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Abstract. This study aimed to determine the community structure of echinoderms and how it related to seagrass cover and water chemical and physical parameters in Pandaratan Beach, Tapanuli Tengah Regency. The research was conducted from Maret to April 2018. Data analysis included community structure analysis and Principal Component Analysis (PCA). The result showed that there were seven species of echinoderms from four classes in Pandaratan Beach. The station I had the highest composition of echinoderms, while the lowest noted at station II. The highest abundance of 77 ind/m^2 was found at the station I and the lowest of 44 ind/m^2 was at station III. The highest diversity index was recorded at the station I, while the highest evenness and dominance index was at station II. Water quality of the waters was still in capacity to support the life of echinoderms. Based on PCA analysis, it was obtained that the abundance of echinoderms was positively correlated with seagrass cover, DO, depth, and phosphate.

1. Introduction

Pandaratan Beach is one of the beaches in Sibolga where seagrass plants are found with several associated marine biota, one of which is echinoderm. Seagrass beds are an ecosystem with many benefits for its surrounding waters and habitat as well as feeding ground and shelter for marine biota [1]. Based on research conducted in the seagrass ecosystem, Unggeh Island found several types of echinoderms which consisted of 3 classes, namely Holothuroidea with 9 individuals [2] Echinoidea were 9 individuals and asteroid classes were 70 individuals [3].

Associations between marine biota and seagrass ecosystems will form an ecological system. When seagrass ecosystem decreases, its ecological function will also reduce. This certainly can affect the lives of biota associated with seagrass, especially echinoderm in both quantity and diversity [1]. According to [4] in the Album of Seagrass Map, seagrass beds in Indonesia, precisely at the research sites in Tapanuli Tengah Regency, were at the poor and unhealthy category. According [5] seagrass cover in Unggeh Island is still in the rare category.

According to that, therefore, research on the community structure of echinoderm in the seagrass ecosystem in Pandaratan Beach, Sarudik district, Tapanuli Tengah Regency, North Sumatra was still

necessary in order to provide data and information on community structure of echinoderm and its relationship to seagrass cover as well as chemistry and physical water parameter for sustainable coastal area management activities.

2. Materials and methods

2.1. Research period and location

This research was conducted from March to April 2018 at Pandaratan Beach. The research site was divided into 3 stations based on the representation of different characteristics [5] according to seagrass cover. Identification of echinoderms was done in the Laboratory of Aquatic Environment, Faculty of Agriculture, Universitas Sumatera Utara. Nitrate and phosphate analysis were conducted at Laboratory of Quality Control and Testing of Fisheries Product (UPT LPPMHP) Medan, North Sumatra. Substrate and C-Organic were analysed at the Laboratory of the Palm Oil Research Centre (PPKS) Medan, North Sumatera.

2.2. Procedures

Sampling was conducted following quadrat transect method by using quadrat transect of 50 cm x 50 cm. The transect was laid perpendicular to the shoreline at each station during low tide. Three line transects with a distance of 50 m between lines were set for each station. Reduplication sampling was carried out along the 100 m lines with a distance of 10 m between plots. Each echinoderm contained in the plot was grouped based on its morphological characteristics and then the total of the individual was counted for each type. The sample obtained was put into a plastic bag and added with alcohol of 70%. To identify the species, Clark and Rowe [6] and web identification of macrozoobenthos "*marine species*" [7] were used as a reference.

2.3. Data analysis

Data used in this study consisted of primary and secondary data. Primary data included samples of echinoderms and physical and chemical parameters of water that obtained directly in the field while secondary data included seagrass cover and water chemical and physical parameters that obtained from another research related to seagrass ecosystem in Pandaratan Beach.

2.3.1. Abundance

Abundance was calculated following the formula (eq. 1), where Di is the abundance of species (Ind/m^2), ni is the number of total individual of species (ind) and A is wide of the area sampled (m^2) [8].

$$Di = \frac{ni}{A} \tag{1}$$

2.3.2. Relative abundance

Relative abundance was calculated using the formula (eq.2), where RDi is the relative abundance (%), ni is the total number of types-i (ind) and ∑n is the total number of individuals of all types (ind) [8].

$$RDi = \frac{ni}{\sum n} \times 100\% \tag{2}$$

2.3.3. Diversity index (H')

Diversity index was calculated using Shannon-Wiener index (eq. 3), where H' is diversity index and Pi is the proportion of the species-i [9].

$$H' = -\sum_{i=1}^{n} Pi \ln Pi \tag{3}$$

2.3.4. Evenness index (E)
Evenness index was calculated using the Evenness index formula (eq. 4), where E is evenness index, H' is Diversity index and S is a number of types of organisms [8].

$$E = \frac{H'}{LnS} \tag{4}$$

2.3.5. Dominance index (C)
Dominance index was calculated using formula (eq. 5), where C is the dominance index, ni is the number of individuals of each species and N is the total number of individuals [10].

$$C = \sum \left(\frac{ni}{N}\right)^2 \tag{5}$$

2.3.6. Principal component analysis (PCA)
Multivariable statistical analysis approach based on Principal Components Analysis (PCA) was conducted to determine the relation of seagrass cover and water chemical and physical parameters to the abundance of echinoderms. PCA analysis was done using XL stat software program.

