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Community structure of Echinoderms at Tanjung Tiram, inner Ambon bay, Indonesia

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Abstract. Research to study community structure of Echinoderms was conducted at Tanjung Tiram, Inner Ambon Bay on August 2013. The objectives of this research were to study species composition, occurrence frequency, density and diversity of Echinoderm at vegetation (seagrass beds) as well as at non-vegetation areas. Data was collected by using linear transect quadrat with the size of quadrat of 5 x 5m^2. A total of 2012 individuals belonging to 16 species of Echinoderms were collected during the research. Density of Echinoderms in the area was 1.97 individual m^{-2} with the highest density represented by *Diadema setosum* i.e. 0.923 individual m^{-2}, while the highest frequency of occurrence belonged to *Holothuria scabra* i.e. 73.2%. Diversity of Echinoderms at Tanjung Tiram could be categorized moderate with the Shannon indexes for total, vegetation and non-vegetation areas were 1.52, 2.27 and 1.16, respectively. Evenness index of Shannon (E) for Echinoderms community at Tanjung Tiram was 0.55; its index at vegetation (E = 0.82) was higher than at non-vegetation (E = 0.48). Totally, Simpson dominance index (D) of Echinoderms community at Tanjung Tiram was 0.33 whereas the indexes at vegetation and non-vegetation were 0.43 and 0.14, respectively. Based on those indexes above, it can be concluded that only Echinoderms at seagrass beds had a steady-state condition.
Key Words: Echinoderms, species composition, density, diversity.

Introduction. Seagrass ecosystem is essential for marine life. Physically, seagrass acts as sediment stabilizer and retaining sediment as well as protecting the coast from erosion. Seagrass serves as diverse habitat for many marine species including fish, crustaceans, mollusks and many other invertebrates. It also serves as a protection for juvenile marine species and a source of nutrient that helps to sustain many complex food chains (Warren et al 2010).

One group of marine animals that inhabit seagrass beds is Echinoderms. Echinoderms are classified into five classes: Asteroidea (sea stars), Ophiuroidea (snake stars), Echinoidea (sea urchins), Crinoidea (sea lilies) and Holothuroidea (sea cucumbers), which consist of approximately 6,500 species (Hendler et al 1995).

Echinoderms are important marine animals which have both economic and ecological value. Echinoderms are detritus feeders, so their role in an ecosystem is to break down the organic material remains unused by other species but can be utilized by some species of Echinodermata (Birkeland 1989; Hernández et al 2006). Some Echinoderms such as sea cucumbers are important source for food and medicine industries in Malaysia (Kamarudin et al 2010; Bordbar et al 2011; Jontila et al 2014). Meanwhile, sea urchins are traded for their delicious gonad (Hammer et al 2006) and sea stars are sold as souvenirs (Alvarado 2011).

Coastal waters of Tanjung Tiram are characterized by two tropical ecosystems namely mangrove and seagrass, and have a variety of substrates such as muddy sand, gravel and rocky sand. Seagrass beds in this area mainly consist of *Thalassia hempricii* and *Enhalus acoroides* which support the presence of Echinoderms.

Information on community structure of Echinoderms in this region is still lacking, so this study is important because it will provide information regarding Echinoderms community, related to the sustainable management of coastal areas. The purpose of this study was to analyze the community structure of Echinoderms from seagrass beds and

non-seagrass in Tanjung Tiram, inner Ambon bay, eastern Indonesia by discussing some ecological aspects such as species richness, occurrence frequency, density, dominance, and diversity.

Material and Method. This research was conducted on August 2013 at Tanjung Tiram, inner Ambon bay, eastern Indonesia (Figure 1). Samples of Echinoderms were collected during low tide using linear quadrat transect proposed by English et al (1994) with the size of the quadrat being 5 x 5 m^2.

