Abundance of microplastic in green mussel *Perna viridis*, water, and sediment in Kamal Muara, Jakarta Bay

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**Abstract.** Research on the abundance of microplastic in green mussel *Perna viridis*, water and sediments in Kamal Muara, North Jakarta in September 2017 has been done. The research determined the abundance of microplastic in water, sediment and green mussel (base on the sizes and microplastic storage organs), also the correlation between abundance of microplastic in green mussel, water and sediments. Samples of green mussel, water and sediments were taken from 3 different stations with a distance of about 500 meters. Analysis of abundance of microplastic was done by isolating microplastic in each sample. The isolation of the green mussel samples was done by dissolving the mussels in the HNO3 solution for 24 hours and added saturated NaCl solution. The microplastics from water and sediment samples were separated by immersion of samples in a saturated NaCl solution. The results obtained were, on average, abundance of microplastic in green mussel size 3, 6, and 9 cm i.e., 5.35; 24.99; and 39 particles/gram. The microplastic fiber was dominant in mussel sample. The average abundance of microplastic in water and sediment are 13.15 particles/L of sea water and 0.92 particles/gram of dry sediment respectively. The microplastic film was dominant in water and sediment samples. Meanwhile, pellet was not found in all three samples. There was a correlation between abundance of microplastic with green mussel size, as well as with abundance of microplastic of film and fiber in water and sediment.

**Keywords:** Correlation, fiber, film, mussel, Jakarta

1. Introduction

Jakarta Bay lies between Tanjung Pasir and Tanjung Karawang. The Jakarta Bay is administered into the provinces of Banten, DKI Jakarta, and West Java. The total area of Jakarta Bay reaches 490 km² [1]. Jakarta Bay is occupied for shipping, ports, tourism, water sports, and fisheries. In addition, aquaculture from various types of fish, shrimp and shellfish are found in Jakarta Bay [2].

Kamal Muara, located in Jakarta Bay, is an area suitable for the cultivation of green mussels since it receives high amount materials brought by Kali Kamal and Kali Dadap [3]. Kamal Muara has a high production capacity, but has a lot of plastic waste that empties into the ocean. Waste in Jakarta as a whole reaches 28,515 m³/day in the first quarter of 2011, plastic waste is 13.25 % of the total waste. Some of these trashes are also carried by a river that empties into Jakarta Bay [4].

The amount of plastic waste in the sea is worrying. Plastic waste is the dominant component of inorganic waste in the sea [5] and more than 10 % of total plastics was dumped in the sea [6].
The Ministry of Industry of Indonesia [7] mentioned that plastic consumption reached 1.9 million tons during the first 6 months in 2013. Plastic waste will gradually be fragmented into smaller sizes. Plastic waste which size of less than 5 mm is called a microplastic. The rate of microplastic formation process is influenced by UV radiation, temperature, oxidation by air, hydrolysis by sea water, and physical abrasion with surrounding materials [8, 9].

Marine biota known to eat microplastic include sponge, cnidarian, crustacean, vermes, mollusca (bivalvian), bryozoa, echinodermata, algae, seagrass, plankton, and marine mammals [5]. Cauwenberghe and Janssen [10] mentions that human consumption on shells contains microplastic. These biota may feed on microplastic directly or through food chains. The microplastic spread through the food chain occurs because the biota feed on another biota that already contains microplastic. Based on the exposure, humans also have the potential to consume microplastic in marine biota is consumed, for example, green mussels.

Microplastic is commonly found in digestive organs of marine biota, so humans can avoid consuming microplastic simply by removing the digestive organs. This can be done in consumption biota such as fish, squid, and shrimp, but not on shellfish. Humans eat whole shellfish and cannot be separated between meats and digestive organs. If there are microplastic in the mussel, then people who eat it will also eat microplastic [10].

Microplastic can threatened health when consumed. Nevertheless, research on microplastic abundance in green mussels as consumption biota and cultivation of Kamal Muara area has not been done. These are the background of research on the abundance of microplastic existing in green mussels *Perna viridis*, water and sediments in the Kamal Muara area.

The purpose of the study was to find out the abundance and microplastic groups of various green mussels, the largest green mussels organ found in microplastic, the abundance and the microplastic groups in water and sediment, and the correlation between microplastic abundance in green mussels, water, and sediments.

2. Materials and method

2.1. Location and time of study

The research station was shellfish farm or shellfish cultivation in Kamal Muara community. The total number of research stations was three, distance between station was 500 m and depth of about 5–6 m. The samples were collected in September 2017.

2.2. Tools and materials

Equipment used in the research, i.e., thermometer, pH meter [universal indicator], refractometer [ATAGO], secchi disk, DO meter [Lutron Do5510], ekman grab, plankton net, monocular microscope, binocular microscope, tweezers, sonde needles, countdown room [Sedgewick Rafter], and 100 mL beaker glass [IWAKI]. The samples of *Perna viridis* were collected 3, 6, and 9 cm shell length respectively, each 10 individuals per station. These sizes are selected as representative of juvenile and consumption size. Other materials and solution were used, sediment samples, alcohols, 65 % nitric acid solution, distilled water, filter paper, and concentrated NaCl solution.

