Global Scientific JOURNALS

GSJ: Volume 7, Issue 9, September 2019, Online: ISSN 2320-9186
www.globalscientificjournal.com

COMMUNITY STRUCTURE AND DISTRIBUTION PATTERN OF SEA CUCUMBER WITH SUBSTRATE PREFERENCE ON COASTAL WATERS IN TUNDA ISLAND, BANTEN

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ABSTRACT

This study aims to examine the community structure and distribution pattern of sea cucumber with substrate preference on coastal waters in Tunda Island, Banten. This study was conducted in August 2019 which is located on South, East, North, and West coastal waters in Tunda Island using the survey method. Data collection was examined consisted of community structure and distribution pattern, water quality parameter, granulometry, and total organic matters. Data was analyzed using descriptive quantitative approach. Observations found 50 (fifty) individuals consisted of 5 (five) species. *Synapta maculata* was classified in order Apodida and *Actynopiga miliaris, Bohadshcia similis, Holothuria nobilis,* and *Holothuria atra* were classified in order Aspidochirotida. The highest density of *S. maculata* was reported on the muddy-sandy, rubble substrate in Station 1. Station 2 The highest density *S. maculata* was reported on the muddy, rubble substrate in Station 2. The highest density of *A. miliaris* was reported on the sandy-muddy, rubble substrate in Station 3. The highest density of *H. atra* was reported on the sandy-muddy, rubble substrate in Station 4. Based on the result, the community structure of sea cucumber was relatable with the observation of substrate preference on each station which was supported by the water quality parameter.

KeyWords

Community Structure, Density, Distribution Pattern, Sea Cucumber, Substrate, Total Organic Matter, Tunda Island

Introduction

Sea cucumbers are a rich diversity of marine biodiversity in Indonesia's marine waters. Sea cucumbers are marine biota of Echinodermata phylum that have ecologically and economically significant roles. In ecological point of view, sea cucumbers contribute as deposit feeders, in a manner of processing the substrate they occupy and as food providers in the form of eggs, larvae and juvenile sea cucumbers for predators in the vicinity. While economically sea cucumbers provide very high nutrient contents. In dry conditions, sea cucumbers contain 82% protein, 1.7% fat, 8.9% moisture content, 8.6% ash content, and 4.8% carbohydrate (Mulyono et al., 2017).

Tunda Island is one of the Banten regions that potentially provides marine biodiversity resources yet unexplored. Marine ecosystems in Tunda Island are strategic areas for regional conservation zones. Tunda Island has rich biodiversity due to three important marine and coastal ecosystems i. e, mangrove, seagrass, and coral reef. Thus, sustainability of these ecosystems are further jeopardized by nature and anthropogenic impacts (Darus et al., 2011).

Besides marine and coastal ecosystems in Tunda Island, assosiated biota i.e sea cucumber, starfish, and macrozoobenthos may need to remain linked to critical habitat determination. *Holothuria* sp. is one of the macrozoobenthos species which reported in the Tunda Island waters (Pamungkas, 2017). Sea cucumbers have the roles as deposit feeders and suspension feeders. Its existence contributes the substrate enrichment (Darsono, 2007).

Sea cucumbers' existence in the waters is likely determined by substrate preferences. The coastal waters in Tunda Island visually has fine sandy substrate, muddy-sandy substrate and coarse sandy, rubble substrate. It generally affects the potential habitat of sea cucumbers (Sarmawati et al., 2016).

No attempts have so far been made to understand the distribution patterns or quantitative estimations of the sea cucumbers in Tunda Island. Therefore, it is important to determine the species of sea cucumbers that associated on coastal waters in Tunda Island with substrate preferences to acknowledge the structure community of the sea cucumbers along with their distribution patterns.

Methodology

This study was conducted on coastal waters in Tunda Island, Banten (5048'43"S dan 106016'47"E) for 2 days on August 2019 (Figure 1).

