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Review Article

Microplastic pollution: Sources, fate, impacts and research gaps

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Abstract: The occurrence of microplastics into the ecosystem has become and eminent threat for the environment as well as gets extensive attention in recent times. Microplastic existence has severely affected lakes, rivers, oceans, coastal zones, and even polar zones biome. Microplastics (primary microplastics) mostly come from used products and by shattering of larger fragments. Through runoff, the microplastic enters into either aquatic or terrestrial environment where it can cause the devastating impacts not only to that ecosystem but also to the humans. Several studies professed that microplastics have a significant impact on marine and terrestrial communities. Microplastic particles are widespread in India, Asia, Southeast Asia, North America, Africa, South Africa, and Europe. The microplastic source and global distribution in the ecosystem, their effects on marine organisms, particularly in the food chain are illustrated in this review. Finding the principal sources of microplastic into the environment and raising the awareness among communities can significantly reduce the extent of microplastics pollution in the environment. This review article is an effort to create understanding about the microplastics pollution, sources and effects on environment. All the possible environmental friendly remediation strategies like bioremediation are also discussed in this article.

Keywords: Aquatic Biodiversity Impacts, Microplastic occurrence and distribution, Environment deterioration.

INTRODUCTION

Plastic refers to brittle and flexible entity which is mostly a synthetic substance that can be molded into various shapes. Plastic is a cheap, durable, lightweight, resilient, and non-corrosive substance with a high thermal and insulating capacity (Garcia and Robertson, 2017). The plastics consist of long-chain porous materials which comprise organic and inorganic ingredients like the carbon, hydrogen, silicon, and chlorine. These ingredients usually come from petroleum products such as coal or natural gas (Doghri et al., 2016). The most used artificial plastics are polyvinyl chloride (PVC), polypropylene (PP), polyethylene (PE), polystyrene (PS), and polyethylene terephthalate (PET) in nature that may have low or high densities (Ilyas et al., 2018). Synthetic plastics contribute up to 90% in total global plastics production. And it is believed that microplastic pollution is largely due to synthetic plastics in the environment (Adam et al., 2020). Microplastics is a term used to denote the smaller (generally micro sized) plastic residues found in aquatic and terrestrial environments. These microplastics are broken down into smaller sizes due to external environmental factors like high temperatures, ultraviolet rays and physical disintegration (Cox et al., 2019).

In 1972, E. J. Carpenter and K. L. Smith were the first investigators to draw attention to plastic particles found in North Atlantic surface (Amy Lusher, 2015). Scientists are in beliefs that the increase in plastic production combined with current disposal practices may lead to higher intensities on the ocean surface (Pauna et al., 2019). Currently, only known about biological role for those particles is because they behave as hydrates, diatoms, and even bacteria grow on the surface. Not surprisingly, just a few months later, fish ingested the same PE particles (Karbalaei et al., 2019). One of the predictions is at the center of the scientific community, and they analyze the smallest plastic fragments as pollutants. Millions of tons of plastic have been delivered from the time of the middle of the past century (over 200 million tons per year) (Solomon and Palanisami, 2016). It was speculated that this plastic will eventually decompose and break in the ocean. Tiny plastic fragments (<5 mm) are scattered in the environment and migrate and collect in polar regions as well as in natural habitats from the sea surface to the seafloor. These fragments are also dumped on urban coasts and primitive sediments (Urban-Malinga et al., 2020). The plastic pollution is abundant and persistent throughout the world's seas and explicitly warns marine biological communities. In this review, we summarize the fate, source, and effects of microplastic pollution on the aquatic environment. To get a better understanding the interaction of microplastics with the natural environment, the important research gaps that need to be filled are also discussed.

SOURCES OF MICROPLASTICS

The resources of microplastics are mostly divided into primary and secondary microplastics (Boucher and Friot, 2017). The microplastics are produced for various purposes, including cosmetic abrasives, pharmaceutical carriers, and industrial and technical applications (**Figure** 1). Mostly, it is very difficult to remove microplastic using wastewater treatment technologies (Sun et al., 2019). Once in the wastewater, they eventually can become the part of the environment. Secondary microplastics come from larger plastics and gradually break down into smaller fragments under various complicated environmental conditions (like that temperature, wind, waves, and ultraviolet rays). By frequently uses of plastic products may lead to fragmentation and produced secondary microplastics (Barlow et al., 2020).

