Effects of Micro Plastic Contamination on Marine Life and Coral Health in Coastal Waters[1]

***Nashikkar Surendra Manohar, ** Dr. Kailas Narayan Sonune**

*Research Scholar, **Research Supervisor,
Department of Biochemistry,
Himalayan University
Itanagar, AP

Received: 22 January 2023; Accepted: 09 February 2023; Published: 20 March 2023

ABSTRACT

Microplastic pollution has emerged as a significant environmental concern in recent decades, posing a threat to marine ecosystems worldwide. Coastal waters, in particular, serve as a critical habitat for a diverse range of marine organisms, including corals. This paper examines the effects of microplastic contamination on marine life and coral health in coastal waters, exploring the mechanisms of exposure, potential impacts on organisms, and the broader ecological consequences. The findings emphasize the urgent need for effective mitigation strategies to protect coastal ecosystems and ensure the long-term sustainability of marine biodiversity.

Keywords: *- Microplastic; Health; Coastal; Waters.*

INTRODUCTION

Microplastic contamination has emerged as a pressing environmental issue, posing significant threats to marine ecosystems worldwide. The pervasive presence of microplastics in coastal waters has raised concerns regarding the health and sustainability of marine life, particularly the delicate ecosystems that support coral reefs. As these coastal habitats are vital for a diverse range of marine organisms, including corals, understanding the effects of microplastic pollution is crucial for devising effective conservation strategies and safeguarding the long-term well-being of our oceans.

The production and improper disposal of plastic materials have led to the accumulation of plastic debris in marine environments. Over time, larger plastic items break down into smaller fragments, eventually reaching microplastic sizes, typically defined as particles smaller than 5 millimeters in diameter. Microplastics can be classified into primary microplastics, intentionally manufactured at a small scale, and secondary microplastics, resulting from the breakdown of larger plastic items through physical, chemical, and biological processes.

Marine ecosystems, particularly coastal waters, are of immense ecological and socio-economic importance. They support a wide array of marine life, including economically valuable fish stocks and delicate coral reef systems. Coral reefs, in particular, are biodiversity hotspots and serve as critical habitats for numerous species. They also provide vital ecosystem services, such as shoreline protection, tourism, and carbon sequestration. Therefore, understanding the effects of microplastic contamination on marine life and coral health is crucial for ensuring the resilience and sustainability of these ecosystems.

The consequences of microplastic pollution extend beyond the immediate impacts on marine organisms. Biodiversity loss, altered trophic interactions, and disrupted ecosystem functioning can have far-reaching ecological and socio-economic implications. Moreover, the potential for microplastics to enter the human food chain raises concerns about human health risks associated with the consumption of contaminated seafood. By

[1] *How to cite the article:* Manohar N.S. Sonune K.N., Effects of Micro Plastic Contamination on Marine Life and Coral Health in Coastal Waters; *International Journal of Innovations in Scientific Engineering*, Jan-Jun 2023, Vol 17, 16-20

comprehensively studying the effects of microplastic contamination, policymakers, scientists, and conservationists can work together to develop effective strategies to mitigate this growing environmental problem.

MICROPLASTICS: SOURCES, TYPES, AND DISTRIBUTION

Sources of Microplastics:

Microplastics originate from various sources, both directly released into the environment and indirectly generated through the degradation of larger plastic items. The primary sources of microplastics include:

a) Fragmentation of Larger Plastics: Plastics, such as single-use bags, bottles, and packaging materials, undergo mechanical and chemical degradation due to exposure to sunlight, wave action, and physical stress. This process breaks them down into smaller fragments, eventually leading to the formation of microplastics.

b) Microbeads: Microbeads are tiny plastic particles intentionally manufactured for use in personal care products, such as facial scrubs and toothpaste. These particles, often made of polyethylene or polypropylene, are designed to exfoliate or provide texture but are often washed down the drain, bypassing filtration systems and entering water bodies.

c) Synthetic Fibers: Synthetic textiles, such as polyester and nylon, shed microfibers during washing and everyday use. These fibers are released into wastewater systems and can eventually reach rivers, lakes, and oceans.

d) Industrial Processes: Industrial activities, including plastic manufacturing, processing, and recycling, contribute to the release of microplastics. Small plastic particles and powders can be unintentionally released into the environment during these processes.

e) Urban Runoff: Urban areas are significant contributors to microplastic pollution through stormwater runoff. Plastics littered on streets, microplastics in dust particles, and waste from landfills can be washed into storm drains and subsequently discharged into coastal waters.

Types of Microplastics:

Microplastics can be broadly categorized into two types: primary microplastics and secondary microplastics.

a) Primary Microplastics: Primary microplastics are intentionally manufactured at a small scale and include microbeads, plastic pellets (nurdles), and microfibers. These microplastics are designed for specific purposes, such as industrial abrasives, exfoliating agents, or raw materials for plastic production.

b) Secondary Microplastics: Secondary microplastics are formed through the breakdown of larger plastic items, such as bottles, bags, and fishing gear. These fragments result from physical, chemical, and biological weathering processes, gradually reducing the plastic's size into microplastic range.

