Research on the Influence of Microplastics on Marine Life

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Abstract. Plastics have been produced and used by humans in large quantities since they were invented, and the resulting environmental pollution problems have become more and more serious. In recent years, researchers have found that many plastic products are not completely decomposed after being discarded, a lot of plastics form microplastics in the ocean, which poses a threat to the survival of marine life. This paper analyzes the source, types and distribution of marine microplastics, and explores the influence of microplastics on marine life.

Keywords: microplastics, fish, plankton.

1. Introduction
Plastics are widely used around the world due to ease of manufacturing, low cost, stable chemical properties, and good water resistance, the production has been steadily increasing year by year. The commonly used plastics include polystyrene, nylon, polyurethane, polypropylene, etc. these plastics are gradually decompose by the physical, chemical and biological effects in the environment, plastics are easily fragmented under the effect of environmental forces, however, it takes about a long time for these plastics to be completely decomposed. Most plastics will form plastic debris with a small particle size; plastics debris whose diameter is less than 5 mm is called microplastics. The microplastics pollution has caused many hazards to marine life, and has already aroused widespread concern.

2. Sources and Types of Marine Microplastics
Plastics are chemically stable and can exist in the environment for hundreds of years or longer. Due to the cheapness and wide applicability of plastics, the global plastics industry has developed rapidly since the 1950s, the production of global plastics growing by 4% every year. About 10% of the waste plastics finally discharge into the ocean through various channels, which account for about 60% to 80% of marine waste, and they are even as high as 90% to 95% in some areas. What is more, with the global population growth and the increasing demand for plastic products, the amount of plastics discharged into the ocean has also increased dramatically. About 8 million tons of plastics flow into the ocean every year. Microplastics in the ocean are usually derived from inland river flows, fisheries and oil, etc. All kinds of plastic particles added in daily necessities, plastic raw materials used in industry, etc. finally flow from the river to the ocean. The main chemical components are polyurethane and polystyrene. In addition, the plastic waste in the coastal zone into the ocean will also cause pollution.
At present, the main sources of microplastics in the ocean are: land flow: plastic wastes such as plastic bags, foam and fibers on land are washed by wind and rain, and flow into the marine environment through river, which cause marine plastic pollution. Land flow is a major source of microplastics in marine environment. Coastal tourism: at the seaside tourist attractions such as densely populated beaches, due to the low specific heat, rapid heating, and fast photodegradation of beach, plastic bags, mineral water bottles and other plastic waste that are randomly discarded by tourists, they are easily broken into microplastics in the marine environment. Ship transportation: Ships throw a lot of plastic wastes to the ocean is also an important source of microplastics. In addition, marine shipping accidents can also cause a large number of plastic products to flow into the ocean. Fishing: In the fishing activities of trawling, fishing ropes and fishing nets will be worn due to abrasion and interception, thereby increasing the contents of microplastics in marine fishery waters. In addition, due to insufficient long-term use and maintenance of these fishing gears, a large number of plastic fishing gears are abandoned in the sea every year; microplastics pollution in life is closely related to local fishery production activities.

3. Distribution and Characteristics of Marine Microplastics
Microplastics are distributed on the surface of water bodies, near-shore beaches and water bottom sediments, and there are large spatial differences. Generally speaking, the pollution of microplastics in coastal waters is serious, which is mostly related to the intensity of human production activities. The contents of coastal sediments are higher than that of deep-sea sediments. At present, the shapes, sizes, colors, and densities of microplastics collected by people are different, depending on the type of plastics. Because microplastics are subjected to various environmental forces during the production process, the shape is irregular, the surface is uneven, and there are many cracks, they are often attached to crude oil, iron oxides, organic pollutants, bacteria and even viruses, etc., are subject to monsoon and ocean currents other external forces and gather in different sea areas.

4. Influence of Microplastics on Marine Fishes
Marine microplastics will affect many aspects of the marine fish and marine food chain. The microplastics can have a toxic effect on fish and other aquatic life, including reducing food intake, delaying growth, causing oxidative damage and abnormal behavior. In addition, nano-scale microplastics will penetrate the biological barrier and accumulate in tissues, resulting in the generation of ROS, affecting lipid metabolism, and may further affect life at the molecular level. For example, fishes that eat nano-sized polystyrene particles through the aquatic food chain had significant differences in body weight, serum triglyceride to cholesterol ratio, cholesterol content in muscle and liver and other metabolic parameters. But overall, the current research on the toxicological effects of microplastics on fishes is in its infancy, and research reports on the effects and mechanisms of growth, development, and metabolism of fishes are still very limited. And fish is an important group in the marine ecosystem, it plays a key role in the process of material circulation, energy flow and information transmission, and its health level can be directly related to the stability of the structure and function of the marine ecosystem. Moreover, because fish is an important source for humans to obtain animal protein, marine pollutants can enter the human body by enriching in fish and threaten human health. Therefore, it is of great significance to carry out research on the ecological effects of microplastics on fish. Microplastics are widely distributed in the marine environment, because of their small particle sizes; they are easily eaten by marine life, and produce a series of toxic effects, including inhibition of growth and development, impact on feeding and behavioral ability, reproductive toxicity, immunity toxicity, genetic damage, etc.

