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Microplastics –Pitfalls for ecosystem

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Introduction

We use a lot of plastic these days, and some of it washes up in the oceans. Over time, this plastic breaks down into very tiny pieces called microplastics. These microplastics are smaller than 5 millimeters, which is about the width of a thin straw. They can be even smaller than that. Microplastics come from two main sources

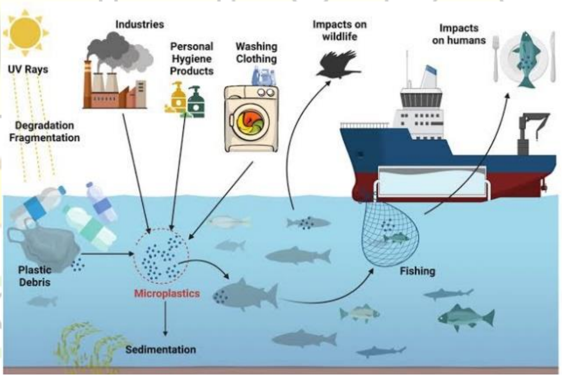
1) Bigger pieces of plastic breaking down,

2) Tiny plastic bits already added to things we buy.

As a pollutant, microplastics can be harmful to the environment and animal health. According to the UN, there are as many as 51 trillion microplastic particles in the seas, way more than stars in the sky.These micro plastics get eaten by the sea creatures.The plastic builds up inside themwe might even eat that plastic later through food chain. Borrelle et al. (2020) projected plastic emissions to 2030 for 173 countries, estimating that plastic emissions to aquatic environment will range between 20 and 53 Mt/year by 2030

Sources of microplastics

Most plastic pollution in the ocean comes from land (70-80%). Land sources include trash, litter, and industrial waste that gets carried to the ocean by rivers, drains, and wind. Surprisingly, a quarter of this land-based plastic comes from overflowing trash cans.The rest comes from places with poor waste management.Fishing gear like nets and lines left in the ocean is another big source of plastic pollution (about half of all ocean plastic from marine sources).Micro plastics, tiny bits of plastic, come from many sources including clothes, dust, tires, and even makeup.



(Microplastics pose a growing concern in oceans and other aquatic habitat. Photo: Sören Funk)

They can be divided into two main categories according to their source: Primary and Secondary. Primary MPs are produced small plastic granules to be used in facial-cleansers and cosmetics, air blasting technology, and vectors for drugs in medicine, while secondary nano plastics are tiny plastic remnants deteriorated from MPs debris

Primary microplastics

Primary microplastics are directly released in the environment as small particles.

Examples:

- Plastic Pellets (Raw Materials)
- Personal Care Products
- Paint
- Washing Wastewater
- Sewage Treatment Plants
- Plastic Running Tracks in Schools
- Artificial Turf
- Rubber Road in Cities
- Vehicle Tire Wear

Main sources: Laundering of synthetic clothes (35% of primary microplastics); abrasion of tyres through driving (28%); intentionally added microplastics in personal care products, for example microbeads in facial scrubs (2%).

Secondary microplastics

Originate from degradation of larger plastic objects, such as plastic bags, bottles or fishing nets.This makes up most (69-81%) of the tiny plastic bits floating around in the seas. These bigger plastic items break down faster or slower depending on what kind of plastic they are, how old they are, and the sun, water temperature, and acidity of the ocean. Basically, different plastics break down at different speeds in the ocean.

Particle category	Diameter range(mm = millimeters)
Nanoplastics	<0.0001 mm (0.1 µm)
Small microplastics	0.00001 – 1 mm
Large microplastics	1 – 4.75 mm
Mesoplastics	4.76 – 200 mm
Macroplastics	>200 mm

Route and fate of Microplastics

Point and nonpoint sources are two categories that help us understand where microplastic (MP) releases are coming from. Point sources refer to MP entering the environment from a single location, while nonpoint sources come from multiple locations simultaneously. These MP are then spread throughout the environment through air and water pathways. Wind and stormwater runoff are considered the main transport mechanisms for plastics from land to water. Heavy precipitation can also carry MP from land areas to nearby water bodies.

