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The Effects of Microplastics and its Additives in Aquatic Ecosystem - A Review

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Abstract: *Many studies have proven that microplastics are transported from the terrestrial ecosystem to the marine ecosystem. It has also been established that a significant quantity is added to the marine ecosystem through river transport and atmospheric deposition. Despite the pollution of microplastics being internationally recognized, the understanding of their behaviour in marine environments is still developing. Microplastics are ubiquitous with the potential to cause harm to the marine ecosystem. This study reviewed the classification of microplastics, the degradation of plastics into microplastics, and the distribution of microplastics. The interaction of microplastics and their additives with marine organisms, as well as the effects of microplastics on aquatic habitats, were also explored.*

Keywords: Contamination, environment, microplastics, review

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1 0 Introduction

The revolution era of the plastic industry was around the 20th century. If the 20th century was the revolutionary era for manufacturing too many plastic-based products, starting from buckets to cars, then the 21st century is the time to bear the consequences. Improper management, lack of information about its negative effects, irresponsible use, and dumping of plastic products turn this planet into a "plastic planet" (Pawan *et al.*, 2023). These plastic materials appeared to pose a great threat to human and animal health. It not only pollutes the roads, forests, and mountains but also our oceans (aquatic habitat) (Zhihao *et al.*, 2022).

The word plastic is etymologically derived from the Greek word Plastikos, meaning "capable of being shaped or moulded," and in turn from Plastos, meaning "moulded." Plastics are solid products of petrochemically derived manufacturing. The petrochemical-derived materials, which include polyethene (PE), polypropylene (PP), polyvinylchloride (PVC), and polyester (Rani *et al*., 2023).

Plastics are a wide range of synthetic or semi-synthetic materials that use repeated numbers of monomers, which are bonded together by a covalent bond as the main ingredient to form a straight or cross-linked large compound called polymers. Polymers have a Greek origin from two words, poly meaning numerous meaning parts (many parts), and they are usually greater than 1000 g/mol in their molecular weight, whereas monomers are less than 100 g/mol in their molecular weight.

Polymers are high-molecular-weight compounds that are constructed by the covalent combination of a large number of low-molecular-weight molecules known as monomers (Sharma, 2014).

Polymers can consist of identical repeating units, which are known as homopolymers, or they may consist of different sub-units in various possible sequences, known as copolymers. Those polymers that are softened on heating and can be moulded are generally referred to as plastic materials (Robert *et al.,* 2021).

Their plasticity makes it possible for plastics to be moulded, extruded, or pressed into solid objects of various shapes. This adaptability, plus a wide range of other properties, such as being lightweight, durable, flexible, and inexpensive to produce, has led to its widespread use (Rodriguez *et al.,* 2023). Plastics are typically made in human industrial systems. Most modern plastics are derived from fossil fuel-based chemicals like natural gas or petroleum; however, recent industrial methods use variants made from renewable materials, such as corn or cotton derivatives. 9.2 billion metric tons of plastic are estimated to have been made between 1950 and 2017 (William *et* al., 2022).

More than half of these plastics have been produced since 2004. In 2020, 400 million metric tons of plastic were produced. If global trends in plastic demand continue, it is estimated that by 2050, annual global plastic production will reach over 1,100 million metric tons (Sharna, 2014).

The success and dominance of plastics starting in the early 20th century have caused widespread environmental problems due to their slow decomposition rate in natural ecosystems. Most plastics produced have not been reused; they are either being captured in landfills or persisting in the environment as plastic pollution. Plastic pollution can be found in all of the world's major aquatic habitat bodies, for example, creating garbage patches in all of the world's oceans (Fig. 1) by increasing the number of microplastics present in aquatic habitats and contaminating terrestrial ecosystems. Of all the plastics discarded so far, some 14% have been incinerated and less than 10% have been recycled (Roland *et al.,* 2017). The infiltration of plastic waste into the environment constitutes a growing challenge for people and ecosystems across the globe.

Fig. ***1 The appearance of the collected waste plastics from the ocean***

The rate of biomagnification and bioaccumulation of microplastics in our food chains is increasing like the speed of light, resulting in massive impacts on the health of aquatic organisms.

There is a need to investigate the contribution of microplastics and study how microplastics contaminate our aquatic ecosystem. This paper discusses one of the increasing concerns of the present world, i.e., microplastics, and plastic debris with various sizes and their distribution. Also highlighted are the origin and sources of microplastics as well as proffered solutions on the way out of this pollutant that has adversely impacted the aqua ecosystem.

2.0 Origin of Microplastics (MPs)

The disposal of plastic materials is an issue of concern these days because of their durability and corrosion resistance. Plastic compounds take years to degrade into smaller fragments. Larger plastic debris slowly degrades into small fragments with various size ranges extending from meter to micrometre and even to nanometer. Due to changes in environmental conditions, these fragmented plastics with sizes smaller than 5mm are known as microplastics and are highly persistent in the ecosystem.

