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Trophic structure of polychaetes around an offshore gas platform

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ABSTRACT

The distribution of polychaetes associated with an offshore gas platform built on a muddy–sandy bottom in the northern Adriatic Sea was investigated with emphasis on their feeding structure. Polychaete species were collected at different distances from the rig using a Van Veen grab. Assessment of the polychaete community and trophic groups for impacts related to the presence of the platform demonstrated significantly different abundances at rising distances from the rig. The present findings highlight an effect of the rig on the spatial distribution of polychaete assemblages. Even though the effects of gas platforms on surrounding benthic communities have been investigated in the Adriatic Sea, no studies have addressed the distribution of polychaete trophic groups along a gradient based on distance from the rig.

1. Introduction

Oil and gas platforms are the largest man-made structures built in the marine environment (Bomkamp et al., 2004). In recent years increasingly intense exploitation of and search for non-renewable energy sources have led to a considerable increase in their number. The northern and central Adriatic Sea hosts the highest concentration of gas platforms in the Mediterranean, with more than 110 offshore rigs erected since the 1960s (Maggi et al., 2007). Platforms are usually erected on the soft seabed and create new microhabitats, enhancing fish and benthic assemblage biodiversity by providing both a hard substrate and topographic relief for species that would not otherwise be usually found on the soft seabed where platforms are typically built (Wolfson et al., 1979; Terlizzi et al., 2008; Manoukian et al., 2010; Scarcella et al., 2011). These structures enrich the food chain for higher-level consumers (Keenan et al., 2007) and may indirectly support surrounding soft-bottom benthic communities through increased production and export of organic matter (OM; Wolfson et al., 1979; Manoukian et al., 2010).

In addition platforms may induce physical and/or biological changes in adjacent soft-bottom habitats and communities, affect currents and alter sediment distribution, e.g. particle size and sedimentation rate, favouring OM accumulation (Olsgard and Gray, 1995; Wilson-Ormond et al., 2000). Initial depletion of local benthic communities is commonly seen close to gas rigs built at various depths in the Mediterranean. Sediment resuspension due to construction operations reduces macrozoobenthic assemblage richness and diversity and leads to the dominance of opportunistic species typical of polluted sediment characterized by high OM content (Lu and Wu, 2000; Grant and Briggs, 2002; Terlizzi et al., 2008; Manoukian et al., 2010; Gomiero et al., 2011, 2013). Benthic communities are sensitive environmental quality indicators. Changes in their structure thus provide valuable data to assess ecological impacts, including those due to platform installation.

Most studies carried out in the Adriatic Sea have investigated the effects of gas platforms on surrounding benthic communities in terms of species richness, diversity, and abundance (see for instance: Trabucco et al., 2008; Fabi et al., 2005; Spagnolo et al., 2009, 2014; Manoukian et al., 2010; Gomiero et al., 2011, 2013). However, none have examined the distribution of polychaete trophic groups along a gradient based on distance from the rig.

It is well-established that polychaetes have the potential to provide insights into benthic community distribution patterns (Giangrande et al., 2005). In addition, analysis of the polychaete trophic structure has been demonstrated to be a useful method to assess the distribution pattern of benthic communities and a major tool of ecological and environmental benthic studies (Castanedo et al., 2012). In fact, there is growing evidence that grouping polychaete species into feeding groups can highlight information that may be hidden by taxonomic approaches (Pagliosa, 2005; Cheung et al., 2008; Shuai et al., 2014). By virtue of their multiple feeding modes, polychaetes are capable alone of

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providing data on the trophic structure of macrobenthic communities (Bianchi and Morri, 1985). Their broad distribution in coastal and marine habitats often contributes critically to total macrofaunal diversity and abundance in benthic marine and estuarine sediment (Manokaran et al., 2013).

Based on these premises this study set out to: (i) evaluate changes in polychaete trophic structure by exploring their distribution pattern at rising distance from a gas platform in the north-central Adriatic Sea; (ii) assess the suitability of using trophic groups as measures of environmental impacts by exploring their relationship with the major biotic indices; and (iii) examine the relationship between feeding groups and some abiotic measures.

2. Material and methods

2.1. Study area and sampling methods

The study was carried out in the north-central Adriatic Sea 50 km off Ancona over a period of 3 years (2006–2008). Samples were collected in the course of 6 field cruises around a 4-leg offshore gas platform built on muddy–sandy bottom at a depth ~70 m, beginning the 5th year from its construction (Fig. 1). The duration of each sampling cruise was usually one week. The sampling week was randomly chosen a priory at the beginning of the study. In the case of adverse weather condition the week was moves of same days.

