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Identification of Microplastics Types and Abundance in Mussels (*Glauconome virens*) from Tanah Merah Coastal Waters Meranti Island, Riau

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ABSTRACT

This study aims to analyze the types and abundance of microplastics in mussels (*Glauconome virens*) and differences in the abundance of microplastics between research stations in the coastal waters of Tanah Merah Village, Meranti Islands. Samples were taken from three different locations: residential areas, fishing ports, and mangrove areas. The number of mussel samples from the three stations was 54 individuals, with three size groups. Water quality parameters such as temperature, salinity, pH, and current speed were measured to determine the condition of the aquatic environment. Microplastics were analyzed using a microscope after going through a process of dissolving the mussel meat with a 10% KOH solution. The results showed that three types of microplastics were found, namely fiber, fragments, and films, with an average value of 46.50 particles/ind. Fiber type was the highest type found, followed by fragments and films. The highest abundance of microplastics was found in the mangrove area with an average value of 54.11 particles/ind, while the lowest was in the fishing port with 37.61 particles/ind. The abundance of microplastics in mussels showed significant differences ($p<0.05$) within the station. Possible causes of the difference were discussed.

Keywords: Microplastics, Pollution, Mussels, *Glauconome virens*, Tanah Merah

1. INTRODUCTION

Tanah Merah is a village in Rangsang Pesisir District, Meranti Islands Regency, Riau Province. This area borders directly on the Malacca Strait, where many anthropogenic activities occur, such as fishing, agriculture, plantations, loading and unloading ships, and household activities. This makes the waters have great potential to become a place where anthropogenic wastes are concentrated.

According to Ariyunita et al. (2022), plastic is one of the marine wastes that can move due to wind and ocean currents. Plastic is a tough polymer that can degrade and last a long time in the environment. Most plastics will accumulate in the environment for hundreds of years or even longer (Kane et al., 2020). In modern times, environmental problems are insep arable from plastic waste, which causes environmental pollution. Plastic is widely used by people in everyday life because plastic has various shapes and functions. Besides, it is also light, cheap, and easy to obtain. The high presence of microplastics in water is caused by the high use of plastic by the community (Tuhumury & Sahetapy, 2022). According to Purnama et al. (2021), plastic waste in water will undergo a mechanical degradation process to form microplastics.

Microplastics are plastic particles that are less than 5 mm in size. Based on their source, microplastics are divided into primary and secondary. Primary microplastics are the result of small-sized plastic production. While secondary microplastics come from fragments or decomposition of previously larger plastics. Secondary microplastics are often associated with areas with high population density (Edy et al., 2021).

Microplastics are very small in size, so they can have a major impact on living things including humans (Amin, 2022). Concerns about the presence of microplastics in the environment continue to grow as new research links them to a higher risk of heart attack, stroke and death (Marfella et al., 2024). The presence of microplastics ranging from size, shape and type in waters can have a negative impact on organisms (Permatasari & Radityaningrum, 2020). Many studies have been conducted to determine the presence of microplastics in

marine organisms, such as shellfish (Woods et al., 2018), shrimp (Abbasi et al., 2018) and also fish (Jabeen et al., 2017). Microplastics have a more serious impact than macroplastics or large plastics, because microplastics can be swallowed by biota in marine waters so that they can disrupt the food chain in the waters. This is because microplastics have a shape almost similar to the type of food (Amin et al., 2020). In bivalves, microplastic particles can be filtered together with plankton and organic particles so that they enter their bodies. Microplastics accumulate in their digestive organs, such as the stomach and gills, which cannot be excreted or removed. One biota that can accumulate microplastics is the mussel (*Glauconome virens*).

The mussel inhabits tidal areas in Southeast Asia. In Indonesia, in addition to the coastal waters of Tanah Merah Village, Meranti Islands, mussels can also be found in the coastal waters of Belawan, North Sumatra Province, the coastal waters of Ranooha Raya Village, Southeast Sulawesi Province, and the coastal waters of Padang Tikar I Village, West Kalimantan Province.

The community widely uses mussels because they have economic value and are a protein source for humans. Mussels are biota that live in coastal areas by burying themselves in mud substrates and can adapt well to the ebb and flow. Mussels are filter feeder biota because they are able to filter organic particles with their main food being phytoplankton. Based on their eating habits and habitat, it is likely that microplastics can contaminate mussels. Mussels that contain high levels of microplastics are likely to have a negative impact on the human body that consumes them.

Currently, in the waters of Tanah Merah Village, Meranti Islands Regency, no data or information has been found related to research on the microplastic content in mussels. Therefore, information on the microplastic content in mussels in the coastal waters of Tanah Merah Village, Meranti Islands, needs to be studied.

2. RESEARCH METHOD

Time and Place

This research was conducted in November 2024, located in the coastal waters of Tanah Merah Village, Meranti Islands (Figure 1). Analysis of the types and abundance of microplastics was carried out at the Marine Chemistry Laboratory, Department of Marine Sciences, Faculty of Fisheries and Marine Sciences, University of Riau.