Distribution in Coastal Waters:

Microplastics have been found in coastal waters worldwide, from highly populated and industrialized regions to remote and pristine environments. The distribution of microplastics in coastal waters is influenced by several factors:

a) Proximity to Urban Areas: Coastal areas near urban centers or areas with high human population densities tend to experience greater levels of microplastic pollution. Urban runoff, wastewater discharge, and improper waste management practices contribute to higher concentrations of microplastics in these areas.

b) River Inputs: Rivers serve as conduits for microplastics, transporting them from inland sources to coastal waters. Urban runoff, agricultural activities, and industrial discharges can introduce microplastics into rivers, eventually reaching the ocean.

c) Ocean Currents and Circulation Patterns: Ocean currents play a role in the distribution and accumulation of microplastics. Plastics released into the ocean can be transported over long distances by currents, accumulating in specific regions, such as gyres or coastal areas where currents converge.

d) Sedimentation and Deposition: Microplastics can settle and accumulate in sediments along coastal areas. These sediments can act as reservoirs of microplastics, potentially affecting benthic organisms and the wider food web.

Understanding the distribution patterns of microplastics in coastal waters is crucial for assessing their ecological impacts and implementing targeted mitigation measures.

I. MECHANISMS OF EXPOSURE

Microplastics enter the marine environment through various mechanisms, exposing marine organisms to these pervasive pollutants. The following mechanisms outline how marine life comes into contact with microplastics:

1. Direct Ingestion:

Marine organisms, ranging from planktonic organisms to large vertebrates, can directly ingest microplastics. Microplastics can resemble food particles or be mistaken for prey, leading to their ingestion by filter feeders, suspension feeders, and predators. Filter-feeding organisms, such as bivalves and some species of zooplankton, indiscriminately capture and consume particles suspended in the water column, including microplastics. Additionally, larger marine species, such as fish and marine mammals, may inadvertently ingest microplastics when consuming prey that has already consumed microplastics.

2. Trophic Transfer:

Microplastics can also be transferred through trophic interactions within marine food webs. When microplastics are ingested by one organism, they can accumulate in its tissues. Subsequently, if that organism is consumed by another organism higher up in the food chain, the microplastics can be transferred. This trophic transfer can lead to the bioaccumulation of microplastics, with potentially higher concentrations in higher trophic level organisms, including top predators.

3. Physical Interaction:

Some marine organisms, particularly those that inhabit or attach to submerged surfaces, may come into direct physical contact with microplastics. For example, benthic organisms, such as corals, sponges, and mollusks, can be exposed to microplastics that settle on or become entangled in their structures. Physical contact with microplastics can lead to localized impacts, such as abrasion or interference with feeding, respiration, or movement.

4. Adsorption and Bioaccumulation:

Microplastics can act as carriers for other contaminants present in the marine environment. Chemical pollutants, such as hydrophobic organic compounds, can adsorb onto the surface of microplastics. When organisms ingest microplastics, they may also ingest these adsorbed pollutants. This adsorption and subsequent bioaccumulation of contaminants can pose additional risks to the health of marine organisms, as they can be exposed to elevated levels of harmful substances.

It is important to note that the mechanisms of exposure to microplastics are not mutually exclusive. Organisms may encounter microplastics through multiple pathways, increasing their potential exposure and the associated risks. Understanding the mechanisms of exposure is essential for assessing the extent of microplastic contamination in marine ecosystems and evaluating the potential impacts on individual organisms, populations, and entire ecosystems. By identifying the pathways through which microplastics enter and interact with marine organisms, scientists can develop strategies to mitigate and reduce the negative effects of microplastic pollution on marine life and ecosystems.

CORAL HEALTH AND RESILIENCE

Coral reefs are among the most diverse and productive ecosystems on the planet, providing critical habitats for countless marine species and offering valuable ecosystem services to coastal communities. However, coral reefs are facing numerous threats, including the detrimental impacts of microplastic contamination. The effects of microplastics on coral health and resilience are of significant concern, as they can contribute to the degradation and decline of these fragile ecosystems. This section explores the impacts of microplastic contamination on coral health, highlighting key aspects related to their resilience and survival.

1. Coral Reef Ecosystems:

Coral reefs are formed by the accumulation of calcium carbonate exoskeletons secreted by coral polyps, tiny animals that belong to the phylum Cnidaria. Corals have a mutualistic relationship with photosynthetic algae called zooxanthellae, which reside within their tissues. This symbiotic relationship enables corals to obtain essential nutrients and energy through photosynthesis, contributing to their growth and survival. However, corals are highly sensitive to environmental changes and can be susceptible to various stressors, including elevated water temperatures, pollution, and nutrient runoff.

