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Keragaman dan Kelimpahan Teripang di Perairan Batam, Kepulauan Riau

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Abstrak

Eksploitasi teripang di Indonesia dilaporkan meningkat pesat hingga 66% selama dua dekade terakhir. Angka ini dianggap sebagai batas maksimum untuk eksploitasi yang berkelanjutan. Perairan Batam, Kepulauan Riau dikenal sebagai salah satu penghasil teripang. Namun, belum ada laporan status terkini terkait keragaman jenis dan kelimpahan teripang di Kawasan Pulau Batam. Penelitian ini bertujuan untuk mengetahui keanekaragaman jenis, dan kelimpahan teripang yang ditemukan di kawasan Pulau Abang, Ngenang, dan Temoyong, Kepulauan Riau. Pengambilan sampel dilakukan secara kuantitatif dengan menggunakan metode transek kuadrat di tiga lokasi. Sebanyak tiga garis transek ditempatkan di setiap stasiun, ditarik tegak lurus dari garis pantai ke arah laut dengan panjang 50 m. Jarak antara setiap garis transek adalah 50 m dan pada setiap garis transek dibuat plot berukuran 5x5 m. Hasil penelitian menunjukkan bahwa terdapat enam jenis teripang yang ditemui pada lokasi penelitian yaitu *Stichopus nactivagus, Stichopus hermanni, Stichopus monotuberculatus, Holothuria scabra, Holothuria impatiens, dan Holothuria leucospila*. Keanekaragaman jenis di ketiga lokasi berada pada rentang 0,214- 0,314. Kelimpahan jenis teripang di Pulau Abang, Ngenang, dan Temoyong pada rentang 0.073 – 0,1 individu/m2. Rendahnya keragaman dan kelimpahan mengindikasikan tingginya tekanan lingkungan terhadap populasi teripang di kawasan perairan Batam, Kepulauan Riau.

Kata kunci : teripang, *Holothuria sp, Stichopus sp*

Abstract

The Diversity and Abundance of Sea Cucumbers in the Batam Waters, Riau Islands

The exploitation of sea cucumbers in Indonesia has reportedly increased by 66% in the last two decades. This figure is considered the upper limit for sustainable exploitation. The waters of Batam, Riau Islands, are known as one of sea cucumber producers. However, no current status report exists on Batam Island's diversity and abundance of sea cucumbers. This study aimed to determine the diversity of species and the abundance of sea cucumbers found in Abang, Ngenang, Temoyong Island, and Riau Island. Sampling was carried out quantitatively by applying the quadratic transect method at the three locations. About three transect lines were placed at each station, drawn perpendicular from the coastline towards the sea with a length of 50 m. The distance between each transect line was 50 m, and a 5x5 m plot was placed on each. The results showed that there were six types of sea cucumbers, namely Stichopus nactivagus, Stichopus hermanni, Stichopus monotuberculatus, Holothuria scabra, Holothuria impatiens, and Holothuria leucospila. The species diversity in three locations ranged from 0.214 to 0.314. The abundance of species on Abang, Ngenang, and Temoyong Islands was in the range of 0.073 to 0.1 individual/m2, respectively. The low diversity and abundance indicate high environmental pressure on Batam, Riau Islands sea cucumber populations.

Keyword : *trepang, Holothuria sp, Stichopus sp*

INTRODUCTION

Batam is the largest city located in the Riau Archipelago Province. It consists of several big islands, namely Batam, Rempang, and Galang, as well as other small islands in the Singapore and Malacca Strait. Some of these small islands include Abang Island in the south, Temoyong Island in the southwest, and Ngenang Island in the north. As an archipelago, Batam waters are rich in marine biodiversity, including sea cucumbers.

Sea cucumbers are one of the most significant marine invertebrate resources, providing livelihoods and income for many coastal communities throughout the Indo-Pacific region (Asha and Muthiah, 2008), including

in the waters of Batam and its surroundings. In general, sea cucumbers are mainly collected for export as a dried product known as beached-mer, a delicacy in most Asian countries. High demand and increasing market value drive intensive exploitation of this resource (Purcell *et al*., 2013).

