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Promoting Transdisciplinary Research for Food Security and Shaping Public Opinion on Oceans to Resolve the Marine Litter Issue

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Introduction

Among topics related to the marine environment, the issue of marine litter has recently been attracting attention worldwide. Most marine litter is waste and runoff generated on land, but, once in the ocean, this waste is carried over a wide area by ocean currents and waves, making it extremely difficult to recover. According to the United Nations Convention on the Law of the Sea, coastal states have the obligation to prevent marine pollution in their EEZs. However, for environmental problems that spread over a wide area, such as marine litter, it is insufficient for each country to respond independently, and cooperation and coordination among many countries are essential to resolve such issues. The transboundary nature of this issue strongly suggests the importance and necessity of creating and expanding "public opinion" on oceans.

Since Jambeck et al.[1] raised the issue in 2015, marine plastic litter has been at the center of the marine litter problem. A report from the World Economic Forum in 2016 stated that "if no action is taken, at this rate, the total weight of plastic litter in the ocean will exceed the weight of fish by 2050."[2] Discussions are already held around the world, reflecting the sense of crisis regarding these marine plastic litter issues, with the Osaka Blue Ocean Vision for resolving the marine litter issue adopted at the G20 Summit in Osaka in June 2019[3] and global interest increasing.

There is already a large amount of waste in the ocean, and it is estimated that 8 million tons of garbage continue to flow into the ocean every year.[1] Therefore, resolving the problem of marine litter will require many years and tireless efforts. How can we ensure that the problem of marine litter is not forgotten, that it receives attention, and that the world continues to work toward its resolution? In this section, we would like to discuss what kind of perspective is important for helping the movement on marine litter issues to develop and shape international public opinion on oceans, leading to concrete solutions to the problem, rather than a passing fad.

I. Accumulation and Use of Scientific Knowledge

It is estimated that as much as 105 million tons of plastic have already drifted into and accumulated in the ocean.[4] This is about 3.5 times the amount of plastic waste generated in Japan[5]; in addition, 8 million tons of waste continue to flow into the ocean every year.[1] Who can say how certain these figures are, though? According to the Ministry of the Environment, the amount of litter that washed ashore along the coast of Japan was reported to be about 32,000 tons in 2019 and 55,000 in 2017.

Given that plastic waste is estimated to be about 20% of the total, it alone amounts to about 6,400 to 11,000 tons. In all other countries, the amount of marine plastic litter is calculated based on this estimate of total waste and the percentage of plastic in that waste. Thus, it would be difficult to speak for certain about data omissions and the accuracy of the figures.

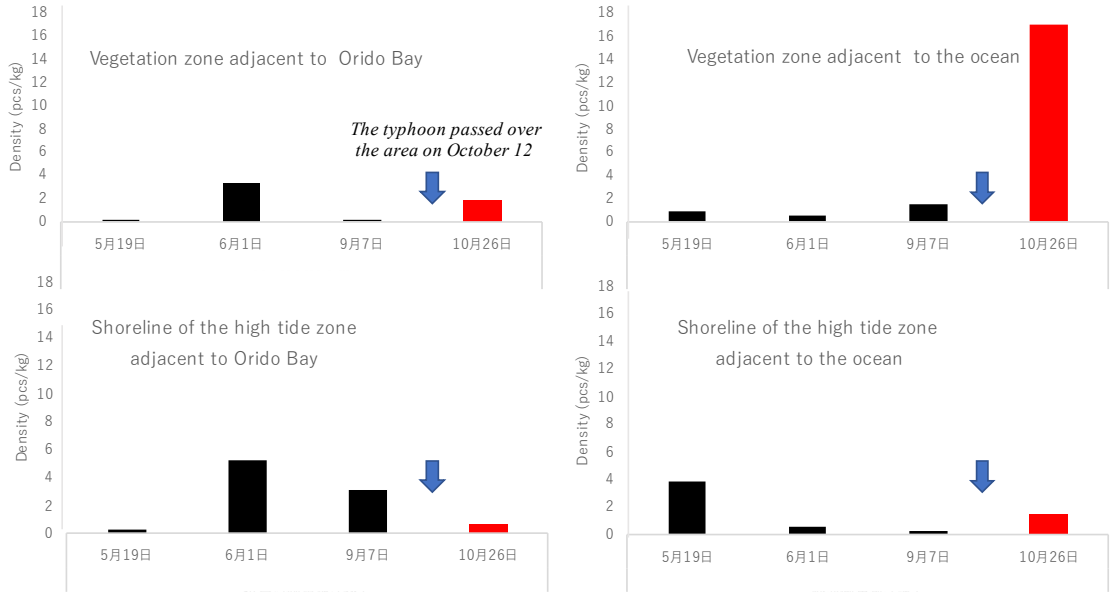
In addition, my group examined the amount of plastic litter on the beach at Masaki Beach in Shimizu Port, Shizuoka Prefecture, from 2019 to 2021. The results confirmed that the amount and types of litter (especially microplastics) vary greatly among various microenvironments, in terms of factors such as moisture content and vegetation, even on the same beach, and that the amount and types of litter can vary greatly each month even at the same location. In particular, the amount and type of litter drifting ashore changed drastically before and after extreme weather events such as typhoons.[6]

For microplastics in seawater, a consolidation of methods is underway, such as the use of a neuston net. However, even within Japan, no standard methods have yet been established for basic survey methods or methods for calculating litter on beaches. Therefore, given the situation of litter drifting ashore, which varies greatly due to weather and wave effects, it is difficult to scientifically understand the actual contamination and damage caused by the litter. To take concrete measures in the future, there is an urgent need to establish internationally standardized methods for both marine litter in the ocean and litter that washes ashore and to strengthen the system to promote the collection and analysis of comparable data.