Mp in the fluvial environment

Inland waters, urban lakes, and riverbanks have been found to be more susceptible to plastic (macro and micro) pollution,while in the marine environment, ocean current convergence zones, beaches, and seafloors are likely depositional environments for MP. Streams serve as MP transport systems. Because MP are translocated by water currents and their vertical distribution is regulated by particle density and biofouling, it is difficult to precisely identify the source of plastic particles in the aquatic environment.

Movement of MP in surface water

Surface Water

MP has been found in freshwater systems across the globe. MP in freshwater systems can originate from a variety of point and nonpoint sources, such as atmospheric deposition, groundwater infiltration, stormwater runoff, and industrial and municipal wastewater discharges. MP concentration in freshwater bodies can vary by orders of magnitude, with urban streams and glaciers having the greatest concentrations of MP (Koutnik et al. 2021). Treatment of industrial and municipal wastewater sources directly affects the volume of MP entering surface water bodies.

Rivers, Lakes and Streams

Rivers, Lakes, and Streams distribution dependent on multiple factors, including wind, currents, streamflow rate, and temperature (Petersen and Flow rates in freshwater systems can impact the spatial distribution and concentrations of MP.Decreased velocity can result in accumulation of particles as well as deposition into underlying sediments, whereas areas of high flow rate can result in more transport and possible resuspension of settled particles and areas of decreased flow velocity act as sinks, whereas rivers and streams (higher flow velocities) will tend to act as conveyance systems (Petersen and Hubbart 2021).

Storm water

In most urban environments in the western United States, rainfall and runoff wash silt, sediment, and debris into stormwater collection systems that discharge directly to receiving waters without treatment. Collection systems increase the contaminant load, including MP that discharge, into our lakes, streams, and bays. Once present, these plastics and MP can be entrained into stormwater runoff, which then drains to collection systems, lakes, streams, or other low-lying areas. Stormwater treatment systems and consequently elevate groundwater pollution risk.

Bay and Estuaries

Bays and estuaries provide an important insight into the fate and transport of MP. Because, they act as transitional areas, important hubs for MP transportation around the world. Hydrodynamic conditions, they are considered an important site for understanding the transition of macroplastics. This is predominantly due to their ability to act as a sink for larger plastic debris. This means that estuaries contains both primary and secondary sources of MP that can be Mangrove swamps, productive habitats that act as valuable nurseries for fish and invertebrates, perform as important factor. These factors make mangroves a vitally important coastal. Mangroves have dense and developed roots that grow in clay-rich environments that contain a high amount of organic. This makes them an important filtration mechanism, ultimately allowing these estuaries to act as MP sinks. In fact, the abundance of MP in the mangrove ecosystems has been found to be 4–10 times higher in the water column, and 2–3 times higher in the sediments, than that of other ecosystems.

MP in Ocean

MP is present in oceans around the world. On the ocean surface, gyres (the major ocean currents) move MP around the ocean, where they eventually. Depending on their buoyancy, MP may remain at the surface for many oceans. Denser MP sink deep into the ocean and are distributed throughout the subsea by currents. Deep pelagic water column with the highest concentrations presents at depths between 200 m and 600 m. There are many physical processes governing transport of floating plastic debris, such as ocean currents and convergence. Vertical transport is also possible due to degradation or aggregation with other denser particles (Fazey and Ryan 2016). Plastic particles less dense than seawater are transported throughout marine environments (Zarfl and Matthies 2010) and the ocean surface will break down through physical and biological processes to produce MP. Transport of MP in deep marine environments is driven by three primary processes (Kane and Clare 2019).

Mp in Soil

It is likely that soils will act as long-term sinks for MP given that most plastics are years due to their suspected omnipresence in soils.The fate and transport mechanisms of MP to and through soil are not well understood (Dris et al. 2016). Available studies suggest that the fate of MP in soils is complex, and many factors play a role, such as the type of MP (that is, polymers vs.others), density (affecting the wind action transport pathway and movement potential), size, colour, shape, soil conditions (forexample, pH, mineral content, organic matter, etc.), weather conditions (that is, greater wet-dry cycles increase the migration depth), etc. Several pathways were documented for larger plastic debris entering terrestrial soils and later becoming MP.

