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Silent Invaders: A Review of Microplastic Accumulation and Its Impacts on Marine Commercial Invertebrates

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Abstract

A new class of contaminants known as microplastics (MPs) has emerged in our environment due to the increased production and consumption of plastic products. Among the various sources of microplastics are larger plastic wastes, synthetic fabrics, and industrial goods. Microplastics, from surface waters to deep-sea sediments, are everywhere in the marine food web. Marine environments, especially marine invertebrates, which provide essential seafood, are being threatened by microplastic pollution. Marine invertebrates are particularly vulnerable to the ingestion, bioaccumulation, and related toxicological consequences of microplastics despite their crucial roles in trophic dynamics and biogeochemical cycles. This review article investigates microplastics' prevalence, sources, and effects on marine invertebrates worldwide. Results from multiple studies are compiled in this review to illustrate the extent of microplastic pollution in different marine environments and the biological consequences for invertebrate species. Important discoveries reveal that various marine invertebrates consume microplastics, negatively impacting their physiology, reproduction rates, and survival. The review addresses the trophic transfer of microplastics within food webs, the interaction with co-contaminants, and the potential for long-term ecological consequences. As part of the review, gaps in current research are identified and future directions are suggested for investigating the effects of microplastic pollution on marine ecosystems.

Keywords: Microplastics, Marine Ecosystem, Commercial Invertebrates, Impacts, Hazards to humans.

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Introduction

Since the 1960s, the production of plastic has increased by roughly 8.7% annually, making it a $600 billion global industry today. More than 5.25 trillion plastic particles are currently floating in the water, and an estimated eight million metric tons of plastic enter the oceans annually. Although some plastics enter the ocean through maritime operations, 80 percent of plastics originate from land-based sources. Waste plastics enter the sea through inland waterways, wastewater outflows, winds, and tides as litter, industrial waste, or other sources. Legislation, local infrastructure, and economic development correlate proportionately with waste generation and leakage. Presently, 75% of these land-based discharges are uncollected waste, with the waste management system contributing 25%. Over the past 70 years, the world's plastic production has grown from 1.5 million tonnes to about 359.0 million tonnes[1], with projections indicating that it will reach 500.0 million tonnes by 2025 [2]. The United States of America recycles a modest amount of plastic garbage. The majority of it is either burned, dumped in landfills, or discharged into the environment, which poses major hazards to human health and the ecosystem[3]. Over 75 % of marine waste is plastic because plastics are rigid and non-biodegradable[4]. Sadly, despite being one of the most vital regions for human existence, the Mediterranean Sea region has become one of the most plastic and microplastic-polluted[5]. The rate at which plastics break down and persist in the ocean depends on their polymer, shape, density, and intended use. Similar to this, these properties control the potential locations of plastics in the water column. For example, there is a greater chance that wind and ocean currents will carry more buoyant plastics throughout the environment. Furthermore, plastics decompose into microplastics when they come into contact with environmental factors like sunlight and waves.

Microplastics are "any synthetic solid particle or polymeric matrix, of either primary or secondary manufacturing origin, which is insoluble in water, and with regular or irregular shape and sizes ranging from 1 μm to 5 mm". In recent years, there has been a sharp rise in the production of microplastic, with thousands of particles per cubic meter found in some marine environments. According to a study[6], these numbers are predicted to double in the coming years due to the absence of appropriate measures. A lack of trustworthy and accurate sampling methods makes the problem even more challenging, raising the possibility that microplastic concentrations in marine ecosystems are underestimated[7]. Various techniques have been devised to identify and determine microplastics. The first step in identifying the existence of microplastics among marine biota and their trophic transmission is particle separation and identification. Multiple processes are involved in extracting and characterising microplastics from organic tissues. Among the several techniques for breaking down biological material oxidising, basic, or acidic treatments can break down pH-sensitive plastic polymers. Although enzymatic digestion appears to be a dependable technique, it has the drawback of being expensive. To enable the digestion of biological material and facilitate the detection of plastic, a protocol has recently been implemented that combines density gradient separation with the addition of 15% hydrogen peroxide.