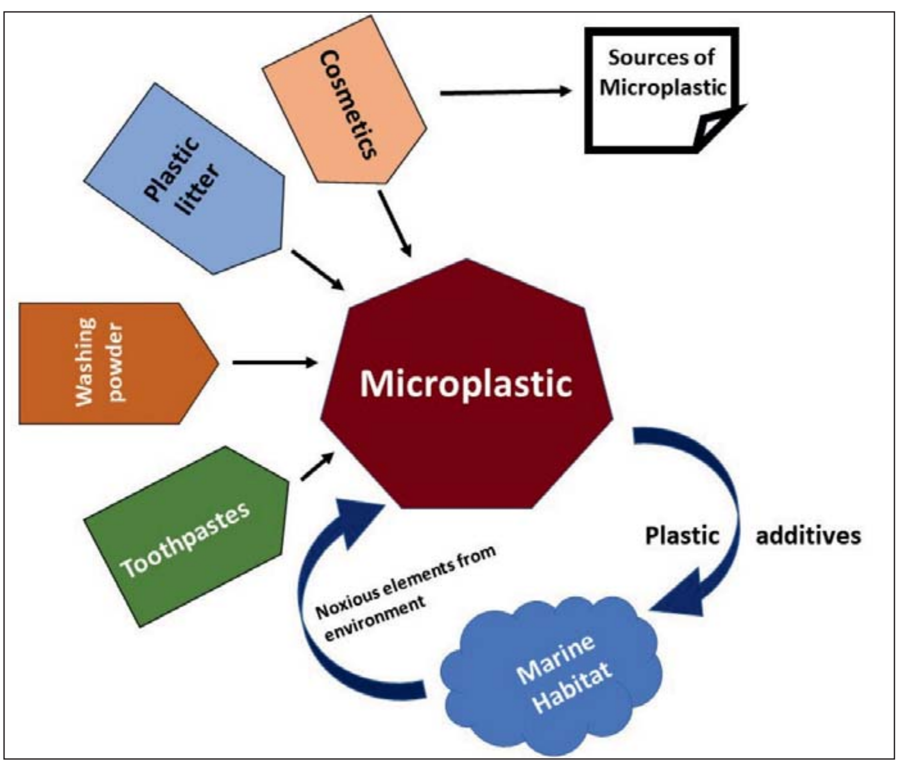

Figure 1: Sources of microplastics in environment

Scientists have found that the microfiber quality of the heaviest household machine in traditional clothing is 1,471 - 2,121 microfibers per garment, which is seven times that of the front-loading machine (Belzagui et al., 2019). A recent study found that 30,000 to 465,000 microfibers (or 175 to 560 microfibers/g) is being disposed-off per square meter of textiles and clothing (Xu et al., 2018). However, plastic emissions linked to vehicle transportation, comprising tire wear, brakes, and road motifs, are other important sources in the ecosystem. It is estimated that global emissions of microplastics from tire wear on-road vehicles are 0.81 kg/year per capita (Kole et al., 2017). Except for road traffic, aircraft tire wear accounts for around 2% of total tire emissions in the Netherlands. Similarly, synthetic surface also plays an important part in the secondary source of microplastics. According to rough estimates, the annual emissions of artificial turf are between 760 and 4500 tons. Therefore, different kinds of microplastics are released into different environments and ecosystems (Rezania et al., 2018).

It is quite evident that microplastic distribution may involve the primarily land resources (80%), coastal tourism, leisure, commercial fishing (such as plastic fishing equipment 18%), seagoing vessels, and marine industries (Avio et al., 2017). Microplastics enter the soil from various sources, comprising landfills, soil changes, land use from sewage sludge, and sewage irrigation, Manure and organic material, agricultural mulch film residues, tire wear and atmospheric sediments. Plastic waste comprises all processes of soil biological activities, digestive and excretory processes and is broken down into microplastics (He et al., 2018). Microplastics existence diminishes soil quality, especially the relocation and nutrient movement of microplastics throughout heavily polluted soils.

