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The leaf-bag and the sediment sample: Two sides of the same ecological quality story?

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A B S T R A C T

A growing number of studies suggest that ecological quality status assessment in transitional waters should rely upon functional indicators rather than structural indices. The experimental study of decomposition rates using leaf-bags are among the former. A recent example was conducted in Ria de Aveiro, Western Portugal, and the decomposition rates of *Phragmites australis* obtained through the registration of the biomass decrease in leaf samples left in the estuary for fixed periods of time (7, 15, 30 and 60 days). The leaf-bags were recollected from the field and the accompanying fauna retained, for comparison to that obtained in sediment samples taken with a hand-held corer. The study was conducted in five areas covering the full salinity gradient, in three sites per area and four replicates per site. A total of 89 *taxa* were registered, 70 in the leaf-bags and 50 in the sediment samples. 39 *taxa* were sampled only in the leaf-bags, 19 only in the corers and 31 were common. From marine to freshwater areas, average abundance increased in both types of samples, and species richness and diversity diminished, except in freshwater and in the leaf-bags. Both samplers portrayed the succession from the marine to the freshwater areas, and the benthic community was found significantly different between all areas except between the two located closer to the estuarine entrance, equally by both samplers. Despite these similarities, the benthic communities sampled by the two methods were significantly different, either dominated by annelids (corers), or by arthropods (leaf-bags), amphipods in the estuary and insects in freshwater. These differences were not significant neither in the freshwater, due to paucity of the endofauna in freshwater, nor in the fully marine area, possibly due to the high variability of samples within the area. These results indicate that the estuarine benthic invertebrates upon which the taxonomic indices are calculated and those which contribute to the functional aspects based in the study of decomposition rates, are essentially very distinct.

1. Introduction

Benthic macroinvertebrates play an important role in many ecological processes in aquatic ecosystems (McCall and Soster, 1990; Griffiths, 1991); they integrate changes in the physical and chemical environment over time and space, are key contributors to chemical fluxes over the sediment–water interface, and present well-established response models to anthropogenic pressures (Cook, 1976; Pearson and Rosenberg, 1978; Aller and Aller, 1998). Benthic macroinvertebrates have thus received appreciable attention on impact assessment and water management studies in transitional aquatic ecosystems (Weisberg et al., 1997; Magni et al., 2009).

Many bio-monitoring programs in the aquatic environment rely on the analysis of communities' structural aspects and macrobenthic communities have long been a favourite for environmental quality assessment and classification (Metcalfe, 1989; Basset et al., 2004; Quintino et al., 2006). Recently, macrobenthic communities have also been included in the biological elements indicated in the European Water Framework Directive (WFD, 2000/60/EC) and the use of benthic assemblages to assess ecological quality of aquatic systems is a major tool for the implementation of this European Directive. At present, such tools are far better established for freshwaters than for coastal and transitional waters. Although in recent years several biotic indices have been proposed to be used as ecological quality indicators for the marine and the estuarine environment (AMBI, Borja et al., 2000, BENTIX, Simboura and Zenetos, 2002, BQI, Rosenberg et al., 2004, BOPA, Dauvin and

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Ruellet, 2007), many uncertainties still persist and further studies are required to standardize the existing indices in transitional waters.

Transitional waters are characterized by highly dynamic physical–chemical and hydro-morphologic conditions, resulting in a mosaic of habitats in which species are particularly well adapted to variability. Such species are essentially more tolerant to change than their marine counterparts, which translates into a scientific challenge to develop suitable quality indicators for transitional waters (Elliott and Quintino, 2007). In such ecosystems, data on benthic communities have been obtained through studies aiming at structural characteristics or at functional processes. The benthic quality indices are most commonly related to composition and structure attributes of the benthic communities and based in species lists from quantitative sediment samples. Investigations on ecosystem functional properties have been based namely in the study of decomposition processes, especially in the freshwater environment (Gessner and Chauvet, 2002), and used the leaf-bag technique (Petersen and Cummins, 1974). Several ecosystem biomonitoring studies include both functional and structural approaches, and compare leaf-litter decomposition rates to structural characteristics of the associated benthic invertebrate communities. Examples of such joint analysis exist in freshwater environments (Pascoal et al., 2003; Bergfur et al., 2007; Castela et al., 2008), but do not question how comparable are the benthic communities sampled by the leaf-bag technique and by the more traditional methods aiming to study taxonomic based indices. Comparable leaf-litter decomposition studies in the estuarine environment are rarer (Quintino et al., 2009), but no studies were ever based on comparisons of the benthic community species composition and structure obtained through grab or corer sediment samples and through leaf-bag samples, as those used in

