Morphological characteristics of sea cucumbers (Holothuroidea) from Socah Waters, Bangkalan, Madura

Rizka Rahmana Putri1, Indah Wahyuni Abida1, Fareza Nabila Dhea Fatma Putri1, and Ainnun Innaya2

1Study Program of Aquatic Resources Management, Department of Marine and Fisheries, Faculty of Agriculture, University of Trunojoyo Madura, Bangkalan, Indonesia
2Study Program of Marine Science, Department of Marine and Fisheries, Faculty of Agriculture, University of Trunojoyo Madura, Bangkalan, Indonesia

Abstract. Sea cucumbers belong to the Phylum Echinodermata with unique and diverse body shape. At the organism level, phenotype is an attribute or characteristic that can be seen, observed, or measured. The study of morphological characteristics in sea cucumbers in the Socah Waters of Bangkalan, Madura is necessary to obtain specific morphological data for different sea cucumber species, allowing us to recognize the distinctive features of each sea cucumber species in the Socah Waters, Bangkalan Regency, Madura. Morphological and morphometric data of a biota that will be used to determine the type and name of the species are preliminary data that are useful for reference in further research. However, of course, in order to determine the type and name of the species more accurately, it should be followed by genetic identification. The method employed in this research was survey method and random sampling techniques to collected various sea cucumber species from the waters. The measurement was conducted on each sea cucumber species, including total length measured from the anterior to the posterior, color, shape, and body patterns. The result showed that the Phyllophorus sp. has a round shape with a body size ranging from 3 to 8 cm, black in color, and small brown spots covering its entire body. The Colochirus sp. has an elongated shape with a body length of 6 to 10 cm, displaying a distinct red and orange body color and a body pattern consisting of ridges with papillae along these ridges. The red sea cucumber also possesses tentacles. The Paracaudina australis has an elongated shape with a transparent white body, featuring white and pinkish-red line patterns. In addition, data of the demographics of sea cucumber fishermen including age, level of education, length of experience, and the purpose of using sea cucumbers, is also needed as a reference for future studies. Knowledge of the demographics of fishermen is also needed to find the suitable method if in the future we will conduct socialization, training, or community service.

Keywords: diversity, demographic, morphometric, phenotype, sea cucumber.

1 Introduction

Bangkalan Regency is one of the regencies located on Madura Island, East Java Province. Bangkalan Regency covers areas along the coastline, including districts such as Socah, Kamal, Modung, Kwayar, Arosbaya, and others. The waters of Socah are situated in the Socah District of Bangkalan. This area is home to various marine biota, including sea cucumbers. Coastal communities around the Socah Waters rely on sea cucumber catches to meet their daily needs. The catch is then sold or processed into food before being sold.

Sea cucumbers are slow-moving marine creatures that inhabit various types of seabeds, including sand, sandy mud, and coral reefs [1-2]. Sea cucumbers belong to the Phylum Echinodermata [3] and consist of various genera [4]. In coral reef ecosystems and related environments, sea cucumbers play a crucial role in the food chain at various trophic levels [5-6]. They serve as deposit feeders, meaning they consume particles found on the seabed, and also as suspension feeders, consuming floating particles in the water. In the Indo-Pacific region, in places where coral reefs are not heavily exploited, sea cucumber populations can reach more than 35 individuals per square meter, with each individual able to process up to 80 grams of dry sediment per day [7]. Sea cucumbers are abundant in the Socah Waters, and there are several types of sea cucumbers that can be found in these waters. Sea cucumbers are known as deposit feeders because they can convert materials from their environment into a food source [8]. In the ecosystem, they serve as a food source for marine predators in the surrounding area, including through the release of sea cucumber eggs and larvae. Sea cucumbers also utilize plankton, various organic materials, and detritus found in sediments [9].

* Corresponding author: rizka.putri@trunojoyo.ac.id
High-intensity exploitation without consideration for the type and size of sea cucumbers has led to a drastic decline in their natural populations. The loss of various sea cucumber species can result in the extinction of valuable natural genetic resources.

