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(THE PROCEEDINGS BOOK)

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AN OUTLOOK OF MICROPLASTICS: A REVIEW

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ABSTRACT
Microplastics are fragments of plastics less than 5mm in diameter, formed by the physical, chemical and biological degradation of macroplastics and they are also intentionally manufactured for industrial purpose. Now a days, it is an emerging environmental pollutant that globally dispersed in every ecosystem. The small size of the microplastic with toxicological potential makes it more harmful to the environment including, humans. Due to the large surface area, the microplastics can act as a vector for contaminants. It can easily enter into the food chain and resulting in biomagnification. The fate and consequences of microplastics depends on their diversity and composition. Microplastics are complex and diverse in nature, they originated from different sources and the differences in the microplastic help to determine how they are entered into the environment. The mitigation of microplastic pollution is difficult due to the morphology and chemical composition. Therefore, it is essential to learn more about microplastics and its characteristics for their sustainable management. This review provides a broad overview of microplastics, their varieties and properties.
Keywords: Microplastics; Environmental pollution; Fate of microplastics

INTRODUCTION
Plastic production has increased quickly over the past 60 years, which has led to an increase in plastic trash on our planet (Bouwmeester *et al*., 2015). Plastic waste accumulation has been observed in a variety of environmental settings around the world (Rezania *et al*., 2018).Since they have a long history of stability, plastics exhibit gradual deterioration, which causes environmental pollution, which is now recognized as a severe problem. Plastic degrades in the environment through a variety of processes and unfortunately, the fragmentation process only partially decomposes the plastic waste, turning it into tiny particles known as microplastics (Arthur *et al*., 2009). There are mainly two sources of microplastics, that are primary sources and secondary sources. Microbead-containing personal care items, paint, sewage sludge, washing wastewater, artificial turf, rubberized streets in cities, and tyre wear from vehicles are the primary sources. The seconadry sources include Municipal waste, such as plastic bags and bottles, fishing waste, agricultural film, and other large-scale plastic wastes. Microplastics are prevalent in a variety of environments, including marine and inland sediments, water, soil and even in the atmosphere due to the rising output of microplastics (Chen *et al*., 2021). Smaller plastic fragments may mix with food, as a result, it enters in the food chain causing biomagnifications of microplastics. Microplastics are capable of absorbing harmful and eternal bioaccumulative compounds (Hidalgo-Ruz *et al*., 2012). Humans are exposed to microplastics in a variety of ways, including through food, the air they breathe, and skin contact with objects, fabrics, or dust that contain these tiny plastic particles (Prata *et al*., 2020).

The smaller size of microplastic makes it easier for aquatic species to consume it, which causes an accumulation of toxic substances and disrupts their physiological processes (Issacc and Kandasubramanian, 2021). Pollutant concentrations on microplastics from environments are influenced by a variety of elements, such as the quantity and kind of pollutants present, the environmental conditions in the water nearby, and the characteristics of the microplastics (Wang *et al*., 2018).

THE EMERGENCE OF MICROPLASTICS

The microplastics derived from both primary and secondary sources. The primary sources include the microplastics designed for commercial uses like cosmetics, textiles, personal care products while the secondary sources includes the disintegration of larger plastics to tiny particles through abiotic and biotic degradation. Abiotic factors like light, temperature, air, water, and mechanical forces cause plastics to alter in terms of their physical or chemical properties, which is referred to as abiotic degradation of plastics (Andrady, 2015). The term "mechanical deterioration" describes how polymers break down as a result of outside influences. Environmental external forces might result from plastics rubbing up against rocks and sand due to wind and waves. Plastics typically photodegrade through reactions mediated by free radicals that are brought on by sunlight. The term "thermal degradation" describes the breakdown of polymers caused by energy input from high temperatures (zhang *et al*., 2021). The term "biotic degradation of plastics" describes the deterioration of polymers carried out by living organisms. Numerous studies have shown that microbes like bacteria and fungi have the potential to break down plastic. Biological degradation of polymers is influenced by environmental factors such as humidity, temperature, pH, salinity, oxygen presence or absence, sunshine, water, stress, and culture conditions.

PHYSICAL AND CHEMICAL PROPERTIES OF MICROPLASTICS

Microplastics are heterogeneous groups of particles differing in their physical and chemical properties which has direct effects on their toxicity. Plastics deteriorates due to environmental weathering caused by both biotic and abiotic processes, it also produces modifications in polymer characteristics (Zheng *et al*., 2021).

