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Studies on Microplastics Morphology Characteristics in the Coastal Water of Makassar City, South Sulawesi, Indonesia

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***Abstract*— *Pollution of plastic waste is the biggest problem in the environment faced by every country, both developing and developed countries. The Continuous entry of plastics into the sea is accompanied by low degradation capabilities that reach tens to hundreds of years and inadequate management of waste making plastic accumulate in the marine environment. Makassar City as one of the big cities in Indonesia, almost 60% of the population spread in the coastal area has the potential to cause pollution of plastic waste distributed through two large rivers, namely the Jeneberang River and Tallo River and city canals and drainage which empties into Makassar City waters. This study aims to identify and quantify microplastic properties on the surface of the water-based on the characteristics of microplastic in Makassar City waters. The method of this research is the survey method using a purposive sampling technique by microscopically analyzing the possibility of microplastic content in seawater samples. Data analysis uses descriptive analysis. The results of the microplastic characteristics found included size and color. Microplastic size classes are grouped into 4 sizes namely: <0.5 mm, 0.5–1 mm, 1.1-2.5 mm and 2.5-5 mm and are dominated by sizes 1.1-2.5 mm (31- 40%), while the microplastic color variations found were 12 colors.*

Keywords*— *Microplastic: Characteristic; Makassar City: Coastal Waters;

I. INTRODUCTION

Pollution of plastic waste is the biggest problem in the environment faced by every country, both developing and developed countries.

World plastic production has increased throughout the year and reached 348 million tons in 2017 (Plastics Europe, 2018). Jambeck et al. (2015) research suggests that plastic waste produced by Indonesia as much as 0.48-1.29 million tons/year is spread in the sea, thus placing Indonesia as the second country that contributes plastic waste in the world. Then, the Ministry of Industry (2019) mentions 2018 the demand for plastic in Indonesia is 7.7 million tons supplied from the National production of 6.74 million tons. The growth of plastic waste in Indonesia is very rapid in the last two decades, this is due to the increasing population and human activities that have penetrated almost all types of human needs using plastic packaging.

Population growth and changes in community consumption patterns lead to increasing volume, species, and characteristics of increasingly diverse waste and waste management so far has not been by the methods and techniques of environment-based waste management. As a result, plastic waste enters continuously into the sea accompanied by low degradation capabilities that reach tens to hundreds of years, making plastic accumulate in the marine environment. Plastics as synthetic polymers undergo degradation caused by Ultraviolet-B (UV-B) and waves (Andrady, 2011; Cooper & Corcoran, 2010). Large plastic fragments that are degraded become micro-size (1 <5 mm) commonly referred to as microplastic (GESAMP, 2015). Then, the transfer of plastic throughout the ocean is strongly influenced by wind and currents (Law, et al., 2010).

Based on the source of microplastic is divided into two namely; primary and secondary sources. Primary sources are mostly found in domestic products and cleaning products containing polyethylene, polypropylene, and polystyrene such as scrubs. Also, pellets are used as raw material for making plastic (Cole et al., 2011). Secondary sources are degraded plastic and fragmented into micro-sized particles (<5 mm). According to Hildago-Ruz et al., (2012) the main source of microplastic presence in waters comes from secondary sources.

The presence of microplastic has been proven by several studies that have been carried out in recent years, showing microplastic has spread widely in the marine environment. The global distribution of plastics shows the total plastic floating at sea level ranges from 7,000 and 35,000 metric tons (Eriksen et al., 2014; Cozar et al., 2014). In the sub-surface waters in the Pacific Ocean, microplastic concentrations of 8 to 9,200 particles/m^3 were found (Desforges et al., 2014). Fossi et al., (2012) found microplastic concentrations in the Mediterranean Sea protection area of 0.94 particles/m^3 (Ligurian Sea) and 0.13 particles/m^3 (Sardinia Sea). Reisser et al. (2013) research conducted in the Great Barrier Reef Marine Park Authority (Australia) region found 839 marine plastics that were recorded were small ("microplastic" fragments, median length = 2.8 mm, mean length = 4.9 mm). The widespread distribution of microplastic with high density in the waters causes some marine organisms to swallow microplastic, either directly or indirectly such as; fish, shellfish, and marine mammals (Thompson et al., 2004; Lusher et al., 2013).

Makassar City as one of the big cities in Indonesia, almost 60% of the population is spread in the coastal area (Dahuri et al., 2001). In 2017 the population of the city of Makassar reaches 8,741 people/km^2 (BPS, 2018). Production of waste per day produced by 6,485.65 m^3 (BPS, 2018). Likewise with the findings of Rochman et al. (2015) that fish traded in Makassar Poetere Port contain microplastic forms of fragments, films, styrofoam and monofilament, further clarifying the existence of plastic pollution.

