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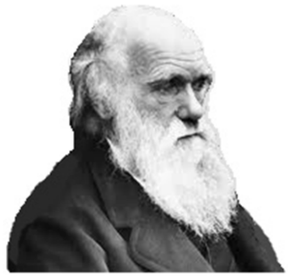

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Conditions for Sediment Coating Microplastic in Mangrove Ecosystems in Kupang and Rote, East Nusa Tenggara, Indonesia

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ABSTRACT

The observation and direct sampling, as well as laboratory tests of this research was conducted from June until October 2018. This study aims to determine the existence of microplastics in the sediment of water bodies in Kupang and Rote Districts based on the number, type, size and abundance of microplastics. The data used in this study include the type of sediment, microplastic abundance and the characteristics of the data collection area. Microplastics are plastic particles sized less than 5 mm, and in our research, were divided into 4 types: manifold fiber, fragment, film and pellets. Herein, 849 particles of microplastic were found: 635 fibers, 160 particle fragments, and 54 particle films. The primary influencing factor for microplastic deposition is the sedimentary texture itself. Sediments of a coarse type do not capture as much microplastic as do sediments of a finer texture. Data collection area characteristics also affect accumulation.

***Keywords*:** microplastics, Kupang and Rote, East Nusa Tenggara, sediment

1. INTRODUCTION

According to the Convention on Biological Diversity (2012), plastics are the most dominant type of marine waste. In 2009, 230 million tons of plastic were produced (Cole et al. 2011) and in 2016, world plastic production reached 335 million tons. The more plastic used, the more plastic waste is disposed of into the environment. Much of this will eventually end up in the waters, especially the sea.

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Generally, the process of plastic decomposition takes place very slowly. Almost all types of plastic will float or float in a body of water. This will cause the plastic to be torn apart and degraded by sunlight (photodegradation), oxidation and mechanical abrasion to form small plastic particles (Thompson et al, 2015).

Plastic particles that are ≤ 5 mm are called 'microplastic' (Tompson et al, 2015). Marine microplastic is divided into primary microplastics and secondary microplastics (Cole et al. 2011). Primary microplastic is a microscopic pure plastic that reaches the sea area directly due to negligence in the handling process, while secondary microplastic come about through degeneration of larger plastic items.

The results of studies that have been carried out show that microplastic is widespread in the oceans, on the surface and deposited on the coastlines and sea floor (Lusher et al, 2015). This causes microplastics to be found in sediments throughout the world (Classens et al. 2013). Indeed, Thompson et al., (2015) believe that about 10% of all newly produced plastics will be discharged through rivers and end up at sea

Sediment has an important role in trapping marine waste either as microdebris or macrodebris. In sediment, the process of degradation of marine waste occurs faster than in the water column. Hence, in coastal sediment there are more microplastic than in the water column. Sediments in an area are strongly influenced by the presence of mangroves. This is because mangroves have a role as sediment traps that prevent sediments from being carried away by the currents.

The mangrove area in the Kupang and Rote areas is subjected to various activities, mainly derived from residential occupation. These activities include fishing, fisheries, agriculture, plantations, and household activities that contribute to producing plastic waste. Marine waste are then distributed into mangrove ecosystems and accumulate in mangrove sediments and roots. The Kupang and Rote regions themselves have an area of mangrove ecosystem covering 344.26 ha and 1256.89 ha, respectively.

The amount is quite extensive, so that the amount of trapped marine waste is quite large. As the mangrove root system can penetrate to a depth of 15cm from the surface of the sediment, potentially, microplastic can be trapped to this depth.

Marine pollution, especially microplastic pollution, can affect the quality and function of the mangrove ecosystem. Among other issues, it can cause the death of mangrove seedlings, interfere with the process of acquistion of nutrients and potentially pollute the food chain of biota that live in the mangrove ecosystem. Based on the description above, it is necessary to conduct microplastic research on mangrove sediment layers in Kupang and Rote, so that the results can be used in determining best waste management strategy.

