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ECHINODERMATA DIVERSITY ON TIDUNG KECIL ISLAND

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ABSTRACT

This study aims to inventory and analyze the diversity of Echinodermata on Tidung Kecil Island and to understand the influence of environmental factors on the distribution of these species. Observations were conducted at three stations using purposive sampling and belt transect methods. Quantitative data were collected to calculate diversity, evenness, and species composition indices. The study identified a total of 34 individuals from 10 species across the classes Asteroidea, Holothuroidea, Ophiuroidea, and Echinoidea. Station 2 exhibited the highest diversity, with a diversity index (H') of 1.589 and the greatest number of species, whereas Stations 1 and 3 demonstrated low diversity, dominated by the species Synapta maculata and Diadema setosum. Environmental parameters, including temperature (31-32°C), pH (8.5), and salinity, significantly influenced the abundance and distribution of Echinodermata. The relatively unstable ecosystem conditions underscore the necessity for conservation efforts to maintain the balance and sustainability of marine habitats around Tidung Kecil Island. These findings provide valuable insights into the management of coastal ecosystems and regional marine waters.

Keywords: Echinodermata, Marine Biodiversity, Diversity Index, Tidung Kecil Island, Marine Conservation, Environmental Parameters.

INTRODUCTION

Tidung Kecil Island is a coastal region notable for its rich marine biodiversity, particularly echinoderms. Previous studies have highlighted the significance of echinoderms as indicators of marine ecosystem health and their role in maintaining coastal environmental balance. Nonetheless, data on echinoderm species specific to Tidung Kecil Island remain scarce, indicating a need for more comprehensive studies (Hikamah et al., 2024).

Research conducted in February 2019 on echinoderm diversity on Tidung Island employed purposive sampling and belt transect methods. The findings revealed a diversity level ranging from low to moderate, with diversity index values between 0.8269 and 1.0057. Dominant species identified included Ophiomastix sp., whose distribution and abundance varied with substrate and environmental conditions near the pier, influenced by human activities such as tourism. Additionally, a study on the coral reef ecosystem of Tidung Island reported moderate diversity, with index values between 1.40 and 2.82, and noted a close interaction between echinoderms and coral reef habitats. This information provides a valuable reference for further research on echinoderm diversity on Tidung Kecil Island (Arkam et al., 2019).

The present study aims to inventory and describe echinoderm diversity on Tidung Kecil Island and to elucidate the factors influencing their distribution. The research questions focus on identifying the types of echinoderms present, as well as assessing the level of diversity and their distribution in the region (Andriyani et al., 2021).

MATERIALS AND METHODS

Time and Location of the Study

The study was conducted on 25 October 2025, between 07:45 and 13:00 Western Indonesian Time (WIB). The research was carried out in the northern and southern regions of Tidung Kecil Island, located in the Seribu Islands, DKI Jakarta Province. It involved three observation stations, each with two replicates. Station 1 was positioned in the southern part of Tidung Kecil Island, while Stations 2 and 3 were located in the northern part. Station 2 was situated approximately 50 metres from the shoreline, with Station 3 positioned an additional 50 metres towards the reef edge from Station 2. The coordinates for the research locations are as follows: Station 1 at 5° 48′ 17″ S, 106° 31′ 25″ E; Station 2 at 5° 48′ 05″ S, 106° 31′ 18″ E; and Station 3 at 5° 48′ 00″ S, 106° 31′ 17″ E.



Figure 1. Research Site Location on Tidung Kecil Island

Tools and Materials

This study employed various tools and materials, including a 200-metre transect composed of measuring tape and raffia rope, stakes, a mobile phone camera equipped with an underwater case, buckets, snorkels, pH indicators, gloves, stationery, and thermometers.

Research Method

The selection of research locations was executed using the purposive sampling method, which involves the intentional selection of sites based on criteria pertinent to the research objectives. The criteria included environmental conditions of the waters, the presence of suitable substrates and habitats, and the potential for encountering Echinoderm populations. This method aimed to identify the most appropriate and representative locations for describing the variation of the target biota.

Data collection employed the Belt Transect method, a field observation technique that involves laying a transect line parallel to the shoreline, measuring 100 metres in length and 50 metres in width towards the sea. This transect line delineated the observation area for documenting the presence of biota within a specified range. Each observation station had an independent transect path to ensure the collection of representative data across stations.

