PLASTOX

DIRECT AND INDIRECT ECOTXICOLOGICAL IMPACTS OF MICROPLASTIC ON MARINE ORGANISMS

Project acronym: PLASTOX

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PUBLISHABLE SUMMARY

PLASTOX WP1 is responsible for gathering knowledge about adsorption/desorption of common pollutants on microplastic (MP) particles with different physicochemical properties in the laboratory and in long-term field experiments. To investigate adsorption /desorption of pollutants on MPs in the environment, available literature methods to extract metals, POPs and plastic additives from different polymers were compared and optimized. In sorption tests in the laboratory and field, it was verified that POPs accumulate more on the surface of PE than PP, PS and PET (Figure 1). It was also confirmed that the affinity of metals for PE is significantly higher than for PVC. Regarding desorption of plastic additives, differences in the effect of pressure and hyperbaric bacterial communities on the release of hydrophobic and hydrophilic plastic additives from recycled LDPE was confirmed.

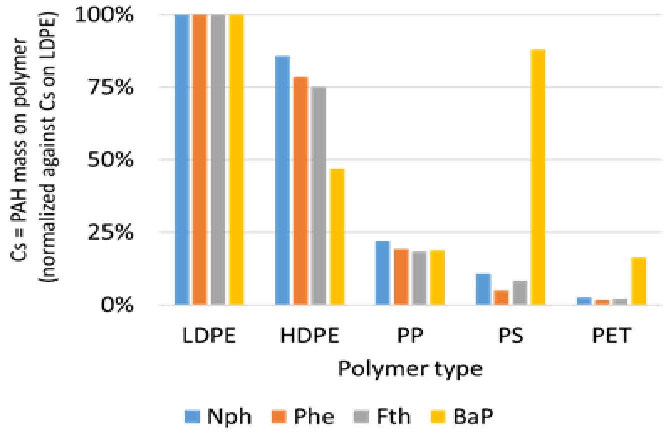

Figure 1. Comparison of PAH sorption capacity of five polymers.

PLASTOX WP2 investigated the toxic effects of ingested MP on European marine organisms from different trophic levels. Polystyrene (PS) MP over the size range 50 nm to 500 um were used in studies depending on specific test species and to provide an insight into the role of particle size. In all short- and long-term experiments, test MPs were rapidly ingested in a density dependent manner by plankton organisms (to which they also can adsorb), bivalves, fish larvae and fish juveniles. No lethalty occurred in any test species, but a range of species-specific sublethal effects were observed. In phytoplankton (*Rhodomonas baltica*), reduced growth rate occurred and reduced chlorophyll production due to shading were observed. In both early life stages and adult mussels (*Mytilus galloprovincialis*), smaller MPs and nanoplastic particles (NP) where found to accumulate in certain organs (Figure 2). Furthermore, there were a range of sublethal responses, including impacts on morphological development, shell biogenesis, immune and lysosomal systems, DNA damage and inflammatory responses. Long-term exposure of juvenile flatfish (*Solea senegalensis*) to MP resulted in ingestion and temporal residency in the gastrointestinal tract. Impacts included oxidative stress and biochemical responses, but no histopathological alterations or lesions on the digestive tract.

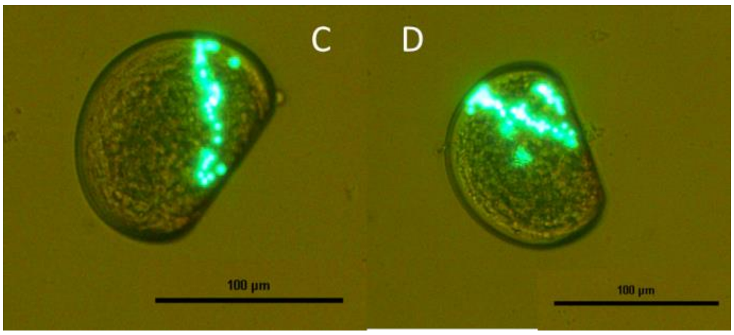

Figure 2. Fluorescent MPs ingested by D-Shaped veligers of M. galloprovincialis led to impacts on morphological development.

