Microplastic contamination on *Anadara granosa* Linnaeus 1758 in Pangkal Babu mangrove forest area, Tanjung Jabung Barat district, Jambi

Syaidah Fitri and M P Patria*

Departmen of Biology, Faculty of Mathematics and Natural Science, Universitas Indonesia, Depok 16424, Indonesia

Corresponding author: *mpatria@gmail.com

**Abstract.** *Anadara granosa* is an important food source for people in Tanjung Jabung Barat District, Jambi. This study uses samples of cockle, sediment and water. The results showed a 100% sample containing microplastic. The types of microplastic found are fiber, fragments and films. The average microplastic amount in *A. granosa* individuals was 434 ± 97.05 particles/individual. Fiber is the type of microplastic that is most commonly found in samples of cockles, sediments and water. In the blood cockles sample, fiber was found as much as 180.6 ± 21.22 particles/individual and 4.1 ± 0.43 particles/g cockle. Fiber is also found with high concentration in water samples of 128.3 ± 0.15 particles/L. The river is indicated as a microplastic source to the sea. The station sample 1 in 100 m near the river mouth has a higher microplastic concentration with an average of 448.3 ± 53.92 microplastic/individual, compared to station sample 3 which is only 420.3 ± 42.66 microplastic/individual.

**1. Introduction**

Microplastic is all plastic fragments smaller than 5 mm [1]. High density microplastics such as PVC (1.14-1.56 g cm$^{-3}$ or PET (1.32-1.41 g cm$^{-3}$) are made as much as 17% of the total world plastic production. This type can cause microplastic abundance in sediment and water column. Marine sediment with marine water density of 1,02 g cm$^{-3}$, for these findings sediment is indicated as a microplastic container [2].

Microplastic is found in water columns and marine sediments throughout the world. Small and large microplastic is detected mainly in coastal, subtidal and offshore sediment [3]. Microplastic originating from various human activities around the sea and rivers, that flows to estuary has the opportunity to be consumed by marine organisms. Microplastic opportunities consumed by marine organisms are caused by two main properties, namely particle and density. Particle with a size <5 mm and having a higher density than seawater will be consumed by benthic organisms. Benthic organisms found to swallow microplastics are sea cucumber, clams, lobsters, amphipods, lugworms and barnacles [4].

Laboratory experiments have shown the effect of consuming microplastic on organisms. *Oryzias latipes* which engulfs polyethylene fragments of <0.5 mm in size, causes bioaccumulation and hepatic impairment in the form of glycogen depletion, fat vacuation, single cell necrosis and initial formation of tumors. The experimental result also showed microplastic modulating contaminant toxicity. In an
experiment with *O. latipes*, fish fed with microplastic and absorbed chemicals showed higher percentages of liver stress, compared to fish given microplastic without absorbed chemical [5].

Microplastic is abundant in densely populated areas with high activity in marine resources. Research along the coast of Belgium, in harbor sediments found microplastic with higher concentration, compared to the surrounding coastal areas. However, not all types of microplastic are sourced from the port. The river is indicated as a potential microplastic source to enter the marine environment [6]. This is evident from the results of research on the Saint Lawrence river, Canada which empties into the sea. High-concentration microplastics is found in the sediments of the Saint Lawrence river. The microplastic from municipal and industrial waste [7].

The Tanjung Jabung Barat District has at least 6 main ports and several individual ports along the Betara River. The waste from the port and river empties into the Pangkal Babu mangrove forest area and marine. The Pangkal Babu mangrove forest has an area of 1442 ha, which is *A. granosa* inhabitation. Sedimentary inhabiting organisms are sensitive indicator species for various types of natural inductions and anthropogenic disturbances. Sedimentary organisms are used throughout the world as biological indicators of an ecosystem [8]. *A. granosa* which has a habitat mangrove sediment causes the organism to be very susceptible to contamination with various pollutants. One of the ingredients that can pollute the mangrove ecosystem is microplastic. Contamination of microplastic need to be done research on its abundance in seafood such as *A. granosa*, because humans can consume microplastic indirectly through the food chain.

