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The ecological impact of white pollution from offshore fisheries and aquaculture on coastal areas

Ning Zheng

College of Life Sciences, Inner Mongolia University, Hohhot, Inner Mongolia Autonomous Region, China

122000099@imu.edu.cn

Abstract. Based on the rapid development of offshore fisheries and aquaculture in recent years, this paper focuses on the increasingly serious pollution and destruction of the ecological environment, especially the serious problem of white pollution represented by microplastics. The author of this article focuses on the study of microplastic white pollution and analyzes and studies the surface sediments of aquaculture waters in Zhoushan Islands, Zhejiang, and Maowei Sea, Guangxi, as well as typical tidal flats around them. Compare by collecting data on surface sediments, microplastics on tidal flats, and microplastic types in nearby tidal flats from two locations. The microplastics in the two regions are divided into fragments, fibers, foams, and films based on their appearance and shape. The proportion of fibers is the highest, and the particle size of microplastics is mainly below 1mm. The color of microplastics is mainly lighter, with the highest amount of white. The chemical components of microplastics include polyester, polyethylene, polypropylene, polystyrene, polyvinyl chloride, and polyamide. The research results are helpful for routine marine biological surveys and can serve as a basis for evaluating marine debris, especially microplastics

Keywords: Zhoushan Islands, Maowei Sea, Microplastics, Offshore Aquaculture.

1. Introduction

Offshore aquaculture, also known as the construction of marine pastures, is an open-source approach established in the context of increasing demand for fishery products that cannot be met under natural conditions. Establishing marine pastures such as offshore aquaculture is also an agricultural means [1], specifically by placing artificial fishing reefs and other structures in a specific sea area as habitats, creating an environment suitable for the living of biological seedlings, and then using proliferation and release methods, Put artificially cultivated biological seedlings into the sea and feed directly on natural bait in the ocean, thereby increasing the biomass of marine fishery resources [2]. However, with the continuous development of offshore aquaculture, more and more problems are exposed. Firstly, due to the strong fluidity of seawater and frequent communication between different sea areas, marine ranching is different from land agriculture. Offshore aquaculture is not conducted in a closed water area, so marine ranching is highly susceptible to pollution. Secondly, the main way of offshore aquaculture in China is cage aquaculture, and the biggest drawback of cage aquaculture is that it is unable to achieve wastewater treatment, in which plastic and other pollutants can directly enter the open sea through the cage. At the same time, there will be many EPS foam floats, small wooden cages, etc., whose anti-wind and wave performance is relatively poor and easy to destroy. Every year, it also brings a large amount of floating garbage to the surrounding waters, causing relatively serious "marine white pollution [3]".

2. Comparison and Analysis of Microplastics in Zhoushan and Maowei Seas

Microplastics can easily become carriers of other pollutants in the environment, such as heavy metals and persistent organic pollutants [4-6]. At present, domestic and foreign research on aquaculture microplastics have made some progress, mainly focusing on macro white pollution, relatively little research on microplastic white pollution at the micro level, the degree of concern is not high enough, and the research results are relatively confusing [7]. In terms of sewage treatment, micro white pollution cannot be managed, resulting in increasingly serious micro white pollution. The world's micro-plastic pollution is becoming more and more serious, and people do not know enough about it, and the concern for macro-white pollution is much greater than the micro level, and the research at home and abroad is relatively chaotic. The authors hope to organize and analyze the changes in microplastics in offshore aquaculture around the world so that human beings can better understand the seriousness of the problem and take measures to protect the environment.

2.1. Case description

The Zhoushan Islands are located in the most developed Yangtze River Delta region of China, with a developed economy, a large population, and frequent human activities. At the same time, it also generates a lot of pollution, and white pollution is one of them. The huge market demand in the Yangtze River Delta has given rise to the prosperous development of Zhoushan's offshore aquaculture industry. As an important marine aquaculture area, it is also necessary to detect marine environmental pollution in the Zhoushan Islands. At the same time, to solve the problem of environmental pollutants, namely marine microplastics, in economic development is an urgent need to carry out work in the ecological environment protection of the Zhoushan Sea area. The abundance data of microplastics obtained from sediment sampling and analysis at 7 aquaculture stations in Zhoushan, as shown in Figure 1, are shown in Figure 1.