Primary microplastics

Primary microplastics are specified as microscopic plastic fragments based on size. According to the chemical composition of microplastics, these are coming from the accidental release of plastic residue (such as particles, nodules, or mermaid cracks), biodegradable plastic products and are in the form of by-products such as the release of raw materials, dust and fibers (Guo et al., 2019)(Kershaw, 2015 #224;Kershaw, 2015 #224). Plastic pallets are raw materials that are used to produce the microspheres in plastic products (from pellets to plastic bags). Plastic particles are made up of lipophilic polystyrene (PS), polypropylene (PP), polyolefin and polyethylene (PE) particles, which means that they can easily absorb harmful and toxic chemicals in surface seawater. These synthetic microplastic substrates are also used as abrasive materials in numerous industries (cosmetics, detergents, pharmaceuticals, and blow molding media) (Hernandez et al., 2017). Various hydrophobic and aromatic hydrocarbons have also been detected in both aquatic and terrestrial ecosystems, like ~~that~~ dichlorodiphenyltrichloroethane (DDT), polychlorinated biphenyls (PCB) and polycyclic aromatic hydrocarbons (PAH) which bind on the surface of particles (Lohmann et al., 2017). Industrial resin pellets (2 – 5 mm) have been reported to be widely used on the coastlines of New Zealand, Lebanon, Canada, Bermuda, and Spain. The density of particles per meter of the beach usually exceeds 1,000 particles (Clunies-Ross et al., 2016).

According to the report, the PCB content in polypropylene fragments from Japanese beaches is very high. Descriptions of the presence of resin particles on coastlines in Singapore, India and Belgium indicate a prevalent distribution of tiny microplastic. These microplastics are used not just in facial scrub cleansers, hand sanitizers, and cosmetics, but also in drilling fluids and industrial abrasives for oil and gas exploration. To remove rust and paint, polyester microplastic washers with a particle size of 0.25 – 1.7 mm are utilized (Burrows et al., 2020). In cosmetics, the main components of pressed powders and skin cleansers are PE and PP particles (< 5 mm), PS balls (< 2 mm), and polyolefin particles (74 – 420 μm). In the analysis of skin cleaners, rough spherical particles made of PE and PS, blue or white linear and irregularly shaped particles can be used to identify. Microplastics can also be utilized as a drug shipment system (carrier) and tooth gloss for dentists. As a source for personal care, cosmetics, and medicines, the final plastic particles can insert in the marine environment through sewage (Sun et al., 2019). More detailed research work is also needed to identify the basic sources and how to limit it in the environment. Moreover, research should be carried out to find a replacement ~~for~~ of the plastics for sustainable environmental purposes.

Secondary microplastics

Secondary plastics are large size and high-density plastic fragments in terrestrial and marine habitats (Weinstein et al., 2016). Weathering causes large plastics to break down into smaller pieces. Another significant process is the photodegradation resulting from the ultraviolet radiation in sunlight, that is causing the breakdown of chemical bonds in the oxidation procedure. Besides the sources, there are 5 types of microplastics i.e. fibers, microbeads, fragments, nurdles and foams (Fischer and Scholz-Böttcher, 2017) (Fig. 2.)