2.3. Method

2.3.1. Green mussels, water, and sediment samplings. Sample of *Perna viridis* was taken by purposive random sampling method. The samples were preserved in a ziplock plastic containing 70 % alcohol based on size and station.

Microplastic samples in water were taken at each research station point by filtering a total of 20 L of sea water per station. The seawater was filtered using a plankton net to trap the microplastic particles.
The mesh of the plankton net was 200 μm in size. The resulting filter volume was ± 250 mL for each station.

Sediment samples were taken 3 times with a grab sampler for each station. The sediments taken amounted to 0.5–1 kg per station. The sediment samples were stored in a ziplock plastic from each station.

2.3.2. **Microplastic analysis of Perna viridis.** Microplastic analysis of green mussels was performed on 3 sample shells for each size and station. The process of analysis begins with immersion of shells in a ziplock containing a 70 % alcohol solution. The soaked shell measured the total mass, soft tissue mass, and length of the shell. The separated soft tissue was immersed in a 65 % HNO₃ solution for 12 hours. Immersion in HNO₃ aims to dissolve the soft tissue of the shells, but not dissolve the microplastic present in the mussels’ body. The immersed solution was then diluted 10 times with aquadest and added NaCl until the solution was saturated. The result of dilution (1 mL) was piped into the calculated chamber for analysis under a microscope (magnification 100 times) and the presence of microplastic was observed. The microplastic were further grouped into four groups, namely pellets, fibers, films, and fragment [10].

Microplastic analysis of green mussels was also performed to find the most commonly found microplastic organs. Analysis was performed by dissecting 6 samples of green mussels for further observation under a microscope. Surgical mussels begins with soaking green mussels with alcohol. Before surgery, the length of the shell, soft tissue mass, and the shell mass were measured. Furthermore, the sample of green mussels will be separated between the shell and soft tissue. The soft tissue shell samples were observed and dissected under a binocular microscope for counting the number and presence of microplastic inside the green mussels organ.

2.3.3. **Microplastic analysis of water.** Microplastic analysis in the water was done by observing sea water samples using a microscope. The filtered water sample was then stored in a bottle for each station. Analysis begins by adding NaCl to 250 mL of sample until the solution becomes saturated. It aims to increase the density of the solution, so that the microplastic will converge on the surface. Observation of microplastic particles was done visually by piping water samples (1 mL) and observed them under microscope with magnification of 40 and 100 times.

2.3.4. **Microplastic analysis of sediment.** Microplastic analysis contained in the sediment begins with a sediment drying process using an oven at 105 °C for 72 hours. Furthermore, the volume reduction and sedimentation stages were carried out by sieving sediment with a 5 mm. Third, the sediment separation step based on the density. Separation was done by immersing each sediment sample into a saturated NaCl solution. Every 3 of 1 saturated NaCl solution was added to 1 kg of sediment sample. The mixture was stirred for 2 minutes [11]. This process will separate polystyrene, polyethylene, and polypropylene plastics. The obtained mixture was piped into the count chamber. Furthermore, visual observation of particles using a microscope with magnification of 40 and 100 times.

2.3.5. **Processing, preparation, and data analysis.** Microplastic analysis in sediment, water, and body shells Perna viridis results qualitative data and quantitative data. The qualitative data from the research was presence-absence of microplastic. The quantitative data obtained were the amount of microplastic contained in each sample. Furthermore, the quantitative data already obtained were analyzed by using Spearman’s correlation equation to find out the correlation between microplastic abundance in various size shells, and in water, and sediment.

3. **Results and discussion**

3.1. **Abundance of microplastic in water and sediment samples**

We found 3 groups of microplastic on water and sediment, fiber, film, and fragment, while pellet was absent. Microplastic group of film has the highest abundance. Meanwhile, fragment has the lowest
abundance. Microplastic fragment groups were found to be more common in sediments than in water. The amount of microplastic in water and sediment can be seen in figure 1.

Microplastic in the film group derived from the degradation of plastic bags or plastic packaging. Plastic waste is known to contribute 29.70% of total plastic waste on the coast. Plastic bags are also known to be easily degraded to microplastic because they have the lowest density [9].

Fiber becomes the codominant of the microplastic group in water and sediment. Microplastic fiber group is a microplastic derived from pieces of string or fishing line, both commonly used Kamal Muara community for fishing activities and aquaculture [12].

Microplastic groups of fragment have greater abundance in sediment than water. This is because fragment has mass greater than fiber and film. Because of the mass greater, the fragment tends to sink to the seafloor, so the fragmented microplastic groups were more abundant found in sediments than in water [9].

3.2. Number of microplastic group by green mussels of various sizes

Microplastic group found in green mussels were fiber, film, and fragment. Fiber was the most commonly found microplastic in green mussels. The fragments were found only in 6 and 9 cm individual. Microplastics of pellets were not found at all in green mussels. The shell length 9 cm contained the most microplastic then other shell length (table 1).

Green mussels is filter feeder which means filtering water to get the food. Animal-filter feeder and feeder feeder will eat microplastic by itself when there is microplastic in its environment [10].