4.1. Inhibit growth and development
Microplastics can inhibit the growth and development of marine life. For example, polystyrene microplastics in the sediment can significantly inhibit the growth of the arenicola marina, and the inhibition degree is positively correlated with the concentration of microplastics. Polyethylene microplastics can inhibit the feeding and growth of the tripneustes gratilla, but it will not have a lethal effect on the tripneustes gratilla. When microplastics are taken into the body by marine life, they will
accumulate in the digestive tract and block the digestive tract, resulting in satiety, and decline in feeding capacity and reduce energy reserves in the body, thereby affecting the growth of marine life. Polystyrene microplastics significantly affect the energy reserve of Sebastes schlegelii and reduce the nutritional quality of the organism. Bivalve molluscs which are exposed to larger plastic particles, it was found that their protein and lipid content did not change, but the total energy reserve decreased as the contents of exposed microplastics increased. The polyethylene microplastics will disrupt the body balance of mytilus galloprovincialis), resulting in increased energy consumption and decreased growth rate of mytilus galloprovincialis.

4.2. Cause toxicological effects
Microplastics can harm the reproductive health of marine life. Under the influence of polystyrene microplastics, the number of egg cells ovulated by thecrassostrea gigas is significantly reduced, and the sperm motility level was reduced, it shows that microplastics would significantly inhibit the reproductive capacity of the thecrassostrea gigas. After the microplastics enter the marine fishery biological tissues and organs, they will trigger a series of immune responses. For example, polyvinyl chloride (PVC) and polyethylene (PE) microplastics with 40 to 150 µm particle size can cause oxidative damage to the white blood cells of sparus aurata and dicentrarchus labrax, resulting in immunotoxicity.

Table 1. Toxicological effects of microplastics on fish

| fish species          | microplastic type | particle size | concentration   | toxicological effects         |
|-----------------------|-------------------|---------------|-----------------|-------------------------------|
| Pomatosiostos microps | PE                | 1~5µm         | 184µg/L         | AChE activity decrease       |
| Acanthochormis Polyacanathus | PET | 1~2mm | 0~0.86mg/L | growth decrease               |
| Dictrarchus labrax    | PE                | 10~45µm       | 10~100pcs/mg   | mortality increase            |
| Dictrarchus labrax    | PVC               | <0.3mm        | 0.1% (quality ratio) | inflammation                |
| Dictrarchus labrax    | polymer           | 1~5µm         | 0.69mg/L       | swimming speed decrease       |
| Oryzias Lapites       | PE*               | <1mm          | 8µg/L          | male: abnormal proliferation of sperm cells |
| Carrassius Carassius  | PS                | (24.7±0.2) nm | 130mg          | vitality decrease            |
| Daniorerio            | PS                | (24.7±0.2) nm | 1.5×10^13pcs/L | body length decrease         |
| Daniorerio            | PE,PP,PA, PVC     | 70µm          | 1.0mg/L        | intestinal injury            |

4.3. Cause genetic damage
Microplastics can cause genetic damage to marine life. Studies have shown that microplastics absorb polycyclic aromatic hydrocarbons, which causes immunotoxicity, neurotoxicity and genotoxicity to M galloprovincialis), and can cause genetic damage to mussels. However, at present, there are few studies on the genotoxicity of microplastics for marine life.

5. Influence of Microplastics on Marine Planktons
The floating nets is used to sample is the most common method for collecting microplastics in surface water in the marine environment. The mesh size used in most studies is 0.3-0.39 mm. Therefore, microplastics smaller than these sizes will not be sampled and quantified. In this research, the high concentration of microplastics and the density of 1.05g/cm3 settled more or less. Nevertheless, it was observed that plankton such as rotifers, cladocerans, and copepods can eat fluorescent plastic with 0.1,
1.0, and 9.9 μm diameter, as shown in Fig.1. The following take Daphnia magna as an example and explore the influence of microplastics (1000 particles/L) on Daphnia magna.

![Fig. 1 Rotifera 0.1μm](image)

**Table 2.** The influence of microplastics (1000 particles/L) on Daphnia magna (21d reproduction experiment, mean ± variance, n=3)

| Microplastics                        | 0.1 μm     | 1 μm       | 9.9 μm     |
|--------------------------------------|------------|------------|------------|
| 21 d algae total food intake (/×10^7 cells) | 1.93±0.79  | 1.72±1.82  | 1.85±1.15  |
| First brood time/d                   | 4.20±0.20  | 4.00±0.35  | 4.00±0.20  |
| First brood amount                   | 9.80±2.62  | 11.1±2.05  | 10.3±0.702*|
| First farrowing amount               | 4.93±2.34* | 8.40±2.82  | 4.73±0.945**|
| Total number of infants born         | 52.5±10.8  | 56.0±9.24  | 48.6±7.41  |
| mortality rate of Daphnia magna/%    | 0          | 0          | 6.70±11.5  |
| Body length/mm                       | 3.51±0.07  | 3.56±0.108 | 3.64±0.064 |
| growth rate                          | 0.263±0.008*| 0.280±0.012| 0.257±0.010**|

Note: * means p<0.05; ** means p<0.01.

Studies have shown that 0.1 μm and 9.9 μm microplastics significantly affect the number of first brood amount and growth rate of Daphnia magna, but the 1.0 μm microplastics experimental group did not have significant effect. The difference between the effects of microplastics may be related to size, while smaller microplastics are more harmful.

6. Conclusion
At present, the pollution of marine microplastics has become more and more serious and has become a global pollution incident, but there is a lack of effective treatment methods. We must start eliminating pollution with various methods. In future work, the size, shape, and related contaminants should be considered to better evaluate the microplastics.

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