



Occurrence of microplastics in marine environments and their potential toxicological impacts

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Abstract

Microplastics (MPs) are now recognized as ubiquitous contaminants in marine environments, from coastal areas to the open ocean, water column, and deep-sea sediments. Their persistence, small size, and wide distribution raise increasing concern about their interactions with marine organisms and the potential for long-term ecosystem-level consequences. MPs can be readily ingested by a broad range of taxa, including invertebrates, fish, and higher trophic level species, leading to physical effects such as gut obstruction, reduced feeding efficiency, false satiation, and impaired energy allocation, which may ultimately affect growth, reproduction, and survival. Beyond these direct physical impacts, MPs may also exert toxicological effects, either due to their intrinsic chemical composition (e.g., additives and monomers) or their ability to adsorb and transport environmental contaminants such as persistent organic pollutants and metals. At the sub-organismal level, these effects can be assessed through a suite of biomarkers, including detoxification enzymes (e.g., phase I and II biotransformation systems), antioxidant defenses and oxidative stress markers, as well as inflammatory and immune response parameters. Integrating biomarker responses with exposure data provides valuable insight into early warning signals of MP-induced stress and helps to elucidate mechanistic pathways underlying toxicity. Overall, understanding both the occurrence and biological effects of MPs is essential to better evaluate their ecological risk and to inform future monitoring, regulatory frameworks, and mitigation strategies.

Keywords: Microplastics; Marine pollution; Oxidative stress biomarkers; detoxification; Ecotoxicology

