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Diversity, distribution and ecology of benthic molluscan communities on the Portuguese continental shelf

R. Martins, L. Sampaio, V. Quintino *, A.M. Rodrigues

Departamento de Biologia e CESAM, Universidade de Aveiro, 3810-193 Aveiro, Portugal

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ABSTRACT

The diversity, ecology and distribution patterns of the Portuguese continental shelf malacofauna and its relationship with abiotic factors were studied from samples covering the western and the southern coast. A total of 2544 specimens were identified corresponding to 169 taxa, mostly bivalves (62% of the total taxa). *Abra alba* was the most abundant and the most frequent species. The *alpha* diversity ranged from one species to 21 spp. 0.1 m^{-2}. The highest abundance and diversity were obtained in coarser sediments. Multivariate analysis based on the abundance data identified five major malacological groups: (a) *Angulus pygmaeus* and *Thracia villosiuscula* in the coarser sediments of the western inner and mid shelf; (b) *Calyptraea chinensis* and *Leptochiton cancellatus* in the heterogeneous and organically enriched sediments of the southern shelf; (c) *Angulus fabula*, *Spisula subtruncata* and *Pharus legumen* in the near shore exposed fine sands; (d) *A. alba* in muddy fine sands, mainly in the northwestern shelf and (e) *Saccella commutata* in the southwestern deeper shelf. The malacofauna could be used as a proxy for the major benthic communities known to occur in this area, except in muddy patches, where molluscs were absent or low abundant. Median grain-size, gravel content, depth and hydrodynamic regime were the environmental factors best related to the malacofauna spatial distribution patterns. This study sets the first record of *Astarte borealis*, *Leptochiton asellus*, *Mercenaria mercenaria* and *Montacuta phascolionis* in the Portuguese shelf and the most northern limit for *Anadara polii*, *Glycymeris nummaria*, and *Leptochiton algesirensis* along the northwestern shelf. This study also gives new ecological insights for several species, in terms of bathymetric range distribution, as well as habitat type and highlighted the transitional characteristics of the molluscan communities from this particular northeastern Atlantic area where boreal, temperate and subtropical faunas can coexist.

1. Introduction

Studies of macrofaunal benthic communities are relevant to assess the biodiversity and the environmental status of the marine environment (e.g. Cacabelos et al., 2008; Koulouri et al., 2006). Benthic communities are well characterized in Portuguese lagoons (e.g. Quintino et al., 1987, 1989), estuaries (e.g. Moreira et al., 1993; Rodrigues and Quintino, 1993; Rodrigues et al., 2006, 2011), intertidal rocky shores (e.g. Araújo et al., 2005; Pereira et al., 2006; Saldanha, 1995), submarine canyons (e.g. Cunha et al., 2011; Cúrdia et al., 2004) and the continental shelf (e.g. Freitas et al., 2011; Marques, 1987; Martins et al., 2013a, 2013b, 2013c).

Within the bent1hic community, the phylum Mollusca is one of the most diverse and widespread in the marine environment (Rueda et al., 2009). Several works focused on the study of spatial and temporal malacofauna distribution patterns and used them as a surrogate of the whole benthic community (e.g. Cacabelos et al., 2008; Quintino et al., 1986; Rufino et al., 2008, 2010; Urra et al., 2013; Zenetos, 1996). Coastal molluscs (mostly bivalves) also represent an important economic resource, being widely exploited in Portugal (Gaspar et al., 2003). Nearly 1600 marine mollusk species are mentioned for the Portuguese coast (Macedo et al., 1999), but no dedicated studies were carried out regarding the diversity of molluscs of the entire Portuguese shelf. This area has a particular ecological and biogeographic interest (Saldanha, 1995), since it corresponds to the majority of the Western and part of the Southwestern Iberian coast, a region of contact between warmer waters from northern Africa and the Mediterranean Sea and colder waters from the North Atlantic (Fiúza, 1983). The area between the latitudes 38° and 40° N mark the transition between two different climatic marine zones (thus, biogeographically distinct), both through the pre-glacial Pliocene, before 3.0 Ma, as well as at the Present-day (Silva et al., 2006, 2010; Monegatti and Raffi, 2007). Furthermore, the Portuguese shelf is dissected by several canyons, important morphological and sedimentary boundaries (Oliveira et al., 2007), and presents a variety of hydrodynamic conditions (Bettencourt et al., 2004) and sediment types (Martins et al., 2012), which increase the probability of occurrence of different faunas.

The scope of the present study was to characterize the diversity and distribution of molluscan communities on the Portuguese continental shelf, to give new insights about the ecology of some mollusk species and to discuss the relationships between the environmental and biological data and its potential use as a surrogate of the overall fauna.

* Corresponding author. Tel.: +351 234370350.
E-mail address: victor.quintino@ua.pt (V. Quintino).

