Preliminary detection of microplastics in surface water of Maninjau Lake in Agam, Indonesia

[1]Deswati Deswati, [1]Olly N. Tetra, [1]Melda Hayati, [2]Adewirli Putra, [3]Wiya Elsa Fitri, [4]Suparno Suparno, [5]Hilfi Pardi

[1] Department of Chemistry, Faculty of Mathematics and Natural Science, Andalas University, Kampus Limau Manis, Padang, 25163, Indonesia; [2] Department of Medical Laboratory Technology, College of Health Sciences Syedza Saintika, Padang, 25132, Indonesia; [3] Department of Public Health, Syedza Saintika College of Health Sciences, Padang, 25132, Indonesia; [4] Study Program of Fisheries Resources Utilization, Faculty of Fisheries and Marine Sciences, Bung Hatta University, Kampus Ulak Karang, Padang, 25134, Indonesia; [5] Department of Chemistry Education, Faculty of Teacher Training and Education Raja Ali Haji Maritime University, Senggarang, Tanjungpinang, 29115, Indonesia. Corresponding author: D. Deswati, deswati@sci.unand.ac.id

Abstract. The use of plastic materials has led to the penetration of microplastic (MP) into the aquatic environment. MP is plastic that is less than 5 mm in size. They have received significant attention in recent years due to their impact on humans and organisms as they absorb organic and pathogenic contaminants from the surrounding media. This study aims to analyze MP abundance, shape, color, size, and polymer characteristics at five water sampling stations in Maninjau Lake. Water samples were extracted to obtain MP, then analyzed using a microscope and ATR-FTIR spectroscopy. MP abundance in Maninjau Lake water samples ranged from 180 to 335 L^{-1} particles. The most dominant shape, color, and sizes found in the waters were fragments (12.5%), black (68.37%), and sizes of 101-300 μm (49%). Based on the results of the characterization and interpretation of functional groups in the FTIR spectrum, several types of polymers were found, including polyamide (PA), polypropylene (PP), and polyester (PES).

Key Words: aquatic environment, MP abundance, organic and pathogenic contaminants.

Introduction. A large number of plastic products are discarded after use, resulting in the accumulation of large amounts of plastic waste in the environment. Under the influence of the interaction of several physical, chemical, and biological environmental factors, plastic degradation results in various shapes and sizes of debris: nanoplastics (≤0.1 μm), microplastic (MP) (<5 mm), mesoplastics (0.5–5 cm), macroplastic (5–50 cm), and megaplastic (>50 cm) (Prata et al 2020; Wu et al 2019; So et al 2022). According to the production method, microplastics are divided into primary and secondary MP (Rhodes 2018). Primary MP consists of direct industrial products and man-made plastic particles that meet special needs. These particles are widely used in everyday chemical products as fillers, film-forming agents, friction-inducing agents, and suspending agents, as well as in the processing and printing of textile and plastic products (Rhodes 2018). Secondary MP mainly comes from decaying industrial plastic products (Rhodes 2018). MP is often mistaken for food due to its smaller size. MP has been detected in various aquatic animals at different trophic levels, such as plankton, crustaceans, bivalves, and fish (Nikki et al 2021; Cole et al 2019; Sun et al 2018). Plastic products are widely used in various industries and daily life because of their low cost, wide applicability, and strong durability (Hirt & Body-Malapel 2020; Dissanayake et al 2022; Priya et al 2020).

In recent years, MP has become known as an emerging pollutant that has caused widespread concern around the world (Ogonowski et al 2018; Revel et al 2018). However, most research on MP pollution focuses more on marine ecosystems than terrestrial ecosystems, which are considered landfills for waste. Most MP pollution in the marine environment is thought to originate from the terrestrial environment (Jambeck et al 2015), with inland freshwater systems being an important pathway for MP to the sea (Lebreton et al 2017). However, studies on MP pollution in inland waters are relatively lacking, especially when compared to the marine environment. In inland areas, rivers and lakes are direct recipients of runoff from urban, industrial, and agricultural areas (Eriksen et al 2013). Therefore, a comprehensive MP monitoring program in freshwater environments is highly recommended.

The presence of a lot of MP lake ecosystems can pollute lake water, disrupt aquatic life, and damage the food chain. Currently there is no research or publication related to the MP content in the waters of Maninjau Lake. Therefore, it is necessary to carry out research to identify MPs found in water. MP can come from various sources such as industrial waste, household waste, or plastic products that are used daily. By knowing the source of the pollution, appropriate countermeasures can be taken to reduce MP input into the lake, reduce plastic use, better recycling, and overall environmental protection. This research will also help understand the extent to which MP has spread in lakes and how it impacts lake ecosystems. The research results are expected to be used as a reference by the public regarding the negative impacts of MP on the environment and health.

Material and Method

Description of the study site. The research was carried out from January to May 2023 at the Chemistry Laboratory of Andalas University, Padang, Indonesia. In this study, water samples were taken at five stations (T1, T2, T3, T4, T5), namely: Muko-Muko (0°17'26.60"S; 100° 9'18.66" E), Koto Malintang (0°16'40.32"S; 100°9'34.28"E), Muaro Suak (0°15'45.67"S; 100°10'33.02"E), Payinggahan, Nagari Maninjau (0°18'35.57"S; 100°13'25.75"E) and Tanjung Sani (0°23'53.01"S; 100°11'40.38"E) (Figure 1; Table 1).