2. MATERIAL AND METHODS

The method used in this research is the survey method, and the data obtained was subjected to descriptive comparative analysis.

Sampling was carried out in June 2018 at 4 stations in Kupang and Rote, East Nusa Tenggara, while sample processing and data analysis was conducted from July to October 2018 at the ITK Laboratory and Biogeochemistry laboratory, Faculty of Fisheries and Marine Sciences, Padjadjaran University (Mochamad, 2018, 2019)

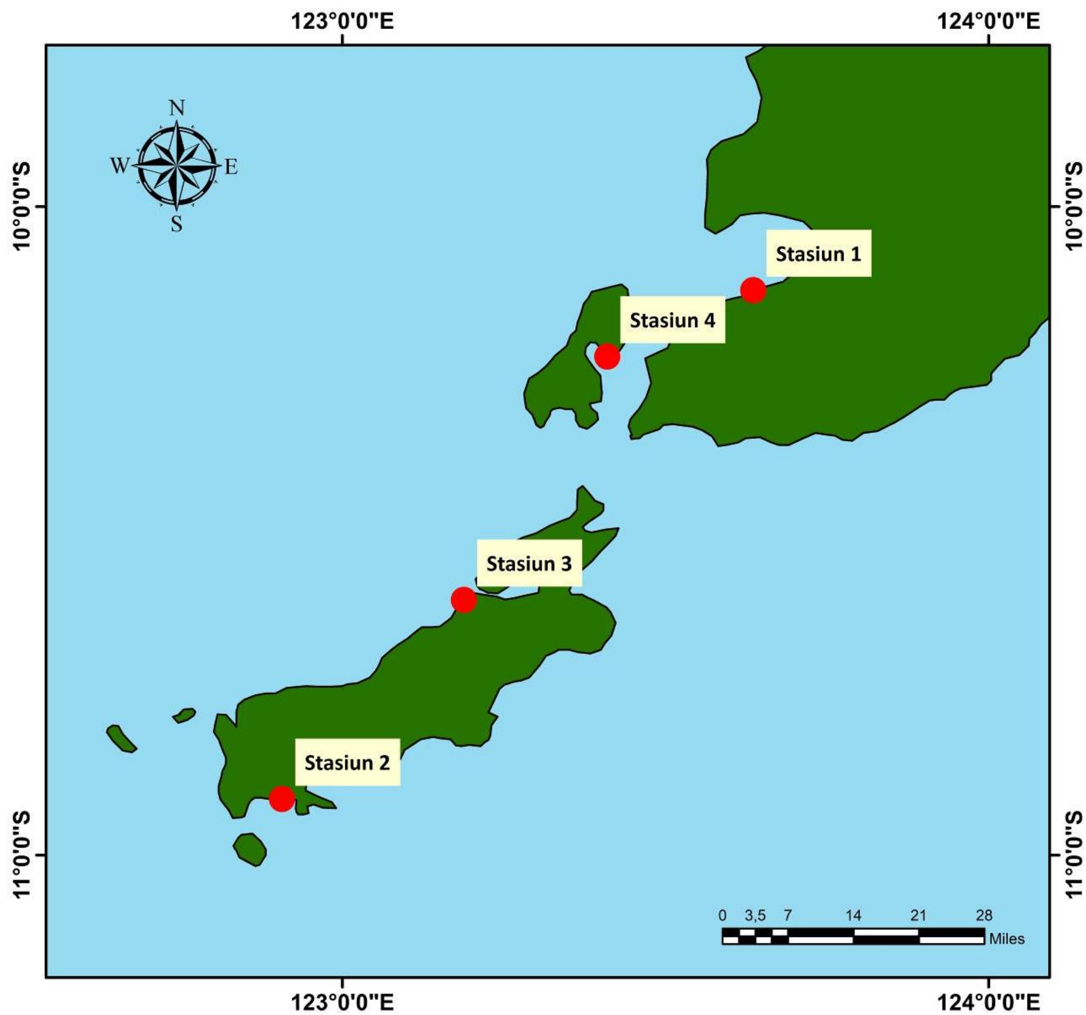

Figure 1. Sample location

a) Sediment Sampling

Sediment sampling was carried out at 4 stations by determining the sampling location based on purposive sampling. Sediment sampling was carried out using a piston core, and was based on 3 depths (0-5 cm, 6-10 cm and 11-15 cm).