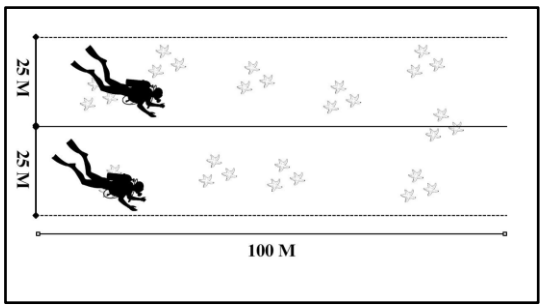


Figure 2. Belt Transect Illustration
(*Source*: Serdiati *et al*., 2021)

Parameter Measurement

Measurements of environmental parameters were conducted at each observation station to facilitate the analysis of the aquatic ecosystem conditions that serve as the habitat for Echinoderms. These parameters encompassed both physical and chemical factors of the waters. The physical parameter assessed was water temperature, which was directly measured using a thermometer at a specified depth to ascertain the thermal conditions of the habitat. The chemical parameters included the degree of acidity (pH) and water salinity. The pH was measured using litmus paper, while salinity was determined with a refractometer. The data obtained from these measurements were utilized to analyze the relationship between the abiotic factors of the waters and the distribution and abundance of Echinoderms at each research station.

Data Analysis

In this study, quantitative data analysis was performed by calculating various indices. The species diversity of Echinoderms was assessed using the diversity index, the evenness index, and species composition, which collectively indicate the level of species diversity at the research site.

Table 1. Distribution and Abundance of *Echinodermata* Species

No	Species	Station			Total
		1	2	3	
1					
2					
3					

Diversity Index

$$H' = -\sum_{i=1}^{S} pi \, ln \, pi$$

Description:
H'= Species diversity
pi= Proportion of individuals of the i-th species to the total number of individuals (Ni/N)
S= Number of species found

Requirements:
H'>1 = The biota community is unstable
1<H'<3 = The biota community has moderate stability
H'>3 = The biota community is in good condition

Meanwhile, species composition is calculated using the following formula:

$$P = \frac{Ni}{N} \times 100\ \%$$

Description:
P = Composition type (%)
Ni = Number of individuals in each type
N = Total number of individuals across all types

Evenness index of Echinodermata species in each habitat:

$$E = \frac{H'}{Ln\, S}$$

Description:
E = Evenness index
H' = Species diversity
S = Number of species found

The estimated value of E varies between 0 and 1. A value of 1 signifies that each species possesses an equal distribution of individuals (Alamsyah et al., 2022).

RESULTS AND DISCUSSION

Analysis of the research findings reveals that the diversity index values across the three observation stations differ. Overall, these values indicate low diversity and productivity, suggesting that the ecosystem remains unstable. The Echinodermata species identified at each station also varied, encompassing species from the classes Asteroidea, Holothuroidea, Ophiuroidea, and Echinoidea. The diversity index values specific to each station are as follows.

Table 2. *Echinodermata* Species Abundance at Three Stations on Tidung Kecil Island

No	Species	Station			Total
		1	2	3	
1	*Synapta maculata*	3	3	3	9
2	*Diadema setosum*	1	-	14	15
3	*Holothuria atra*	-	2	-	2
4	*Ophiomastix janualis*	-	2	-	2
5	*Culcita novaeguineae*	-	3	-	3
6	*Echinothrix calamaris*	-	2	-	2
7	*Holothuria scabra*	-	-	1	1
	Total	4	12	18	34
	Total Species	2	5	3	10

At Station 1, two classes of Echinodermata were identified: Holothuroidea and Echinoidea, comprising a total of four individuals, predominantly Synapta maculata. Station 2 exhibited the highest diversity, with 12 individuals representing five species, including Synapta maculata, Holothuria atra, Ophiomastix janualis, Culcita novaeguineae, and Holothuria scabra. At Station 3, 18 individuals from three species were observed, with Diadema setosum being the most prevalent. Overall, 34 individuals from 10 species of Echinodermata were documented, with Synapta maculata and Diadema setosum being the most frequently encountered species across multiple stations.