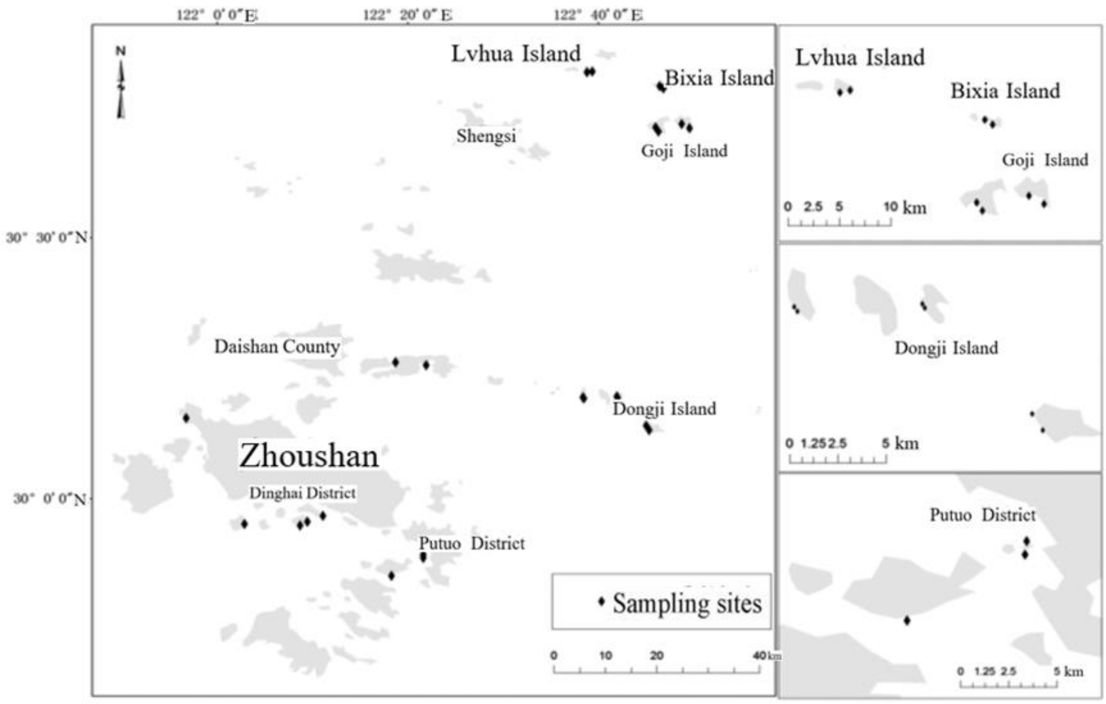

Figure 1. Sampling Location.

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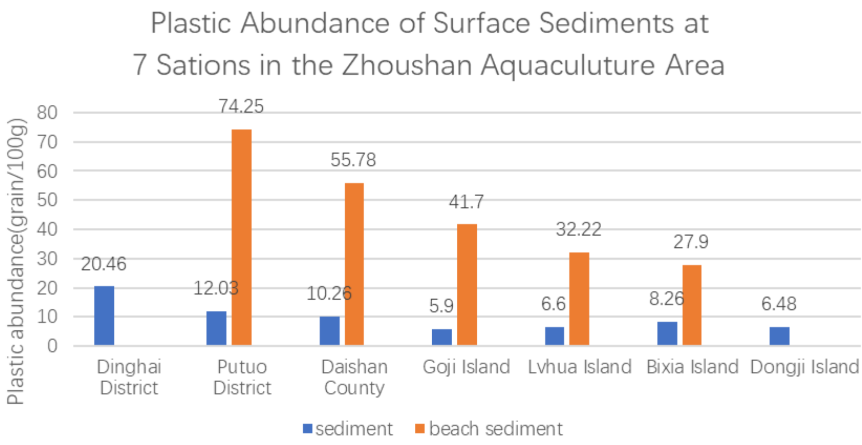

Figure 2. Statistical chart.

A total of seven sediment sampling stations were set up in this experiment, and the order of sediment microplastic abundance was Dinghai District > Putuo District > Daishan County > Bixia Island > Greening Island > Dongji Island > Goqi Island. The order of beach sediment plasticabundance was Putuo District>Daishan County>Goqishan Island>Luohua Island>Bixia Islan (Figure 2).

The Maowei Sea in Guangxi is located in the northern part of Qinzhou Bay and is a semi-enclosed inland sea. The southern part of the sea area is an outlet It is a bag-shaped inland sea bay surrounded by land on three sides: east, west, and north. The unique terrain, hydrological characteristics, and excellent water quality of the sea area are extremely suitable for the development of aquaculture. The main aquaculture products include oysters, green crabs, shrimp, grouper, and so on Among them, oysters account for the main part, and over 70% of the country’s oyster production comes from this sea area In addition to aquaculture activities, Maowei Lake is also a famous scenic tourist area. Extract and inspect the microplastics in the sea from the site shown in the figure, and obtain the data and comparison as shown in the figure 2.