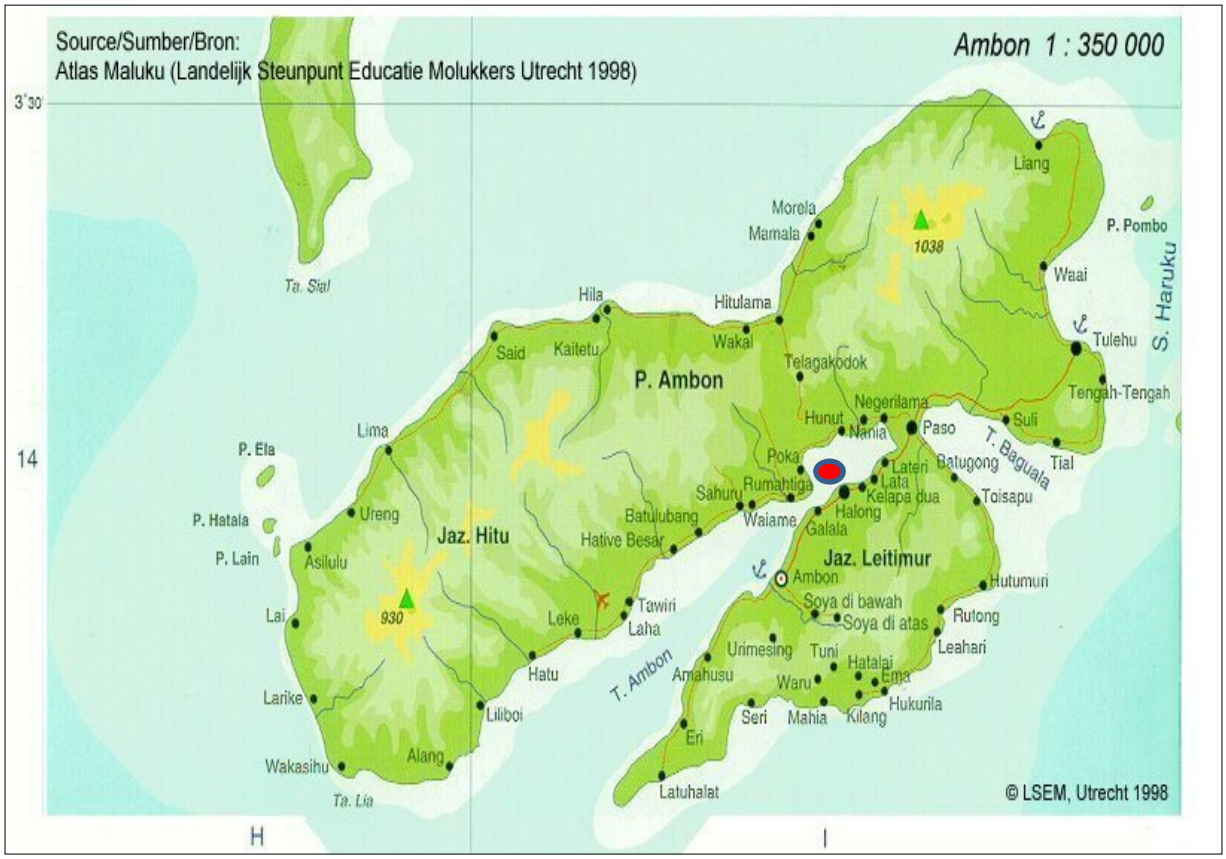

Figure 1. Map showing sampling site (red circle).

Species identification was based on Clark & Rowe (1971) and Lane & Vandenspiegel (2003). Data were processed with PAST (Palaentological Statistic) software (Hammer et al 2001). Comparison of Echinoderms diversity at vegetation area (seagrass) and non-vegetation area was analised using t-student test proposed by Magurran (1991).

Results and Discussion

Species composition of Echinoderms. A total of 2012 individuals belonging to 16 species from three classes of Echinoderms namely Holothuroidea (9 species), Echinoidea (4 species) and Asteroidea (3 species) were collected during the study using 41 quadrats (Table 1). Partially, Echinoderms in vegetation area (seagrass) have more species (16 species) than in non-vegetation area (11 species). The five species that are not found in non-vegetation area are *Stichopus hermanni, Opheodesoma spectabilis, O. gray, Synapta maculata* (Holothuridea) and *Archaster* sp. (Asteroidea).