2. Methodology

2.1. Determination of research sample points
Sampling was carried out in the Pangkal Babu mangrove forest, the location of fisherman in search of *A. granosa*. There are have 3 sampling points, in each points mussels, sediment and water were sampled. Taking blood cockles samples by hand with a depth of 1 to 15 cm from the surface of the sediment, 5 individual shellfish samples were taken at each station. Taking a sediment sample of ± 250 grams using a shovel at a depth of 1 to 15 cm from the sediment surface at each station. Taking water samples is done by using a 200 µm plankton net, a sample of water used is 5 liters of water.

![Figure 1. Map Illustrating the sample location in Tanjung Jabung Barat District, Jambi. Sample point 1, sample point 2 and sample point 3.](image)

2.2. Microplastic extraction from *A. granosa*
The mussel are removed from the shell then weighed before being inserted into the 500 ml beaker glass. 100 ml of HNO3 is put into a beaker glass containing the mussel and left for 12 hours [9]. Ten times dilution was done towards the sample using water, then 1 ml was pipetted into the counting chamber. The sample was observed under the microscope with magnification of 10x10 [10].
2.3. Microplastic extraction from sediment and water
The sediment sample was dried using oven for 12 hours with the temperature of 60 0C. The dried sample was soaked inside concentrated NaCl 26% with the proportion of 1:3 [9]. The sample was stirred for two minutes and allowed to stand for 3 hours, then 1 mL was pipetted into the counting chamber. The sample was observed under the microscope with magnification of 10x10. Water samples are treated with the same method as sediment samples starting from mixing samples with concentrated NaCl [10].

3. Result and discussion
The average microplastic particles found in A. granosa 434 ± 97.05 particles/individuals. Based on the sampling station, microplastic with the highest number of 448.3 ± 53.92 particles/individuals found at station 1, which is ± 100 meters from the river mouth. Station 2 has an average microplastic amount of 435 ± 62.64 particles/individuals. Station 3 which has the most distance from the river mouth with an average microplastic 420.3 ± 42.66 particles/individual is the lowest number compared to stations 1 and 2.

![Figure 2. Microplastic type of fiber](image)

The types of microplastic found in the sample are fiber, fragments, and films. Based on the type, fiber is the most common type of microplastic which is 180.6 ± 21.22 particles/individuals. Films were found 135.6 ± 16.71 particles/individual. Fragment has the least amount is found compared to fiber and film. The fragments were found to be 117.8 ± 15.09 particles/individuals.

![Figure 3. Microplastic average based on the type in A. granosa.](image)
Based on the mean for each g blood cockles, microplastic was found to be $9.8 \pm 2.26$ particles/g cockle. The highest mean microplastic is $10 \pm 0.98$ particles/g found at station 1, which is $\pm 100$ meters from the river mouth. Station 2 has a microplastic average of $9.8 \pm 0.05$ particles/g. Station 3 which has the furthest distance from the river mouth with an average microplastic $9.5 \pm 0.75$ particles/g is the lowest number compared stations 1 and 2.

Fiber is the most common type of microplastic found in *A. granosa* in the Pangkal Babu mangrove forest. Fiber type microplastic is widely used in the manufacture of synthetic clothing/fabrics, monofilament fragmentation of fishing nets and ropes [11]. Fragments and films found in blood cockles indicate that microplastic pollution also comes from household waste in the form of plastic bags, plastic packaging, drinking bottles, gallon chips and others which are dumped into the river to the sea.

1.9 million tons of plastic were produced during 2013 in Indonesia, with an average production of 1.65 million tons/year. 10% of all newly produced plastics will be discharged through the river and end up in the sea [12], so it can be concluded that 165,000 tons of plastic/year will lead to Indonesian marine waters. Plastic waste will be degraded in physics, chemistry, and biology to a size of $<5$ mm.

The function of mangrove forests as a biological filter for marine debris that originates from land and sea, causes abundant microplastic in the mangrove forest area which is a natural habitat for blood cockles. Microplastic contaminated marine biota such as *A. granosa*, will also contribute to microplastic contamination in humans who consume the same amount. This is related to how to consume which is directly cooked along with the shell and consumed throughout the soft tissue.

