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Echinodermata Composition in Ngentup Beach and Banyu Meneng Beach, Malang Regency

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Abstract

Echinodermata is one of the main constituents of marine biodiversity that has an essential role in the marine ecosystem. The purpose of this study was to look at the composition of Echinodermata by looking at the diversity index, abundance, dominance, and similarity of the two Echinodermata locations found, as well as looking at supporting abiotic factors by correlating abiotic factors with the number of Echinodermata found at Ngentup Beach and Banyu Meneng Beach. The research was conducted in July-October 2020 with a purposive sampling method using line transects then the data was analyzed with the Microsoft Excel program and PAST v.4.03. This study obtained 9 species at Ngentup Beach and 11 species at Banyu Meneng Beach. The Echinodermata diversity index is 1.864 (Ngentup Beach) and 1.117 (Banyu Meneng Beach) respectively. The Echinodermata dominance index was 0.185 (Ngentup Beach) and 0.515 (Banyu Meneng Beach). The Echinodermata abundance index was 0.042 in Tripneustes gratilla (Ngentup Beach) and 0.349 in Ophiocoma scolopendrina (Banyu Meneng Beach) with a similarity value of 0.387. Abiotic factor conditions at Ngentup Beach and Banyu Meneng Beach include pH 7.8, salinity 32.59%, temperature 27.2°C, and DO 5.2 ppm, and at Banyu Meneng Beach pH 8.2, salinity 30.47%, 27.7 °C, and DO 5.57 ppm. The correlation test results showed a high correlation between Ophiocoma scolopendrina and the abiotic factor pH, namely 0.845, Echinothrix calamaris with the abiotic factors of salinity, Diadema setosum with the temperature 0.807 and DO 0.961.

1. INTRODUCTION

Indonesia is the center of the world's coral triangle, so Indonesia's coastal zone has high diversity (Giyanto *et al*., 2017). Indonesia's coastal zone is home to approximately 557 species of Echinodermata which are divided into Class Ophiuroidea (142 species), Class Crinoidea (101 species), Class Asteroidea (89 species), Class Echinoidea (84 species) and Class Holothuroidea (141 species) (Widjaja *et al.,* 2014). Echinodermata is one of the main constituent components of marine biodiversity that has an important role in ecosystem function, one of its roles is as decomposer for the remains of organic matter from other species (Dahuri, 2003).

Echinodermata in ecological roles is referred to as a key organism that can play a role in maintaining the balance of marine ecosystems because some species of Echinodermata can act as nutrient recyclers (Sese *et al.,* 2018). Echinodermata habitats are found in almost all marine ecosystems, but the highest diversity is in the intertidal zone and shallow beaches (Wahyuni & Susetya, 2018).

Banyu Meneng Beach is one of the tourist destinations in Malang. This beach attracts tourists with a stretch of sand and is coupled with rock formations that stretch along the coast (Aryanti *et al.,* 2018). Meanwhile, Ngentup Beach is a coastal area with tourism potential in Malang Regency (Rahma & Primasworo, 2018). Rocky beaches with a hard material composition have the greatest diversity for animal species such as the Echinodermata animal community (Campbell *et al.,* 2010). The increase in tourist visits can lead to habitat destruction and reduce the population of Echinodermata. So this research needs to be done to determine the composition of Echinodermata by analyzing its diversity.

2. MATERIALS AND METHODS

Time and Place of the Study

This research was conducted in October 2020 at Ngentup Beach and Banyu Meneng Beach, Malang Regency during the highest low tide conditions. Data were collected at 04.30 - 08.30 am and 02.30-5.30 pm.

Materials

The tools used for observation and data collection of Echinodermata at Ngentup Beach and Banyu Meneng Beach, Malang Regency are a thermometer, refractometer, pH meter, roll meter, GPS, snorkel set, stationery, raffia rope, and underwater camera.

Research procedure

Preliminary studies

The Preliminary Study was conducted in August - September 2020. This activity aims to determine the area to be observed. Determination of the research location was carried out using a random selection method (Purposive Sampling), determination of observation stations and sampling points selected based on predetermined plots, namely at Ngentup Beach (8°23'45''S and 112°31'02''E) and Banyu Meneng Beach (8°23'45''S and 112°30'56''E).

