Comparative analysis of microplastic content in water, sediments, and digestive traces of sea urchin *Diadema setosum* (Leske, 1778) on Untung Jawa Island and Tidung Island, Seribu Islands, Jakarta

D R Huseini¹, A Suryanda² and M P Patria¹,*

¹ Department of Biology, FMIPA Universitas Indonesia, Campus UI Depok, Depok 16424, Indonesia
² Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Negeri Jakarta, Rawamangun, Jakarta Timur, 13220, Indonesia

*mpatria@sci.ui.ac.id

Abstract. This study aims to compare the abundance and types of microplastics in water, sediments, and digestive tracts of sea urchins *Diadema setosum*, in Untung Jawa Island and Tidung Island, Seribu Islands. Samples of sea urchins, water, and sediment were taken from 15 different locations based on the location of the biota colony. Samples of the digestive tracts of sea urchins were analyzed by dissolving them at 65% HNO3, water samples (20 l) were filtered with a 300 μm plankton net, and sediment samples (200 g) were dried in the oven first, then each sample was given NaCl to saturate. Each sample (1 ml) is placed in the Sedgwick Rafter Chamber to be examined under a microscope. The results showed that the abundance of microplastic in Untung Jawa Island was higher at 99.88 ± 1.79 particles l⁻¹ in water, 110,737.77 ± 4,197.61 particles Kg⁻¹ particles in sediment, and 2,175.55 ± 584.26 particles Ind⁻¹ in the digestive tract of sea urchins. On Tidung Island microplastic abundance contained in the water amounted to 87.4 ± 9.61 particles l⁻¹, the sediment of 87,626.66 ± 4,957.00 particles Kg⁻¹, and in the digestive tract of sea urchins to 1,786.66 ± 451.17 particles Ind⁻¹.

1. Introduction

Every year, Jakarta's Border Environment Conditions are declining. Counted within a period of 10 years (1985-1995) there was a drastic change in the amount and composition of waste. In 1985, garbage in Jakarta's marine waters was moved by organic waste such as water hyacinth, wood chips, wood, used rattan, banana trees. While in 1995 the garbage in the Jakarta sea was handed over by inorganic waste in the form of plastic [1]. Plastic is a material or material that is very difficult to decompose, plastic is difficult to decompose but plastic can be degraded to a smaller size with a size of less than 5 mm or commonly referred to as microplastic with various forms of fibers, films, fragments, and granules [2].

The semi-enclosed shape of the Jakarta Bay region causes a heavy burden of pollution, as a result of this pollution is felt up to 50 km from the Jakarta bay to the Seribu Islands [3]. Untung Jawa Island and Tidung Island are two islands that are entirely composed of Jakarta Bay. Based on distance measurements using digital maps (Google Maps) each 7.4 km away and 29.1 km from the Jakarta Coast...
(Tanjung Pasir). Administratively the two islands are included in the District of the Seribu Islands in the South where in the South the environment is not good or can be said to be polluted [4].

Bioindicators that are commonly used to assess the quality of an environment, especially waters are macrozoobenthos, this is because benthos has a very good response to the pollution of a waters. Benthos is a biota that has low mobility (relatively passive) so that benthos will remain in the place of exposure to pollution if a waters are polluted [5,6]. Echinoderms are one of the phyla that are included as macrozoobenthos [7]. Sea urchin Diadema setosum is one of the biota derived from the phylum Echinodermes [8]. It is necessary to know the abundance of microplastics that accumulates in water, sediments, and digestive tracts of sea urchins to determine the level of microplastic pollution in the waters of Untung Jawa Island and Tidung Island, Seribu Islands, Jakarta related to the difference in distance between the two islands to Jakarta Bay.

The purpose of this study is, to (i) analyze the abundance and types of microplastic particles contained in water, sediments, and digestive tracts of sea urchins Diadema setosum in Untung Jawa Island and Tidung Island, Seribu Islands, Jakarta, (ii) analyze the correlation between microplastic abundance contained in sediments, and digestive tracts of sea urchins Diadema setosum on Untung Jawa Island and Tidung Island, Seribu Islands, Jakarta, and (iii) comparing the results of microplastic abundance analysis on water, sediments, and digestive tracts of Diadema setosum sea urchins on Pulau Tidung, Kepulauan Seribu, Jakarta, and (iii) comparing the results of microplastic abundance analysis on water, sediments, and digestive tracts of sea urchins Diadema setosum on Untung Jawa and Seribu Islands, Jakarta.

