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Temporal distribution of intertidal macrozoobenthic assemblages in a *Nanozostera noltii*-dominated area (Lagoon of Venice)

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A B S T R A C T

We describe the temporal distribution of intertidal macrozoobenthic assemblages in a small marsh pond of the Lagoon of Venice colonized by the seagrass *Nanozostera noltii* (Hornemman) Tomlinson *et* Posluzny. Three stations ranging in the degree of *N. noltii* cover were selected about 100 m apart and sampled 9 times at regular intervals from March 1996 to March 1997. We applied the concepts of resistance and resilience to “natural stress” (e.g. extent of protection from seagrass meadows, exposure of macrozoobenthic assemblages to high temperatures in summer) with the aim to assess the stability of a community along a gradient of seagrass coverage. Results showed that the most structured and taxa-rich macrozoobenthic assemblage occurred at the station covered by a continuous stand of *N. noltii*, where permanent taxa (i.e. found in 100% of samples) were almost double than those found at the other stations. During the annual cycle, the macrozoobenthic assemblages showed a cyclical pattern, with temporal fluctuations increasing as they moved further away from the seagrass beds. We propose the role of *N. noltii* offering structural complexity and stability as the more probable explanation to the observed differences between stations in the intertidal assemblages.

1. Introduction

It is well known that seagrasses increase habitat complexity and provide living space and shelter for a diverse animal community (e.g. Orth et al., 1984; Mazzella et al., 1992; Duffy, 2006). Seagrass bed communities are usually characterized by a larger number of species and higher abundances than adjacent unvegetated sediments (e.g. Mattila et al., 1999; Bowden et al., 2001; Fredriksen et al., 2010; Barnes and Barnes, 2012). These differences are related to the above-ground component of seagrass, favoring the successful recruitment and colonization of animals, and the below-ground structural complexity of the interlacing rhizome layer and roots increasing sediment stability (Orth, 1977; Bachelet et al., 2000; Yamada et al., 2007; Leopardas et al., 2014).

Along the European coast, most studies on seagrass–animal relations have been conducted on *Zostera marina* Linnaeus, 1753 or *Posidonia oceanica* (Linnaeus) Delile, 1813 seagrass beds in the subtidal (e.g. Rasmussen, 1973; Boström and Bonsdorff, 1997; Mazzella et al., 1989; Como et al., 2008; Rueda et al., 2009). However, studies on macrozoobenthic assemblages in seagrass-dominated areas within the intertidal zone, particularly in the Mediterranean region, are scant (Bachelet et al., 2000; Blanchet et al., 2004; Bouma et al., 2009). In other cases focus has been given to specific taxonomic groups such as polychaetes (Gambi et al., 1998), peracarids (Esquete et al., 2011) or molluscs (Honkoop et al., 2008). Intertidal dwarf eelgrass often presents patches of bare substrate inside the meadows or, when the disturbance increases, the beds are reduced to little patches here and there (Barnes, 2013). However, no studies in coastal lagoons have ever evaluated the temporal distribution of intertidal macrozoobenthic assemblages along an environmental gradient within a small area dominated by *Nanozostera noltii* meadows.

In the Venetian lagoon *Nanozostera noltii* (Hornemman) Tomlinson *et* Posluzny, 2001 grows in beds on pelitic sediments chiefly in the intertidal belt around the mean low water neap tide level (Sfriso and Facca, 2007). A serious decline in seagrass beds occurred

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during the second half of the last century, however, *Z. marina* and *Cymodocea nodosa* (Ucria) Ascherson, 1870 seem to be recovering in deeper parts of the Venetian lagoon (Sfriso and Facca, 2007). On the contrary, the dwarf eelgrass which was once widespread all over the Lagoon of Venice, now appears to be in decline, particularly in the northern basin of the lagoon where this study was conducted (Caniglia et al., 1990; Scarton et al., 1995; Tagliapietra et al., 1999). There is rising concern about the fate of the communities dwelling the intertidal belt and the inner shallow areas.

In this study, we investigated the community structure and year-round distribution of intertidal macrozoobenthic assemblages along a putative environmental gradient indicated by the extent of coverage of *N. noltii* meadows within a small area. We hypothesized that the temporal distribution of macrozoobenthic assemblages would vary along such an environmental gradient, both in terms of univariate measures (i.e. abundance, biomass, number of taxa, taxonomic composition and diversity) and multivariate analysis. Within this context, we aimed to assess the stability of the benthic communities within the study area in terms of their resistance and resilience to natural stress as related to the harshness of the intertidal zone (e.g. exposure of macrozoobenthic assemblages to high temperatures in summer, lack of protection from seagrass leaves in unvegetated areas).

