Presence of Microplastics in Sea Cucumber *Paracaudina* sp from Karimun Island, Kepulauan Riau, Indonesia

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Abstract. Karimun is one of islands located in the Kepulauan Riau Province that has high anthropogenic activities which produces a certain amount of wastes, including plastics. The plastic wastes will be degraded into small-particles called microplastics. Due to its small size and widespread distribution, microplastics could be consumed by marine organisms, such as deposit feeder organisms including sea cucumber *Paracaudina* sp. The aim of this research was to determine type and abundance of microplastic particles and its correlation with the sea cucumber body size. Samplings of sea cucumber for microplastic analysis were taken from two stations by digging the sediment from each station. Separation of microplastic particles from sea cucumber organs was carried out through 4 stages, (a) dissection, (b) separation of organ from its body (c) submersion using KOH 10% solution (d) incubation for 3 weeks and (e) sorting visually. The results of this research found only 3 types of microplastic (fibre, film and fragment). The abundance of microplastic in *Paracaudina* sp. was found between 289.40-1380.00 particles/individu with fibers being the dominant type. Fibers are the most abundant in both stations followed by films and fragments. Independent t-test analysis revealed that the abundance of microplastic between the two stations was significantly different (p<0.05). Positive correlation between microplastic abundance and the body-size of *Paracaudina* sp were found, indicating that the larger the size of sea cucumber, the higher microplastic particles contained in the body of the organisms.

1. Introduction
People around the world has been facing garbage problem since the last few years, both on land and in the ocean. One of the most dominant types of waste is plastic waste [1]. In the aquatic environment, plastic waste will be degraded into very small particles called microplastics. Microplastics scattered in the ocean will settle and be carried away by the currents of the waves so that they mix with the sediment. The wide distribution of microplastics and their size and colour resembling zooplankton and phytoplankton causes the potential for microplastics to be consumed and accumulated by various marine organisms [2].

The smaller the size of the microplastic, the more likely it is to be ingested by marine organisms [3, 4, 5]. One of the organisms that has the potential to accumulate microplastics through their food is sea cucumbers, this is due to their eating habits as deposit feeders [6]. Sea cucumbers are animals that belong to the phylum Echinoderms of the class Holothuroidea. Economically, sea cucumbers are used as food ingredients, sea cucumbers are also often consumed in raw form and as medicinal ingredients...
in dry form. Ecologically, sea cucumbers are an important component in the food chain because of their role as suspension feeders and deposit feeders [7].

Besides having a dense activity in various fields, the coastal area of Karimun Island, are also one of the waters that have marine and fisheries potential that are used by fishermen to catch fish and other biota such as sea cucumbers. The phenomenon of marine waste in the form of microplastics can cause undesirable effects in the local community with the presence of debris that has polluted coastal areas and oceans. Based on this, a study is needed to determine the type and distribution of microplastics in sea cucumbers in the coastal waters of Karimun Island, Kepulaian Riau Province.

2. Methodology
This study was conducted in the coastal waters of Karimun Island, Kepulaian Riau Province of Indonesia. Two sampling stations were chosen based on their most abundant population, namely station 1 at 0°59'36.8" N 103°25'22.7" E (Puakan Beach) and station 2 at 1°03'02.2" N 103°18'46.1" E (Pelawan Beach) as shown in Figure 1. The number of sea cucumber samples taken was 10 individual per station. Sea cucumber samples were analyzed for their microplastic content at the Marine Chemistry Laboratory, Faculty of Fisheries and Marine Science, Universitas Riau.

Figure 1. Sampling stations in Karimun Island

The materials used in the present study were samples of sea cucumbers (Paracaudina sp) and 10% KOH solution as a separator between inorganic materials, namely microplastics and samples of sea cucumber organic materials. The selection of the sampling locations used purposive sampling method. Samples of sea cucumber were collected by digging sediments by hand during low tide conditions in areas that are known as habitat for sea cucumbers with a water depth of about one to two meters [8].

Identification of microplastics in sea cucumber samples was carried out through several stages as follows: a) dissection, b) separation of the entire digestive tract, c) immersion in 10% KOH solution in a ratio of 1: 3, d) incubation for 3 weeks, e) microplastic observations using Sedgewick Rafter Counting Cell under an Olympus CX23 microscope by taking as much as 1% of the total solution.

