E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2017; 5(2): 311-315

www.fisheriesjournal.com
Received: 11-01-2017
Accepted: 12-02-2017

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Density and diversity of echinoderms in seagrass bed, Baguala Bay, Maluku, Eastern Indonesia

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Abstract
Coastal waters of Suli have an extensive seagrass bed which several of marine biota inhabitant. One of them is echinoderms which associated in the seagrass bed. The objective of the present study was to determine the density and species diversity of echinoderms at Suli coastal waters, Maluku, Indonesia. Sampling was conducted by using transect line from September to December 2014. The results showed that there were 17 species found which belonged to class Asteroidea, class Echinoidea, class Holothuroidea and class Ophiuroidea. The highest density was from class Echinoidea and followed by class Holothuroidea. Species diversity of the echinoderm was low and the number of individual of each species was nearly equal as well as certain species tend to dominant namely *Echinometra mathaei* and *Synapta maculata.* Community of echinoderms consisted of three groups which the similarity was higher than 50% at two groups of station whereas other 5 stations had low similarity.

Keywords: Seagrass, echinoderms, diversity, Baguala bay

1. Introduction
The seagrasses are aquatic angiosperms, which found exclusively in the marine environment with various substrates [1]. The occurrence of seagrass beds in shallow waters plays important roles as primary producer, nutrient cycle and carbon, spawning and nursery grounds for benthic organisms and fish, sediment stablilizer, providing area for nursery, feeding ground and shelter area for many species such as fish and shellfish [2].

Echinoderms are one of the macrobentic animal associated with the seagrass. Echinoderms have an important role in the ecology of seagrass is a primary consumers in the food chain cycle in these ecosystems [3] and echinoderms can act as a beach cleaner for marine organisms which consuming organic materials that go into the water. Additionally, echinoderms are an export commodity that has a high value (e.g sea cucumbers) and important source for food and medicine industries in Malaysia [4]. Nowadays, certain species of sea urchins are culture due to their delicious gonad [5] whereas starfish are sold as souvenirs [6].

Coastal waters of Suli has a sloping topography with varies substrate so that support for seagrasses can grow well. Suli has an extensive seagrass beds. These conditions allow for several of marine life, especially for echinoderms with diverse species in this ecosystem. Species diversity is one of the characteristics of a community level. Species diversity can be used to express the community structure. A community has a high diversity if they are developed by many species and have equal abundance of each species [7].

The objective of the present study was to determine the density and species diversity of echinoderms at Suli coastal waters, Maluku, Indonesia. The results of this study are expected to provide information about the community structure of echinoderms in seagrass ecosystems as well as a recommendation for the stakeholders in coastal zone management, especially management of seagrass ecosystem and its organism associated.

2. Materials and Methods
2.1. Study site
The study was carried out in the coastal waters of Suli ($128^0$17'26"- $128^0$18'15"E and $03^0$37'00"- $03^0$38'19"S), Baguala bay, Maluku Province, Eastern Indonesia from September to December 2014 (Fig. 1). The substrates consisted of sand, mud, sand muddy, rocks to rubble.

There are seven species of seagrass found which are *Enhalus acoroides, Cymodocea rotundata, Cymodocea serrulata, Halodule uninervis, Thalassia hemprichii, Syringodium isoetifolium,* and *Halophila ovalis*.