Sea cucumbers have important ecological and significant economic value in the fishing industry due to their high nutritional content and taste [10]. Commercially valuable sea cucumber varieties belong to the Holothuridae and Stichopodidae families. In addition to their nutritional richness, compounds found in sea cucumbers have the potential as antibiotic agents. Some countries like China, Hong Kong, South Korea, Singapore, and Japan have used specific sea cucumber extracts in traditional medicine. The sandfish sea cucumber (Holothuria scabra) has the potential to become a new source of biopharmaceuticals through the separation of active compounds or extraction. Research has shown that the compounds suspected to have antifungal properties in Holothuria scabra sea cucumbers are alkaloids, saponins, and triterpenes found in methanol extracts. Ethyl acetate extracts contain only saponins and triterpenes, resulting in lower antifungal activity compared to methanol extracts. Sea cucumber extracts from Holothuria scabra in Asia exhibit antimicrobial, antibacterial, and antifungal activities [11-12]. Sea cucumbers are known to have good nutritional value for the body. Sea cucumbers contain bioactive compounds that are used in the field of health. Indonesia is known as one of the main sea cucumber producers that meet the demands of various countries such as Europe, Japan, Singapore, Malaysia, and the United States.

Sea cucumbers tend to inhabit shallow waters, typically with depths of less than 20 meters. They prefer areas with natural protection, high nutrient content, and the ability to adapt to various types of habitats, including muddy, sandy, rocky, coral, seagrass, and areas with seaweed growth [13–15].

Phenotype refers to a visible, observable, or measurable attribute or characteristic. An organism's phenotype is determined by genetics and the environment [16–18]. Morphometrics pertain to characteristics related to the physical dimensions of an organism, such as total body length and the size of specific body parts. These measurements are essential indicators in the identification process and assist in taxonomic classification. Morphometric character measurements can provide a more comprehensive overview of the body shape of biota and yield a systematic geometric characterization of biota body shape, indicating an improvement in the ability to perform identification [19]. Morphometric characteristics are crucial to study in the field of biology [20] because they can be observed directly, are easy to measure without complicated equipment, and are relatively cost-effective compared to genotypic measurements [21]. Phenytype and morphometric data are useful for enriching information related to the phenotype and morphometrics of each species and can serve as a reference in relation to genetic conditions.

Research on sea cucumbers in the Socah Waters area includes morphological and morphometric identification then determining the name of the species is still very little. So far, only the types of sea cucumbers that can be consumed are known, even though there are some sea cucumbers that are not consumed by the community. In addition, knowledge of the demographics of sea cucumber fishermen also needs to be done. Basic information such as this needs to be done as a reference for future studies. Knowledge of the demographics of fishermen is also needed to find the right method if in the future we will conduct socialization, training, or community service, for example about sea cucumber management, fishing gear management, etc. Therefore, we conducted research on determining the type of sea cucumber species through morphological and morphometric identification, and also collected demographic data of sea cucumber fishermen.

2 Material and methods

2.1 Sample collection

The research on the phenotype and morphometric measurements of sea cucumbers from Socah Waters was conducted in August–October 2023. The method used in this research was a survey and qualitative descriptive method. The survey method involved gathering information through interviews with 20 fishermen. The qualitative descriptive method was carried out using random sampling techniques, where sea cucumbers were randomly collected from various locations in Socah Waters. Sea cucumbers were collected in a fresh and live condition, and then their morphometric and phenotypic characteristics were identified. Morphometric and phenotypic observations on sea cucumbers were conducted in the Laboratory of Marine Biology, University of Trunojoyo Madura.

2.2 Fishermen interviews

Demographic data collected on sea cucumber fishermen, including age, education level, length of experience, and purpose of sea cucumbers utilization was carried out by conducting interviews with 20 fishermen. The data were then recorded and processed.

2.3 Phenotype and morphometric observations

Phenotype refers to the characteristics possessed by an organism, which are a reflection of its genetic condition. Phenotype is data that can be seen, measured, and observed. Each species has its own unique characteristics, which distinguish it from other species within the same genus. In the observation of sea cucumber phenotypes, we examined in detail the characteristics possessed by sea cucumbers, including body shape, color, body patterns, skin surface texture, the size of papillae, tentacles, mouth, anus, and etc. Morphometric measurements of sea cucumbers were
conducted by measuring the total length of the sea cucumber's body from the anterior to the posterior using a ruler or meter. Body width of the sea cucumber, interpreted as the diameter of the sea cucumber's body, was measured using calipers or a ruler. The total weight of the sea cucumber was also measured by weighing the entire sea cucumber body without dissection.

