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An Overview of Microplastics in the Marine Ecosystem of North Maluku

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Abstract. North Maluku has been the site of microplastic study for some years. The goal of this paper is to revisit the earlier analysis. The intent is to be a quick guide for scholars studying microplastics in North Maluku. Additionally, this article's goal is to quantitatively analyse some of the findings from the research that has been done. The terms "Microplastics in the North Maluku Sea" were entered into the search engines Google Scholar and Science Direct to conduct journal and research searches. Previous studies on microplastics on Mare Island looked at sediments in the island's waters and the levels of microplastics in various kinds of sea cucumbers. A total of 272 microplastic fragments were discovered in sea cucumbers. At the same time, two stations were doing a study on deposits. Microplastics weighing between 17,000 and 37,000 particles/kg of dry sediment were discovered at the first station in Maregam. 13,839-30,666 particles/kg of silt were discovered in Marekofo. According to research conducted on the island of Ternate, skipjack tuna contains up to 948 microplastic particles that were collected from 16 market fish samples. According to studies on other fish species like Epinephelus Fuscogutattus, E. coioides, and E. Suillus, the digestive tract of fish contains 594 microplastic particles.

Keywords: *Microplastics, Marine Ecosystem , fish, Mare Island*

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1 Introduction

Plastic is widely produced and will keep growing (Hsu et al., 2022) because of its durability, versatility, lightweight, and strength (Kautish et al., 2021; Okoffo et al., 2021). Plastic garbage disposal in rivers, coastal areas, and the sea has grown due to increased plastic production (Wang et al., 2022). Due to the growth of the plastic manufacturing industry, 391 million metric tonnes of plastic garbage were created globally in 2020, as opposed to only 1.5 million metric tonnes in 1950 (Zhou et al., 2022). According to many academics, if the rapid growth rate of plastic garbage in the waters continues, there will be more plastic than fish in the oceans by the year 2050 (Hasan Anik et al., 2021).

This waste plastic will decompose, erode, photodegrade, and fragment into microplastics (MP), which are less than 5 mm in size (Andrady, 2011), and even into minuscule fragments known as nanoplastics (Jaiswal et al., 2022).

Microplastics threaten both humans and marine life since species can consume them at lower trophic levels because they are regarded as food. The larger sea species and people who eat the microbes later consume these organisms. The public will see things like fish (Sharma & Chatterjee, 2017).

Humans exposed to microplastics have a risk of worsening health. Microplastics in aquatic ecosystems can negatively affect humans and other biota in the food chain (Browne et al., 2011). Other effects on living things exposed to microplastics are that they can inhibit enzyme production, reduce hormone levels, inhibit reproduction, disrupt the nervous system, trigger cancer cell growth, allergic reactions, cell damage, and metabolic disorders (Wright et al., 2013). Testing microplastics on rats being fed for 28 days with microplastics of the polystyrene type found microplastics distributed in the liver, kidney, and intestine, with larger particles regularly distributed in all tissues (Deng & Zhang, 2019). Microplastics, such as the placenta, are also found in human organs (Ragusa et al., 2021).

In North Maluku's Mare Island conservation area, microplastics have been found in the seagrass sediments, according to a brief summary of recent research on the topic (Ramili & Umasangaji, 2022). The presence of microplastics in the marine environment is also evaluated by another literature analysis that focuses on determining the features and quantity of microplastics eaten by skipjack tuna sold in the Ternate market (Lessy & Sabar, 2021).

The presence of microplastic particles in the digestive systems of reef fish, specifically Kasturian, Kampung Makassar, Mangga Dua, and Kalumata, in the waters surrounding Ternate Island was the subject of a different study that was evaluated (Henie et al., 2021). In addition to evaluating the quantitative information that is currently available regarding the plastic debris that is adrift in Ternate Island's waterways (Muhdhar et al., 2020).

2 Methodology

Studies on microplastics in North Maluku are reviewed in this article. This study was located by searching for "microplastics in North Maluku" on the Google Scholar and Science Direct websites. Six studies were discovered in the data, including the first study on microplastics in sea cucumbers' digestive tracts in the Mare Island conservation area. Second, the buildup of sedimentary microplastics in Mare Island's seagrass meadows. Third, determine how much skipjack tuna has been consumed in terms of microplastic. Fourth, a review of microplastic fragments found in reef fish's gastrointestinal tract. Fifth, describe the traits and quantity of microplastics found in tuna stomachs. Sixth, ascertain the makeup of the various types of microplastic trash present in Ternate waters. The following six studies looked at the research area, the extraction technique for removing microplastics from their environment, the analytical technique (tools utilised), the types of microplastics analysed, the size and type of microplastics, and their shape.