2. Materials and methods

2.1. Study area and sampling site

The present study was conducted in the marsh pond of Sacca Sant'Antonio, a middle intertidal area colonized by a pure fragmented bed of the seagrass *Nanozostera noltii* located in the northern sub-basin of the Lagoon of Venice (Fig. 1). The Venetian lagoon can be classified as micro-tidal (Tagliapietra and Ghirardini, 2006), with an average tidal amplitude of about 60 cm, reaching 1 m during sygyzy (the intertidal range, HAT-LAT, is 121 cm) or just a few centimeters during neap tides. In our study area, tides are less pronounced than other sectors of the lagoon. Here, the tides are very close to being semidiurnal during spring tides and almost diurnal during neap tides, presenting a plateau of slack of water between two subsequent neap peaks. Tidal regime and bottom morphology allowed dwarf eelgrass to establish just in a narrow belt on the steep sides of the main canals, but to form extensive meadows on the tidal flats. Three stations ranging in degree of vegetation cover were chosen about 100 m apart: station AZ (012°25′44.81″ E, 45°29′59.93″ N) was covered by a continuous stand of *N. noltii*, station AN (012°25′50.13″ E, 45°30′04.59″ N) was devoid of *N. noltii* and station AI (012°25′40.25″ E, 45°29′58.86″ N) represented an intermediate condition, with fragmented meadows and patches of bare substratum where samples were collected. Each station was limited to a circle of 10 m diameter around the pole that physically marked them. At each sampling campaign, macroscopic observations at the study site were made. At the beginning of the survey, in March 1996, green algae (e.g. Chaetomorpha, Cladophora, Ulva) were present in low amounts A marked increase in algal coverage, especially Chaetomorpha, of bottom sediments has been observed since July. Ulva appeared in October, reaching in association with Chaetomorpha >50% of coverage at stations AZ and AI. At this time, *N. noltii* leaves at station AZ were colonized by sponges (*Halichondria bowerbanki* Burton, 1930), however sponges were not observed during the following months, while a visible biofilm of diatoms covered the surface layer of sediment at station AN. In December, algal coverage in both areas decreased to the spring levels, while degraded filamentous thalli of Cladophora, Chaetomorpha were present throughout winter.

2.2. Sampling procedure and sample treatment

Nine sampling campaigns were conducted at regular intervals

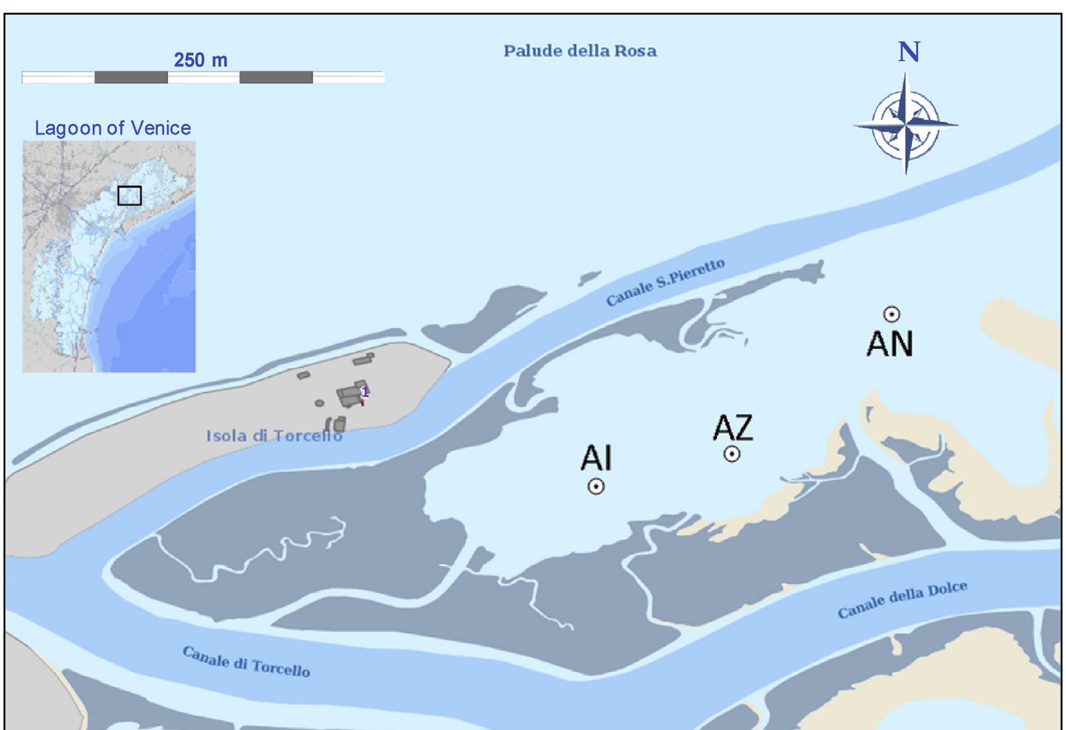

Fig. 1. Study area in the northern sub-basin of the Lagoon of Venice and location of the three sampling stations (AZ, AI and AN) in the marsh pond of Sacca Sant'Antonio. The circle shows the position of the sampling area in the Lagoon of Venice. Maps obtained from the online "Atlas of the lagoon" (Atlante della laguna) http://www.atlantedellalaguna.it.