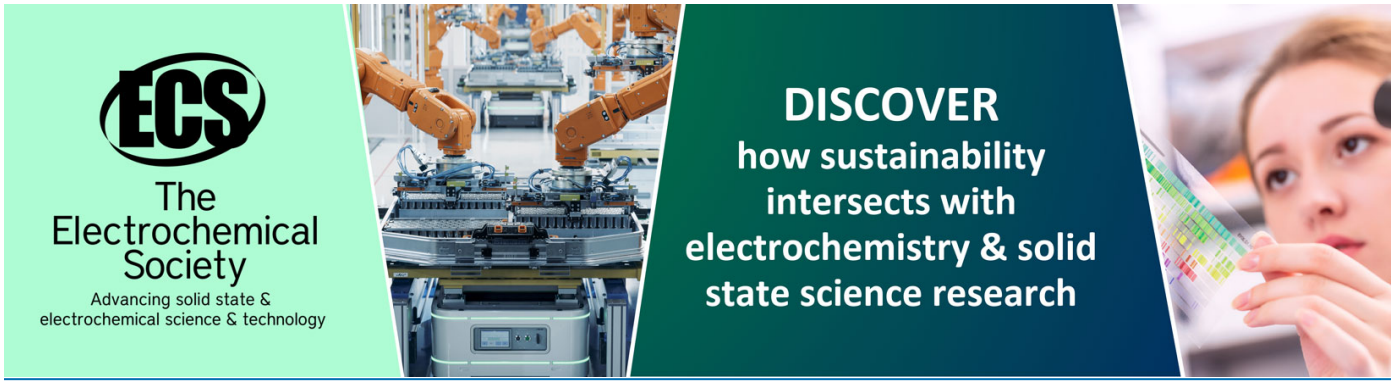
Research Progress on Ecotoxicological Effects of Micro-Plastics Loaded Pollutants



Research Progress on Ecotoxicological Effects of Micro-Plastics Loaded Pollutants

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Abstract. The origin of microplastics and the effects of ecotoxicological effects of microplastics on organisms were summarized in this paper. Microplastics can directly affect the environment, such as being ingested directly by organisms. Because microplastics are small in size, they can be eaten by organisms by mistake, so they can inhibit the digestive system, respiratory system, immune system, reproductive system and genetic level of organisms. Microplastics will gradually release the chemicals added in the production process, these chemicals have toxic effect on the environment. When the environmental factors change, the additives contained in the microplastics components will be degraded and released, which will have toxic effect on the environment.Microplastics, as carriers, can carry pollutants, which together with microplastics can cause complex pollution to the environment. Because of the physical properties of microplastics, it is easy to load various pollutants on their surfaces. This will result in a deeper level of complex pollution to organisms and the environment. The ecotoxicological effects of microplastics loaded pollutants on the environment are more complicated, so we should pay more attention to the ecological toxicological effects of micro-plastics loaded pollutants.

1. Introduction

Microplastics refer to plastic particles less than 5 μm in the environment [1]. Microplastics are not easily degraded, so they will exist in the environment for a long time. Microplastics can affect the growth and development of organisms, and after loading pollutants, their toxicity will increase, which in turn will aggravate the degree of toxicity to organisms, and even affect the gene expression of organisms, and may even endanger human health. We should attach great importance to the ecological toxicological effect of microplastics.

2. Classification and characteristics of microplastics

There are many kinds of microplastics. At present, the main microplastics detected in the environment are polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC), polystyrene (PS), polyvinyl acetate (PEST) and polyterephthalic acid (PET) [2], and the microplastics can be divided into plastic pellets, microfibers, plastic particles, foam plastics and thin films [3]. Microplastics have a higher specific surface area because of their small size, and their ability to adsorb pollutants becomes stronger, which makes the toxicological effects of microplastics more complicated.

3.The source of microplastics in environment

The sources of microplastics are as follows: Firstly, the relatively large microplastics products will decompose under various external forces for a long time and break into plastic particles with diameter less than 5 μ m. For example, polymer can easily degrade into small plastic fragments under the action of high salinity, Radiant heat and microorganism in marine environment. Larger plastic products, once in the environment (e.g., land,) can eventually be broken up into nanoplastics under UV radiation, mechanical wear, biodegradation and decomposition, weathering, and weathering [4].Secondly, we use cosmetics and toothpaste in our daily life. We may add plastic particles, which can wear off horny and peel off dead skin. These tiny plastic particles will be discharged into sewage treatment plants with domestic sewage. But sewage treatment plants can't filter them out, so the plastic particles will eventually be discharged into the water. Sewage plant is an important point source of microplastic pollution [5].Thirdly, the washing of synthetic textiles such as clothing is also considered to be an important source of microplastic pollution. Fourth: Improper disposal of plastic waste in life, agriculture, tourism, industry and so on will cause pollution of microplastics and enter the environment through various channels. Fifth：Shipping, leakage of industrial raw materials, wind transport and other processes can also cause a certain degree of microplastic pollution in the environment. Sixth：Irrigation and atmospheric deposition of water contaminated by micro-and nano-plastics will lead microplastics from aquatic environment to terrestrial environment and atmospheric environment respectively.

