Marine Debris: A Study of the Abundance, Distribution and Effects of Plastic Debris in Oceanic Ecosystem

[1] Venu Anand Das Vaishnav, Assistant Professor, Department of Pharmacy, Kalinga University, Raipur, India.

Abstract: Marine systems are significantly impacted by plastic waste both economically and environmentally. Monitoring is essential for evaluating the effectiveness of policies put in place to lessen the amount of plastic waste, but it is made more difficult by the wide variations in the amounts of plastic waste over time and space, as well as our incomplete knowledge of the routes that plastic waste takes and its ultimate destiny. The cross-sectional line and the high strandline have different patterns of small plastic debris's spatial distribution. Different plastic categories had different cross-sectional distributions of small plastic abundance, suggesting the need for representative beach sample of small plastic debris. Given that many marine species are already threatened due to other anthropogenic activities, it is well recognized that plastic waste harms and/or kills a significant proportion of them. The main way that plastic waste affects marine life is through entanglement and ingestion. Other less well-known risks include the absorption of polychlorinated biphenyls from consumed plastics and the utilization of plastic waste by "invader" species. Even less noticeable types, including plastic pellets and "scrubbers," can be dangerous.

Keywords: Plastic Debris; Abundance; Distribution; Effects; Marine Systems.

(Submitted: June 03, 2024; Revised: July 07, 2024; Accepted: August 05, 2024; Published: September 30, 2024)

I. Introduction

Large plastic items that decompose over time release microplastic, which spreads across vast areas due to wind-driven development of the ocean surface layer. Accordingly, plastic garbage is currently the most challenging problem impacting the marine environment, not just for coastal areas of agricultural nations with inadequate waste management systems, but also for the world's oceans as a whole. Concern over the effects of plastic use by marine life and the growth of plastic in oceanfront areas is being stoked by the creation of objective and noteworthy care. Public and private initiatives, such as volunteer beach clean-ups and rubbish disposal campaigns, are the primary sources of data on the types and quantities of marine litter. Towns and government agencies must continuously clean seashores to maintain their appeal to tourists, which comes at a significant financial expense. It is now widely acknowledged that floating plastic debris negatively impacts marine life and ecosystems in a number of ways. In any event, precise information about the amount, origins, growth, and predetermination of plastics in the oceans is still lacking. The ingestion, suffocation, and capture of a few marine species is the most obvious and upsetting effect of marine plastic pollution. Currently the most well-known type of marine trash, floating plastics also contribute to the growth of distant (pariah) marine life, endangering marine biodiversity and the hierarchy of dominance. Throughout their whole stay in contaminated saltwater, these floating particles accumulate toxic substances on their surface. In this sense, they could act as a conduit for harmful toxins that emerge in hierarchical structures or as a concentrated source of common contamination. (the "bio-collection of foreign substances" cycle). Reports of significant levels of drifting plastic debris in isolated maritime districts have sparked concern about the growth of plastic litter on the sea surface. The development of plastic has essentially exploded since the introduction of plastic materials in the 1950s, and this trend is expected to continue for a very long time. The amount and distribution of plastic garbage in the wild sea remain unknown despite evidence of its effects on creatures ranging from tiny shellfish to whales. Human mobility has virtually reduced the world's organic variety, and the problem is so severe that cumulative human influences may have accelerated current elimination rates to 1000–10,000 times the normal pace. Overfishing and collecting, trash disposal, pollution, alien species, land recovery, excavation, and environmental change are some of the factors that harm marine life in the oceans. One type of human impact that poses a major threat to marine life is pollution from plastic waste. 30 million tonnes of plastic are regularly produced, despite the fact that they have only been in existence for a little over a century. Natural polymers are used to make

plastics. Due in large part to their adaptability, these materials have become increasingly used in recent years and have quickly permeated every aspect of daily life. Because of their strength, durability, affordability, and light weight, plastics may be used to create a vast array of items. Plastics provide a significant environmental risk because of these identical characteristics. Due to its buoyancy, a growing amount of plastic waste is being spread across great distances, and once it settles in sediments, it may remain there for generations. Plastics have long been disregarded as a threat to the marine ecosystem, but only recently have their seriousness been acknowledged. Because of the immensity of the seas and the obvious abundance of marine life, the proliferation of plastic waste in the marine climate has been dismissed as a possible concern.