Sea cucumbers are scattered throughout the sea, from West to East, and from shallow areas to the deep sea. The distribution also cuts across the sea, such as coral habitats, seagrass beds, rocky, sandy-muddy habitats, and sandy plains (Setyastuti *et al*., 2019; Wirawati *et al*., 2021).

The characteristic properties include an elongated shape with a soft body. At one end of the body, sea cucumbers have organs mostly elongated and flexible (tentacles) around the mouth, which serve to catch prey. Movement is usually performed by pseudo-feet to form a tube (podia) on the side of the abdomen (ventral). Most species are suspension or deposit feeders, feeding majorly on sediment and organic matter, which is then excreted (Atkinson and Sink, 2018).

Sea cucumbers are benthic invertebrates that feed on marine sediments, such as microorganisms, dirt, and detritus, leading to a recycling role in coastal marine ecosystems (Kalthoumi *et al*., 2023). Furthermore, sea cucumbers live in shallow waters, usually less than 20 m, in protected areas with high nutrient content and can adapt to various habitats, including muddy, sandy, rocky, coral, seagrass beds, and algae growth areas. At low tide, this species comes out in a half-submerged position (Manuputty and Noya, 2019).

Apart from the ecological function, sea cucumbers are also used for consumption and medicine. Around 56 species have been consumed in Indonesia and traded in dried or frozen form. Based on data from the Indonesian Institute of Sciences (LIPI), all belong to the Aspidochirotida (Holothuroidea) order. In addition, sea cucumbers have been used as medicine for a long time. Traditional medicine is a tonic food that treats damage to the kidney, reproductive organs, and digestive tract (Setyastuti *et al*., 2019).

Several previous studies also showed that sea cucumbers in Indonesia, such as *Stichopus, T. ananas, T. canax, H. fuscogilva, H. leucospilota, H. atra, H. scabra*, and *A.mauritiana* are edible species, have medical effects, and low toxicity (Pangestuti and Arifin, 2018). Other benefits include being a source of animal protein that reaches 43% of dry weight and being classified as having high nutritional value (Elfidasari *et al*., 2012). Approximately 80% of the collagen contained in sea cucumbers has the ability to regenerate cells for healing ulcers (Pangestuti and Arifin, 2018) as a wound and anti-inflammatory agent (Gianto, Suhandana and Putri, 2018). The secondary metabolites also reportedly have the ability to reduce free radicals and prevent various degenerative diseases (Avigail, Yudiati and Pringgenies, 2019).

The several benefits of sea cucumbers have led to increased market demand, specifically in the pharmaceutical world. This activity directly reduces the diversity of species in coastal waters. This fishery commodity is also not managed well due to very limited local policies, raising concerns over sustainability (Brown EO, Perez ML, Garces LR, Ragaza RJ, 2010). Currently, not only economically valuable species are caught, but also cheap species, which were not initially a concern. This underscores the need for conservation efforts to reduce excessive fishing.

Studies on the community and abundance of sea cucumbers mainly focus on eastern Indonesia (Papua, Maluku, and Makassar) and Java (Karimunjawa, Jepara, and Seribu Island). Meanwhile, studies carried out in the last five years in the western Indonesian region are limited. Several studies related to the ecological status of sea cucumbers in this area were reported by (Armi *et al*., 2022) and (Marni, Febriannti and Susiana, 2020) for Pesisir Laut waters, Aceh, and Bintan waters, Riau Island provinces, respectively. The types, abundance, and diversity of sea cucumbers in Batam waters have never been reported. Therefore, this study aimed to discover the conditions that allow sea cucumbers to live in the Batam waters, represented by three locations: Abang, Temoyong, and Ngenang Island. The results will provide the baseline data regarding the current status of sea cucumbers in the intertidal zone of Batam waters, including types, species diversity, and abundance. It also can be used as a basis for information on water management and the potential of sea cucumbers in the pharmaceutical industry.

