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Abundance of Microplastics in the Waters of Pelangan Village, West Lombok as an Indicator of Pollution

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Abstract:
Background: *Microplastics are plastic particles with micro (<5 mm). Its small size and long durability cause microplastics to potentially accumulate in the bodies of living things so that they can endanger the health of aquatic life. This study aims to analyze the level of microplastic pollution in Pelangan Village, West Lombok.*
Materials and Methods: *The microplastic pollution test was carried out by collecting water samples, sediment samples, and samples of marine biota (gastropods) from three different locations, then extracted using the density separation method. The extracted microplastics were observed using a reverse microscope to identify the shape and color characteristics of the microplastic particles.*
Results: *The results of this study show the types of microplastics found, namely fragments, films, fibers, pellets, and granules. Among the five types of microplastics found, fragment microplastics had the highest abundance and fiber-type microplastics had the lowest abundance. Meanwhile, based on the color of the MP particles, the proportions are black, white, red, blue, yellow, and green. Based on the color characteristics of MP particles, the proportions are black, white, red, blue, yellow, and green.*
Conclusion: *The results of the study show that microplastic pollution has spread in the waters of Pelangan Village, which shows the potential impact on the coastal ecosystem, hence the need for better plastic waste management.*
Key Word: *Gastropods; Microplastics; Pelangan Village; Plastic Waste.*

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I. Introduction

Indonesia's ocean area is very large, estimated at 5.9 million km² and includes the second order of the coastline length reaching 95,161 km with the number of islands around 17,504 islands [1]. The Indonesian sea certainly has great potential both in terms of natural resources and environmental services that can be used to support economic development at the local, regional, and rational levels. Behind that, all Indonesian beaches have various problems, one of which is in the form of garbage. In Indonesia, the opportunity for an increase in the existence of waste is supported by the dense population of Indonesia, accompanied by development, development of transportation facilities and high tourism activities [2]. One type of waste that is often found is plastic. Globally, Indonesia is one of the second highest contributors of plastic waste in the world and the waste is estimated to enter sea waters as much as 1.29 million metric tons [3].

Pelangan Village reflects the general condition of coastal areas in Indonesia, where the lack of waste management and high human activity are the main factors in environmental pollution. Pelangan Village, located in Sekotong District, West Lombok, is known as an area with diverse economic activities such as fishing, small-scale gold mining, and agriculture. High human activity has the potential to harm the environment and marine ecosystem in the area, because the coastal area has an ecosystem that is important for the survival of marine life. Many people are not aware of the importance of protecting the environment, throwing garbage carelessly and not paying attention to the correct way of disposal, so that the garbage can be carried away by sea currents and pollute the beach.

Plastic waste in Pelangan Village generally comes from domestic activities, mining, and fisheries. The types range from organic waste to plastic waste. Glass bottle to plastic bottle waste is easy to get in coastal areas, so it is a potential for microplastic pollution in coastal areas[4]. Microplastics are plastic particles that are less than 5 mm in diameter. The lower limit of particle size belonging to the group of microplastics has not been definitively defined, but most studies have taken particle objects with a size of at least 300 µm3 [5]. Microplastics are one of the hazardous materials or wastes that if accumulated in the waters will cause disruption of the food chain in the waters. Microplastics in waters can directly or indirectly enter and be consumed by aquatic organisms through entanglement, ingestion, and interaction [6]. The small size causes microplastics to often be considered food by aquatic animals and enter the digestive tract, potentially bringing these particles into the food pyramid to the highest trophic levels. Aquatic animals that are often found in waters, including gastropods.