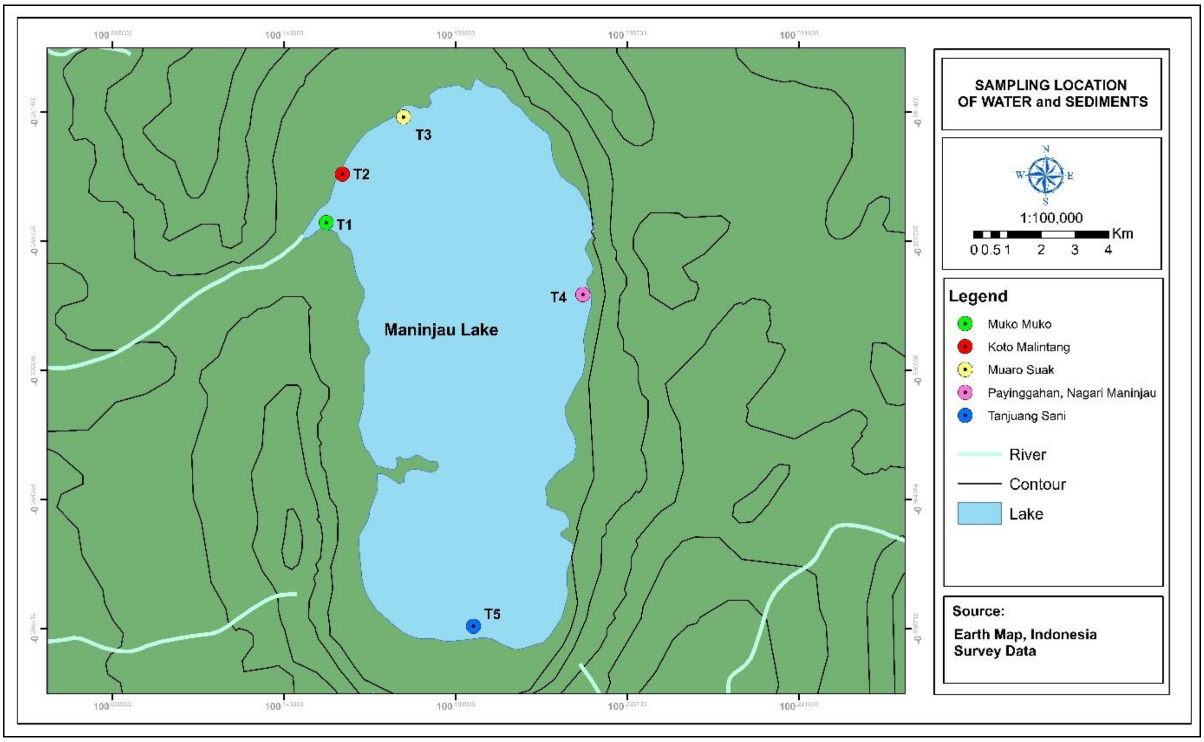

Figure 1. Research sampling location in Maninjau Lake, West Sumatera, Indonesia (Indonesia Geospatial Portal 2022).

Table 1

Description of the sampling stations

No	Station	Description
1	Muko Muko	The water exit of Maninjau Lake; there is a turbine and a sluice gate to regulate lake water. Since there is a hydroelectric power center (HEPC) present, the water outlet had always been regulated so that the lake's waste was stuck in this location. The existence of floating net cages (FNC) is limited to 30 units; community activities are focused on tourism, education, and housing.
2	Koto Malintang	Farmers' activities in tilapia cultivation using the FNC system were the highest, with 3,459 units. Another activity is paddy fields.
3	Muaro Suak	This location is the estuary of the Batang Suak River, which flows from Nagari Koto Gadang. Community activities are FNC system fish farming of 660 units and paddy fields.
4	Payinggahan, Nagari Maninjau	Tourism area. The other activities were fish farming in 1,332 units of FNC, and there are no paddy fields.
5	Tanjung Sani	The largest aggregation of villages on Maninjau Lake, but with a low population density. Farmers cultivate tilapia with FNC systems totaling 4,364 units. Many protected steep forests and prone area to landslides. There are no paddy fields.

Source: CSA 2018.

Sampling. Water sampling in the lake was carried out directly using a bucket with a capacity of 5 L and water was filtered using plankton net no. 25. Sample screening was carried out 20 times. The filtered sample (sample bottle) is then put into a HDPE sample bottle to avoid particle contamination and put into a cool box.

MP extraction. To lake water samples 20 ml of 30% H_2O_2 was added and homogenized with a magnetic stirrer for 5 minutes. Samples were then covered with aluminum foil to avoid environmental pollution, and the samples were left for 24 hours. Then the sample was filtered using Whatman filter paper no. 42 with the help of a vacuum pump. The results obtained on filter paper were then identified visually with a 100x magnification microscope and counted based on the number of particles suspected to be MP.

MP observations. Visual inspection was first carried out to measure and filter suspected MP based on their characteristics. All suspected MP particles were observed, photographed, and marked under a camera-equipped trinocular microscope (B-350 Optika). MP size was measured using Moticplus 3.0 software, then MP size, shape, and color were recorded. MP forms are categorized into fibres, fragments, films, and granules. In addition, MP is categorized by size range: <100 μm; 101–300 μm; 301–500 μm; 501–1000 μm; and > 1000 μm (Cordova et al 2019).

MP identification. All tagged items were confirmed with a PerkinElmer Spectrum Spotlight 400 micro-Fourier transshape infrared spectroscope (μ-FT-IR; PerkinElmer Inc., U.S.A.) (Ding et al 2018). Attenuated total reflection mode (ATR) was used, and germanium (Ge) crystals in the ATR imaging attachment were in direct contact with the MP. Spectra were obtained from a spectral resolution of 8 cm^{-1} and a spatial resolution of 6.25 μm (the highest spatial resolution was 1.56 μm), and the spectral range was defined as from 4000 to 750 cm^{-1} with 16 coscans for each measurement. Therefore, MP diameters up to 6.25 μm can be identified in this study. The resulting spectra were compared with the database from Sadltler to confirm polymers, and spectra matching higher than 70% was reliable and accepted as MP (Su et al 2020). Non-plastics are removed from the MP count, and the MP count is recalculated.

Quality control. To minimize contamination, MP extraction and observations in this study followed procedures carried out by previous studies, such as using latex gloves, laboratory clothing made of 100% cotton and using a clean and closed room (Falahudin et al 2020; Mai et al 2018). In addition, all laboratory equipment (sample bottles, test tubes, tweezers, and filters) is made of non-plastic materials (glass or stainless steel). All laboratory equipment is sterilized before use; samples were kept covered when not analyzed, and double distilled water was used during all processes (Cordova et al 2019; Mai et al 2018). To control contamination from the air, especially from synthetic fiber materials (Chen et al 2020; Dris et al 2016), a blank procedure was applied during laboratory analysis (Falahudin et al 2020). The filter paper is then observed under a microscope after completing all laboratory processes. From observing the procedure blank, MP was not found on the filter paper, which means there was no contamination during the laboratory process.

MP abundance calculation. MP abundance analysis in water was calculated using the following formula (Masura et al 2015):

$$K=\frac{n}{v}$$

K = abundance of MP (particle L^{-1})
n = number of MP
v= sample volume (L)

Data analysis. Data on the number and type (shape) of MP are presented descriptively in the form of tables and graphs. Differences in MP abundance in water was determined using one way analysis of variance (ANOVA) and Duncan's follow-up test. Analysis possible at the 0.05 significance level using SPSS v25.

Results and Discussion

Abundance of MP in water. MP abundance in Maninjau Lake water samples ranged between 180 and 335 L^{-1} particles, and the highest MP abundance occurred at sampling location T2 (Figure 2).

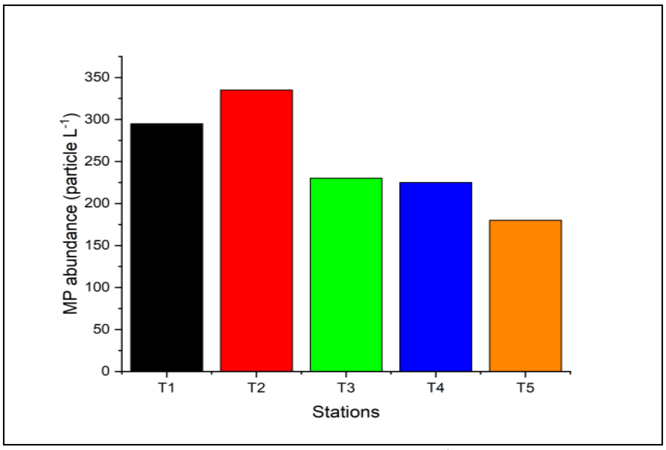

Figure 2. MP abundance in water (particle L^{-1}) at different stations.