3. Results and discussion

3.1. Abundance (Di) and relative abundance (RDi)
The results showed that the highest abundance of 77 ind/m^2 was found at the station I, followed by the abundance of 57 ind/m^2 at the station II while the lowest of 44 ind/m^2 was at station III (Figure 1). The highest abundance at the station I was related to higher DO content of 6.33 mg/l and high seagrass cover while on the contrary, station III was noted to have lower DO and seagrass cover. Based on the research by [11] seagrass cover at the station I was 34.47% which indicated the area to have many food sources and provide better shelter for biota. According to [12] the high and the low of the density of an organism was strongly influenced by various environmental factors and ones of the most influential factors was the availability of food and adequate oxygen.

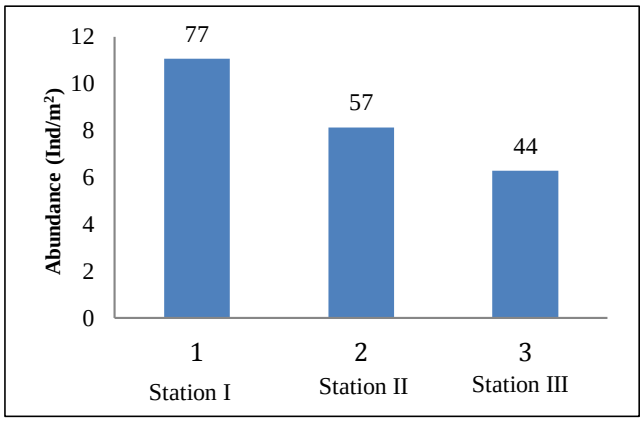

Figure 1. Abundance of echinoderms

As much as seven species of echinoderms from four classes such as Asteroidea, Echinoidea, Holothuroidea, and Ophiuroidea, were found in Pandaratan Beach. The station I had more species than other stations because station I had a higher seagrass closure. The highest relative abundance of echinoderms corresponded to *Archaster typicus* with percentage of 50.08%, 54.47% and 52.34% at station I, II and III, respectively, and and the lowest was noted for *Diadema setosum* with the relative abundance at station I, II and III were 0.78%, 0.00% and 0.00%, respectively (Table 1). Station II was recorded to have the highest relative abundance of *A. typicus* (54.47%) because station II served habitat

with preferable characteristic to *A. typicus* with its sandy substrate and little seagrass cover [13]. The lowest relative abundance was noted for *D. setosum* with the lowest at station II and III (0.00%) because station II and III were more dominated by seagrass *Cymodocea rotundata* [11] which had a relatively small leaf size for epiphytes to attach.

Table 1. Relative abundance of echinoderms for each station

No	Echinodermata species	Relative abundance (%)		
		Station I	Station II	Station III
1	*Holothuria scabra*	0.00	0.00	4.68
2	*Holothuria atra*	0.00	0.00	5.79
3	*Holothuria leucospilota*	19.87	0.00	37.19
4	*Laganum laganum*	14.55	36.38	0.00
5	*Archaster typicus*	50.08	54.47	52.34
6	*Ophiocoma erinaceus*	14.71	9.15	0.00
7	*Diadema setosum*	0.78	0.00	0.00
	Number	100.00	100.00	100.00

3.2. Diversity, evenness and dominance index

The highest diversity index was recorded at the station I, while the highest evenness and dominance index was at station II (Table 2). Overall Shanon diversity index (H') of echinoderms in Pandaratan Beach ranged from 0.918-1.268. The diversity index of echinoderms in Pandaratan Beach was higher than diversity index of echinoderms in Tenakeke, South Sulawesi [14] but lower than diversity index in Tanjung Tiram, Maluku [15] and Suli, Maluku [16]. All diversity indices among stations were higher in the station I compare to other stations because the station I had more species. According to [9], for the community to have high diversity, it must be composed of many species. The evenness index (E) for echinoderms in Pandaratan Beach from 0.732–0.835 respectively. It was high compared to evenness index of echinoderms in Tanjung Tiram, Maluku [15] but it was lower than that of echinoderms in Suli, Maluku [16] and Teluk Kuta, West Nusa Tenggara [17]. The dominance index (D) for echinoderms overall in Pandaratan Beach ranged from 0.335-0.437 respectively. Similar to evenness index (E), the dominance index was high compared to dominance index of echinoderms in than dominance index in Tanjung Tiram, Maluku [15] but it was lower than that of echinoderms in Suli, Maluku [16].

