

Research Article

Abundance and Distribution Pattern of Echinoderms in Intertidal Zone between Sadranan and Sili Beach, Gunung Kidul, Yogyakarta

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Abstract. Echinoderm is one of the animal phyla which has high diversity and abundance in Indonesia, especially in Gunung Kidul, Yogyakarta. Sadranan and Sili beach are side by side beach located in Gunung Kidul. This beach is dominated by coral and rocky coral with macroalgae that provide the habitat of Echinoderms. This research is conducted to study the abundance and distribution pattern of Echinoderms in the intertidal zone between Sadranan and Sili beach. Sampling was carried out on Friday, 4 September 2019 at 05.00 p.m. in the intertidal zone using quadrat plot methods. The beach area is 2240 m² which is divided into 21 plots with 1 x 1 m size. Data analysis was performed by measuring Margalef index (D), Pielou index (e), and Shannon-Wiener index (H') then analyzing the distribution pattern and habitat parameters. The result shows that the Echinoderms which has the highest abundance is *Echinometra mathei* with 19 individual founds. The distribution pattern of *Echinometra mathei*, *Stomopneustes variolaris*, *Heterocentrotus trigonarius*, *Ophiocoma erinaceus*, *Macrophiotrix longipeda*, *Ophiomastix annulosa*, and *Echinus* sp. is clumped. The distribution pattern of *Tripneustes gratilla*, *Diadema antillarum*, *Echinotrix calamaris*, and *Ophiocoma scolopendrina* is uniform



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1. INTRODUCTION

Indonesia is one of the countries with high biodiversity, including the marine biodiversity. An example of the abundant marine life found in Indonesia is a member of phylum Echinodermata. Echinodermata is a group of marine invertebrates that have

spines attached on the surface of the body. The members of the phylum Echinodermata have radial symmetry body as an adult, have an endoskeleton, and moves with the Water Vascular System with ambulacral feet (Pandian, 2017). Echinoderms inhabit depth ranging from shallow water at tides line to

the deep sea. Echinoderms consist of 5 classes, including Crinoidea, Asteroidea, Ophiuroidea, Echinoidea, and, Holothuroidea (Llacuna *et al.*, 2016).

Crinoidea (sea lilies) has about 600 species. The crinoid body consists of the mouth facing upwards and the body does not contain calcium. Asteroidea (starfish) has about 1,500 species. Its body parts consist of a central disk with several arm attached on it. Ophiuroidea (brittle star) has 5 arms that can move flexibly and attached to the central disk. Ophiuroidea consist of around 2,000 species. Echinoidea has a pentaradial symmetrical body shape, there are spines that protect all parts of the body, the oral sides are flat, and the aboral side is curved. Holothuroidea (sea cucumber) has a long cylindrical body. The body is divided into two parts, namely posterior and anterior. In general, the body of the member of the class Holothuroidea is soft, slippery, and speckled. Echinoderms like habitat with relatively calm water and coral substrates (Latupono *et al.*, 2017). Each species has a specific habitat, for example Asteroidea which is often found in corals, rocky, sandy seagrass substrates, and deep sea to a depth of 6000 meter (Pourvali *et al.*, 2014)

Sadranan Beach is one of the beaches in Gunung Kidul Regency, Yogyakarta which has a marine biodiversity. Sadranan Beach has a rocky sand substrate, and also seagrass that supports the life of Echinodermata. The existence of Echinoderms is important to another marine organism. Distribution and development of

Echinoderms is very affected to the substrate, food availability, and environmental conditions for the organism. This research was conducted to find out the Echinoderms abundance in Sadranan and Sili Beach, Gunung Kidul, Yogyakarta.

2. METHODS

2.1. Materials and Methods

The research was conducted in the intertidal zone of Sili and Sadranan Beach, Gunung Kidul, Yogyakarta, Indonesia at October 4th 2019 at 05.00 a.m. at Sadranan and Sili beach is located in Ngestirejo, Tanjungsari, Gunung Kidul, Yogyakarta. The beach consisting of substrates: coral, sea grass, macroalgae, and sandy coral. The survey method used was descriptive method to find out the condition of the research location. Descriptive method focused on an object intensively to collect and analysis the data in a certain time and restricted in a particular area. The materials used were animal samples and pH universal indicator. The tools used were quadrant plot 1 x 1 meter to calculate the abundance of samples, line transect to divide the research areas, roll meters to measure length of line transect, beach's length and beach's width, thermometer to measure temperature of sea water, stationery to write down data. Research location was determined by observation method. Before sampling, research location determined at zone between Sili and Sadranan Beach, Gunung Kidul, Yogyakarta that has 2240 m², 32 m of length and 70 m of width.