Microplastics have existed in the environment since the early 1970s, but scientific interest in them has only recently grown. Research on microplastics as a novel pollutant has significantly increased worldwide within the last ten years. These plastic fragments raise many concerns because they are small enough to be ingested by living organisms and thus reach humans through consuming contaminated food, the presence of which was only reported in early 2010. The current COVID-19 pandemic has caused significant environmental chaos due to insufficient use of plastic products. A review study[8] discusses the ecological effects of single-use plastic products, such as disposable face masks. The use of plastics in our environment poses a serious threat to almost all living things, causing the loss of species and releasing harmful emissions into the atmosphere when they burn. After reviewing the effects of plastic exposure on various organisms worldwide, another study[9] discovered reports of injuries, accidental ingestion, and fatalities in aquatic organisms, as well as impairments in the functionality of different body parts in humans. Microplastics can potentially affect human health, especially by contaminating the food chain. They can go from one trophic level to the next and be consumed by marine life. Given the commercial seafood industry, the bioaccumulation and biomagnification of microplastics in the marine web may be dangerous from the standpoint of the human food chain, which would be a major concern for food safety.

An Overview of Microplastics

Shapes and Types of Microplastics

The word "plastic" describes a material's ability to be moulded during production. Because of this property, the material can be cast or moulded into various shapes for different purposes. Plastics have advanced from the chemical processing of natural materials to the synthesis of fully synthetic molecules. The earliest plastics were made of biological materials and organic polymers[10]. The "big six" polymer families that make plastics include polypropylene (PP), polyvinyl chloride (PVC), polyurethane (PUR), polyethylene terephthalate (PET), high- and low-density polyethylene (HDPE & LDPE), and polystyrene (PS). Eighty percent of the plastic produced in Europe comes from these families[11]. The three primary categories of plastics are elastomers, thermosets, and thermoplastics. Among the thermoplastics, polyethylene (PE), polypropylene (PP), polytetrafluoroethylene (Teflon), and polyethylene terephthalate harden at low temperatures and soften at high temperatures. Polyamide, Polyvinyl Chloride, and Polystyrene are thermosets that do not soften after moulding. Polymers that can stretch and then revert to their original shape are known as elastomers. Elastomers include materials like rubber and neoprene. There are roughly twenty distinct groups of plastic polymers in all. Apart from the widely recognised polymers, which include PE, PP, PS, PET, PVC, PU, and PA, a diverse array of polymers and co-polymers are produced with unique physical traits [10].

The classification of microplastics includes pellets (spherical shape), fragments (irregular shape), films (fragile particles), and fibres (slender shape)[12]. Polystyrene (PS), Polyethylene (PE), Polypropylene (PP), Polyethylene Terephthalate (PET), Polyvinyl Chloride (PVC), Nylon, and rayon are a few of the popular microplastic polymers seen around the world. These polymers account for more than 85% of the plastic polymers synthesised globally[11]. Polymers with a specific gravity higher than the water body may settle in the sediments, whereas those with a lower specific gravity float in the water column. For example, polymers such as PET and PVC are known to sink to the bottom of the water, while PE, PP, and PS are known to float on the surface due to their specific gravities. Some low-density polymers may eventually sink to the bottom because of the adherence of biofilms to them, which promotes the settling of microorganisms on the plastic surface[13]. The shape of microplastics significantly influences their behaviour, such as affecting their biofouling rate and sinking/rising behavior[14]. The size, buoyancy, and colour of microplastics are the primary attracts for marine creatures[15].

