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Classification and Impacts of Microplastics

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The size and prevalence of microplastic (MP) contamination have just recently been apparent, despite sporadic observations of microscopic plastics in the environment dating back to the 1960s (Ryan, 2015). The number of research examining the spread and effects of MP in the marine environment has grown practically exponentially as a result of increased awareness, and attention to freshwater and terrestrial environments is also growing at an exponential rate. Nevertheless, despite the field's tremendous growth, there are still a lot of unanswered problems about how MPs should be categorised, monitored, and how they affect the environment. Our current state of knowledge could be characterised as wide but shallow.

Classification of microplastics

The term "microplastic," which was previously used without consistency within or between study domains, has undergone a number of attempts to be formally defined over the past ten years. A further source of confusion is the fact that a lot of researchers also use the word "mesoplastics" to refer to particles that are at the largest end of the MP size range. The categorization and classification of MPs have varied depending on discipline, leading to the emergence of common terminology and definitions; however, the continued ambiguity has led to some misconceptions by people even one step removed from the research (e.g., regulators, media) and may subsequently affect the development of public understanding, meaningful policy, and efficient mitigation methods. Size is not the most crucial descriptive component, according to a recent framework for plastic definitions proposed by a group of international scientists (Hartmann *et al*., 2019). The framework takes biological affects and endpoints as well as other significant cross-discipline subjects into account.

In order to compare datasets, it is imperative to address the issue of standard definitions; examples of inconsistently represented things include fibres, rubbers, paint particles, and cellophane. Rubber, certain fibres, and paint particles, according to polymer chemists, are not considered to be plastic; but, if natural fibres are taken into account, cellophane, various forms of regenerated cellulose, and semisymmetric materials are. This implies that size should be taken into account once particles have been defined. Size, form, colour, and provenance become characterization criteria after classifying the physiochemical attributes. Aside from this ongoing discussion, size is currently the most popular criterion for defining plastics. Size classes are typically listed as nano, micro, and macroplastics. Because size affects how a particle interacts with biota and how it behaves in the environment, particle size has ecological significance. It is frequently disputed that the size range of particles known as "microplastics" has any real scientific basis. The top limit that is most usually utilised is 5 mm, as suggested by NOAA and partly based on the availability of small particles for consumption by marine biota.

Origin of micro plastics

When studying legislative strategies to reduce plastic pollution, MPs may also be categorised by their source in addition to size. This should only be used when it is possible to accurately trace the origin of the plastic because identifying the origin of several MPs can be unmanageable. In general, primary MPs are defined as those particles that are purposefully produced within the MP size range, whereas secondary MPs are created when primary MPs are broken down or fragmented in the environment. Preproduction pellets, the feedstock for a significant percentage of the plastics industry, are among those particles that are purposefully made to be small. Around 350 million tonnes of raw plastics are produced each year, and these are transported to manufacturers who melt them down to be converted into individual products or components.

Secondary MPs come from a wide variety of terrestrial and marine sources. In MP, in-use fragmentation and post-use fragmentation are two separate stages of secondary production. Tyre wear, the development of microfibres during clothing washing, and the wear on fishing gear are a few examples of in-use fragmentation. In addition, organisms may contribute to the degradation of in-use plastics. For example, isopods that bore into polystyrene (PS) floats create MPs and polychelates as they construct their burrows.

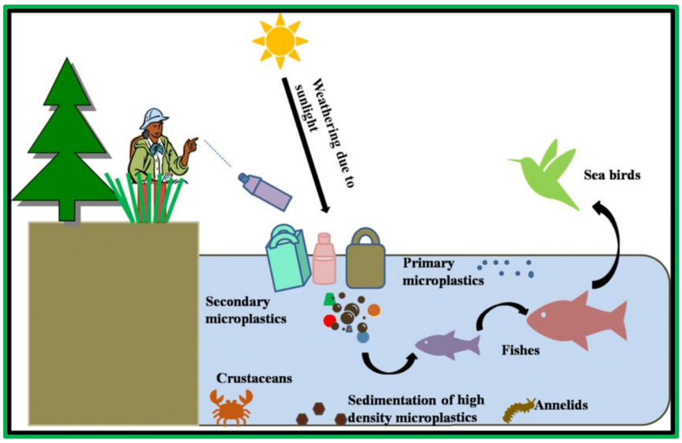

Fig 1: Microplastics pathway in organisms

Production of microplastic

The widespread use of plastics in manufacturing and consumer goods, as well as the consequent improper treatment of plastic trash, are the main causes of MP pollution. According to the most thorough calculations, there could be anywhere between 5 and 511012 (5-51 trillion) particles in the marine environment.

