Corso di Dottorato di Ricerca in Scienze della Vita e dell'Ambiente - Ciclo XXXVI

Presence, behaviour and effects of microplastic and microfiber in marine environment

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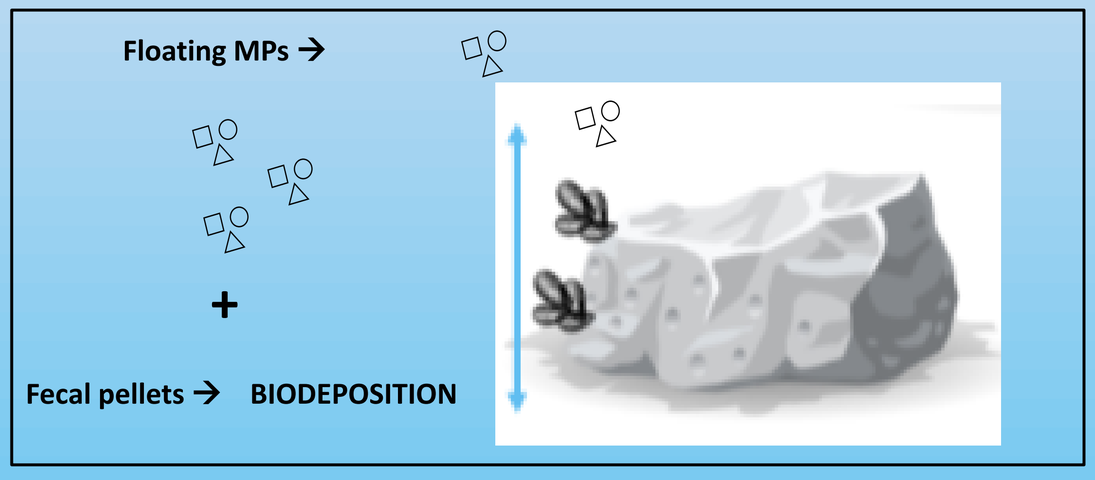
INTRODUCTION

The Mediterranean Sea was recently defined as one of the most impacted areas by plastic pollution in the world and several studies have been carried out in this basin on the ingestion of plastic particles by marine organisms, ranging from zooplankton to top predators (Pellini et al., 2018). The fate of microplastics (MPs) and microfibers (MFs) in the marine environment is affected by several factors, sea currents and other chemical and physical oceanographic conditions as well as by their specific properties. Filter-feeders such as mussels significantly contribute to the removal of MP from the water column by incorporating them into biodeposits, enhancing their deposition from the water column to the bottom. Seagrass ecosystems have been identified as substantial sinks for microplastics, both in the sediment within meadows and adhered to seagrass blade surfaces (Gerstenbacher et al., 2022). The ability of macrophyte to attenuate wave and reduce current velocity is potentially facilitating MPs deposition and due to their morphologies (filamentous and non-filamentous) they might work as important factors to govern MPs retention .

Role of Mussels in the fate of MPs: Benthic pelagic coupling

Mussels are sampled at two different depths with a range of 2m vertical distribution. Three replicates (of 5 individuals) are taken for each depth . Sampling is carried out trough snorkeling. Sediment samples (3 replicates) are taken under and outside the mussel population to assess if their presence influences the MPs typology and abundance in the sediment.



Role of Algae in the fate of MPs

Three algae species has been collected, since macroalgae might work as traps for MPs: *Cystoseira compressa, Gongolaria barbata* and *Ulva lactuca*.

Algae with different morphologies were chosen since different surface structures may influence the MPs retention capacity. At the same time sediment samples were taken under the macroalgal populations and outside the algal forest to assess if the presence of macroalgae influences the MPs abundance and typology in the sediments; 3 replicates for each sample are taken .


U. lactuca

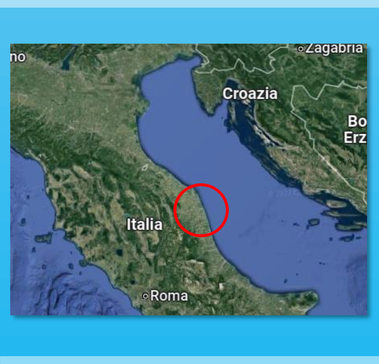

C. compressa

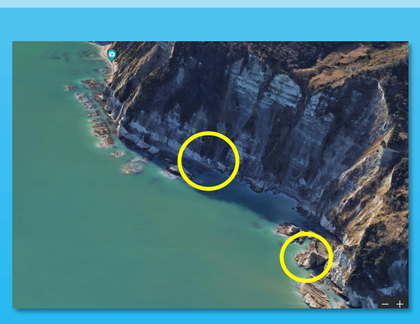

G. barbata

AIMS OF THE PHD STUDY

i. Assessing the presence of MPs and MFs in different biotic anc abiotic matrices, including organisms of ecological relevance within the Adriatic Sea: sea urchins (grazers), anemones (predators), mussels (filter feeders) .
ii. Determining the retention capacity of MPs and MFs in macroalgal forests to understand their fate in the environment.
iii. Assessing the benthic pelagic coupling in mussels , since they could mediate the vertical distribution of MPs through ingestion and biodeposition