4.Influence of toxicological effect of microplastics on environment

Microplastics are easy to be eaten by organisms because of their small size. Microplastics exposed to the environment will have a certain impact on all aspects of biology after they are ingested by organisms.

4.1.Effects of microplastics on organisms after ingestion

Microplastics are ingested by marine life, and the microplastics after ingestion affect the growth and development of organisms, individual reproduction, digestive system, behavioral activity, immune system and gene expression, as well as heredity, which can lead to biological death. Because microplastics are similar in size to plankton, they can be eaten by mistake [6]. The higher the abundance of microplastics in the ocean, the more likely they are to be swallowed by organisms, accumulating not only in organisms, but also in the food chain, which may have a more profound potential impact on organisms. Therefore, the pollution of microplastics needs to be paid more and more attention.

Microplastics affect the digestion, growth and reproduction of organisms. Microplastics clog up zooplankton's feeding organs and digestive tract [7], reduce its intake rate [8], or directly interfere with its feeding process [7] [9], because ingestion of microplastics can cause a false sense of satiety, leading to a lack of energy, growth, and reproduction of zooplankton. The ability of activity is weakened [10]. For example, the gene expression of germ cells and oocytes in oocytes of oyster after ingestion of microplastic will be changed [11] and even lead to individual death [9]. Microplastics not only affect the gene expression of organisms, but also produce genotoxicity [12].

Exposure to microplastics can affect organisms' olfactory and activity abilities. Studies have shown that perch larvae may eat microplastics exposed to the environment by mistake, causing them to become dull in the face of external stimuli, and also affecting their olfactory sensitivity and mobility [13].

Microplastics affect the immune system of organisms[14]. Microplastics affect the body's immune system by affecting enzyme activity [15].

High-nutritional organisms ingest microplastics from low-nutrient organisms by preying on them. Studies have shown that when seabirds feed from the ocean, microplastics from low trophic organisms will enter the body of seabirds, so that seabirds are also affected by microplastics [16]. Microplastics are more likely to accumulate in the food chain through predation, which can have a more profound

effect on organisms. Microplastics have been found in marine organisms, such as stomach, intestine, digestive tract, muscle and other tissues, organs, and even lymphatic systems, which can be transmitted and enriched in marine organisms [17].

Plastic nanoparticles can be introduced into the brain tissue of animals, causing metabolic disorders and local inflammation, resulting in cytotoxicity at molecular level [18].

4.2.Carrier function of microplastics and effect of covering on organism

Microplastics may provide spawning carriers for certain marine organisms. Microplastics affect the structure and composition of biota by providing spawning carriers for marine fish[19].

Microplastic particles reduce the chlorophyll content of algae and thus affect their photosynthesis [20]. Microplastics can adsorb on the surface of Crescent algae [21] through electrostatic interaction, which hinders the absorption and utilization of sunlight and CO2 by algal cells, and affects the photosynthesis of algae, thus inhibiting the growth of algae [22].

The microplastic in sediment will impede the water and gas exchange process at the sediment interface and affect the biochemical reaction process on the sediment surface[23].

Microplastics have a significant effect on the activity of soil enzyme. Soil enzyme is an important component of soil. Polystyrene particles greatly reduce the biomass and enzyme activity of soil microbes, and have an inhibitory effect on soil microbial community [24].

4.3.Effects of released chemicals from microplastics on biology

Many additives will be added in the plastic processing process, which will be released gradually as the plastic degrades. Plasticizers, flame retardants and antimicrobials will be released into the ocean and cause pollution [25]. At present, plasticizer has been detected from marine plastic particles [26].Polyethylene pentachlorophenol and tetrachlorophenol added in plastics have direct toxicity to phytoplankton [27].Plastic leachates affect the genetic and gene expression of organisms or have lethal effects on organisms, such as the death of marine copepods（Nitocra spinipeses）; plasticizers (e.g. phthalates, bisphenol A, etc.) may affect the reproduction of animals, damage the developmen of crustaceans, induce genetic variation [28], and even affect human endocrine, reproduction and development [29].