II. Background

The quantity of plastic debris in the water has become a major environmental concern in recent decades. Rapid industrialization, population growth, and increased reliance on single-use plastics have resulted in the accumulation of millions of tons of plastic waste in marine environments. Plastics are strong and non-biodegradable; they can persist in the environment for centuries before breaking down into small, equally hazardous microplastics (Van Sebille, 2015). These pollutants originate from both land-based sources, such as riverine input, urban runoff, and improper waste disposal, as well as ocean-based sources, such as shipping and fishing (Cózar et al., 2014). Both land-based and ocean-based sources, including rivers, urban runoff, wastewater discharge, and maritime operations like shipping and fishing, can introduce plastics into marine habitats. Plastics are carried and spread by winds, waves, and ocean currents once they are in the sea. Eventually, they gather in places like subtropical gyres, where circulation currents create enormous convergence zones like the Great Pacific Garbage Patch. The distribution of plastic garbage is uneven. The proliferation of plastic waste. The exponential growth of plastic manufacture and poor waste management are the main drivers of the growing environmental concern in the ocean. River inputs, fishing, and shipping are some of the causes of plastic contamination in marine habitats (Thushari & Senevirathna, 2020). Ocean plastic waste has grown to be a serious environmental problem that threatens human livelihoods, marine ecosystems, and biodiversity. These plastics break down into microscopic pieces called microplastics, which are ingested by marine animals and result in physical injury, chemical toxicity, and bioaccumulation in food chains. Larger garbage harms habitats, entangles marine life, and causes species extinction. Examples of this include single-use plastics and abandoned fishing nets. Global fisheries, tourism, and coastal industries are all impacted by plastic pollution, which can also introduce dangerous contaminants into people's diets through seafood intake (Schmaltz et al., 2020).

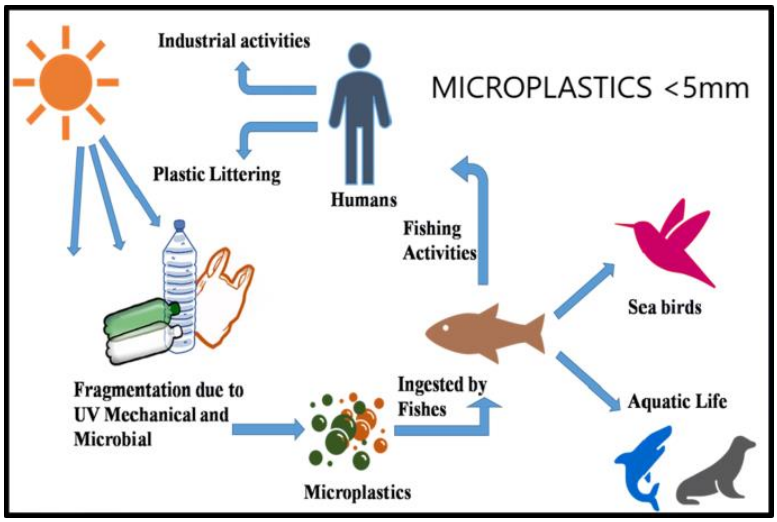

Figure 1: Factors that Influence the Distribution of Plastics and Microplastics within and between the Zones of the Marine Environment