Gastropods are one of the bottom feeders that live at the bottom of the water, so gastropods come into direct contact with sediment and have the potential to be polluted by pollutants, including microplastics. In addition, gastropods have eating habits by filtering nutrients contained in the water media so that pollutants contained in the water medium also enter the gastropod's body. As a bioaccumulator, microplastics detected in the gastropod's body can be used to determine the presence of plastic waste contamination in waters. Microplastics in the gastropod's body are resistant and can absorb harmful chemical compounds, besides that microlasts are also a habitat for pathogenic microorganisms that are able to degrade chemical compounds. [7] reports that microplastics that have entered the body of organisms through the process of food filtration can be found in the digestive tract.

Contamination of microplastics in the environment and organisms can have a harmful effect. However, not many people are aware of the current condition of the existence of microplastics around so it is very important to monitor and educate the community on an ongoing basis to form a wise society in managing waste. Research on environmental pollution in Sekotong has mostly focused on heavy metals due to small-scale gold mines, while studies related to microplastics are still very limited. Until now, there has been no research that specifically evaluates the presence of microplastics in the waters of Pelangan Village, especially in gastropod biota. Therefore, this study aims to analyze the level of microplastic pollution in Pelangan Village, West Lombok as a database used to educate the public regarding environmental pollution. This research is expected to provide a basis for waste management decision-making in Pelan Village, as well as be part of community education efforts to be wiser in managing plastic waste.

II. Material And Methods

This study uses a quantitative descriptive approach, which aims to describe the abundance and characteristics of microplastics in various environmental media, namely water, sediment, and biota (gastropods), and analyze their relationship with environmental quality parameters such as Total Dissolved Solids (TDS), temperature, dissolved oxygen (DO), nitrates, nitrites, and phosphates. This design allows researchers to obtain a comprehensive picture of the distribution of microplastics by medium and location, and to link them to potential sources of pollution from human activities around coastal areas. The research was carried out from January to April 2025. Samples were taken from three types of environmental media (water, sediment, and gastropods) using the purposive sampling method, which is the selection of sampling locations based on certain considerations relevant to the research objectives. The entire laboratory analysis process was carried out at the Marine and Terrestrial Bio Industry Laboratory, National Research and Innovation Agency (BRIN), using standard procedures for physical and chemical identification of microplastics.

Study Location: This research was conducted in Pelangan Village, Sekotong District, West Lombok Regency, West Nusa Tenggara. This location was chosen because it is a coastal area that has quite high community activities, but waste management in the area is still lacking. Sampling was carried out at three stations selected based on the different types of human activities in the vicinity. The following is an explanation of each location: Station A (Location a): Sungai Desa Pelangan**,** located near residential areas. This location was chosen because there is a possibility of pollution from household waste and garbage dumped directly into the river. Station B (Location b): The mouth of the Selindungan River, is located in a coastal area close to the mouth of the river and is used for various activities of residents, such as fishing. This estuary is also a meeting place between river water and the sea, so it has the potential to carry waste from the mainland to the waters. Station C (Location c): The beach near the Palmyra Hotel**,** this location is in a tourist area and is a crossing route to Gili Gede. The large number of tourist activities and the use of single-use plastics make this location vulnerable to microplastic pollution.

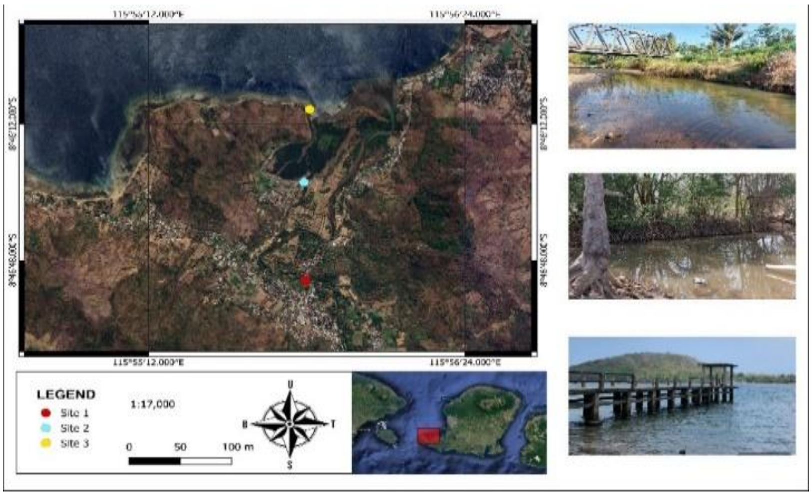

Figure 1. Sampling in Desa Pelangan, West Lombok. a) River (site 1), b) Estuary (site 2), c) Beach in Pelangan Village (site 3).