b) Sediment Processing

The sediments were dried with the help of sunlight for approximately 24 hours. Subsequently, the sediment were weighed and then underwent large separation using sieve shakers for approximately 10 minutes / sample. After sieving, the sediment samples left at each filter size were weighed again and compared to the original dried weight, so that the weight distribution of the sediment was obtained based on the size range of the filter net density. The analyzis was carried out using Kummod-cell software.

c) Extraction of microplastics samples

Each dried sample was suspended with saturated NaCl and stirred and left to stand until the sediment settled and the suspension was clear (Claessens et al. 2011). The top sediment layer was then decanted to another glass beaker, and a solution of 20 ml ofFe (II) and 6 mls of 30% H_2O_2 in water was added. The solution was heated on a hot plate for 30 minutes, and covered with aluminum foil and left to stand for 24 hours. After 24 hours, the solution was filtered using filter paper. The microplastic was then distinguished by type, namely: fiber, film, fragments and pellets (Dewi, 2015), using a monocular microscope with 4x and 10x magnification.

d) Data analysis

The data obtained was in the form of number, type and size. Microplastic abundance was calculated as the number of particles present compared to the weight of dry sediments (particles / 100 gr) in each sediment sample. After sorting, the data was analyzed descriptively and comparatively with regard to the number and type of microplastic between depths obtained at stations 1, 2, 3 and 4 and with possible influences upon distribution. The microplastic abundance data that was obtained was represented using tables / charts by means of applying Microsoft Excel so that differences in abundance can be seen between stations.