The method used in this study is the survey method, which is collecting data directly in the field by means of observation and measurement. Data collection is in the form of primary data obtained from survey activities at three stations in the coastal waters of Tanah Merah Village, Meranti Islands and data obtained from sample analysis in the laboratory.

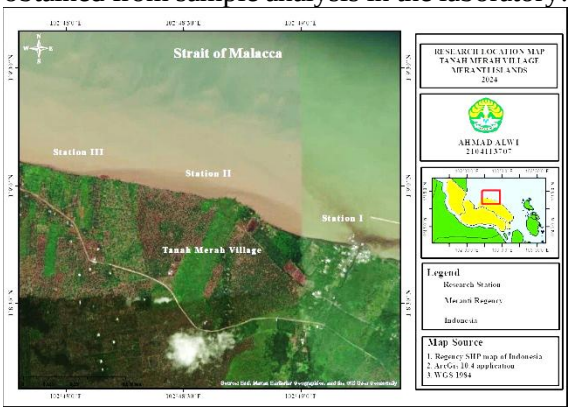

Figure 1. Research location

Method

The location of this study was determined by purposive sampling or by observing environmental conditions and research objects. The sampling location was divided into three stations, namely residential areas (station I), fishing ports (station II) and around the mangrove area (station III).

Procedures

Density gives an idea of the number of water quality parameters, including temperature, salinity, acidity (pH), and current speed. These parameters were measured during high tide with three repetitions carried out at the three research stations. The aim is to describe the condition of the waters when the research was conducted.

The mussels samples were taken during low tide, then the mussels were divided into three different groups, namely small size with a length range (2.5-2.9 cm), medium size with a length range (3.5-3.9 cm) and large size with a length range (4.3-4.5 cm) at each station. The mussels were taken as many as 6 individuals at each size. The total mussels samples taken from the three stations were 54 individual samples. Then the mussels samples were put into labeled sample plastic, then stored in an icebox and given ice cubes, for further analysis at the

Marine Chemistry Laboratory, Department of Marine Sciences, Faculty of Fisheries and Marine, Universitas Riau.

Sample Preparation and Analysis

The mussel samples were first cleaned using running water. After that, the mussel samples were measured for their morphology, including shell length and shell width, then the total weight of the mussel samples was weighed using an analytical scale. There are three stages in analyzing microplastics in bivalves referring to Rochman et al. (2015), namely preparation, sample dissolution, and sample observation using a microscope.

After the mussel samples were weighed, they were dissected to separate the shells from the mussel meat. The mussel meat and shells were weighed using an analytical scale. The mussel meat that had been separated from its shell was then put into a sample bottle with the addition of 10% KOH solution until the meat was submerged (approximately three times the volume of the meat weight). The sample was left for 2 weeks at room temperature (20-25˚C). The function of the 10% KOH solution is to destroy the organic material in the sample so that microplastics are easy to observe. The dissolved sample was then filtered using a vacuum pump that had been given Whattman filter paper number 42. Then, the filter paper was observed using an Olympus CX23 microscope.

Observations were made with three repetitions. For each microplastic particle encountered, the number was recorded in each repetition. Then the abundance of microplastic particles was calculated, based on research conducted by Boerger et al. (2015), using the following formula:

$$K = \frac{Ni}{N}$$

Description:

K : The abundance of microplastics (particles/ind)
Ni : Number of microplastic particles found (particles)
N : Number of mussels (ind)

Data analysis

To analyze the differences in microplastic abundance based on observation stations in mussels, the One-Way Analysis of Variance (ANOVA) test was used.

3. RESULT AND DISCUSSION

General Conditions of the Research Area

Tanah Merah Village is a research location in Rangsang Pesisir District, Meranti Islands Regency, Riau Province. Tanah Merah Village has an area of 48 km^2 with a population of 1891. This area is directly adjacent to the Strait of Malacca in the north, the east is adjacent to Sonde Village, the south is adjacent to Kayu Ara Village, and the west is adjacent to Kedabu Rapat Village. Geographically, it is located at coordinates 1°09'01.99"LU - 102° 47'28.96" BT. These waters have quite strong wave currents and there are also many fishing activities that occur in these waters. In general, the location of each station can be described as follows: Station I is a residential area of Tanah Merah Village. Many activities of residents occur such as household activities, fishermen looking for shellfish and fishing spots. This can be a source of plastic waste entering the waters.

Station II is a fishing port where fishing boats dock, fish, look for shellfish, and daily fishing activities. In addition, there is a bridge that is used as a tourist spot by local residents to enjoy the scenery. This can cause fishing nets from fishermen and plastic waste from tourists to become problems in the area. In addition, there are also wave-breaking rocks at this location.

Station III is a mangrove rehabilitation area because Tanah Merah Village Beach waters are directly adjacent to the Malacca Strait, resulting in high abrasion. This location is also close to the ditch/canal that originates from residential areas to the sea which functions to drain rainwater overflow. This can be a source of plastic waste input in this area.