![Figure 1. Graph of microplastic quantities on water and sediment samples.](image)

| Size of mussels | Pellet | Group of microplastic | Total |
|-----------------|--------|-----------------------|-------|
|                 |        | 3 cm                  | 6 cm  | 9 cm  | Total |
| 3 cm            | 0      | 39                    | 30    | 0     | 69    |
| 6 cm            | 0      | 538                   | 449   | 5     | 992   |
| 9 cm            | 2078   | 2125                  | 18    | 4221  |
| Total           | 2655   | 2605                  | 23    | 5282  |

Table 1. The number of each microplastic group on the green mussels.
Microplastic abundance in green mussels is known to have a positive correlation with the size of the shell length. This is caused by the longer the shell, the older the age of the green mussels. Green mussels have a growth rate of 0.7–1 cm each month [13]. The 9 cm-sized clams are estimated to be 9–12.85 months old, indicating the shell size is 9 cm longer exposed to microplastic from the environment. Microplastic exposures and their effects are directly proportional to the time of microplastic contaminated organisms.

Respiratory organs contains more microplastic than digestive organs. Microplastic fibers were found to be the most numerous among the groups. Pellet microplastics were not found in either respiratory or digestive organs. The amount of microplastic found in the organ of the green mussels can be seen in table 2.

3.3. Average microplastic abundance (particle/g) and microplastic density (particles/individual) on green mussels Perna viridis

The average microplastic abundance of each gram and each green mussels increased every increase in the size of the mussels’ green mussels length. Shells with a length of 3 cm contain the lowest microplastic, while the green mussels measuring 9 cm contain the highest microplastic.

Green mussels that grow in the area, during his life exposed to microplastic contamination as much as 13.15 particles/L. The longer exposed to microplastic, the more microplastic ingested by the biota [10]. Green mussels will accumulate microplastic because of the exposure so that the microplastic density on the green mussels is increased significantly.

3.4. Correlation analysis of microplastic abundance in green mussels with water and sediment

The results of correlation analysis can be seen in table 3, which indicates that there is a correlation to the microplastic abundance of fiber and film groups in shells with water and sediment samples. Green mussels eat by filtering water which makes them called filter feeder. Green mussels take whatever food around and do not pick and choose which will be eaten and not eaten. Green mussels will also eat small objects that exist in the environment, both food and microplastic existing in the water. Microstructures are widely present in the waters of the fiber and film groups so it is possible that green mussels will eat both groups of the microplastic.

The results in the table 3 showed no correlation between microplastic abundance of fragment groups in green mussels-water and green mussels-sediment. This happens because the green mussels grow at a depth of 1.5–2.5 m. While the depth of the sea reaches > 5 m. Because that’s what makes the microplastic abundance in water more influential than microplastic in the sediment. Microplastic fragment groups are easier to find in sediments compared to water, since fragments generally have a much weigher than other microplastic groups [9]. This is the reason for the absence of a correlation between the fragments microplastic abundance in green mussels with in water and sediment (tabel 3).

| Mussels’ organ | Pellet | Group of microplastic | Total |
|---------------|--------|-----------------------|-------|
|               |        | Group of microplastic |       |
| Digestive     | 0      | 86                    | 118   | 2      | 206   |
| Respiratory   | 0      | 263                   | 186   | 2      | 551   |
| Total         | 0      | 349                   | 304   | 4      | 757   |
Table 3. Spearman's correlation between microplastic abundance in green mussels in water and sediment.

| Correlation of microplastic abundance | Value of $P_{\text{counting}}$ | Information            |
|--------------------------------------|-------------------------------|------------------------|
| Fiber in water – Fiber in mussels    | 0.50                          | Positive correlation   |
| Film in water – Film in mussels      | 0.50                          | Positive correlation   |
| Fragment in water – Fragment in mussels | -0.25                        | No correlation         |
| Fiber in sediment – Fiber in mussels | 0.50                          | Positive correlation   |
| Film in sediment – Film in mussels   | 0.50                          | Positive correlation   |
| Fragment in sediment – Fragment in mussels | -1.25                        | No correlation         |

*27 samples, $\alpha=0.01 \Rightarrow P_{\text{tab}}=0.456$

3.5. Correlation analysis between microplastic abundance in green mussels with green mussel sizes

Microplastic abundance tends to increase every increase in shell length of shells. Spearman's correlation test was used to test the correlation between microplastic abundance in green mussels with shell length of green mussels.

4. Conclusion

Microplastic were found in shells consists of 3 groups, fiber, film, and fragment. The fiber group was microplastic with the highest abundance, while the fragment was the lowest abundance. The microplastic abundance in green mussels was positively correlated with the size of the shell length. Respiratory organs of *Perna viridis* contain more microplastic. The film group has the highest abundance in both water and sediment. The fragment group has higher abundance in the sediment than in water. There is a positive correlation between the microplastic abundance of film and fiber groups in green mussels with the abundance of microplastic groups of films and fibers in water, and sediment. This is suggested that the area around Kamal contains microplastics which already affect the green mussels community.

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