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Spatio-temporal variation of trematode parasites community in *Cerastoderma edule* cockles from Ria de Aveiro (Portugal)

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ABSTRACT

Cerastoderma edule (edible cockle) is among the most exploited bivalves in Europe playing an important socio-economic role. Cockles live in estuaries and lagoons where their population is controlled by several environmental factors including parasitism. Parasites represent an important part of the world known biodiversity but are often neglected. Trematodes are the most prevalent macroparasites of cockles being able to exert an impact both at the individual and population levels. Therefore, it is of prime relevance to recognize and understand the parasite-host system dynamics in order to better predict potential conservation threats to bivalve populations and to maximize the success of stock and disease episodes management.

Cockle monitoring was conducted in 2012 and 2016, in six and eight stations, respectively, at the Ria de Aveiro coastal lagoon, Portugal. Cockles were sampled in one single occasion in 2012 and seasonally in 2016. The tested hypothesis is that the trematode community in cockles was spatially and seasonally heterogeneous but stable over time. The main result showed that despite a relative homogeneity of the parasite community structure in cockles, the among-years heterogeneity of trematode communities was higher than among-stations and among-seasons heterogeneity rejecting the postulated hypothesis. Results demonstrated that trematode communities from the Ria de Aveiro are characterized by low abundance, which resulted in a spatial and seasonal trematode homogeneity (despite an overall channel difference and a slight downstream-upstream gradient). The interannual analysis showed a worrisome loss of trematode diversity and prevalence which consequently indicates an important loss of overall diversity and/or environmental conditions reflecting the negative effects of global change (mean temperature rise and overharvesting, among others). The present study highlighted the importance of trematodes in characterising their associated environment and respective biodiversity which might be helpful to assess ecosystem ecological status and to identify threatened areas.

1. Introduction

The recognition of species presence and distribution is very important in coastal and estuarine science namely to assess ecosystem ecological status and to identify priority areas for protection and conservation (McLusky, 1999). Macroparasitic fauna comprises among the most important species within these ecosystems, representing 40% of total metazoan species richness (Dobson et al., 2008) although, it is often neglected with more taxonomic (Bartoli et al., 2000) and experimental (Studer and Poulin, 2013) studies than studies presenting quantitative field data (de Montaudouin et al., 2000).

In coastal waters, trematode is the most abundant and prevalent clade of macroparasites (Lauckner, 1983). These parasites have a complex life cycle using vertebrates as final host, where the adult parasitic stage develops, sexually reproduces and spawns its eggs. Eggs are released in the environment, develop into the miracidium free-living stage that will infect a mollusc as first intermediate host (sporocyst or rediae parasitic stage). From mature sporocysts (or rediae), cercariae larvae are released in the environment, another free-living form, which rapidly penetrates an invertebrate or vertebrate species (second intermediate host) and settles as metacercariae. During this cycle, the parasite experiences different habitats with different abiotic and biotic drivers that will affect parasite success and consequently its distribution pattern. Among these drivers, temperature (de Montaudouin et al., 2016), light: dark cycle (de Montaudouin et al., 2016), hydrodynamics (de Montaudouin et al., 1998), diversity of host species (Thieltges and Reise, 2007) and target host density (Magalhães et al., 2017) are considered important drivers. The annual fluctuation of these parameters usually leads to a seasonal pattern with an optimal infection window occurring in the warmer season (Desclaux et al.,