3 Result and Discussion

There have only been two locations in North Maluku where microplastic research has been done: Mare Island and Ternate City. On Mare Island, studies concentrated on the number of microplastics found in sea cucumbers and their presence in sediments and seagrass meadows. It was investigated in Ternate to see how much microplastic was present in reef fish and skipjack tuna. The following table shows the research findings that need to be examined:

Table 1. Microplastic Research Result in North Maluku

Region	Sample	Morphology	Microplastic Abundance (Particles)
Ternate Island	skipjack tuna	Fibres, fragments, and films	948
	Coral fish	Fragments, films, foams, fibres, and pellets	594
Ternate Island	Mackerel tuna	Fibres, components, and films	35
Mare Island	Sea Cucumbers	Fibres and fragments	272
	Seagrass sediments	Fibres, filaments, fragments, and pellets	30.000 – 37.000

Sources: Lessy & Sabar (2021); Henie et al(2021); Ramili & Umasangaji (2022).

The quantity or number of microplastic particles discovered in the Mare Island seagrass bed sediments is shown in Table 1. Mare Island has a lower population density, claim Ramili and Umasangaji (2022). However, microplastics are pretty high compared to other regions of the world. Without considering the local region's contribution to North Maluku, the findings are believed to have originated from a great distance and were conveyed by hydro-oceanographic and meteorological forces. The high concentration of microplastics in sediments is also related to the ongoing erosion of deposits, which leads to the buildup of microplastics in deeper sediment layers (Hidalgo-Ruz et al., 2012). Gravity influences the microplastics that sink to the sediment's bottom because plastic has a higher density than water. As a result, plastic subsequently sinks and gathers in sediments (Wright et al., 2013).

The accumulation of microplastics in seagrass sediments also suggests that seagrass beds can capture microplastics, as evidenced by the discovery of microplastics in seagrass sediments from China (Huang et al., 2022), England (Unsworth et al., 2021), the Pacific Ocean region, the Mediterranean (Dahl et al., 2021), and the Baltic Sea (Kreitsberg et al., 2021). However, compared to other seagrass beds in various locations of the world that have been researched and in marine sediments, the average value of microplastic abundance found in the seagrass sediments on Mare Island is higher.

Higher concentrations of microplastics are believed to be caused by factors such as poor coastal management and significant anthropogenic contamination (Huang et al., 2022). Geographically, microplastics originate outside of Mare but close to Mare Island, specifically Ternate Island, because Ternate produces more plastic garbage than Mare Island does, claim Ramili and Umasangaji (2022). However, this plastic trash breaks down into microplastics, which are transported to nearby regions like Mare Island by the local hydrodynamics.

Even though the amount of each fish varied, microplastics were discovered in the digestive tract of samples of skipjack tuna. Nine hundred forty-eight microplastic particles, acquired from 16 fish samples over three sampling times, were the total amount of microplastic found in all models. The skipjack tuna sample from Bastiong Market included 360 microplastic particles, the most of any sampling site. Following this were samples with 319 particles from the Dufa-Dufa market and 269 particles from the Gamalama market.

Skipjack contains microplastics from home garbage, and other sources dumped into the water near Ternate. Fibre, film, and fragment-type microplastics were the ones that were discovered. Waste produced as a result of human activity can contain fragments. Different sources produce fragments of diverse sizes, shapes, and climates. In fishing nets, ropes, and synthetic textiles, which dump garbage into the ocean, monofilament can fragment into fibre, a sort of micro-plastic. The most prevalent type of microplastic detected in sediments is fibre, which resembles thread.

The low-density film is made of a polymer created when plastic packaging or bags are broken up. Fragments are more minor than film, yet both have a three-dimensional shape. They were cutting plastic objects with solid synthetic polymers resulting in fragments. The main microplastics industries produce as a source of raw materials for producing plastics are pellets.

Microplastics were discovered in samples taken from the sea cucumbers' digestive tract. Sea cucumbers' gastrointestinal tracts include three different kinds of microplastics: fibre, pieces, and balls. According to multiple earlier investigations, fibre and fragments were also discovered in the digestive tracts of sea cucumbers on Tidung Island and Bintan Island (Sayogo et al., 2020; Idris et al., 2022). Numerous other kinds of microplastics are discovered in the digestive tract of different species of sea cucumber. In their native settings, such as seagrass ecosystems, different sea cucumber species have different forms of microplastics in their digestive tracts. Compared to other types of microplastics like films, foam, pellets, and balls, fibre and fragments are the microplastics most frequently found in the digestive tract of sea cucumbers. The most prevalent type of microplastic that can be identified in different marine creatures, according to Dahl et al. (2021), is made up of fibres and pieces.