Based on Figure 2, the abundance of MP from T1 to T5 tends to decrease, except for T2. Statistically, MP abundance at T2 was significantly different ($p<0.05$) from other sampling locations (T1, T3, T4, T5) (Table 2). The abundance of MP in surface water at T2 is caused by farmers cultivating tilapia with the biggest floating net cages (FNC) system, namely 3,459 units, planting rice in paddy fields, and high residential activity. This finding follows the opinion of Ding et al (2019), who reported in their study area high MP abundance because most of the sampling locations were in densely populated areas and the communities had high activity. Su et al (2016) stated that the high MP abundance in the lake water from their study area was caused by anthropogenic activities around the lake which were thought to originate from domestic activities, such as washing machine waste. In addition, the lake area under study also has other anthropogenic activities that cause MP to appear in lake waters, such as agricultural and commercial fishing activities. Wastewater originating from agricultural sources that do not have proper processing is a source of lake water pollution.

Table 2

MP abundance in water at different stations of Maninjau Lake

MP abundance	*Stations*				
	1	*2*	*3*	*4*	*5*
Water (particle L^{-1})	287.50 ± 10^{d}	332.50 ± 3^{c}	227.50 ± 3^{b}	215.00 ± 14^{d}	177.50 ± 3^{d}

Note: average ± SD (n=3) with different superscript letters horizontally indicating significant differences ($p<0.05$).

Location T1 has the second highest abundance of MP in surface water because at this location there is a water outlet for Maninjau Lake, as well as turbines and sluice gates to regulate lake water. The existence of FNC is limited to only 30 units, community activities are focused on tourism, education, and housing. Since it was turned into a hydroelectric power plant, the water outlet has always been regulated, so that the lake's waste is stuck in this location. Several macroplastics such as drinking bottles, food wrappers, pieces of fishing nets, and waste from tourism activities were found at this location. The slow movement of water around T1 causes macroplastic motion to slow down and accumulate.

The slow motion of water in T4 causes macroplastic motion to slow down and accumulate. Then plastic fragmentation occurs which causes more MP deposition compared to T1, T2, T3, and T5 (Andrady 2011; Manalu et al 2017). Plastic particles with a heavy density stick more easily to sediment grains than MP with a lighter density. The difference in density is very important because it can affect the degree of degradation, surface characteristics, and the shape of the MP particles. The specific density of plastic particles varies greatly depending on the polymer and the manufacturing process (Embulaba et al 2022). In general, intense human activities, disposal of plastic and household waste, and activities related to fishing are the reasons behind the high MP in lake water levels. Since there is wide variation in the lower and upper limit ranges, it is better to express the results as the average concentration of MP abundance so that inter-comparisons can be made among various studies worldwide (Malla-Pradhan et al 2023).

MP shapes in water. The MP shapes found is dominated by fragments with the order of fragments with 835 particles L^{-1} (66%) > fibers with 215 particles L^{-1} (17%) > films with 155 particles L^{-1} (12.25%) > pellets with 60 particles L^{-1} (4.74%). The MP shapes of the water in Maninjau Lake can be seen in Figure 3.

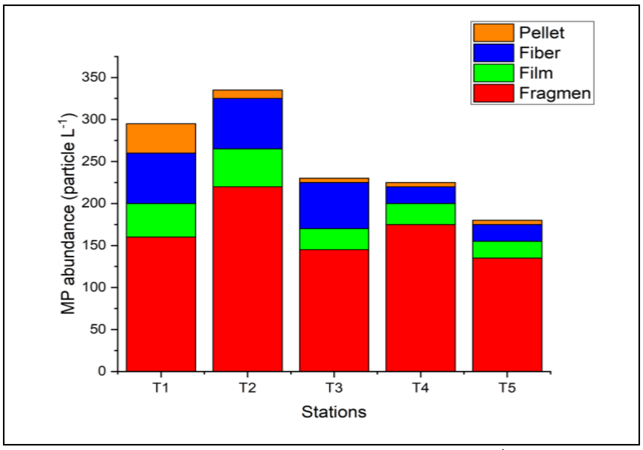

Figure 3. MP shapes abundance in water (particle L^{-1}) at different stations.

Secondary MP dominates the forms of MP found in Maninjau Lake, presumably due to the degradation of ultraviolet rays and physical abrasion which causes macro-sized plastics to turn into micro and even nano-sized plastics. Secondary MP in films and fragments comes from weathering of plastic packaging or plastic bags (Hasibuan et al 2020). Fragments are plastics that have undergone degradation into secondary MP with strong polymer properties, such as polypropylene, polyethylene, and polystyrene. These three types of resin are commonly used in product storage containers, mineral water bottles and caps, drinking glasses, pipes, and other plastic equipment (GESAMP 2019). Fragments have the highest density compared to other types of MP. Most of the fragments found in sediments are in the form of fibers (Hidalgo-Ruz et al 2012).

MP in the form of fragments predominates in water, presumably due to the high activity of fish transporters and fish feed (Yin et al 2019; Ding et al 2019). In addition, water hydrodynamic fluctuations trigger erratic current surges, photodegradation reactions, and thermal degradation, contributing to an abundance of secondary MP particles originating from larger primary plastic wastes (Cole et al 2011; Frias & Nash 2019). Most of the secondary MP that comes from larger MP fragmentation will still exist as MP fragments. Several sampling stations in Maninjau Lake have become concentration points for domestic plastic waste, such as food and beverage packaging. The current of the lake is likely to have an impact on the plastic waste that is scattered at several points.

This type of MP film has the characteristics of being shaped like a sheet or plastic shards, generally used for the manufacture of plastic bags or plastic packaging (Ambarsari & Anggiani 2022). Fiber pollution can come from laundry, domestic wastewater, and other local human activities in lake waters. In addition, fishing gear and airborne MP contribute to the accumulation of fiber-type MP. Fiber is a type of MP whose sources are nylon, polyvinyl and polypropylene. Usually, nylon is used by the community as a raw material for making clothes, carpets, and also rope (Claessens et al 2011). Polyvinyl alcohol is usually used as a basic material for making fishing rods, while polypropylene is often used for making carpets and ropes which are widely used on ships.