2. Material and methods

2.1. Research location and time
The study was conducted in the coastal areas of Untung Jawa Island and Tidung Island, Kepulauan Seribu, Jakarta on 15 different stations around the island based on the location of the Diadema setosum sea urchin colony (stations 1 — 5 the southern part, 6-8 East, 9-13 North, and 14-15 West), during August-December 2019. Sampling was carried out on 28-29 September 2019 and microplastic analysis was carried out at the FMIPA UI Marine Biology Laboratory on 30 September-30 October 2019.

2.2. Materials and equipment
The materials used in this study were analytical NaCl salt crystals [Merck], nitric acid (HNO3) 65% [Merck], 70% alcohol, distilled water, aluminum foil, tissue, disposable latex gloves [Sensi], disposable masks [Sensi], samples of the digestive tract of sea urchins Diadema setosum, water samples, and sediment samples taken from Untung Jawa Island and Tidung Island each 15 samples from different colonies. The equipment used in this study are GPS [Garmin], digital maps [Google Maps], refractometer [As One], thermometer, pH neutral Neutralite indicator paper 5.5-9.0 [Merck], dipper, plankton net with a filter diameter of 300 µm, mini shovel, 300 mL glass sample bottle, digital scale [Kris], 250 mL Erlenmeyer flask [Pyrex], Beaker glass 250 mL, 500 mL, 1000 mL, and 2000 mL [Pyrex], container, monocular light microscope [Nikon ], light microscope [Leica], drop pipette, glass stirrer, glass funnel, sieve net with 5 mm mesh, Sedgwick Rafter counting chamber, glass object, glass cover, paraffin surgical board, dissecting set, and drying oven [Jisico].

2.3. Sampling, extraction, observation and analysis of microplastic
In this research, environmental parameters observed include temperature, pH, and water salinity. Retrieval of environmental parameter data is done by measuring the temperature of sea water samples using a thermometer, measuring salinity of sea water samples using a refractometer [As One], measuring the pH of sea water samples using pH neutral Neutralite indicator paper 5.5-9.0 [Merck] by dropping the sample water on paper and match colors to the parameters listed on the pH indicator packaging. Then each data obtained from measurements of water sample temperature, salinity, and pH is recorded.
Water is taken as much as 20 liters directly using a dipper and then filtered using a 300 µm plankton net in sea urchin habitat from 15 different locations based on the location of the colony, then the water is filtered again using a sieve net with a 5 mm mesh, then given NaCl saturated with a ratio of 1: 4 to study the microplastic content. Sediments will be taken directly in the Diadema setosum habitat of 200 grams using a shovel at the location studied, namely Untung Jawa Island and Tidung Island, Seribu Islands, Jakarta. The sediment that was taken was then placed in a 250 ml glass bottle and then dried in an oven at 60° C and then given 1: 4 saturated NaCl to examine the microplastic content. *Diadema setosum* samples will be taken directly around the island as many as 15 individuals from different colonies using hands that have been protected by thick gloves. *Diadema setosum* that has been taken, then immediately cleaned from the thorn and then isolated the digestive organs. Digestive organs that have been isolated then weighed and prepared into containers that were given 70% alcohol, to be prepared, then given 65% HNO₃ with a ratio of 1:10 so that the tissue is destroyed, and added saturated NaCl to study the microplastic content that accumulates in the digestive organs *Diadema setosum*.

2.4. Data processing, compilation and analysis

Microplastic content data obtained will be recorded, calculated, averaged, converted in units (Kg⁻¹ particles, L⁻¹ particles, Ind⁻¹ particles), processed, and then displayed in quantitative and qualitative forms. Quantitative data is the acquisition of microplastic data contained in all samples (water, sediments, and digestive tracts of *Diadema setosum* sea urchins) that have been converted, compared between the acquisition data of Untung Jawa and Tidung Islands, Seribu Islands, Jakarta. Analysis of the data used is the statistical approach namely the Two Sample T-Test (Independent sample t-test) with α 0.05 or 95% confidence value. To see whether or not there is a relationship between the amount of microplastic and sediment weight contained in the digestive tract of sea urchins, a spearman level correlation test with α 0.05 was performed.