3. RESULTS AND DISCUSSION

3. 1. Type of microplastic

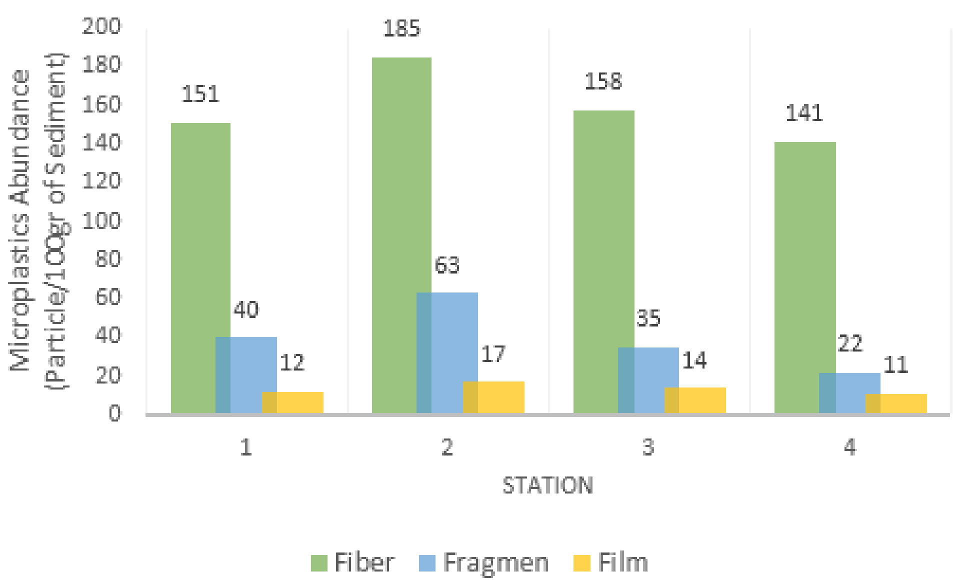

Figure 2. Total microplastic of each station

The dominant type of microplastic at the four sampling stations is fiber. Fiber microplastic has a fiber-like shape and is very easy to accumulate in sediments. The amount of fiber microplastic at Station 2 (close to the residential area of Oenggae Village, and the site of fishing activity) is thought to be the result of degradation of fishing nets and household fabric items. Fragment type microplastic is the second most common type of microplastic found after fiber microplastic, and most of this was also found at Station 2. One source of this type of fragment microplastic is waste or household waste. The least found type of microplastic is film-type microplastic. This was also most common at Station 2 (Oenggae), and was the least common type found in Station 4 (Goat Island). The low abundance of film type microplastic is due to the characteristics of the microplastic film itself, which has a low density so that it is highly influenced by UV light. According to Thompson et al., (2013), the density of microplastic will affect the distribution and decomposition process. As film type microplastic has a lower density, it is easily distributed by currents and waves. Furthermore, the research conducted by Kalogerakis, et al., (2017) found that film microplastic has a threshold of 6 months in sea water before it is fully broken down by pressure and UV radiation. Referring to Cauwenberghe et al., (2014), film microplastics are derived fragments of plastic waste such as beverage bottles and plastic food wrappers. Cauwenberghe et al., (2014) also add that the presence of microplastic in an area depends on the dominant plastic waste in the area.

3. 2. Microplastics Size

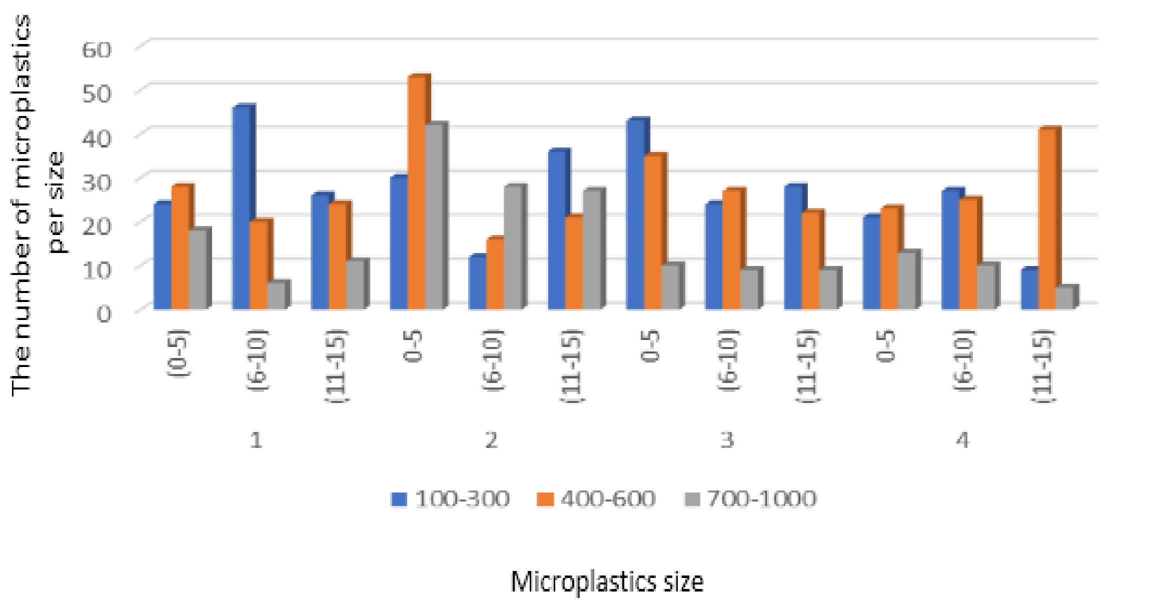

Figure 3. Microplastics size.

Microplastic of size of 700-1000 µm was most common at Station 2 at a depth of 0-5 cm (42 particles). In contrast, microplastic of size 400-600 µm was mostly found at Station 3 at a depth of 0-5 cm (53 particles). The highest number of microplastic for the size of 100-300 µm was at Station 1 at a depth of 6-10 cm (46 particles). Over all, the highest number of microplastic in each size range was found at a depth of 0-5 cm, and this could be due to the weight and type of microplastic.

