatures because it gave the best correlation with elemental analysis of Organic Carbon conducted on 53 of the samples. Organic matter content, number of species, abundance and the diversity indices H' , $E(S_{10})$, $E(S_{50})$, calculated on numerical abundances, were analysed by regression methods and mapped using GIS.

Regressions showed negative relationships between species number (and diversity indices) with residence times, but gave less interpretable results with organic matter. Conversely, the visual comparison of distribution maps offered a good perception of the complementary spatial distribution of organic matter and species diversity. Numerical abundances did not show easily interpretable relationships.

Although the general scheme was applicable to the whole Lagoon of Venice, some differences emerged among the four lagoonal sub-basins. Some “anomalous” areas were identified, where species diversity was high with respect to high levels of sediment organic matter. These areas, some time ago, were vegetated marshes but now are submerged and the organic matter present in their sediments is made mostly by refractory remnants of old rhizomes. This fact suggests that not only the total sediment organic content should be taken into account, but also its degree of lability.

Many environmental quality indices are based on the diversity of macrobenthic assemblages. To apply these indices to coastal lagoons they should be in some way weighted, taking into careful consideration the “physiological” distribution patterns of diversity in such environments.

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