METHOD

Location and time of study

This study was carried out in August 2023. The locations were randomly selected in the intertidal waters of Abang (0o31’2.37” N; 104o15’4.68” E), Ngenang (0o58’59.28” N; 104o12’9.76” E), and Temoyong Island (0o53’53.30” N; 104o0’13.24” E), Batam City. The sampling location is shown in Figure 1.

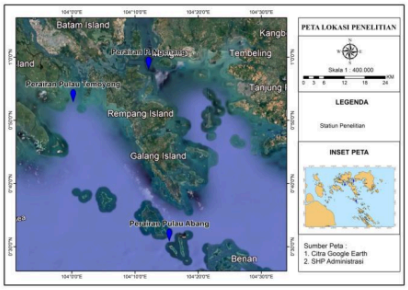

Figure 1. Sampling location of sea cucumbers in the Abang, Ngenang, and Temoyong Islands, Indonesia

Data collection

This study was carried out quantitatively by applying the quadratic transect method at predetermined locations. Three transect lines were placed, each drawn perpendicularly from the coastline towards the sea with a length of 50 meters. The distance between each transect line was 50 meters, and on each, a plot measuring 5 x 5 meters was placed. Observations were made at the lowest low tide or before low tide. In each transect plot (plot), a census of individual sea cucumbers was carried out and then collected. One individual representing each species was taken, preserved in 70% formalin, and then sent to the laboratory for identification. The water condition data collected directly (in situ) from the field includes physico-chemical parameters, namely water temperature, salinity, degree of acidity (pH), and dissolved oxygen (DO).

Data analysis

Morphological observations were carried out traditionally. According to Kalthoumi et al. (2023), the traditional method was performed by analyzing size, color, and shape. Determination of the type was carried out with the guidance of the General Guideline for Identification of Sea Cucumber Populations, Directorate of Conservation and Marine Biodiversity, Directorate General of Marine Spatial Management, Ministry of Maritime Affairs and Fisheries of the Republic of Indonesia (Sadili *et al*., 2015).

The abundance of species was calculated using the Odum formula (Ulum, Widianingsih and Hartati, 2012):

$$D_i = \frac{n_i}{A}$$

Information:
D_i = species abundance
n_i = total number ofindividual of type i
A = total area of sampling area

The level of diversity at each station was determined using the Shannon-Wiener diversity index formula (Ristina, Sulardiono and Solichin, 2018) with the equation:

$$H' = -\sum_{ni=1}^{s} P_i \, lnP_i$$

Information:
H' = Shannon-Wienner diversity index
Pi = ni/N (Proportion of type – i)
ni = total number of individuals of type i
N = total number of individuals of all types

The criteria for the level of species diversity are as follows (Ristina, Sulardiono and Solichin, 2018; Ramses *et al*., 2020):

i. H' > 3.0, shows very high diversity
ii. ≤ H' ≤ 3.0, shows moderate diversity
iii. H'< 1.0 shows low diversity

RESULT AND DISCUSSION

Types and Morphology of Sea Cucumbers

Six species were obtained from two different genera, and the collected samples are shown in Table 1. These species include *Stichopus nactivagus*, locally known as gamat, *Stichopus hermanni* (gamat batu), *Stichopus monotuberculatus* (mentonan), *Holothuria scabra* (nabi-nabi), *Holothuria impatiens* (kulong), and *Holothuria leucospila* (butoh keling). Purcell et al. (2012) stated that from a morphological point of view, comprising the color and shape of bodies, *Holothuria* species are almost similar and vary according to the environment. Visible differences are evident directly from the shape, color pattern, and cross-sectional weight.