Table 3. Observed *Echinodermata* Species

No	Species	Taxonomy
1	 *Synapta maculata*	Kingdom : Animalia Phylum : Echinodermata Class : Holothuroidea Order : Apodida Family : Synaptidae Genus : *Synapta* Species : *Synapta maculata* Source : gbif.org
2	 *Diadema setosum*	Kingdom : Animalia Phylum : Echinodermata Class : Echinoidea Order : Diadematoida Family : Diadematidae Genus : *Diadema* Species : *Diadema setosum* Source : gbif.org
3	 *Holothuria atra*	Kingdom : Animalia Phylum : Echinodermata Class : Holothuroidea Order : Holothuriida Family : Holothuriidae Genus : *Holothuria* Species : *Holothuria atra* Source : gbif.org
4	 *Ophiomastix janualis*	Kingdom : Animalia Filum : Echinodermata Kelas : Ophiuroidea Order : Ophiacantida Family : Ophiocomidae Genus : *Ophiomastix* Spesies : *Ophiomastix janualis* Source : gbif.org

No	Species	Taxonomy
5	 *Culcita noaeguineae*	Kingdom : Animalia Phylum : Echinodermata Class : Asteroidea Order : Valvatida Family : Oreasteridae Genus : *Culcita* Species : *Culcita novaeguineae* Source : gbif.org
6	 *Echinothrix calamaris*	Kingdom : Animalia Phylum : Echinodermata Class : Echinoidea Order : Diadematoida Family : Diadematidae Genus : *Echinothrix* Species : *Echinothrix calamaris* Source : gbif.org
7	 *Holothuria scabra*	Kingdom : Animalia Phylum : Echinodermata Class : Holothuroidea Order : Holothuriida Family : Holothuriidae Genus : *Holothuria* Species : *Holothuria scabra* Source : gbif.org

Table 4. *Echinodermata* Diversity Index at Stations 1, 2, and 3

No	Species	Ni	Pi	LnPi	$-\sum$ **Pi Ln Pi**
Station 1					
1	*Synapta maculata*	3	0.750	-0.288	-0.216
2	*Diadema setosum*	1	0.250	-1.386	-0.347
Total		4			-0.562
H’					0.562
Station 2					
1	*Synapta maculata*	3	0.250	-1.386	-0.347
2	*Holothuria atra*	2	0.167	-1.792	-0.299
3	*Ophiomastix janualis*	2	0.167	-1.792	-0.299
4	*Culcita novaeguineae*	3	0.250	-1.386	-0.347
5	*Echinothrix calamaris*	2	0.167	-1.792	-0.299
Total		12			-1.589
H’					1.589
Station 3					
1	*Synapta maculata*	3	0.167	-1.792	-0.299
2	*Diadema setosum*	14	0.778	-0.251	-0.195
3	*Holothuria scabra*	1	0.056	-2.890	-0.161
Total		18			-0.655
H’					0.655

According to Table 3, the diversity index values for Echinodermata vary across the stations. Specifically, Station I exhibits an H’ value of 0.562, Station II has a value of 1.589, and Station III shows a value of 0.655. These values suggest that Station I has the lowest diversity level, whereas Station II has the highest.

Table 5. *Echinodermata* Species Composition at Stations 1, 2, and 3

No	Species	Total	Abundance (%)
Station 1			
1	*Synapta maculata*	3	75
2	*Diadema setosum*	1	25
Total		4	100
Station 2			
1	*Synapta maculata*	3	25
2	*Holothuria atra*	2	16.70
3	*Ophiomastix janualis*	2	16.70
4	*Culcita novaeguineae*	3	25
5	*Echinothrix calamaris*	2	16.70
Total		12	100
Station 3			
1	*Synapta maculata*	3	16.70
2	*Diadema setosum*	14	77.80
3	*Holothuria scabra*	1	5.6
Total		18	100

Analysis of the Echinodermata species composition revealed varying abundance percentages across observation stations. At Station 1, Synapta maculata exhibited the highest abundance at 75%, whereas Diadema setosum accounted for only 25%. Station 2 was characterized by equal dominance of Synapta maculata and Culcita novaeguineae, each with an abundance of 25%, followed by Holothuria atra, Ophiomastix janualis, and Echinothrix calamaris, each representing 16.70% of the abundance. In contrast, Station 3 was predominantly occupied by Diadema setosum with an abundance of 77.80%, followed by Synapta maculata at 16.70% and Holothuria scabra at 5.60%.