Microplastics are generally characterized as water-insoluble because they are hydrophobic solid polymer particles that are less than or equal to 5mm in size (Bergmann *et al.,* 2015). They can also be referred to as small, optically detectable granular or fibrous fragments of plastic materials found in the marine environment (Thompson *et al*., 2004). These smaller plastic fragments and particles can be categorized as either primary or secondary microplastics based on their source. Microplastics (MPs) are present worldwide due to their higher mobility and longer periods of dwelling across the coast as well as in remote oceanic islands (Coast and Barletta, 2015; Lusher, 2015), inside the Antarctic flows (Lusher, 2015), on the Arctic seabed (Bergmann and Klages, 2012; La Daana *et al*., 2019), and even above glaciers (Bergmann *et al*., 2017). In summary, no ecosystem on Earth seems to have avoided microplastic contamination (Taylor et *al*., 2016).

2.1 Classification of microplastics

The classification of microplastics is based on the origin, whether the particles were originally produced to that size, which is known as primary microplastics, or whether the particles originated from the breakdown of larger items (plastic materials), which is secondary microplastics. Primary microplastics include microbeads found in personal care products, plastic pellets (or noodles) used in industrial manufacturing, and plastic fibres used in synthetic textiles (e.g. nylon) (GESAMP 2015).

Primary microplastics enter the environment directly through any of various channels for example, product use (e.g., personal care products being washed into wastewater systems from households), unintentional loss from spills during manufacturing or transport, or abrasion during washing (e.g. laundering of clothing made with synthetic textiles). Secondary microplastics form from the breakdown of larger plastics; this typically happens when larger plastics undergo weathering through exposure to, for example, wave action, wind abrasion, and ultraviolet radiation from sunlight (Rogers *et al*., 2023).

2.2 Nanoplastics(NPs)

Nanoplastics are synthetic polymers with dimensions ranging from 1 nm to 1 μm. Nanoplastics are associated with several risks to the ecology and toxicity to humans. They are directly released into the environment or secondarily derived from plastic disintegration in the environment. Nanoplastics are widely detected in environmental samples and the food chain (Lai *et al*., 2022); therefore, their potentially toxic effects have been widely explored.

2.3 Formation of microplastics in aquatic habitat

The presence of this hazardous plastic fragment, known as microplastics, in the ecosystem is due to different anthropogenic activities, which include domestic, industrial, and coastal activities. The introduction of microplastics in the aquatic ecosystem is mainly because of domestic runoff, which contains microbeads and microplastic fragments (used in cosmetics and other consumer products), and also from the fragmentation of large plastic trash. The plastic industries release plastics in the form of pellets and resin powders from air blasting, which also contaminate the aquatic habitat. Some human activities, including fishing practices and tourism activities, and marine industries are the main sources of plastics in marine ecosystems, which will later break down into microplastics by some reactions.

According to the different causes, degradation is usually classified as photo-oxidative degradation, thermal degradation, ozone-induced degradation, mechanochemical degradation, catalytic degradation, and biodegradation (Singh and Sharma, 2008).

Plastic debris on beaches and floating in water is exposed to solar ultraviolet radiation (UV), which is the predominant cause of degradation. Photodegradation is the process of using light (photons) as an energy source to facilitate the oxidative degradation of polymers. Common plastics such as polyethene, polypropylene, and polystyrene (Yousif and Hadad, 2013) with the help of photodegradation and other mechanical factors like the waves in the ocean, wind, change in temperature, and so on, break or weaken the cohesive force holding the molecule of the plastic together and convert them to microplastics.

Photo-oxidation is a form of photodegradation and begins with the formation of free radicals on the polymer chain, which then reacts with oxygen in chain reactions. For many polymers, the general autoxidation mechanism is a reasonable approximation of the underlying chemistry. The process is autocatalytic, generating increasing numbers of radicals and reactive oxygen species. These reactions result in changes to the molecular weight (and molecular weight distribution) of the polymer, and as a consequence, the material becomes more brittle. The process can be divided into four stages (Fig. 2).

Initiation: The process of generating the initial free radical due to the presence of light and oxygen

Propagation: In the conversion of one free radical to another, the free radical reacts with oxygen to form the peroxide ROOH, which could decompose and produce new radicals. These new radicals decomposed by ROOH can go on to the next reactions. After that, there will be more new radicals that are produced and react with each other.

Chain branching: steps that end with more than one active species being produced. The photolysis of hydroperoxides is the main example.

Termination: Steps in which active species are removed, for instance, by radical disproportionation, and also different radicals may react with each other, leading to coupling

Photo-oxidation can occur simultaneously with other processes like thermal degradation, and each of these can accelerate the other.