III. Abundance of Plastic Debris in Ocean

Marine systems are significantly impacted by plastic waste both economically and environmentally. Monitoring is essential for evaluating the effectiveness of policies put in place to lessen the amount of plastic waste, but it is made more difficult by the wide variations in the amounts of plastic waste over time and space, as well as our incomplete knowledge of the routes that plastic waste takes and its ultimate destiny. Up until now, the main focus of observation has been oceanside assessments of trash, including plastics that have been abandoned. The effects of infrequent evaluations of the standing load of litter on seashores, which provide ambiguous estimates of the types and quantities of garbage, are influenced by beachcombing, cleanups, and oceanside features. Even though it is expensive, tracking the growth of abandoned rubbish is an indication of trash patterns in nearby oceans (Ryan et al., 2009). Because of the wide range of geological and temporal heterogeneity, adrift examination necessitates a large number of examples in order to detect variations in overflow. An additional mechanism is monitoring the effects of plastics. Seabirds and other marine animals that store plastic in their stomachs should make it moderately practicable to observe the quantity and composition of tiny plastic litter. Entrapment rates are more difficult to assess since they are susceptible to changes in the numbers of impacted species (Manullang, 2019). It is helpful to monitor ship waste removal, the amount of plastic flotsam and jetsam in rivers, and stormwater overflow in order to identify the primary sources of plastic rubbish entering the sea and direct moderation actions. Plastic pollution is acknowledged globally as a significant human-caused problem for beachfront and marine environments. The construction, capabilities, and consequently, administrations and values of biological systems are disrupted by anthropogenic sources of the remarkable and ongoing increase of plastic contamination in seagoing circumstances, either directly or indirectly. Both land-based and ocean-based sources are the main sources of these contaminants in the various ways they enter the water.

IV. Effects from Plastic Debris to Marine Ecosystems

There is still a severe lack of information about how plastic debris affects marine biological systems. In any event, more information on their detrimental effects on marine life is emerging. The greatest mechanical hazards to marine animals are ingestion of plastic waste and entanglement in float nets, designed ropes and lines, or pressing groups. Additionally, the accumulation of plastic debris on the ocean floor poses a risk to marine biological systems. The negative effects of eating plastics include delayed ovulation, reduced steroid chemical levels, decreased eating improvement, blockage of stomach chemical discharge, and regenerative disappointment (Gall & Thompson, 2015).