Figure 1. Sampling Design using Quadrant plot between Sadranan and Sllili Beach, Gunung Kidul, Yogyakarta

The sampling was done in the intertidal at 70 m width of the beach. Samples were collected using belt-transect method with 3 transects and 7 plots in each transect. Total of the plot is 21. The square plot that used was 1 x 1 m with 1 m gap between plot and 1 m between transect. Sampling carried out when the maximum neap. The determination of the research location also sees the abundance of the Echinoderms. Pictures of oral and aboral parts of obtained samples were taken using digital camera for further identification.

The measurement of habitat parameters such as temperature, pH, and substrate were measured in each line transect. The air temperature and water temperature were measured using a thermometer and pH measured by using a universal indicator. The specimens were identified by its morphological character like spine characteristics, plate structure, body color, and morphometric analysis using taxonomic classification keys.

2.2. Data Analysis

The abundance of Echinoderms species can be determined by using following formula:

$$\text{Magdalef Index } (D) = \frac{S - 1}{\text{Log}N}$$

$$\text{Shannon - Wiener Index } (H') = - \sum P_i \ln P_i$$

$$\text{Pielou Index } (e) = \frac{H'}{\ln S}$$

Annotation(s):

S : Total Number of Species

N : Total Number of Observed Individual

n_i : The Number of i individual

P_i : n_i/N

Relative abundance is to determine the number of individuals toward the total number of individuals. It can be calculated by the following formula:

$$RA = \frac{ni}{N} \times 100\%$$

Annotation(s):

- RA* : Relative Abundance
N : Total Number of Observed Individual
ni : The Number of I individual

To calculate the distribution pattern of the species of Family Echinometridae, can be known by measuring the mean values and the variant value (standard error) using the following formula:

$$V = \sqrt{\frac{2}{n-1}}$$

To calculate the mean value by using following formula:

$$m = \frac{n}{N}$$

Annotation(s):

- V* : Variant Value
n : Number of Individuals
m : mean
N : Total Number of Individuals

The distribution pattern of individual organisms in nature is divided into three parts that are random, uniform, and clumped (Afian *et al.*, 2013) whose give results if:

$v = m$ distribution pattern random

$v > m$ distribution pattern clumped

$v < m$ distribution pattern uniform

3. RESULT AND DISCUSSION

The result of this research are the number of species, number of individual, relative abundance, abundance index, distribution pattern and, habitats parameters.

3.1. Number of Species and Individuals

There are 11 species of Echinoderms found in the Terrestrial Transitional Zone between Slili and Sadranan beaches, Gunung Kidul, Yogyakarta.

Table 1. Number of Echinoderms in the Intertidal Transitional Zone

No.	Name Species	Number of Individual
1	<i>Echinometra mathaei</i>	19
2	<i>Tripneustes gratilla</i>	1
3	<i>Diadema antillarum</i>	1
4	<i>Heterocentrotus trigonarius</i>	3
5	<i>Echinotrix calamaris</i>	1
6	<i>Stomopneustes variolaris</i>	7
7	<i>Ophiocoma scolopendrina</i>	1
8	<i>Ophiocoma erinaceus</i>	6
9	<i>Macrophiotrix longipeda</i>	2
10	<i>Ophiomastix annulosa</i>	6
11	<i>Echinus sp.</i>	2

Based on the research that has been done, obtained in the form of 49 individuals which are included in 11 species from 2 classes members of the Echinodermata phylum, namely *Echinometra mathei*, *Trineustes gratilla*, *Diadema antillarum*, *Heterocentrotus trigonarius*, *Echinotrix calamaris*, *Stomopneustes variolaris*, *Ophiocoma scolopus*, *Ophiocoma scolope*, *Macrophiotrix longipeda*, *Ophiomastix annulosa*, and *Echinus sp.* The identification process is done by comparing the morphology of animal samples to the identification key.

3.2. Diversity, Evenness, and Abundance

The results of calculations and analysis are presented in the following Table 2.

Table 2. Diversity, Evenness, and Abundance Index in the Intertidal Transitional Zone of Sili and Sadranan Beaches

No.	Parameters	Value
1	Total number of individuals	49
2	Total number of species	11
3	Diversity index (H')	1.9
4	Evenness index (e)	0.79
5	Richness index (D)	5.91

The diversity index value (H') in the transitional areas of Sili and Sadranan Beaches is 1.9. Based on the Shannon-Wiener criteria, it was found that the presence of echinoderms in the intertidal transition zone between Sili Beach and Sadranan Beach was classified as medium level. The evenness (E) on the beach is 0.79, according to Krebs this value can be classified as an even community.