The film originates from the fragmentation of plastic bags and has a low density. Film is a type of secondary MP whose source comes from the fragmentation process of plastic packaging and plastic bags made of polyethylene polymers. Particle films also come from fragile plastic shards (Ayuningtyas et al 2019). Microbeads (pellets), MP in granular form, are a type of MP primer; MP primers are incorporated in micro-form in beauty and hygiene products. MP microbeads usually come from the polymer types of polyethylene, polystyrene, and polymethyl methyl acrylate (GESAMP 2019). MP in the form of pellets is produced from raw materials left over from industrial activities, toiletries, soap, and facial cleansers, while the foam is made from packaging and plastic bags. The forms of fibers, fragments, pellets, and films show that the MP found in this study are secondary MP formed through the photolysis process.

MP size in water. The results of the MP size in water of Maninjau Lake can be seen in Figure 4.

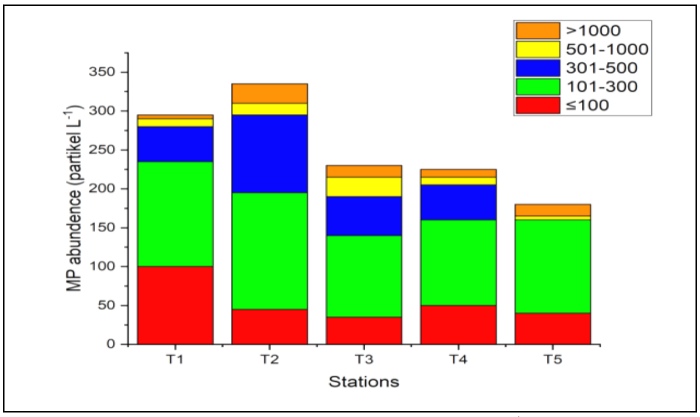

Figure 4. MP sizes abundance in water (particle L^{-1}) at different stations.

Based on Figure 4, the commonly found MP size is 101–300 µm with an abundance in water of 620 particles L^{-1} (49%). The percentage of size abundance in water samples ≤100 µm, 301-500 µm, 501-1000 µm, and >1000 µm was 21.34%, 18.97%, 5.12% and 5.53%. The size of 101–300 µm dominates in the water, and the 300 µm (net) sampling tool was used so that MPs smaller than 300 µm could escape the net when taking water samples (Suteja et al 2021).

MP size can be used as an indicator of the potential impact on organisms in aquatic environments. Its smaller size allows it to be digested by organisms (Cordova & Hernawan 2018). MP with a size of <100 µm cannot be seen directly with the eye so that MP can easily enter the body and endanger human health (Sathish et al 2020). Smaller particles can be ingested by living organisms up to 150 µm in size, migrate through the intestinal wall into lymph nodes and other organs, releasing toxic chemicals that can cause diseases, including cancer. MP can cause acute toxicity, chronic subtoxicity, carcinogenicity, and genotoxicity (Yuan et al 2022). MP with sizes <1000 µm are commonly found in the digestive tract of marine organisms. Marine organisms cannot differentiate between food and MP (Cordova & Hernawan 2018). MP size <500 µm require a long time to experience displacement, especially in waters that are not affected by tides and waves, such as rivers and lakes.

The smaller size of MP approaching nanoplastic size increases the possibility of MP being eaten by aquatic organisms, and its bioaccumulation potential increases with the decrease in size (Wagner et al 2014). Small plastic flakes are also dangerous because fish and birds can eat them. In addition, MP can act as a medium for chemicals such as PCBs to transfer toxic chemicals at the trophic level (Victoria 2016), which can damage biota's body tissues and are carcinogenic to humans. The smaller the size of the MP, the higher its capacity to adsorb harmful chemicals because it has a larger surface area and a short diffusion path. Smaller MP particles have the potential to lose their buoyancy and sink in waters due to biofouling. Differences in the size of MP marine debris are strongly related to wind direction and speed (González-Hernández et al 2020), the presence of biofouling (Leiser et al 2020), and water hydrodynamic conditions such as currents, waves, tides (Zhang 2017).

Color of MP in water. The results of the MP colors studied in the water of Maninjau Lake can be seen in Figure 5.

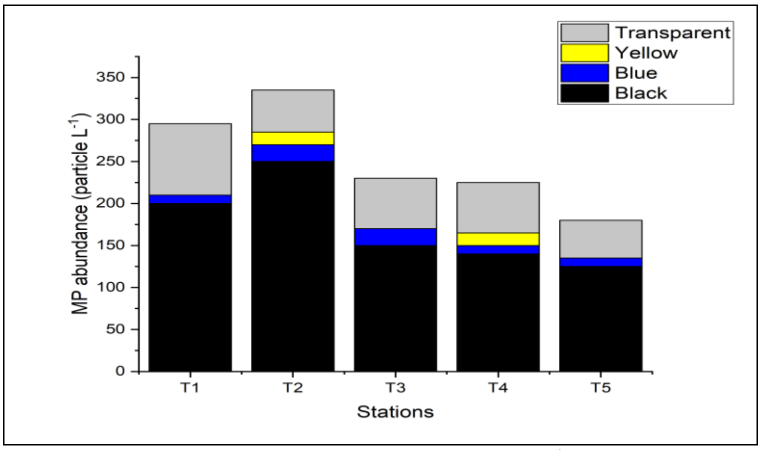

Figure 5. MP colors abundance in water (particle L^{-1}) at different stations.

Based on Figure 5, the MP colors identified in this study varied from transparent, yellow, blue, and black. Color data found in all water samples at all sampling stations (T1, T2, T3, T4, T5) are black (68.37%) > transparent (23.71%) > blue (5.53%) > yellow (2.37%). The black MP comes from black plastic shards. Black plastic is widely used in various sectors, such as food packaging, cookware, trays, toys, household electronics and auto components. Due to lower recycling rates, greater amounts of black plastic are likely to end up as waste in the environment, which can be a source of black MP. The black color indicates that the MP comes from a type of polystyrene (PS) or polypropylene (PP) with a chemical content of polycyclic aromatic hydrocarbons (PAHs). Black MP has a relatively high pollutant absorption capability and can affect the texture of MP (Lie et al 2018). MP can be clear in color if plastic shards have been exposed to sunlight for a long time, so MP can change color (Laksono et al 2021).

MP that is light in color tends to be more easily consumed by zooplankton (Botterell et al 2019), but MP in sediments has the potential to be consumed by deposit feeders and filter feeders without considering MP color. Several deposit feeders and filter feeders that are known to be exposed to MP contamination include *Arenicola marina*, *Orchestia gammarellus*, and *Mytilus edulis* (Wegner et al 2012). In general, fiber types are dominated by blue, film types are dominated by black and blue, and fragment types are dominated by transparent colors. The existence of color differences in each type of MP is thought to be influenced by the MP source. Therefore, information about MP color and the characteristics of each MP type can be used to trace the main source of MP presence in the environment.

Several types of MP colors appear because they are influenced by environmental and climatic conditions. Judging from the influence of garbage and waste on the environment, it does not only consist of one color. Continuous exposure to sunlight or ultraviolet rays can affect the color in the MP particles found. The MP color photodegradation index can be used as a determinant of how long MP is in the water, because the longer the plastic stays in the water, the more color degradation will occur (Sianturi et al 2021).