Procedure methodology

Microplastic Extraction and Observation

Microplastics are extracted using a density separation method with some modifications [8]. A 100 ml water sample was taken, the researchers extracted its organic content by adding 10 ml (KI), 10 ml of hydrogen peroxide (H2O2) and homogenizing it and then heating it with a hot plate at 75°C for 30 minutes. A hot water sample was then added with 20 ml of sodium chloride (NaCl). 300 grams of sediment samples are dried using an oven at 60°C for 72 hours/ 3 days. The ovened sediment was weighed using an analytical scale of 50 grams and transferred to a beaker for the addition of 10 ml of sodium chloride (NaCl) and then incubated for 24 hours. The sediment samples are then filtered to extract sedimentary water and followed by the extraction of organic content such as extracting organic content in the water. Biota samples were dried in an oven at 70°C for 72 hours. After the oven, the sample is weighed using an analytical scale. The biota sample was transferred into a beaker to add 10 ml of sodium hydroxide (NaOH) and homogenized. The sample was then incubated for 24 hours. The incubated biota samples were then added to 10 ml of hydrogen peroxide (H2O2) and 20 ml of homogenized sodium chloride (NaCl) and heated with a hot plate at 75°C until the NaCl dissolved in the sample. After surface water, sediment and biota samples were extracted and incubated for 24 hours, filtered using a 0.3 nm filter and then filtered again using filter paper (whatman) and dried. Furthermore, the calculation of microplastic abundance was carried out using an inverter microscope with a magnification of 4×100 to see the total presence of microplastic abundance in water, sediment, and biota samples in Pelangan Village.

Parameter Testing of Water samples

Water quality testing was carried out using TDS meters and Salifert Freshwater Test Kit in the form of phosphate (PO4), nitrate (NO3), nitrite (NO2), and dissolved oxygen (DO) parameters.

Data analysis

The results of the process of identifying microplastics found in the form of photos based on type, color, and shape were processed using Microsoft Excel to calculate the amount of abundance. Microplastic abundance data were analyzed descriptively quantitatively to describe the distribution of microplastic types.

III. Result

Microplastic Abundance

The form of microplastics found consists of fragments, fibers, films, pellets, and granules shown in figure 2.

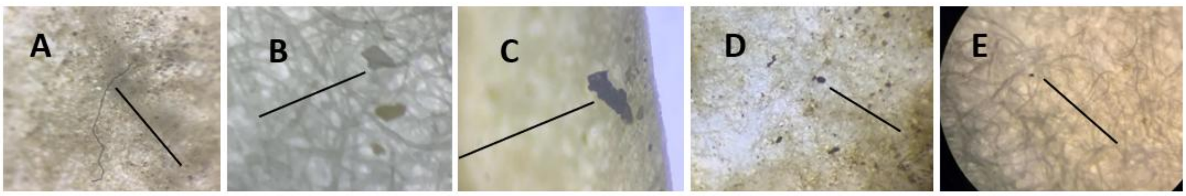

Figure 2. Types of microplastics observed in the sample: (A) Fiber, (B) Film, (C) Fragment, (D) Granule, (E) Pellet

The water samples contained five different types of microplastics at each station. At station 1, the highest microplastic abundance values were shown in the form of films (28%), followed by fragments (26%), granules (19%), pellets (16%), and fibers (11%). Meanwhile, at stations 2 and 3 the highest proportion of microplastics was shown in the form of fragments (28% and 46%). Among the three stations, the highest proportion of microplastics is shown in the form of fragments (46%) found in the third station shown in figure 3.