Sampling methods

The line transect method was used. The line transect method is made using transects that are stretched perpendicular to the shoreline and 5m away from the shore of the highest tide. Five plots were made as transect lines at each research location with the distance between transects being 20m and 10 plots with a size of 5x5 m^2 with a distance of 10m between each plot (Oedjoe & Eoh, 2015).

Echinodermata Identification

The identification of Echinodermata samples was carried out by directly observing morphological characteristics such as the shape of tube feet and the number of arms

for the Asteroidea class, the shape of the arms and tentacle scale for the Ophiuroidea class, the presence of anus and ambulacral shape for the Echinoidea class by referring to Fell (1960), Clark & Rowe (1971), Colin & Arneson (1995), and Gosliner et al. (1996). The results of the collection of Echinodermata specimens in the form of images or photos obtained from the field were then identified using identification manuals from Clark & Rowe (1971), Filander & Griffiths (2017), Boissin et al. (2016) and identification keys starting online from the website http://www.marinespecies.org/ and https://www.gbif.org/.

Abiotic Factor Measurement

Measurement of water samples for abiotic factor analysis was carried out at the same time as Echinodermata collection. This abiotic factor analyzis uses parameters including temperature, water pH, salinity, and DO and substrate.

Data Analysis

The data obtained were then analyzed with the PAST 4.03 program to determine the Shannon-Wiener Diversity Index, the Abundance Index, Simpson's Dominance Index, the Two Land Similarity Index (Cs), and the Correlation of Abiotic Factors with Total Echinodermata Diversity.

. Diversity Index

a. For the Shannon-Wiener diversity index (H'), we used the equation as follows (Odum, 1996).

$$H' = -\Sigma (ni/N) \ln (ni/N)$$

Relating to the equation, *ni* represents the total individuals of species-*i*, and N represents the total number of individuals of all species. The categorization of this index falls into: [1] H' > 3, high diversity; [2] 1 ≤ H' ≤ 3, moderate diversity; [3] H' < 1, low diversity (Fachrul, 2007)

b. Simpson Dominance Index

For The dominance index, we used the equation as follows (Odum, 1996).

$$D = \sum [ni/N]^2$$

The D represents the Simpson Dominance Index, *ni* represents the total individual of species-*i*, and N represents the total individual of all species:

Simpson Index Criteria The categorization of this Simpson dominance index falls into 0 (<0,5), no dominance species, and 1 (≥0.5) there are dominance species.

c. Relative Abundance Index

For the abundance index, we used the equation as follows (Odum, 1996).

$$Kr = ni/N \times 100$$

The Kr value represents the relative abundance Index, ni represents the individual of spesies- *i*, and N total individual of species.

d. Similarity Indeks

For the similarity indeks we used the equation as follows Sorensen (Cs) (Southwood & Henderson, 1999):

$$Cs = 2c/(a+b)$$

Cs represent the similarity index Sorensen, abundance Index, 2 multiplied by the smallest number of the same species from both habitats, *a* represents the number of species in habitat 1 while *b* the number of species in habitat 2.

Research Location

Determination of the research location was carried out using a random method selected (Purposive Sampling), namely the researcher made a brief observation of the condition of Echinodermata parallel to the coastline. Determination of observation stations and sampling points were selected

based on predetermined plots as shown in Figure 1

Figure 1. A) Ngentup Beach, and Banyu meneng Beach (Goggle earth and Qgis Softwere).

3. Results and Discussion

Based on observations at Ngentup Beach and Banyu Meneng Beach, 11 species of Echinodermata were found consisting of 4 classes (Ophiuroidea, Echinoide, Holothuroidea, Asteroidea), 5 orders, 6 families, and 8 genera. Where the highest number of individuals was found in Banyu Meneng Beach with a total of 619 individuals, while in Ngentup Beach the number of individuals as much was as 178. Ophiocoma scolopendriana species were found the most with a total of 436 individuals in banyu meneng beach while in ngentup beach species were found from Tripneustes gratilla(Table1).

