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Diversity of Echinoderms on the Beach of Ranowangko II Village, Kombi District, Minahasa Regency

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ABSTRACT

This research is motivated by the lack of studies and absence of research data on the diversity of Echinoderms on the Beach of Ranowangko II Village, Kombi District, Minahasa Regency. The aim of this study is to determine the diversity of the phylum Echinodermata found on the Beach of Ranowangko II Village, Kombi District, Minahasa Regency. Sampling in this research used the quadrat transect method with 3 transect lines, each line being 100 m long, and 10 quadrats, each measuring 1 x 1 m². The results of the study found 4 classes and 5 species including the class Asteroidea (*Protoreaster nodosus*), class Ophiuroidea (*Ophiocoma scolopendrina*), class Echinoidea (*Tripneustes gratilla*), class Holothuroidea (*Holothuria atra* & *Holothuria vagabunda*), and there were 21 individuals, and the dominant species is *Holothuria atra* from the Holothuroidea class of which there are 11 individuals, indicating that the diversity index (H') of the phylum Echinodermata on the location is moderate with a value of 1.204. These findings offer initial insights into the condition of the local ecosystem, classified as moderate, and may serve as a foundational reference for long-term ecological monitoring.

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INTRODUCTION

Biodiversity is the diversity of living organisms or natural resources found in an ecosystem (Nandy, 2021). Particularly in a marine ecosystem where there is a high diversity of fauna (animals), such as in the marine waters of Indonesia which have very high biodiversity (Budiman et al., 2014). Among the many islands in Indonesia, Sulawesi Island, specifically in North Sulawesi Province, is one area that has a very diverse marine biota, one of which is the group of animals from the phylum Echinodermata, which has its own attraction in marine ecosystems (Karim et al., 2022). The phylum Echinodermata is also one of the animal groups that have a very high level of species diversity and also play important ecological and economic roles (Suryanti, 2019). In the marine waters of Indonesia, there are 5 classes of the phylum Echinodermata consisting of 545 species, including 87 species of starfish, 142 species of brittle stars, 84 species of sea urchins, 141 species of sea cucumbers, and 91 species of sea lilies spread across every marine region of Indonesia (Jambo et al., 2021).

The phylum Echinodermata itself is one of the animal groups with very unique body shapes and diverse types. This group of animals is also the most important component of the fauna diversity in coral reef areas and seagrass meadows, and they are also known as beach cleaners because Echinodermata ecologically serve as water detritus or as consumers of organic materials such as fallen mangrove leaves in marine waters (Arifah et al., 2017). Echinoderms also play a role in the marine food chain, as they feed on algae and other small organisms, which in turn are preyed upon by fish and seabirds (Kusumantoro, 2023). Because of these roles, the presence of the Echinodermata animal group is considered very important. Echinoderms also have commercial value as they can be used as wall decorations or table ornaments, and they also have high economic value because some species can be consumed by humans. Most of the communities living near marine waters utilize various species of Echinodermata, processed for consumption as high-nutrient food ingredients beneficial for health (Ariyanto, 2016). The significant roles and benefits of the phylum Echinodermata make their population presence crucial in marine ecosystems to maintain balance within them. Therefore, research on the diversity of Echinodermata animals in a marine ecosystem is necessary.

Initial observations conducted in one of the marine areas of North Sulawesi Province, specifically at Ranowangko II Village Beach, Kombi District, Minahasa Regency, found extensive seagrass beds, especially in the intertidal zone, which is one of the habitats for Echinodermata animals. However, studies related to Echinodermata animals are still very minimal, and the Echinodermata found on the beach have not been thoroughly researched, thus the species present in the waters along with their diversity levels are unknown. This is due to the lack of research conducted in the Ranowangko II Village Beach area. Therefore, there is a need for research on the diversity of Echinodermata animals on this beach so that the data obtained can become a database to determine the level of biodiversity on the beach, as explained by Nandy (2021) that biodiversity can be one of the indicators or measures determining the health of the earth. Based on the above, the researcher is interested in conducting research on the diversity of Echinodermata in Ranowangko II Village Beach, Kombi District, Minahasa Regency.

MATERIALS AND METHOD

Type and Location of the Research

The type of research used is quantitative descriptive method, which describes or depicts then calculates, explains, and presents the amount of data obtained at the research location as the result of this study. The method used in this research is the quadrat transect method. This research was conducted at Ranowangko II Village Beach, Kombi District, Minahasa Regency, North Sulawesi Province, from September to December 2023.