The deformation of microplastics in aquatic habitats is generally influenced by a combination of environmental factors and the properties of the polymers. The basic mechanism of this autocatalytic oxidation of plastic is well observed during degradation. The plastic waste in the water will discolour, develop surface features, and become weak and brittle over time due to exposure to ultraviolet radiation and water. This brittle plastic can now be turned into microplastics by the action of mechanisms like wind, waves, animal bites, and sometimes human activities (Ali *et al*., 2020).

Fig. 3 explains in detail the process by which secondary microplastics are formed from plastics.

It is estimated that approximately 15–50 % of the total plastics produced are released into the oceans. This usually happens once the land-filled plastic squares are carried by airflow or by erosion into different water bodies like rivers, lakes, and many more (Yashart, 2021). River beds are temporary sinks for microplastics and suffer from extensive microplastic contamination, particularly in rivers in urban areas, which may contain as many as 517,000 particles per m^2 before they move or flow into the oceans (River Tame, UK), because naturally, all rivers flow into the ocean. The main pathway by which plastic debris gets to the marine environment is via rivers, which release approximately 1.15-2.41 million metric tons of plastic into the oceans each year (Leverton *et al*., 2017).

2.4 *Distribution of microplastics particles in oceans and rivers*

The distribution of microplastics has been studied in ten different rivers with different geographical regions in South Africa and Nigeria. The Ogun and Osun Rivers from Nigeria; the Obiaraedu, Nwangele, Okumpi, Ogbajarajara, and Onuezuze rivers from south-eastern Nigeria; and the Jukskei River,

$$RH \xrightarrow{hv} RH^* \longrightarrow R^* + H^*$$

$$R^* + O_2 \longrightarrow ROO^*$$

$$ROO^* + RH \longrightarrow ROOH + R^* \qquad ROOH \longrightarrow R^* + {}^*OOH$$

$$ROOH \longrightarrow RO^* + HO^* \qquad RO^* + RH \longrightarrow R^* + ROH$$

$$HO^* + RH \longrightarrow R^* + H_2O$$

$$ROO^* + ROO^* \longrightarrow ROOR + O_2$$

$$ROO^* + R^* \longrightarrow ROOR$$

$$R^* + R^* \longrightarrow R\text{-}R$$

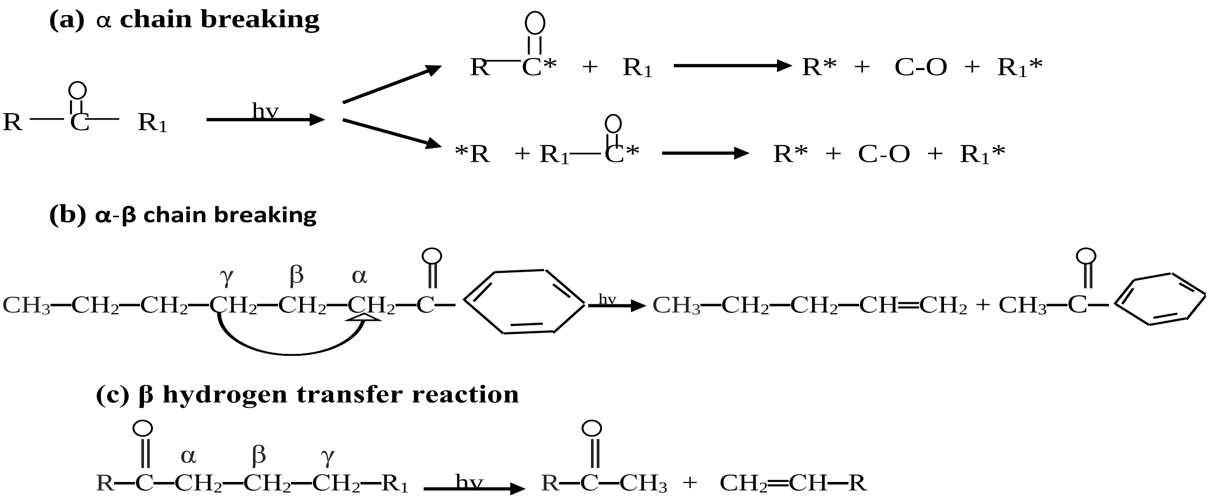

Fig. 2.1. Photooxidation stagess in microplastics.