Table 1. Six species of sea cucumbers were found at sampling locations

Samples	Latin name	Local name	Number of samples found		
			Abang island	Ngenang island	Temoyong island
	*Stichopus nactivagus*	Gamat	-	15	16
	*Stichopus hermanni*	Gamat batu	3	-	-
	*Stichopus monotuberculatus*	Mentonan	-	1	1
	*Holothuria scabra*	Nabi-nabi	-	3	7
	*Holothuria leucospilota*	Butoh keling	27	1	4
	*Holothuria impatiens*	Kulong	-	1	-

S. noctivagus, also known as gamat has a body shape resembling a rectangle, hard, stiff, and flat on the stomach. Woo et al. (2015) reported that the body is rectangular in cross-section with four distinct sides, smooth, firm, and hard, showing a thick integument. It is dark blue underwater and almost black outside. Large, long papillae on the dorsolateral edge extends from the tentacle collar towards the anus in two rows. There are similar papillae on the ventrolateral edge but in one row. The tip to the base of the papilla is yellow to ocher. Tube feet and small inter ambulacra are present, while the central ambulacrum is wider than the others. On the ventral

side of the mouth, there are 20 peltate tentacles and an anus. Spicules are present with dorsal body walls with tables, C-shaped, and S-shaped rods.

S.hermanni is locally known as gamat batu. The color of the body ranges from light mustard-yellow to orangey-brown, brown, or olive green. Furthermore, the color is lighter ventrally, with numerous dark brown to black dots spread across the body. Two double rows of bigger wart-like papillae are flanked by fine dark rings. Podia are abundant ventrally. The body is a bit elongated and squarish in cross-section. The ventral mouth has 8-16 thick green tentacles, while the anus is a terminal condition in which there are no teeth or surrounding papillae (Purcell, Samyn and Conand, 2012). According to Woo et al. (2015), *S. herrmanni* papillae are significantly smaller and less prominent than *S. monotuberculatus*. The size and number of rosette spicules in *S. herrmanni* varied greatly. It can be distinguished from other congeners by the presence of pseudo-tables in the dorsal body.

H. scabra, locally known as nabi-nabi, has a long round body cross-section. The ventral side tends to be flat, and the anus hole is round. The body color is greenish-white. Murphy et al. (2010) state that the shape is elongated and cylindrical along the oral–aboral axis. The mouth and anus location are opposite at the ends of the axis. Specifically, the mouth is anterior, while the anus is posterior. Around the mouth, some tentacles can be extended and retracted quickly. Tentacles are modified tube feet that function to capture food. Some studies reported that sand sea cucumbers have a maximum length of 40 cm and weigh about 1500-2000 grams (Manuputty, 2019). Furthermore, *H. scabra* is found in areas with coarse sand substrate; the body is often covered with fine sand. This species is the most common black sea cucumber in Indonesian intertidal waters (Setyastuti, 2016).

H. leucospilota, locally known as butoh keling is usually found in sandy areas of coral reefs. This species is tolerant to long periods of air exposure and may be found in areas closest to the coast. Harith et al. (2018) stated that morphologically, *H. leucospilota* has a uniform black body color. It has a soft body and is equipped with smooth protrusions. This species has shield-shaped tentacles. *H. impatiens* (kulong) has a round body cross-section, the ventral side tends to be flat, and the anus is round. The body is greyish brown in color, soft, and thin. The types of spicules found on the dorsal side are table and button, according to (Kalthoumi *et al*., 2023). Furthermore, H. impatiens has dark transverse stripes with varying brown colors. Small samples may reach 5.7 cm in length, with a cylindrical vermiform body shape, thin integument, soft body wall, and white to yellowish papillae.

Species Diversity

The diversity index of sea cucumbers found in three sampling locations is shown in Table 2. Overall, the diversity index of sea cucumbers at all locations is in the low category with a value of (H') < 1. This result is similar to those of (Marni, Febriannti and Susiana, 2020) and (Suryaningsih, Putra Dirgayusa and Giri Putra, 2020)for Tanjung Keramat and Tanjung Benoa waters with diversity index ranges of 0.500 - 0.550 and 0.140 - 0.370, respectively. Furthermore, these three locations have lower values compared to West Simeulue water, as reported by (Armi *et al*., 2022), with a diversity index range of 1.890 – 2.023.

