Microplastic abundance in sea cucumber at seagrass ecosystem of Bintan Island and surrounding area, Indonesia

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Abstract. The increasing use of plastic in various aspects of life impacts the increase in plastic waste in the environment. The plastics are degraded into the smallest fragments to a size of <5 mm called microplastics. Further, microplastics will accumulate in the water, marine biota, and sediment. Sea cucumbers are deposited feeder and found in the seagrass ecosystem. This study aims to examine the abundance of microplastics in sea cucumbers, which are scattered in seagrass ecosystems in the waters of Bintan Island and the surrounding area. The method used is a purposive random sampling in a seagrass ecosystem area of 100 x 20 meters. The sea cucumbers obtained will then be dissected and observed for their microplastic content. The results showed that the sea cucumber found in the seagrass ecosystem on the Bintan island are Holothuria atra, H. scabra, and Sticopus variegatus. The highest density of sea cucumbers was found in Pengujan waters, with a value of 90 ind/ha. The highest microplastic content in sea cucumbers was found in Pengudang water, with a total of 52 ± 7.68 particles/ind. The dominant type of microplastics is fiber, with a total of 84 particles/ind.

Keywords: Bintan Island; microplastic; sea cucumber; seagrass ecosystem

1. Introduction

Bintan is one of the islands located in the Riau archipelago province located in the west of the Indonesian territory, which has enormous marine and fisheries potential such as mangroves, coral reefs, and seagrass ecosystem. There are 11 species of seagrass on Bintan Island [1]. Bintan Island and the surrounding islands are adjacent to the Malacca Strait and Singapore Strait, the busiest sea and maritime route. Bintan Island is a congested sea lane and maritime traffic zone [2]. It can contribute to plastic waste due to leakage into the marine environment.

Plastics are generally not biodegradable that can persist for long periods. Plastic waste that floats in the water can be exposed to solar radiation and cause oxidative degradation of polymers (photodegradation). In addition, mechanical forces such as waves and wind can break down the degraded plastic into ever smaller particles (mechanical degradation) [3]. The plastics are degraded into the smallest fragments to a size of <5 mm, called microplastics [4]. The microplastics were found in the water and sediment and found in marine biotas [5].

Sea cucumber (Holothuroidea sp.) is affected by microplastics. Sea cucumber is a benthic biota with slow movements, living in sand and mud habitats and commonly found in seagrass and reef coral ecosystems [6]. Economically, sea cucumbers are fishery commodities that have a selling value for trading. Sea cucumbers are one of the indicator biotas that play an important role in ecology. Sea cucumbers are deposited feeder-type biota, and the presence of sea cucumbers in the ecosystem helps fertilize the substrate by stirring the bottom of the water. Sea cucumbers are non-selective scavengers that feed on debris on the ocean floor, ingest large amounts of sediment [7]. So that, organic and
inorganic materials such as microplastics from the environment can easily swallow by sea cucumbers. Previous research showed that the average number of floating microplastics from 11 stations around Bintan Island was 122.8 ± 67.8 pieces per station. Concentration microplastic in Bintan Island represents a low-medium microplastic pollution level compared to the levels of other marine environments worldwide [8]. Based on this statement, it is necessary to research how microplastics around Bintan Island affect sea cucumbers.

2. Materials and methods
   2.1. Sampling area
   This research was conducted in the area of Bintan Island, Riau Archipelago Province. Sea cucumber sampling locations are determined based on regional characteristics, community activities, and the presence of seagrass as a sea cucumber habitat. Research location can be seen in figure 1.

   2.2. Sample collection
   The method used to collect sea cucumbers data is field observation (survey) (figure 1) to determine the sampling location. Sampling was carried out at 3 locations on Bintan Island, 1 location on Dompak Island, and one on Penyengat Island. The method used is a purposive random sampling in the seagrass area of 100 x 20 meters. Samples were taken as many as found to obtain density data. Then the sample is stored in a container and placed in an icebox.