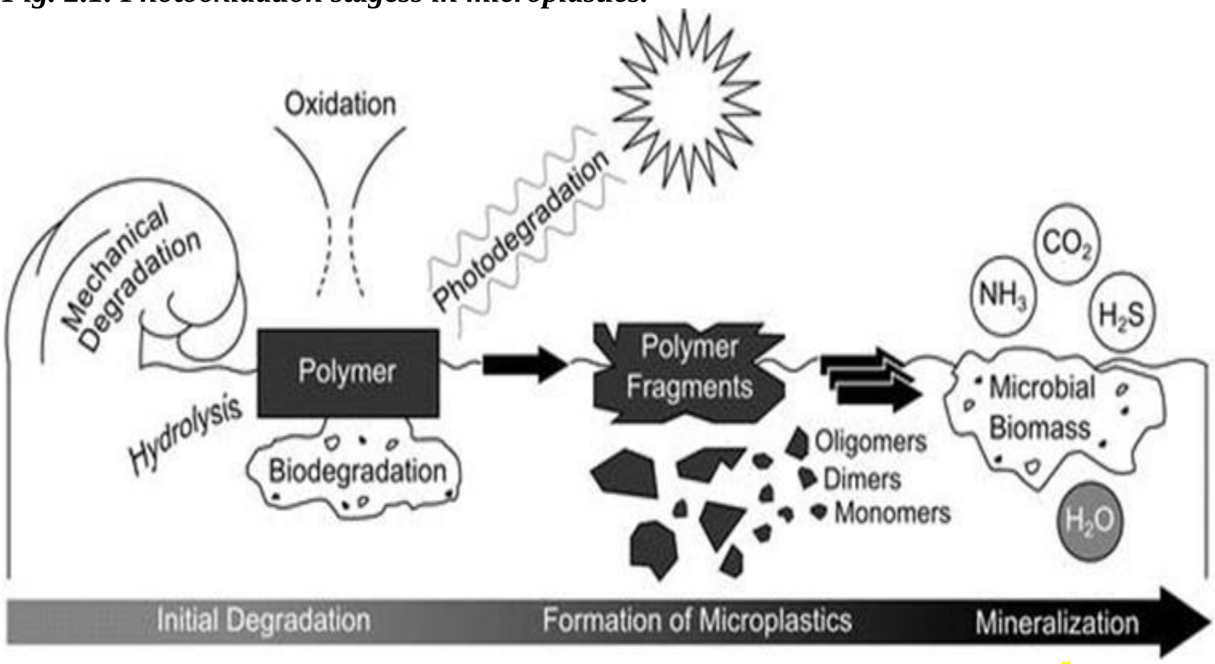

Fig. 2 ***photo degradation of plastics to produce secondary microplastics.***

Orange-Vaal River and Bloukrans River from South Africa were studied.

MPs pollution in the River Jukskei from water and sediment samples at the urban streams has been studied and recorded at different sampling sites. The mean values of mcroplastics were recorded as 705 particles m^3 in water and 166.8 particles kg^1 in sediment samples (Dahms*et al*., 2020). The microplastics pollution from the rivers Obiaraedu, Nwangele, Okumpi, Ogbajarajara, and Onuezuze in southeastern Nigeria was reported by Ebere *et al.* (2019). The MPs abundance was recorded as 3487 items/m2, 469 ± 153.33 items/m^2 (downstream), 85.8 ± 174.94 items/m^2 (midstream), and 211.4 ± 109.84 items/m^2 (upstream) (Ebere *et al.*, 2019). The highest abundance of MPs downstream could be from the small rivers that carry plastic waste and end up at downstream of the big river where the samples were taken.

Average microplastic abundance was recorded as 1.7 ± 5.1 L^{-1} equivalently > 99% fibres in Orange-Vaal River, South African water samples independent of sites, and confirmed that the river is highly polluted (Weideman *et al*. 2020).

The microplastic abundance in Bloukrans River, South Africa, from sediment samples was potentially studied in other rivers. The mean abundances were recorded as 160.1 ± 139.5 MP particles kg^{-1} in sediment samples independent of the season (Nel *et al*., 2018). Microplastic particles are found in almost every aquatic habitat, from the Arctic to the tropics, and in all sea surfaces and oceans (the Pacific, Atlantic, Indian, Antarctic, and Arctic Oceans). Plastics debris have accumulated on the ocean surface because the density of the ocean is generally less than that of the seawater (Segawa, 2018).

The total global mass of floating microplastics in the world's oceans is estimated at 15–51 trillion particles, weighing a total mass of between 9.3 trillion and 2.4 million metric tons (Van e*t al.*, 2015). It is predicted that by 2100, the total mass of floating microplastics will increase between 2.5×10^{7} and 1.3×10^{8} tons (Everaert *et al.*, 2018).

2.5 T*he age distribution of microplastics*

The world's production of plastics annually is approximately increasing gradually from 1.7 million metric tons in 1950 to about 299 million metric tons per year in 2013, according to data from Alexandra *et al.* *(*2017).