Tabel 1. Type and number of Echinodermata

Classes	Order	Family	Genus	Spesies	P.N	P.B.M
Ophiuroidea	Ophiacanthida	Ophiocomidae	*Ophiocoma*	*Ophiocoma scolopendriana*	36	436*
			Ophiomastix	*Ophiomastix annulosa*	18	64
Echinoide	Camarodonta	Echinometridae	*Echinometra*	*Echinometra oblonga*	20	32
				Echinometra mathaei	0	1
		Toxopneustidae	*Tripneustes*	*Tripneustes gratilla*	52	37
	Diadematoida	Diadematidae	*Diadema*	*Diadema setosum*	32	26
			Echinothrix	*Echionothtix calamaris*	7	12
Holothuroidea	Holothurida	Holothuriidae	*Holothuria*	*Holothuria impatiens*	6	4
				Holothuria leucospilota	3	2

				Holothuria difficilis	4	4
Asteroidea	Valvatida	Asteropseidae	*Asteropsis*	*Asteropsis carinifera*	0	1
			Total		178	619

P.B.M : Banyu Meneng Beach
P.N : Ngentup Beach

Tripneustes gratilla had the highest number at Ngentup Beach, which was 52 individuals. The number of Tripneustes gratilla at Ngentup Beach is relatively large compared to the number at Banyu Meneng Beach. It is possible that T. gratilla was abundant due to the substrate contained in Ngentup Beach being in the form of sand and rocks, as well as dead coral, besides sand there are also algae in this area.

Silahooy et al. (2013) stated that T. gratilla can live well in seagrass and algae areas. T. gratilla habitat is very good in calm waters and the availability of nutrients from healthy seagrass beds, algae, and coral reefs. Based on research by Eryandi (2017), the high number of T. gratilla is related to a suitable habitat, namely sandy substrates and dead corals.

The species with the highest number at Banyu Meneng Beach was Ophiocoma scolopendrina with 436 individuals. The large number of Ophiocoma scolopendrina on this beach is because snake stars prefer to live under rocks or corals (Chinn, 2006). The condition of this beach does consist of rocks, at the time of the study O. scolopendrina found many clusters under broken rocks or corals.

One species that is rarely found on both beaches is Asteropsis carinifera which is classified as a type of starfish. According to (Farizi, 2019) the small number of starfish found can be influenced by the habitat of this animal is a sandy substrate, and this animal lives solitary so it is difficult to find this animal in large numbers.

Table 2. Diversity Indeks Echinodermata

No.	Analysis	Nilai	
		Ngentup Beach	Banyu Meneng Beach
1	Number of species	9	11
2	Number of Individuals	178	619
3	Diversity Indeks	1,864*	1,117*
4	Dominancy Indeks	0,185**	0,515**
5	Similirity Indeks Two Communities	0,387	

Information: * significantly different on the diversity T test with a value of P = 0.000000000000000000000036534
** Significantly different on the diversity T Test with a value of P = 0,000000000000000000000000000010

The Echinodermata diversity index at Ngentup Beach showed an H' value of 1.864 (Table 2). The H' value indicates that the condition of Ngentup Beach has a moderate diversity category because it has a value of H' = 1-3. Similarly, Banyu Meneng Beach obtained a medium category with an H' value of 1.117. Goltenboth (2012) states that the limited number of individuals obtained and the condition of the ecosystem make a factor in the high and low value of the diversity index. Eryandi (2017) added that the high and low diversity index can be caused by several factors including the presence of abundant species and substrate homogeneity. Based on the results of the diversity T test obtained the p-value <0.05 (Table. 2), indicatesthat the diversity on both beaches, namely banyu meneng, and ngentup, is significantly different.

This is in accordance with Greenland *et al.* (2016) the P value below 0.05 is stated to be significantly different.

The dominance index of Echinodermata at Banyu Meneng Beach was high at 0.515, while Ngentup Beach was low because it has a dominance index value of 0.185. The dominance index value according to Odum (1996) ranges between 0 and 1, if there are only 1 species in the community then the dominance index is 1, but if there are more species then the dominance index will be close to 0. The results of the diversity T-test with the Dominance index obtained a p-value <0.05 (Table. 2), indicating that the Dominance on both beaches, namely banyu meneng, and ngentup are significantly different. This is by Greenland et al. (2016) the P value below 0.05 is stated to be significantly different.