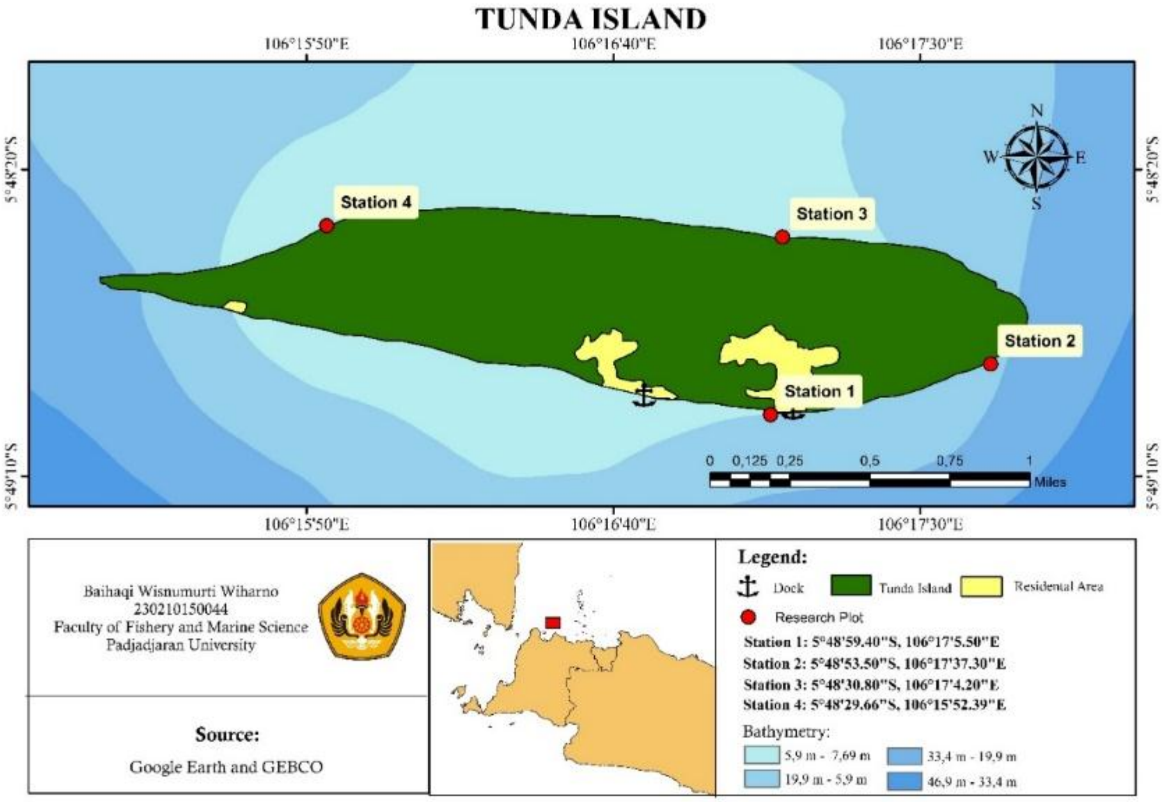


Figure 1. Research Location in Tunda Island, Banten

This study used a survey method on field observations in the predetermined stations (station 1, 2, 3, and 4). The sampling unit was a 5 x 5 m transect. Observations used a roll meter tool to limit and represent the observation area. Area of observations reached 50 m with the distance between transects was 2 m (Directorate of Marine Conservation and Biodiversity, 2015). Data was analyzed using descriptive quantitative approach.

Parameter of Observation

Water Quality

Water quality sampled with 3 (three) repetitions at each station. Data sampling included i.e water clarity, temperature, acidity (pH), Dissolve Oxygen (DO), current velocity, water depth, and salinity.

Granulometry

Analysis of sedimen samples used sieve shaker to examine the sedimen fractions. The results were further processed at kummod cell software.

Total Organic Matter

Loss on Ignition method is frequently used method of analysis to examine the value of total organic matter. The formula is used to obtain the value (Allen et al., 1975), as the following :

$$\%TOM = \frac{Wo - Wt}{Wo} x\ 100\%$$

TOM : Total Organic Matter (%)
Wo : weight of observation (gram)
Wt : weight of total (gram)

Density of Sea Cucumber

The density of sea cucumber is the total number of individuals of sea cucumber in area of observation (m^2). Identified samples were used in the formula (Brower dan Zar, 1977), as the following :

$$K = \frac{Ni}{A}$$

K : density (ind/m^2)
Ni : total number of individuals for spesies-i
A : area of observation (m^2)

