MICROPLASTICS OCCURENCE AND COMPOSITION IN THE CENTRAL-WESTERN MEDITERRANEAN SEA

G. Suaria [1]*, C. G. Avio [2], A. Mineo [1], F. Regoli [2] and S. Aliani [1]
[1] CNR-ISMAR, La Spezia (Italy) - giuseppe.suaria@sp.ismar.cnr.it
[2] Dipartimento di Scienze della Vita e dell'ambiente (DISVA), Università Politecnica delle Marche, Ancona - Italy

Abstract
We report the results of a large-scale survey of neustonic microplastics in Mediterranean waters. Plastics particles were found in all samples collected with an average concentration of 1.25 ± 1.62 particles/m^2 and 703.16 ± 1573.95 g/km^2. Thirteen different classes of synthetic polymers were identified, including polyethylene, polypropilene, polyamides, biodegradable polyesters and synthetic paints. A large heterogeneity in plastic concentrations and polymeric composition was found, likely reflecting the influence of diverse factors governing plastic distribution at sub-basin scales. According to our calculations, between 933.4 and 2675.4 tonnes of plastic were floating on the surface of the entire Mediterranean basin, confirming it as one of the most heavily impacted regions of the world with regards to microplastics pollution.

Keywords: Plastics, Mediterranean Sea, Pollution, Surface waters

Numerical models predict some of the highest concentrations of plastic particles in the world to occurr in the Mediterranean Sea [1]. As a result, together with the main five oceanic gyres, the Mediterranean basin has been proposed as the sixth great accumulation zone for marine litter [2]. In order to test model predictions, we present the results of a large-scale survey of neustonic microplastics in Mediterranean surface waters, carried out between May and June 2013 with the main goal of providing detailed information about the occurrence, abundance, distribution and polymeric composition of these floating particles.

A total of 74 samples were collected using a 200 µm neuston net. Plastic was found in all samples with a mean concentration of 1.25 ± 1.62 particles/m^2 and 703.16 ± 1573.95 g/km^2. Most of the particles (93.2%) were classified as hard-plastic fragments (i.e. secondary microplastics), while pellets, films and foam constituted only a small fraction of the total. Microplastics *sensu stricto (*i.e. particles smaller than 5 mm), accounted for the vast majority of all collected items (98.6%). However, particles > 1 mm accounted for 92.5% of the total weight of plastic collected, with meso-plastics alone (> 5 mm) accounting for 56.6% of the total. No indication about the loss of smaller size fractions from the sea surface was found and, contrarily to what has been previously reported in the literature, the number of particles steadily increased with decreasing size, with 26.4% of the particles being smaller than 0.3 mm and more than half of all items (50.8%) being smaller than 0.5 mm.

13 different polymer typologies were identified through FT-IR analysis (n = 4050 particles). More than half of all characterized items (52%) were classified as polyethylene (PE), which was followed in abundance by polypropylene (PP) (16%), synthetic paints (7.7%), polyamides (PA) (4.7%), epoxy resins (5%), polyvinyl chloride (PVC) (2.6%), polystyrene (PS) (2.8%), nylon (1.9%) and polyvinyl alcohol (PVA) (1.2%). Other polymer classes encountered less frequently included poly(ethylene terephthalate) (PET), polyisoprene (synthetic rubber), poly(vinyl stearate) (PVS), ethylene-vinyl acetate (EVA), cellulose acetate, paraffin wax and polycaprolactone, a biodegradable polymer, which was found in seven different samples throughout the study area. The molecular characterization revealed also that 4.4% of all analyzed particles did not consisted of plastic but were rather made of cotton, chitin, cellulose and other non-synthetic materials, suggesting a potential bias when visually sorting for microplastics.

A very high spatial heterogeneity was observed, with plastic concentrations spanning two or three orders of magnitude across the study area (Fig. 1). Maximum concentrations (9.23 particles/m^2 and 10.63 kg/km^2) were found in the Corsica Channel, while the lowest concentrations were observed in the Southern Adriatic Sea. On the whole, plastic was significantly ($p = 0.002$) less abundant in the Adriatic (0.83 ± 1.05 particles/m^2 ; 485.07 ± 1153.07 g/km^2; n = 30) than in the rest of the Mediterranean Sea (1.54 ± 1.87 particles/m^2 ; 851.85 ± 1803.66 g/km^2 ; n = 44).

Also, the polymeric composition of non-Adriatic samples was more homogeneous and markedly characterized by an higher occurrence of polyethylene and polypropylene fragments. In contrast, Adriatic samples appeared to be more heterogeneous and rather characterized by an higher presence of paint chips, PVC, PVA, PS and PA, probably indicating a closer link with pollution sources.

Lastly, by computing 95% BCa bootstrapped confidence intervals of our mean density values and averaging them over the entire basin we estimated that between 2.2 and 4.0 x 10^{12} particles and between 933.4 and 2675.4 tonnes of plastic were floating on the Mediterranean Sea during our survey, confirming the Mediterranean Sea as one of the most heavily poluted basins in the world with regards to microplastic pollution.

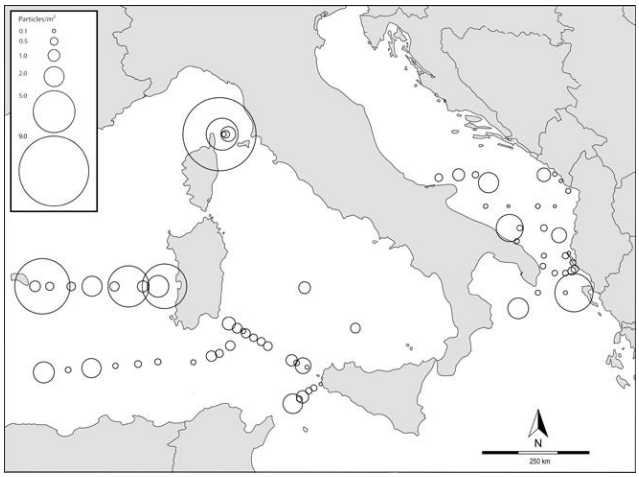

Fig. 1. Map of the study area showing the location of all sampling stations and measured microplastic concentrations expressed as number of items/m^2.

References
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