Chemical characterization of MP. The determination of the chemical composition of MP pollution is a reference (Zhang et al 2020). FTIR can help identify the chemical composition of MP which may be able to trace possible sources of MP in fresh water (Ballent et al 2016). The FTIR spectrum of the water samples at the stations (T1, T2, T5) can be seen in Figure 6.

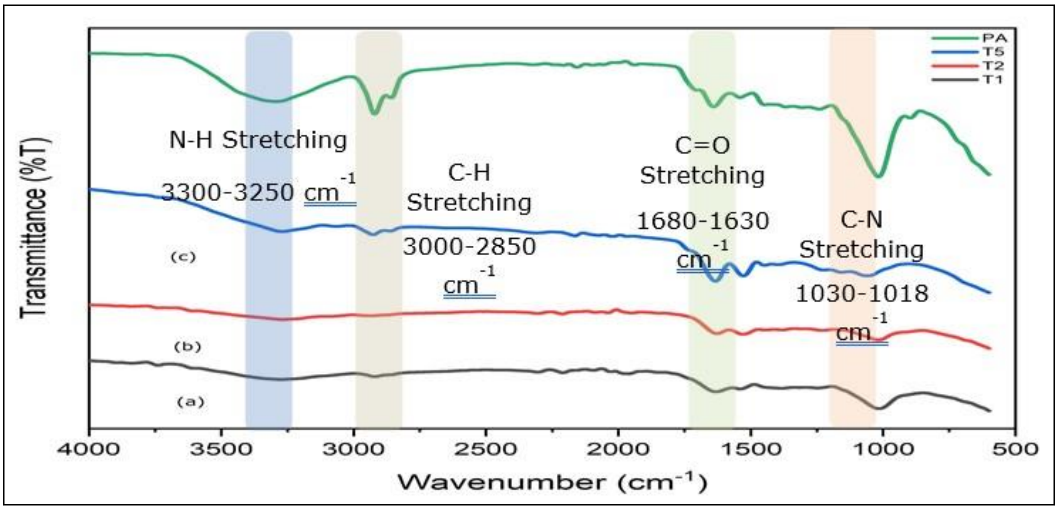

Figure 6. FTIR spectrum in water: (a) yellow fiber in T1; (b) blue fiber in T2; (c) black fiber in T5.

Figure 6 shows in the water samples a polyamide polymer, where: (a) the presence of polyamide in the T1 water sample was identified by the emergence of absorption at wave number 3275.08 cm^{-1}, indicating N-H stretch bonds, that have a wave number range of 3360-3310 cm^{-1}. Furthermore, wave number 2921.32 cm^{-1} shows C-H stretch bonds, C-H stretch bonds which have a range of 3000-2850 cm^{-1}, C=O stretch bonds have wave numbers of 1630.78 cm^{-1} (1680-1630 cm^{-1}), and the wave number 1016.48 cm^{-1} shows a stretching C-N bond. The existence of C-N stretch bonds is in amide compounds with a wave number range of 1030-1018 cm^{-1}; (b) the presence of polyamide in the T2 water sample was identified by the emergence of absorption at wave number 3270.11 cm^{-1}, indicating N-H stretch bonds, having a wave number range of 3360-3310 cm^{-1}. Furthermore, at wave number 2933.82, it shows C-H stretch bonds, which have a range

(3000-2880 cm^{-1}), C=O stretch bonds at wave number 1627.08 cm^{-1} (1680-1630 cm^{-1}), with the area of the fingerprint found at wave number 1017.89 cm^{-1}, which shows the absorption of the C-N bond; and (c) the presence of polyamide in the T5 water sample was identified by the emergence of absorption at wave number 3270.92 cm^{-1} indicating N-H stretch bonds, having a wave number range of 3360-3310 cm^{-1}. Furthermore, wave number 2926.82 cm^{-1} shows C-H stretch bonds, C-H stretch bonds that have a range of 3000-2880 cm^{-1}, C=O stretch bonds have wave number of 1632.95 cm^{-1} (1680-1630 cm^{-1}), and wave number 1057.40 cm^{-1} shows a stretching C-N bond. C-N stretch bonds exist in amide compounds with a wave number range of 1090-1020 cm^{-1}.

Polyamide detected in water originates from fishing activities (Deswati et al 2023). The impact of using PA polymer (polyamide) is respiratory irritation, skin corrosion/irritation, eye irritation, and organ damage (Rodrigues et al 2019). Furthermore, the FTIR spectrum of water samples at station T4 can be seen in Figure 7.

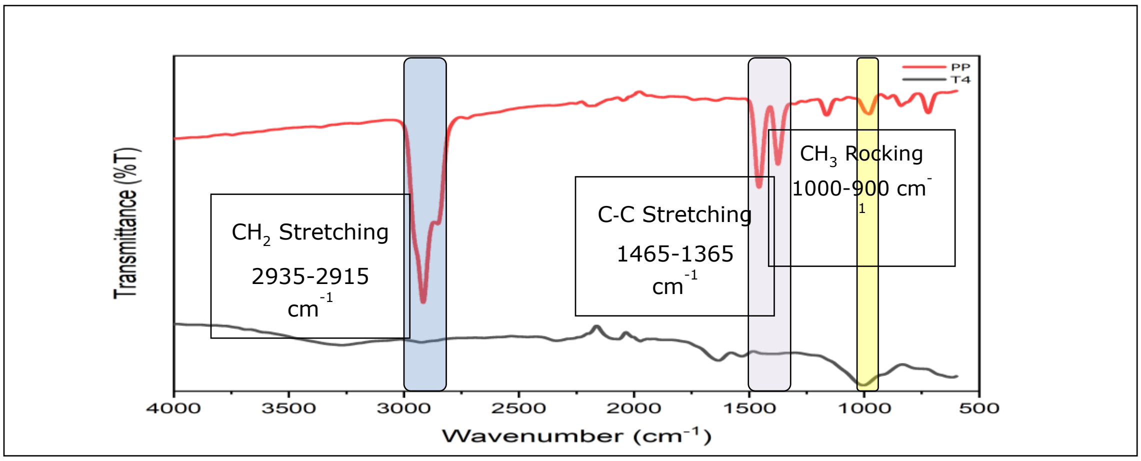

Figure 7. FTIR spectrum of black fragments of T4 water.