Observation of microplastics in global level

Similar to the massive plastic debris covered in the chapter before it, MPs have a variety of characteristics that maximise their dispersal on land and at sea. Plastic can travel great distances on air and water currents because of its buoyancy and durability. Due to this broad mobility, MPs have now been seen in every environment in the world.

Air: Many plastics are made with a high surface-area-to-volume ratio, which makes them capable of being carried on air currents, in addition to the various low-density polymers. Large plastic objects like bags in the wind or the millions of invisible MPs that float on the slightest breeze are examples of wind-borne plastic transport. Although research on airborne MPs is still in its infancy, nothing is known about their concentration and origins at this time. The disintegration of textiles, which results in fibrous particles that have been found in atmospheric fallouts as well as in indoor and outdoor contexts, is thought to be the source of many airborne MPs.

Terrestrial: Although it is acknowledged that the majority of marine MP pollution is of terrestrial origin, the presence of plastics in terrestrial ecosystems has not received the same level of research as that of air. The amount of research conducted on the terrestrial environment compared to those on coastal and marine systems differs. The intricacy of distribution patterns and pathways on land as well as the recognition of marine systems as a final destination for plastic pollution may be to blame for this. Due to the masking effects of vegetation and soils, it is frequently more difficult to identify plastics and MPs on land. Furthermore, there is a significant geographical bias, 67% of studies on terrestrial plastics were from developed countries; data are still lacking in areas that have some of the largest rivers, and further studies are required to validate predicted values of MP input (Jambeck *et al*., 2015).

Lakes: In locations where there is little water movement, lakes, which are transient features in the aquatic environment, can serve as sinks and MP particle reservoirs (Free *et al*., 2014). The Great Lakes have surface water concentrations of 43,000 particles per square kilometre, which are comparable to Lake Geneva in Europe (48,146 fragments per square kilometre), and these concentrations were the subject of some of the first studies on MPs in freshwater systems. Urbanisation, industrial activity, and wastewater intake appear to have an impact on the composition and quantity of MPs in lakes, which can serve as catchment-scale sinks for MPs.

Fig 2: Microplastics in lake sand

Rivers: MPs are often transported downstream into estuarine habitats with recurring stranding and refloatation episodes, making river systems one of the main entry points for plastics and MPs into the marine environment. However, these locations are prone to MP pollution because of their closeness to populated areas and industrial facilities, and they may even exhibit high MP levels on their own. Particularly clear evidence of this can be found in investigations of the sediments and water column of urban rivers and their larger catchments. In the United Kingdom, observations of sediments in the River Thames revealed an average of between 12.1 and 22.3 synthetic microfibres per 100 g, and a larger study of 14 river catchments in North West England revealed that microfibres make up an average of just 9% of recovered MPs before flood events and 3% after flood events.

Fig 3: Microplastics in rivers

Interaction effects between biota and microplastics

MPs and creatures frequently interact with plastics in all situations. Small plastics may stick to the surfaces of organisms; entanglement is less likely but has been documented in a variety of species with varying sizes and feeding modes. Although MP adherence is currently understudied, it has been noted in bivalve molluscs, oligochaetes, polychetes, and crustaceans, as well as in algae like *Fucus vesiculosus*. Grazing herbivores like *Littorina* may consume MP as a result of adhering to algae and common prey species.

Conclusion

There is a lot of MP contamination in the environment. The potential MP sources will increase in line with the continued expansion in our use of plastics.Highly impacted locations where MP pollution has been observed may be a sign of distant environments in the near future, and assessments of the consequences that now employ increased plastic concentrations may be effective forecasting tools. Numerous recommendations have been made to help us lessen our plastic footprint in light of our rising reliance on plastic. Many of these have drawn criticism for concentrating on goods or plastics that have a narrow range of applications, as the total effect on plastic use will be negligible. But by doing away with easily replaceable plastics, we might develop more thoughtful, less impulsive habits that result in substantial reductions.

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