Density: The density of microplastic plays a crucial role in their distribution. In an aquatic ecology, heavier particles sink to the bottom and lighter debris floats on the surface. This floating characteristic affects the kinds of species that consume food in the pelagic water column (Hidalog *et al*., 2012). Denser plastics should scatter less readily in the atmosphere since they are less likely to be picked up by the wind (Rochman *et al*., 2019).

Size: Weathered MPs will have poly-dispersed particle size distributions. Microplastics will become more concentrated as size distribution decreases. All creatures, from the smallest zooplankton to giant predatory fish and birds, can consume microplastics due to their size. It is anticipated that certain sizes of microplastics will be able to pass through the gut and penetrate the cells, organs, and other tissues of living things (Lusher *et al*., 2017). The probability of transmission of microplastics outside the gut is anticipated to rise as the size of microplastics shrinks. This translocation could promote bioaccumulation or possibly biomagnification in food webs. (Rochman *et a*l., 2019)

Shape: The morphology of microplastics is crucial enough to serve as a basis for traceability and a source of information about their origin. The environment encompasses microplastics in a wide range of shapes, including films, foams, pieces, sponges, beads, fibres, flakes, and pellets. Clothing often sheds fibres and the pellets are typically a product of industrial feedstock. Microbeads are frequently found in industrial scrubbers or personal care products. Food packaging or expanded polystyrene foam products are common sources of foam.

While smooth edges of microplastics suggest a long residency time due to a variety of environmental factors, sharp edges imply a recent incursion into the environment (Muller *et al*., 2018).

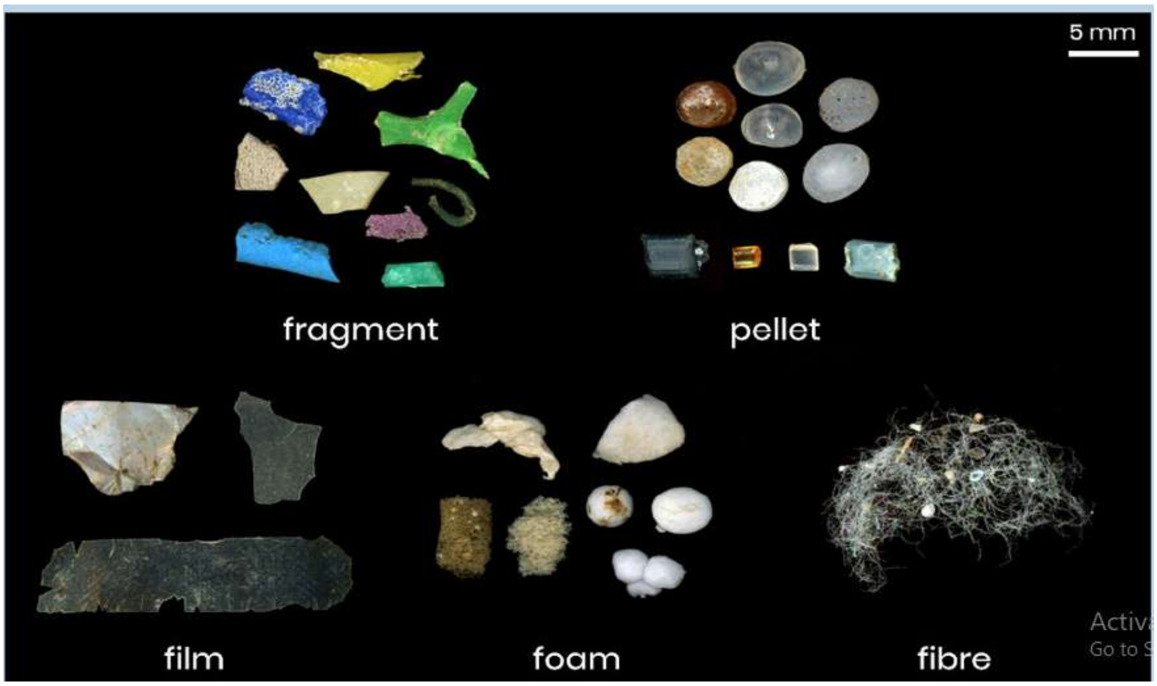

Figure 1: Types of microplastics (Dr.Alexander Kunz- Microplastic research in Taiwan)

Colour: Microplastics are frequently discovered in a variety of colors, including pink, translucent, red, yellow, blue, green, black, brown, grey, and purple. Finding the likely origin sources of microplastics can be done with the help of the colour of the microplastics. The colour can influence how long they stay in the environment and how much the microplastics deteriorates. The degree of fading reflects the exposure time of microplastics in the environment (Turner and Holmes, 2011). In aquatic environment, colour of microplastics plays a crucial role in its dispersal, by encouraging the consumption of tiny plastic particles by species mistaking them for food.