Based on the average for each g sediment, microplastic samples were found to be $11.2 \pm 2.63$ particles/g. The highest amount of microscopy is $11.5 \pm 0.83$ particles/g found at station 1, which is $\pm 100$ meters from the river mouth. Station 2 has an average microplastic amount of $11.1 \pm 0.61$ particles/g. Station 3 which has the farthest distance from the river estuary with an average microplastic $10.9 \pm 0.90$ particles/g is the lowest number compared to stations 1 and 2.

Based on the type of microplastic, the fragment is the type of microplastic which is found the most amount of $4.7 \pm 0.15$ particles/g. Films were found in $3.3 \pm 0.10$ particles/g. Fragment types of microscopy have the least number found compared to fiber microplastic and film types. Fiber is found in $3.1 \pm 0.05$ particles/g.

![Microplastic average based on the type in sediment.](image)

Based on the average for each L water sample, microplastic was found as much as $283.9 \pm 2.63$ particles/L water. The highest amount of microscopy is $292 \pm 0.87$ particles/L found at station 1, which is $\pm 100$ meters from the river mouth. Station 2 has an average microplastic number of $282 \pm$
1.11 particles/L. Station 3 which has the farthest distance from the river estuary with an average microplastic of 277.7 ± 1.87 particles/L which is the lowest number compared to stations 1 and 2.

Based on the type of microplastic, fiber is the most common type of microplastic, which is 128.3 ± 0.15 particles/L. The film was found to be 80.5 ± 0.11 particles/L. Fragment types of microplastic have the least number found compared to fiber and film microplastic types. The fragments were found to be 75 ± 0.05 particles/L.

Figure 5. Microplastic average based on the type in water.

Microplastic which has a low density when compared to sea water, tends to float on the surface of the water. However, microplastic which has a higher density compared to sea water, will sink and accumulate in sediments [13]. Fiber has a high concentration in water samples because it has a lower density, compared to microplastic types of films and fragments, so it tends to float on the surface of the water.

Rope or ship mine is a material that is found mostly along the Pengabuan river body, especially in the harbor. Fish nets are also the main ingredient used by fishermen in Tanjung Jabung Barat District to catch fish. This net is found more in the river mouth, installed on bamboo stems 5 to 10 meters from the edge to the middle of the river. Fiber can also come from synthetic fibers originating from household waste derived from washing clothes [14]. Synthetic fiber washing clothes originating from household waste will flow along the river flow and empties into the sea, contributing to the high concentration of microplastic types of fiber in the waters of the Pangkal Babu mangrove forest area.

Fragment types have high concentrations in sediments compared to water, because fragments generally have greater density and density than fiber and film. High density makes fragments tend to sink in the sea, causing microplastic groups of fragments to be more easily found in sediments than water [15]. Household waste, with plastic material, is found in the river mouth of the comb in the Pangkal Babu mangrove forest area. Plastic household appliances and drinking bottles disposed of in the river will go through physical, chemical and biological pressures that will turn into fragment microplastic types, which can be easily distributed by water [16].

Films are secondary microplastic which have weak polymers and low density, so the microplastic concentration of film types is higher in water than in sediments. Films are generally used by humans to support daily life such as food/beverage packaging, soap packs/detergents, plastic bags and others [14]. Contamination of plastic packaging waste and high plastic bags in an area increases significant biofilm formation over time, accompanied by changes in chemical physical properties such as decreased buoyancy [18]. Based on the type and amount of microplastic found, it was indicated that
the activities of fishermen, ports and household wastes in Tanjung Jabung Barat District were indicated as sources of microplastic pollution in the Pangkal Babu mangrove forest.

4. Conclusion
Based on the results of the study, samples of Anadara granosa, sediments and water contained microplastic. The types of microplastic found in the sample are fiber, film and fragments. The average number of microplastic in A. granosa individuals was 434 ± 97.05 particle/individuals. Fiber is the most common type of microplastic in the blood cockle which is 180.6 ± 21.22 particles/individuals. The average microplastic in the sediment was found to be 11.2 ± 2.63 particles/g. Fragments are the most commonly found microplastic in sediment samples (4.7 ± 0.15 particles/g). The average microplastic in water is 283.9 ± 2.63 particles/L. Fiber is the most common type of microplastic found in water samples (128.3 ± 0.15 particles/L).