Then the microplastic samples were classified into several types, namely fiber, film, fragments and pellets. After that all tools and equipment were rinsed three times with distilled water to avoid contamination [9]. The number of particles found is converted according to the formula:

\[
Z = \frac{a}{b} \times \frac{100\%}{c}
\]

Note:
Z: Abundance of microplastics (particles/individual) 
   a: Number of particles found 
   b: Percentage of observed solution (1%) 
   c: The number of observed biota (individuals)

All data analysis were carried out using SPSS program version 17 and graphs were plotted with Microsoft Excel 2010. The difference in the microplastics abundance between stations was examined by using Independent sample t-test, whilst the relationship between abundance and type of microplastic particles with the weight and length of sea cucumbers was determined by using simple linear regression [10] with the mathematical model:

\[ Y = a + bx \]

Note:
Y: Abundance and types of microplastics in sea cucumbers
x: Length/weight of sea cucumber
a and b: Constant

### 3. Results and Discussion
Karimun Besar Besar Island is administratively located at 00°02'36"-01°01'12" North Latitude and 10°30'13"-10°40'36" East Longitude in the Karimun Regency, Kepulauan Riau Province [11]. Karimun Island is very strategic in term of area for the industrial activities and the economic development. It is directly in the border with two neighboring countries (Malaysia and Singapore). The west coast of Karimun Island is also in the border area between the Kepulauan Riau Province and Riau Province. In addition, several industries such as shipbuilding, granite industry, crude oil storage and other anthropogenic activities are concentrated along this coastal area. Therefore, the west coast area of Karimun Island is categorized as one of the distribution route for wastes, including microplastics, from the sea based and anthropogenic activities in the island.

#### 3.1. Types and abundance of microplastics
Results showed that the sea cucumbers observed at two stations in the coastal waters of Karimun Besar Island contained microplastic particles, with an abundance ranging from 289.40 – 1380.00 particles/individual (Table 1). The abundance of microplastics obtained was greater than the microplastic studies observed in other biota as reported by [12] in Spermonde Islands, Makassar City, South Sulawesi who found only 2 - 3 particles/individual [3] and in Ancol Beach, Palabuhan Ratu and Labuan who found 2-18 particles/individual. Meanwhile, [13] found 2 - 13 particles/individuals in the Bali Strait. The difference in the abundance of microplastic particles in each study might be due to the characteristics of the research sites that receive different anthropogenic wastes, and the object of research that has different feeding habits [14]. Sea cucumber may absorb microplastics from their habitat which are commonly organic-rich sediment.

| Station | Particle/individual |
|---------|---------------------|
| 1       | 1380.00 ± 370.58    |
| 2       | 289.40 ± 93.177     |

The characteristics of different research locations may lead to different abundance of microplastics [15]. The current research location is a coastal area that is directly influenced by many anthropogenic...
activities such as residential areas, roads, coastal tourism, and industries. The coastal waters of Karimun Besar Island are also directly connected to the Malacca Strait and Singapore Strait [16]. Therefore it can be assumed that the distribution of microplastics and other wastes also comes from these waters. The comparison of microplastic abundance between stations can be seen in Figure 2.

Figure 2. Microplastic abundance in sea cucumber (*Paracaudina* sp)

Figure 2 showed that the abundance of microplastics at station 1 is higher than station 2 with a total of 1380.00 particles/individual, while the average of microplastic abundance at station 2 is 289.40 particles/individual. These differences are assumed to be caused by different environmental influences. Station 1 is the waters of Puakang Beach which is close to the city center. Urban activities such as roads, trade, human settlements, loading and unloading of goods and shipyard also occurred on the surrounding of Puakang Beach. Previous results of research on microplastic particles in sediment were also found to be dominant in Puakang Beach [17]. Whilst station 2 is the waters of Pelawan Beach which is a tourist beach with relatively few population. Based on observations, the size of sea cucumbers from station 1 is also larger than that at station 2. It was stated by [18] that the larger the size of aquatic biota, the accumulation of pollutants in their bodies will also increases.