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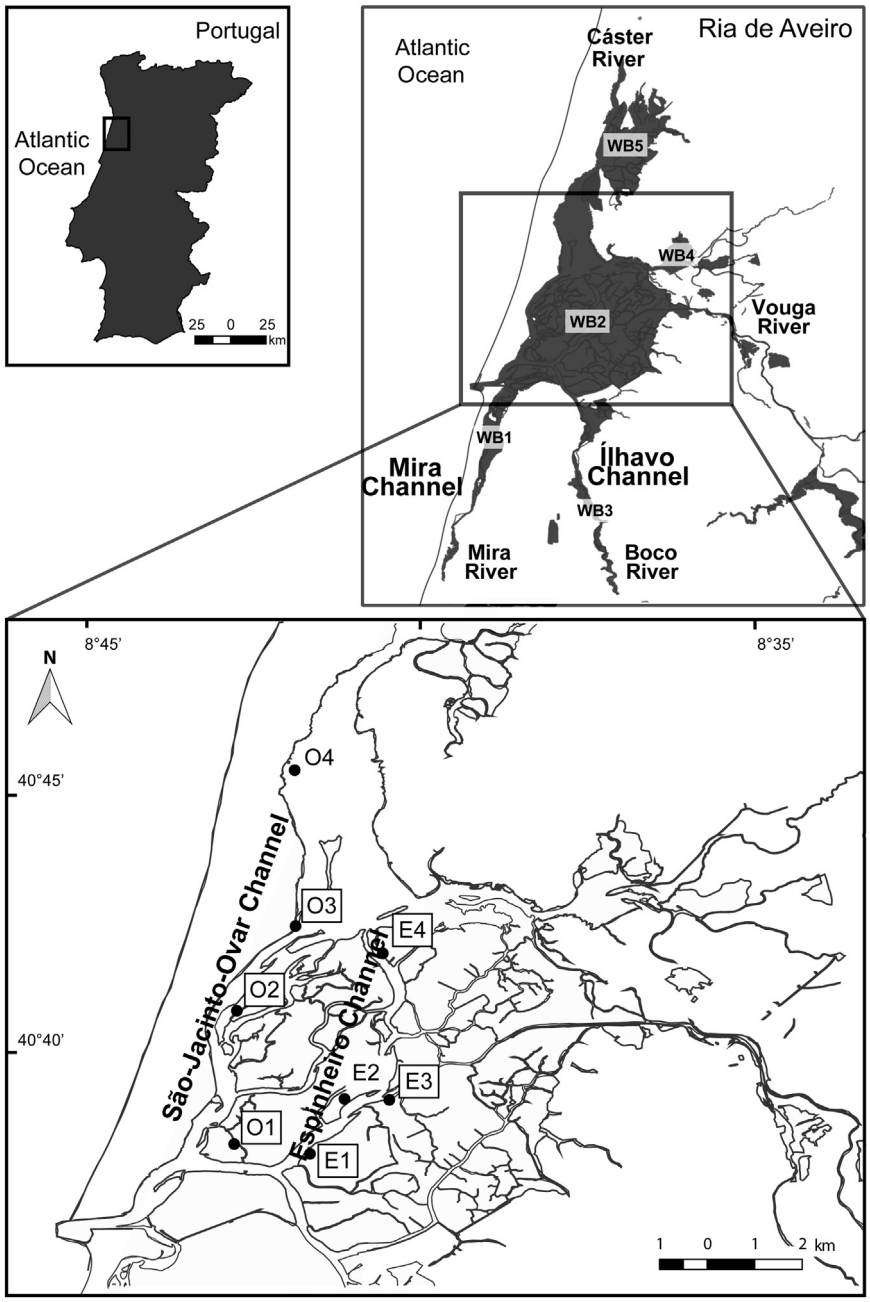

Fig. 1. Study area. The Ria de Aveiro coastal lagoon (Northwest Portugal) indicating the positions of the seasonal sampling stations (São[HYPHEN]Jacinto[HYPHEN]Ovar channel: O1, O2, O3, O4 and Espinheiro channel: E1, E2, E3, E4) with indication of the lagoon division into five transitional water bodies (WB). Compatible stations used for 2012-2016 comparisons are identified by a black square.

2004; Thieltges and Rick, 2006; de Montaudouin et al., 2016).

At the individual level and by definition, the parasite exerts a negative impact on the host and can alter its biological functions (Carballal et al., 2001; Babirat et al., 2004). The impact of a parasite on a particular organism, or its pathogenicity, is specific and also depends on host and parasite abundance. However, impact on host population is usually reported when there is obvious disease symptoms and mass mortality playing a significant role in host population regulation (Marcogliese, 2004). On the other hand, the complexity of the trematode life cycle described above, namely its multi-host nature, makes trematodes indicators of ecosystem diversity and health indicators (Hechinger et al., 2006; Hudson et al., 2006). Trematodes were also used to assess habitat stability over time, at the scale of several years (de Montaudouin et al., 2012) or to detect global changes effects through fish long-term monitoring (Dzikowski et al., 2003; Zander, 2005).

Among the different host-parasite systems taking place in marine environment, the present study investigated a bivalve-trematode model: firstly because bivalves (along with several other molluscs) are suitable and favourite first and/or second intermediate hosts for trematode parasites (Lauckner, 1983); secondly because bivalves represent the major proportion of the benthic fauna biomass in many coastal systems, occurring also at high densities (Sousa et al., 2009); thirdly because some species represent the basis of important commercial fisheries (Beukema and Dekker, 2006); and finally due to their important role on the ecosystem functioning (Morgan et al., 2013). Thus, bivalves are keystone species, they act as ecosystem engineers creating, modifying and maintaining habitat for other species (Philippart et al., 2007). They provide structural conditions for other invertebrates to settle and occupy a crucial position within food webs