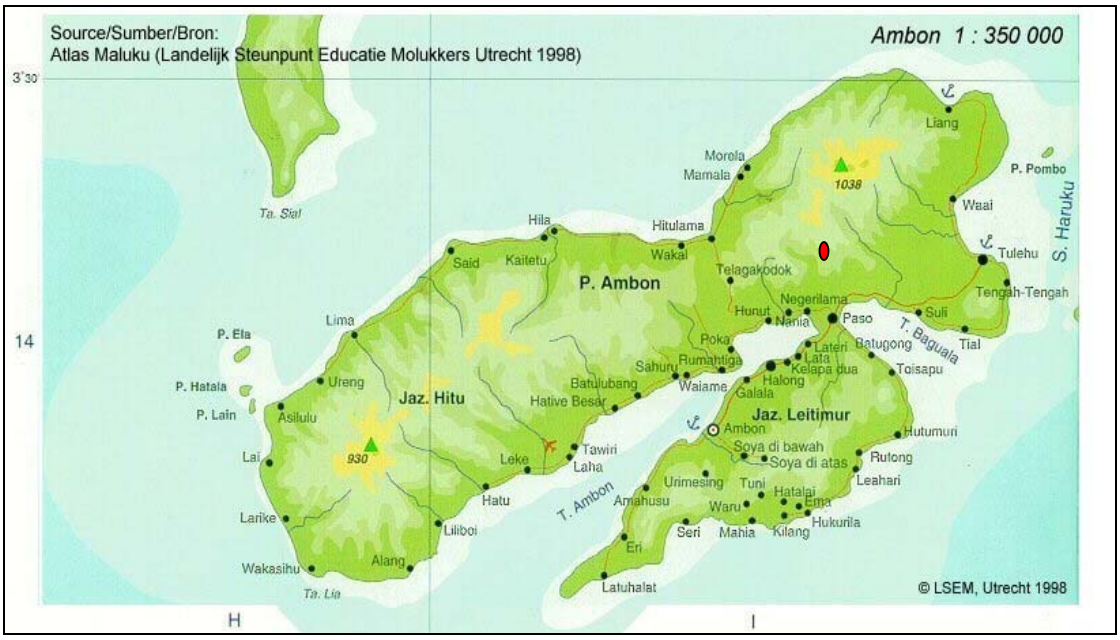

Fig 1: Study area site (red circle) in the coastal waters of Suli, Baguala bay, Maluku Province, Eastern Indonesia

2.2. Field sampling and Data analysis.

Sampling was conducted at seagrass bed following line transect method (English *et al.,* 1997) [8] for nine stations. Transects was laid perpendicular to the shoreline at each station during low tide. The quadrates measured 10 x 10 m^2 was placed along the transect line. All echinoderms found in each transect were counted and some individuals were collected for identification. The preserved samples with alcohol were identified following guideline by Clark and Rowe (1971) [9], Cannon and Silver (1987) [10], Colin and Anerson (1995) [11], and Susetiono (2004, 2007) [12, 13]. Data were analyzed by using PRIMER 6 [14] and PAST [15] softwares.

3. Results and Discussion

3.1. Species composition

A total of 544 individuals of 17 species found belonged to four classes: Asteroidea (starfish), Echinoidea (sea urchin), Holothuroidea (sea cucumbers) and Ophiuroidea (brittle stars) (Fig. 2). It could be seen from Fig. 2 that the Holothuroidea was the most occupied the seagrass bed almost 50% respectively. Whilst the other three classes were similar percentage.

The Holothuroidea had higher species than other 3 classes which consisted of 8 species and prefer gravel, sand and muddy substrate. The Holothuroidea was also dominant in Hormuz Island and preferred mud and gravel, and rock with mud and gravel substrates [16]. Similarly, Tuapattinaja *et al*., (2014) [17] also found that the Holothuroidea was dominant class of echinoderms in Tanjung Tiram.

Otherwise, some studies showed that echinoidea and ophiuroidea were pre-dominant in the community structure of echinoderms [18, 19, 20]. It is suggested that the occurrence of echinoderms depend on environmental and biological factors. Mandal and Harkantra (2013) [21] stated that temperatures in the tropics had less effect on benthic invertebrate with reference to seasonal changes in food availability. Therefore, benthic invertebrate inhabiting intertidal zone may still stable all the year [22] and also in the regions with difference rainy and dry seasons [23].

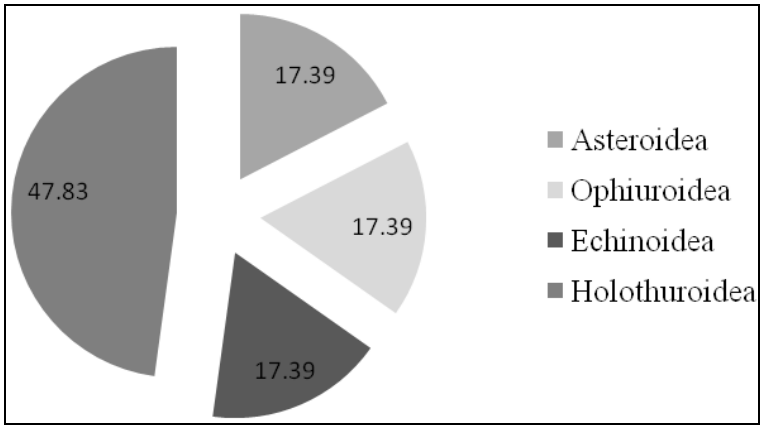

Fig 2: Percentage composition of echinoderms in seagrass bed at Suli

There were five species found of the Holothuridae considered to have economic value and known as sea cucumber (Table 1). Among the five species, *Holothuria scabra* was more expensive than others four species.

Table 1: Species composition of echinoderms in Suli (*= low economic value, **= high economic value).