Table 2. Diversity, evenness and dominance index

Index	Station			Average
	I	II	III	
Diversity (H')	1.268	0.918	1.015	1.067
Evenness (E)	0.788	0.835	0.732	0.785
Dominance (C)	0.335	0.437	0.418	0.396

3.3. Water chemical and physical parameters and substrate texture

Based on the measurement results, the water chemistry physical parameters were still in capacity to support the life of echinoderms. pH, salinity, and nitrate were the lowest at the station I whereas the depth, DO and phosphate was the highest. The highest salinity, pH, nitrate, C-Organic were recorded at station III while the lowest DO and phosphate were found at this station. Substrate texture at the station I, II and III are sand, sand and clay sand, respectively. Water chemical and physical value parameters and substrate texture at each station are presented in Table 3.

Table 3. Measurement results of chemical-physical parameters and substrate texture

Parameters	Station		
	I	II	III
Physical			
Temperature (°C)	30.2	30.6	30.6
Depth of water (m)	0.47	0.32	0.39
Water transparency (%)	100	100	100
Current (m/s)	0.09	0.09	0.10
Chemical			
DO (mg/l)	6.33	6.13	5.77
pH	7.57	7.68	7.72
Salinity (ppt)	29	29.33	30
Nitrate (mg/l)	0.7	1.6	3.0
Phosphate (mg/l)	0.3	0.26	0.21
Substrate			
C-Organic (%)	0.63	0.26	0.87
Substrate texture	Sand	Sand	Clay sand

Source: Secondary [18]

3.4. Principal component analysis (PCA)

The result of seagrass closure analysis and measurement of chemical and physical water parameter were linked using PCA (*Principal Component Analysis)* on the abundance of echinoderms, which is shown in Figure 2.

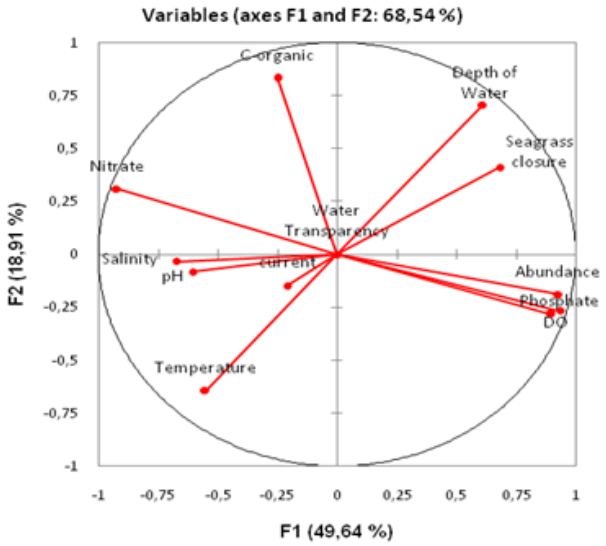

Figure 2. The result of principal component analysis

Based on the results of PCA analysis, echinoderms abundance was positively correlated with seagrass cover. According to [8] seagrass played an important role as habitat, feeding ground, spawning ground, nursery ground and shelter from a predator. Abundance was also positively correlated with DO content because it affects the physiological activities of echinoderms. This is in accordance with the statement [10], the amount of dissolved oxygen will affect echinoderm activity, one of which is the development of larvae. Depth was also positively correlated with echinoderm density because changed in water depth could affect the self-immersion behaviour of sea cucumbers. According to [19] low water depth could cause the reduced appearance of echinoderms to the surface, especially sea cucumbers

because in low tide conditions brightness increases, temperature increases and salinity also increases. Abundance also positively correlated with phosphate levels because correlated with a food source. [10] stated that phosphate is useful for plankton food which is one of the food sources of echinoderm.

Echinoderms abundance was negatively correlated with temperature because high temperatures would cause high evaporation so that salinity will increase. According to [14], the increase of $3.0^{0}/_{00}$ in salinity would lead to flaking skin or even death in extreme condition, especially on the sea cucumber. Abundance also negatively correlated with C-Organic and nitrate level. According to [20] the high amount of nitrate causes reduced dissolved oxygen in the waters and causes many organisms to die. The level of dissolved oxygen in a water would decrease due to the decomposition of organic matter. The abundance of echinoderms was negatively correlated with pH because according to [21] a high pH is harmful to organisms because it can interfere with metabolism and respiration which results in the death of biota. Echinoderms abundance was negatively correlated with current because it is associated with suspended solids and dissolved oxygen. According [22] a high current caused high suspended solids (TSS) in the waters and cover the seagrass surface so that photosynthesis decreases as oxygen in the waters decreases.

4. Conclusion

Community structure of echinoderms in Pandaratan Beach, Tapanuli Tengah Regency, North Sumatra covered the highest abundance at the station I (77 ind/m^2) and the lowest at station III (44 ind/m^2). The highest diversity index was recorded at the station I, while the highest evenness and dominance index was at station II. Based on PCA analysis, the abundance of echinoderms was positively correlated to seagrass cover and water chemical-physical parameters, including DO, phosphate, and depth. While the abundance of echinoderms was negatively correlated with temperature, brightness, pH, current, salinity, nitrate and C-Organic.

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