Fragmentation and biodegradation of C-C backbone plastics in the marine environment

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ABSTRACT

Plastic pollution in the marine environment is one of the foremost environmental problems of our time, as it affects wildlife and human health both directly and indirectly through the effects of contaminants carried by microplastics. This study investigates the temporal and spatial distribution of plastic pellets and fragments in sandy beaches along the coastline of Northern Crete, during 2013. Their densities varied throughout the year in each beach, with highest densities during the summer and towards the upper parts of the beaches. The con- centrations of 16 polycyclic aromatic hydrocarbons (PAHs) sorbed on microplastics sampled from nine sandy beaches of Northern Crete was quantified using Gas chromatography – Ion Trap Mass Spectrometry (GC-ITMS). PAHs concentrations ranged from non-detectable levels to 1592 ng/g and fluctuated between sampling periods.

Microplastics (MPs) have been detected in atmosphere, soil, and water and have been characterized as contaminants of emerging concern. When exposed to these environments, MPs interact with the chemical compounds as well as the (micro)organisms inhabiting these ecosystems. This work overviews the interactions and significant factors influencing the sorption process of antibiotics on MPs since distinct interactions are developed between MPs and antibiotics. The interplay between the MPs and the antibiotic resistant genes (ARGs) microbial hosts is presented and the important factors that may shape the plastisphere resistome are discussed. The interactions of MPs, antibiotics and antibiotic resistant bacteria (ARB) and ARGs in wastewater treatment plants (WWTPs) are presented with the aim to provide a perspective for better understanding of the role of WWTPs in bringing together MPs, antibiotics and ARB/ARGs and further as release points of MPs carrying antibiotics, and ARB/ARGs.

Furthermore, this work sheds light on the physicochemical changes of naturally weathered polymer surfaces along with changes of polymer buoyancy due to biofilm formation and degradation processes. To support the degradation hypothesis, a microcosm experiment was conducted where a mixture of naturally weathered plastic pieces was incubated with an indigenous pelagic community. A series of analyses were employed in order to describe the alteration of the physicochemical characteristics of the polymer (FTIR, SEC and GPC, sinking velocity) as well as the biofilm community (NGS). At the end of phase II, the fraction of double bonds in the surface of microbially treated PE films increased while changes were also observed in the profile of the PS films.

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