Vol. 4 Issue- 2, October 2023 (e-ISSN: 2582-8223)

Impacts of Microplastics on Marine Organisms: A Comprehensive Overview

Suman Karmakar[1*]
[1] Division of Fisheries Science, The Neotia University, Diamond Harbour, West Bengal

ARTICLE ID: 01

Introduction

Microplastics, minute plastic particles measuring less than 5 µm, have become pervasive in marine environments. Unlike a singular entity, they are a complex mixture of polymers and additives that have the ability to absorb various substances from the surrounding environment. Marine organisms, including plankton, fish, and filter-feeding invertebrates, mistake these microplastics for food due to their small size. In the year 2010, approximately 4.8-12.7 million tonnes of plastic found their way into the Earth's oceans. As a consequence, it is estimated that there are now over 5 trillion individual plastic pieces adrift in the world's marine environments. In ocean water, the frequently encountered synthetic polymers in the form of microplastics include polypropylene (PP), polyethylene (PE), polystyrene (PS), polyvinylchloride (PVC), and polyethylene terephthalate (PET). During ingestion, these particles can cause various detrimental effects. Firstly, they can physically damage the digestive organs of the organisms, leading to internal injuries and potential death. Additionally, the absorbed pollutants on the microplastics, such as pesticides and heavy metals, can transfer into the bodies of the organisms upon ingestion, leading to bioaccumulation and biomagnification of toxic substances within the food chain. Furthermore, the presence of microplastics in the marine ecosystem can disrupt nutrient cycling and alter food webs. As these particles accumulate in various organisms and sediments, they can interfere with natural processes, impacting the balance of marine ecosystems. This disturbance can have cascading effects on both aquatic and terrestrial ecosystems, as many organisms depend on marine resources for their survival (Guzzetti *et al*., 2018).

Fate of microplastic in marine environment

Microplastics primarily infiltrate marine environments due to various human activities, including aquaculture, fishing, tourism, and industrial and domestic wastewater systems. The distribution of these microplastics is highly uneven. Studies have shown a direct correlation

JUST AGRICULTURE
multidisciplinary e-Newsletter

between the rise in human population density and the abundance of microplastics. This connection suggests a potential escalation in the accumulation of plastic debris within marine environments, highlighting the urgent need for comprehensive efforts to address and mitigate this growing environmental concern. The transport dynamics, distribution, and accumulation of microplastics in marine environments are influenced by a range of physico-chemical properties, including size, specific density, charge, and chemical composition (Duis and Coors, 2016).

