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Seasonal variability of suprabenthic crustaceans associated with *Cymodocea nodosa* seagrass meadows off Gran Canaria (eastern Atlantic)

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ABSTRACT

Seagrass meadows are important ecosystems on shallow coastal waters, maintaining a high diversity of species. Mysids are the dominant taxa of suprabenthic organisms associated with seagrass meadows in temperate coastal waters, where they are an important food resource for the coastal fishes. Five meadows of *Cymodocea nodosa* were sampled off the east and west of Gran Canaria Island in spring and autumn 2011 to describe associated suprabenthos and to determine seasonal changes in the abundance of suprabenthos assemblages. Mysids, decapods and amphipods made up 95% of total suprabenthos abundance, which was more abundant in spring (May) than in autumn (November). A total of 29 species were identified, 12 amphipod, 11 decapod and 6 mysid species. The mysid *Leptomysis lingvura* did not show seasonal differences, while *Anchialina agilis* showed greater abundance in May at all localities. For the other mysid species, abundances were higher in May than November, although significant differences varied among localities. The dominant amphipod, *Apherusa vexatrix*, and the dominant decapod, *Hippolyte* spp., also showed significant differences in density between seasons, being higher in May at all localities. From these results, we conclude that there is an overlap between the natural life cycle of the seagrass *C. nodosa* and associated suprabenthos.

1. Introduction

Seagrass meadows are important ecosystems that contribute to ocean primary and secondary production, and have important ecological and physical functions, being responsible for about 15% of the carbon storage in the ocean (Duarte and Cebrian, 1996; Duarte and Chiscano, 1999). Conservation of seagrass meadows is important, specially because these ecosystems are declining worldwide mainly due to human disturbances (Duarte et al., 2002; Waycott et al., 2009).

Suprabenthos, also called "hyperbenthos", is an important assemblage in coastal ecosystems, exploiting a diversity of food resources: organic particles, detritus, zooplankton, and have an important trophic role as food for juveniles and adults of several commercially important fish species (Mees and Jones, 1997; Cunha et al., 1999). Suprabenthos include mysids, amphipods, cumaceans, isopods, decapods and bottom-dependent polichaetes, which perform regular vertical migrations above the bottom (Sainte-Marie and Brunel, 1985). Recently, there has been an increase in the interest in suprabenthic studies (Mees et al., 1995, 1993b; San Vicente and Sorbe, 1999, 2001; Dauvin et al., 2011; Dauvin and Pezy, 2013; Dewicke et al., 2003; Azeiteiro and Marques, 1999; Beyst et al., 2001; Cunha et al., 1999; Mouny et al., 2000; Sánchez-Jerez et al., 1999) and their role in trophic chains (Wang and Dauvin, 1994; Mees and Jones, 1997; Cartes et al., 2008, 2011; Madurell et al., 2008; Herrera et al., 2014). Most mysids feed on detritus and are responsible for the remineralization of an important part of refractile detritus (Mees and Jones, 1997). Other studies have shown the importance of suprabenthic mysids for the nitrogen regeneration in the surf zone (Cockcroft et al., 1988).

Mysids are a dominant motile macrofauna in temperate coastal seagrass ecosystems and, as suprabenthos, they are important as food for both juvenile and adult fishes (Mauchline, 1980; Murano, 1999; Herrera et al., 2011; Yamada and Kumagai, 2012). For example, in Gran Canaria Island, Castro (1995) highlighted the importance of mysids as food of *Scomber colias*. This species consumes annually about 242,000 tons of mysids and 29,000 tons of euphausiids.

In the Canary Islands, the seagrass *Cymodocea nodosa* is the dominant vegetal species on soft bottoms in coastal waters along the eastern and southern coasts (Reyes et al., 1995; Pavón-Salas et al., 2000; Barberá et al., 2005). This seagrass provides important ecological functions, such as generation of detritus, habitat creation for omnivorous and herbivorous organisms that transfer

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carbon to high trophic levels, recruitment and nursery habitat for numerous coastal fish species (Espino et al., 2011a, 2011b). The seagrass *C. nodosa* is legislated as an endangered species by the autonomous government of the Canary Islands (Decreto 151/2001, de 23 de julio, Catálogo de Especies Amenazadas de Canarias). Despite the serious decline of *C. nodosa* in the past 20 years (Tuya et al., 2013, 2014), environmental protection has been reduced since 2010 (Ley 4/2010, de 4 de junio, del Catálogo Canario de Especies Amenazadas, BOC no 112 de 9/6/10).

In this study, we hypothesized that patterns in the abundance of suprabenthos in the Canary Islands would follow a similar seasonal trend as that displayed by *C. nodosa*, which shows a maximum production period during spring and summer, and a subsequent senescent period in autumn–winter (Reyes et al., 1995; Tuya et al., 2006). Specifically, we sampled in May (late spring) and November (late autumn) to determine the main taxonomic groups of suprabenthos associated with *C. nodosa* and their temporal variability. While there are several studies on seasonality of *C. nodosa* and associated ichthyofauna and macrofauna in the Canaries (Tuya et al., 2001, 2006; Barberá et al., 2005; Espino et al., 2011b, 2011a), there is no study on diversity and seasonality of seagrass associated suprabenthos.