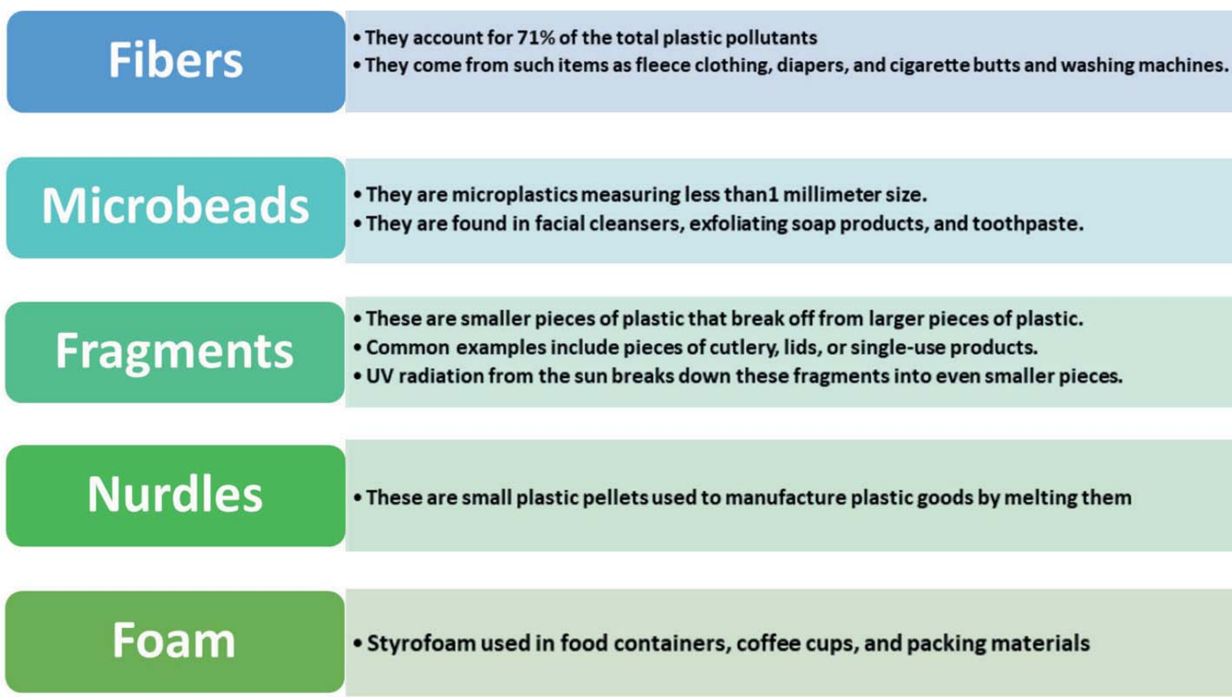

Figure 2: Types and distribution of secondary microplastics and their commercial use

Nanoplastics

Nanoplastics are the smallest fragments of plastic less than 100 nm dimensions. (add reference here) The crushing or weathering of plastic waste creates micro and nano-plastics. When synthetic fibers break and plastic objects break down during the washing process (e.g. extended PS with a fast-track mechanical wear system), transfer into nano-plastics. Due to the decrease in the size of these nano-plastics with high surface area, various marine biota (like that corals, phytoplankton, and zooplankton) can ingest them easily. In addition to the microplastics itself, organic pollutants adsorbed/ absorbed on their surfaces adds to the potential harmful effects to aquatic life as well as humans (Ng et al., 2018).

ENVIRONMENTAL FATE OF MICROPLASTICS

The resources of waste of microplastics and microspheres (less than 2mm in size) on land account for 80% of all plastic waste in marine ecosystems. Households, industry and beach activities are the main route for plastic waste to enter the environment. The manufacture of plastic products from industrial residual materials, the burst of microscopic plastic particles and resin powder, tourism at coastal zone, fishing and aquaculture are other entails of microplastic contamination. These activities severely pollute the marine environment and plastics residue enter water corpses via rivers, sewage and wind currents. In connection with this, the trash produced onboard by careless handling of plastic fishing gear (Lehner et al., 2019).

The polymer microplastics and nano-plastics sources in marine habitats include cosmetics, toothpaste, hand sanitizers, and various cleaning products by waterways as domestic wastewater through municipal and industrial sewage systems (Fu et al., 2018). In contrast to macromolecular plastics, microplastics and nano-plastics are not collected in a sewage treatment plant but are transported to the sea via river water together with wastewater and landfill leachate. The movement of microplastic waste from land to water is also controlled by natural procedures such as floods, winds and hurricanes (Braga Moruzzi et al., 2020). During the drying process and applying as agricultural fertilizer, micro powders and microspheres are released into the atmosphere through the decomposition of the agricultural PE film and sewage sludge. Besides, the advent of 3D printing technology for rapid prototyping, the supply of nanoparticles and nano-capsules polymer and the use of thermal cutting of PS foam to release nanoplastics (~20 – 220 nm) and ultrafine materials to release Polymer particles (11.5 – 116 nm) (Rodríguez-Hernández et al., 2020).