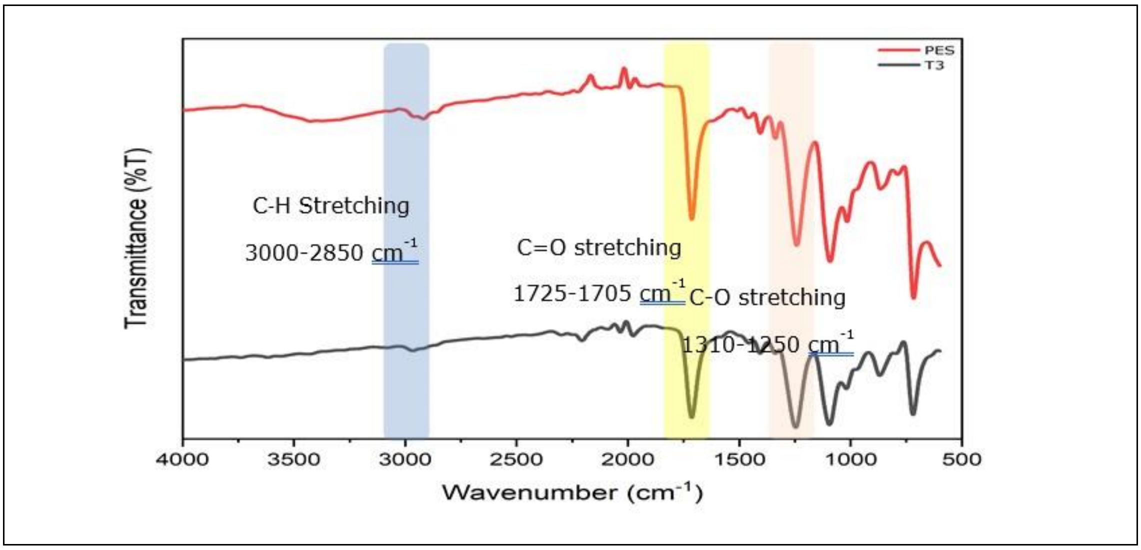

Figure 8. FTIR spectrum of transparent fiber of T3 water.

Based on Figure 8, the water sample shows that the sample measured is a polypropylene polymer: (a) the presence of polypropylene in the T4 water sample is indicated by the appearance of absorption at wave number 2924.84 cm^{-1} which shows C-H strain bonds, which has a range of 3000-2840 cm^{-1}. Wave number 1431.91 cm^{-1} indicates C-C stretching with a range of 1465-1365 cm^{-1}. The wave number of 1003.62 cm^{-1} indicates a CH_3 bond oscillation which has a range of 1000-900 cm^{-1}. Polypropylene (PP) is commonly found in bottle caps, straws, yogurt containers, household appliances (Manalu et al 2017), beverage packaging, food packaging, and medicine packaging (Proshad et al

2017). This polymer has potential hazards in the form of changes in cell structure in living organisms (Manalu et al 2017).

The presence of polyester in the T3 water sample was identified by the appearance of absorption at wave number 2966.83 cm^{-1} indicating C-H strain bonds. At wave number 1713.78 cm^{-1}, C=O stretch bonds can be seen which have a range of 1725-1705 cm^{-1}. Wave numbers 1246.86 cm^{-1} and 1095.12 cm^{-1} indicate C-O stretch aromatic bonds. C-O strain bonds have a range of 1310-1020 cm^{-1}. Polyester is usually found in clothing materials and cosmetic products that produce MP in the form of fibers.

Several studies have shown that in aquatic environments, plastics with the polymer types of polyethylene (PE), polypropylene (PP), and polystyrene (PS) absorb toxic organic compounds that are larger than polyvinyl chloride (PVC), and polyethylene terephthalate (PET). Hazardous chemical compounds such as polycyclic aromatic hydrocarbons (PAHs) are absorbed in greater concentrations in polyethylene (PE) and polystyrene (PS) polymers when compared to polypropylene (PP). Polyethylene (PE) is known to have the highest absorption capacity for chemical compounds because it has a larger surface area when compared to other polymers. Polystyrene (PS) contains benzene which can shorten the diffusion path so that chemicals are more easily absorbed into the polymer and are composed of styrene monomers which are toxic (Rochman 2015).

Conclusions. It can be concluded that the abundance of MP in water samples ranged between 180 and 335 L^{-1} particles. The most dominant form of MP in water and sediment is fragmented. Overall, the size of MP in water is dominated by sizes 101-300 μm (49%). The predominant color of MP in water is black. Based on the identification of the types of MP polymers with the FTIR test, it is suspected that the types of polymers that make up the MP detected are PA (polyamide), PP (Polypropylene), and PES (polyester).

Acknowledgments. This research was supported by the Andalas University, Primary Research Scheme of Publication Research Cluster of Andalas University Professor in Research Contracts: T/4/UN.16.19/Pangan-PDU-KRP1GB-Unand/2023, April 4, 2023.

Conflict of interest. The authors declare that there is no conflict of interest.

References

Ambarsari D. A., Anggiani M., 2022 [Study of the abundance of microplastics in sediments in Indonesian marine waters]. Oceana 47(1):20–28 [In Indonesian].

Andrady A. L., 2011 Microplastics in the marine environment. Marine Pollution Bulletin 62(8):1596–1605.

Ayuningtyas C. W., Yona D., Julinda S. H., Iranawati F., 2019 [Abundance of microplastics in water in Banyuurip, Gresik, East Java]. JFMR-Journal of Fisheries and Marine Research 3(1):41–45 [In Indonesian].

Ballent A., Corcoran P. L., Madden O., Helm P. A., Longstaffe F. J., 2016 Sources and sinks of microplastics in Canadian Lake Ontario nearshore, tributary, and beach sediments. Mar. Pollut. Bull. 110(1):383-395.

Botterell Z. L. R., Beaumont N., Dorrington T., Steinke M., Thompson R. C., Lindeque P. K., 2019 Bioavailability and effects of microplastics on marine zooplankton: a review. Environmental Pollution 245:98–110.

Chen G., Feng Q., Wang J., 2020 Mini-review of microplastics in the atmosphere and their risks to humans. Sci. Total Environ. 703:135504. doi: 10.1016/j.scitotenv.2019.135504.

Claessens M., Meester S., Van Landuyt L., De Clerck K., Janssen C. R., 2011 Occurrence and distribution of microplastics in marine sediments along the Belgian coast. Marine Pollution Bulletin 62(10):2199–2204.

Cole M., Coppock R., Lindeque P. K., Altin D., Reed S., Pond D. W., Sørensen L., Galloway T. S., Booth A. M., 2019 Effects of nylon microplastic on feeding, lipid accumulation, and molting in a coldwater copepod. Environ. Sci. Technol. 53(12):7075–7082.

