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Plastic litter in aquatic environments of Maremma Regional Park (Tyrrhenian Sea, Italy): Contribution by the Ombrone river and levels in marine sediments

Cristiana Guerranti [a,*], Susanna Cannas [a], Costanza Scopetani [b], Paolo Fastelli [a], Alessandra Cincinelli [b], Monia Renzi [a]

[a] Bioscience Research Center, Via Aurelia Vecchia 32, 58015 Orbetello (GR), Italy
[b] University of Florence, Department of Chemistry "Ugo Schiff", Via della Lastruccia 3, 50100 Sesto Fiorentino (FI), Italy

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ABSTRACT

During two surveys in 2015 and 2016, sediments samples were collected along the Ombrone river (Maremma Regional Park, province of Grosseto, Italy), in particular at its mouth and in the marine area in front of it, in order to quantify, identify and categorize plastic items (macro, *meso* and micro-plastics and colour, material etc.) and evaluate their potential sources. The Albegna and Osa rivers were identified as external areas of comparison. The results of the analysis showed different situations, especially as regards fluvial inputs, in addition to evidencing local provisions of plastic material derived from agricultural activities. The microplastics values per kg of sediment and the prevailing type of items found largely varied between the investigated sites (45–1069 items/kg dry sample).

1. Introduction

The presence of waste in the sea is an emerging issue of international concern, especially in relation to the ecological and biological consequences of the phenomenon (Alomar et al., 2016; Fossi et al., 2016). Marine litter is an important component of marine pollution; among the various types of wastes, plastics, mainly items smaller than 1 mm, are globally dominant, on the surface, the bottom of the sea and along the beaches (Derraik, 2002; Fossi et al., 2012, 2014; de Lucia et al., 2014; Fastelli et al., 2016; Blăsković et al., 2017). In spite of the relatively recent diffusion of plastics, this type of litter has already invaded almost all marine habitats, such as freshwater ecosystems (Wagner et al., 2014; GESAMP, 2015) and including the most pristine environments, such as the deep Arctic Ocean (Bergmann and Klages, 2012) and Ross Sea (Antarctica) (Cincinelli et al., 2017).

Marine litter, which includes microplastics (MPs), is one of the eleven descriptors taken into account by the Marine Strategy Framework Directive (MSFD) and a potential source of contamination to the ecosystem and food web (Fossi et al., 2016). Contamination by plastics in aquatic environments is a problem whose extent is therefore only recently been recognized in many areas, including Italy, and that have not yet been characterized well; among these, also the area considered in this study, the Maremma Regional Park, that stretches, with a total surface area of 8902 ha protected, along 25 km of the coast of Tuscany. Considering that, while the research on marine MPs is more advanced, there are consistent gaps of knowledge regarding freshwater MPs and that the majority of marine plastics are considered to originate from land-based sources, including surface waters, the need for studies focused on freshwater ecosystems is evident (Wagner et al., 2014).

Under this premises, the overall objective of the research was a screening to evaluate/define the sediment's litter levels of the last stretch of the Ombrone river, of the transitional areas and of the river mouth, in the Maremma Regional Park, in order to establish a useful background knowledge on the impact of plastic litter, also in relation to the future possibility of extending the protection levels at sea. The Albegna and Osa rivers, near and outside the park, have been identified as comparison areas.

Sediments act as long-term deposits for MPs (Morét-Ferguson et al., 2010; Cozar et al., 2014) and therefore tend/have the ability to accumulate this type of waste (Fries et al., 2013; Nuelle et al., 2014), providing a significant sink, given the presence of microplastic in the whole ecosystem.

2. Materials and methods

2.1. Study area

The Ombrone River, the longest river in southern Tuscany (about 160 km), passes within the Maremma Regional Park for 12 km before

* Corresponding author.
E-mail address: cristiana.guerranti@bsrc.it (C. Guerranti).

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flowing into the Tyrrhenian Sea at Bocca d'Ombrone (Grosseto, Italy). The Ombrone crosses natural areas and heavily populated districts: the Chianti area, the Crete Senesi area and the Grosseto plain. Along the rod and at the mouth of the Ombrone, 8 superficial sediment samples were collected, during two samplings; sampling sites were located as shown in Fig. 1.

The Osa river has a total length of 20 km; it flows in the province of Grosseto and emerges into Tyrrhenian Sea, about 17 km southernmost of the Ombrone. The sampling points selected for this study are also shown in Fig. 1, together with those of the Albegna river.

The Albegna is a 66 km river, which flows into the Tyrrhenian Sea in Albinia (about 4 km southernmost of the Osa, without entering in the Orbetello lagoon, and remaining North of few hundred meters. The "Middle Albegna" is a heritage site, which is both safeguarded as a Special Protection Area (SPA) and proposed as a Site of Community Importance (pSCI).

The sampling sites of the surface sediments selected for this study are shown in Fig. 1, together with those of the river Osa.

The coast is microtidal (tidal range = 30 cm) and exposed to south - south western storms (Cipriani et al., 2013). The climate in the study area is typically mediterranean, with summers characterized by moderate temperatures, mitigated by mistral and westerly marine breezes and winters not particularly cold, with rare episodes of night and morning frosts. Average annual rainfall varies from 419 to 650 mm; all locations record a minimum summer and a more or less accentuated fall spike (Giusti, 1993).

The main external critical elements of the environment monitored include water catchment and drawing in the basin, intensive farming practices in lowland areas and transformation of agro-ecosystems, with gradual increase of habitat fragmentation for the most sensitive species linked to these environments.

2.2. Sampling

Samples were collected in January 2015 and August 2016 from surface sediments of Ombrone (8 stations, 16 samples) and Osa/Albegna (6 stations, 12 samples) (exactly the same in both years), from different points on river course, including the mouth, the shore and the submerged beach.

A manual bucket 2 L volume has been used for the sampling. Samples were taken at a depth of 0–50 cm in submerged areas, and on the surface in those emerged, always in the first 10–15 cm. The sediment was then transferred to stainless steel trays in order to homogenize it, before being stored in glass jars.

After collection, samples were stored at 4 °C until analysis, performed in the Bioscience Research Center laboratories.

2.3. Analysis

The samples were processed according to the steps below, which refer to "DeFishGear Protocols for sea surface and beach sediment sampling and sample analysis" (http://mio-ecsde.org/wp-content/uploads/

Fig. 1. Sampling stations along the Ombrone river, the transitional area and the sea near the mouth (left). All the stations but OM_A and OM_B are in the Maremma Regional Park territory. Sampling stations along the Osa and Albegna rivers, the transitional area and the sea near the mouths (right). This areas are southern than the Maremma Regional Park and outside its territory.

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