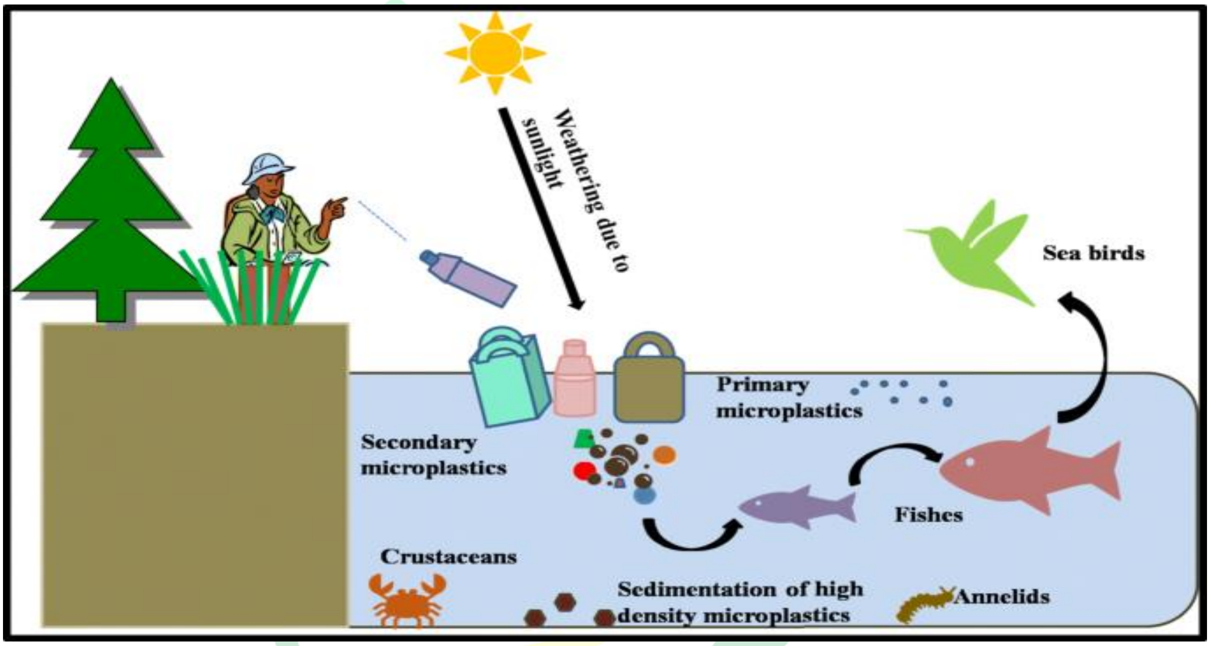

Figure (1): Microplastic pathway in marine organisms

Effects of microplastic in marine organisms

Effects in fish

Various authors have extensively documented the impact of microplastics ingestion on different fish species. Oliveria *et al*. (2013) investigated that due to exposure of microplastic the AChE activity was increased significantly in *P. microp*. Accumulation of polystyrene microplastics leads to inflammation and lipid accumulation in the liver tissue of *D. rerio*. Additionally, a notable rise in antioxidant enzymes like superoxide dismutase (SOD) and catalase (CAT) was observed, indicating that microplastics are accountable for the onset of oxidative stress. Exposure of *D. rerio* to microplastics led to modifications in metabolic pathways within fish liver, resulting in alterations in lipid and energy metabolism. Japanese medaka fish (*Oryzias latipes*) exposed to both virgin and marine polyethylene fragments for a short duration exhibited bioaccumulation of chemical pollutants such as PAHs, PCBs, and PBDEs. These exposures led to signs of liver stress, including glycogen depletion, fatty vacuolation, and cellular necrosis, as well as early tumor formation.

Effects in invertebrates

After 60 days of exposure, it was observed that the respiration rates of *O. edulis* were elevated in response to high concentrations of Polylactic acid, indicating that biodegradable microplastics induced stress in these organisms. Under exposure to high concentrations of plastic, *A. marina* accumulated nonylphenol and triclosan from polyvinyl chloride (PVC), leading to impaired immune functions, physiological stress, and eventual mortality. Multiple studies have provided evidence that the primary consequence of pollutant accumulation within mussels is cellular damage, triggered by oxidative stress. The authors demonstrated that microplastics translocated into the haemolymph and haemocytes of *M. edulis* within 3 days and persisted for over 48 days, resulting in severe consequences. Specifically, early granulocytoma formation (indicative of inflammation), a rise in haemocyte levels, and a significant decrease in lysosomal membrane stability (LMS) were observed as a result. Avio *et al.* (2015) confirmed the ability of *M. edulis* to ingest and accumulate both virgin and contaminated microplastics. They discovered a heightened concentration of pyrene in the digestive gland of mussels treated with microplastics. Numerous studies have concentrated on investigating the effects of microplastics on individual organisms. Additionally, it has been established that chronic exposure to microplastics can result in not only toxic effects but also diminished natural food ingestion, leading to reduced nutritional status and growth in Langoustine. In Copepods, this exposure affects fecundity, fertility, and survival, while in *Daphnia magna*, it impacts survival, growth, and development. Mussels are highly valued as seafood, suggesting the possibility of their role as a vector for the potential transfer of pollutants from marine environments to humans. However, it is important to note that this connection must still be substantiated through further research and evidence (Guzzetti *et al*., 2018).

Conclusion

In conclusion, the impact of microplastics on marine organisms is a complex and multifaceted issue. These tiny plastic particles, introduced into marine environments primarily through human activities, pose significant threats to various marine species. Microplastics, often acting as carriers for pollutants, can be ingested by a wide range of organisms, leading to a series of adverse effects. Furthermore, the ability of microplastics to accumulate and transport harmful chemicals raises concerns about bioaccumulation and biomagnification within marine food webs. Addressing the issue of microplastics requires a comprehensive approach, including reducing plastic usage, improving waste management, developing eco-friendly alternatives. Mitigating the impact of microplastics is essential to preserving marine biodiversity and ensuring the health and sustainability of our oceans.

References

Avio, C. G., Gorbi, S., Milan, M., Benedetti, M., Fattorini, D., d'Errico, G., ... & Regoli, F. (2015). Pollutants bioavailability and toxicological risk from microplastics to marine mussels. *Environmental pollution*, *198*, 211-222.

Duis, K., & Coors, A. (2016). Microplastics in the aquatic and terrestrial environment: sources (with a specific focus on personal care products), fate and effects. *Environmental Sciences Europe*, *28*(1), 1-25.

Guzzetti, E., Sureda, A., Tejada, S., & Faggio, C. (2018). Microplastic in marine organism: Environmental and toxicological effects. *Environmental toxicology and pharmacology*, *64*, 164-171.

Oliveira, M., Ribeiro, A., Hylland, K., & Guilhermino, L. (2013). Single and combined effects of microplastics and pyrene on juveniles (0+ group) of the common goby Pomatoschistus microps (Teleostei, Gobiidae). *Ecological indicators*, *34*, 641-647.