Research Tools and Materials

The tools used in this research are 10 pieces of 4-meter PVC pipes with a diameter of ½ inch, 40 pipe elbows/joints with a size of ½ inch, and pipe glue to make 10 quadrats/frames with a size of 1 x 1 m^2. Additionally, 1 bale of raffia rope is used to create transect lines, a measuring tape for measuring the distance between each transect and quadrat, an e-book and website for identifying various species of Echinoderms, a mobile phone for documentation, tweezers for sampling, a ruler, and writing materials. The materials in this research are the types of Echinoderms animals found on Ranowangko II Village Beach, Kombi District, Minahasa Regency, North Sulawesi Province.

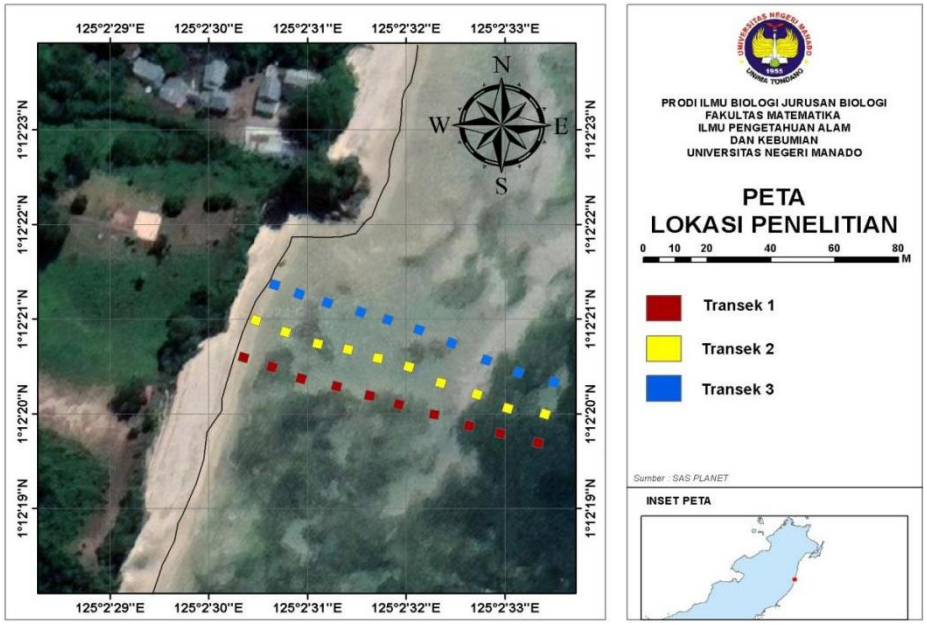

Figure 1. Research location map, consisting of three transection baselines, where plots were placed.

Sampling

Sampling and observation of samples were conducted during low tide (0.1 m) and prior to conducting research at Ranowangko II Beach. To determine the tidal conditions of the sea, the researcher used the Tide Times application. Data sampling of various types of Echinoderms animals in this study used the quadrat transect method. Three transect lines, each 100 m long, were established, with 10 quadrats, each measuring 1 x 1 m², along each transect.

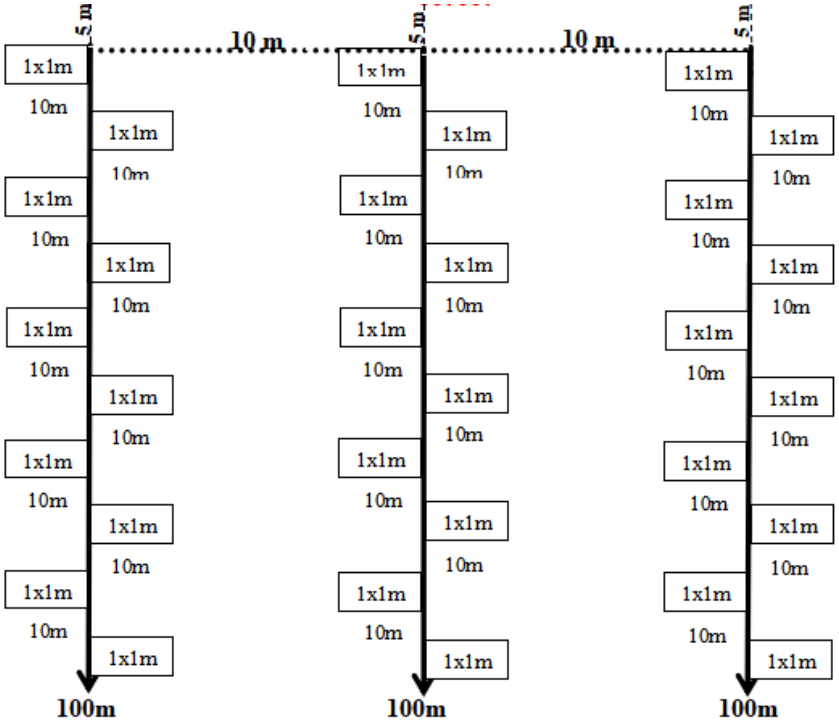

Figure 2. Diagram of quadrat plot and transect lines in the research.