Reef fish showed microplastic fragments discovered in their stomachs and digestive systems in the waters off Ternate Island. Microplastics most likely originate from certain plastics people have put into the ocean. Microplastics in fish digestive systems are clear, black, pink, yellow, and red. Transparent and black were the most prevalent colours, whereas Epinephelus fuscogutattus and Synanceia fish tended to be predominantly pink and yellow, and Epinephelus coioides were mostly blue and red.

4 Conclusion

Microplastic research in North Maluku is only a few—the most common microplastics found in seagrass sediments. Microplastic particles found ranged from 30,000 to 37,000 particles. The average value of microplastic abundance found in Mare Island seagrass sediments is higher than that of some other seagrass beds in several regions of the world that have been studied, as well as in marine sediments. These microplastics are suspected to originate from other areas around Mare Island, such as Ternate and Tidore, carried by local hydrodynamic conditions to other adjacent areas, such as Mare Island. Microplastics are also commonly found in skipjack tuna as many as 948 particles. The large amount of microplastic found in skipjack tuna is due to bioaccumulation and biomagnification, where skipjack tuna prey on small fish exposed to many microplastics. The more skipjack tuna consumes small fish, the more microplastic content in skipjack tuna.

References

1. Andrady, A. L. (2011). Microplastics in the marine environment. *Marine Pollution Bulletin*, *62*(8), 1596–1605. https://doi.org/10.1016/J.MARPOLBUL.2011.05.030
2. Browne, M. A., Crump, P., Niven, S. J., Teuten, E., Tonkin, A., Galloway, T., & Thompson, R. (2011). Accumulation of microplastic on shorelines worldwide: Sources and sinks. *Environmental Science and Technology*, *45*(21), 9175–9179. https://doi.org/10.1021/ES201811S/ASSET/IMAGES/MEDIUM/ES-2011-01811S_0003.GIF
3. Dahl, M., Bergman, S., Björk, M., Diaz-Almela, E., Granberg, M., Gullström, M., Leiva-Dueñas, C., Magnusson, K., Marco-Méndez, C., Piñeiro-Juncal, N., & Mateo, M. Á. (2021). A temporal record of microplastic pollution in Mediterranean seagrass soils. *Environmental Pollution*, *273*, 116451. https://doi.org/10.1016/J.ENVPOL.2021.116451
4. Deng, Y., & Zhang, Y. (2019). Response to Uptake of microplastics and related health effects: a critical discussion of Deng et al., Scientific reports 7: 46687, 2017. *Archives of Toxicology*, *93*(1), 213–215. https://doi.org/10.1007/S00204-018-2384-8
5. Hasan Anik, A., Hossain, S., Alam, M., Binte Sultan, M., Hasnine, M. T., & Rahman, M. M. (2021). Microplastics pollution: A comprehensive review on the sources, fates, effects, and potential remediation. *Environmental Nanotechnology, Monitoring & Management*, *16*, 100530. https://doi.org/10.1016/J.ENMM.2021.100530
6. Henie, M., Al Muhdhar, I., Sumberartha, W., Hassan, Z., Rahmansyah, M. S., & Nasir Tamalene, M. (2021). *Examination of Microplastic Particles in Reef Fish Food in Ternate Island Waters, Indonesia*. *14*(4). https://doi.org/10.54319/jjbs/140427
7. Hidalgo-Ruz, V., Gutow, L., Thompson, R. C., & Thiel, M. (2012). Microplastics in the marine environment: a review of the methods used for identification and quantification. *Environmental Science & Technology*, *46*(6), 3060–3075. https://doi.org/10.1021/ES2031505
8. Hsu, W. T., Domenech, T., & McDowall, W. (2022). Closing the loop on plastics in Europe: The role of data, information and knowledge. *Sustainable Production and Consumption*, *33*, 942–951. https://doi.org/10.1016/j.spc.2022.08.019
9. Huang, Z., Hu, B., & Wang, H. (2022). Analytical methods for microplastics in the environment: a review. *Environmental Chemistry Letters 2022 21:1*, *21*(1), 383–401. https://doi.org/10.1007/S10311-022-01525-7
10. Idris, F., Febrianto, T., Hidayati, J. R., Rajib, & Nugraha, A. H. (2022). Microplastic abundance in sea cucumber in seagrass ecosystem of Bintan Island and surrounding area, Indonesia. *IOP Conference Series: Earth and Environmental Science*, *967*(1), 012009. https://doi.org/10.1088/1755-1315/967/1/012009
11. Jaiswal, K. K., Dutta, S., Banerjee, I., Pohrmen, C. B., Singh, R. K., Das, H. T., Dubey, S., & Kumar, V. (2022). Impact of aquatic microplastics and nanoplastics pollution on ecological systems and sustainable remediation strategies of biodegradation and photodegradation. *The Science of the Total Environment*, *806*(Pt 3). https://doi.org/10.1016/J.SCITOTENV.2021.151358
12. Kautish, P., Sharma, R., Mangla, S. K., Jabeen, F., & Awan, U. (2021). Understanding choice behaviour towards plastic consumption: An emerging market investigation. *Resources, Conservation and Recycling*, *174*, 105828. https://doi.org/10.1016/J.RESCONREC.2021.105828
13. Kreitsberg, R., Raudna-Kristoffersen, M., Heinlaan, M., Ward, R., Visnapuu, M., Kisand, V., Meitern, R., Kotta, J., & Tuvikene, A. (2021). Seagrass beds reveal high abundance of microplastic in sediments: A case study in the Baltic Sea. *Marine Pollution Bulletin*, *168*, 112417. https://doi.org/10.1016/J.MARPOLBUL.2021.112417
14. Lessy, M. R., & Sabar, M. (2021). Microplastics Ingestion by Skipjack tuna (Katsuwonus pelamis) in Ternate, North Maluku - Indonesia. *IOP Conference Series: Materials Science and Engineering*, *1125*(1), 012085. https://doi.org/10.1088/1757-899X/1125/1/012085
15. Okoffo, E. D., Donner, E., McGrath, S. P., Tscharke, B. J., O'Brien, J. W., O'Brien, S., Ribeiro, F., Burrows, S. D., Toapanta, T., Rauert, C., Samanipour, S., Mueller, J. F., & Thomas, K. V. (2021). Plastics in biosolids from 1950 to 2016: A function of global plastic production and consumption. *Water Research*, *201*, 117367. https://doi.org/10.1016/J.WATRES.2021.117367
16. Ragusa, A., Svelato, A., Santacroce, C., Catalano, P., Notarstefano, V., Carnevali, O., Papa, F., Rongioletti, M. C. A., Baiocco, F., Draghi, S., D’Amore, E., Rinaldo, D., Matta, M., & Giorgini, E. (2021). Plasticenta: First evidence of microplastics in human placenta. *Environment International*, *146*, 106274. https://doi.org/10.1016/J.ENVINT.2020.106274
17. Ramili, Y., & Umasangaji, H. (2022). An Assessment of Microplastics (MPs) Sedimentary