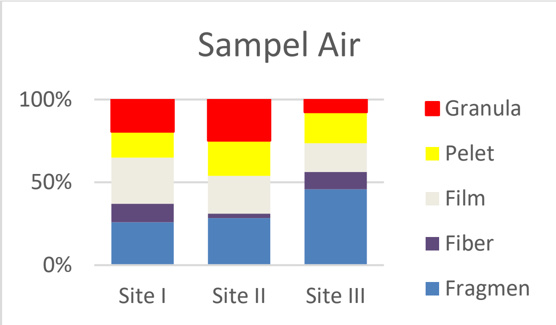

Figure 3. Microplastic characteristics are based on the proportion of microplastics in the study site in water samples.

After the identification of the microplastic shape in the water sample, the analysis was also continued on the sediment sample Different types of sediment samples are shown in (Figure 4). At station 1, the highest microplastic abundance values were fragments (34%), followed by pellets (28%), granules (22%), films (12%), and fibers (4%). Station 2 had the same pattern results as station 1, with the dominant microplastic abundance values indicated by fragments (37%), followed by pellets (32%), granules (21%), films (7%), and fibers (4%). Meanwhile, at station 3 the highest microplastics remained fragment form (50%), the lowest form of microplastic, namely film (8%). Of the three stations, the fragment form is the most commonly distributed form in sediment samples with an abundance value (50%).

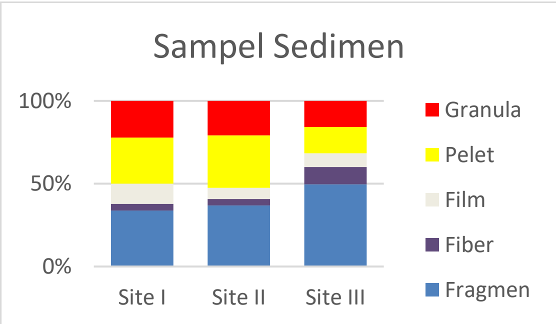

Figure 4. Microplastic characteristics based on the proportion of microplastics in the study site in sediment samples

In addition to water and sediment samples, microplastic types were confirmed positive in marine life, measured by observing body parts (Figure 5). In this study, films and fragments were the dominant microplastics found in most of the biota samples, followed by granules, then pellets, and the lowest being fiber. At station 1 the highest microplastic abundance values were films (27%), followed by fragments (25%), granules (22%), pellets (20%), and fibers (6%). Station 2 had the same pattern results as station 1, with the dominant microplastic abundance values shown in the form of film (41%), followed by fragments (29%), granules (13%), pellets (11%), and fibers (6%). Meanwhile, at station 3 the highest proportion of microplastics is the fragment form (42%), followed by film (24%), granules and pellets (14%), and the lowest at the station is the fiber form (6%). The percentage of microplastic abundance in biota samples, namely in gastropods, is fragments (42%).

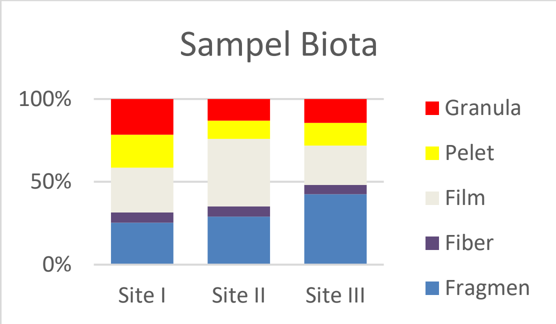

Figure 5. Microplastic characteristics based on the proportion of microplastic types at the research site in gastropod samples

In addition to the shape type, microplastics from water, sediment, and gastropod samples were successfully identified based on colors that included black, white, red, blue, yellow, and green. The proportion of sample colors varies greatly, but black is the most dominant microplastic color in the three samples and stations shown in figures 6, 7, and 8.