Table 6. *Echinodermata* Evenness Index at Stations 1, 2, and 3

No	Station	Total Individuals	Evenness Index (*E*)
1	Station 1	4	0.811
2	Station 2	12	0.987
3	Station 3	18	1.438
Total		34	

Table 7. Aquatic Environmental Parameter Measurements

No	Parameters	Result
1	Temperature	31-32°C
2	pH	8.5

Observations identified ten echinoderm species distributed across four primary classes: Asteroidea, Holothuroidea, Ophiuroidea, and Echinoidea. The most frequently observed species were Synapta maculata and Diadema setosum, each exhibiting distinct distributions and abundances at various observation stations. Station 2 demonstrated the highest species diversity, with five species and 12 individuals, whereas stations 1 and 3 exhibited lower diversity. The diversity index (H') calculated for each station revealed significant variation. Station 1 recorded the lowest index value of 0.562, indicating low diversity and a less stable biotic community. In contrast, Station 2 had the highest value at 1.589, suggesting a more stable and diverse community, while Station 3, with a value of 0.655, indicated suboptimal conditions with species dominance.

According to Table 6, the evenness index values at each station varied. Station 1 had an evenness index value of 0.811, Station 2 was 0.987, and Station 3 was 1.438. These values suggest an uneven distribution of individuals among species at the three stations. Generally, an evenness index value within the range of 0.6–0.8 indicates a relatively balanced distribution of individuals among species in the community. Therefore, the calculation results suggest that the distribution of Echinodermata at Stations 1, 2, and 3 is classified as uneven.

Water parameter measurements (Table 7) indicated that the water temperature at the study site ranged between 31–32°C, which is considered normal and conducive to the survival of marine organisms, including Echinodermata. The measured pH value was 8.5, indicating mildly alkaline water conditions, which remain suitable for supporting biological activities and ecosystem balance. Parameter measurements

were conducted in situ during the study period without seasonal repetition, suggesting potential variations in water parameter values at different times or seasons (Jambo et al., 2021).

Analysis of environmental parameters such as temperature, pH, and salinity demonstrates that variations in these abiotic factors significantly influence the distribution of echinoderms. Habitats with more favorable substrates and water conditions support higher species diversity and abundance, as observed at Station 2. Ecologically, echinoderms play a crucial role in maintaining marine ecosystem balance. For instance, Synapta maculata contributes to the nutrient cycle on the sea floor, while Diadema setosum aids in controlling algal growth on coral reefs. The presence of species such as Holothuria atra and Ophiomastix janualis further enhances the diversity of ecological functions in these habitats (Tuhumury et al., 2019).

Overall, this study confirms that the diversity of echinoderms on Tidung Kecil Island is categorized as moderate to low, with a tendency for dominance by several species in specific locations. These data can serve as a reference for conservation efforts and the management of the marine ecosystem around the island to maintain biodiversity and ensure ecosystem stability (Karim et al., 2022).

CONCLUSION

Research conducted at three observation stations on Pulau Tidung Kecil identified a total of 34 individual Echinodermata, encompassing 10 species across four primary classes: Asteroidea, Holothuroidea, Ophiuroidea, and Echinoidea. The diversity index (H') varied among the stations, with values of 0.562 at Station 1, 1.589 at Station 2, and 0.655 at Station 3. These findings suggest that Station 2 exhibits the highest diversity and a more stable biotic community, whereas Stations 1 and 3 are predominantly occupied by specific species, notably Synapta maculata and Diadema setosum. The evenness index (E) also displayed variation, with values of 0.811 at Station 1, 0.987 at Station 2, and 1.438 at Station 3, indicating an uneven distribution of individuals among species. Species composition analysis revealed that Synapta maculata was prevalent at Stations 1 and 2, while Diadema setosum was notably dominant at Station 3, with an abundance of 77.8%. Abiotic factors, including temperature (31–32°C), pH (8.5), and stable salinity, facilitated the presence of Echinodermata. However, variations in substrate conditions and human activity pressures at different sites also contributed to diversity differences.

In summary, the diversity of Echinodermata on Tidung Kecil Island is classified as moderate to low, with a tendency towards species dominance, indicating that the ecosystem is not fully stable. Consequently, ecosystem management and continuous conservation efforts are essential to maintain ecological balance and ensure the sustainability of marine biodiversity in the region.

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