2. Material and methods

2.1. Sampling method

We selected five meadows of *C. nodosa* in the east and west coast of Gran Canaria: Veneguera, Risco Verde, Roque, Faro and Cabron (Fig. 1). Surveys were conduced in late spring (May 2011) and late autumn (November 2011). In general, the meadows were not only similar in depth, but also presented similarities for a range of environmental factors, particularly sea water temperature, surface PAR and wave exposure (Tuya et al., 2014). Four meadows were located in the east coast, as seagrass meadows are naturally more developed in this stretch of the coast. Table 1 shows the environmental scenario of each meadow.

Samples ($n=4$) were collected during day time using a 6 m-long, 4 m-wide, 0.5 m-high seine net with a mesh size of 1 mm. The net was towed by two SCUBA divers along a 25 m transect parallel to the shore line, collecting a volume of 50 m^{-3}. This net captures small organisms and has been previously used by Espino et al. (2011a) to collect small fishes in *C. nodosa* meadows. Samples were fixed in 4% formaldehyde and the main groups were sorted in the laboratory. Mysids, amphipods and decapods were further classified to species level. The suprabenthos abundance was expressed as number of individuals per m^3.

2.2. Statistical analysis

Differences in the abundance of suprabenthos between different seasons (May 2011 *vs*. November 2011) were tested by means of a 2-way, permutational ANOVA (Anderson, 2001), based on Euclidian distances calculated from square root-transformed data. The ANOVA model included the factors: "Locality" (random factor) and "Time" (fixed factor). P-values were calculated from 999 unrestricted permutations of the raw data. Pairwise comparisons (using 999 permutations) were used, when appropriate, to resolve differences between levels of significant factors.

Multivariate analysis of assemblage structure using multidimensional scaling (MDS) was applied to visualize differences in the structure of the entire suprabenthos, and mysid, decapod and amphipod assemblages. For this analysis, we eliminated one replicate from Roque (autumn), because it did not contain any organism. The similarity matrix was calculated by the Bray–Curtis index with a double square transformation of data. The individual contribution of each species to the dissimilarity between seasons was calculated by the SIMPER routine. All statistical analyses were carried out using the PRIMER 6.1 software and PERMANOVA statistical package.

3. Results

3.1. Suprabenthos

Mysids, decapods and amphipods were the main constituents of suprabenthos in *C. nodosa* seagrasses (65%, 17% and 16% of total abundance respectively), which represent up to 95% of the total suprabenthos abundance (Table 2). During late spring at most locations, mysids constituted the largest fraction, followed by amphipods and decapods. In late autumn, decapods assumed this position, followed by mysids and amphipods (Fig. 3, Table 2).

The MDS showed a pattern of sample aggregation according to seasons (Fig. 4). For the three most abundant groups of

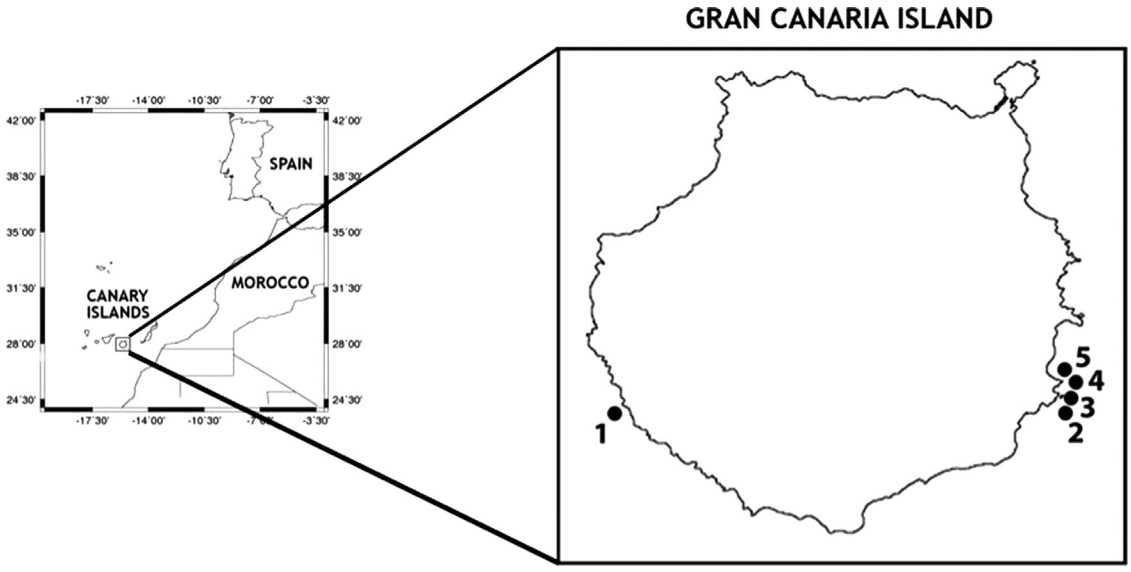

Fig. 1. Map of Gran Canaria showing the location of *Cymodocea nodosa* meadows: 1. Veneguera, 2. Risco Verde, 3. Roque, 4. Faro and 5. Cabron.