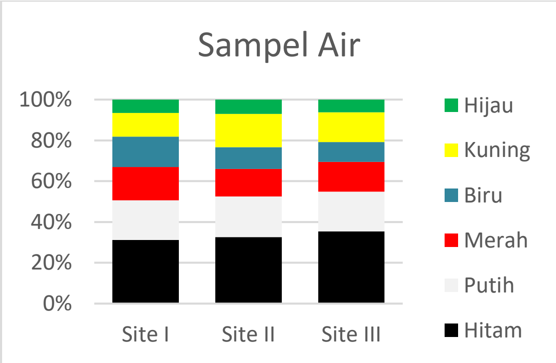

Figure 6. The characteristics of microplastics are based on the proportions of colors from different study sites on water samples

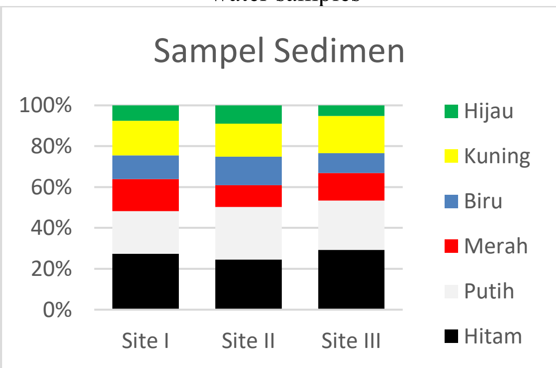

Figure 7. The characteristics of microplastics are based on the proportions of colors from the various study sites on sediment samples

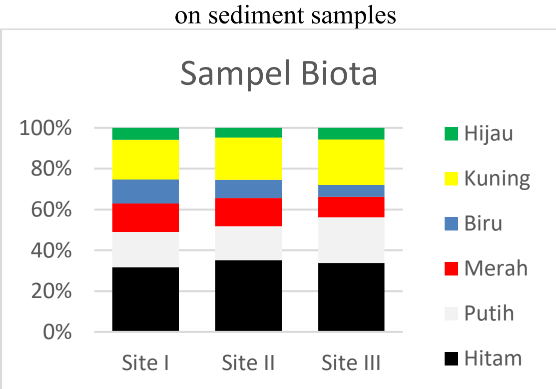

Figure 8. Karateristik mikroplastik didasarkan pada proporsi warna dari berbagai lokasi penelitian pada sampel gastropoda

Water Quality Assessment

The results of water quality measurements at stations 1, 2, and 3 can be seen in table 1.

Table 1. Water Quality Test Result

Sampling	Water Quality		
	Site 1	Site 2	Site 3
Suhu (°C)	32.3	26.6	26.6
TDS (ppm)	7952	4097	375
PO_4 (mg/L)	0.03	0.03	0.5
NO_3 (mg/L)	5	5	2
NO_2 (mg/L)	0.5	0.5	0.5
Dissolved Oxygen (DO) (mg/L)	5.00	3.00	7.00

The measurement results show that the TDS meters on water stations 1, 2, and 3 are 7952, 4097, and 375. The TDS value indicates that the TDS at station 1 is higher compared to other locations, while station 3 has the smallest variation in value. The temperature measurement results range from 27-32°, based on table 1, the highest measurement results are found at station 2. The results of the PO4, NO3, NO2, and DO tests in sequence show; 0.03, 5.0,5, 3.00 on site 1; 0.03, 5, 0.5, 3.00 at site 2; 0.5, 2, 0.5, 7.00 on site 3.