Table 2. Diversity index of sea cucumbers

No	Sampling location	H'	Criteria
1	Abang island	0.263	Low diversity
2	Ngenang island	0.214	Low diversity
3	Temoyong island	0.314	Low diversity

The diversity index can be impacted by various factors, including the number of species collected, the presence of many species found in abundance, substrate homogeneity, and ecological conditions (Sukmiwati *et al*., 2012). The low value of the diversity index at all sampling locations may be related to the condition of waters that connect directly to the open sea. Therefore, waters are directly associated with coral reefs and have a coarse sand substrate due to the presence of several dead coral fragments. As stated by Ramses et al. (2020), low diversity can also show extreme environmental pressure from various sources, including pollutants.

Species abundance of sea cucumbers

Abundance describes the number of species per unit area of observation. Table 3 shows the abundance of sea cucumbers found at each location in Abang, Ngenang, and Temoyong Island waters. Based on Table 3,

abundance of sea cucumbers ranges from 0.003 ind/m^2 to 0.09 ind/m^2. The highest abundance was found on Abang Island, namely H. leucospilota, at 0.09 ind/m^2. This species was found in a seagrass zone with a muddy sand substrate and fertile corals. Purcell et al. (2012) stated that the suitable habitat for H. leucospila is rich seagrass beds, muddy sand substrate with coral debris, and rock crevices with algae suitable habitat for this species. The abundance of this species on Abang Island can be related to its low economic value. Cañada et al. (2020) state that this condition may have prevented the species from fishing pressure, thereby allowing breeding in the area.

Table 3. Species abundance of sea cucumbers

Species	Species abundance (individuals/m^2)		
	Abang island	Ngenang island	Temoyong island
S. noctivagus	0	0.050	0.053
S. hermanni	0.010	0.000	0.000
S. monotuberculatus	0	0.010	0.023
H. scabra	0	0.003	0.003
H. leucospilota	0.090	0.007	0.013
H. impatiens	0	0.003	0.000

The second highest abundance was S. noctivagus, with 0.050 ind/m^2 on Ngenang Island and 0.053 ind/m^2 on Temoyong Island. This species has been used in a traditional medicinal ointment product known locally as 'Gamat Oil'. Furthermore, the species with the lowest abundance were H. scabra and H. impatiens. As stated by Darsono, both types have low abundances due to the relatively high price and inclusion in the main category (Silaban, Rahajaan and Ohoibor, 2022). Considering this species is caught widely, only a few were found at the sampling location. The abundance of sea cucumbers in the Batam Sea varied from 30-900 ind/ha. This figure is higher than Tanjung Keramat, Bintan waters, which range from 4-46 ind/ha (Marni, Febriannti and Susiana, 2020); Ambon, Maluku waters, at 10-55 ind/ha (Luhulima, Zamani and Bengen, 2020); and Tanjung Benoa, Bali waters, at 34-104 ind/ha (Suryaningsih, Putra Dirgayusa and Giri Putra, 2020).

Physicochemical parameters of water

Water quality affects survival and can be a limiting factor in the distribution of marine biota (Hamuna *et al*., 2018; Tanjung, Hamuna and Alianto, 2019). The physicochemical parameters of water measured in this study included DO, temperature, salinity, and pH. The data is shown in Table 4.