Utilization of areas in Makassar City waters such as; industrial activities, coastal tourism activities, reclamation activities, sea transportation activities, and activities of port (Soekarno Hatta Port) have the potential to cause pollution of plastic waste through human activities. Community activities on the Makassar mainland which dispose of littering will also contribute to the pollution of plastic waste distributed through two large rivers, namely the Jeneberang River and Tallo River and city canals and drainage which empties into Makassar City waters (Hamzah, 2007). World Bank (2018) mentions Makassar City as one of the highest plastic waste hotspots in Indonesia from 15 hotspots. According to Stolte et al., (2015), rivers are one of the pathways for microplastic entry into the marine environment. Therefore, Lack of information about the existence of microplastic on the surface of Makassar Coastal Water makes this research very important to do.

II. METHOD

2.1 Study AREA

Lack of information about the existence of microplastic on the surface of Makassar Coastal Water makes this research very important to do.

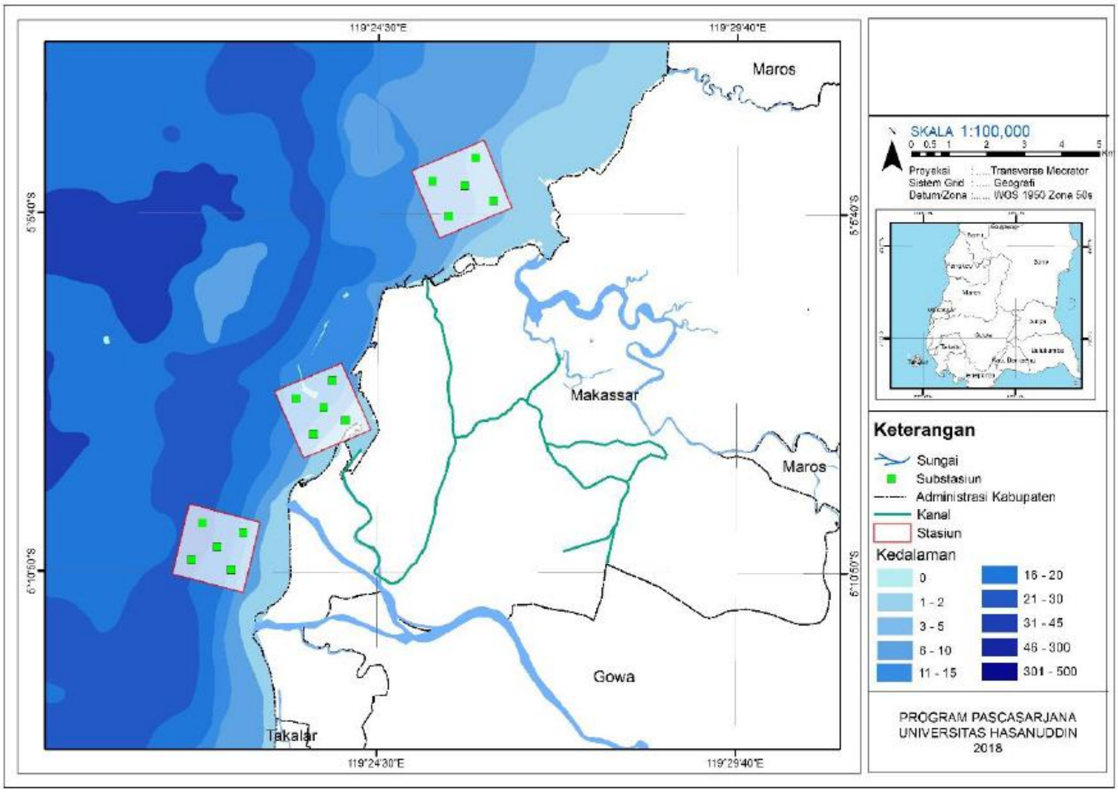

Fig.1: Map of the research location

2.1 Sample Collection

The method of collecting data is a systematic sampling survey method. This method is done by paying attention to the location of the waste discharge from rivers and canals in the city of Makassar. Station one which is in the determination of location sampling point uses a purposive sampling technique. The sampling location consisted of 3 stations with each station consisting of 5 plots. The area of the station is 2 km x 2 km and the plot is 400 m x 400 m. Each sub-station was sampled with a trajectory length of 300 m 4 times (Chesire et al., 2009).

