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Note

Marine litter on the seafloor of the Faial-Pico Passage, Azores Archipelago

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ABSTRACT

Plastic pollution in the marine environment attracts much attention from both researchers and the general public. Plastic items and other debris are commonly observed everywhere in the ocean, from the surface down to the deep ocean floor. In this study, we analysed 45.2 km of video footage, collected during 56 transects surveying the seafloor of the Faial-Pico Passage in order to quantify the abundance of marine litter and its interactions with benthic fauna. The footage was collected by a Remotely Operated Vehicle (ROV) and a manned submersible at depths ranging between 40 and 525 m. The mean litter density in the passage was 0.26 ± 0.03 items·100 m^{-1} (±SE) and was significantly higher between 151 and 250 m compared to other depth strata. Overall, derelict fishing gear, mostly made of plastic, were the most common objects found on the seafloor, representing 64% of all items. Although we observed few evidence of direct deleterious effects by the litter, interactions with fauna were observed in more than half of the items. This study makes an important contribution in quantifying the abundance of marine litter on the seafloor of the Azores. The location of the Faial-Pico Passage, close to shore, makes it an appropriate site for long-term monitoring of litter on the seafloor and evaluate the efficiency of upcoming public policies aimed at reducing litter input into the oceans.

1. Introduction

Marine litter is widely recognized as a global environmental problem that severely affects marine ecosystems (Bergmann et al., 2015). Although the widespread distribution and accumulation of marine litter in coastal areas and at the sea surface is well documented (Galgani et al., 2015), contributions to minimize the knowledge gap on benthic marine litter and in the deep sea are still needed. The deep sea is a technically challenging and expensive ecosystem to sample. Consequently, there is little information available on the abundance of marine litter, the effects of fishing pressure and the status of benthic communities, especially for areas of ecological interest. Recently, the European Union has highlighted the need to assess the environmental status of the seafloor (descriptor 6 "seafloor integrity" of the Marine Strategy Framework Directive (MSFD)) and to quantify the abundance and impacts of marine litter on the seafloor and other compartments of the marine environment (descriptor 10 of the MSFD). Such information is essential to develop and implement adequate management and conservation measures at both the European and local levels.

Marine litter results from both land and sea-based sources and once at sea, larger items tend to either fragment or sink, and then accumulate on the coastline or on the seafloor (Bowmer and Kershaw, 2010). On the other hand, small items remain at the surface or in the water column for longer periods before being accidentally ingested by marine animals or colonised by marine organisms, which in case leads to an increase in their weight and to consequently sink down the water column (Ivar do Sul and Costa, 2014). Recently, the seafloor and especially the deepsea has been considered as a potential sink for microplastics (Woodall et al., 2014) and long-term research conducted at the HAUSGARTEN observatory indicates increasing litter quantities on the deep seafloor (Bergmann and Klages, 2012; Tekman et al., in press).

Types and sources of marine litter on the seafloor are directly linked to uses and activities on and offshore, but also to a combination of environmental factors such as physiographic settings, wind and current patterns (Pham et al., 2014a; Tubau et al., 2015). Oceanic islands, such as the Azores Archipelago (NE Atlantic), are located far from large population centers and initial studies show that fishing is the main anthropogenic activity responsible for the accumulation of marine litter on the seafloor in the region (Pham et al., 2013; Pham et al., 2014a). However, surveys on sites located closer to the islands are necessary to fully understand the scale and source of litter input in this location. Over the past decade, the use of underwater video platforms has been widely used to obtain information on the deep seafloor of the Azores, opening a new window of research on this important part of the Azorean territory (e.g. Gomes-Pereira et al., 2012; Matos et al., 2014; Pham et al., 2013; Porteiro et al., 2013; Tempera et al., 2014).

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The current research aims at providing data on the quantity of marine litter on the seafloor, and uses the Faial-Pico Passage in the Azores as a case-study. It is a well-studied area of the archipelago, with particular relevance for local integrated marine strategic planning and management (Afonso et al., 2014). Therefore, there is a need for a complete assessment of human pressure in the area. Video recordings of the Faial-Pico Passage were analysed to document the presence of litter and their impact on benthic fauna.

2. Materials and methods

2.1. Study site

This study was carried out on the central group of the Azores Archipelago, in the southern side of the passage separating the islands of Faial and Pico (Fig. 1). It is an area characterized by a steep slope that rises from a maximum depth of 800 m to a minimum of 30 m. The shallowest mid-passage reef is 8 m deep and is recognized as a Site of Conservation Interest under EU-Natura 2000 Network. Two other nearby sites, "Monte da Guia" and "Ilhéus da Madalena", bear the same designation. The Regional Government of the Azores intends to classify the area as "Marine Park", which includes the oldest marine protected area of the Azores ("Monte da Guia").

There is a wide range of habitats in the passage such as sandy beaches, exposed rocky coast, boulder beaches, shallow mid-passage reefs, islets, caves, boulder fields, and small shallow hydrothermal fields (mainly gas leaks). Aggregations of cold-water corals were recently discovered in this area (Matos et al., 2014; Tempera et al., 2014).