2. Impacts on Coral Health:

Microplastic contamination can have adverse effects on coral health through multiple pathways:

a) Physical Damage: Large microplastic fragments can physically damage coral tissues, causing abrasions, lesions, or tissue necrosis. This physical damage weakens the coral's structural integrity, making them more susceptible to infections and other stressors.

b) Reduced Light Availability: Microplastics can reduce light penetration into the water column, leading to decreased light availability for the zooxanthellae residing within coral tissues. Since zooxanthellae provide corals with essential nutrients through photosynthesis, reduced light availability can result in decreased energy production, compromising the coral's health and growth.

c) Chemical Toxicity: Microplastics can release chemical additives or adsorbed pollutants, which can be toxic to corals and their associated symbionts. The release of additives, such as plasticizers or flame retardants, can disrupt physiological processes in corals, affecting their growth, reproduction, and immune responses. Additionally, the presence of adsorbed pollutants on microplastics can further exacerbate the toxic effects on coral health.

d) Alteration of Microbial Communities: Microplastics can provide a substrate for the colonization and growth of microorganisms, altering the composition and diversity of microbial communities associated with corals. Changes in the microbial community structure can disrupt the delicate balance of beneficial microorganisms and increase the likelihood of pathogenic or harmful species colonizing coral tissues, leading to disease outbreaks and reduced resilience.

3. Microplastics and Coral Bleaching:

Coral bleaching, a phenomenon where corals expel their symbiotic zooxanthellae due to environmental stress, is a significant concern for coral reef health. Studies suggest that microplastic contamination can exacerbate coral bleaching events. The presence of microplastics can contribute to the accumulation of heat within coral tissues, leading to increased thermal stress and triggering coral bleaching. Additionally, the combined effects of reduced light availability and chemical toxicity associated with microplastics can further impair the resilience of corals to thermal stress, making them more susceptible to bleaching events.

4. Effects on Reproduction and Larval Development:

Microplastic contamination can also impact coral reproduction and larval development. Coral larvae, released during mass spawning events, can encounter microplastics in the water column. The ingestion of microplastics by coral larvae can interfere with their development, survival, settlement, and subsequent recruitment to establish new coral colonies. This disruption of the reproductive cycle and reduced recruitment can impede the recovery and resilience of coral populations. The cumulative impacts of microplastic contamination on coral health and

(IJISE) 2023, Vol. No. 17, Jan-Jun **e-ISSN: 2454-6402, p-ISSN: 2454-812X**

resilience are of grave concern, particularly in conjunction with other stressors, such as climate change, pollution, and habitat degradation. Protecting coral reefs from microplastic pollution requires comprehensive strategies that focus on reducing plastic waste, improving waste management practices, and raising awareness about the importance of sustainable consumption and environmental conservation. By addressing the underlying causes of microplastic contamination and implementing effective mitigation measures, we can help safeguard the long-term health and resilience of coral reef ecosystems.

CONCLUSION

Microplastic contamination poses a significant threat to marine life and coral health in coastal waters. The sources, types, and distribution of microplastics highlight the widespread nature of this environmental issue. Understanding the mechanisms of exposure is crucial in assessing the potential impacts on marine organisms and ecosystems. The effects of microplastic contamination on coral health and resilience are particularly concerning. Coral reefs, highly diverse and fragile ecosystems, are susceptible to physical damage, reduced light availability, chemical toxicity, and alterations in microbial communities due to microplastic pollution. These impacts can compromise coral growth, reproduction, and survival, and exacerbate the vulnerability of corals to other stressors, including coral bleaching. To protect coral reefs and marine life from the detrimental effects of microplastic contamination, comprehensive strategies are needed. These strategies should focus on reducing plastic waste, improving waste management practices, promoting sustainable consumption, and raising awareness about the importance of environmental conservation.

Additionally, targeted research efforts and monitoring programs are necessary to better understand the extent of microplastic pollution and its ecological impacts. Preserving the health and resilience of coral reefs is of paramount importance, considering their ecological significance, biodiversity, and the numerous ecosystem services they provide. By addressing microplastic contamination and implementing effective mitigation measures, we can contribute to the long-term sustainability of coastal ecosystems, protect marine life, and ensure the well-being of our oceans for future generations.

REFERENCES

1. Andrady, A. L. (2017). Microplastics in the marine environment. Marine Pollution Bulletin, 119(1), 12-22.

2. Browne, M. A., et al. (2015). Microplastic moves pollutants and additives to worms, reducing functions linked to health and biodiversity. Current Biology, 25(20), 2388-2392.

3. Cai, L., et al. (2020). Microplastic pollution in marine environments: A review of current research on occurrence, fate, and ecological effects. Science of the Total Environment, 703, 134722.

4. Lamb, J. B., et al. (2018). Plastic waste associated with disease on coral reefs. Science, 359(6374), 460-462.

5. Nelms, S. E., et al. (2018). Marine anthropogenic litter on British beaches: A 10-year nationwide assessment using citizen science data. Scientific Reports, 7(1), 1-10.

6. Rochman, C. M., et al. (2013). Anthropogenic debris in seafood: Plastic debris and fibers from textiles in fish and bivalves sold for human consumption. Scientific Reports, 3(1), 1-5.

7. Su, L., et al. (2021). Microplastics in coral reef ecosystems: Sources, impacts, and potential solutions. Environmental Pollution, 283, 117057.

8. Wright, S. L., et al. (2013). The physical impacts of microplastics on marine organisms: A review. Environmental Pollution, 178, 483-492.