The similarity value of the two sites analyzed using Sorensen's similarity index (Cs) was 0.387. Different substrates in both locations cause differences in the types and numbers of echinoderms so that the value obtained is close to 0. The value of Sorensen's similarity index according to Magguran (2004) if the value is close to 0, the level of species similarity between the two locations is negligible, but when the value is close to 1, the level of species similarity is almost the same between the two communities.

The higher abundance index value of *T. gratilla* than other species at Ngentup Beach, namely 0.042, does not make *T. gratilla* the dominating species. The dominance index value on this beach is relatively low at 0.185, the low dominance index value indicates that there is no dominating species on Ngentup Beach.

The dominance index value at Banyu Meneng Beach was 0.515 (Table 2), this value can be categorized as the presence of dominating species on this beach. *Ophiocoma scolopendrina* had a higher relative abundance than the other species at Banyu Meneng Beach, which amounted to 70.4%, while at Ngentup Beach the highest relative abundance was *Tripneustes gratilla* with a relative abundance value of 29.2% (Figure 2).

Based on the research, it is known that the abundance at Banyu Meneng Beach has a high value. This is possible because the substrate of Banyu Meneng Beach is rock and coral substrate. Based on Ariyanto's (2016) research, Echinodermata is found more in the coral zone than in other zones.

Figure 2. The Echinodermata Relative Abundance

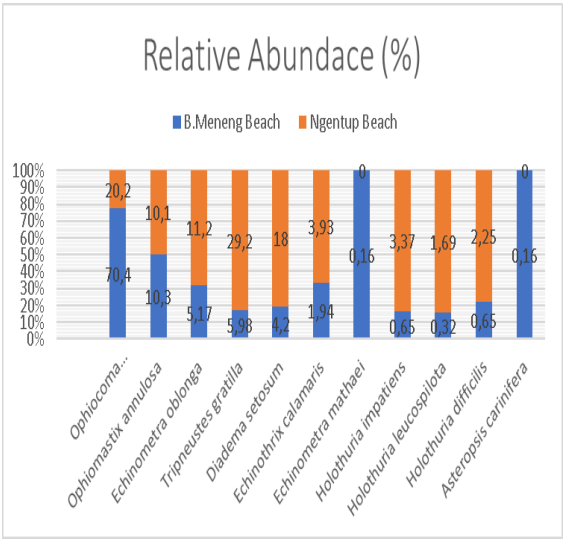

Table 4. Correlation Value of Abiotic Factors with the Abundance of Echinodermata in Ngentup and Banyu Meneng Beach

	Y1	Y2	Y3	Y4
X1	**0,74459**	0,67096	-0,62549	0,16406
X2	-0,69972	**-0,79611**	-0,084579	**-0,79334**
X3	0,64884	0,12599	-0,30935	0,72954

X4	0,30352	-0,35332	-0,6795	-0,0083461
X5	-0,23911	0,20001	-030233	-0,6324
X6	-0,71193	0,019183	**0,85338**	-0,23558
X7	-06376	0,33665	0,33764	-0,63671
X8	-0,11302	0,43005	0,46218	0
X9	0,22106	-0,29251	0,24713	0,74564
X10	-0,16083	0,61663	0,59832	0,34874
X11	0,57439	0,60671	-0,40795	0,0581244

Notes: Bold numbers indicate the highest value, X1= Ophiocoma scolopendrina, X2= Ophiomastix annulosa, X3= Echinomerta oblonga, X4= Tripneustes gratilla, X5= Diadema setosum, X6= Echinothrix calamaris, X7= Holothuria impatiens, X8= Holothuria leucospilota, X9= Holothuria difficilis, X10= Echinometra mathaei, X11= Asteropsis carinifera, Y1= pH, Y2= Salinity, Y3= DO, and Y4= Temperature

The results of the correlation of the pH factor with the abundance of Echinodermata showed the highest value in the species *Ophiocoma scolopendrina* which is 0.74459 (Teble 4). These results indicate that the correlation between the pH factor and Echinodermata diversity is directly proportional. The number of *Ophiocoma scolopendrina* individuals will increase as the pH increases. Higher pH can increase the growth of algae, which is a food source for *O. scolopendrina* (Fabricius et al., 2011). Higher pH levels can help some echinodermata species reproduce better, according to some studies (Byrne et al., 2009).