3. Results and discussion

In all samples isolated from Untung Jawa and Tidung Islands, Kepulauan Seribu, Jakarta in the form of water, sediment and digestive tracts of sea urchins, *Diadema setosum* found microplastic content (fibers, films, fragments, and granules) with the type of fiber that dominated the throughout the sample in the Untung Jawa Island water and sediment sample, the highest abundance of microplastic was in station 3 and the lowest abundance was in station 11. In Tidung Island, the highest microplastic abundance was in station 13 and the lowest was in station 15 (Figure 1).

![Figure 1](image_url)

**Figure 1.** Comparative diagram of microplastic abundance in water, sediments, and digestion tract of sea urchin *Diadema setosum* sediments in Untung Jawa and Tidung Island.
The results of observations showed that of the three types of samples taken, the greatest abundance of microplastic was in sediment samples, then samples of digestive tracts of sea urchins, and the last was in water samples. Microplastic abundance in all samples was relatively higher in abundance on Untung Jawa Island compared to microplastic abundance in Tidung Island (Table 1).

Table 1. Comparative table of microplastic abundance in water, sediments, and digestion tract of sea urchin *Diadema setosum* sediments in Untung Jawa and Tidung Islands.

| Island     | Water          | Sediment                   | Digestive Tract |
|------------|----------------|----------------------------|-----------------|
| Untung Jawa| 99.88 ± 1.79 particles l⁻¹ | 110,737.77 ± 4,197.61 particles Kg⁻¹ | 2,175.55 ± 584.26 particles Ind⁻¹ |
| Jawa       | 87.4 ± 9.61 particles l⁻¹  | 87,626.66 ± 4,957.00 particles Kg⁻¹ | 1,786.66 ± 451.17 particles Ind⁻¹ |
| Tidung     | 87.4 ± 9.61 particles l⁻¹  | 87,626.66 ± 4,957.00 particles Kg⁻¹ | 1,786.66 ± 451.17 particles Ind⁻¹ |

The results of the Spearman correlation analysis between abundance of microplastic and sediment weight in the digestive tract show that Untung Jawa Island has a calculated \(\rho\) value greater than \(\rho\) table (0.951 > 0.441), it can be concluded that there is a correlation between the amount of microplastic with the sediment weight contained in the digestive tract of sea urchins on the island of Untung Jawa. While on Tidung Island the value of count \(\rho\) is smaller than \(\rho\) table (0.145 < 0.441), it can be concluded that there is no correlation between the amount of microplastic with the weight of sediment contained in the digestive tract of sea urchins in Tidung Island.

Based on the results of the Two Sample T Test, the results obtained in water samples (4.947 > 2.048), sediments (13.780 > 2.048), have a decision \(t\) Stat > \(t\) Table, it can be concluded that there are differences in microplastic abundance in the two islands. Whereas in the samples of sea urchin digestive tract has a decision \(t\) Stat < \(t\) Table (2.040 < 2.048) it can be concluded that there is no difference in microplastic abundance in the sea urchin digestive tract in the two islands.

4. Discussion

Benthic animals, especially sea urchins, ideally live at 25-30°C, with salinity of 30-34 ppt, and at a pH of 6.5-8.5 [9]. Based on observations on several environmental factors in Untung Jawa Island and Tidung Island in the form of data collection on temperature, salinity, and degree of acidity on the two islands, it can be concluded that the environmental conditions on the two islands are in accordance with the criteria of Echinodermal living habitat, especially the sea urchins *Diadema setosum*.

Fiber-type microplastics are the ones with the most abundance. This microplastic is usually derived from fishing activities such as fishing gear and fishing line, then the film is a type of microplastic which is the result of macroplastic fragmentation that has low density derived from plastic bags and food packaging [10;11]. Granule type microplastic particle size which is only around 0.05-6 µm makes this type of microplastic difficult to be observed with a light microscope, so the results of microplastic observations of granule types in all samples and their abundance stations are low because not all microplastic particles can be observed [12].