2.4 Data analysis

All data obtained from interviews were processed using Excel. The phenotypic and morphometric data were then analyzed and described according to the actual conditions.

3 Results and discussion

3.1 General description of the research location

Bangkalan Regency is one of the regencies located in the westernmost part of Madura Island, East Java, Indonesia, with an area of 1,260.14 square kilometers. The regency is situated between 112° 40' 06" to 113° 08' 44" East Longitude and 6° 51' 39" to 7° 11' 39" South Latitude. Bangkalan Regency encompasses coastal areas, including the districts of Sepulu, Bangkalan, Kamal, Modung, Kwanyr, Arosbaya, Klampis, Tanjung Bumi, Labang, Burneh, and Socah, which served as the location of our research.

Furthermore, the waters located in the Socah District will be referred to as Socah Waters. Socah Waters have abundant resources with various marine biota that can be captured and utilized for daily needs. Shellfish, fishes, gastropods, sea cucumbers, and mangroves that grow along the socah coast can be found in Socah waters. Therefore, some residents of Socah Village work as fishermen. One of the many marine animals found in Socah Waters and caught by fishermen is the sea cucumber, commonly known as a sea cucumber.

3.2 Characteristics of fishermen

Based on the survey and interviews conducted with fishermen in Socah Village, there were 20 fishermen involved in sea cucumber harvesting. When the sea is relatively low, the fishermen work together to search for sea cucumbers using four boats. The age range of fishermen engaged in sea cucumber harvesting in Socah Village is 40-55 years. The educational background of the sea cucumber fishermen in Socah Village is predominantly elementary school graduates (60%), followed by junior high school graduates (30%), and high school graduates (10%). The characteristics of the fishermen in Socah Waters are presented in Table 1.

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>N</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Fisherman's age (years)</td>
<td>20</td>
<td>42.1</td>
</tr>
<tr>
<td>2.</td>
<td>Experience as a fisherman (years)</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>3.</td>
<td>Fisherman education (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Elementary School</td>
<td>12</td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td>- Junior High School</td>
<td>6</td>
<td>30%</td>
</tr>
<tr>
<td></td>
<td>- Senior High School</td>
<td>2</td>
<td>10%</td>
</tr>
<tr>
<td>4.</td>
<td>Purpose of sea cucumbers use (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Made crackers</td>
<td>10</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td>- Processed into dishes</td>
<td>4</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td>(urap-urap and stir-fried)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Sold raw</td>
<td>6</td>
<td>30%</td>
</tr>
</tbody>
</table>

The results of profiling fishermen who harvest sea cucumbers in Socah Village can help provide information about the backgrounds of the fishermen, enabling us to find appropriate methods to convey information or organize outreach to the fishermen. Additionally, in the future, there is a need for education in the field of fisheries and marine to enhance the welfare of the fishermen's group in Socah Village. Examples of activities, include the empowerment program for fishermen supported in the long term by establishing specialized fisheries vocational schools. This school is the result of collaboration and cooperation among relevant institutions. The presence of this school is expected to change the traditional mindset of the community [22].
3.3 Sea cucumber utilization

The sea cucumbers caught by the fishermen are processed into crackers and then sold in the city center of Bangkalan, Socah Village, and Kenjeran Surabaya. However, not all sea cucumber species are consumed by the community. People only consume sea cucumbers of the Phyllophorus sp. and Paracaudina australis, while the red sea cucumber of the Colochirus sp. is not consumed. If caught, red sea cucumbers are released back into the sea.

In addition to being processed into crackers, sea cucumbers are also prepared as “urap-urap” and stirred dishes. Urap-urap and stirred dishes are primarily sold in the vicinity of Socah Village. Both Phyllophorus sp. and Paracaudina australis are processed into crackers. The flesh of Paracaudina australis can also be prepared as “urap-urap” and stirred dishes, while the flesh of Phyllophorus sp. is not used for “urap-urap” and stirred dishes due to its tough texture. However, all parts of Phyllophorus sp., from the intestines to the eggs, can be utilized in cooking as soup additives. The residents of Socah Village often refer to Phyllophorus sp. sea cucumbers as “terung,” while Paracaudina australis is known as “blonyo.” Sea cucumbers are sold at relatively high prices, with larger sea cucumbers fetching around IDR 80,000 per kilogram, while smaller ones are priced between IDR 50,000 to IDR 70,000 per kilogram. Paracaudina australis sea cucumbers are sold for IDR 12,000 per kilogram in wet condition, IDR 200,000 per kilogram in dried condition, and at a higher price if they are large. Smaller Paracaudina australis sea cucumbers are sold at IDR 150,000 per kilogram.

