PERSPECTIVE

# Review on colonisation and biodegradation by the "plastisphere" in relation to the microbial ecotoxicology of marine plastic debris

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ABSTRACT

Given the growing amount of plastic waste in the oceans, it is now obvious that plastic pollution poses a global societal and environmental concern. The "plastisphere" of microbial life that develops on the surfaces of these contaminants has been the subject of an expanding body of work, although the fundamental ideas of microbial ecotoxicology have only sometimes been included. Microbial ecotoxicology examines I how contaminants affect microbial communities, and how much microorganisms can affect how quickly pollutants degrade. This review's objective is to provide light on the rising body of research over the last 15 years on microbial ecotoxicology and ocean plastic contamination. The effects of plastic on marine microbial life and the numerous roles it ensures in the first place. In this section, we also go over the elements that affect how biofilm forms on plastic surfaces and the potential utility of plastic debris as a vehicle for the spread of pathogen species that are dangerous. Second, we provide a critical assessment of both the applicability of the current benchmark tests for plastic biodegradability at sea and the amount to which marine microorganisms can contribute to the breakdown of plastic in the oceans. We present a few illustrations of the metabolic processes involved in polymer biodegradation. We end by posing a number of queries about the gaps in our present understanding of plastic biodegradation by marine microorganisms and identifying potential research avenues.

**Keywords:** Thermal waters; Biodegradation; Obstructive pulmonary; Plastisphere; Colonisation

## INTRODUCTION

An estimated 4.8 to 12.7 million tonnes of land-based plastic trash enter the ocean each year. It is crucial that plastic be recognized as a defining characteristic of the Anthropocene. A growing body of research has examined the distribution of plastic and its toxicity for marine life. A relatively small but expanding body of literature has been devoted to the microbial ecotoxicology of marine plastic debris, i.e., the impact of plastic on marine microbial life and the various ecosystem services that marine microbial life ensures, and the role of microorganisms in the degradation of oceanic materials.

Recently, large DNA sequencing techniques were used to investigate how bacteria colonise plastic surfaces. To describe the microbial life developing on these surfaces, the authors coined the term "plastisphere." In addition, they discovered members of the Vibrio genus, which may be dispersed across great distances by floating persistent polymers. The North Pacific Gyre and the Mediterranean Sea, among other marine habitats, have been the subject of numerous research since then Parallel to this, an expanding body of literature characterised the early stages of colonisation of new plastic up until the development of a mature biofilm Such information is very valuable for understanding how plastic affects marine life and ecosystem processes. Shotgun metagenomics has only been employed in one study thus far, which shown that microorganisms living on plastic have a greater variety of genes than microbes living in nearby waters.

## DESCRIPTION

In this review, we contend that the current body of knowledge is insufficient to provide a comprehensive picture of how plastic affects marine life and ecosystem functions, and we suggest several lines of research for future work in this area (see section "microbiology of microorganisms colonizing plastic at sea"). Another issue of concern is how bacteria contribute to the breakdown of plastic in the ocean. Recent thorough reviews found that "current international standards and regional test methods are insufficient in their ability to realistically predict the biodegradability of carrier bags in marine

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environment, due to numerous shortcomings in experimental procedures and a paucity of information in the scientific literature."

To gain a clearer understanding of the function played by the plastisphere in the ocean's carbon cycling, measurements of primary production and heterotrophic production over broad temporal and spatial scales will need to be combined. The presence of plastic in the ocean may also have an impact on microorganisms' roles in the nitrogen, sulphur, iron, manganese, chromium, phosphorus, calcium, and silicate cycles, which are all fundamentally connected to the carbon cycle.

## CONCLUSIONS

Abiotic degradation, which weakens the structure of polymers as evidenced by roughness, cracks, and molecular changes, is thought to occur after or concurrently with biodegradation. The term "aging" refers to changes in plastic properties brought on by abiotic degradation. In nature, ageing is influenced by a number of variables, including temperature, solar light, and chemicals that speed up degradation by oxidizing or disrupting the polymer chain.

- Physical deterioration of the plastic is caused by the biofilm that is developing on its surface and inside of it, which also causes cracks and increases hole size. Acid chemicals released by the biofilm also change the pH inside the pores and alter the microstructure of the plastic matrix (chemical deterioration).
- Bio-fragmentation is the result of bacteria colonising the polymer surface secreting extracellular enzymes (oxygenases, lipases, esterases, depolymerases, and other enzymes that may be as different as the wide range of polymer types). These enzymes will cause polymers to have lower molecular weights, releasing oligomers and subsequently monomers that can be taken up by cells.
- The microbial biomass can be increased by assimilation, which enables oligomers of less than 600 daltons to be integrated inside the cells and used as a carbon source.
- The final stage of a plastic polymer's biodegradation is mineralization, which causes the excretion of completely oxidised metabolites.