Acknowledgement
This research was supported by The Grant of International Publications for UI Students Final Project (PITTA) 2018, and supported by Coastal and Marine Resources: Environment and Management Department of Biology, Faculty Mathematics and Natural Science, Universitas Indonesia.

Reference
[1] Arthur C, Baker J and Bamford H 2009 Proceedings of the international research workshop on the occurrence, effects and fate of microplastic marine debris. *NOAA Techno Memo. 30*: 49-53.
[2] Cozar A, Echevarria F, Gonzalez-Gordillo J I, Irigoien X, Úbeda B, Hernandez-Leon S, Palma A T, Navarro S, Garcia-de-Lomas J, Ruiz A, Fernandez-de- Puelles M I and Duarte C M 2014 Plastic debris in the open ocean. *CBD Techno. Seri. 111*: 10239-10244.
[3] Fisher V, Elsner N O, Brenke N, Schwabe E and Brandt A 2015 Plastic pollution of the Kuril-Kamchatka Trench area (NW Pacific). *Deep Sea Res. II 111*: 399-405.
[4] Imhof H K, Ivleva N P, Schmid J, Niessner R and Laforsch C 2013 Contamination of beach sediments of a subalpine lake with microplastic particles. *Curr. Biol. 23*: pp 867-868.
[5] Bakir A, Rowland S J and Thompson R C 2014 Transport of persistent organic pollutants by microplastics in estuarine conditions. *Estuarine. Coast. Shelf Sci. 140*: 14-21.
[6] Claessens M, De Meester S, Van Landuyt L, De Clerck K and Janssen C R 2011 Occurrence and distribution of microplastics in marine sediments along the Belgian. *Coast. Mar. Pollut. Bull. 62*, 2199-2204.
[7] Castaneda R A, Avlijas S, Simard M A and Ricciardi A 2014 Microplastic pollution in St. Lawrence river sediments. *Can. J. Fish. Aquatic Sci.70*, 1767-1771.
[8] Thain J E, Vethaak A D and Hylland K 2008 Contaminants in marine ecosystems: developing an integrated indicator framework using biological-effect techniques. *ICES J. Mar. Sci. 65*: 1508-1514.
[9] Claessens M, Van C L, Vandegehuchte M B and Janssen C R 2013 New techniques for the detection of microplastics in sediment and field collected organisms. *Mar. Pollut. Bull.70*: 227-233.
[10] Hidalgo-Ruz V, Gutow L, Thompson R C and Thiel M 2012 Microplastics in the marine environment: A review of the methods used to identification and quantification. *Environ. Sci. Technol. 46*, 3060-3075.
[11] Nor M H N and Obbard J P 2014 Microplastics in Singapore’s coastal mangrove ecosystems. *Mar. Pollut. Bull. 79*: 278-283.
[12] Cauwenberghe L V, Claessens M, Vandegehuchte M B, Mees J and Janssen C R 2013 Assessment of marine debris on the Belgian Continental Shelf. *Mar. Pollut. Bull. 73*: 161-169.
[13] Graca B, Szewc K, Zakrzewska D, Dolega A and Szczersowska-Boruchowska M 2017 Sources and fate of microplastics in marine and beach sediments of the southern baltic sea preliminary study. *Environ. Sci. Pollut. Research Intern. 24*(8) 7650-7661.
[14] Browne M A, Crump P, Niven S J, Teuten E, Tounkin A and Thompson G T 2011 Accumulation of microplastic on shorelines worldwide: sources and sinks. Environ. Sci. Techno. 45(21), 9175-9179.

[15] Teuten E L, Saquing J M, Knappe D R U, Barlaz M A, Jonsson S, Bjorn A, Rowland S J, Thompson R C, Galloway T S and Yamashita R 2009 Transport and release of chemicals from plastics to the environment and to wildlife. Phil. Trans. Roy. Soc. Lond. B 364

[16] Gewert B, Plassmann M and Macleod M 2015 Pathways for degradation of plastic polymers floating in the marine environment. Environ. Sci.: Procecess Impacts 17: 1513-1521.

[17] GESAMP 2015 Sources, fate and effects of microplastics in the marine environment: a global assessment (London: International Maritime Organization) 90 pp 96-217