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Diversity of Sea Urchins on the Samboang Beach, Bulukumba District

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Abstract

The aim of this research is to determine the diversity of sea urchins found in the waters of Samboang Beach, Bulukumba Regency. This research method uses a line transect method with a size of 1 m x 1 m. The data obtained was then identified, then analyzed using the diversity index (H'), evenness index (C) and dominance index (D). The results show that the number of sea urchin species found on Samboang Beach, Bulukumba Regency is 4 species consisting of Echinometra oblonga, Echinometra mathaei, Echinometra viridis, and Diadema setosum. The sea urchin diversity category is classified as medium, namely 1.25. The dominance index is relatively low, namely 0.31, and the evenness index is relatively stable, namely 0.903..

Keywords: Diversity, Dominance, Evenness, Sea urchins

INTRODUCTION

Indonesia is an archipelagic country that has the longest coastline in the world (61,000 km) and also has a very large sea area where there are three types of water areas based on international maritime law conventions, namely territorial sea waters, exclusive economic zone (EEZ) and continental shelf; This illustrates that the coastal areas in Indonesia are very extensive (Hidayat, 2020). Coastal areas consist of several ecosystems with different ecosystem composition. Ecosystems that we can find in coastal areas include mangrove ecosystems, seagrass ecosystems and coral reef ecosystems. Each ecosystem consists of different components which make the coast have a high level of diversity. Climate diversity, soil type,

Indonesia is known as a region that has high biodiversity. Apart from that, the ecosystem and marine resources in coastal areas are known to be very productive. One natural resource that has economic potential and is quite productive is sea urchins (Nane, 2019).Seagrass ecosystems and coral reef ecosystems are home to various types of biota that are a source of life, one of which is sea urchins. Sea urchins are associated with coral animals that make up coral and seagrass beds by using them as homes, foraging places and even as a food source. Apart from that, the presence of sea urchins in an ecosystem cannot be separated from the influence of environmental physical and chemical factors, even though they do not have a direct effect (Nane, 2020).

Sea urchins belong to the class Echinoidea, playing a significant role in the marine ecosystem. They serve as important bioindicators, capable of monitoring changes in marine environments due to their high sensitivity to environmental shifts. Beyond their ecological significance, sea urchins hold economic value. They can be used for various purposes, including as fertilizer, medicine, and as a source of decorative materials (Rumahlatu, 2012). Furthermore, sea urchins, particularly their

gonads, are sought after internationally due to their relatively high market value. These gonads have long been used in culinary dishes by communities, with Diadema setosum being a notable example. Additionally, sea urchins are utilized as materials for environmental toxicology tests (Toha, 2019).

Sea urchins are a group of invertebrate animals characterized by their hard and sturdy shells and round spines. They belong to the phylum Echinodermata, which is further divided into five classes: Echinoidea (sea urchins), Crinoidea (sea lilies), Asteroidea (starfish), Ophiuroidea (brittle stars), and Holothuroidea (sea cucumbers). The Echinodermata group uses coral reefs as a place to live/protect from predators. Echinoderms themselves have relationships with other creatures, especially in the food chain because most sea urchins usually eat annoying predators (Schories & Kholberg, 2016).

According to (Prasetyo et al., 2019), sea urchins typically inhabit areas such as coral reefs, seagrass beds, and sandy substrates. Sea urchins live in colonies which function to defend themselves. Sea urchins that live solitary lives are more vulnerable to predator threats. Sea urchins have physical defenses (spines) to survive and protect themselves from predators. Sea urchins are generally nocturnal animals or active at night, all day long they hide in coral crevices and come out at night to look for food.

The presence of sea urchins in marine ecosystems affects the ecological balance. The balance of sea urchin populations will maintain the balance of algae and coral populations. Meanwhile, the mass death of sea urchins has an impact on drastically reducing coral cover, causing corals to be dominated by algae. Apart from that, sea urchins are well known among experts because these organisms are often used to study reproductive biology, embryology, toxicology, gene regulation and evolutionary biology (Tupan & Br Silaban, 2017).