EFFECTS OF MICROPLASTICS

Interaction with marine biota

When microplastic content rises then the bioavailability of pollutants for marine biota also increases. The color, aggregation, density, shape, and size of tiny particles have an impact on their potential bioavailability for marine biota. The biological interaction between microplastics and marine biota is crucial to comprehend the movement, influence and fate of microplastics into the marine ecosystem. Since the existing research has been undertaken within the controlled lab experiments, increasing the need of studies in practical environments on the absorption of microplastic fragments by marine biota and their effects. The uptake of microbial particles in numerous marine organisms has been observed worldwide (Ferreira et al., 2019).

In most cases, the absorption of microplastics by marine organisms is random as these particles are ingested mistakenly as food (Ferreira et al., 2019). The absorption of microplastics by marine biota has been studied, and most of the research comes from the analysis of gastric contents. When marine biota ingests microplastics, it can cause disorders in organelles to organismic levels. The microplastics consumed by marine biota can causes adverse health effects (Peng et al., 2020). The outer surface of the adhesive polymer is obstructed, which hampers the fluidity and blockage of the digestive system, or this effect can be a chemical reaction, like ~~that~~ inflammation, liver pressure and growth reduction (Zhang et al., 2018).

The consumption of microplastics by various non-nutritious marine organisms, containing invertebrates, particularly noctuid, mussels, sea cucumbers, amphibians and zooplankton as well as fish-eating birds, fish, turtles and animals, as microplastics ingested by nutrient-poor organisms (including zooplankton and foot-shell animals) can disrupt the food chain. Microplastics also contain organic toxins that are added in them during the manufacturing of plastics.. Depending on the larger specific surface area and the van der Waals force, chemical adsorbing is chiefly since organic toxins have a higher similarity for the hydrophobic surface of microplastics than seawater (Toussaint et al., 2019).

Due to the bulky volume ratio make the microplastics more vulnerable to water-based pollutants (like that persistent organic pollutant (POPs), toxic heavy metals, and endocrine-disrupting chemicals for years. These substances are present in high content in the microlayers on the ocean surface, and low-density microplastics are also common in the microlayers on the ocean floor. Dichlorodiphenyltrichloroethane (DDT), polycyclic aromatic hydrocarbons (PAH) and polychlorinated biphenyls (PCB), as well as other organochlorine pesticides, can be adsorbed on the hydrophobic surface of microplastics. The adsorption capability of microplastics is stimulated by the nature of the polymer and its conditions (glass or rubber). A large number of studies have shown evidence of traces of plastic pollution. Some scientists enumerated that the worldwide content of POPs in marine plastic particles is 1 – 10,000 ug g^{-1}. Marine biota has been used to metabolize POPs that have been adsorbed in microplastics (Ferreira et al., 2019).

For example, suggested that Allorchestes compress absorbed Polybrominated Diphenyl Ethers (PBDE) from microplastics. It was found that the organism had taken in about 45 particles that were absorbed into the tissue. Scientists also suggested that fish absorb PBDE into tissues. Aquatic sediments can also sink into the aquatic environment as potential metals and be absorbed by microplastics. The main source of heavy metals is antifouling coatings, industrial waste, and fuel combustion to entering the marine ecosystem. Research has been enumerated the capability of microplastics to adsorb trace metals from a marine ecosystem. Heavy metals such as aluminum (Al), copper (Cu), silver (Ag), zinc (Zn), lead (Pb), iron (Fe) and manganese (Mn) have been detected in plastic product particles extracted from seawater (Singh et al., 2019). Microplastics covered by POPs and heavy metals can migrate through the ocean and certainly pollute further.

Also, the substance can be absorbed by marine organisms that are transported along with the food chain. Similarly, investigated the leaching of Zn and Cu from the antifouling coating of polyvinyl chloride fragments and pure PS spheres in seawater and adsorbed by microplastics. These harmful chemical pollutants have a variety of harmful effects, e.g. cancer and endocrine disorders, birth defects, immune system troubles and developmental problems in children. Plastics can also contain harmful additives that can get into the environment. These plastics have been shown the potential to migrate into the aquatic food chain and damage the marine biota that consumes them (Amereh et al., 2019).

The absorption of trace plastics in organic substances can take place through a ventilation process. In other words, as water flows through the bottom of the organism's limbs, small particles are absorbed into the cavity. Studies by (Ferreira et al., 2019) on the absorption of microplastics in the ocean explain its toxic effects, in particular the toxic effects on *pomatoschistus* microorganisms, zebrafish (Danio rerio), whales, microalgae, frivolous fish, flounder and pelagic fish (mackerel and herring).