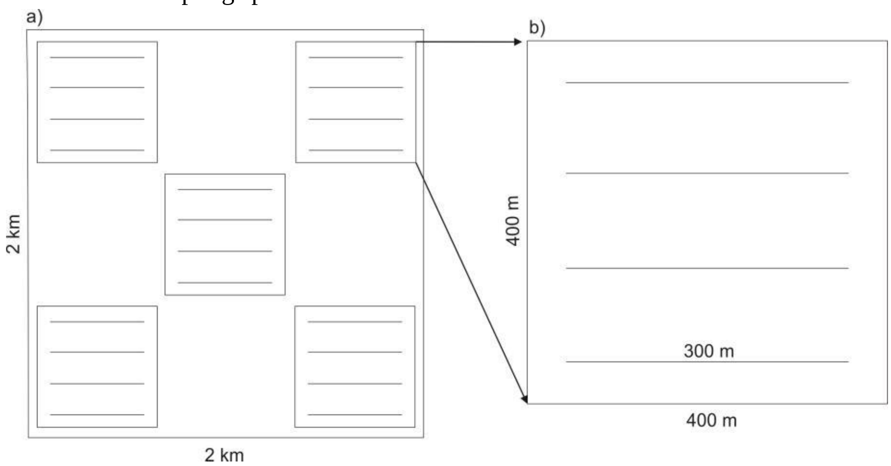

Fig. 2: Illustration in sampling

Water samples were taken using nesuton net from the boat, where the method used refers to the previous method (Syakti et al., 2017). Seawater sampling consists of 3 stations, where the area of the station used is 2 x 2 km. Each station consists of 5 plots with a plot area of 400 x 400 m. The neuston net has a rectangular openings (width 76 cm; height 15 cm), mess size 300 µm, and length from the net opening to the end of the net (Bottle cod end) which is 1.13 meters (figure 3). Neuston net is installed on the side of the boat using a rope with a stretch of 2-3 meters and pulled at a speed of 2-4 knots in the direction of the coastline as far as 300 m x 4 trajectories, with a total track length of 1,200 m in each plot. After that, the coordinates were recorded using GPS (Global Position System). Then, neuston net was rinsed with seawater, so that all existing microplastic particles were netted into the cod end bottle with a volume of 300 ml. Water samples that have entered the cod end were transferred to the sample bottle and put into the cool box, then taken to the laboratory for further analysis (Xiong, et al., 2018).

2.2 Laboratory Analysis

Water samples were filtered using filter paper (Whatman 0.45 µm 47 mm diameter) using Medi Pump brand vacuum equipment. After filtration, the filter results (filter paper) were inserted into the petri dish for furtherobservations of the characteristics (shape, size, and color) of microplastic visually using a Stereo Microscope (Euromex Stereo Blue 1902) with a magnification of 4.5 x 10. Microplastic that has been found placed on glass preparations and closed using a glass cover. Furthermore, it is stored in a room with a maintained temperature to avoid degradation. Microplastic measurement using ImageJ software.

2.3 Data Analysis

This study analyzed the size and color of microplastic, us descriptive analysis.

III. RESULT AND DISCUSSION

1.2. Characteristics of Microplastic

1.3. 1. Size of Microplastic

aa The results of microplastic measurements are grouped into 4 sizes: <0.5 mm, 0.5–1 mm, 1.1–2.5 mm and 2.5–5 mm. The percentage of microplastic size <0.5 mm is 13-25%; size 0.5-1 mm (28-40%); size 1.1-2.5 mm (31-40%); and size 2.6-5 mm (12-19%) (figure 3). The highest microplastic size is at station 3 which is 0.5-1 mm, while the lowest size is at stations 1 and 3 which is <0.5 mm. Then, at stations 1 and 2 the class size is 1.1-2.55 mm.

Based on this study, the highest percentage of microplastic abundance was found in the class size 1.2-2.5 mm (31-40%), while the lowest abundance was in the 2.6-5 mm class (12-19%). Syakti et al., (2017) also found microplastic abundance in Cilacap Beach waters to be in the size of <2.5 mm (20-46%). The Baini et al., (2018) study of microplastic abundance in coastal waters of Tuscany (Italy) was found in sizes 1-2.5 mm (60%), which consisted of 4 size classes (<0.5 mm; 0.5-1 mm; 1-2.5 mm; and 2.5-5 mm). Then, Zhao et al. (2014) found

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an abundance microplastic of surface water of the Yangtze Estuary system (China) is <1 mm.

Based on the results of this study with several studies, it shows the highest similarity of microplastic abundance in the class 1.2-2.5 mm, where the percentage value is different. Decreasing particle size will increase microplastic abundance (Barnes et al. 2009; Zhao et al. 2014). Troyer (2015) also found differences in microplastic size distribution, suggesting that large microplastic has not been sufficiently damaged. The difference in microplastic size distribution is due to the influence of hydrodynamic conditions (Troyer, 2015), wind speed (Kukulka et al., 2012), and the presence of bio-fouling (Pedrotti et al., 2016)..