Like other rigs built at similar depth, the platform stands in an area where variable currents may affect water column dynamics (Marini et al., 2008). During the study the main bottom current was a slow North–South or South–North current that rarely reached 15 cm/s (unpublished data).

The sampling design was based on a 'gradient design' approach, which is especially useful when assessing stressors or disturbances whose impact declines with increasing distance from their source (Manoukian et al., 2010; Gomiero et al., 2011; Spagnolo et al., 2014). Samples were collected from 6 stations at rising distances from the rig, i.e. close to the platform (about 5 m) and then 30, 60, 120, 250, and 1000 m from it. The 6 sampling stations were designated S0, S30, S60, S120, S250, and S1000. During each cruise, 6 samples were taken at 4 randomly selected sites per station using a Van Veen grab (capacity, 13 L; surface area, 0.095 m^2), totaling 24 samples per station per cruise. The biological samples were sieved in situ through a 0.5 mm mesh size; retained organisms were fixed in 5% buffered formalin and preserved in 70% ethanol. The sediment samples, collected with a box-corer, were analyzed for grain particle size and OM content, two major factors affecting the spatial distribution of trophic groups (Muniz and Pires, 1999; Pagliosa, 2005).

Macrozoobenthos was sorted in the laboratory using a stereomicroscope and a binocular microscope. Polychaetes were identified to the species level, designated according to Checklist of the Italian Seas nomenclature (Castelli et al., 2008), and quantified.

2.2. Data analysis

Samples from each station and cruise were pooled (24 samples × 6 cruises) and data were expressed as means. Abundance (N), species richness (S), Shannon diversity index (H'), and Simpson's diversity index (λ), four major biotic parameters used as benthic community descriptors, were calculated for polychaete assemblages using the DIVERSE routine of the PRIMER 6 software package developed by Plymouth Marine Laboratory (Clarke and Warwick, 2001). The data from each station and cruise were able to be pooled because two-way analysis of variance (ANOVA), which was applied to test the biotic indices with Station and Cruise as fixed factors, found no significant differences for either single factor or for their interaction.

Polychaetes were then classified into 6 feeding groups according to Fauchald and Jumars (1979), Pearson (1971), and Gambi and Giangrande (1985), as follows: carnivores (C), subsurface deposit feeders (or burrowers; B), surface deposit feeders (Sd), suspension (or filter) feeders (F), herbivores (H), and omnivores (O).

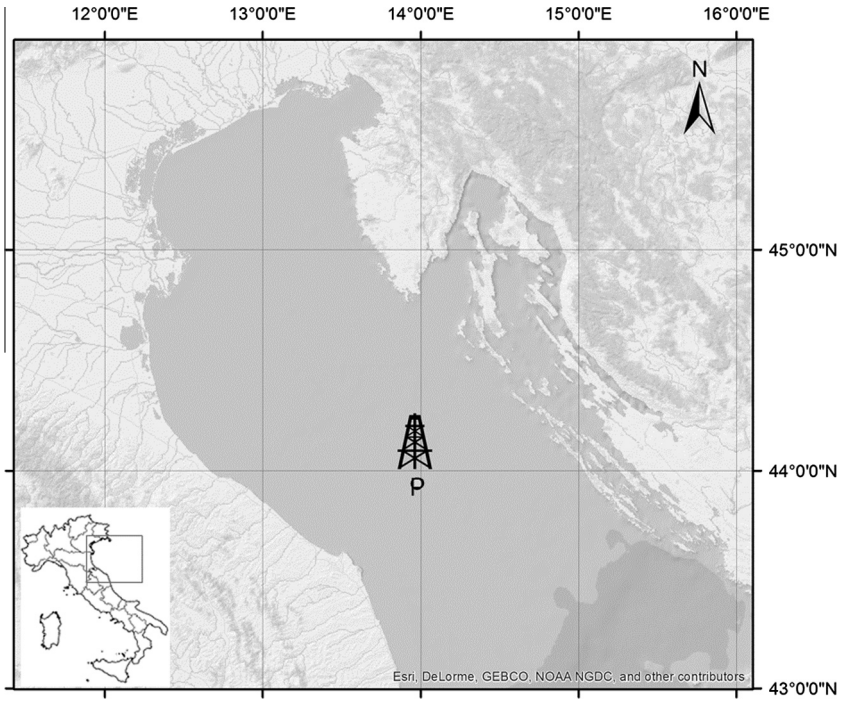

Fig. 1. Study area and location of the offshore gas platform (P).