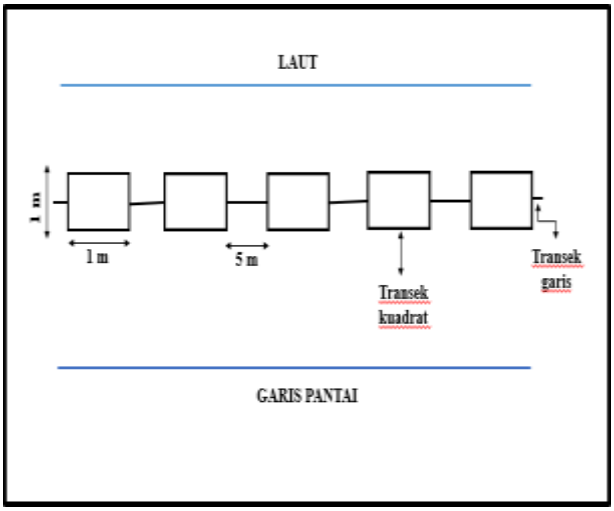
The beach is an area that is the boundary between sea and land. The beach has a diversity of marine life, one of which is sea urchins. Sea urchins are distributed from shallow intertidal areas to the deep sea. The waters of Samboang beach, located in Bulukumba Regency, are rich in marine biota and coral reefs. One type of marine biota that is often found on Samboang Beach is the type of echinoderm, namely sea urchins.

The beach in Bulukumba Regency serves as a popular tourist attraction. However, the diverse activities of tourists have led to disturbances in the aquatic ecosystem, affecting various organisms, including sea urchins, which play a crucial role in maintaining the ecosystem's balance. Consequently, research was conducted to assess the diversity of sea urchins in the area.

Research on sea urchins in the coastal waters of Bulukumba Regency is still limited, with a lack of data regarding the types of sea urchins present in the region. Therefore, there is a need for comprehensive research on sea urchin diversity along the beaches of Bulukumba Regency.

RESEARCH METHODS

This research was carried out from february to march. Sampling was carried out in the coastal waters of Bulukumba Regency, namely Samboang Beach. The method used is the line transect method. Transect lines are drawn parallel to the coastline for 100 m. Quadrat transects measuring 1 m x 1 m were installed at predetermined sampling points on each transect line. On the transect line, 20 sampling points were made with a distance of 5 m between each point.



(a) (b)

Figure 1. (a) Samboang Beach, (b) Observation Transect

Data obtained from observations of sea urchin species were then analyzed qualitatively and quantitatively. Qualitative data analysis includes descriptive analysis of Sea urchin species in the coastal waters of Bulukumba Regency. Quantitative analysis includes the sea urchin species dominance index, diversity index and evenness index using the respective formulas as follows:

Dominance Index

Dominance index value (D) calculated using the formula Simpson of Odum (1996) as cited in Fachrul (2012).

$$D = \sum \left(\frac{ni}{N}\right)$$

Note:
D = Dominance Index
ni = Number of Individuals of Each Species
N = Total Number of Individuals

Diversity Index

Species diversity index *Echinoidea is calculated using the formula* Odum's (1993) Shannon-Wiener species diversity index.

$$H' = -\sum \left(\frac{ni}{N}\right) ln \left(\frac{ni}{N}\right)$$

$$= -\sum Pi \; ln \; ln \; Pi$$

Note:
H' = Species Diversity Index
ni = Number of Individuals of each Species
Pi= Proportion of the i-th Species

ln= Natural Logarithm
$\sum$ Amount=
N = Total Number of Individuals

Evenness Index

The evenness index value is calculated using the formula from Pielou (1966) listed in Odum (1993).

$$E = \frac{H'}{ln\ S}$$

Note:
E = Evenness Index
H' = Diversity Index
ln S = Number of Species

RESULTS AND DISCUSSION

This research was conducted at Samboang Beach, Bulukumba Regency from February to March 2023 using the line transect method. Each quadrat transect has a different number of individuals with a total of 30 individuals observed. The number of sea urchins found, both in terms of individuals and species diversity, was relatively low. This can be attributed to the relatively poor percentage of live coral cover in the waters of Samboang Beach. Most sea urchins live on hard substrates, namely rocks or coral reefs and only a small portion inhabit sand and mud substrates, as it is challenging for their tube feet to find suitable attachment points.