Crystalinity: During the deterioration, properties of plastics such as crystallinity, thermal properties, and surface characteristics, might change (Balani *et al*., 2014). Polymers can be categorised into three groups based on their degree of crystallinity: crystalline polymers, semicrystalline polymers, and amorphous polymers. As the microplastics shrinks, the preferential breakdown in the polymer's amorphous portion causes the overall crystalinity to rise. As a result, crystallites of the microplastics are different from the parent plastic (Rouillon *et al*., 2016).

Surface groups and chemical composition: Carbon and hydrogen atoms are joined in a polymer chain to form microplastics. Typically, microplastics also contain other chemicals such as phthalates, polybrominated diphenyl ethers (PBDEs), and tetrabromobisphenol A (TBBPA). Different functional groups are purposefully modified in primary microplastics, and their surface oxidation capacity varies as well (Lambert and wagner, 2016). When plastics are produced, used, and weathered, these chemicals are easily discharged into the environment. The diversity of surface groups is also the main element influencing the connections with other compounds (Chen *et al*., 2021).

IDENTIFICATION OF MICROPLASTICS

Numerous methods are available for identifying microplastics, from straightforward visual identification to analytical methods based on the chemical makeup of the polymer (Crowford and Quinn, 2016). The most used method, visual identification, first directly chooses particles (1–5 mm) and some probable particles from composite samples. It offers the benefits of quick sample processing and simple access to the physical characteristics of microplastics, such as colour, shape, and size (Irfan *et al*., 2020). A high-intensity electron beam is fired at the sample's surface and scanned across it in a zigzag pattern using a scanning electron microscope (SEM), which produces an image of the sample's tiny surface. The physical characteristics of microplastics retrieved from environmental samples can be analyzed using scanning electron microscopy, together with their physical size and the precise dimensions of any surface features. Therefore, a scanning electron microscope (SEM) can assist in differentiating a plastic object from a non-plastic item based on the surface morphology ((Crowford and Quinn, 2016).) Information on the structure and chemical make-up of microplastics also obtained through spectroscopy (Chen *et al*., 2021). Raman spectroscopy can distinguish the microplastics. It has improved spatial resolution for microscopic particles, is particularly sensitive to non-polar functional groups, and has shorter spectrum bands as a result of water's diminished impact on the outcomes (Araujo *et al*., 2018). The most well-known and extensively used method for determining the type of plastic that makes up microplastics in environmental samples is Fourier-transform infrared (FTIR) spectroscopy. By creating highly specialized infrared (IR) spectra with discrete band patterns and permitting discrimination between plastic materials and natural materials, FTIR is extremely accurate in determining the type of plastic present (Crowford and Quinn, 2016).

NOXIOUS EFFECT OF MICROPLASTICS

As environmental microplastic concentrations rises, there is a greater probability that ecosystems will be exposed, which inturn results in increasing the possibility of contact, ingestion, and hazardous impacts across food webs (Ziajahromi *et al*., 2017). The easiness with which microplastics can be flown to far-off locales suggests that atmospheric diffusion of microplastics may contribute to the contamination of other remote places, such as Antarctica (Bergmann *et al*., 2019). Microplastics have now been discovered in the soils of numerous terrestrial ecosystems including cities and industrialized areas as well as very isolated places and agricultural fields (Piehl *et al*., 2018). Microplastics can alter the general structure of soil, which can have an impact on soil aggregation (Machado *et al*., 2018) and also it could have impacts on plant growth, either in a positive or negative manner (Riling *et al*.,2018). Microplastics can enter the human body by both inhalation and ingestion, which could have a negative health impact. Microplastics can have a range of biological effects on humans such as physical toxicity, which can cause oxidative stress, cytokine secretion, cellular damage, immune system dysfunction, and DNA damage, as well as neurotoxic and metabolic effects (Vethaka and Legler, 2021). Due to its smaller size it can penetrate through epithelial tissues and even cell membranes. Recently microplastics are discovered in the tissues and blood vessels of several marine organisms and humans (Yang *et al*., 2021& Leslie et al., 2022).

CONCLUSION

Microplastics are diverse assemblages of particles that vary in size, shape, and chemical content. The physical and chemical properties of the microplastics affects their toxicity in the environment. Microplastics have drawn particular attention and are considered as the second-most important scientific problem in ecology and environmental science.

It has been well-documented that microplastics are widely dispersed, abundant, and included in food webs. There is a need for new policies and strategies to reduce future generation of microplastics. The development of sustainable waste management policies and relevant standards for microplastic pollution is essential for the well being of environment.

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