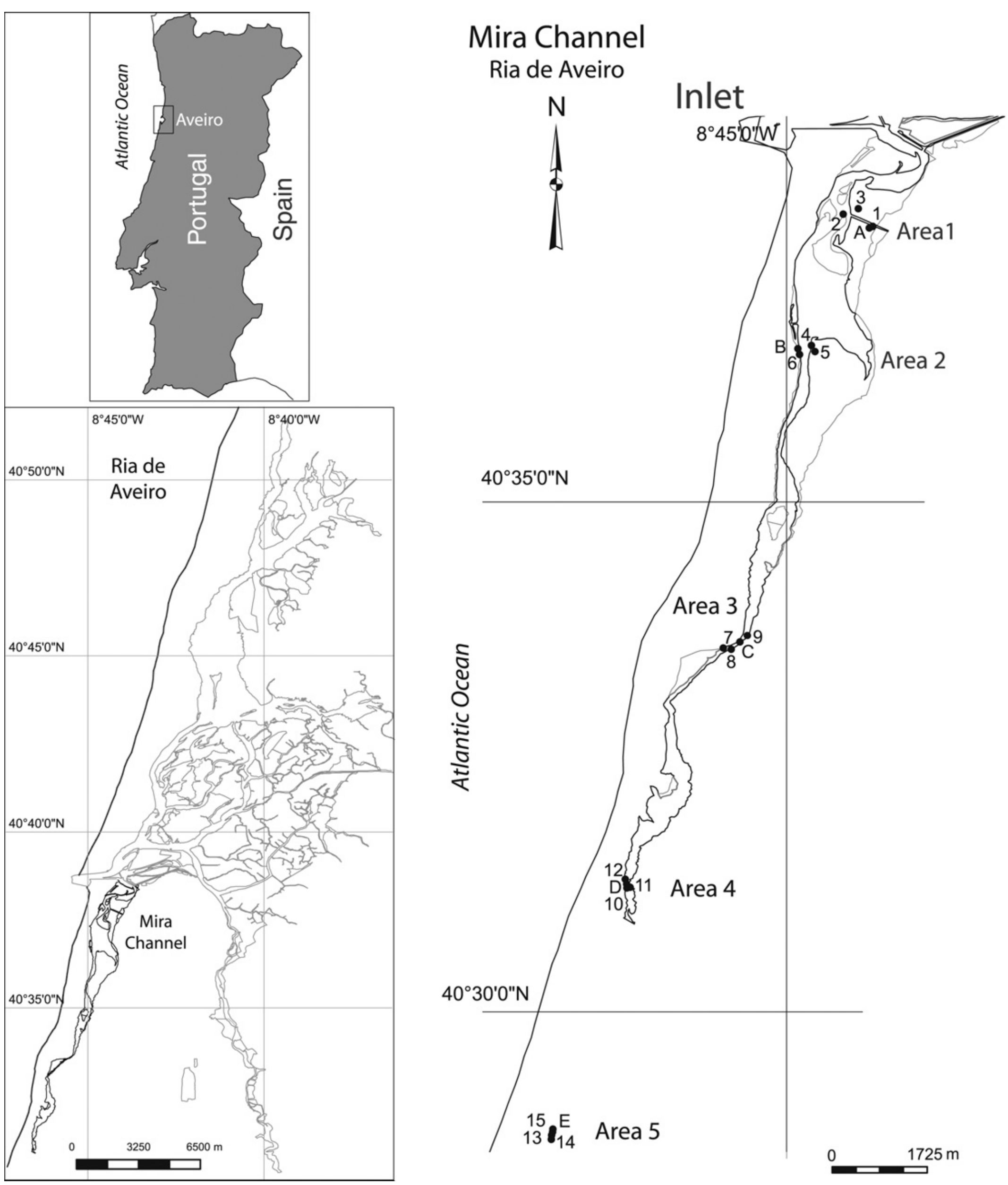

Fig. 1. Positioning of the sampling sites in Mira Channel, Ria de Aveiro, Western Portugal, for the study of the benthic communities (sites 1–15, nested in areas 1–5), and bottom water salinity (sites A–E).