2.2. Data collection

Underwater video footage was collected during exploratory surveys (as part of Corazon and CoralFISH research projects) in the southern section of the passage (Fig. 1). For this purpose, we used the Remotely Operated Vehicle "ROV-SP" (SeaBotix LBV300S-6; IMAR-DOP/UAç, rated 300 m) and the "LULA" manned submersible of the Rebikoff-Niggeler Foundation. The "ROV-SP" was equipped with a 520 line high resolution colour camera, a scaling laser (5 cm) and four lights (480 lm each), while "LULA" had a high-definition video HDTV Panasonic HVX 200. The first camera was orientated downwards at an angle of about 30°. On the "LULA", the camera was mounted in a forward-looking position inside the submersible. A total of 56 dives were conducted between 2009 and 2011 at depths ranging between 41 and 524 m (Table S1). Three of these dives were done with "LULA" and the remaining 54 were conducted by "ROV-SP" (Fig. 1).

In order to only consider the portion of the footage showing the seafloor, off bottom and low visibility segments were removed from the analysis. The "ROV-SP" recorded a total of 19 h of bottom imagery, surveying a distance of 22,229 m (excluding off bottom/low visibility segments). The duration of each dive was constrained by weather conditions and bottom currents, varying from 1 min to 61 min. Overall, the distance covered ranged between 17 and 1357 m per dive (average = 433 m). The ROV was travelling at a speed ranging between 0.2 and 0.6 $m \cdot s^{-1}$, at a height of about 2 m from the seafloor.

The "LULA" submersible obtained a total of 8 h of footage, surveying a distance of 22,945 m. Each dive lasted between 2 and 4 h.

Operational details for each dive is provided in the supplementary material (Table S1).

2.3. Data analysis

Video recordings collected were visualized thoroughly to detect the presence of manufactured items, which were then allocated to different categories according to the type of object and material composition. The main categories established were: derelict fishing gear, glass bottles, and, others. Derelict fishing gear included longlines, ropes, anchors, buoys and weights, while "others" included items such as shoes, fabric or tyres. The material composition of each object was categorised to either plastic, glass, metal, textile, rubber or "unknown". In addition, we recorded all litter/fauna interactions and when possible, the degree of colonisation of litter items. Litter/fauna interactions included both positive (e.g. using litter item as a shelter) and negative (e.g. entanglement) interactions.

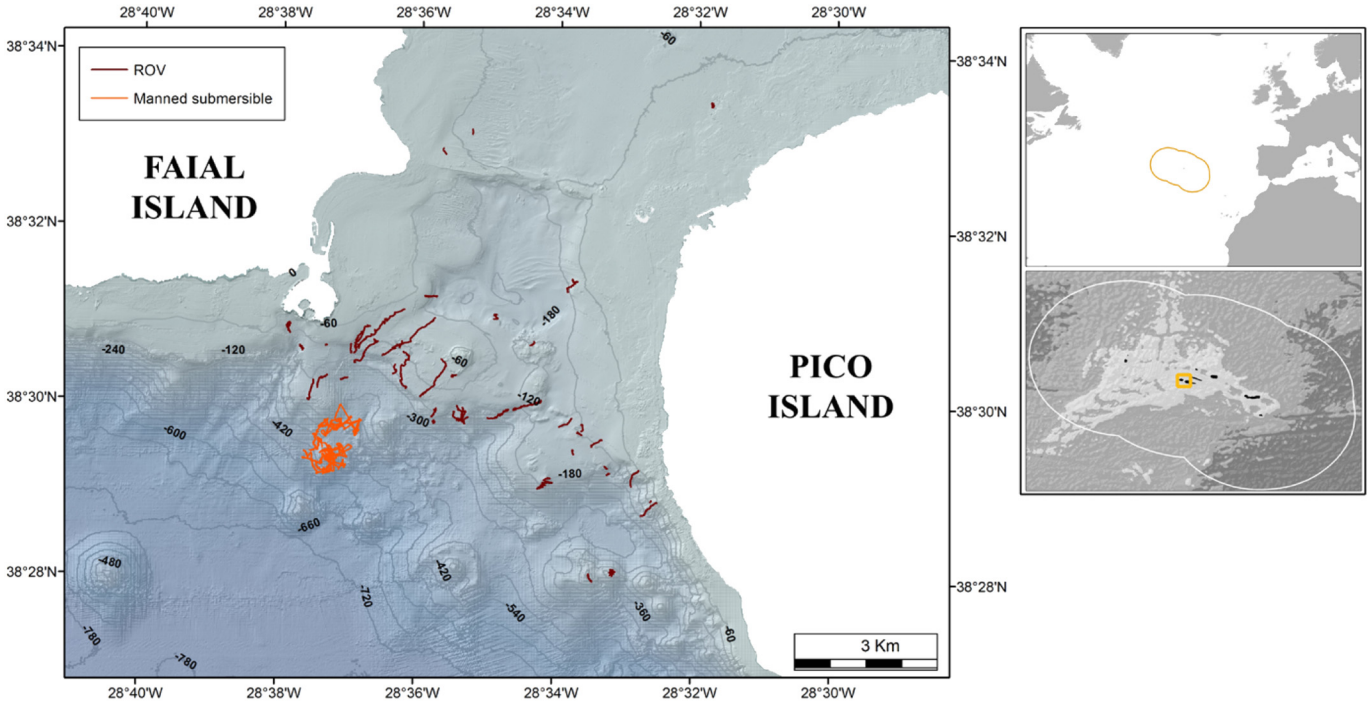

Fig. 1. Localization of the 56 dives conducted by "ROV-SP" and the manned submersible "LULA" in the southern section of the Faial-Pico Passage, Azores along with the depth contours.

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