Table 4. Physicochemical parameters of water in the sampling locations

Location	Temperature (°C)	Salinity (‰)	pH	DO (mg/l)
Abang Island	31.57±0.12	29.33±1.15	8.01±0.60	6.20±0.22
Ngenang Island	31.47±0.12	30.00±0.00	6.30±0.00	7.00±3.36
Temoyong Island	31.40±0.36	31.00±1.00	7.29±0.20	7.40±0.28

*The measurement was performed in triplicate

Water temperature is a very important factor in the life of marine organisms. The temperature at all locations was the same, namely 31°C, which is the appropriate value for sea cucumbers (Mazlan and Hashim, 2015). According to (Sulardiono, Purnomo and Haeruddin, 2017), the water temperature for sea cucumber life ranges from 26°C-33°C. The Minister of Environment Decree No. 51, 2004 also states that the optimal temperature for marine life is in the range of 28-32°C. Elfidasari et al. (2012) stated that sea cucumbers can survive at temperatures of 25-35°C. Higher temperatures will cause the body to be inactive even though the tentacles can still move.

Salinity is an important factor hindering the spread of sea cucumbers. Most species live in the normal seawater salinity range of 30–34‰, but some may survive up to 37‰ (Elfidasari *et al*., 2012; Sadili *et al*., 2015). Salinity is the concentration of all salt solutions obtained in seawater and affects osmotic pressure. Low salinity levels will cause cell lysis leading to death (Elfidasari *et al*., 2012). Abang, Ngenang, and Temoyong Island

salinity was 29.33‰, 30‰, and 31‰, respectively. Based on the results, the salinity is ideal for sea cucumbers to survive and grow optimally. (Armi *et al*., 2022) stated that the ideal habitat for sea cucumbers is seawater with a 29-33% salinity.

The degree of acidity is an indicator that determines the quality of water. It plays an essential role in the lives of aquatic organisms. Water quality is considered good when the pH is > 7. Meanwhile, the pH value is influenced by biological activity, photosynthesis, temperature, and oxygen content. Changes in pH values may cause alteration in the balance of carbon dioxide, bicarbonate, and carbonate content in water. The water pH at Abang, Ngenang, and Temoyong Island was 8.01, 6.30, and 7.29, respectively. The suitable pH for sea cucumbers ranges from 6.5 to 8.4 (Sulardiono, Purnomo and Haeruddin, 2017).

DO in water determines the level of water quality. The presence of oxygen in water is required by living beings or marine biota for respiration and oxidation activities. Moreover, the presence of oxygen in marine waters functions as an oxidant for chemical compounds. The highest oxygen content originates from free air and phytoplankton or green plants containing chlorophyll (Sukmiwati *et al*., 2012). The DO values at the study location were 6.20, 7.0, and 7.40 for Abang, Ngenang, and Temoyong Island, respectively. These values are in the optimum range for the life of sea cucumbers (4-8 ppm), as stated by Elfidasari et al. (2012). According to (Sulardiono, Purnomo and Haeruddin, 2017), the tolerant DO levels for sea cucumber growth range from 4 to 9 ppm. This implies that DO in waters is available in sufficient quantities for the respiration and metabolism of sea cucumbers. Furthermore, the Minister of Environment No. 51 Decree of 2004 states that the optimum range of DO for sea biotas ranges from 5.30-7.67 mg/l. The physicochemical parameters showed that the quality of waters on Abang, Ngenang, and Temoyong Island in Batam City was in good condition for the growth and development of sea cucumbers.

CONCLUSION

Six sea cucumbers were found in three water locations: Abang, Ngenang, and Temoyong Islands. These include *S. noctivagus* (gamat), *S. hermanni* (gamat batu), *S. monotuberculatus* (mentonan), *H. scabra* (nabi-nabi), *H. impatiens* (kulong), and *H. leucospilota* (butoh keling), which belongs to the class Holothuroidea. The species diversity in three locations ranged from 0.214 to 0.314. Based on the results, *H. leucospilota* had the largest abundance on Abang Island, with 0.090 ind/m^2, followed by *S. noctivagus* with 0.050 ind/m^2. Overall, the diversity and abundance of sea cucumbers at the study locations were relatively low, which can be related to the extremely environmental pressure on Batam waters.

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