II. Natural Disasters and the Ghost Gear Issue

Litter may be washed into the ocean due to natural disasters, in addition to improper waste disposal and illegal dumping on land. The Ministry of the Environment estimates that approximately 5 million tons of debris were flowed into the sea as a result of the Tohoku earthquake. Debris washed away from the coast includes a variety of items, and, especially in the northeastern coastal areas where the fishing industry is thriving, a large amount of fishing equipment stored on land is also thought to have washed out to sea. Loss of fishing gear occurs not only in Japan but around the world. 160,000 crab traps are lost every year in the Chesapeake Bay in the United States, and, in Canada, it is estimated that 70 km of gill nets were lost over a five-year period. Also, in the Great Pacific garbage patch, a North Pacific gyre of trash, about 46% of the floating plastic trash is related to fishing gear.[7]

Change in the volume of trash at Shimizu Port Masaki Beach before and after the passage of Typhoon No. 19 in October 2019.



Fishing gear washed out to sea not only causes damage by decomposing into microplastics due to waves and ultraviolet rays, but also results in ghost fishing, where fishing gear originally made of materials resistant to seawater remains in the ocean for a long time, capturing and starving many marine resources. It has also been noted that underwater fishing gear can become ghost gear that captures and drowns not only fish but also marine mammals, birds, and reptiles.[7]

Ghost gear is often addressed as a problem in the fishing industry, as illegal dumping of fishing gear by fishermen and IUU fishing (illegal, unreported, and unregulated fishing) are thought to be the main causes. This requires the fishing industry to take measures such as removing fishing gear from the sea. According to the Fisheries Agency of Japan, approximately 10,000 tons of fishing gear have been recovered from Japan's Exclusive Economic Zone over the past decade. The cost of this project is estimated at approximately 1 billion yen. The recovered fishing gear includes many items that appear to have originated from foreign fishing vessels. If all the ghost gear were collected solely by those involved in the fishing industry, the problem would be unaddressed because they would be unable to bear the enormous costs involved. Otherwise, if the cost were to be passed on, the cost of ghost gear removal would ultimately be borne by the Japanese consumer. Considering that the causes of ghost gear includes natural disasters and illegal dumping by overseas fishermen, it is necessary to tackle the solution in terms of it being a problem for humanity as a whole, just like other marine plastic litter. We must move forward with the investigation and removal of ghost gear within a global framework before marine fishery resources are further devoured. This should take precedence in some cases over resource management concerns.

III. Food Security and Marine Litter

The "State of Food Security and Nutrition in the World 2022"[8] published by the United Nations in July 2022 states that 828 million people worldwide are going hungry. Meanwhile, according to the Food and Agriculture Organization of the United Nations (FAO), the world produces more than 2.65 billion tons of grain annually, which means that there is enough food to feed the world's population. Thus, the current hunger is considered to be a distribution problem. However, it is not certain that this situation will continue. The world population is still growing and is estimated to increase to 10.4 billion by 2080. It is estimated that an increase in food production of more than 60% of the current level is needed to support this growing world population.

Alarm bells have been sounded several times in the past about global food shortages. Older examples include the Malthusian population theory and the 1972 Club of Rome proposal. In the past, technological innovations such as the expansion of cultivated land and the development of artificial fertilizers increased food production and the problem was avoided. However, in the modern era, much land is already in use, and further expansion of farmland is not expected when deforestation is a problem. With the use of chemical fertilizers and the problem of genetically modified ingredients, it will be difficult to increase food production through technological innovation alone. In addition to these factors, issues of extreme weather and desertification occurring on a global scale are destabilizing and reducing agricultural production. The decrease in freshwater resources and their depletion, which has already been pointed out in various regions, also indicate that it will be difficult to increase food production in the future. Under these circumstances, there is great promise for food production in the ocean. In particular, the development of increased aquaculture in offshore and open ocean areas, which have not been utilized to a great extent in the past, is expected to expand, involving technological and economic development.[9]

Resolving the problem of marine plastic litter will be essential for expanding the sustainable use of marine resources in this open sea area because it has been suggested that miniaturized micro- and nanoplastics are at risk of being consumed by marine organisms, thereby inhibiting their ability to reproduce. In particular, the ingestion of plastic by zooplankton, which occupy an important position in the marine ecosystem, and the disruption of their reproduction, should be considered a major problem.[10] A decline in plankton, which link basic production to fisheries' resources, could lead to a decline in overall ocean biomass. With food shortages predicted as the world's population grows, the decline in ocean productivity is a major challenge from a future food security perspective. In addition, a wide variety of microorganisms and bacteria have been observed growing on the surface of microplastics, and the spread of plastic contamination could lead to increased risks to food safety and human health.