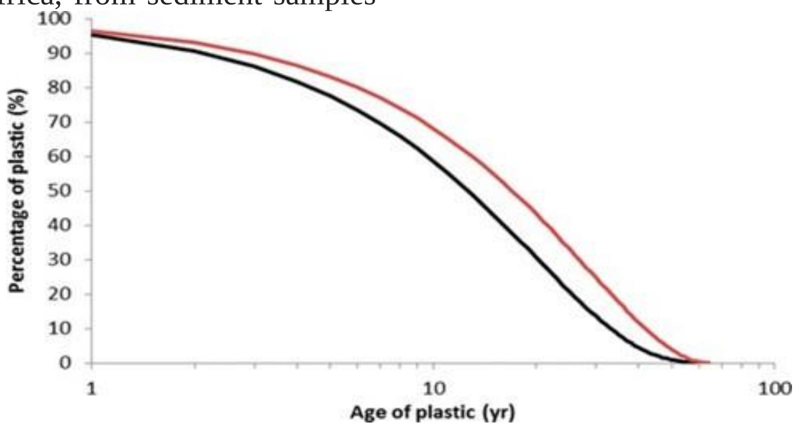

Fig. 3 Age distribution of microplastics

The graph shows the cumulative age distribution of plastic in the oceans based on world plastic production data (black curve). For about 90 % and 50% of the world-produced plastics, the residence time at sea is more than 2 years and 13 years, respectively. The red curve represents the cumulative age distribution based on plastic production in Europe. Using the European production data, the 90% and 50% cut-offs relate to residence times at sea of more than 3 and 17 years, respectively.

The curve can be smoothened using a second-order polynomial. The curve accurately captures the trend in plastic annually, but there are small fluctuations that are caused by stagnations in the world economy in the 1970s, 1980s, and most recently in 2007. It is assumed that a more or less constant fraction of the world's plastic production ends up in the oceans (Albert *et al*., 2017). Some of the million metric tons of plastic emitted in the first years of production have an "environmental age" of about 60 years, whereas the production of 299 million metric tons in 2014 has by definition an age of less than a year.

By combining the annually emitted volumes per year with the age of these yearly volumes (i.e., present year minus year of emission), an age distribution for the cumulative quantity of emitted plastic can be calculated. More or less constant plastic production in the world ends up in the oceans, and that is why the cumulative quantity of emitted plastics can be calculated. The calculation for 2015 shows that about 50 % of the plastic has been present in the oceans for more than 13 years, whereas 80% and 90 % of all the plastic are older than 4 and 2 years, respectively.

If we use European production data (Alexandra *et al*., 2017), the age distribution is similar; however, it shows that 50 % and 90 % of the produced plastics have been present in the European seas for more than 17 years and 3 years, respectively (Fig. 3). In reality, the oceans do not represent one uniform compartment (Ellen *et al.,* 2017). However, mixing within areas or in gyres can be considered more homogeneous. Furthermore, sources and types of plastics do not substantially differ across the globe. Microplastics are considered ubiquitous global contaminants, whereas transport and mixing cause the spreading of microplastics in the oceans, with contamination of even very remote areas as a result. (Niko *et al.,* 2016*).*

Coastal areas may contain relatively "young" plastic particles, yet these areas also receive aged plastics from remote areas. Indeed, beached plastic has been shown to also come from remote sources. Remote areas like the Arctic (Stephanie *et al.* 2017) or deep-sea sediments are further away from anthropogenic sources, implying that they may have a higher share of older microplastics.

The age distribution of microplastics in a given area probably does not show a strong spatial heterogeneity, and the age distribution as given in Fig. 2.2 is roughly uniform across the different major oceanic regions (Albert *et al.*, 2016).

3.0 Distribution of microplastics additives in the marine habitat

During the process or production of different plastics, some different materials or components are incorporated into the plastic that modify the plastic and improve some of its properties. These materials are called additives.

Additives such as plasticizers, flame retardants, heat stabilizers, antioxidants, UV absorbers, foaming agents, initiators, lubricants, antistatic agents, curing agents, colourants, fillers and reinforcements, solvents, and optical brightness are used in the process of manufacturing plastics as shown in Fig. 4.

All these additives are harmful chemicals, and they are leached out into the aquatic environment when the larger plastics undergo weathering via wave action and sunlight (photodegradation) to form microplastics. The additives present on the surface of microplastics are easily absorbed by marine organisms because of the low surface area of the microplastics. Phthalate esters are responsible for endocrine-disrupting substances (Foster et *al.,* 2015). Polyethylene (PE) bags release di-isobutyl phthalate (DiBP) and di-n-butyl phthalate (DnBP). Whereas polyvinylchloride (PVC) cables release important polyaryl ether sulfones (PAEs), dimethyl phthalate (DMP), and diethyl phthalate (DEP) as phthalates.