The data collected on sea urchins were then identified and classified by referring to the e-book 'Field Guide to Identification of Coral Fish and Marine Invertebrates' by Setiawan (2010) and scientific journals using morphological characteristics. Subsequently, the research data were analyzed using diversity index (H'), evenness index (C), and dominance index (D).

Table 1. Classification of sea urchins on Samboang Beach

Order	Family	Genus	Species
Echinoids	Echinometridae	Echinometra	*Echinometra oblonga* *Echinometra mathaei* *Echinometra viridis*
Diadematoid	Diadematidae	Diadem	*Diadema setosum*

Table 2. Types of sea urchins found

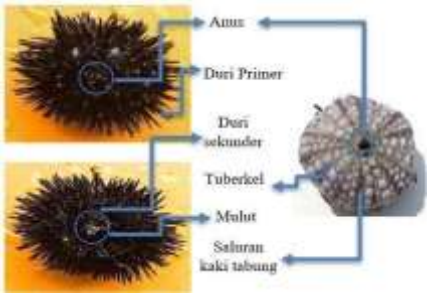
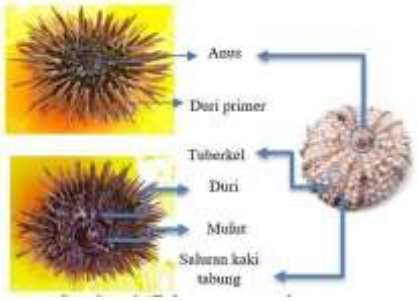
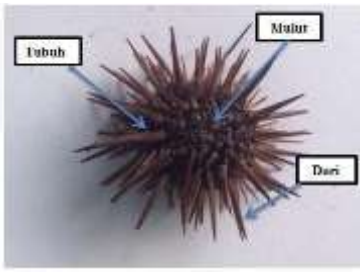
Observation Image	Comparative Image
 *Diadema setosum*	 (Suryanti, 2020)
 *Echinometra oblonga*	 (Suryanti, 2020)
 *Echinometra mathaei*	 (Suryanti, 2020)
 *Echinometra viridis*	 (Alwi, 2020)

Table 3. Values of diversity index (H'), evenness index (E) and dominance index (D)

No	Species	H'	E	D
1	*Echinometra oblonga*	-0.29863	0.903452476	0.027777778
2	*Echinometra mathaei*	-0.36237		0.187777778
3	*Echinometra viridis*	-0.23026		0.01
4	*Diadema setosum*	-0.36119		0.09
Amount		1.252451		0.315555556

The overall diversity index at the research location is in the medium diversity category. The diversity index calculation aims to measure the level of order of a system. The diversity index will have a large value if all individuals obtained come from different species, whereas it will have a small value if the individuals tend to come from the same (Latuconsina, 2019).

Based on the number of individuals of each species found at the research location, it can be seen that the species found were diverse. The diversity of sea urchin species found in this research area reflects their adaptability and ability to survive in distinct ecological niches. As Apriani , (2017) suggests, the presence of high or low numbers of sea urchin species indicates varying levels of adaptability among them. Furthermore, the research location encompassess four different substrates, namely seagrass, coral, muddy sand, and sand. Apart from that, it is known that there are 4 substrates at the research location, namely seagrass substrate, coral substrate, muddy sand substrate, and sand substrate. According to Yudasmara, (2013), the diversity of coastal topographic zones such as sand zones, coral reef zones, reef edge and slope zones, seagrass and seaweed growth zones, will also influence the diversity of sea urchins found. The more types of substrate, the more variety of sea urchins that can be found.

