MONITORING FLOATING MICROPLASTIC DEBRIS IN THE WESTERN MEDITERRANEAN SEA

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Abstract
In this study we provide a quantitative estimation of the distribution of floating microplastic debris in the Western Mediterranean Sea. We sampled 26 stations (three replicates for each tow) along the coastline of the Eastern Iberian Peninsula, from the Gulf of Lions to the Alboran Sea, during two time periods in 2014 and 2015. Microplastics were extracted using a two-step novel methodology to separate floating isolated microplastics from those aggregated to marine organic matter and thus potentially sinking. Debris were counted and classified according to their plastic nature (colour properties and polymer type), and density and temporal variations investigated to understand origins and pathways bringing and dispersing microplastics into the Mediterranean Sea.

Keywords: Mediterranean Sea, Plastics

It is well known that microscopic plastic fragments are ubiquitous marine pollutants around the world's oceans [1]. Recent studies show high relative abundances of floating microplastic debris in a global-scale context, with high densities found in shelf waters near highly populated areas. The high demography and visiting tourists concentrating in Mediterranean coastal countries, and the semi-enclosed character of the Mediterranean Sea with high residence time of surface waters, suggest the Mediterranean Sea could be acting as a microplastic concentrator and probably as source for Atlantic floating plastic pollution . Indeed current estimations set the weight of microplastics in the Mediterranean Sea between 1,000 and 3,000 tons (in average 1 plastic item in 4 m^2 as numerical concentration), which is comparable to the accumulation zones described for the five subtropical ocean gyres [2]. Here we provide an estimation of the floating microplastic debris distribution and abundance at a broad spatial and temporal scale in the Western Mediterranean Sea. Indeed the information collected in this study represents a step further in the implementation of the Marine Strategy Framework Directive (MSFD, 2008/56/EC) in the region as for one of the 11 descriptors used to assess the Good Environmental Status of Eurpean Marine waters, which is marine litter and microplastic pollution. More importantly, this study provides useful information about the spatiotemporal distribution of marine litter and the anthropic or natural factors that lead to possible dissimilarities between sampled sites. This research is framed in the Spanish NUREIEV project which main aim is to verify the hypothesis that sea storms are the main trigger for the transfer of matter and energy, including pollutants, litter and microplastics, from the coastal to the deep ocean. This will allow to fill critical gaps in the current knowledge of the environmental status of entire continental margin segments of the Western Mediterranean. Floating plastic debris were sampled in the Western Mediterranean basin off Almeria and Murcia in early spring and late summer 2015, and in the Catalan coast from the Cap de Creus to Barcelona in early and late summer 2015, onboard the Spanish vessels R/V Angeles Alvariño and I/V Lluerna, respectively [Fig.1]. Three consecutive 20 min interval net tows were taken at 26 locations (total: 72 net tows) while the ship was travelling at a speed of 2-3 knots. Plastic debris in surface waters were collected using a Manta Trawl net (0.61 x 0.25 m mouth, 335 µm mesh). After each tow, the net was rinsed to collect the remaining debris stuck to the mesh prior to their transfer into glass jars. Samples were then fixed in 30% formalin and stored in a cool dark place on board the vessel and in the lab prior to analysis. Afterwards, the samples were poured into a 2 L glass jar and filled with (0.7 µm) filtered Mediterranean seawater in order to separate the floating microplastics from the denser potentially-sinking microplastics aggregated to floating marine organic matter. Both fractions were analysed and stored separately. Analysis of plastic debris consisted in manual separation and maximum length determination with the aid of an optical microscope using the image processing NIS-Elements software. Colour data in CIE-l-a*-b* (using the Avaatech line scan software) and total weight of Microplastics of every sample was calculated. Finally, to confirm the plastic nature of the material, Raman spectroscopy was applied to a random subset of particles. This is the first study differentiating between those microplastics floating isolated in surface waters (floating debris) from those that are aggregated to alive marine organic matter floating in the sea surface and that thus may end sinking and become buried in the sediments as a part of the biological pump (potentially sunk debris). The importance of those sunk microplastic debris have been recently discovered, being deep sea sediments a major sink for microplastic debris [3]. In this presentation we are going to discuss how microplastics interact with organic matter according to their properties, which could help us to understand the key-playing role of organic matter and the biological pump in the removal of microplastic debris from surface waters. Furthermore, we will discuss how sea surface circulation dynamics (i.e. the southwards flowing Northern Current that connects all areas investigated) as well as other hydrodynamic patterns (e.g. eddies, storms, etc.) and anthropogenic pressure in the coastal sea could be affecting microplastic distribution and its characteristics. Finally, aspects of the seasonal variability in sampled sites will be discussed, as weather could be influencing plastic particle quantification.

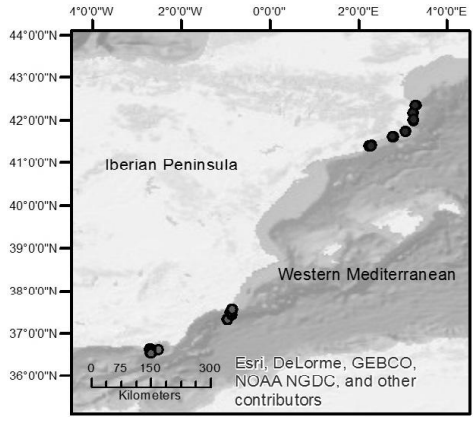

Fig. 1. Map with the sampled sites in the Western Mediterranean

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