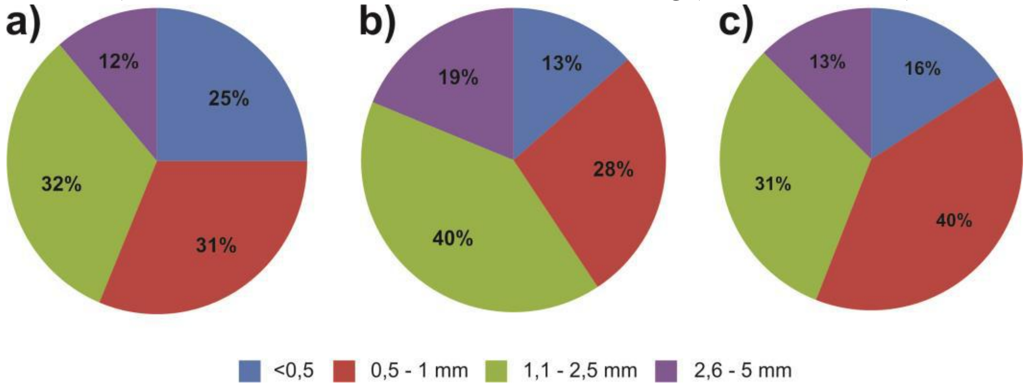

Fig. 3 : Percentage of Form of Microplastic a) Station 1; b) Station 2 and c) Station

Microplastic in size <1 mm has the same size range as marine food so it is likely to be consumed by various marine organisms (Lusher et al., 2013). The main potential hazards associated with microplastic consumption by birds, fish, and invertebrates include reduced ability to eat and stimulate food, loss of nutrients and intestinal blockages, and even death (Ashton et al., 2010; Cole et al., 2013).

Research in fish shows that microplastic and toxins can accumulate and cause problems such as intestinal damage and changes in metabolic profiles (Li et al., 2017). Then, microplastic can carry out the task of carrying organic contaminants including chemical additives, hydrophobic organic compounds and polycyclic aromatic hydrocarbons (Mato et al., 2001; Karapanagioti et al., 2011, Zhang et al., 2018).

3.3.2. Color of Microplastic

Microplastic color observations found around 12 types of colors grouped by the station. At all stations, most commonly found microplastic colors are blue as much as 28-% (594 pieces). Then, at stations 1 and 2 are dominated by blue; while station 3 the highest color is transparent (30%), followed by blue (28%). According to Andrady (2011) and Zhao et al., (2015) light-colored microplastic proportions are more easily consumed by fish and the colors that float almost resemble their natural food. Whereas according to a study conducted by Boerger et al. (2010) in the North Pacific Gyre shows that white, clear, and blue plastic is the color of plastic that is generally digested by fish.

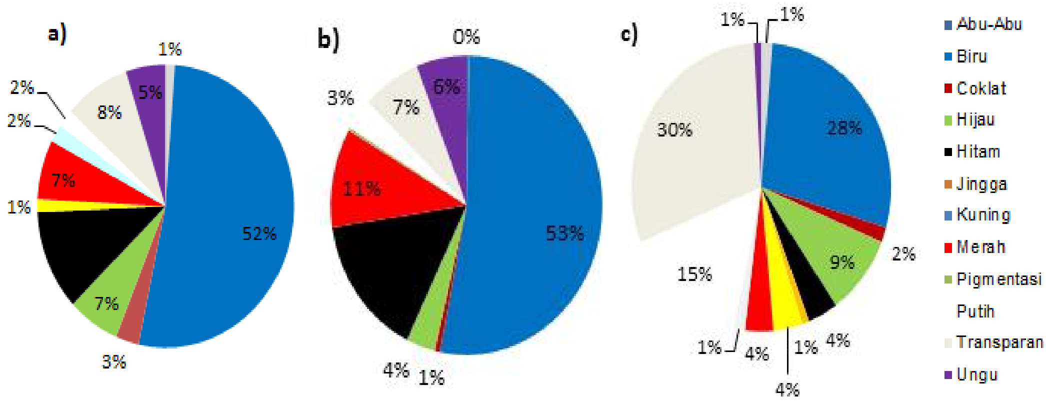

Fig. 4: Percentage color of Microplastic a) Station 1; b) Station 2 and c) Station 3

IV. CONCLUSION

Microplastic morphology characteristics founded were include the size and color. The microplastic size is grouped into 4 classes, namely: <0.5 mm (13-25%); 0.5-1 mm (28-40%); 1.1-2.5 mm (31-40%); and 2.5-5 mm (12-19%), while for the microplastic colors, 14 types of colors were found, dominated by blue and transparent.

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