EXPERIMENTAL PLAN





During the first 4 month of PhD, we designed an experimental plan to carry out sampling activities on a rocky beach of about 200m (*43.602992°N 13.5512981°E)* next to a local beach called Scalaccia, Conero Riviera (AN) Central Adriatic Sea.
The peculiar features of this area makes it an ideal spot for the growth of algae and mussels of hard substrates. The plan expects a seasonal beach cleaning beside a sampling activity of mussels, sediment, and algae. The first sampling (T0) has been already carried out in April 2022.

PROCESSING OF DIFFERENT MATRICES AND FINAL CHARACTERIZATION OF MPS AND MFS

KOH 10%

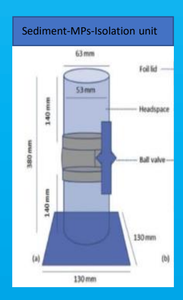
MUSSELS

The tissue undergoes an alkaline digestion using a standardized method with 10'% KOH solution at 45°C for 24h. Following digestion, each solution is glass vacuum filtered through a 8 µm pore size, 47 mm diameter cellulose acetate filter . The residual organic matter present on the filter is further digested with 15% H2O2 solution (Bessa et al., 2019)

Resuspension NaI

SEDIMENT

The processing of the samples requires a specific Sediment-Micrto perform a density separation of the sediment samples using NaI.
The supernatant is then filtered through a 8 µm cellulose acetate filter membrane (Coppock et al. oplastic Isolation (SIM) unit 2017)



Direct sorting

ALGAE

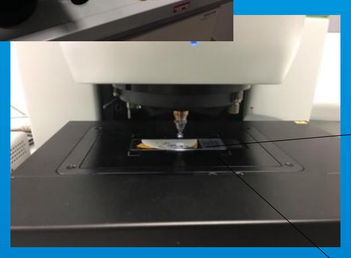
To analyze the presence of MPs the algal tissue is directly observed under a stereomicroscope. MPs and MFs are directly moved from the algae to a clean cellulose acetate membrane using some tweezers
(Feng et al., 2020)

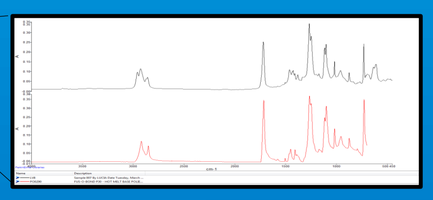
H202 15%

ANEMONES

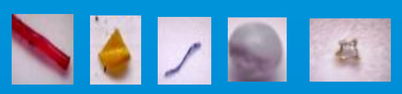
The tissue is digested using 15% H202 solution at 45°C. The complete digestion can require up to 1 week. The solution is glass vacuum filtered through a 8 µm pore size, 47 mm diameter cellulose acetate filter , filtration occurs slowly (up to 6h).

The macroplastic sampled during beach cleaning is characterized trough FTIR spectroscopy (UATR-FTIR) to determine the polimeric features .
Each plastic object is catalogued in categories according to specific monitoring guidelines (Cheshire et al., 2009).
MPs and MFS are characterized using FTIR spectroscopy coupled with a microscope (micro ATR FTIR).
MPs extracted from the samples are assigned to a specific categorie depending on their shape and size .





Different shape classes of MPs extracted from the organisms



Part of the first months as PhD student were dedicated to divulgation and orientation activities for middle and high schools within PLS and PTCO projects.
Sampling campaign, workshops and outreach programs were organized within projects of Mare Circolare, JPI Oceans, RESPONSE and SOLVING in collaboration with Garbage Group, CNR Ancona and CNR-IAS Genova.

REFERENCES
Cheshire et al. (2009). UNEP/IOC Guidelines on Survey and Monitoring of Marine Litter. UNEP Regional Seas Reports and Studies. No. 186.
Bessa et al. (2019) Harmonized protocol for monitoring microplastics in biota. Deliverable 4.3. JPI-Oceans BASEMAN project. , portable method for extracting microplastics from marine sediments.
Movasaghi, Z., Rehman, S., & Rehman, D. I. (2008). Fourier Transform Infrared (FTIR) Spectroscopy of Biological Tissues. 134-179.
Ng, K. L., Suk, K. F., Cheung, K. W., R. H., Chan, S. M., Tam, N. F., . Lo, H. S. (2022). Macroalgal morphology mediates microplastic accumulation on thallus and in sediments.
G.Pellini et al. (2018). Characterization of microplastic litter in the gastrointestinal tract of Solea solea from the Adriatic Sea. 943-952

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