3.3. The Relative Abundance

The results of relative abundance are presented in the following Table 3.

Table 3. The relative abundance of Echinoderms in the Intertidal Transitional Zone of Sili and Sadranan Beaches

No.	Name of Species	RA (%)
1	<i>Echinometra mathaei</i>	38.78
2	<i>Tripneustes gratilla</i>	2.04
3	<i>Diadema antillarum</i>	2.04
4	<i>Heterocentrotus trigonarius</i>	6.12
5	<i>Echinotrix calamaris</i>	2.04
6	<i>Stomopneustes variolaris</i>	14.29

7	<i>Ophiocoma scolopendrina</i>	2.04
8	<i>Ophiocoma erinaceus</i>	12.24
9	<i>Macrophiotrix longipeda</i>	4.08
10	<i>Ophiomastix annulosa</i>	12.24
11	<i>Echinus</i> sp.	4.08

The species most commonly found is *Echinometra mathaei* as many as 19 individuals with a relative abundance of 38.78%. The high abundance of *Echinometra mathaei* influenced by the suitability of the organism in the habitat. *Echinometra mathaei* is known to be often tethered in rocky or craggy substrate and eat algae as a source of nutrition (McClanahan and Muthiga, 2001). This is in accordance with the state of the research zone which only covers rocky substrates and is filled with algae.

3.4. Distribution Patterns

The results of distribution pattern are presented in the following Table 4.

Table 4. Echinoderms Distribution Patterns in the Intertidal Transitional Zone of Sili and Sadranan Beaches

No	Name of Species	V	M	Distribution pattern
1	<i>Echinometra mathaei</i>	3.0	0.39	Clumped
2	<i>Tripneustes gratilla</i>	0.0	0.02	Uniform
3	<i>Diadema antillarum</i>	0.0	0.02	Uniform
4	<i>Heterocentrotus trigonarius</i>	1.0	0.06	Clumped
5	<i>Echinotrix calamaris</i>	0.0	0.02	Uniform
6	<i>Stomopneustes variolaris</i>	1.7	0.14	Clumped
7	<i>Ophiocoma scolopendrina</i>	0.0	0.02	Uniform
8	<i>Ophiocoma erinaceus</i>	1.6	0.12	Clumped
9	<i>Macrophiotrix longipeda</i>	0.7	0.04	Clumped
10	<i>Ophiomastix annulosa</i>	1.6	0.12	Clumped
11	<i>Echinus</i> sp.	0.7	0.04	Clumped

Based on the calculation of distribution patterns, Echinoderms in the zone are known to have clumped patterns, namely *Echinometra mathaei*, *Heterocentrotus trigonarius*, *Stomopneustes variolaris*, *Ophiocoma erinaceus*, *Macrophiotrix longipeda*, *Ophiomastix annulosa*, and *Echinus* sp. But there is also a uniform distribution pattern, namely *Tripneustes gratilla*, *Diadema antillarum*, *Stomopneustes variolaris*, and *Ophiocoma scolopendrina*. The pattern of clustered or clumped distribution is the most common pattern found in nature. This is because Echinoderms in their lives tend to find a more suitable place to support their existence, so that it will affect the pattern of its spread (Odum, 1993).

3.5. Habitat Parameters

The measurement results of habitats parameters are presented in the following Table 5.

Table 5. Habitat Parameters of Intertidal Zone of Slili and Sadranan Beaches

No	Parameters	Range	Optimum
1	Water Temperature (°C)	25-26	26
2	pH	7-7.4	7.4

The parameters measured at the time of the research were temperature and pH of water. The water temperature obtained when sampling is 26°C while the pH of water is 7.4. Physicochemical factors such as temperature, pH, and salinity greatly affect the distribution patterns and abundance of Echinoderms and other macrobentic organisms. That is because these chemical physical factors will determine the growth rate, metabolic

activity, and the organism's immune response, which is indicated by the relationship between stress and reproductive success (Llacuna and Villaluz, 2016).

4. CONCLUSION

Based on this study, the diversity of Echinoderms is in the medium category. There are 11 species found in the intertidal zone between Sadranan and Slili Beach. The distribution pattern of *Echinometra mathaei*, *Stomopneustes variolaris*, *Heterocentrotus trigonarius*, *Ophiocoma erinaceus*, *Macrophiotrix longipeda*, *Ophiomastix annulosa*, and *Echinus* sp. is clumped. The distribution pattern of *Tripneustes gratilla*, *Diadema antillarum*, *Echinotrix calamaris*, and *Ophiocoma scolopendrina* is uniform

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