The correlation between the salinity factor and the abundance of Echinodermata showed the highest value in the species *Ophiomastix annulosa* of -0.79611 (Table 4). This result shows that the correlation between the salinity factor and Echinodermata diversity is inversely proportional. The number of *Ophiomastix annulosa* individuals will decrease as salinity increases.

The natural habitat of *Ophiomastix annulosa* is marine waters with stable salinity. Although they can adapt to a wide range of salinity levels, they are more commonly seen in waters with rather stable salinity concentrations. *Ophiomastix annulosa* shows limited resistance to salinity variations. Significant osmotic stress to the organism can be caused by increased salinity. Increased salinity in O. annulosa can disrupt a number of important physiological functions, such as abnormalities in the nervous system, metabolism, and ion balance. Changes in salinity can affect ion and water balance in echinoderms, potentially disrupting their regular bodily functions (Talbot & Lawrence, 2002). Research conducted by Byrne (2011) showed how salinity variations can affect echinodermata larval growth and fertilization success.

The correlation between the Dissolved Oxygen (DO) factor and Echinodermata diversity shows the highest value in *Echinothrix calamaris* species, which is 0.74459 (Table 4). This result shows that the correlation between the DO factor and Echinodermata diversity is directly proportional. The number of *Echinothrix calamaris* individuals will increase as DO increases. The metabolic rate of *E. calamaris* can increase with higher dissolved oxygen levels. *E. calamaris* species require oxygen for cellular respiration and energy production. *E. calamaris* species may be able to increase their activity levels, including foraging and movement, with greater DO. According to research by Christensen & Colacino (2000), echinoderm activity can be affected by the amount of oxygen present in the surroundings.

The correlation between the temperature factor and the abundance of Echinodermata shows the highest value in the species *Ophiomastix annulosa* of -0.79344 (Table 4). This result shows that the correlation between the temperature factor and Echinodermata diversity is inversely proportional. The number of *Ophiomastix annulosa* individuals will decrease as the temperature increases. *Ophiomastix annulosa*, or sea cucumber, has a close relationship with the temperature of the surrounding environment. According to Byrne (2011), temperature variations can have an impact on echinoderm larval growth and reproductive success. Temperature variations can affect the environment of O. annulosa, as well as the community of creatures that interact with the organism.

4. CONCLUSION

Total Echinodermata species found in Ngentup and Banyu Meneng beachs were 11 species including *Ophiocoma scolopendrina, Ophiomastix annulosa, Echinometra oblonga, Tripneustes gratilla, Diadema setosum, Echinothrix calamaris, Holothuria impatiens, Holothuria leucospilota, Holothuria difficilis, Echinometra mathaei and Asteropsis carinifera.*

The diversity of species found in Ngentup Beach and Banyu Meneng Beach were classified as moderate while the value of the diversity index (H') of Ngentup Beach is higher with a value of 1.86 than that of Banyu Meneng Beach 1.11, for the dominance index Banyu Meneng beach has a higher dominance than Ngentup Beach with a value of 0.51, while for the diversity index, it has a high abundance value in the species Tripneustes gratilla which is 0.04 in Ngentup Beach and the species Ophiocoma scolopendrina with a value of 0.34. The similarity value of the 2 locations is 0.38 and the high abundance value of Tripneustes gratilla species is 0.04 at Ngentup Beach and Ophiocoma scolopendrina species with a value of 0.34 at Banyu Meneng Beach.

The results of the correlation of Abiotic Factors with Echinodermata in Ngentup Beach and banyu meneng produced positive correlation values in Ophiocoma scolopendrina and Echinothrix calamaris species with pH and DO factors while in Ophiomastix annulosa species negatively correlated with abiotic factors of salinity and temperature.

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