Microplastic Pollution Sources

With the world's population growing and the demand for plastic products increasing, the amount of plastic garbage being dumped into the ocean has increased dramatically. Every year, almost 8 million tons of plastic debris find their way into the sea. The primary sources of marine microplastics are inland river flows, oil, and fishing. Every kind of plastic particle that is added to everyday objects, industrial raw materials, etc., eventually finds its way into the ocean from rivers. Primary and secondary sources are the two main microplastic pollution sources, depending on where they originate. The difference lies in whether those dimensions were created by the particles themselves (primary) or if they came from the breakdown and degradation of larger debris (secondary). Synthetic textiles and personal hygiene products contain small-scale primary microplastics produced on an enormous scale. Other products that use primary microplastics are toothpaste and cosmetics. Primary microplastics used as raw materials could accidentally leak into the environment during transhipment and transportation or come from processing plant runoff [10]. Primary microplastics with smooth surfaces, like microbeads, typically have a uniform appearance. Artificially created microbeads are used in toothpaste, body washes, and face cleansers. These particles may eventually be released into the environment after passing through wastewater treatment facilities[16]. Microplastic emissions from road wear and tire abrasion are the most significant, releasing around 13,000 tons annually. The amount of microplastics in stormwater and artificial turfs is uncertain, and the loss of industrially produced plastic pellets in manufacturing and handling is estimated to be between 300 and 530 tons per year[17].

Research on six continents indicates that secondary microplastics make up the majority of microplastics in the marine environment. UV light exposure, temperature, and abrasion are the key environmental elements associated with the production of secondary microplastics. Secondary MPs frequently have uneven surfaces and clear signs of weathering or erosion, giving them a more hazardous appearance[18]. Laboratory studies have unequivocally demonstrated that microplastics may be toxic to living things. The size and shape of microplastics significantly influence their toxicity. Winds and ocean currents can carry microplastics over longer distances, dispersing them throughout the planet, including the polar ice caps [10]. One of the main sources of plastic pollution in the environment is single-use products made of polymeric plastics, such as straws, bags, cutlery, drinking bottles, and coffee cups. Additionally, the extensive usage of single-use face masks made of plastic polymers like polyester and polypropylene during the coronavirus outbreak (COVID-19) has resulted in a noticeable increase in microplastic waste [19].

Microplastics In Marine Ecosystem

Microscopic plastic particles have occasionally been found in the marine environment since the early 1950s, but it wasn't until 2004 that a ground-breaking study led by marine scientist Richard Thompson began to effectively investigate their distribution and impacts. Scholars from around the world have written and studied microplastics, leading to significant advancements in our understanding of the causes, fates, and effects of microplastics and related materials. Microplastics hurt marine life at every level of the food chain, from the sea to the surface and from pole to pole, as many hundred scientific studies have now shown. Around 8 million metric tons of plastic enter the ocean each year, and there are an estimated 5.25 trillion plastic particles in saltwater, totalling more than 2,50,000 tonnes. While marine operations contribute to the ocean's plastic pollution, land-based sources account for 80% of the total. Trash, industrial waste, landfills, inland waterways, wastewater discharges, wind, and tides carry disposable plastic debris into the marine ecosystem. The pellets, fragments, or threads known as seawater microplastics are made of several polymers thicker than seawater and are predicted to sink to the bottom of the ocean. These polymers include acrylic, polyester, polyamide, and polymerizing vinyl chloride (PVC). Certain materials, such as polyethylene, polypropylene, and polystyrene, are frequently observed floating on the surface and have densities lower than seawater[20].

