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Beyond Ingestion: Adhesion of Microplastics to Aquatic Organisms

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Abstract

The interactions between microplastics and aquatic organisms have predominantly been explored through studies involving various animal species, with dietary ingestion identified as the primary pathway of uptake. Nevertheless, recent investigations have illuminated an additional mode of interaction: bioadhesion between microplastics and biota. This phenomenon has been extensively examined in laboratory settings using aquatic macrophytes, revealing the attachment of microplastics to their biomass. Importantly, field studies have corroborated these findings, demonstrating that microplastic bioadhesion is not confined to specific species or environments. Microplastics have also been observed adhering to microorganisms and becoming ensnared within pervasive biofilms in aquatic habitats. These biofilms, which naturally form on substrates like sediment and rocks, also play a role in augmenting the adhesion of microplastics to other biological surfaces, such as those of plants.

Keywords: Adsorption • Attachment • Aquatic ecosystems

Introduction

The adhesion of microplastics to these substantial biotic surfaces has the potential to significantly influence the abundance and bioavailability of microplastics in the environment. While research on the bioadhesion of microplastics to animals remains limited, initial findings indicate that this adhesion process could surpass particle ingestion in certain organisms, such as corals or bivalves. However, the complete ecotoxicological implications of such interactions are not yet fully comprehended, and the potential transport of microplastics-adhered, for instance, to fish or aquatic insects-must also be taken into account. In summation, bioadhesion emerges as a pivotal mechanism governing the interactions between microplastics and biota. Disregarding the significance of bioadhesion within the environmental context may curtail a holistic understanding of the behaviors, fates, and impacts of microplastics in aquatic ecosystems [1].

Microplastics, the tiny fragments of plastic less than 5 millimeters in size, have garnered significant attention in recent years due to their widespread presence in aquatic ecosystems and potential environmental impacts. While much research has focused on the ingestion of microplastics by aquatic organisms and its consequences, another critical aspect of microplastic pollution has emerged: the adhesion of microplastics to aquatic organisms. This phenomenon has far-reaching implications for both the organisms themselves and the broader ecosystem [2]. Microplastics enter aquatic environments through various sources, including the breakdown of larger plastic items, the degradation of synthetic textiles, and the release of microbeads from personal care products. Once in the water, they are subjected to various physical, chemical, and biological processes that can lead to their adhesion to aquatic organisms. Adhesion refers to the attachment of microplastics to the external surfaces of organisms, including their skin, gills, and appendages [3].

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Description

The adhesion of microplastics to aquatic organisms is a multifaceted process influenced by several factors:

Surface characteristics: The surface properties of both microplastics and organisms play a significant role in adhesion. Microplastics with rough, irregular surfaces are more likely to adhere to organisms compared to smoother particles. Similarly, the presence of mucus or other biofilms on organism surfaces can enhance adhesion.

Chemical interactions: Microplastics contain a variety of chemical additives and contaminants that can interact with the chemical composition of organisms' surfaces. These interactions can promote adhesion by creating bonds or attractive forces between the two.

Hydrophobicity: Microplastics are hydrophobic, meaning they repel water. Aquatic organisms, particularly those with hydrophilic surfaces, may experience increased adhesion due to the preferential interaction of microplastics with their surfaces [4].

Organism behavior: The behavior of aquatic organisms, such as swimming, feeding, and grooming, can influence the likelihood of microplastic adhesion. Filter-feeding organisms, for example, may inadvertently capture microplastics while filtering food particles from the water.

Physical agitation: Wave action, currents, and turbulence in aquatic environments can bring microplastics into contact with organisms, facilitating adhesion.

The consequences of microplastic adhesion to aquatic organisms are diverse and can impact both individual organisms and the ecosystem as a whole:

1. **Physical harm:** Microplastics adhering to organisms' surfaces can cause physical abrasion, irritation, and damage. This can lead to impaired movement, compromised feeding, and increased susceptibility to disease.
2. **Chemical exposure:** The chemicals present in microplastics can leach onto organism surfaces upon adhesion, potentially leading to toxic effects. This is particularly concerning for filter-feeding organisms that may accumulate high levels of microplastics and associated contaminants.

3. **Dispersal and transport:** Microplastics adhering to mobile organisms can serve as vectors for the transport of these pollutants across different parts of aquatic ecosystems. This can lead to the dispersal of microplastics to areas where they were not originally present.

4. **Trophic transfer:** Organisms that have microplastics adhered to their surfaces can become part of the food chain. Predators consuming these organisms may inadvertently ingest microplastics, leading to their bioaccumulation in higher trophic levels [5].

Addressing the issue of microplastic adhesion requires a comprehensive approach:

Research: Further studies are needed to understand the mechanisms of adhesion, the factors influencing it, and its ecological consequences. This will aid in developing targeted mitigation strategies.

Regulation and policy: Regulations aimed at reducing microplastic pollution, including bans on microbeads in personal care products and improved waste management, can help minimize the presence of microplastics in aquatic environments.

Innovative materials: The development of biodegradable and less adhesive plastics can mitigate the impacts of microplastics on aquatic organisms.

Educational initiatives: Raising awareness about microplastic pollution and its various impacts can encourage individual and collective actions to reduce plastic consumption and pollution.

Ecosystem management: Integrated ecosystem-based approaches can help address the issue of microplastic adhesion within the broader context of aquatic ecosystem health [6].

Conclusion

Microplastic adhesion to aquatic organisms represents a significant and complex dimension of microplastic pollution. As we continue to expand our understanding of this phenomenon, it is imperative to develop effective strategies to mitigate its impacts and preserve the health and resilience of aquatic ecosystems. By tackling both ingestion and adhesion, we can work towards a cleaner and more sustainable future for our planet's aquatic environments.

Acknowledgment

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Conflict of Interest

None.

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