Conclusion

Environmental issues in the ocean, such as eutrophication and red tides, and water quality problems caused by oil and chemicals, are widely discussed, and several conventions already exist, including the MARPOL Convention and the London Convention on marine dumping. However, the problem of marine plastic litter seems to differ significantly from conventional marine environmental issues in terms of its transboundary nature, the diversity of its causes, and the uncertainty of the extent of its damage. The adverse effects of micro- and nanoplastics, especially those generated in the open ocean, on ecosystems and marine resources are difficult to acknowledge on a daily basis and may be difficult to discuss on a global scale.

Problems that are invisible or not acknowledged on a daily basis are often forgotten. Even if they become a topic of conversation for a time, it is difficult to keep the public's attention until they are resolved. Compared to other economic or security issues, it can be said that sustainability is a major problem for environmental issues. In the past, issues such as the ozone hole and environmental hormones were widely discussed for a time and became global concerns. These issues have not been completely resolved, but they are less-discussed internationally once the fad has passed.

The problem of marine plastic litter is undoubtedly a major issue that will not be resolved unless it is tackled worldwide. To resolve this problem will require a long-term effort that must continue to attract the attention of many people. To this end, it is necessary to establish an adequate research system, an accumulation of scientific data and a system for use, and the constant dissemination of new information, now that the world's attention is focused on this issue.

However, it is difficult to sustain people's interest in environmental issues and to change their behavior to resolve such issues simply by collecting scientific data. In fact, the World Climate Research Program (WCRP) was organized in 1980 on the issue of global warming and climate change, followed by global climate research. In addition, the International Geosphere-Biosphere Programme (IGBP) was organized in 1987 to address issues related to the biodiversity crisis, and various studies have been conducted. Scientific data were accumulated and scientific discoveries were accomplished. During this period, however, the global environment did not improve and social systems did not seem to reach a point of conversion. As pointed out in the subsequent Earth System Science Partnership (ESSP) and Future Earth,[11] it is difficult to continue a movement that leads to solutions to broad environmental problems simply by presenting scientific data and presenting concerns and dangers. It is necessary to recognize each issue and problem as important to each individual and nation, while constantly disseminating new information. In this regard, it is expected that clarification of the relationship with health and food security issues will provide strong social penetration. At the same time, it will be necessary to consider a system in which the resolution of the marine litter issue will benefit individuals and society. To this end, it is important that research and analysis be recognized as a transdisciplinary activity involving a variety of people (stakeholders), rather than simply a task to be performed by researchers and government officials. Now that the issue is attracting attention on a

global level, it is important to create a mechanism that enables the building of this system, dissemination of information, and working toward a solution that provides benefits. There are expectations for a mechanism that enables waste management to become a new industry, not merely a cleanup of economic activities, and the sharing (standardization) of science and technology to support this new industry.

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1 Jenna R. Jambeck, Roland Geyer, Chris Wilcox, Theodore R. Siegler, Miriam Perryman, Anthony Andrady, Ramani Narayan, Kara Lavender Law, 2015, Plastic waste inputs from land ino the ocean, Science, 347, pp. 768-771.

2 World Economic Forum, 2,016, The new plastics Economy, pp. 34.

3 Zhu, Mengyao, 2021, Current Situation for Research into the Marine Issue of Microplastics, and Future Challenges, United Nations Environment Assembly (UNEA), OPRI Perspectives, No. 24, pp. 1-6.

4 WWF Japan, 2018, About the Marine Plastic Problem, https://www.wwf.or.jp/activities/basicinfo/3776.html (accessed December 20, 2022)

5 Environment, 2022, R4 Environmental White Paper https://www.env.go.jp/policy/hakusyo/r04/pdf.html (accessed January 3, 2023)

6 From 2019 to 2021, students from the Department of Environmental and Societal Affairs, School of Marine Science and Technology, Tokai University, studied the changes in litter over time on the Masaki beach. The amount and type of trash changed from April to August at the same location. Significant changes were reported, especially before and after the passage of a typhoon.

7 WWF, 2020, Stop Ghost Gear (Japanese translation), pp. 63.

8 FAO, 2022, The State of Food Security and Nutrition in the World 2022 (Japanese version, 2022).

9 Blue Economy CRC-Co. Ltd, https://blueeconomycrc.com.au/ (accessed December 12, 2021), among others, stated that the target is the development of aquaculture technology in the open ocean.

10 Matthew Cole, Pennie Lindeque, Elaine Fileman, Claudia Halsband, Tamara S. Galloway, 2015, The Impact of Polystyrene Microplastics on Feeding, Function and Fecundity in the Marine Copepod *Calanus helgolandicus,* Environ. Sci. Technol. 49, pp. 1130−1137.

11 Future Earth Japan Committee, https://japan.futureearth.org/ (Accessed December 20, 2022)