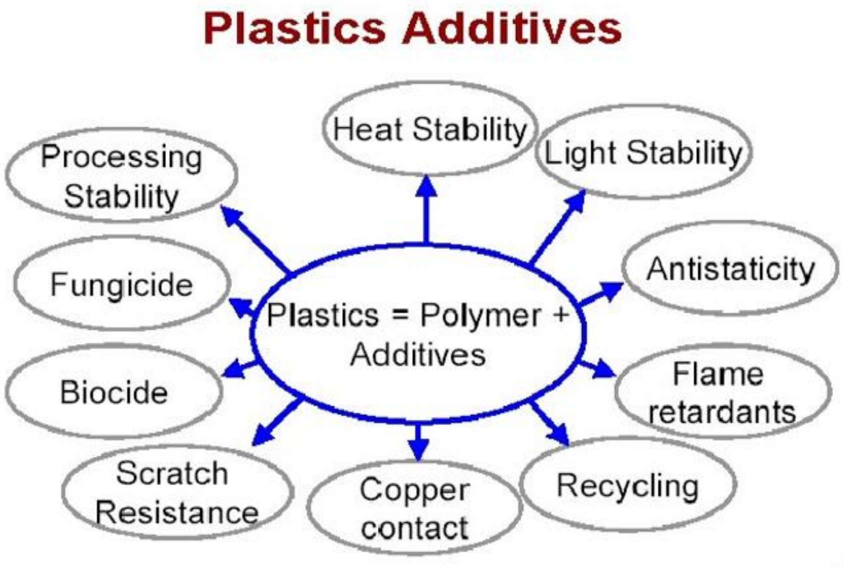

Fig. ***4 Different types of plastic additives***

3.1 Discharging of additives

The small size of microplastics makes it easier for aquatic organisms (animals) to consume, resulting in the amassing of noxious waste and thereby disturbing their physiological functions. Microplastics are abundantly available and exhibit a high propensity for interrelating with the ecosystem, thereby disrupting the biogenic flora and fauna. About 71% of the earth's surface is occupied by oceans, which hold 97% of the earth's water (Merlin *et al.,* 2021). The pH variance in the ocean may alter the chemical balance of microplastics by raising or lowering the rate of chemical leach from their surface, so PET, which is commonly understood to be safe, may become dangerous shortly (Piccardo *et al*., 2020). But some monomeric units are dangerous to the health of organisms in aquatic habitats, like polystyrene (Garrigos *et al*., 2004), polyvinylchloride (Marcilla *et al*., 2004), and polycarbonate (Vom Saal and Hughes, 2005), which have been shown to release toxic monomers that are associated with cancer and reproductive abnormalities in humans, rodents, and invertebrates.

Research shows that additives could leach from plastics ingested by marine organisms (Koelmans *et al*., 2014), providing a negligible exposure pathway. Additives in polyvinylchloride could transfer from medical supplies to humans (Mettang*et al*., 1996), indicating that additives could accumulate in the blood (Rochman *et al*., 2013). An initial screening study of the toxicity of leachates from weathering plastics has shown that 38% of plastics produced leachates that caused acute toxicity to Nitocraspinipes (Bejgarn *et al*., 2015).

There are some additives, like nonylphenol and brominated flame retardants which are leached out of the surface of the microplastics and cause a lot of damage to the endocrine system and are carcinogens to the animal in the marine ecosystem. For example, Brominated flame retardants which are not covalently bound to the plastic matrix and because of this, can easily leach out and get absorbed into the body tissue. Polybrominated diphenyl ethers which do not only have toxic effects on neurological development but also disrupt the endocrine system are another example. Even at very low concentrations, nonylphenol can interfere with the endocrine (Gałązka and Jankiewicz, 2022).

Microplastics can readily accrue and release hazardous organic pollutants like DDT, polybrominated diphenyl ethers, and other additives that are added during manufacture, into the water body, thereby elevating their concentration. Additive-free microplastics are not chemically hazardous to aquatic organisms, but they create problems in physical conditions such as bowel obstructions (Udayakumar *et al*., 2021). Since microplastics can adversely impact various organisms, the risk of humans getting affected by microplastics cannot be overlooked.

4.1 The effects of microplastics on aquatic habitat

Due to the non-biodegradable nature of microplastics, their size, colour, and some of the additives used during plastics production in the manufacturing of plastics, these additives can be leached into aquatic habitats because of the small surface area of microplastics, causing contamination of waterways and resulting in the pollution that is a direct or indirect threat to various aquatic organisms that inhabit them. Direct impacts result from the ingestion of microplastics by both marine and freshwater organisms. The ingestion of microplastics has been shown to have adverse or negative biological effects on aquatic organisms, which can reduce the fitness and functionality of these organisms (Samantha *et al.,* 2016).

4.2 Impact on food web

Due to the small size of microplastics, their uptake by a wide range of aquatic species disturbs their physiological functions, which then go through the food web, creating adverse health issues in humans. Fig. 5 below explains how people degrade aquatic environments and how we are invariably exposed to these contaminants again. Because humans are the final consumers of seafood, which is extensively contaminated with microplastics (Saha *et al.*, 2021), there is a considerable risk of microplastics being transmitted to people (Smith *et al*., 2018). The presence of microplastics in tap water (Tong *et al*., 2020), sea salt (Selvam *et al.*, 2020), and bottled water (Mason *et al.*, 2018) is proven by studies on how many ways they can reach the human body. Recent studies of microplastics in human stool (Zhang *et al*., 2021) and placenta (Ragusa, 2021) are examples of their presence in humans. If plastics can harm humans so badly, we need to do more research on them. The greater the number of microplastics consumed, the more likely it is to pose a risk to the species consumed.