Species richness of Echinoderms in the waters of Tanjung Tiram is low compared to the number of Echinodermata species in Kema waters, North Sulawesi (Supono & Arbi 2010) and in the Lembeh Strait, Bitung, North Sulawesi (Yusron 2009). In contrast, the number of species in this study is slightly higher than the Echinoderms species of Kairatu, West Seram (Rumahlatu et al 2008) and in the intertidal zone of Gorontalo (Katili 2011).

Variation in the number of species in those regions is probably related with differences in the water characteristics, type and diversity of the habitat.

Table 1

Species composition of Echinoderms in Tanjung Tiram

Class	Species	Area	
		V	NV
Holothuroidea	*Holothuria scabra*	+	+
	H. atra	+	+
	Bohadschia tenuissima	+	+
	B. marmorata	+	+
	Stichopus hermanni	+	-
	Actinopiga echinites	+	+
	Opheodesoma spectabilis	+	-
	O. grisea	+	-
	Synapta maculata	+	-
Echinoidea	*Diadema setosum*	+	+
	Echinothrix calamaris	+	+
	Mespilia globulus	+	+
	Tripneustes gratilla	+	+
Asteroidea	*Protoreaster nodosus*	+	+
	Archaster typicus	+	+
	Archaster sp.	+	-

Legend: "+" = presence; "-" = absence; V = vegetation; NV = non-vegetation.

Occurrence frequency and density. Overall, *Holothuria scabra* has the highest frequency of occurrence i.e. 73.2%. Other species which also have a fairly high frequency are *Bohadschia marmorata, B. tenuissima, Diadema setosum* and *Echinothrix calamaris* while the lowest frequency is represented by *Mespilia globulus* (9.8%) (Table 2).

For vegetation area, the highest occurrence frequency belonged to *H. scabra* (80.6%) and followed by *B. marmorata, B. tenuissima* and *D. setosum* while the lowest occurrence is represented by *M. globulus* (6.5%). In non-vegetation area, the highest occurence was represented by two species of Echinodea i.e. *D. setosum* and *E. calamaris* with frequency of occurrence of 90%, while the lowest belonged to *Tripneustes gratilla* i.e. 10%.

Overall, the highest density is represented by *D. setosum* (0.923 individual m^{-2}), followed by *E. calamaris* (0.649 individual m^{-2}) whereas the lowest is represented by *Stichopus hermanni* (0.005 individual m^{-2}) (Table 2). The total density of of Echinoderms in Tanjung Tiram was 1.97 individuals m^{-2}.

The highest densities in vegetation area as well as in non-vegetaton area are represented by *D. setosum*, followed by *E. calamaris* (Table 2). In vegetation area, the lowest density belonged to three species namely *S. hermanni, Actinopiga echinites* and *M. globulus*, whereas in non-vegetation area is represented by *T. gratilla*. Total densities in vegetation and non-vegetation areas are 0.64 individuals m^{-2} and 6.10 individuals m^{-2}, respectively.

These results indicated that overall, the density of *D. setosum* is 10 times higher than *H. scabra* which has the highest occurrence frequency. Density is not determined by the number of quadrats in which a species is found but related to the number of individuals found in a quadrat. The highest density of *D. setosum* is also found in several other areas in Indonesia such as in the coastal waters of Kema, North Sulawesi (Supono & Arbi 2010) and in the intertidal area of Kairatu, West Seram (Rumahlatu et al 2008). The high density of *D. setosum* is not surprising because this species tends to live in groups and has a good adaptability to various habitats and food. According to Supono & Arbi (2010), *D. setosum* can live on a variety of substrates such as sand, gravel, muddy sand and boulders. The authors also note that in seagrass beds, *D. setossum* is herbivore, but in deeper area where there is no vegetation, this species can adapt to

become omnivore by eating worms, mollusks, crustaceans, diatoms and fragments of algae that were swept away by current.