Large-scale fishing, leisure and marine activities, and changing demographics that promote immigration to coastal regions will all contribute to the future increase in plastic waste entering the oceans[21]. Beach litter is one of the land-based sources of over 80% of plastic trash. The global fishing fleet currently uses plastic gear, and some of this gear is constantly lost or even thrown away carelessly while being utilised, per study[22]. Mostly, fishing gear applications use nylons and polyolefins (PE and PP)[23]. An estimated 18% of the marine plastic waste discovered in the ocean environment is a result of fishing. Additionally, aquaculture may contribute significantly to the amount of plastic trash found in the oceans[24]. Beach litter and other land-based sources account for the majority of the remaining amount. Frequently found in garbage, virgin resin pellets enter the waters by runoff from processing facilities or accidental losses during ocean transportation[25]. Plastics can be broken up by UV and mechanical forces once they're in the ocean. Less dense plastics can float before biofouling, aggregating, and depositing on the marine bed, while denser plastics can sink and deposit straight onto sediments. Microplastics can enter trophic chains through mixing, advection, and fish ingestion after being adsorbed by zooplankton and expelled as fecal pellets. It takes hundreds of years for environmental degradation mechanisms, including oxidation, UV radiation, and biodegradatio,n to eliminate microplastics from the ocean. Different circulation flows at different depths impact microplastic dissemination rates because sea currents' involvement varies with depth[26]. Microplastics are a new and comparatively understudied threat among the various dangers that marine organisms face. Available data on the prevalence of microplastics in marine biota indicates that a sizable fraction of organisms may be susceptible to ingesting these man-made polymers, which may result in varying degrees of health problems. Increased exposure to microplastics has been linked to oxidative stress, decreased filtration capacity, tissue inflammation, impaired digestive tract, pseudo-satiation, and weakened immunity in marine organisms.[27,28]

Bioavailability of Microplastics to Fishes

The presence of microplastics in aquatic environments significantly enhances the probability of regular interactions with marine organisms. Various aquatic animals may have greater access to microplastic due to the products' gradual disintegration [29]. Lower-level species are not very selective toward smaller food items and microplastic particles. However, higher trophic-level species that consumed plankton demonstrated passive microplastic ingestion[30]. Microplastics (MP) accumulate and become increasingly concentrated as they move up the food chain. Predators higher in the food chain, such as juvenile fish and filter-feeding whales, consume microplastics continuously, leading to higher levels in their bodies. This occurs even if the amount of microplastics consumed by zooplankton in their habitat is not significantly higher[31]. The bioavailability of microplastic particles in aquatic environments is influenced by particle density. Low-density, positively buoyant plastic particles are preferred by suspension feeders and organisms that feed on filters. According to a study[32], biofouling on the surface of microplastics decreases their ability to float, but de-fouling of the water column compels the microplastic components to return to the air-sea interface. Due to the cyclic fouling and defouling process, microplastic will be found in the water column. Benthic creatures can reach high-density plastic particles because they tend to sink to the bottom [13]. According to some studies, the types of microplastics—beads, fragments, and fibres—have a substantial impact on how much an organism absorbs them. Compared to spheres and fibres, fragment-shaped microplastics accumulate more in the gut of grass shrimp[33]. There are still many unknown factors concerning the underlying mechanisms that lead fish to selectively consume microplastics.

Microplastics in Marine Commercial Invertebrates

Concerns about food safety and human health are growing worldwide due to microplastics in commercial invertebrate fish. Microplastic consumption has been observed in various marine invertebrate organisms, including zooplankton[34], echinoderms[35], crustaceans[36], and bivalves[37]. Microplastics can transmit pollutants, heavy metals, and pathogens from the environment to biota[38]. This transfer has raised concerns about microplastics in seafood species. In general, shellfish have a higher abundance of microplastics than fish. Given that the majority of shellfish are filter feeders, this can be explained by their feeding habits. Filter feeders are more likely to consume microplastics because they exhibit a non-selective feeding behaviour, such as bivalves, oysters, and clams. Microplastics have been found in the flesh of bivalves consumed by humans worldwide[39,40]. Microplastics are frequently found in crustaceans, including oysters, lobsters, and shrimps [41]. Research shows that shrimp are highly vulnerable to microplastic pollution due to their multipart intestine, which retains microplastics for long periods, along with their scavenging feeding habits[42]. The first report of microplastic contamination among Indian crustaceans' and cephalopods' edible tissues was published in 2020 by Daniel et al.[27]. Only a handful of recent studies have documented microplastics in mussels, such as Perna viridis [43] and Magallana bilineata[44], two edible oyster species from India. Endocytosis and perception are the common processes that account for the movement of intestinal microplastics into other tissues [45,46]. M cells in the