IV. Discussion

Pelangan Village reflects the general condition of coastal areas in Indonesia, where the lack of waste management and high human activity are the main factors in environmental pollution. Pelangan Village, located in Sekotong District, West Lombok, is known as an area with diverse economic activities such as fishing, small-scale gold mining, and agriculture. High human activity has the potential to harm the environment and marine ecosystem in the area, because the coastal area has an ecosystem that is important for the survival of marine life. As a form of pollution that is now widely found in coastal areas, microplastics are an important issue that needs special attention. Microplastics are one of the hazardous materials or wastes that if accumulated in the waters will cause disruption of the food chain in the waters. Contamination of microplastics in the environment and organisms can have a harmful effect. Therefore, it is very important to carry out monitoring efforts to detect microplastic contamination in Pelangan Village, West Lombok as a database used to educate the public regarding environmental pollution. The results showed that microplastics were found throughout the analyzed samples, with characteristics that varied in shape and color. The results of microplastic analysis on various samples were in water, sediment, and biota. The types of microplastics found are fragments, fibers, films, pellets, and granules.

One of the important findings in this study is the dominance of fragment shape in all types of samples, starting with water. Based on the results of the study on water samples, the three stations showed that the three stations had the highest value of microplastic abundance in the form of fragments (47%) contained in the third station, as shown in figure 3. The large number of particles at this location point comes from garbage that is widely disposed of in the research area, so that it is degraded to a smaller size and sinks. This is related to the location of the research in a densely populated area where many community activities are carried out in the area which causes a lot of waste in the location. According to the study [9], the source of the fragment form pollutants comes from large plastic fragments so that they have a denser density [10]. Microplastic fragments originate from the fragmentation of larger plastic products, such as plastic bottles and plastic bags, due to exposure to ultraviolet light and water currents [11].

Once the presence of microplastics in the water samples is known, the analysis continues on the sediment to get a more complete picture of the distribution. Of the three stations, the fragment form is the most commonly distributed form in sediment samples with an abundance value (50%) shown in Figure 4. Microplastics deposited at the bottom of the sediment are affected by the gravitational force and the higher density of plastics compared to the density of water. This causes the plastic to sink and accumulate in the sediment [12]. Several studies show that sediments deposited on the coast are found to contain microplastics. Sediments in Singapore waters contain microplastics of 1,282 particles/kg [13]. Microplastics are also found in the waters southwest of Sumatra [14]. According to previous research, three types of microplastics were found, namely fragments, fibers and films in Muara Badak, Kutai Kartanegara Regency[15]. The shape of the fragments suggests that they tend to accumulate more easily in sediments compared to other types of microplastics. The distribution of microplastics in the sediment at each station is related to the characteristics of the study site. Microplastics are secondary plastic polymers that come from the fragmentation of plastic bags or plastic packaging and have a low density. Low-density microplastics are mostly found floating in waters rather than depositing in sediments [16].

Meanwhile, the presence of microplastics in gatropod samples also shows a real impact on aquatic organisms. The percentage of microplastic abundance in gastropod samples, namely in gastropods, is fragments (42%) as shown in figure 5. Aquatic biota can consume anything that comes and is seen, so the biota cannot distinguish microplastics from their food which is almost similar in shape. The microplastics consumed by gastropods are in the form of fragments, because their lifestyle and habitat affect the shape of the microplastics that accumulate into the body. Microplastics consumed by biota can cause damage to the organs of the biota, inhibit the production of enzymes and can affect reproduction [17].

In addition to shape, the color characteristics of microplastics also provide important information about their source and degradation process. Analysis of the calculation of all microplastics in each type found several colors of microplastics, namely black, white, blue, red, yellow, and green. The color of microplastics can be different because they are caused by the length of exposure to sunlight, weather and the color of the plastic from which the synthetic material comes from, resulting in color changes experienced by microplastics [18]. Based on the results of the research in figures 5, 6, and 7, microplastic colors were obtained from 3 different types of samples, black color dominating in the three samples. The color of microplastics that are widely found at the research site is generally dark/intense in color. According to previous research, dark microplastic colors are usually used for the early detection of polyethylene polymers that are abundant floating on the surface of water, with low density[19]. Dark or deep (black) color mostly indicates that the microplastics are still pure and have not undergone discoloration.