Table 2

Occurrence frequency and density of Echinoderms in Tanjung Tiram

Species	Occurence (%)			Density (individual m^{-2})		
	V + NV	V	NV	V + NV	V	NV
Holothuria scabra	73.2	80.6	50.0	0.093	0.090	0.100
H. atra	24.4	19.4	40.0	0.014	0.009	0.028
Bohadschia tenuissima	53.7	54.8	50.0	0.051	0.044	0.072
B. marmorata	61.0	67.7	40.0	0.049	0.053	0.036
Stichopus hermanni	7.3	9.7	0.0	0.005	0.006	0.000
Actinopiga echinites	17.1	9.7	40.0	0.010	0.006	0.020
Opheodesoma spectabilis	31.7	41.9	0.0	0.024	0.032	0.000
O. grisea	14.6	19.4	0.0	0.012	0.015	0.000
Synapta maculata	24.4	32.3	0.0	0.019	0.025	0.000
Diadema setosum	56.1	45.2	90.0	0.923	0.183	3.216
Echinothrix calamaris	46.3	32.3	90.0	0.649	0.095	2.364
Mespilia globulus	9.8	6.5	20.0	0.013	0.006	0.032
Tripneustes gratilla	12.2	12.9	10.0	0.009	0.009	0.008
Protoreaster nodosus	29.3	25.8	40.0	0.032	0.027	0.048
Archaster typicus	34.1	25.8	60.0	0.058	0.019	0.176
Archaster sp.	12.2	16.1	0.0	0.014	0.018	0.000
Total				1.97	0.64	6.10

Legend: V = vegetation; NV = non-vegetation.

Diversity of Echinoderms. Shannon diversity index (H') of Echinoderms community in Tanjung Tiram was 1.52. This value is similar to the Shannon index for Echinoderms community at Kema waters, North Sulawesi (Supono & Arbi 2010) but lower than diversity indexes of Echinoderms at Kairatu, West Seram (Rumahlatu et al 2008) and at Tanjung Merah, North Sulawesi (Yusron & Susetiono 2005).

Partially, Shannon index at vegetation area (H' = 2.27) was higher than at non-vegetation area (H' = 1.16). The result of t-student test showed that there is highly significant difference of diversity between vegetation area and non-vegetation area ($t_{calc.}$ = 23.34 > t_{table} = 3.30; p = 0.001, df = 928). However, Mason (1981) stated that diversity based on Shannon index can be categorized into three namely low (H' < 1), moderate (1 ≤ H' ≤ 3) and high (H' > 3). Based on those, diversity of Echinoderms in Tanjung Tiram can be categorized as moderate.

The evenness index of Shannon (E) of Echinoderms in Tanjung Tiram for overall, vegetation and non-vegetation areas were 0.55, 0.82 and 0.48, respectively. Based on Magurran (1991), evenness index ranging from 0 to 1, in which E = 1 indicating equal number of individual for every species in the community. Furthermore, Odum (1975) stated that a community is in stable condition if the value of E ≥ 0.6. Based on this criterion, Echinoderms community at vegetation area is the only one which is in steady condition.

Overall, Simpson dominance index of Echinoderms community in Tanjung Tiram was 0.33. Based on location, the index at non-vegetation area (D = 0.43) was higher than at vegetation area (D = 0.14). According to Legendre & Legendre (1983), the dominance index can be categorized into three i.e. low (D < 0 .4), moderate (0.4 < D < 0.6) and high (D > 0.6). Based on those criteria, non-vegetation area has moderate value while vegetation area and mix area (vegetation + non-vegetation) have low dominance indexes. To describe diversity, reciprocal of dominance index ($1D^{-1}$) is used more frequent than dominance index (D) because increasing in the reciprocal value will increase diversity (Magurran 1991). The value of reciprocal index for vegetation area was 7.00 whereas its value for non-vegetation area was 2.33, which indicates that Echinoderms community at vegetation area is more diverse than at non-vegetation area.

Low diversity at non-vegetation area is caused by dominance of one or more species at that area. It can be seen in Table 2 that there are two species i.e. *D. setosum* and *E. calamaris* which consist up to 90% of the total individual dominate Echinoderms community at non-vegetation area.

Conclusions. A total of 16 species which consist of 2012 individuals from three classes of Echinoderms namely Holothuroidea (9 species), Echinoidea (4 species) and Asteroidea (3 species) were collected during the study. *Holothuria scabra* has the highest occurrence frequency while the highest density belongs to *Diadema setosum*. Based on Shannon index, diversity of Echinoderms at Tanjung Tiram can be categorized as moderate, but only Echinoderms community at vegetation area (seagrasss beds) has a steady state condition.

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