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Review

Marine debris: Implications for conservation of rocky reefs in Manabi, Ecuador (Se Pacific Coast)

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ABSTRACT

Marine debris (MD) pollution is a problem of global concern because of its impact on marine ecosystems. The current extent of this problem and its implications concerning reef conservation are unknown in Ecuador. The composition and distribution of submerged MD was assessed on two reefs using underwater surveys of geomorphological areas: crest, slope and bottom. MD items were classified according to source and use. Plastic-derived debris represents >90% of total MD found on the reefs, principally composed by plastic containers and nets. 63% of the MD was associated to fishing activities. The composition showed differences between sites and geomorphological areas, monofilament nets were found on the crests, multifilament lines on the slopes and plastic containers on the bottom. MD disposal might be a result of the influx of visitors and fishing activities. Distribution is related to bottom type, level of boating/fishing activity and benthic features.

Contents

1. Introduction

Marine debris (MD) pollution is, together with overfishing and habitat degradation, one of the greatest perceived threats to the conservation of marine biodiversity (Ivar do Sul and Costa, 2007; SCBD STAP—GEF, 2012; Gall and Thompson, 2015). The most abundant form of MD is made of plastic (Sheavly and Register, 2007; Moore, 2008), plastic pollution has been spread throughout the entire world's oceans due to the action of winds and sea currents (Eriksen et al., 2014) that influence its distribution and concentration in gyre areas (Galgani et al., 2015).

Only a small part of these plastic items floats on the sea surface. It is estimated that two thirds of the plastic sinks to the sea bottom, the product of accidental loss or careless handling during human activities (Galgani et al., 1996, 2000, 2015; Ioakeimidis et al., 2014). Despite this, there is a lack of studies about plastic pollution on the SE Pacific Coast and the current study is the first evaluation of this kind of pollution along the continental coast of Ecuador. Accumulation of MD on the seabed is higher than on the surface, the existence of large dumps of MD on the sea floor has the potential to exert negative impacts on marine life and benthic ecosystems (Derraik, 2002; Dameron et al., 2007; Katsanevakis, 2008; Galgani et al., 2015; Kühn et al., 2015). Such impacts on marine life and ecosystems include: 1) entanglement and ingestion (cetaceans, marine turtles, seabirds, fish and crustaceans) (Gregory, 2009; Williams et al., 2011; Baulch and Perry, 2014; Gall and Thompson, 2015), 2) assisting the invasion of alien species

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(Molnar et al., 2008), 3) alteration of the structure of the benthic community (Chiappone et al., 2002; Chiappone et al., 2005; Richards and Beger, 2011), 4) habitat disruption and damage to coral and rocky reefs (Al-Jufaili et al., 1999; Donohue et al., 2001; Katsanevakis, 2008; Lewis et al., 2009). The accumulation of such MD (plastic on the seabed) can inhibit the gas exchange between the overlying waters and the pore waters of the sediments, and the resulting hypoxia or anoxia in the benthos can interfere with the normal functioning of the ecosystem, and alter the make-up of life on the seafloor (Goldberg, 1994).

Moreover, it is necessary to take into consideration that plastics have been manufactured to be durable, which means they may remain for many years in the environment (Barboza and García-Gimenez, 2015) and, in this way, the residence time of this kind of MD on rocky reefs increases the risk exposure for the marine biota. Oliveira et al. (2013) has suggested that the intake of plastic particles by the marine biota can cause direct physical injuries and also facilitate the transfer of chemicals to the organisms, including absorption of contaminants from the surface of the plastic. This may, therefore, increase the potential risk for the health of animals, including humans, by the incorporation of the contaminants into superior trophic webs (Teuten et al., 2009; Hidalgo-Ruz et al., 2012; Oliveira et al., 2013). For this reason, it is imperative that effective measures are taken to address the problem at both international and national levels, since even if the production and disposal of plastics suddenly stopped, the existing debris would continue to harm marine life for decades (Derraik, 2002).