Cole M., Lindeque P., Halsband C., Galloway T. S., 2011 Microplastics as contaminants in the marine environment: a review. Marine Pollution Bulletin 62(12):2588-2597.
Cordova M. R., Purwiyanto A. I. S., Suteja Y., 2019 Abundance and characteristics of microplastics in the northern coastal waters of Surabaya, Indonesia. Mar. Pollut. Bull. 142:183–188.
Cordova M. R., Hernawan U. E., 2018 Microplastics in Sumba waters, East Nusa Tenggara. IOP Conference Series: Earth and Environmental Science 162:012023. doi: 10.1088/1755-1315/162/1/012023.
Deswati D., Wisna N. D., Zein R., Tetra O. N., Suparno S., Pardi H., Suteja Y., 2023 Preliminary study on microplastic pollution in water and sediment at the Beaches of Pariaman City, West Sumatra, Indonesia. AACL Bioflux 16(1):381-397.
Ding L., Mao R. F., Guo X., Yang X., Zhang Q., Yang C., 2019 Microplastics in surface waters and sediments of the Wei River, in the northwest of China. Science of the Total Environment 667:427-434.
Ding J., Li J., Sun C., Jiang F., Ju P., Qu L., Zheng Y., He C., 2018 Detection of microplastics in local marine organisms using a multi-technology system. Anal. Methods-U.K. 11:78–87.
Dissanayake P. D., Kim S., Sarkar B., Oleszczuk P., Sang M. K., Haque M. N., Ahn J. H., Bank M. S., Ok Y. S., 2022 Effects of microplastics on the terrestrial environment: a critical review. Environ. Res. 209:112734. doi: 10.1016/j.envres.2022.112734.
Dris R., Gasperi J., Saad M., Mirande C., Tassin B., 2016 Synthetic fibers in atmospheric fallout: a source of microplastics in the environment? Mar. Pollut. Bull. 104(1-2):290–293.
Embulaba O., Kolibongso D., Tapilatu R. F., Saleh F., Bawole R., 2022 Distribution and types of microplastics on the coast of Aipiri and Andai Beaches, Manokwari District, Indonesia. Indo. Pac. J. Ocean Life 6(1):10-16.
Eriksen M., Mason S., Wilson S., Box C., Zellers A., Edwards W., Farley H., Amato S., 2013 Microplastic pollution in the surface waters of the Laurentian Great Lakes. Mar. Pollut. Bull. 77(1-2):177–182.
Falahudin D., Cordova M. R., Sun X., Yogaswara D., Wulandari I., Hindarti D., Arifin Z., 2020 The first occurrence, spatial distribution, and characteristics of microplastic particles in sediments from Banten Bay, Indonesia. Sci. Tot. Environ. 705:135304. https://doi.org/10.1016/j.scitotenv.2019.135304.
Frias J. P. G. L., Nash R., 2019 Microplastics: finding a consensus on the definition. Marine Pollution Bulletin 138:145-147.
González-Hernández M., Hernández-Sánchez C., González-Sálamo J., López-Darias J., Hernández-Borges J., 2020 Monitoring of meso and microplastic debris in Playa Grande beach (Tenerife, Canary Islands, Spain) during a moon cycle. Marine Pollution Bulletin 150:110757. https://doi.org/10.1016/j.marpolbul.2019.110757.
Hasibuan N. H., Suryati I., Leonardo R., Risky A., Ageng P., Addauwiyah R., 2020 [Analysis of types, forms and abundance of microplastics in the Sei Sikambing River, Medan]. Jurnal Sains dan Teknologi, Jurnal Keilmuan dan Aplikasi Teknologi Industri 20(2):108-115 [In Indonesian].
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 and Technology 46(6):3060–3075.
Hirt N., Body-Malapel M., 2020 Immunotoxicity and intestinal effects of nano- and microplastics: a review of the literature. Part. Fibre Toxicol. 17:57. doi: 10.1186/s12989-020-00387-7.
Jambeck J. R., Geyer R., Wilcox C., Siegler T. R., Perryman M., Andrady A., Narayan R., Law K.L., 2015 Plastic waste inputs from land into the ocean. Science 347(6223):768–771.
Laksono, Brylliant O., Suprijanto J., Ridlo A., 2021 [Microplastic content in sediments in Bandengan Waters, Kendal Regency]. Journal of Marine Research 10(2):158–164 [In Indonesian].

Lebreton L. C. M., van der Zwet J., Damsteeg J.-W., Slat B., Andrady A., Reisser J., 2017 River plastic emissions to the world's oceans. Nat. Commun. 8:15611. doi: 10.1038/ncomms15611.
Leiser R., Wu G.-M., Neu T., Wendt-Potthoff K., 2020 Biofouling, metal sorption and aggregation are related to sinking of microplastics in a stratified reservoir. Water Research 176(4):115748. doi: 10.1016/j.watres.2020.115748.
Lie S., Suyoko A., Effendi A. R., Ahmada B., Aditya H. W., Sallima I. R., Arisudewi N. P. A. N., Hadid N. I., Rahmasari N., Reza A., 2018 Measurement of microplastic density in the Karimunjawa National Park, Central Java, Indonesia. Ocean Life 2(2):54-58.
Mai L., Bao L. J., Shi L., Wong C. S., Zeng E. Y., 2018 A review of methods for measuring microplastics in aquatic environments. Environ. Sci. Pollut. Res. 25(12):11319-11332. doi: 10.1007/s11356-018-1692-0.
Malla-Pradhan R., Pradhan B. L., Phoungthong K., Joshi T. P., 2023 Microplastic in freshwater environment: a review on techniques and abundance for microplastic detection in lake water. Trends In Sciences 20(8):5202. https://doi.org/10.48048/tis.2023.5202.
Manalu A. A., Hariyadi S., Wardiatno Y., 2017 Microplastics abundance in coastal sediments of Jakarta Bay, Indonesia. AACL Bioflux 10(5):1164–1173.
Masura J., Baker J., Foster G., Arthur C., 2015 Laboratory methods for the analysis of microplastics in the marine environment: recommendations for quantifying synthetic particles in waters and sediments. NOAA Technical Memorandum NOS-OR&R-48. 31 pp.
Nikki R., Abdul Jaleel K. U., Rajesh S., Shini S., Saha M., Dinesh Kumar P. K., 2021 Abundance and characteristics of microplastics in commercially important bottom-dwelling finfishes and shellfish of the Vembanad Lake, India. Mar. Pollut. Bull. 172:112803. doi: 10.1016/j.marpolbul.2021.112803.
Ogonowski M., Gerdes Z., Gorokhova E., 2018 What we know and what we think we know about microplastic effects – a critical perspective. Curr. Opin. Environ. Sci. Health 1:41–46.
Prata J. C., da Costa J. P., Lopes I., Duarte A. C., Rocha-Santos T., 2020 Environmental exposure to microplastics: an overview on possible human health effects. Sci. Total. Environ. 702:134455. doi: 10.1016/j.scitotenv.2019.134455.
Priya A. K., Jalil A. A., Dutta K., Rajendran S., Vasseghian Y., Qin J., Soto-Moscoso M., 2022 Microplastics in the environment: recent developments in characteristic, occurrence, identification and ecological risk. Chemosphere 298:134161. https://doi.org/10.1016/j.chemosphere.2022.134161.
Proshad R., Kormoker T., Islam Md. S., Haque M. A., Rahman Md. M., Mithu Md. M. R., 2017 Toxic effects of plastic on human health and environment: a consequences of health risk assessment in Bangladesh. International Journal of Health 6(1):1-5.
Revel M., Châtel A., Mouneyrac C., 2018 Micro(nano)plastics: a threat to human health? Curr. Opin. Environ. Sci. Health 1:17–23.
Rhodes C. J., 2018 Plastic pollution and potential solutions. Sci. Prog. 101(3):207–260.
Rochman M. C., 2015 The complex mixture, fate and toxicity of chemicals associated with plastic debris in the marine environment. In Marine Anthropogenic Litter, Springer International Publishing. pp 117–140.
Rodrigues M. O., Abrantes N., Gonçalves F. J. M., Nogueira H., Marques J. C., Gonçalvesa A. M. M., 2019 Impacts of plastic products used in daily life on the environment and human health: what is known? Environmental Toxicology and Pharmacology 72:103239. doi: 10.1016/j.etap.2019.103239.
Sathish M. N., Jeyasanta I., Patterson J., 2020 Microplastics in salt of Tuticorin, Southeast Coast of India. Archives of Environmental Contamination and Toxicology 79(1):111–121.
Sianturi, Triau K. P., Amin B., Galib M., 2021 Microplastic distribution in sediments in coastal of Pariaman City, West Sumatera Province. Asian Journal of Aquatic Sciences 4(1):73–79.