3. 3. Relationship between the abundance of microplastic and sediment depth

Microplastic abundance was assayed at sediment depths of 0-5 cm 6-10 cm and 11-15 cm. In Kupang and Rote, microplastic was most common at a depth of 0-5 cm and least common at a depth of 11-15 cm. This is contrary to the results of the work of Hidalgo (2012). This states that the depth of 0-10 cm tends to have the lowest microplastic abundance due to the decomposition of the top layer of sediment due to water runoff. Hence, the depth of 10-20 cm and 20-30 cm do not experience flux and are stagnant and accumulation is greater. Of note, our experiments were conducted in mangrove swamp where there is little water movement.

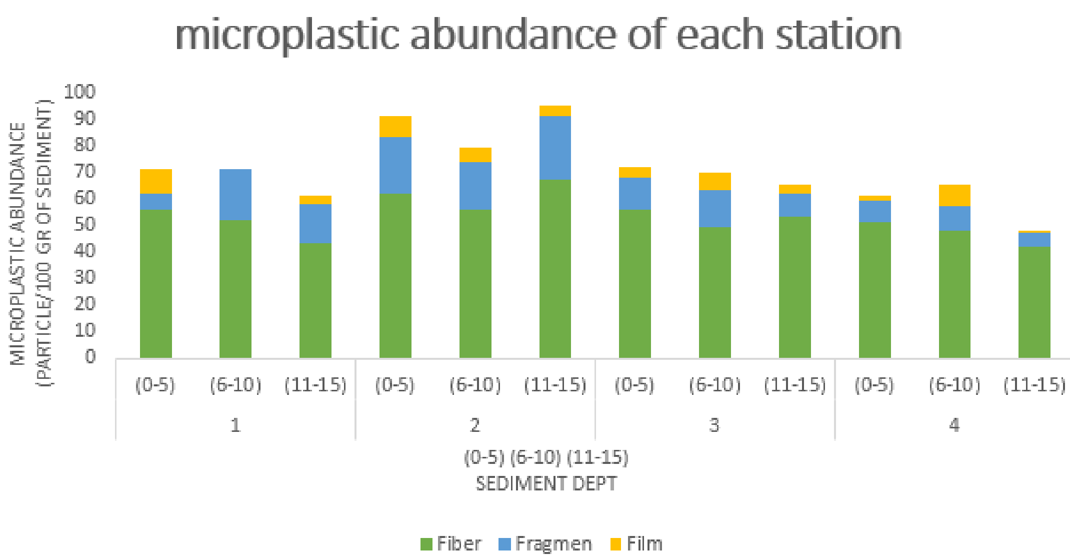

Figure 4. Microplastic abundance of each station

3. 4. Relationship between the abundance of microplastic with sediment types

Table 1. Sediment types.

Station	Gravel	Sand	Sediment Types	Microplastics Abundance
1	5.5	94.5	Sand Gravel	203
2	4.8	95.2	Sand Gravel	265
3	2.3	97.7	Sand with a little gravel	207
4	6.0	94.0	Sand Gravel	174

From the results of the analysis of the type of sediment using the KUMMOD-SEL software, it was found that the overall type of sediment in the four research stations was small sand. In (Table 1) it can be seen that although the type of sediment is the same, the total microplastic abundance produced is different between each station. The highest microplastic abundance is at Station 2 (Oenggae) with a total abundance of microplastic of 265 particles / dry sediment 100gr. In contrast, Station 4 (Goat Island) has the lowest total abundance of 174 dry sediment particles / 100gr. Here in, we think that the difference in the amount of microplastic abundance is caused by differences in the characteristics of the data collection area at each station.

4. CONCLUSION

The types of microplastic found in Kupang and Rote are of 3 types, namely fragments, films and fibers. Of these, fiber dominates. The highest number of microplastic particles are found at Station 2 (Oenggae), with an abundance of 265 particles / 100g sediments. Over all, the dominating microplastic size is the size of 200-600 μm (335 particles).

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