Microplastics in fish

Research has shown that fish tissues contain the same chemical substances as plastic. The interaction between carnivores and prey increases the concentration of toxic chemicals from multiple resources accumulate into the body. With people concerned about the transmission of trace and detrimental chemicals between nutrient levels, and the impact on marine biota demonstrate by the laboratory studies of plastics. Several experiments have been conducted to evidence for microplastics carriage a threat to fish as ingesting microplastics before they ripen can cause death. Scientists explored the transmission and potentially harmful microplastic between different nutrient contents in the marine ecosystem. In research, Artemia sp. Nauplius was exposed to high concentrations of microplastic materials (1.2 × 106 mg $^{-2}$), although some accumulated microplastic particles are excreted from the body, but some remained in the epithelial cells and intestinal villi (Bessa et al., 2018). The study also found that the microparticles act as carriers for the transfer of the related persistent organic pollutant benzo (BaP) from nauplii to zebrafish, and the substance remained in the intestine where it was found in nauplii and zebrafish with no bodily harm was detected. Scientists showed that microplastics and related harmful materials can be carried along the food chain at various nutrient levels. Scientists examined the adsorption of microplastics in marine fish and the effects of toxic chemicals (Oryzias latipes). Ingestion and accumulation of harmful chemicals can cause oxidative stress and hepatitis. There are other studies on the different fish intake of microplastic feed, about 18% in the central Mediterranean area. Of the top predators found micro, meso-sized swordfish (*Xiphias gladius*), bluefin tuna and tuna large plastic fragments of 65 mm or 5 – 25 mm and 25 mm (Romeo et al., 2015).

Scientists are recommending that 36.5% of microplastics be found in the gastrointestinal tract of pelagic and lower fish. The frequency of plastic particles per fish is between 1 and 15 pieces. Total 351 number of plastic particles were discovered with an fourier transform infrared spectroscope (FTIR) (Gigault et al., 2016). There have been reports that 63.5% of benthic fish and pelagic fish contained trace plastic 36.5%. A total of 73 microplastics were found in the stomach of the fish. In another study on the absorption and effect of zebrafish on microplastics, it was found that most plastic particles (5 μm in diameter) aggregate in the intestines and liver, while plastic particles with a diameter of 20 μm only occur in diseases part of the intestine and liver (Karami et al., 2017). Therefore, the build-up of plastic particles can cause inflammation and lipid build-up in fish liver. It has also been noticed that microplastics can induce oxidative stress and alter the metabolic profile of fish liver, thereby disrupting lipid and energy metabolism (Yin et al., 2019).

In an experiment to examine the transfer of microplastic, which are absorbed by personal hygiene products. The rainbow fish (*Melanotaenia fluviatilis*) was exposed to microspheres that had adsorbed PBDEs monitored after 0, 21, 42 and 63 days. After ingestion, it was found that the exposed fish accumulate high amounts of PBDEs (approximately 115 $pgg^{-1}wwd^{-1}$) in their tissues. According to reports, the Baltic Sea is severely polluted by the high content of microplastics (7000 – 10,000 particles m^{-3}) (Wardrop et al., 2016). European sea bass (*Perca fluviatilis*) touches and absorbs 90 μm PS microplastic particles. This PS microplastic is absorbed and accumulated, resulting in decreased growth, impaired hatching, eating and behavior changes, and even impairment of the sense of smell, increasing the susceptibility to being killed by predators. This enables us to understand that the effects of microplastic ingestion go further than the direct effects on the digestive tract of fish (Karbalaei et al., 2019).

Studies show that fish prefer to eat pellets rather than natural foods. The inclination of PS microplastic particles for natural foods can be recognized to the size and shape of PS microplastics, which may make them suitable for ingestion, as described by Jovanović et al. (2018). Similarly, the color of PS microplastic particles can cause them to be ingested, as color is one of the properties of microplastics to attract prey. The number of habitats in Europe has declined sharply, and the research attributed this to the high contamination of the ocean by highly plastics materials.