So M. W. K., Vorsatz L. D., Cannicci S., Not C., 2022 The fate of plastic in the environment: from macro to nano by macrofauna. Environ. Pollut. 300:118920. doi: 10.1016/j.envpol.2022.118920.

Su L., Sharp S. M., Pettigrove V. J., Craig N. J., Nan B., Du F., Shi H., 2020 Superimposed microplastic pollution in a coastal metropolis. Water Res. 168:115140. doi: 10.1016/j.watres.2019.115140.

Su L., Xue Y., Li L., Yang D., Kolandhasamy P., Li D., Shi H., 2016 Microplastics in Taihu Lake, China. Environmental Pollution 216:711–719.

Sun X., Liang J., Zhu M., Zhao Y., Zhang B., 2018 Microplastics in seawater and zooplankton from the yellow sea. Environ. Pollut. 242:585–595.

Suteja Y., Atmadipoera A. S., Riani E., Nurjaya I. W., Nugroho D., Cordova M. R., 2021 Spatial and temporal distribution of microplastic in surface water of tropical estuary: a case study in Benoa Bay, Bali, Indonesia. Marine Pollution Bulletin 163:111979. doi: 10.1016/j.marpolbul.2021.111979.

Victoria A. V., 2016 [Microplastic contamination in fresh waters]. ITB Bandung. 10 pp. [In Indonesian].

Wagner M., Scherer C., Alvarez-Muñoz D., Brennholt N., Bourrain X., Buchinger S., Fries E., Grosbois C., Klasmeier J., Marti T., Rodriguez-Mozaz S., Urbatzka R., Vethaak A.D., Winther-Nielsen M., Reifferscheid G., 2014 Microplastics in freshwater ecosystems: what we know and what we need to know. Environmental Sciences Europe 26(12):1–9.

Wegner A., Besseling E., Foekema E. M., Kamermans P., Koelmans A. A., 2012 Effects of nanopolystyrene on the feeding behavior of the blue mussel (*Mytilus edulis* L.). Environmental Toxicology and Chemistry 31(11):2490–2497.

Wu P., Huang J., Zheng Y., Yang Y., Zhang Y., He F., Chen H., Quan G., Yan J., Li T., Gao B., 2019 Environmental occurrences, fate, and impacts of microplastics. Ecotoxicol. Environ. Saf. 184:109612. doi: 10.1016/j.ecoenv.2019.109612.

Yin L., Wen X., Du C., Jiang J., Wu L., Zhang Y., Hu Z., Hu S., Feng Z., Zhou Z., Long Y., Gu Q., 2019 Comparison of the abundance of microplastics between rural and urban areas: A case study from East Dongting Lake. Chemosphere 244:125486. doi: 10.1016/j.chemosphere.2019.

Yuan Z., Nag R., Cummins E., 2022 Human health concerns regarding microplastics in the aquatic environment - from marine to food systems. Science of the Total Environment 823:153730. doi: 10.1016/j.scitotenv.2022.153730.

Zhang H., 2017 Transport of microplastics in coastal seas. Estuarine, Coastal and Shelf Science 199:74–86.

Zhang Y., Kang S., Allen S., Allen D., Gao T., Sillanpaa M., 2020 Atmospheric microplastics: a review on current status and perspectives. Earth Sci. Rev. 203:103-118. https://doi.org/10.1016/j.earscirev.2020.103118.

*** Central Statistics Agency (CSA), 2018 Agam District, West Sumatera Province, Indonesia. 521 pp.

*** Indonesia Geospatial Portal, 2022 www.tanahair.indonesia.go.id [Last accessed on 17 December 2022].

*** GESAMP, 2019 Guidelines or the monitoring and assessment of plastic litter and microplastics in the ocean. Kershaw P. J., Turra A., Galgani F. (eds), IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UNEP/UNDP/ISA Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection, Rep. Stud. GESAMP No.99, 123 pp.

Received: 14 July 2023. Accepted: 27 August 2023. Published online: 13 October 2023.
Authors:
Deswati Deswati, Department of Chemistry, Faculty of Mathematics and Natural Science, Andalas University, Kampus Limau Manis, Padang, 25163, Indonesia, e-mail: deswati@sci.unand.ac.id
Olly N. Tetra, Department of Chemistry, Faculty of Mathematics and Natural Science, Andalas University, Kampus Limau Manis, Padang, 25163, Indonesia, e-mail: ollynorita@sci.unand.ac.id
Melda Hayati, Department of Chemistry, Faculty of Mathematics and Natural Science, Andalas University, Kampus Limau Manis, Padang, 25163, Indonesia, e-mail: meldahayati24@gmail.com
Adewirli Putra, Department of Medical Laboratory Technology, College of Health Sciences Syedza Saintika, Padang, 25132, Indonesia, e-mail: adewirliputra@gmail.com
Wiya Elsa Fitri, Department of Public Health, Syedza Saintika College of Health Sciences, Padang, 25132, Indonesia, e-mail: wiyaelsafitri@gmail.com
Suparno Suparno, Study Program of Fisheries Resources Utilization, Faculty of Fisheries and Marine Sciences, Bung Hatta University, Kampus Ulak Karang, Padang, 25134, Indonesia, e-mail: suparnopranoto@bunghatta.ac.id
Hilfi Pardi, Department of Chemistry Education, Faculty of Teacher Training and Education Raja Ali Haji Maritime University, Senggarang, Tanjungpinang, 29115, Indonesia, e-mail: hilfipardi@umrah.ac.id

How to cite this article:
Deswati D., Tetra O. N., Hayati M., Putra A., Fitri W. E., Suparno S., Pardi H., 2023 Preliminary detection of microplastics in surface water of Maninjau Lake in Agam, Indonesia. AACL Bioflux 16(5):2601-2614.