Peyer's patch of the intestinal epithelium are found to endocytose particles up to 10 mm, allowing them to enter the systemic circulation[47]. Through a process known as persorption, larger particles up to 150 mm pass through the intercellular space of enterocytes and cross the intestinal barrier [48]. Although microplastics in bivalves and crustaceans have been documented in journals, there is a dearth of information on microplastics in cephalopods. Apart from the initial discovery of microplastics in edible squid tissue and the discovery by Laist (1997) that flying squid consume plastic lines [49], the study by Daniel et al. 2020 [27] is the only other study documenting the presence of plastics in a squid species. Squids have a habit known as diel vertical migrations (DVMs), whereby they gather near the ocean floor during the day and surface at night [50]. Because of constant interaction with microplastics from different depth zones, it is known that organisms undergoing DVMs accumulate more microplastics[51].

Research on several commercially significant crustaceans revealed that 83% of Nephrops norvegicus (Norway lobster) captured on Scotland's west coast had plastics, primarily filaments, in their stomachs[52]. However, the plastic consumption risk was considered negligible because humans only eat the tail muscle, not the guts. An average of 1.23 microplastic pieces per shrimp were found in whole shrimps. However, nothing was found in the peeled shrimp, which is the portion that is eaten. Fibers larger than 20 µm are not transferred from the GI tract to the edible muscle. The GI tract is not removed during the peeling process; scientists estimate that consumers in Belgium may swallow between 15 and 175 microplastic particles each year, depending on their shrimp consumption. Microplastics can be consumed by marine invertebrates using a variety of feeding techniques, such as detritivores and filter and deposit feeders. Depending on the concentration and distribution of plastic particles in the ocean, commercial bivalve mollusks can filter and retain microplastics of varying sizes [53]. Although the concentration of microplastics in wild and farmed mussels is not significantly different, the latter may be subjected to microplastics because of the use of plastic nets and ropes. Research indicates that cultured mussels tend to have higher quantities of microplastics than in situ samples. Numerous studies have compared the levels of microplastics in wild and farmed mussels, oysters, and clams. Depending on the lobster's sex, microplastics are measured at various levels. Due to less frequent moulting, female lobsters retain more microplastics than males[54]. Commercial crustaceans use a variety of feeding strategies. They may absorb microplastics unintentionally or as a result of purposeful collecting during feeding. Crustaceans that swim may consume more particles than those that reside on the seafloor.

Trophic Transfer of Microplastics

Microplastics (MPs) can be ingested by marine creatures directly or indirectly through trophic transfer from contaminated prey. Multiple marine animals from diverse trophic levels, including fish, marine mammals, and zooplankton, have shown successful demonstrations of microplastic ingestion and accumulation[55]. Low-trophic level organisms like crabs have shown signs of trophic transfer in lab settings, but there is a dearth of empirical data for high-trophic level taxa. Research has shown that microplastic particles can be found in the gastrointestinal tracts (GIT) of a variety of wild fish species, emphasising the possibility of their transfer to predators. Trophic transfer rather than direct intake may be the main method of microplastic ingestion for marine mammals that use a raptorial feeding strategy, in which food is caught using just the jaws and teeth. Because the samples used in the studies may come from the fishing industry and were not gathered per the required sampling standards, it is impossible to accurately determine the rates of microplastic ingestion by fish prey. This is significant since it has been demonstrated that under stress, several fish species would release their stomach contents during capture. This can cause microplastics to disappear and distort the findings of any research. On the other hand, during capture, fish could swallow microplastics that build up within the net or that come from the net itself[56]. To ascertain the degree of pollutant transit within food webs, ecological risk assessments employ two fundamental concepts: bioaccumulation and biomagnification. The net uptake of a pollutant (such as MPs or additives) from the environment through all pathways (such as touch, ingestion, or respiration) from any source (such as water, sediment, or prey) is known as bioaccumulation. Due to bioaccumulation and subsequent trophic transfer, pollutants can bio-magnify at higher trophic levels. Since higher trophic levels are consuming prey in lower trophic levels, trophic transfer is the direct cause of all contamination in those classes [57]. A study states that the majority of research on the trophic transfer of microplastics and their subsequent bioaccumulation has been conducted in lab settings. For example, green crabs that eat mussels that have accumulated microplastics have been shown to do the same in controlled laboratory settings [10]. Diurnal migrating zooplankton species, for instance, tend to carry microplastics into deep water using predation or the production of pellets that sink to the bottom of the sea [58]. Microplastics may spread throughout the food chain because the majority of bivalves and crabs are significant global food sources for humans.