In **Figure 2**, the procedure begins with establishing transect lines in the designated area, positioned 5 m from the shoreline and extending 100 m perpendicular to the shore toward the sea. Once the transect lines are

established, quadrats are placed alternately along these lines, with a total of 10 quadrats spaced 10 m apart. The distance between transects (I, II, III) is also 10 m. The use of 1 × 1 m quadrats in this study is adapted from vegetation analyses of small plants such as seagrasses, which are inhabited by groups of echinoderms, the focus of this research.

Identification of Sample Types

The types of Echinoderms found are then identified and their numbers recorded. Identification is carried out using guidance from the e-book "Biology and Ecology of the Phylum Echinodermata" written by Suryanti in 2019, as well as using the WoRMS (World Register of Marine Species) and GBIF (Global Biodiversity Information Facility) websites. Identification is done by matching the characteristics of the species found at the research site with those in the pictures from the literature, with the aim of determining the name of the species and its taxonomy.

Data Analysis

The data analysis used in this study is quantitative descriptive analysis, which describes and calculates the diversity index (H') of the Echinoderms species found at the research site. The results of this data analysis are then presented in tabular form. The diversity index (H') describes the population status of organisms mathematically, making it easier to analyze the information on the number of individuals of each species in a particular community. Based on Zaun (2021) and Siburian et al. (2023) states that the diversity index (H') calculated using the Shannon-Wiener equation is as follows:

$$H' = -\sum Pi \ ln \ Pi \ ; \quad Pi = \frac{ni}{N}$$

Explanation: H' = species diversity index; ni = number of individuals of species i; ln = natural logarithm. N = total number of individuals of all species; Pi = proportion of the number of individuals of species i to the total number of individuals; -∑ = sum of species found to determine the diversity index.

Based on Zaun (2021), species diversity index is categorized as follows: H' ≥ 3 indicates high diversity, 1 ≤ H' ≤ 3 indicates moderate diversity, and H' ≤ 1 indicates low diversity.

RESULTS AND DISCUSSION

Based on observations of the echinoderm group of animals conducted at Ranowangko II Village Beach, Kombi District, Minahasa Regency, a total of 5 species from 4 classes were found: Class Asteroidea (*Protoreaster nodosus*), Class Ophiuroidea (*Ophiocoma scolopendrina*), Class Echinoidea (*Tripneustes gratilla*), and Class Holothuroidea (*Holothuria atra* & *Holothuria vagabunda*). There were a total of 21 individuals found. The results of these observations are shown in **Table 1**.

Table 1. The Types of Echinoderms on the Beach of Ranowangko II Village, Kombi District, Minahasa Regency.

No.	Class	Spesies	Transect			Number of Individuals
			I	II	III	
1.	Asteroidea	*Protoreaster nodosus*	0	0	1	1
2.	Ophiuroidea	*Ophiocoma scolopendrina*	2	0	0	2
3.	Echinoidea	*Tripneustes gratilla*	0	2	4	6
4.	Holothuroidea	*Holothuria atra*	2	4	5	11
		Holothuria vagabunda	0	1	0	1
		Total	4	7	10	21

Based on the observation results of Echinoderms species on the beach of Ranowangko II Village using the transect quadrant method, there were 5 species found within 3 transects and 10 quadrants as shown in **Figure 3**. In transect 1, two species were found: *Ophiocoma scolopendrina* in quadrant 3 and *Holothuria atra* in quadrant 9. Moving to transect 2, three species were found: *Tripneustes gratilla* in quadrant 2, *Holothuria atra* in quadrant 1 and 2, and *Holothuria vagabunda* in quadrant 2. Finally, in transect 3, three species were found: *Protoreaster nodosus* in quadrant 1, *Tripneustes gratilla* in quadrant 4 and 9, and *Holothuria atra* in quadrant 1 and 8.