Microplastics in other marine biotas

The problem of trace collection is not limited to fish. Zooplankton and sea turtles are also vulnerable to microplastics. Performing outdoor mesoscopic studies to study the effects of plastics on the health and biological functions of edible Ostrea edulis and the structure of related large animals. The organism was exposed to low and high doses (0.8 μg^{-1} and 80 μg^{-1}) biodegradable and conventional microplastic treatment for 60 days. After exposure, the respiratory rate of edible oysters was observed to increase in response to high doses of polylactic acid (PLA) microplastics, indicating that the oysters were in a state of stress. Similarly, the wealth and biomass of related benthic organisms including periwinkles (*Littorina sp.*), Isopods (*Idotea balthica*) and chilli clams (*Scrobicularia Plana*) have also decreased. The decrease is due to microbial uptake and the resulting decrease in reproductive production and mortality as well as decreased food intake (Li et al., 2018).

Steer et al. (2017) examined the microplastic feeding of two ecologically significant zooplanktons in the North Pacific food web. The acid digestion method was used to assess zooplankton in small foot fish (*Neocalanus cristatus*) and mesophytic larvae (*Euphasia pacifica*). In the score pick up 1 particle in 34 plastic dishes and 1 particle in 17 eukaryotic animals. Among these, the absorption of microplastic particles in the symbiotic mercury glass is highest (816 ± 108 μm), higher than Copod (556 ± 149 μm). The results suggest that low levels of organisms in the marine food web absorb microplastic particles that may be caused by accidental or intentional ingestion of microplastics by biota, as microplastic particles may be confused with food. An example is salmon on the northwest coast or in North America, which are told to eat many ichthyro pods and cut the animals off.

Wesch et al. (2016) have proved the influence of PS microspheres on the feeding, function and fertility of the marine animal, Calanus helgolandicus. The pepods were exposed to 75 ml^{-1} PS beads and 250 $\mu g\ L^{-1}$ algae. It was observed that human feet exposed to microplastics ingested fewer algal cells, resulting in an 11% reduction in algal cells and a significant reduction in carbon biomass (40%). Prolonged exposure can lead to the death of some pods, decreased egg production, and decreased reproductive performance, all of which affect hatching. Studies have shown that food feet exposed to microplastics use up energy over time, making it difficult for food feet to find food. The result has also shown that exposure to high levels of microplastics can affect the survival of zooplankton. Consumption of filter-feeding biota is a very significant part of the marine nutritional web and their deterioration in the water environment may be able to pose a grave threat to many nutritional levels (Sharma and Chatterjee, 2017).

Considering that many microplastic particles enter the aquatic atmosphere, the bioavailability of microplastics and detrimental organic contaminants (bisphenol A, PBDEs, DDT, etc.) sticks to the microplastics and is ultimately absorbed by aquatic animals and entered into the food chain. It is rich in marine life and therefore has high bioavailability. People are increasingly concerned that large quantities of toxic chemicals are causing infertility, genetic damage, poisoning, decreased food intake, and improved mortality of marine life and humans (Guzzetti et al., 2018).

Microplastics: A growing human health concern

The increased consumption of plastics is leading to increased performance of microplastics in humans. Under conditions of high concentration or high individual sensitivity, microplastic inflammatory lesions may be the cause, resulting from their surface ability to interact with tissues. The increased incidence of neurodegenerative diseases, immune disorders, and cancer may be due to increased exposure to environmental pollution, including micro-pollution (Fig. 3). However, knowledge on the affects of environmental exposure ~~to~~ of microplastics on human health is limited, to high uncertainties that should not be translated into alarmism even when applying the precautionary principle. With the anticipated growth of these synthetic materials in our environment, more studies are needed to fully understand the risk of microplastics to human health, requiring knowledge on human exposure, pathogenesis, and effects (Carbery et al., 2018).