Of the four types of microplastics [19], only three types were found in this study (fragment, fiber and film) as seen in Figure 3, whilst the pellet type was not found. This is presumably due to the absence of a plastic factory around the research location. According to [20] pellet type microplastics are primary microplastics that are directly produced by factories as raw materials for making plastic products.

Table 2. Microplastic abundance (Mean ± Std. deviation) between stations by type

| Station | Fiber     | Particle/individual | Film     | Fragment |
|---------|-----------|---------------------|----------|----------|
| 1       | 960 ± 241,29 | 330 ± 216,28         | 90 ± 128,66 |
| 2       | 246,3 ± 89,21 | 33,1 ± 31,34        | 10 ± 31,62  |

Figure 3. The shape of the microplastic particles found in sea cucumbers
The comparison of the overall microplastic abundance between stations based on the type of the microplastics in sea cucumbers (*Paracaudina* sp) in the coastal waters of Karimun Island is shown in Figure 4.

![Figure 4](image-url)  
*Figure 4. The abundance of microplastics between stations based on its type*

Based on the results of the study, the abundance of fiber was the most dominant type found at the two research stations due to fishing activities, loading and unloading of ships, and urban community activities. According to [21] microplastic fiber may come from rigging and fishing nets. Microplastics in the form of films are the second type found in high enough abundance because microplastics in the form of films are particles derived from the degradation of plastic bags with low density, thus this type of microplastic can spread to all parts of the waters [20].

In this study, microplastics in the form of fragments are the fewest types found due to the source of microplastics in the form of fragments originating from plastic which has a sturdy type so that the degradation process that occurs is also quite long, thus the source of plastic fragments at the research site has not been completely degraded. According to [1] microplastics in the form of fragments are plastics derived from rice wrappers, ready-to-eat food packages and plastic drink bottles.

Result of the independent sample t-test showed that the number of microplastics in the two stations showed $p < 0.05$. This indicates that the number of microplastics at the two stations is significantly different. Based on visual observations, the size of sea cucumbers at station 1 is larger than at station 2 and this might be attributed to the higher abundance of the microplastics found in Station 1.

### 3.2. Relationship of Microplastic Abundance in Sea Cucumbers of Different Sizes

The amount of pollutant is closely related to the size of the biota, where the larger size of the biota generally has a larger pollutant content than the smaller biota [18]. The results of the analysis showed that the weight of sea cucumbers had a positive correlation with the abundance of microplastics with correlation coefficient values of 0.88 (fiber), 0.73 (film), 0.47 (fragment) as seen in Figure 5 (A). Similarly, Figure 5 (B) indicated that the results of the analysis between the length of the sea cucumber and the type of microplastic also has a positive correlation with the abundance of microplastics with a correlation coefficient of 0.87 for fiber, 0.72 for film, and 0.44 for fragment.

Positive correlations between microplastics abundance and size of sea cucumber might be attributed to their feeding habit as they are known as either suspension feeders or deposit feeders. As mentioned by [22] that microplastics are known to be consumed by sea cucumber since this species do not select their food. Four types of microplastics (fibre, fragment, film and pellet) were found in their
study in Tidung Island and Bira Besar Island. Based on their feeding habit, sea cucumber is considered as significant species that could be at risk of ingesting microplastics.

Figure 5. Relationship of abundance of microplastic fiber, film and fragments in sea cucumbers with different body weight (A) and length (B).

According to local peoples in Karimun Island, sea cucumber are usually consumed either as raw ingredient for specific traditional dishes or as ingredient in traditional medicine. It is therefore important to conduct further study on the evaluation of possible effects of microplastics to not only the marine animals but also to human health. Higher number of microplastics accumulated by edible marine organisms may lead to potential environment and health effects.

4. Conclusion
Microplastic particles found in sea cucumbers in the coastal waters of Karimun Besar Island consisted of three types; namely fragments, films and fibers with an average abundance of 289.40-1380.00 particles/individual. Particles with fiber form were the most dominant found at both stations followed by film and fragment type. The abundance of microplastic was significantly different (p < 0.05)
between stations. Larger size of sea cucumbers accumulated higher number of microplastic in their body.

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