According to Thiel et al. (2011), information about MD on the seafloor of the SE Pacific coasts is unavailable. However, Coello and Macías (2005) and CPPS (2007) affirm that the question of MD is an issue of particular concern in South America and Ecuador. Unfortunately, important aspects such as: quantitative information about the abundance and distribution of persistent materials (general plastic and fishing items), the action of physical factors affecting the dynamics (disposal and movement) of non-floating materials and the impacts on local marine ecosystems and microhabitats are still unknown and are much less widely researched topics than surface patterns (Barnes et al., 2009; Galgani et al., 2015). Only a few initiatives stemming from the Regional Program for Integral Management of Marine Litter (a CPPS intergovernmental agency) and national government agencies, such as the Secretary for the Sea and the Undersecretary for Fishery Resources (SETEMAR, SRP), have been developed for the continental coast of Ecuador in the last five years. Most of these initiatives have concentrated their efforts on campaigns for the removal of underwater litter and have focused on removing abandoned, lost and discarded fishing gear (ALDFG). However, all these campaigns lacked a standardized methodology, which is an important factor in quantifying, analyzing and comparing the accumulation rates and spatial distribution of MD over time within benthic marine ecosystems and microhabitats (Spengler and Costa, 2008; Katsanevakis, 2008; Cheshire et al., 2009; Lippiatt et al., 2013). The main objective of the present study was to characterize the current status of MD pollution on the rocky reefs of Manabi (Ecuador). The analysis of physical factors influencing changes in accumulation rates and patterns of spatial distribution of MD were assessed, in order to support the implementation of effective conservation and recovery programs for the marine ecosystems affected.

2. Materials and methods

2.1. Study area

Two study sites were chosen: 1) Perpetuo Socorro (PS) (00° 55.637 S 80° 44.353 W), located 2.3 km off the coast of Manta and oriented from West to East and 2) Ureles (UR) (00° 54.113 S 80° 38.863 W), located 4.6 km from the nearest port in Jaramijo, and oriented from North to South (Fig. 1). Both sites share structural similarities: submerged rocky reefs at depths of between 6 and 13 m, and distinct geomorphological areas (crest, slope and bottom). The sites described also share similarities in diversity in the fish and marine invertebrate patterns and have a high biological productivity; they are traditional areas of artisanal fishing activities throughout the year (line and net fishing, autonomous and semiautonomous diving) and tourism (autonomous diving) (Figueroa et al., 2013). Thus, these two sites were chosen as a model of the rocky reef ecosystem of the SE Pacific Coast. PS is a rocky

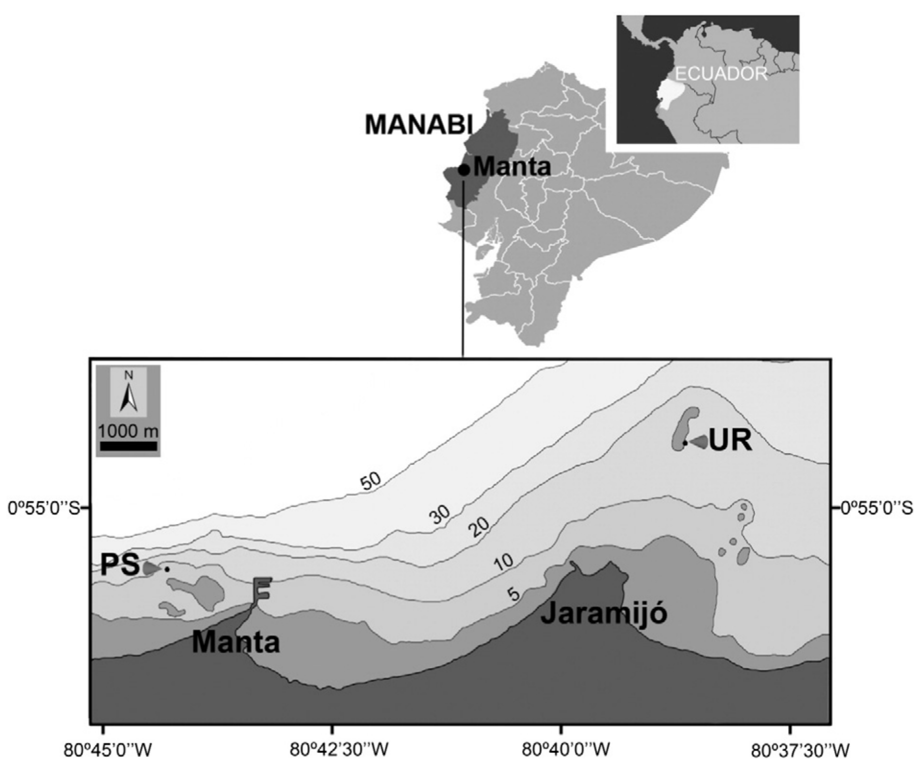

Fig. 1. Map of study sites represented as PS (Perpetuo Socorro) in Manta and UR (Ureles) in Jaramijo.