   2.3. Extraction and separation processes
   Microplastic analysis in sea cucumbers was carried out by several stages. First, the digestive tissue of the sea cucumber was separated from the sea cucumber, and the wet weight was measured. Then, the digestive tissue of the sea cucumber is separated from other ingredients by soaking it in H₂O₂. After that, ZnCl was added so that the microplastics floated on the surface. The solution on the surface was taken and filtered using 0.45 m filter paper. For the last step, the drying results were observed under a microscope to determine the presence of microplastics as well as group them according to microplastic groups based on shape and colour [9].

   Figure 1. Research location map.
3. Results and discussion

3.1. The density of sea cucumber

Based on field observations, it was found that three types of sea cucumbers were found in the seagrass ecosystem on the Bintan island, namely *Holothuria atra*, *H. scabra*, and *Stichopus variegatus*. Sea cucumbers were carried out at 5 stations, which is Pengujan, Pengudang, Malang Rapat, Penyengat, and Dompak stations. The density of sea cucumbers for each station can be seen in figure 2.

Sea cucumbers are found in rock, sand, and mud substrates. The highest density of sea cucumbers was found at Pengujan station with a value of 90 ind/ha, and the type was found is *H. scabra*. Pengudang Station is closed water and is not affected by human activities. This is suspected to be the cause of the high-density value at the Pengudang station. In contrast, the lowest density values were found at the Malang Rapat, Penyengat, and Dompak station with a value of 25 ind/ha consisting of *H. scabra* and *Stichopus variegatus* species. The low-density value at three stations is thought to have occurred due to sea cucumber fishing, community boat, and marine tourism. In addition, physical development such as offices, resorts, and others around the sea was increased. Other than natural factors and predators, the low density of sea cucumbers can also be caused by the community's high level of ecological pressure [10].

3.2. Abundance of microplastic

Plastic particle types found in the digestive tract of sea cucumbers at each location showed no significant differences based on the results of the one-way ANOVA test. However, based on the density of
The high value of microplastics in the digestive tract of sea cucumbers in Pengudang is thought to be due to the semi-enclosed water conditions. So that, the plastic distribution is smaller and will accumulate more in the sediment and be fragmented into microplastics. Fragmenting plastic waste into smaller particles does not only occur through physical processes but also biologically [11]. In addition, wind conditions at the time of sampling also affect the presence of microplastics. Sampling in the northeast monsoon caused the plastic floating in the waters to move towards the northeastern part of Bintan. Plastics are used in various human activities because they are versatile, durable, inexpensive, and this is the cause of increasing plastic products every year [12]. Microplastics can be digested by marine biota because the particles of microplastics can resemble food for marine biota [13].

3.3. Characteristic of microplastics

The characteristics of microplastics in this study were seen by colour and type. The colour of the microplastics found can be seen in figure 4. The colour of microplastics found at each location was dominated by white with an average of 30%, followed by black 23%, red 16%, blue 13%, brown 11%, and so on.
and green 7%. Microplastics with white colour were dominated at each location. Presumably, the microplastics found had been embedded in the sediment for a long time, resulting in a change in colour due to exposure to ultraviolet light. Then, the microplastics embedded in these sediments are eventually eaten by the sea cucumbers. Previous research found that the dominant microplastic colours found were transparent white and blue [13]. These colours are similar to the colour of plankton which is a food source for fish or sea cucumber. Previous research showed different results, where the blue colour of the microplastics was dominated the sea cucumber samples [14]. The results of this study found that the types of microplastics found from all locations were dominated by fiber types with a total value of 84 particles/individual, followed by fragment types 79 particles/individual, film type 48.2 particles/individual, and foam type 13.6 particles/individual (figure 5).

The predominant type of fiber is thought to be because this type is the most common type of microplastic, easy to stick, be carried by the current, and enter the digestive tract. In contrast, the type of fragment is the type that comes from ready-to-eat food packaging and plastic drink bottles and has a low-density value. The type of polypropylene polymer that originates from the microplastic type in the form of filaments and fragments has the lowest density with the value of 0.9-0.91 g/m³ [15]. So that, microplastics in the form of filaments (fibers) and fragments are the most dominant found because easy to distribute. The dominant type of microplastic in the digestive tract of sea cucumbers is fiber [16].

4. Conclusion
Microplastics are found throughout the digestive tract. The characteristics of microplastics based on colour are dominated by white microplastics, and based on the type, the type of fiber and fragments dominates microplastics.

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