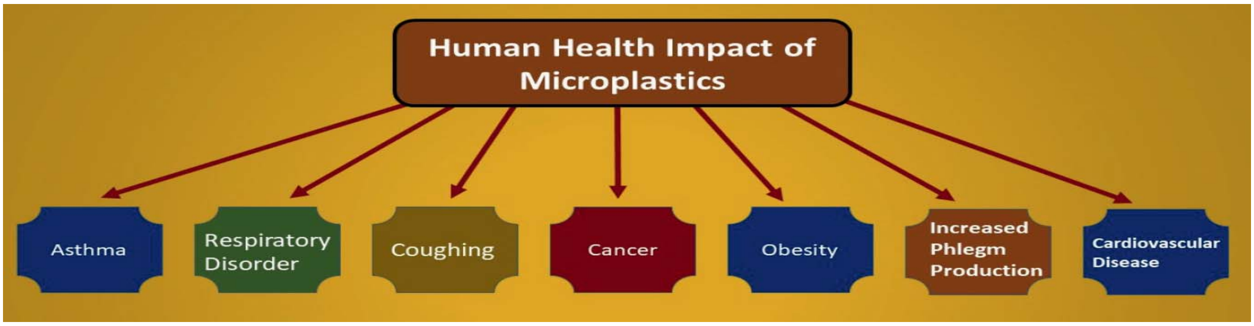

Figure 3: Health hazards of microplastics on human health.

REMOVAL/REMEDIATION OF MICROPLASTICS FROM ENVIRONMENT

Although different laboratory scale studies have reported effective remediation of microplastics in the environments; but when it comes to the practical applications, it lacks the efficient monitoring technology which monitors and records the remediation process.

Different technologies like membrane bioreactors, retrofiltration, and bioremediation using different microplastics degrading microbes are studied (Wagner and Lambert, 2018).

CONCLUSIONS AND FUTURE RESEARCH

Plastic contamination in the marine ecosystems is in a worrying situation as it is ubiquitous in the natural environment. It also has detrimental effects on aquatic biota and spreads along with the food web, which is a problem. There is an urgent need to take strong action at international, national and local levels to resolve this problem. Developing countries such as India, South Korea, Vietnam, Sri Lanka, Pakistan, Indonesia, China, Bangladesh, Thailand, and the Philippines mainly cause plastic pollution in the ocean and atmosphere (reference needed here). Microplastics are very tiny plastic particles that are entering the marine ecosystem from two major sources. Cosmetics are typically used when larger fragments of plastic are weathered into smaller ones. In general, this type of plastic enters the marine ecosystem through runoff from rivers, drainage systems, sewage treatment plants, and exposure to wind, water, and waves. Microplastics are dispersed in aquatic environment where they accumulate, disintegrated and converted to smaller in size (nanoplastics) and cause more damages to organisms. Microplastics are very common in the water column, surface water and sediments in Europe, Asia, Africa and North America. Due to its small size, microplastics they are readily absorbed by marine biota and accumulates in the tissues, circulatory system and brain.

The absorption of many marine biota and the presence of sea salt clearly show the degree to which the microplastics are harmful to the entire ecosystem. This is very worrying as microplastics can cause serious harm to marine life and humans. Since existing methods cannot be eliminated, these particles will inevitably continue to increase over the next few years. Without the participation of the public, socio-economic departments, tourism and firms that specialize in waste management impossible to reduce the problem of microplastics. Also, the bacteria can then be used to clean up contaminated environments. Using microorganisms to break down microplastics is a hopeful and eco-friendly action plan. It can protect the managing of microplastics from negative influences and ultimately help to naturally cleanse the polluted environment.

Many countries in the developing world have not invented laws and regulations to regulate and monitor the microplastic pollution.

- It is therefore suggested that local governments formulate strict laws and regulations and encourage examination to monitor the long-term environmental impact of plastic waste. For protection management, new scientific data on contamination by microplastics should be devised, normative guidelines should be formulated and the basis for awareness-raising campaigns should be strengthened.

- Public awareness of microplastic pollution is very important as it determines their behavior when consuming plastic and, most crucially, the negative consequences of plastic pollution are not yet recognized by general population.
- Various campaigns and plans should be implemented that can play a significant role in raising public awareness of the long-period and long-term consequences of plastic contamination. Some maritime active international organizations such as the International Maritime Organization (IMO) and the United Nations Environment Program (UNEP) should organize particular campaigns at a global level to reduce microplastic contamination.
- Ultimately, the plastics industry should be responsible for and keep their scrap products. The government would set a "zero tolerance" on this subject, forcing the industry to utilize biodegradable substances like starch, lignin, cellulose rather than non-degradable materials. This biodegradable substance then broken down by microorganisms (bacteria/fungi) and eventually shortens the lifespan of the following are plastics in the environment.

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