Accumulation in Seagrass Meadows of Mare Island Conservation Area, North Maluku, Indonesia. *Omni-Akuatika*, *18*(1), 48–61. https://doi.org/10.20884/1.OA.2022.18.1.921

18. Sayogo, B. H., Patria, M. P., & Takarina, N. D. (2020). Microplastic density in sea cucumber (Holothuria sp.) and sediment at Tidung Besar and Bira Besar island, Jakarta. *Journal of Physics: Conference Series*, *1524*(1), 012064. https://doi.org/10.1088/1742-6596/1524/1/012064
19. Sharma, S., & Chatterjee, S. (2017). Microplastic pollution, a threat to the marine ecosystem and human health: a short review. *Environmental Science and Pollution Research*, *24*(27), 21530–21547. https://doi.org/10.1007/S11356-017-9910-8
20. Unsworth, R. K. F., Higgs, A., Walter, B., Cullen-Unsworth, L. C., Inman, I., & Jones, B. L. (2021). Canopy Accumulation: Are Seagrass Meadows a Sink of Microplastics? *Oceans 2021, Vol. 2, Pages 162-178*, *2*(1), 162–178. https://doi.org/10.3390/OCEANS2010010
21. Wang, Q., Huang, K., Li, Y., Zhang, Y., Yan, L., Xu, K., Huang, S., Junaid, M., & Wang, J. (2022). Microplastics abundance, distribution, and composition in freshwater and sediments from the largest Xijin Wetland Park, Nanning, South China. *Gondwana Research*, *108*, 13–21. https://doi.org/10.1016/J.GR.2021.07.009
22. Wright, S. L., Rowe, D., Thompson, R. C., & Galloway, T. S. (2013). Microplastic ingestion decreases energy reserves in marine worms. *Current Biology*, *23*(23), R1031–R1033. https://doi.org/10.1016/J.CUB.2013.10.068
23. Zhou, C., Bi, R., Su, C., Liu, W., & Wang, T. (2022). The emerging issue of microplastics in marine environment: A bibliometric analysis from 2004 to 2020. *Marine Pollution Bulletin*, *179*, 113712. https://doi.org/10.1016/J.MARPOLBUL.2022.113712