Ingested Microplastics' Biological Fate

One crucial element that impacts the degree of harm or adverse impacts that microplastics generate is their biological destiny after being consumed. The biological effects of microplastics are mostly determined by a factor called "retention," which is dependent on a number of the particles' characteristics, including size and shape. Research indicates that the tiny plastic particles remain inside the body of the organism for a longer period. The delayed "egestion" is caused by these tiny particles adhering to the foot and mantle of mussels, as well as the intestinal villi in fish. The process by which microplastics are removed from the body by the digestive system is known as egestion. If the retention duration is shorter, egestion can happen without harming the body. Toxins that adhere to these microplastic particles and go up the trophic chain may also bioaccumulate as a result of retention. The term "translocation" describes the transfer of microplastics from the intended tissue to another tissue. The size of the microplastics has a major impact on translocation. Researchers studying the effects of microplastics on bivalves discovered that 10 µm microplastics can enter mussels' circulatory systems. Microplastics (less than 80 µm) are absorbed by blue mussels by cellular absorption, are tissue transferred to the gills and digestive gland, and accumulate in the lysosomal system. [20]

Impacts of Microplastics on Marine Invertebrates

Marine microplastics can cause oxidative damage, decreased food intake, slower growth, and aberrant behaviour in fish and other aquatic species. Due to their ability to penetrate biological barriers, accumulate in tissues, and generate reactive oxygen species, nanoscale microplastics may affect lipid metabolism. In the marine ecosystem, fish are a vital group that facilitates material, energy, and information flow. The structural and functional stability of the marine ecosystem is directly correlated with the health of the fish population. Additionally, marine pollutants have the potential to enter the human body through fish enrichment, endangering human health because fish is a significant source of animal protein.

Inhibit growth and development

Marine life's ability to grow and flourish can be hampered by microplastics. Polyethylene microplastics, for instance, can stop *Tripneustes gratilla* from feeding and proliferating, but this won't kill the species. When marine life eats microplastics, their body's energy stores will be depleted, their ability to feed will be diminished, and they will feel satiated. The development of marine life will be impacted by these factors. Additionally, microplastics will build up and obstruct the digestive tract. Bivalve mollusks were shown to have the same lipid and protein contents when exposed to larger plastic particles, but their total energy reserve rose as the number of exposed microplastics increased. The disruption of the body equilibrium caused by the polyethylene microplastics will cause *Mytilus galloprovincialis* to use more energy and grow slower.

Cause Genetic Damage

Marine life's genetic composition may be harmed by microplastics. Research has demonstrated that the absorption of polycyclic aromatic hydrocarbons by microplastics can lead to immunotoxicity, neurotoxicity, and genotoxicity in *Mytilus galloprovincialis*, as well as genetic harm to mussels. Nonetheless, there isn't much research on microplastics' genotoxicity to marine life.[59]

Physiological Impacts

The fish may become exposed to chemicals contained in or bound to the microplastics, which could have various effects, such as changed blood biochemistry, immune function, or expression in reaction to the foreign microplastics and any related chemicals. The processing of microplastics or any associated chemicals induces an immune response, which results in localised cell damage and altered morphology of physiological structures. Common effects at the organ/tissue level include oxidative stress and histological damage. The types and activities of symbiotic microorganisms may also change as a result of changes in GIT morphology, leading to altered metabolism and gut dysbiosis [60,61,62].