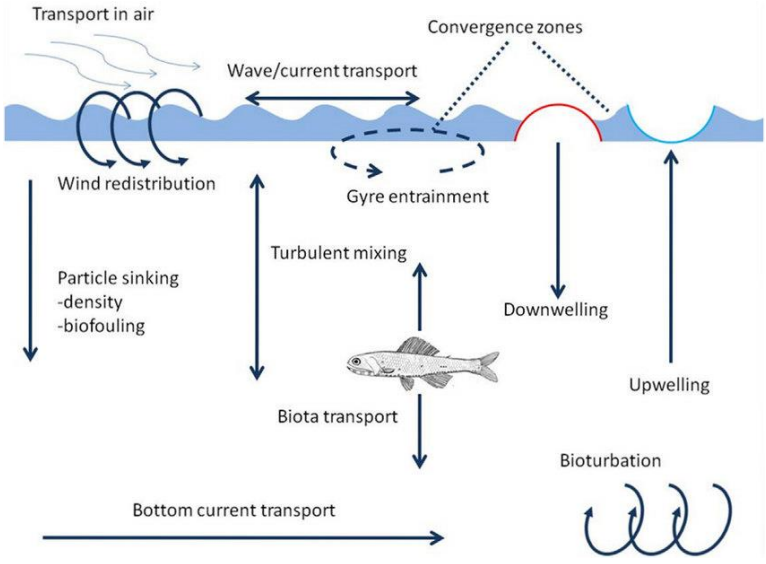

Figure 2: Effects of Microplastic Pollution on Marine Ecosystems

For example, small fish and seabirds who eat plastic debris may have reduced food intake, internal damage, and even death due to obstruction of the digestive system. However, the severity of the damage will differ depending on the species. Marine life is seriously threatened by becoming entangled in plastic waste, particularly from abandoned fishing gear. tiny pieces of plastic (often up to 0.5 mm across) that come from airblast cleaning medium, cosmetic preparations, and hand cleaners. It is still unclear how tiny particles, together with flakes of a similar size that result from the breakdown of larger plastic waste, affect the environment. Marine ecosystems may suffer significant effects from the introduction of alien organisms (Thompson, 2006). The natural marine biodiversity may be threatened by this biotic mixing, which is becoming a common issue as a result of human activity. Numerous encrusting species, including bacteria, diatoms, algae, barnacles, hydroids, and tunicates, can grow on plastics that float at sea. Human-made waste has destroyed marine conditions from the Arctic to the equator, and from coasts, estuaries, and the ocean surface to the depths of the sea. There are several reasons to be concerned about marine trash's prevalence. It poses a risk to shipping, is recognized to be bad for the environment and human health, can accelerate the movement of organic and inorganic pollutants, and is unsightly, all of which have a negative socioeconomic impact. Not much research has been done on the extent of the marine debris issue and how it can harm biodiversity.

V. Conclusion

Significant biological and environmental repercussions are highlighted by the research on the quantity and distribution of plastic waste in the ocean. Ocean gyres, coastal regions, and areas impacted by human activity, like shipping lanes and fishing grounds, have higher concentrations of plastic litter than other marine habitats. This distribution is influenced by elements such as wind patterns, ocean currents, and distance from urban areas. Because it disrupts habitats, introduces hazardous compounds into the food web, and presents a risk of ingestion and entanglement to marine species, the buildup of plastics has an impact on marine ecosystems. Because they are easier to consume and disperse across huge areas, microplastics produced by the breakdown of larger waste eventually make the issue worse. These results highlight the pressing need for international initiatives to lessen plastic pollution, enhance waste management, and lessen its long-term effects on biodiversity and ocean health.

References

[1] Van Sebille, E. (2015). The oceans' accumulating plastic garbage. *Physics Today*, *68*(2), 60-61. https://doi.org/10.1063/PT.3.2697

[2] Cózar, A., Echevarría, F., González-Gordillo, J. I., Irigoien, X., Úbeda, B., Hernández-León, S., ... & Duarte, C. M. (2014). Plastic debris in the open ocean. *Proceedings of the National Academy of Sciences*, *111*(28), 10239-10244. https://doi.org/10.1073/pnas.1314705111

[3] Thushari, G. G. N., & Senevirathna, J. D. M. (2020). Plastic pollution in the marine environment. *Heliyon*, *6*(8), e04709. https://doi.org/10.1016/j.heliyon.2020.e04709

[4] Schmaltz, E., Melvin, E. C., Diana, Z., Gunady, E. F., Rittschof, D., Somarelli, J. A., ... & Dunphy-Daly, M. M. (2020). Plastic pollution solutions: emerging technologies to prevent and collect marine plastic pollution. *Environment international*, *144*, 106067. https://doi.org/10.1016/j.envint.2020.106067

[5] Ryan, P. G., Moore, C. J., Van Franeker, J. A., & Moloney, C. L. (2009). Monitoring the abundance of plastic debris in the marine environment. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *364*(1526), 1999-2012.

[6] Manullang, C. Y. (2019, April). The abundance of plastic marine debris on beaches in Ambon Bay. In *IOP Conference Series: Earth and Environmental Science* (Vol. 253, No. 1, p. 012037). IOP Publishing. https://doi.org/10.1088/1755-1315/253/1/012037

[7] Gall, S. C., & Thompson, R. C. (2015). The impact of debris on marine life. *Marine* pollution *bulletin*, *92*(1-2), 170-179. https://doi.org/10.1016/j.marpolbul.2014.12.041.

[8] Thompson, R. C. (2006). Plastic debris in the marine environment: consequences and solutions. *Marine nature conservation in Europe*, *193*, 107-115.