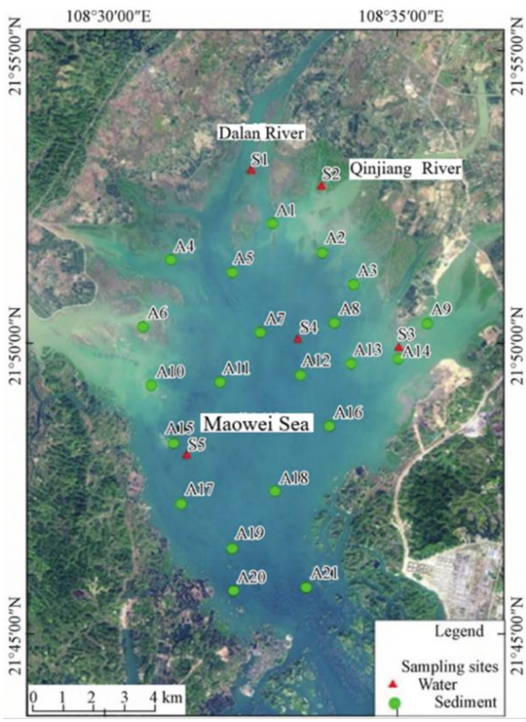

Figure 3. Sampling Location.

Figure 4. Statistical results.

2.2. Analysis

The order of microplastic abundance in sediment is Dinghai District>Putuo District>Daishan County>Bixia Island>Lvhua Island>Dongji Island>Goji Island. The order of plastic abundance in beach sediment is Putuo District>Daishan County>Goji Island>Lvhua Island>Bixia Island. From the location of each station, the main reasons for the regional distribution differences of microplastics are the wear and tear of aquaculture equipment, the arbitrary disposal of discarded aquaculture equipment, the discharge of various land-based garbage, especially laundry wastewater [8]. rainwater erosion, the combined effects of land-based sewage outlets or rivers, ocean currents, and tides. Due to these abandoned areas being relatively enclosed ponds, the amount of microplastics inside has not decreased. The maximum abundance of microplastics is in Putuo District, and the minimum is in the sparsely populated Goji Island. The proportion of fibers in microplastics extracted in this experiment is the highest, and the type of microplastics in sediment is related to the breeding methods in the breeding area [9]. Dinghai District and Daishan County mainly rely on pond aquaculture. As the water used for aquaculture mainly comes from the surrounding ocean, the types of microplastics in the sediment are basically the same as those in the surrounding ocean. Putuo District and Dongji Island mainly rely on cage aquaculture, which generates a large amount of fiber during use, which increases the abundance of sediment near the aquaculture area. The Goji Island, Bixia Island, and Lvhua Island in Shengsi mainly rely on raft aquaculture, which uses a large amount of foam plastic to increase suspension force. Therefore, the amount of foam microplastics in sediment is higher than in other locations.

The distribution of microplastics in the environment is influenced by various factors, such as weather, the surrounding water environment, and nearby human activities. In the Maowei Sea area, human activities are frequent, including fishing, aquaculture, and tourism activities During these processes, large plastic waste such as plastic bags, plastic bottles, and fishing gear used in fishery production may be abandoned in seawater due to human factors or wind forces. This plastic waste may break down and form microplastics under the action of seawater erosion. Samples of 5 water and 21 sediment samples from different locations in Figure 3, sampling points S1-S3 are located in the coastal areas of the Qinjiang and Dalan rivers, where microplastics are commonly found in the water bodies of the Qinjiang and Dalan rivers that enter the Maowei Sea. This is also one of the reasons why the abundance of microplastics in the water bodies of the northern sea area is higher than that of the other two sea areas. At the same time, there are many small islands in the eastern part of the Maowei Sea, which slow down the flow rate after water flow is blocked, which is conducive to the settlement of microplastics in the water body, leading to the accumulation of microplastics in seabed sediments. By analyzing the 21 samples collected from A1-A21(Figure 3), it can be clearly seen that the abundance of microplastics in the sediment shows a decreasing trend from four sides to the center (Figure 4), and the abundance of microplastics in the eastern coastal area of the sea area is significantly higher than that in the western region ($P=0.036$). This may be due to the main tourist attractions in the eastern coastal area, which are influenced by tourism activities and the input of terrestrial microplastics. The western region, on the