Polybrominated diphenyl ether (PBDEs) is usually added as a flame retardant in plastics[30], which is easy to escape from plastics, resulting in the release of PBDEs, which will pollute the soil and other environmental media, which will seriously threaten the environmental safety and human health.

Phthalic acid ester（PAEs） is a kind of important organic compounds, which is used in the production of plastic modified additives, so it will be used in the production of plastic film. It is one of the environmental estrogenic pollutants, and has a certain acute toxicity to animals. And has "three causes" effect [31], has become a global environmental pollutants.

The release of chemicals from micro plastic has a significant effect on soil enzyme activities. The accumulation and landfill of waste plastics will release some of the harmful substances, which will have a certain effect on the enzyme activity in soil. The effect of waste plastic resources on soil enzyme activity were mainly activated, and the higher concentration, the stronger soil enzyme activity [32]. This may be related to some heavy metals in waste plastics. Enzymes in soil are the main participants in soil cycling and energy flow and are the most active components of soil ecosystem.

4.4.Effects of microplastic loaded pollutants on the Environment

Microplastic particles are small and hydrophobic, or because of weathering, they form porous surfaces, which are carriers of persistent toxic and harmful pollutants, heavy metals (such as lead, zinc, copper, chromium, etc.) and form complex pollution [33].Microplastics will also attach some soil particles, organic substances, biological organisms, etc., which will increase the load of microplastics on pollutants, enhance the harm of microplastics to the ecological environment, and also enable biological organisms to migrate in the environment. Thus endanger ecosystem health. When the microplastics are loaded with pollutants, these pollutants will be released in the organism, which will

cause greater harm to the organism, which is far more than the effect of the microplastics themselves on the organisms. Therefore, the ecotoxicological effects of the microplastic loaded pollutants are needed more attention. New pollutants such as PFCs, PCBs, DDT, drugs and personal care products (PPCPs) and polybrominated biphenyl ether (PBDEs), and influence the migration, transformation and ecotoxicological effects of these new pollutants.

Microplastics loaded with contaminants can damage the liver of fish. For example, microplastic-loaded contaminants can reduce the expression of polygenes in green crocodiles. Microplastics-loaded contaminants also damage the liver tissue of alligator and exert stress on the liver, which plays a central role in the metabolism and detoxification of different biomass in the body [16].

Microplastics loaded with contaminants affect organisms at both genetic and gene levels. Some studies have found that the gene expression of fish can be changed after ingesting microplastics loaded with contaminants[34], indicating that microplastic loaded contaminants can affect organisms at genetic level. Microplastics also adsorb DDT, a residual organochlorine pesticide in the environment, which also changes gene expression in fish [23] .

Contaminants loaded with microplastics are also enriched in the food chain. High-nutrient microbes can enrich microplastics from low-nutrient microbes through predator-prey relationships. Microplastics can be transferred to large zooplankton via medium zooplankton, researchers have found.

Microplastic loaded contaminants have lethal effects on organisms. The mixture of microplastics and pyrene significantly reduced the activities of Acetylcholinesterase (AChE) and isocitrate dehydrogenase (IDH) in goby, which increased the mortality of natural fish population .

Antibiotics in water environment are mainly transferred by adsorption process. Microplastics have large specific surface area, so it becomes the carrier of antibiotic migration and transformation in water environment. Oxytetracycline (which belongs to tetracycline antibiotics) is often used in aquaculture, which can migrate and remain in the environment. The residual antibiotics in the environment can harm the microbial community [35] and induce the formation of resistance genes .

5. Summary and recommendations

Because microplastics themselves have different shapes, small size, large specific surface area and hydrophobic properties, they can support different pollutants, as well as various additives released when microplastics migrate in the environment. The ecotoxicological effects of microplastics on the whole environment are complicated and should be paid special attention to.At present, micro plastics have polluted fresh water resources. Because of the small size of the micro plastic and the limitations of the current technology, there is no way to ensure that these micro plastics can be completely filtered out. Then it is necessary to consider whether the toxicological effects of the micro plastic will directly affect the effectiveness of human life function, the human respiratory system, and the digestive system. The reproductive system, the immune system and the gene expression can also be affected like some lower organisms. There is no direct evidence to prove it, but it is also a vigilance. It would not be an interesting thing to make a large amount of micro plastic in the body.

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