MP in Sediment

MP have been detected in marine and freshwater sediments and in both flowing and non-flowing systems. Source of MP in sediment is the settling out of suspended MP in the water column. Wind, tides, biofouling, and weathering influence particle settling frequently detected MP in sediments, and higher density MP are more likely to be trapped and settle in sediment. MP are more likely to settle in surficial sediments, and MP abundance decreases with MP in river sediments are often unaccounted for and are likely a pollution.

MP in Air

The atmosphere plays an important role in MP transport, with increased occurrence and higher transport concentrations noted in more densely populated areas. Atmospheric deposition of MP may be driven by precipitation events, including both rain and snow. Airborne and atmospheric transport of MP was first reported in Paris during 2015.Atmospheric transport is considered an important vector affecting MP transport. Dynamics of plastic pollution in both marine and terrestrial environments (Bank and Hansson 2019). Atmospheric fallout could be a significant source of fibres in freshwater ecosystems. atmosphere in pristine remote areas far away from source regions, suggesting potential long-distance atmospheric transportation.

MP in biota

MP have been found in terrestrial and marine biota, including plants, invertebrates, birds, mammals, and fish, spanning all. For example, some studies have found that bioaccumulation is clearly taking place among trophic levels (Miller, Hamann, and Kroon 2020).MPs have been found in edible fish, according to various research, and as a result of biomagnifications, MPs penetrate human systems (Alfaro-Núñez et al., 2021; Goswami et al., 2020; James et al., 2020). MP-induced impairments in species ranged from minimal biological systems disturbance to substantial unfavorable consequences that resulted in mortality Physiological harm as a result of MPs accumulating within the digestive system; disruption of organisms' energy flow as a result of MPs expelling as pseudofeces; and inner body tissue exposed to MPs after transfer within the body were all designated as harmful by Ma et al. (2020). They also serve as a pathway for organic contaminants and trace metals to reach aquatic habitats)..As fish is a major source of protein for humans, the prevalence and ecotoxicological effects of MPs in fish may influence aquatic food security

Microplastic in freshwater:

Microplastics, i.e., plastic particles in the size range of planktonic organisms, have been found in the water columns and sediments of lakes and rivers globally. MPs are a varied contaminants suits which originated from many different product types, composed of various polymers and chemical additives, characterized by a broad range of colour and shapes.Innature,MPs contaminate inland and marine waters. Assessment of the hazard due to MPs within inland water ecosystem focus on several different topics (such as bioaccumulation, biomagnifications, sedimentation, spreading etc.) .Moreover ,rivers are proposed as the main source of plastic for sea and ocean .Accordingly, rivers and stormwater runoff transport plastics from the terrestrial and freshwater compartments into the ocean (Preston-Whyte et al., 2021). In fact, rivers are estimated to annually input between 0.8 million and 2.7 million metric tons of plastic waste into the ocean (Meijer et al., 2021).

Microplastic in estuary

Estuaries are characterized by their brackish waters that result from the mixing of salty seawater and riverine freshwater in their middle section. The water exchange in such environments is a factor of river discharge on the continental side (upper estuary) and tidal cycles on the marine side (lower estuary). The multiple water inputs cause a high nutrient content, making estuaries among the most biologically productive ecosystems in the world (Barletta et al., 2019; Lourenço et al., 2017). They act as habitats for countless species of flora and fauna. In fact, numerous commercial fish species utilize estuaries as nursery areas due to the availability of food and sheltered waters (Barletta et al., 2019; Rodrigues et al., 2019).

Conclusion

Plastic is a valuable, useful, and useful material that is used to make up the bulk of the items in daily life; however, in today's world, mismanagement, improper handling, and abuse of plastics have resulted in MPs pollution in every edge of the aquatic environment, from the highest-ranked pelagic layer to seafloor sedimentary rocks.Reducing MPs contamination is critical. Implementing efficient waste management methods, enhancing the shelf life of plastic items, and increasing awareness can substantially limit the input of litter into environments, allowing the aquatic ecosystem to be recovered.

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