The difference in microplastic abundance between the two islands is thought to be due to differences in population, number of visitors, anthropogenic activities carried out by the community, port activities, to the distance of sources of pollution from land which are known to have a significant impact on waste pollution, especially microplastics at sea [10,13,14]. Population growth is known to have a positive correlation with increased pollution in water areas [15]. It is known that there are several factors that influence the distribution of microplastic distribution in the sea such as waves, floating ladies, waste input from land, tides, tides, wind direction, particle size dams, and current trajectories in waters [13,16]. In this study sampling was conducted in late September into early October. It is known that the winds that blow in October are Transitional Muson winds and tend to be the type of West Muson winds that
move towards the East and Southeast waters [17]. Based on observations obtained, the highest abundance of microplastics in Java Untung Island and Tidung Island, Seribu Islands, Jakarta is in the southern territorial waters, and one location in the North on Tidung Island. This condition illustrates that the direction of the compass does not significantly affect the microplastic distribution of the two islands.

5. Conclusion
It was found that there were microplastic contents of fiber types, films, fragments, and granules in all samples taken from Untung Jawa Island and Tidung Island, with the highest abundance of microplastic fiber types. There is a positive correlation between microplastic abundance in the digestive tract of sea urchins with sediments on the island of Untung Jawa, and there is no significant correlation between microplastic abundance in the digestive tract of sea urchins with sediments on Tidung Island. There are differences in microplastic abundance in water, sediment, and there are no differences in microplastic abundance in the digestive tract of sea urchins Diadema setosum between Untung Jawa Island and Tidung Island, based on the results of the T-Test Independent Sample T-test.

Acknowledgment
This research has been funded by Directorate of Research and Community Service at the University of Indonesia through the PITTA-B Grant (International Indexed Publications for UI Final Projects), No NKB-0642/UN2.R3.1/HKP.05.00/2019 to Mufti Petala Patria.

References
[1] Sahwan F L 2004 Jurnal Teknologi Lingkungan 5 12-6
[2] Kramm J and Volker C 2018 Understanding the Risks of Microplastics: A Social-Ecological Risk Perspective (Frankfurt: ISOE – Institute for Social-Ecological Research) p 11
[3] Sachoemar S I and Wahjono H D 2007 JAI 3 1-14
[4] Sugiarto H and Supardi 1995 Oseana 20 35-41
[5] Rachmawaty 2011 Bionature 12 103-09
[6] Meisaroah Y, Restu I W and Pebriani D A A 2019 J. Mar. and Aquat. Sci. 5 36-43
[7] Fajri N 2013 Jurnal Educatio 8 81-100
[8] Lubis S A, Purnama A A and Yolanda R 2017 Jurnal Ilmiah Mahasiswa FKIP Prodi Biologi 3 1-6
[9] Irianto A, Jahidin and Sudarajat H W 2016 Jurnal AMPIBI 1 27-30
[10] Hastuti A R, Yulianti F and Wardiatno Y 2014 Bonorowo Wetlands 4 94-107
[11] Hiwari H N, Purba P, Ilisan Y N, Yuliodi L P S and Mulyani P G 2019 Pros. Sem. Nas. Masy. Biodiv. Indon. 5 165-71
[12] Jeong C B, Won E J, Kang H M, Lee M C, Hwang D S, Hwang U K, Zhou B, Souissi S, Lee S J and Lee J S 2016 Environ. Sci. and Techno. 50 8849-57
[13] Auta H S, Emenike C U and Fauziah S H 2017 Environ Intl. 102 165-76
[14] Nugroho D H, Restu I W and Emawati N M 2018 Curr. Trends in Aquatic Sci. 1 80-8
[15] Guzzetti E, Sureda A, Tejada S and Faggio C 2018 Environ. Toxicol. Pharmacol. 64 164-71
[16] Septian F M, Purba N P, Agung M U K, Yuliodi L P S, Akuan L F and Mulyani P G 2018 Jurnal Geomaritim Indonesia 11-8
[17] Purba N P, Pranowo W S, Simanjuntak S M, Faizal I, Jasmin H H, Handyman D I W and Mulyani P G 2019 DEPIK Jurnal Ilmu-Ilmu Perairan, Pesisir, dan Perikanan 8125-34