Sea cucumbers are highly prized [23] and are extensively traded in both local [24] and global markets [25-26]. The cost of dried sea cucumbers varies from 400,000 to 6,000,000 IDR per kilogram, depending on factors such as the species, quantity, and the market in which they are sold (local or international). The cost of sea cucumbers fluctuates based on factors such as species [27], size [28], physical condition, moisture, and they are commonly available for purchase in a dehydrated form. Another reference stated that the elevated economic worth in the international market primarily results from the nutrient content and bioactive compounds found within the body of sea cucumbers [25].

3.4 Qualitative and quantitative characteristics of sea cucumbers

The first type of sea cucumber has a soft, slightly slimy, perfectly round body shape. The total length, or essentially the body diameter, is approximately 3-7 cm, with a body weight of about 110-198 grams. This sea cucumber species is black to off-white in color. The body of the sea cucumber has small spots (papillae) with a slightly rough skin texture. Tentacles are not visible on this sea cucumber. Both the mouth and anus of this sea cucumber are located at the two ends of the body. Based on the observations, it can be identified as the Phyllophorus sp. For a more accurate species identification, genetic research is needed [29-30]. Sea cucumbers Phyllophorus sp. have a total length or body diameter of approximately 3-7 cm with a body weight of about 110-198 grams.

Phyllophorus sp. is often found in a round shape, with its body sometimes inflating into white spherical balls. It also has small, evenly distributed filaments throughout its body. Like other sea cucumbers, Phyllophorus sp. will eject its gut contents if it feels threatened or stressed [1].

Moreover, this sea cucumber has an elongated shape with a slightly pointed end. It is transparent white in color, with a smooth and sleek skin texture. The body of the sea cucumber has five white lines running along it. Papillae are not found on this sea cucumber, and long tentacles are not visible at the end of its body. This sea cucumber is identified as Paracaudina australis, based on its characteristics. Paracaudina australis has total length of 7-10 cm with a body weight of 99-178 grams.

The last, this sea cucumber has an elongated shape with long tentacles near its mouth. It is red and orange in color with long orange papillae running along its body. The skin texture is slightly rough. This sea cucumber is identified as Colochirus sp. This type of sea cucumbers has total length of 5-9 cm with a body weight of 75-159 grams.

The weight of sea cucumbers can be increased by implementing good management of sea cucumbers. The changes in sea cucumber weights in the Aegean Sea region between 2008 and 2015. The mean weights of different species increased by 46% during this period, attributed to the region's closure to sea cucumber fisheries from 2012 to 2015. The study suggests that ongoing management practices, including rotational fallowing and a fishing ban during reproduction, contribute to maintaining a sustainable stock. However, it emphasizes the importance of continuous monitoring for effective fisheries management [31].

4 Conclusion

The three types of sea cucumbers originating from Socah Waters have various body shapes, ranging from round to elongated, with colors including red, transparent white, and off-white. Papillae on the sea cucumbers can be either small spots or long papillae. Some sea cucumbers have long tentacles, while others do not exhibit tentacles on their bodies. The three species are identified as Phyllophorus sp., Paracaudina australis, and Colochirus sp. To determine the type of species accurately and more validly, genetic identification is needed, such as DNA Barcoding. Not all three species of sea cucumbers collected from Socah Waters, Bangkalan, are consumed by the local community. Only Phyllophorus sp. and Paracaudina australis are consumed, while Colochirus sp. is not consumed. Furthermore, the data revealed that the sea cucumber fishermen in the area have an average age of 42.1 years, with the majority having completed elementary school education (60%). Most fishermen
utilize sea cucumbers for making crackers (50%), while the rest are used for making dishes like "urap-urap" (stir-fried) (20%) and are sold raw to collectors (30%). The results of profiling fishermen who harvest sea cucumbers in Socah Village can help provide information about the backgrounds of the fishermen, enabling us to find appropriate methods to convey information or organize outreach to the fishermen.

We thank all laboratory members who helped this research process. This work was supported by Independent Research Grant from University of Trunojoyo Madura.

References