Sea urchins in areas of coral, seagrass and sand generally live in colonies which function to defend themselves. Sea urchins that live solitarily are more vulnerable to predator threats. Sea urchins have physical defenses (spines) to survive and protect themselves from predators. Sea urchins are generally nocturnal animals or active at night, all day long they hide in coral crevices and come out at night to look for food (Prasetyo, 2019).

There are three species of sea urchins from the Order Echinoidea, namely Echinometra oblonga, *Echinometra mathaei*, and *Echinometra viridis* from the Echinometridae family. These three species have habitats that are suitable for the Samboang beach substrate type which is dominated by rocks and coral. The *Echinometra oblonga* species can be found in coral crevices. This is done so that it can survive extreme conditions such as changes in temperature, salinity and exposure to waves. The morphological characteristics of the *Echinometra oblonga* species are thick, blunt and not too long spines, and have brownish black spines. The *Echinometra mathaei* species is the most commonly found type of sea urchin. The characteristics of the *Echinometra mathaei* species are that the body is round, the spines are not too long, can be found in coral crevices which aim to protect themselves from the tides of sea water. The *Echinometra viridis* species can be found in crevices under coral rocks. It has brown, slightly red spines, thick and not too long.

There is only one species of sea urchin from the Order Diadematoida, namely *Diadema setosum*. The characteristics of *Diadema setosum* are that it has long spines which function as self-defense, short spines on the bottom which function as a means of movement, the spines are black and brittle. *Diadema setosum* lives in groups. *Diadema setosum* can be found in coral reef areas, sand flats, areas where algae and seagrass grow.

The results of research on the diversity of sea urchins on the Samboang beach, Bulukumba Regency, show that the majority of sea urchins are found in areas that have coral rock substrates. This is in accordance with the opinion of (Suryanti & Ruswahyuni, 2014) that the abundance

of sea urchins in coral ecosystems is greater in type and number and a small proportion inhabit seagrass ecosystems.

The dominance index at the research location is in the low category. Dominance describes a certain type of community. The results of the analysis of the sea urchin dominance index at the research location stated that there was no dominant species because the value obtained was 0.31 (low species dominance). The dominance index ranges from 0-1. The closer it is to one, the higher the dominance of a particular species. A dominance index value close to 0 indicates that there are no species that dominate other species to the extreme. The dominance index is related to the evenness index, if the evenness value is higher, then no species dominates a community, this is because the distribution of individuals in all types of sea urchins is evenly distributed in the research location.

The evenness index at the research location based on the analysis results is classified as stable because the value obtained is 0.903. This is in accordance with the criteria according to Krebs (1997), if the E value is $0.20 \leq E \leq 1$, it can be said that the type of distribution is stable. Apart from that, the stable evenness value at the research location shows that there is no significant competition between species in terms of space or food, and it can also be confirmed that ecologically the existence of the sea urchin community at the research location is still in a stable condition. (Mattekawang, 2013) argues that similarly, if a certain species dominates in a community, the balance of the community will become unstable and will affect diversity and uniformity.

The life of sea urchins is greatly influenced by the environmental conditions around them. The biotic and abiotic components of an ecosystem form a system that balances each other and cannot be separated. If one component in the ecosystem decreases or increases, it will directly affect the other components. Therefore, biotic and abiotic factors must be balanced. Abiotic factors that significantly influence the life of sea urchins are temperature, salinity, pH and substrate type.