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other hand, is relatively open, with water flowing quickly towards the outlet, and microplastics in the water can quickly migrate, which is not conducive to the deposition of microplastics. Through microscope observation, plastics are divided into flakes, fragments, fibers, lines and foam according to their shapes. Through analysis, it is found that among the microplastics collected from the Maowei Sea water body, foam is the main type of microplastics at five sampling points, followed by flakes, fragments and fibers. The types of microplastics in the 5 sampling points are basically consistent and the color is mainly white. In previous reports, the microplastics in marine water are mainly flakes and fibers, and foam is not a common type of microplastics in seawater. However, the foam type accounts for a large proportion (60.1%) in the Maowei Sea. This kind of microplastic in the aquatic environment is usually related to fishing activities, and is used for packaging, containers or making buoyancy materials Maowei Sea is greatly affected by aquaculture, and mariculture activities may import a large number of foam fragments into the water body. Compared with the rich types of microplastics in the water body, only fiber and sheet microplastics are found in the sediment. Except for S1 and S2, which are all fibers, the majority of the sampling points are thin films, ranging from 50% to 100%. The colors of microplastics in sediment vary, with thin sheets mainly being white, blue, and green, and fibers mainly being black and red Among the five types of microplastics, the thin film has a larger surface area and a relatively rough surface, which can attach more microorganisms in a short period of time, causing it to gain weight and cause sedimentation [10].

2.3. Suggestion

There are various types of microplastics [11]: One type of fiber microplastics is that they break and fall from objects such as clothing, woven goods, and fishing ropes, and exhibit different fracture states. After fracture, the fiber surface often presents a forked and uneven state, completely changing the original smooth surface. The second type of fragmented microplastics has a wide range of uses, with richer surface features. Their edge fractures exhibit irregular shapes, and the fracture surface becomes brittle after corrosion, with prominent edges and corners. There are also some pores on the surface. The third type of thin film microplastics falls off due to corrosion and embrittlement, resulting in many shapes after detachment, making thin film materials more prone to curling. The chemical composition of the fourth type of foam microplastics is mainly polystyrene, which has a porous structure. Depending on different uses, these pores also have many sizes. The surface corrosion behavior of foamed microplastics is mostly characterized by the fracture of the porous structure surrounding it becoming irregular pores, and after more pores fracture, a large depression is formed. The surface of microplastics has undergone certain changes compared to new plastics, especially in this regard, which has led to a stronger adsorption capacity of microplastics for pollutants (heavy metals, organochlorine pesticides, etc.), thereby exacerbating the pollution of the sea area. For example, the amount of trace metal elements adsorbed on the surface of new resin particles is much lower than that of resin particles on beaches [12]. Therefore, the detailed classification of these plastics is of great significance for the study of microplastics.

3. Conclusion

In summary, pollution in coastal aquaculture not only causes damage to the original ecosystem but also causes damage to the aquaculture products themselves. White pollution in plastic directly affects the entire ecosystem and cannot be eliminated in the short term. Moreover, pollutants can also adsorb each other, leading to more serious pollution. From the comparison of microplastic samples in the Zhoushan Sea area and Maowei Sea area, it can be seen that a large number of foamed plastics will be produced under the influence of aquaculture, and then the proportion of foamed plastics in microplastics in the sea area is high. However, in areas near human life such as river inlets, the fiber content is relatively high. This is because human life produces a large amount of wastewater containing fibers, especially when washing clothes, and a large amount of fiber microplastics are washed out. However, current sewage treatment does not treat the fibers in the water, resulting in a higher fiber content in microplastics near the estuary. As a subtropical and economically developed area in the surrounding Yangtze River

Delta, Zhoushan, Zhejiang Province, has a higher content of microplastics than the relatively closed Maowei Sea area in Guangxi. This is because the population of the Yangtze River Delta is much larger than that of Guangxi. Therefore, although Maowei Sea is a closed sea area and Zhoushan Sea area is open, Zhoushan has too many sources of microplastics and too much input, making it difficult to dilute the flow of the sea on time. Moreover, Maowei Sea is also a tropical coastal area, with a faster exchange rate of organisms and other substances, resulting in a higher content of microplastics in Zhoushan compared to Maowei Sea. This paper uses a comparative method to study microplastics in the sea area and then draws conclusions. However, this is only a one-day data, which will be affected by weather and other factors. Therefore, the author believes that it is necessary to increase the comparison of different times and years, in order to reduce the error impact caused by weather changes. Therefore, in the future, it is necessary to conduct monthly testing and analysis in order to have more convincing results.

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