Class	Family	Genus	Species
Asteroidea	Archasteridae	*Archaster*	*A. typicus*
	Ophidiasteridae	*Linckia*	*L. laevigata*
	Oreasteridae	*Protoreaster*	*P. nodosus*
Ekinoidea	Diadematidae	*Diadema*	*D. setosum*
		Echinotrix	*E. calamaris*
	Echinometridae	*Echinometra*	*E. mathei*
	Toxopneustidae	*Tripneustes*	*T. gratilla*
Holothuroidea	Holothuriidae	*Bohadschia*	*B. argus**
			*B. marmorata**
		Holothuria	*H. atra**
			*H. edulis**
			H. hilla
			*H. scabra***
	Synaptidae	*Synapta*	*S. maculata*
		Opheodesoma	*O. spectabilis*
Ophiuroidea	Ophiocomidae	*Ophiomastix*	*O. annulosa*
	Ophiuriae	*Ophiolepis*	*O. superba*

3.2. Density of echinoderms

It could be seen from Fig. 3 that the density of echinoderms ranged from 2.3-12.92 ind.100m^{-2} and the average was 6.69 ind.100m^{-2}(± 3.47 SD). Station 3 had the highest density (12.93±3.47 SD) followed by stations 9, 8, 7, 6, and 5. The density of other stations was less than 5.28 ind.100m^{-2}. Station 3 had hard substrate such as rocky, coral fragment, gravel, pebbles and the sea urchin *Echinometra mathaei* was found in high number of individuals compare to other species. The common substrate from other stations was sand, mud and gravel, so they have also different kind of species.

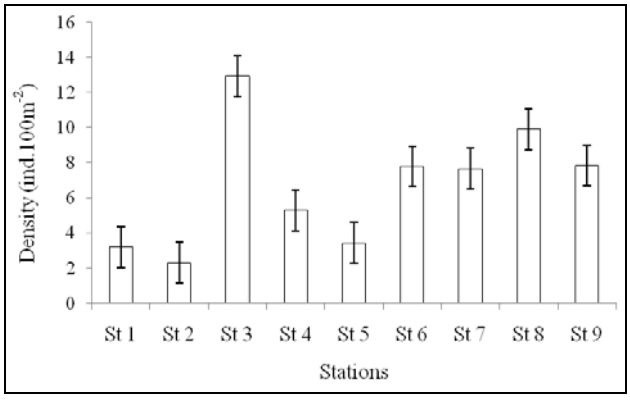

Fig 3: Density of echinoderms at Suli waters

Among the four classess, the echinoidea had higher density than that of other classes eventhough consisted of only four species and followed by the holothuroidea, asteroidea and ophiuroidea (Table 2). The highest density was represented by *E. mathaei* which distributed in all stations specifically from middle intertidal to lower intertidal with the mix substrate found. *E. mathaei* was found in the crevices of reef flat, sand mud and prefered to associate with *Cymodoceae serrulata, Syringodium isoetifolium* and *Thalassia hemprichii*. According to Chiu (1985) *cited in* Supono and Arbi (2010) [3] that *E. mathaei* was herbivore that was consumed algae and seagrass. In addition, a study which analyzing the stomach contents of several species of sea urchins found that they consumed seagrass *Thalassia hemprichii* and *Syringodium isoetifolium* (Mukai & Nojima 1985 *cited in* Supono and Arbi, 2010) [3]. Both two species of seagrass are mostly found in the study sites. So, it could be assumed that the highest density of *E. mathaei* was due to the availability of food in the area. This species was also unconsumed by local community not like *Tripneustes gratilla*, a harvested species.

Apart from the echinoidea, the high density species was also shown by *Synapta maculata* which belonged to the holothuroidea (Table 2). *S. maculata* could be found most among the root of seagrass, hiding it. In addition, the local community considered that this species was toxic, so it was not good to be consumed. Therefore, this species could be found in high number of individuals compare to other holothuroidea.

Table 2: Density of echinoderms in sea grass bed at Suli

No	Class/Species	Density (ind.100m^{-2})
	Asteroidea	
1.	*Archaster typicus*	1.86
2.	*Linckia laevigata*	0.7
3.	*Protoreaster nodosus*	1.57
	Total	4.13
	Echinoidea	
4.	*Diadema setosum*	1.9
5.	*Echinothrix calamaris*	0.88
6.	*Echinometra mathaei*	33.32
7.	*Tripneustes gratilla*	0.83
	Total	36.93
	Holothuroidea	
8.	*Bohadschia argus*	0.20
9.	*B. marmorata*	0.44
10.	*H. atra*	1.5
11.	*H. edulis*	0.97
12.	*H. hilla*	0.72
13.	*H. scabra*	0.66
14.	*Synapta maculata*	15.47
15.	*Opheodesoma spectabilis*	0.63
	Total	20.59
	Ophiuroidea	
16.	*Ophiomastix annulosa*	1.11
17.	*Ophiolepis superba*	0.2
	Total	1.31

3.3. The diversity of echinoderms

Species diversity was indicated by species richness and equitability of individuals among species. Beside that there were several indices which related to species diversity namely species diversity index (Shannon Index, H'), dominance Simpson Index (λ'), and evenness index (E).