Table 4. Results of measuring aquatic abiotic parameters

Quadrant	Temperature (ºC)	Salinity (o/oo)	pH	Substrate Type
1	30	26	7	Coral, seagrass and muddy sand
2	30	26	7	Coral, seagrass and muddy sand
3	30	27	7	Coral, seagrass and muddy sand
4	32	27	.1	Coral, seagrass and muddy sand
5	31	27	.3	Coral, seagrass and muddy sand
6	33	28	7.5	Coral, seagrass and muddy sand
7	34	29	7.5	Coral and sand
8	35	30	7.5	Coral and sand
9	35	33	8	Coral and sand
10	33	35	8	Coral and sand
11	34	35	7.4	Coral and sand
12	31	37	7.4	Coral and sand
13	30	37	7.5	Coral, seagrass and muddy sand
14	32	37	8	Coral, seagrass and muddy sand
15	34	36	7.5	Coral and muddy sand
16	35	37	7	Coral and muddy sand
17	34	36	7.4	Coral and muddy sand
18	33	36	7.5	Coral and sand

19	35	36	7.7	Coral and sand
20	35	36	7.7	Coral and sand

Table 5. Range of values for aquatic abiotic parameters

No	Abiotic Parameters	Results
1	Temperature (oC)	30-35
2	Salinity (o/oo)	26-37
3	pH	7-8
4	Substrate type	Coral, muddy sand, sand and seagrass

The water quality in the intertidal zone of Samboang beach, Ekatiro Village, typically ranges between 30-35ºC. According to Suryanti & Ruswahyuni, (2014), sea urchins generally thrive in water temperatures ranging from 29-31°C, but they can still survive in higher temperatures, ranging from 36-40°C. Temperature is a critical factor influencing the condition of aquatic ecosystems, impacting the life and growth of aquatic organisms. It plays a pivotal role in metabolic processes, physiology, and respiration. The temperature of water bodies is influenced by various factors, including season, latitude, time of day, air circulation, cloud cover, and water depth. Optimal water temperature supports the growth and life of coral, seagrass, and sea urchins. Sea urchins lack specific adaptations to withstand temperatures exceeding the maximum threshold of 36-40°C. Conversely, extremely cold temperatures below the minimum threshold can also result in mass mortality of marine biota in subtropical regions.

The pH value at the research location is around 7-8. This pH value is still in the good category for the growth and survival of sea urchins (Alwi et al., 2020). According to Kapsenberg et al., (2017), a good pH for sea urchins is around 7.6-8.3. Water conditions that are very alkaline will harm organisms because they will disrupt metabolic and respiration processes, besides that pH values that are too acidic will cause the mobility of various heavy metal compounds, especially aluminum ions, which will affect the abundance of sea urchins in these waters.

The salinity obtained at the research location was around 26-37 PPT. According to Suryanti et al., (2020), water salinity ranging from 30-40 PPT is still optimal for sea urchin species. According to Aziz, (1994), sea urchins in general, like other echinoderm fauna, cannot tolerate low salinity. Except for the species that live in tidal areas, the types of sea urchins that live in tidal areas are relatively resistant to salinity dilution during the rainy season. The salinity range in a body of water is between 23-26 PPT, which will result in changes in color pigment, spines will fall out, and sea urchins will become inactive, not want to eat, and will ultimately die after a few days.

Based on the results of observations of the abiotic parameter values of the waters at the research location, the values obtained are still in the optimal category and it can be said that the abiotic parameters of the waters at Samboang Beach are still in optimal conditions for the life of sea urchins.

CONCLUSION

In conclusion, the research reveals that the sea urchin species found in Samboang Beach were diverse. There are 4 species of sea urchins found on Samboang beach, Bulukumba Regency, consisting of *Echinometra oblonga*, *Echinometra mathaei*, *Echinometra viridis*, and *Diadema setosum*. The sea urchin diversity falls within the medium category at 1.25, with a relatively low dominance index of 0.31 and a stable evenness index of 0.903. This is supported by the environmental conditions of Samboang beach waters which are in good condition and

suitable for the life of sea urchins. Apart from that, Samboang Beach has the characteristics of a beach with a substrate in the form of sand, coral and seagrass which is a habitat for various types of biota, one of which is sea urchins.

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