PLASTOX WP3 analysed how MPs enter food webs and investigated their subsequent transfer from basal to higher trophic levels. The presence and variable distribution of MP was quantified in key pelagic and benthic species (including heterotrophic nanoflagellates, salps, benthic invertebrates, fish, sea turtles, birds and marine mammals) at different trophic levels in a variety of marine ecosystems (coastal areas, saltmarshes, open waters) around Europe. Generally, the occurrence of MP was low and variable between individuals, species, locations, and did not reflect environmental MP levels. The effects of MP characteristics on uptake and egestion rates in key pelagic and benthic species (including variety of filter-feeding or detritivore benthic invertebrates) was studied using a combination of laboratory experiments and field-based measurements (*Figure 3*). A clear selection for small size particles (<50 µm) was identified in low trophic level organisms. MP >20 µm do not accumulate and transit quickly through the digestive tracts of most organisms before being expelled via faeces or pseudo-faeces and accumulating in biodeposit aggregates. This limits MP transfer to higher trophic levels via predator-prey interactions but could enhance MP transfer via detrital pathways. Subsequent laboratory experiments showed MP in mussel biodeposits become significantly more available to detritus feeding organisms such as polychaetes, representing an alternative pathway for MP transfer to higher trophic levels.

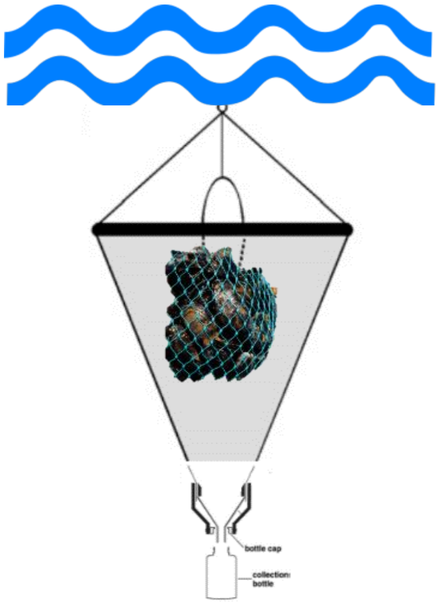

Figure 3. Biodeposit traps developed to quantify MP uptake and egestion by benthic filter feeders like mussels directly in the field.

PLASTOX WP4 investigated the bioavailability and potential effects of persistent organic pollutants adsorbed onto the surface of MP to marine organisms. Both lipid-rich copepods (*Calanus finmarchicus*) and lipid-poor copepods (*Acartia tonsa*) rapidly ingested polyethylene MPs with the polycyclic aromatic hydrocarbons (PAHs) adsorbed to their surface. However, there was no significant contribution from the adsorbed PAHs to toxicity or bioaccumulation, indicating that gut conditions and residence times were insufficient for desorption to occur (Figure 4). PS MPs can act as carriers of PAHs to mussels (*M. galloprovincialis*), with smaller MP transfer higher amounts than larger MP. However, PS MPs with sorbed PAH do not caused additional effects to those caused by pristine MPs in either adults or early life stages. The studies conducted within the framework of the PLASTOX project highlighted the complexity of this issue. In studies investigating the colonization of different types of MP and microbial transformation of MP-associated PCBs, marine microbial communities were found to rapidly colonize PCB-polluted MP in marine sediment. This led to PCB dechlorination, which may affect the toxicity and bioavailability of MP-sorbed PCBs.

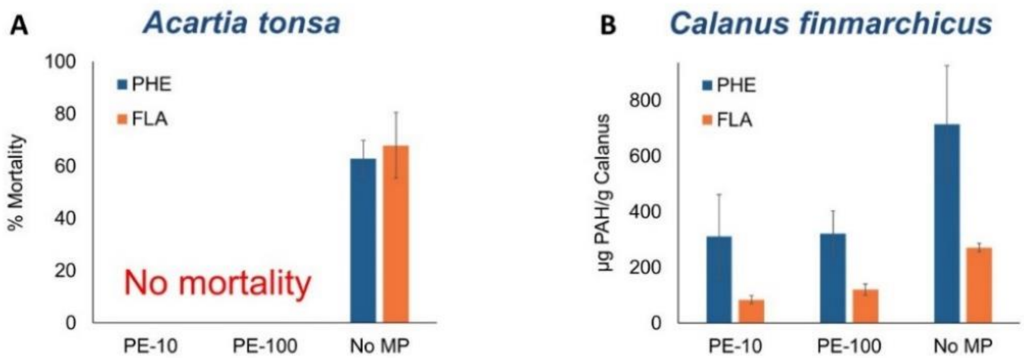

Figure 4. (A) Mortality in Acartia tonsa exposed to MP modulated PAHs, and (B) PAH body burden in Calanus finmarchicus exposed to MP modulated PAHs.