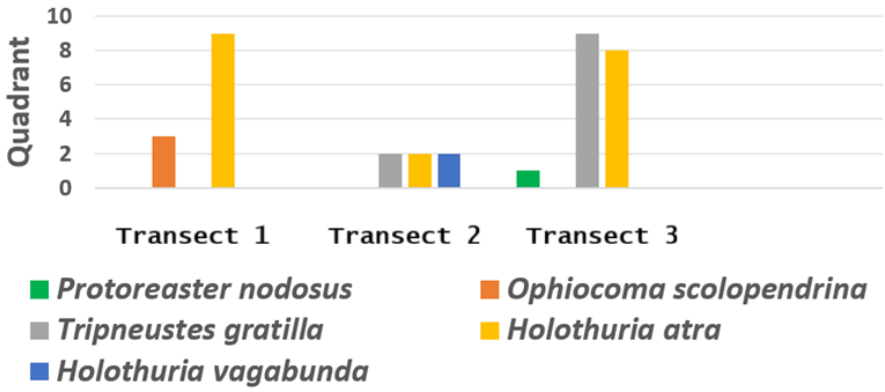

Figure 3. Observation results of species in 3 transects and 10 quadrants.

The Diversity Index of the Echinodermata phylum on the Beach of Ranowangko II Village has been calculated, resulting in a diversity index value of 1.204 as shown in **Table 2**. This indicates that the diversity of Echinoderms species on Ranowangko II Beach is moderate, falling within the range of $1 \leq H' \leq 3$, classifying it as a moderate species diversity index.

Table 2. The Diversity Index of Echinoderms on the Beach of Ranowangko II Village, Kombi District, Minahasa Regency.

No.	Species	Diversity Index (H')			
		ni	Pi	ln(Pi)	Pi × ln(Pi)
1.	*Protoreaster nodosus*	1	0.047	-3.057	-0.143
2.	*Ophiocoma scolopendrina*	2	0.095	-2.353	-0.223
3.	*Tripneustes gratilla*	6	0.285	-1.255	-0.357
4.	*Holothuria atra*	11	0.523	-0.648	-0.338
5.	*Holothuria vagabunda*	1	0.047	-3.057	-0.143
	Total	21			-1.204
	Shannon-Wiener Index (H')				1.204

The species described in this research are shown in **Figure 4**. These species belong to the phylum Echinodermata, which includes a wide variety of marine organisms with unique body structures and adaptations suited to their environments. *Protoreaster nodosus* is the first species observed. It is a star-shaped (radially symmetrical) organism, as its name suggests, called a starfish. On the surface of its body, there are protrusions and blunt spines with a brownish color. It has 5 arms, tube feet on the underside of its body, and its body color is pale white with a hard texture. Its taxonomic classification is as follow, Kingdom: Animalia; Phylum: Echinodermata; Class: Asteroidea; Order: Valvatida; Family: Oreasteridae; Genus: *Protoreaster*; Species: *Protoreaster nodosus* (Suryanti, 2019).