Overall, Shannon diversity index (H') of echinoderms in Suli ranged from 1.30 to 2.16 (1.71±2.99). The diversity index (H') of echinoderms ins Suli was higher than diversity index (H') of echinoderms in Moti island, North Maluku [19] and Teluk Kuta, West Nusa Tenggara [24] and Tanjung Tiram, Maluku [17]. On the other hand, it was low compared to the diversity index in Tanjung Merah, North Sulawesi [18]. According to Mason (1981) [25], the diversity index (H') could be classified into three namely low ((H' < 1), moderate (1 ≤ H' ≤ 3) and high (H' > 3). Therefore, it could be suggested that species diversity of echinoderms in Suli was moderate

The eveness index (E) for echinoderms in Suli fom 0.78-0.94 (0.87±0.63) respectively. Similar to Shannon diversity index (H'), the eveness index was high compared to evenness index of echinoderms in Tanjung Tiram [17] but it was lower than that of echinoderms in Tanjung Merah, North Sulawesi [18]. Magurran (1991) [7] stated that the eveness index ranged from 0-1, so there was almost equal number of individuals for each species in echinoderms found in Suli. The echinoderms community in Suli was also in steady state condition based on Odum (1975) [26] in which E ≥ 0.6.

The dominance index (D) for echinoderms overall in Suli ranged from 0.67-0.87 (0.77±0.73) respectively. Legendre and Legendre (1993) [27] stated that the dominance index (D) could be divided into three categories specifically low (D < 0.4), moderate (0.4 < D <0.6) and high (D > 0.6). So, the echinoderms community in Suli belonged to high value. It means that there were some dominant species such as *Echinometra mathaei* (54%) and *Synapta maculata* (25%).

All diversity indices among stations were higher in station 6 compare to other stations. The reasons were probably due to various substrates (sand and coral fragment), dense of seagrass and high species richness.

Cluster analysis indicated that there were 3 main groups between stations (Fig. 4). First group includes stations 7 and 9, the second group includes stations 1, 2, 5, 6 and third group was stations 8, 3, 4. The similarity ranged from 5.16-55.29%. The high similarity was from second group which was 55.29% (Station 1 and 2) and 53.98% (Station 5 and 6). Out of 17 species of echinoderms, there were 4 species could be found at station 1 and 2 such as *Linckia laevigata, Archaster typicus, Echinometra mathaei* and *Synapta maculata* whereas 6 species could be found in station 5 and 6 namely *Protoreaster nodosus*, *Linckia laevigata, Echinothrix calamaris, Synapta maculata, Holothuria atra* and *H. scabra.* On the contrary, the highest different in species was 74.26% at third group station 3, 4 and 8 followed by the first group station 7 and 9 (58.77%). Meaning, the species similarity among station 3,4,8,7 and 9 was less than 50%.

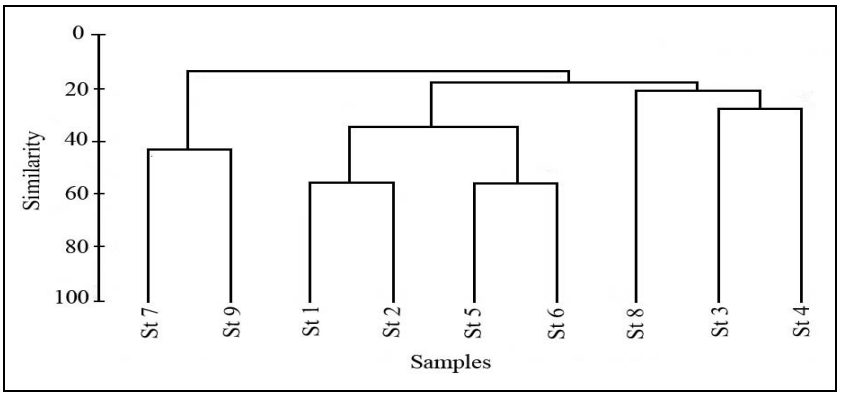

Fig 4: Dendrogram showing similarity of echinoderms among stations at Suli waters

4. Conclusion

There were 17 species from 4 classes of echinoderms found at seagrass bed in Suli waters, Baguala bay with the highest density was represented by *Echinometra mathaei* and followed by *Synapta maculata.* The echinoderms diversity was moderate, steady state condition with two dominant species. Species similarity was higher than 50% from station 1 and 2; station 5 and 6 while other 5 station had low species similarity.

5. Acknowledgement

This study was a part of research funded by Directorate of Higher Education through scheme PHB year 2014 to the authors.

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