Biological Consequences

Exposure to microplastics can lead to alterations in behaviour because these substances can affect the brain or central nervous system cells. This can harm swimming activity and survival rates in fish. Temporary swimming behaviour impairments are possible, but studies have also indicated more detrimental effects if microplastic exposure affects early development. Additionally, microplastics can be externally bound by fish eggs, and they can absorb smaller nanoparticles, which can change gaseous exchange and postpone hatching [63].

Hazards To Humans

Microplastics, a byproduct of global seafood consumption, are inevitably present in human bodies. The Food and Agricultural Organization of the United Nations (FAO) reports that out of approximately 179 million tons of fishery products produced globally in 2018, 82 million tons came from aquaculture. Humans consumed a total of 156 million tons of these products. The remaining 22 million tons were used for non-food purposes, mainly in the manufacturing of fishmeal and fish oil[64]. Over 90% of microplastics that are consumed are eliminated by the body's excretory system through feces; clearance rates vary depending on the size, form, type of polymer, and chemicals. Research indicates potential inflammatory response, plastic particle toxicity, chemical transfer, and gut microbiome disruption due to microplastics, but their physical effects are less understood than their toxicant distribution. Microplastics can pass between living cells, such as dendritic cells, circulate through circulatory and lymphatic systems, and accumulate in secondary organs, impacting the immune system and cell health. Absorption and transportation occur through endocytic pathways and persorption[65].

Microplastics' Migration to Remote Tissues and the Circulatory System

Microplastics can have local effects in the gut after exposure, or they might travel through the bloodstream to other organs. As microplastics enter blood arteries, they can induce vascular occlusions, pulmonary hypertension, internalization-induced blood cell cytotoxicity, and systemic inflammation. The human placenta, including its maternal, fetal, and amnio chorial membranes, has recently been found to contain microplastics with sizes ranging from 5 µm to 10 µm for the first time. The human renal cortical epithelial cells can accumulate PS nanoparticles (44 nm) without causing any cell damage and without showing any clearance during the first ninety minutes, according to other in vitro studies. Still, if these particles continue to build up, renal function may be compromised. Moreover, persistent inflammation, diminished organ function, and an elevated risk of cancer can be brought on by microplastics travelling to distant organs [66].

Cancer Caused by Microplastics

The surface area-to-volume ratio of microplastics is high because of their small size. Materials with a large surface area are highly cytotoxic to cells and tissue and can damage the deoxyribonucleic acid (DNA) inside cells. According to a study[67], deoxyribonucleic acid damage causes these alterations, which can result in cancer. According to epidemiological research, both human and animal cancer development is strongly correlated with extended exposure to microplastics. Due to their small size, microplastics can enter the human food chain through the bioaccumulation process and be consumed directly by a variety of marine life [68]. Facts and statistics on the amount of seafood consumed globally indicate that humans are likely to come into contact with microplastics to some degree. Because of things like hydrophobicity and chemical makeup, the amount of microplastic consumed affects the accumulative effect. Microplastics in human stool samples further supported this theory, which was based on the amounts of microplastics in human gastrointestinal tracts. According to the research conducted by two scientists [67,69], there is established evidence that using plastic may increase the risk of developing several types of cancer in people.