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2. Material and methods

2.1. Study area

This study was conducted on the entire Portuguese continental shelf, from Caminha (41° 51.8′ N, 9°15.6′ W) to Vila Real Santo António (36° 56.1′N, 7° 24.7′ W), covering the majority of the Western and the Southwestern Iberia (Fig. 1). A total of 145 sampling sites were positioned in a regular grid of perpendicular lines to the coastline, separated from each other 10 to 15 km (Fig. 1) and stratified by depth (<50 m, 50 m, 75 m, 100 m, >100 m), ranging from 13 to 195 m water depth. The sites were distributed over the entire survey area in order to cover as much as possible the whole range of potential benthic habitats. At each site, two 0.1 m^2 Smith-McIntyre grab samples were collected, one for macrofauna and the other for baseline sediment analyses (grain-size and total organic matter content (TOM)). The samples for macrofaunal analyses were sieved on board over 1 mm mesh size and the residue fixed in neutralized formalin (4%) stained with rose Bengal. The detailed grain-size results and the spatial distribution of superficial sediments were given in Martins et al. (2012). The spatial distribution of the sediment fine content and TOM is shown in Fig. 1. Coarser sediments with less than 5% fines content were dominant in the northwestern inner and mid shelf sector

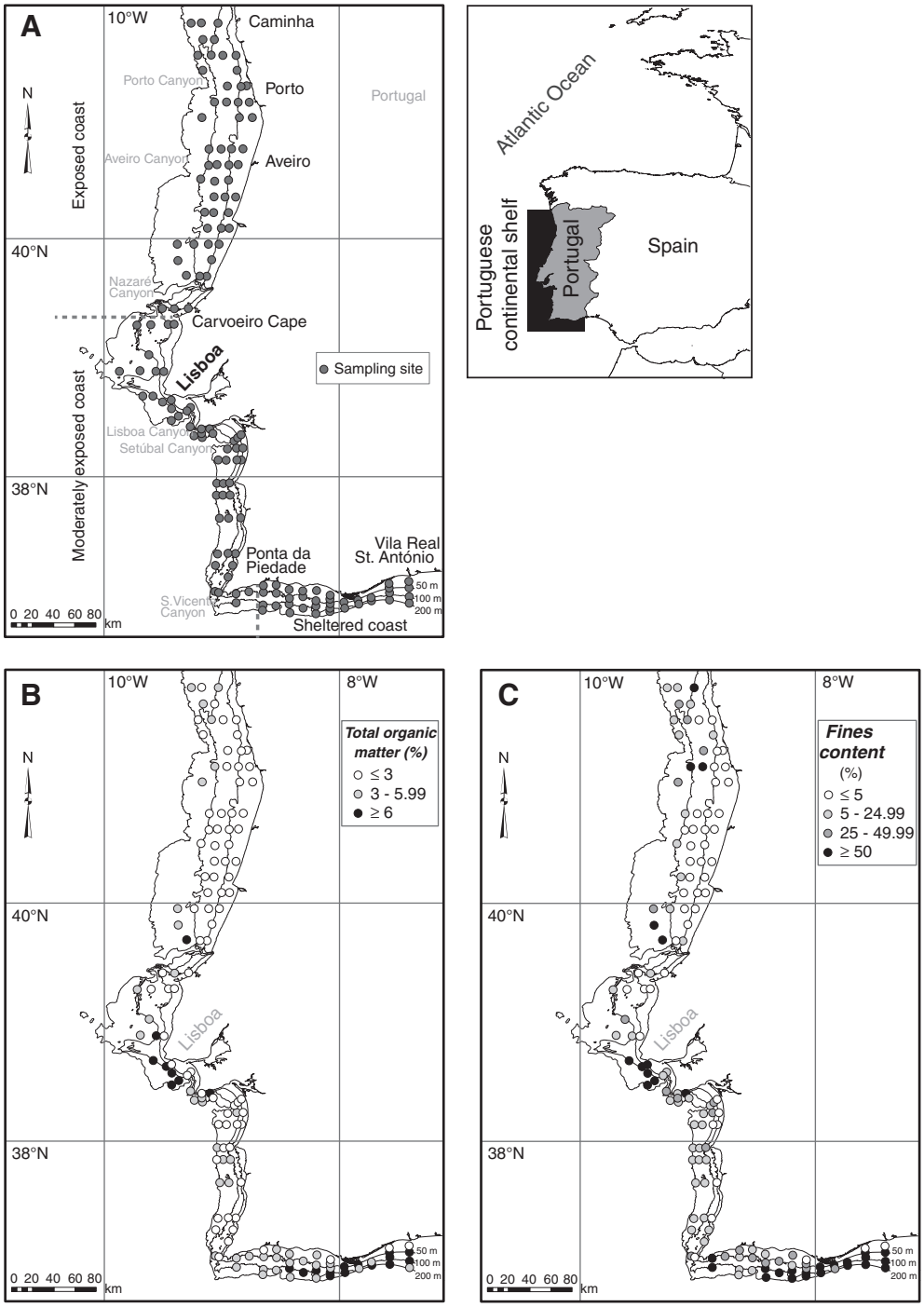

Fig. 1. Study area: the Portuguese continental shelf (Western Iberia) showing the coastal hydrodynamic regime subdivisions according to Bettencourt et al. (2004) (A), and the distribution of sediment total organic matter content (B) and fines content (C).