They are uptaken and mostly excreted rapidly by numerous marine species, and so conclusive proof of biomagnification is not obtained (Cozar *et al.* 2014). However, the effects of microplastic uptake result in reduced food intake, developmental disorders, and behavioural changes.

4.3 Microplastics as a vector

Microplastics provide a habitat for the growth of microorganisms because of their small size and varying effects (Yang *et al.*, 2020). The high intake of microplastics reduces development and variance in feeding habits (Horton *et al.*, 2018). Deadly reactions from the discharge of hazardous substances—additives such as plasticizers, antioxidants, flame retardants, pigments, etc. Incorporated during the manufacture of plastic may be leached into body tissues, resulting in induced changes or bioaccumulation. The toxicity can also differ according to the ratio of additives needed for each plastic (Botterell *et al*., 2019). Noxious reaction to pollutants absorbed involuntarily by microplastics—large surface area due to weathering, longer exposure periods, and hydrophobic nature promote the sorption of pollutants to

Due to the increase in surface area of microplastics at a higher concentration, making them a carrier for contaminants to enter aquatic species such as polycyclic aromatic hydrocarbons, Polychlorobiphenyls, DDT, organohalogenated pesticides, hexachlorocyclohexanes, and chlorinated benzenes (O'Donovan *et al*., 2018). The surface area-to-volume ratio of microplastics is large, making them a good sorbent for toxic chemicals such as heavy metals and organic chemicals, i.e., persistent organic pollutants loading on their surface.

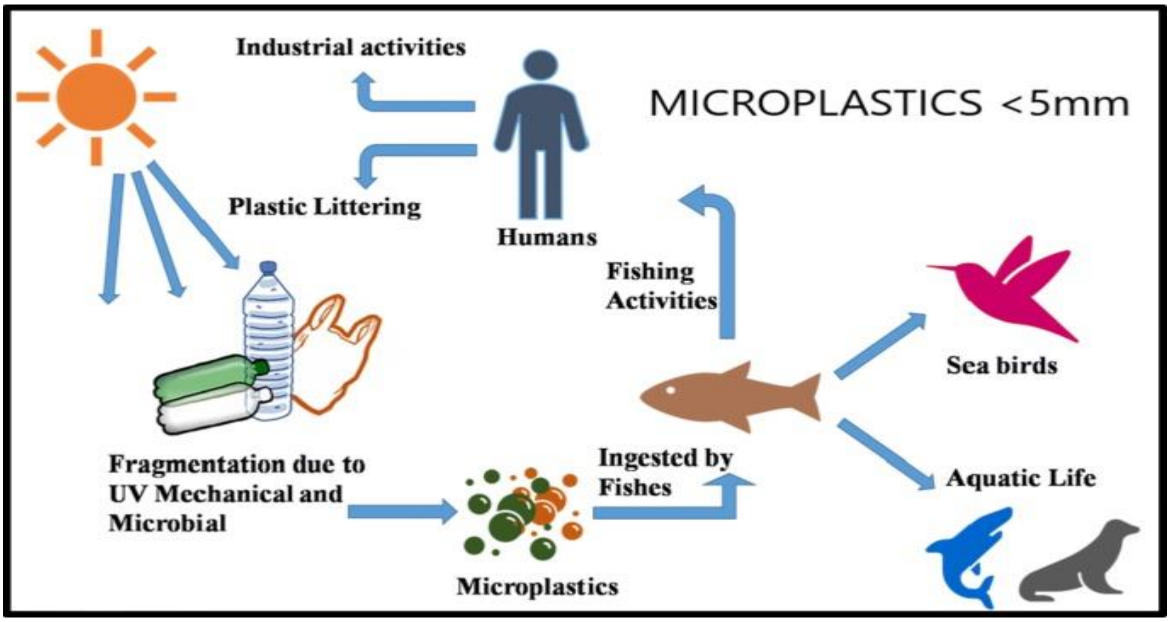

Fig. 5 Microplastics in Food Web

4.4 Impacts of microplastics on aquatic organisms

The presence of plastics in the aquatic environment presents a crucial condition that adversely affects the socio-economic facets of the tourism industry, shipping, trawling, and fish farming (Thushari and Senevirathna, 2020). The floatable and incessant characteristics of microplastics make them prevalent in aquatic environments as marine contaminants, acting as carriers for the transfer of pollutants to organisms present in water (Rodrigues *et al.*, 2019).

Reports show that 267 species, including 86% of all sea turtle species, 44% of all seabird species, and 43 % of all marine mammal species, have been affected by plastic debris. More than 180 species of organisms have been documented to ingest plastic debris, including fish, turtles, marine birds, and mammals (Laist, 1997).