Toxicity To the Immune System

Interactions between microplastics and the immune system may lead to immunotoxicity and negative consequences, such as immunosuppression, immunological activation, and aberrant inflammatory responses. Polymeric microparticles' toxicity and absorption in mammalian systems have been investigated[70]. For example, following a five-day oral course of 60 nm polystyrene nanoparticles, 10% of the dose was discovered in the gastrointestinal system of rats [71]. Microplastics do not break down; instead, they remain attached to the apical region of intestinal epithelial cells. Intestinal inflammation and effects on the local immune system could arise from this action. Peyer's patches containing many microfold cells are the main site of microplastic absorption .[72]

Effects Of Contaminants Associated with Microplastics

Persistent organic pollutants (POPs), such as organochlorine pesticides like DDT, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs), can build up in microplastics in the ocean. POPs continuously accumulate in the microplastics seen in marine environments because of their hydrophobic qualities. POPs offer a major risk to human health due to their persistent characteristics, which cause them to accumulate in human adipose tissue once absorbed. Exposure to these pollutants has been linked to cancer, heart disease, diabetes, endocrine disorders, reproductive issues, and obesity. Moreover, the health of the fetus is adversely affected by prenatal exposure to POPs in addition to the mother. Prenatal exposure to persistent organic pollutants (POPs) has been linked to several adverse effects, such as reduced birth weight, childhood obesity, elevated blood pressure, and disruption of the endocrine system. [73]

Conclusion and Recommendations

The longevity of plastics, mass use, and poor waste management have all contributed to the immense buildup of plastic debris in aquatic habitats worldwide. According to current estimations, plastic output levels will grow rapidly and exponentially. Consequently, there's a good chance that associated marine pollution will rise. Since microplastics have been found in every aquatic environment, they are currently regarded as a ubiquitous contaminant that concerns humans who consume fisheries products. Studies conducted in labs have verified that aquatic creatures, including fish species of commercial significance to humans, consume microplastics. There have been several theories on the harmful effects of microplastics on humans; nevertheless, the information available to us at this time is insufficient to determine the threats to public health. The risks associated with consuming fisheries products that contain microplastics are currently thought to be minimal, but it's important to remember that the amount of microplastics in aquatic environments will only grow as a result of future plastic pollution and the degradation of currently present plastic. All of this means that it is critical and pressing for academics to conduct additional research to close the information gaps that exist now about microplastics. Furthermore, it's critical to gather more information on the quantity and size of these particles in fisheries products as well as comprehend the potential impacts of food processing on microplastics to accurately estimate human exposure to these particles. According to the FAO, the number of fish products consumed per person increased significantly from 9.0 kg in 1961 to 20.5 kg in 2018. Estimating the amount of microplastics that humans consume through fishery products remains challenging. Most microplastic particles are retained in the gastrointestinal tract of fish, and since most species are usually eviscerated before being eaten, the risk of ingesting these particles is significantly reduced. Bivalve mollusks, tiny crabs, and certain species of small fish—which are typically consumed whole—are the exceptions to this rule. The seafood trade has not yet been negatively impacted by the issue of microplastics in seafood since export items are not screened for microplastic levels and there is insufficient data for risk assessment. But with more and more reports of microplastics in seafood products and the number of microplastics in the watery environment expected to increase, it seems likely that food safety management systems will soon adopt regulatory measures. Given the effects of marine invertebrate microplastics on food security, seafood export, and seafood safety, it is critical to assess the microplastic content of the edible tissues of all key commercial species that are consumed both domestically and internationally.

Microplastic pollution is becoming a major environmental problem that affects many things, and marine commercial invertebrate species are especially prone to its negative consequences. The research undertaken globally has been emphasised in this review, highlighting the vast distribution and different concentrations of microplastics in marine habitats. Microplastics are consumed by commercial invertebrate fish, as studies have repeatedly shown. This presents a concern to human health and marine ecosystems through the seafood supply chain. The coastal areas are at risk due to heavy plastic trash production and fishing, causing alarming microplastic contamination in invertebrate species, necessitating urgent research to evaluate its extent. To sum up, the convergence of research worldwide highlights the critical need for coordinated action to reduce microplastic contamination. Protecting human health and preserving marine biodiversity depend on solving the microplastic epidemic. The main goals of future studies should be to standardise methods, comprehend the long-term effects of consuming microplastics, and create creative ways to cut plastic waste right at the source.

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