These findings are inseparable from the influence of environmental conditions around the research site. The abundance of microplastics in waters is not only influenced by pollution sources, but also by various environmental factors such as temperature, TDS, nitrates, nitrites, phosphates, and DO contained in table 1. The TDS value at station 1 is higher than at other locations, while station 3 has the smallest variation in value. This high value if not managed can pollute the waters. The accumulation of TDS in the waters can be caused by community activities around the station that produce waste that is discharged into the waters [20]. This condition can increase the abundance of microplastics. Meanwhile, station 3 with the lowest average TDS value shows clearer water, which allows microplastics to be more easily carried away, thus reducing their abundance.

Water temperature is also an important factor that affects the plastic degradation process. The results of temperature measurements at the study site showed a range of 27-32°C. This shows that the temperature at the research site is still included in the category of the optimal temperature range of Indonesian sea level. According to the Decree of the Minister of Environment Number 51 of 2004, it is emphasized that the optimal temperature value of the waters ranges from 28-32ºC. The highest temperature value is obtained at station 1, which is 32ºC. Temperature plays an important role in the process of fragmentation of large plastics into smaller plastics. Temperature can affect the plastic fragmentation process. Rising temperatures can accelerate the process of fragmentation of plastics into small particles. Plastics are fragmented by photooxidation by ultraviolet (UV) light and accelerated by high temperatures. In waters, plastic polymers are less biologically decomposed, but instead break down into smaller pieces due to UV radiation and water currents. The higher the temperature of the waters, the higher the value of microplastic abundance in a body of water [21].

In addition, the content of dissolved oxygen (DO) also plays a role in the quality of the waters and the presence of microplastics. Table 1 shows the DO results at each station. DO can be a value to know the pollution load in waters. Based on the results of the study in table 1, station 3 is the station with the highest DO value. The higher the DO content in a water, the better the quality of the water. According to previous research, the highest concentration of DO is on the surface of the water[22]. This is because sunlight reaches the surface more easily. Meanwhile, at stations 1 and 2 the DO values are low, this condition can contribute to an increase in the abundance of microplastics.

Overall, the presence of microplastics in the environment and gastropods as marine life shows a serious impact on the ecosystem. Contamination of microplastics in the environment and organisms can have a harmful effect. However, not many people know the current condition. The abundance of microplastics in the gastropod sample also proves the transfer of microplastics from the water medium into the gastropod's body. Microplastics have hydrophobic properties that make it easier for organic contaminants to be absorbed on the surface of particles as the surface area of microplastics increases. Microplastics can also absorb metals, additives in the environment, and become a habitat for pathogenic microorganisms [23]. Therefore, microplastics in the body of organisms can cause irritation in the digestive tract, cause false satiety and have an effect on weight loss, inhibit growth, disorders of the reproductive system, reduced mobility and even lead to death [24]. One of the roles of gastropods in the ecosystem is as a source of feed for other animals at a higher trophic level. Gastropod soft tissues that have been proven to have been contaminated with microplastics have the potential to be eaten by predators, resulting in the transfer of microplastics through the food chain and the potential for an increase in the concentration of microplastics on the top of predators, or known as biomagnification. Increased concentrations of pollutants in the organism's body will increase the potential harm to the organism.

V. Conclusion

The results of this study show that different types of MP and color proportions are observed from water and sediment from various sampling locations and body parts of marine animals. The types of MP shapes found include fragments, fibers, films, pellets, and granules, while based on the color of the MP particles, the proportions are black, white, red, blue, yellow, and green. The results of the study showed widespread MP contamination in the waters of Pelangan Village. This research is expected to provide a basis for waste management decision-making in Pelan Village, as well as be part of community education efforts to be wiser in managing plastic waste.

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