Plastic debris has been reported in the gut content of fish globally, including from estuaries (Possatto*et al.*, 2011; Dantas *et al.*, 2012; Ramos *et al.*, 2012), pelagic habitats, and demurral habitats (Davison and Asch, 2011; Lusher *et al., 2013).* Ingestion of plastic debris has also been seen in wild seafood bivalves (Van and Janssen, 2014). Due to their small size, microplastics are known to be ingested by a wide range of organisms, including amphipods (detrivores), lugworms (deposit feeders), barnacles (filter feeders), mussels (suspension feeders), sea cucumbers (Echinodermata), and Nephrops norvegicus (crustaceans) (Thompson *et al.*, 2004; Browne *et al.*, 2008; Graham and Thompson, 2009; Murray and Cowie, 2011).

Ingestion of microplastics by marine organisms may be retained in their digestive tract, egested in the form of faeces, absorbed into the epithelial lining of the gut by phagocytosis (Browne *et a*l., 2007), or translocated to other tissues. From research, the precise mechanisms of translocation in organisms remain unknown. Thus, a lot of laboratory studies have been carried out. Microplastics were observed in the gills and digestive glands of muscles exposed to concentrations of microplastics under polarized light microscopy (von Moos *et al.*, 2012).

The ingested microplastics are also found in the stomach, hepatopancreas, ovary, and gills of the crabs with the help of fluorescent microspheres (Farrell and Nelson, 2013). Microplastics ingested by blue mussel Mytilus edulis could be translocated from the gut to the circulatory system and persisted for over 48 days (Browne *et al*.,2008). Microplastics are translocated from the gut into the cells and tissue of the blue mussel, Mytilus edulis (von Moos *et al*., 2012).

The retention of plastic debris might occur inside the organisms, resulting in chemical leakages of additives present, thus creating accumulation leading to detrimental effects (Setälä *et al*., 2014).

Microplastics found in marine systems worldwide influence the feeding, growth, spawning, and existence of organisms in aquatic environments. However, the extent to which microplastics are affected by the transfer of chemicals present in and on the surface of microplastics to the more complex food chains is not known (Granek *et al*., 2020). Only limited information (Furtado *et al*., 2016) is available on trophic transfer, so whether the pollutants are ejected or bioaccumulated at higher trophic levels still needs to be studied.

Sussarellu *et al*. (2016), in their studies, showed the adverse Impact of polystyrene microplastics on the reproduction and feeding of oysters due to changes in their food intake and energy distribution on exposure to microsized polystyrene, Oysters showed a reduction in the number of eggs produced, oocyte quality, and sperm motility. Fertilization in oysters occurs externally in the sea, where the eggs and sperm are released, but due to the intake of micropolystyrene, fertilization is affected by reduced sperm speed and its smaller amount (Sussarellu *et al*., 2016). In its faces, 6-µm micropolystyrene ingested by oysters was found. The yield and growth of offspring of microplastic-exposed oysters dropped by 41% and 18%, respectively. The study stipulated information on the effects of microplastics on the development and reproduction of oysters, with considerable impacts on progeny.

The entry of microplastics into the gastrointestinal tract of penguins is either directly due to the misconception of plastics as food, feeding on contaminated prey, or polluted waters. The plastic debris cumulated in the guts of penguins, preventing their consumption of food and also resulting in the absorption of toxic substances from water, thus affecting their growth and development (Bessa *et al.* 2019). Cole *et al.* (2015) showed how ingestion of microplastics affects the feed habit, fertility, and functioning of zooplankton like copepods.

These and many more are some of the detrimental effects identified in aquatic organisms as a result of ingesting or absorbing microplastics and their additives.

5.0 Conclusion

The effects of microplastics are not only on the aquatic ecosystem but also affect higher organisms that feed on these aquatic animals and plants that have been contaminated with microplastics. Humans can also be severely impacted because sea water is their primary source of fish consumption, and most nations around the world, which are responsible for the majority of the world's plastic pollution, have yet to fully comprehend the magnitude of microplastic contamination, particularly in a continent like Africa, that has not yet identified the distribution of microplastics in the oceans and freshwater surrounding it. There is a need to carry out more research to ascertain the distribution of microplastics and to understand the mechanisms of the reaction in the systems of aquatic organisms. These nations need to undertake critical steps to minimize, reuse, or recycle plastics, as well as advocate the use of biodegradable plastics, to improve their ability to curtail their usage.

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Compliance with Ethical Standards Declarations

The authors declare that they have no conflict of interest.

Data availability

All data used in this study will be readily available to the public.

Consent for publication

Not Applicable

Availability of data and materials

The publisher has the right to make the data Public.

Competing interests

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Authors' contributions

Comfort M. Ngwu was involved in conceptualization, writing and editing. Adeniji Moshood Oluwafemi was involved in the writing of the manuscript while editing and corrections were done by Chioma Ikechi