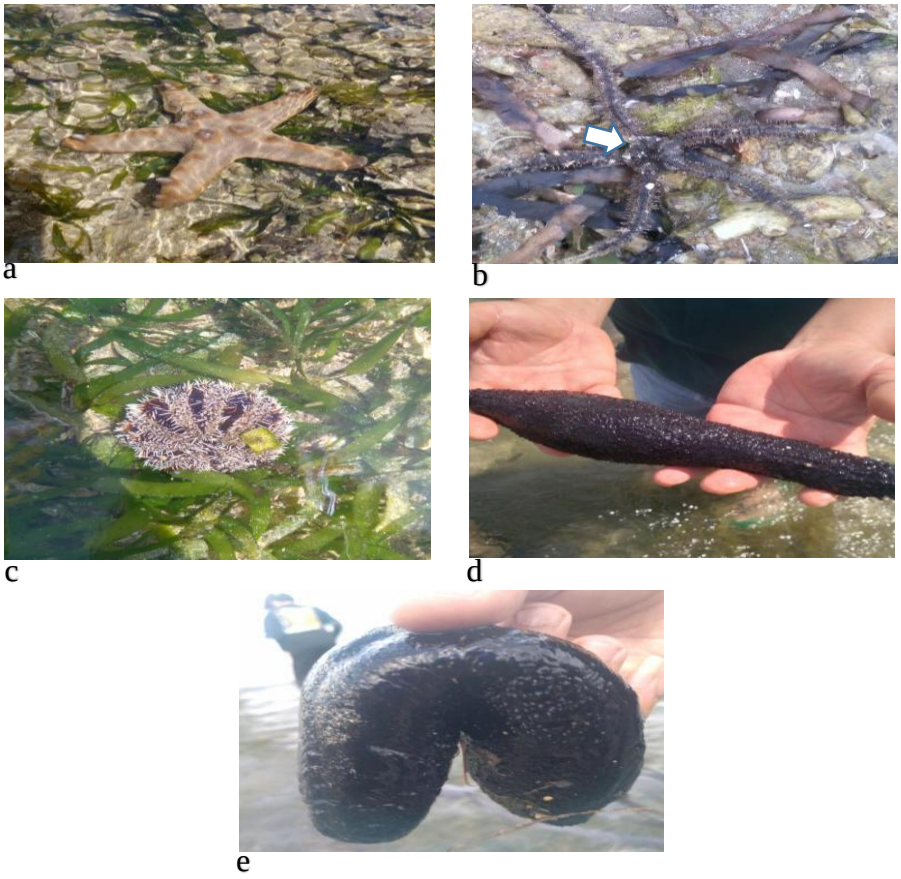

Figure 4. Identification of Echinoderm Species at the Sampling Location: (a) *Protoreaster nodosus*; (b) *Ophiocoma scolopendrina*); (c) *Tripneustes gratilla*; (d) *Holothuria atra*; and (e) *Holothuria vagabunda*. Personal documentation of the research.

The second species is *Ophiocoma scolopendrina*. The body structure of this elongated starfish resembles a flat disc with 5 long, spiny, and flexible arms. However, these arms are easily breakable, and their color is black. Its taxonomic classification is as follow, Kingdom: Animalia; Phylum: Echinodermata; Class: Ophiuroidea; Order: Ophiacanthida; Family: Ophiocomidae; Genus: *Ophiocoma*; Species: *Ophiocoma scolopendrina* (Website GBIF).

The third species is *Tripneustes gratilla*. The body of this sea urchin is black, shaped like a sphere, with sharp white spines and a hard texture. Its taxon level is as follow, Kingdom: Animalia; Phylum: Echinodermata; Class: Echinoidea; Order: Camarodonta; Family: Toxopneustidae; Genus: *Tripneustes*; Species: *Tripneustes gratilla* (Website WoRMS).

The fourth species is *Holothuria atra*. The sea cucumber, or "timun laut" is black in color, with an elongated and slender body shape. Its skin surface is smooth with a slight slimy texture, and its body is soft. It releases fluid from its mouth or anus when handled. Its taxon level is as follow, Kingdom: Animalia; Phylum: Echinodermata; Class: Holothuroidea; Order: Aspidochirotida; Family: Aspidochirotae; Genus: *Holothuria*; Species: *Holothuria atra* (Suryanti, 2019; Andriyani et al. 2021).

The fifth species is *Holothuria vagabunda*. The sea cucumber has an elongated and slender body shape, is black in color, and has a rough, ridged texture. Its taxon level is as follow, Kingdom: Animalia; Phylum: Echinodermata; Class: Holothuroidea; Order: Aspidochirotida; Family: Aspidochirotae; Genus: *Holothuria*; Species: *Holothuria vagabunda* (Suryanti, 2019).

CONCLUSION

The diversity index of echinoderms at Ranowangko II Village Beach, Kombi District, Minahasa Regency, is moderate with a value of 1.204. From the observation results, 4 classes and 5 species were found, including the class Asteroidea (*Protoreaster nodosus*), class Ophiuroidea (*Ophiocoma scolopendrina*), class Echinoidea (*Tripneustes gratilla*), and class Holothuroidea (*Holothuria atra* & *Holothuria vagabunda*), with a total of 21 individuals The dominant species is *Holothuria atra* from the Holothuroidea class of which there are 11 individuals. The result provides an initial assessment of the local ecosystem status of North Sulawesi, categorized as moderate, which establishes a baseline for future long-term monitoring and conservation efforts.

AUTHORS CONTRIBUTION

I. J. A. Letsoin designed and conducted the research, analyzed and interpreted the data, and wrote the draft of the manuscript. M. M. F. Rampengan, V. I. Y. Roring, and H. J. Lawalata designed the research, reviewed the draft of the manuscript, and supervised the process.

CONFLICT OF INTEREST

The authors declare no conflicts of interest and take full responsibility for the content of the article, including any implications of AI-generated art.

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