Water Quality Parameters

Measurement of water quality parameters in the waters of Tanah Merah Village Beach includes temperature, salinity, pH and current speed. Measurements were carried out with the aim of determining whether the water quality at the location is good or not for the life of mussels. The results of the measurement of water quality parameters of Tanah Merah Village Beach when the study was conducted had a temperature value ranging from 29-30 °C, water salinity of 20-22 ppt, water pH of 7.56-8.27, and current speed of 0.27-0.56 m/sec. The results of the measurement of water quality parameters in Tanah Merah Village can be seen in Table 1.

The results of temperature measurements indicate that the temperature range is suitable for the life of mussels. Noris (2021) states that an appropriate bivalve temperature is around 25-35°C. Water temperature affects mussels' activity, directly affecting the growth and metabolism of organisms and can even cause death to organisms (Putri et al., 2021). The results of salinity measurements at the research location are classified as suitable for the life of mussels, as in Zens' (2021) research, bivalves survived at a salinity of 10-30 ppt. Salinity affects the survival of bivalves in production, distribution, life span, and migration orientation (Febrina et al., 2018). The pH value obtained is classified as good for the life of mussels. According to Samson & Kasale (2020), the appropriate pH value for bivalves is around 5.8-8.3. pH is one of the water quality factors that can affect the survival of mussels.

Table 1. Water quality parameters

Station	Temperature (°C)	Salinity (ppt)	pH	Current speed (m/s)
I	30	21	7.56	0.56
II	30	20	8.27	0.27
III	29	22	7.72	0.53

Microplastic Types and Abundance by Station

Based on the observation results that have been obtained, there are three types of microplastics found in mussels in the waters of Tanah Merah Village Beach, namely fiber, fragment and film types, as seen in Figure 2. While granule/pellet microplastics were not found at the research location. This is because there is no plastic factory around the research location. This opinion is reinforced by Sewwandi et al. (2022), who stated that granules come from domestic waste and the plastic industry. Granules are the main raw material for making plastic products. The results of this study are also the same as other studies such as Makhtuumah (2024) who found three types of microplastics in green mussels, namely film, fiber and fragments.

(a) (b) (c)

Figure 2. Types of microplastics found in the waters of Tanah Merah Village Beach, Meranti Islands, description: (a) Fiber, (b) Fragment, (c) Film

The fiber type of microplastic had the highest abundance at the three stations, with an average value of 21.11 particles/ind, followed by the fragment type with an average value of 13.39 particles/ind, and the film type had the least abundance at the three stations, with an average value of 12 particles/ind.

Many types of fibers found came from ship ropes and fishing nets of the community around the research location, most of whom are fishermen. Fiber-type microplastics come from the degradation of various fishing activities, both fishing gear and decomposed ship ropes (Islami et al., 2020). Fiber-type microplastics also come from the degradation of textile industry waste and the release of synthetic fibers from household goods in the washing process (Periyasamy & Bagha, 2022). Household industrial waste will enter the ocean through river flow. The abundance of fiber-type microplastics can also be caused by the elongated structure of the fibers, so they are easily carried by wind and currents, so they collect in sediment and waters (Harikrishnan et al., 2024).

The abundance of microplastics at each

station that has been observed shows that the highest microplastic abundance value in mussels is at station III with an average value of 54.11 particles/ind, then station I with a value of 47.78 particles/ind, and the lowest microplastic abundance is at station II with a value of 37.61 particles/ind.

The high abundance of microplastics at station III is thought to be due to the location being a mangrove area. In addition, there is also a ditch/canal close to station III which is a source of plastic waste entering from land to the sea, so that the plastic waste gets caught and accumulates in the mangrove roots. Microplastics then accumulate in this area and settle in the sediment during sedimentation. The types and abundance of microplastics based on the station can be seen in Table 2.

Table 2. Types and abundance of microplastics based on the station

Station	Microplastic Abundance (Particles/ind±Std. Deviation)			Amount (Particles/ind±Std. Deviation)
	Fiber	Fragment	Film	
I	22.39±8.40	13.83±4.93	11.56±5.01	47.78±15.40
II	16.72 ±9.18	11.17±5.66	9.72±4.80	37.61±18.80
III	24.22±11.85	15.17±7.38	14.72±6.59	54.11±22.99
Average	21.11±10.23	13.39±6.19	12±5.81	46.50±20.15

Based on the results of the One-Way ANOVA test, it is known that the abundance of microplastics in mussels against the station showed a significant difference in value ($p < 0.05$), although the abundance of microplastics was found most dominantly in the mangrove area. This can occur because the source of microplastics in the waters of Tanah Merah Village Beach provides different contributions, so the abundance value of microplastics in mussels is significantly different. The characteristics of each location also influence differences in microplastic abundance. This opinion is supported by the opinion of Islami et al. (2020) which states that differences in microplastic abundance values at each research location are influenced by the characteristics of each different location.

4. CONCLUSION

From the results of the study on the abundance of microplastics in mussels in the coastal waters of Tanah Merah, Meranti Islands, it was concluded that the types of microplastics found were fiber, film, and fragments. Then, the abundance of microplastics in mussels at different stations showed significant differences ($p < 0.05$).

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