Diversity of Sea Cucumber

The diversity of sea cucumber was examined using Shannon-Wienner Diversity Index (Dermawan et al., 2015). Diversity index describes the community structure of an organism to easily analyze the information about species and number of the species. The formula of Shannon-Wiennerr Diversity Index, as the following :

$$H' = -(\sum \frac{ni}{n} Ln \frac{ni}{N})$$

H' : diversity index
ni : total number of individuals for spesies-i
n : total number of individuls for all spesies

Based on the formula above, the Shannor-Wienner diversity index is categorized, as the following :

H'<1 : low diversity
1<H'<3 : moderate diversity
H'>3 : high diversity

Uniformity of Sea Cucumber

The uniformity of sea cucumbers was examined using uniformity index. The uniformity index is used to identify the dominant species in a community and to know the spread of the number of individuals of each species (Odum, 1971). Uniformity index was obtained from ratio of diversity index with its maximum value, as the following :

$$E = \frac{H'}{H'maks}$$

E : Uniformity index
H' : Diversity index
H'maks : Ln S
S : total number of spesies

Based on the formula above, the uniformity index is categorized, as the following :

E < 0,4 : low uniformity
0,4< E < 0,6 : moderate uniformity
E > 0,6 : high uniformity

Dominance of Sea Cucumber

The dominance of sea cucumbers frequently calculates dominance of the particular species on the community. Simpson Dominance index is used to obtain the value (Odum, 1993), as the following :

$$C = \sum (\frac{ni}{N})^2$$

C : Simpson Dominance Index
Ni : total number of individuals for species-i
N : total number of individuals for all species

Distribution Patterrn of Sea Cucumber

The dstribution pattern of sea cucumbers can be identified by Morisita index. The formula of Morisita Index, as the following :

$$ID = n \times \frac{\sum x^2 - N}{N(N-1)}$$

ID : Morisita index
n : total number of station
N : total number of individuals obtained
$\sum x^2$: total number of individuals on each station

Based on the formula above, the morisita index is categorized, as the following :

Id = 1 : random pattern
Id < 1 : dispersed pattern
Id > 1 : cluster pattern

Result and Discussion

Water Quality

The parameters of water quality in the observation sites were 29 – 31.5°C, acidity (pH) 8.4 – 8.6, Dissolved Oxygen (DO) 7.35 – 11 mg/l, salinity (27 – 34 ppt), water clarity at each station was 100% with water depth 0.6 – 0.7 m, and current velocity (0.0016 – 0.053 m/s) (Table. 1).

Table 1. Water quality on coastal waters in Tunda Island, Banten

Parameter	Station			
	1	2	3	4
Temperature (°C)	31.5	32	31 – 31.5	29
Acidity (pH)	8.4 – 8.5	8.5	8.5	8.5 – 8.6
DO (mg/l)	7.8	8.1 – 8.6	9 – 11	7.35 – 9.8
Water clarity	100%	100%	100%	100%
Water depth (m)	0.7	0.6	0.6	0.6
Salinity (ppt)	27 – 28.5	32 – 34	32 – 34	32 – 33
Current velocity (m/s)	0.0016 – 0,0033	0.022 – 0.033	0.037 – 0.053	0.045 – 0.053

Substrate

According to visual approach, Station 1 had sandy-muddy substrate, Station 2 had sandy-muddy substrate with rubble, Station 3 had sandy substrate with rubble, and Station 4 had sandy substrate with rubble. Besides visual approach, sediment sample was analyzed in the laboratory to know further about sediment fraction (Table. 2)

Table 2. Substrate preference in each station

Station	Sediment fraction (%)			Substrate
	Gravel	Sand	Silt	
1	1.8	18.1	80.1	Muddy-sandy, rubble substrate
2	5.6	39.9	54.4	Muddy, rubble substrate
3	13.3	46.2	40.5	Sandy-muddy, rubble substrate
4	17	41.9	31.1	Sandy-muddy, rubble substrate

Station 1 has sediment fraction i.e 1.8% gravel, 18.1% sand, and silt 80.1%. Station 2 has sediment fraction i.e 5.6% gravel, 39.9% sand and 54.4% silt. Stations 1 and 2 had seagrass and mangrove ecosystem with low currents and the presence of coral reef mounds on the edge. These conditions lead sediment easily deposited at the benthic zone. Station 3 had sediment fraction i.e gravel 13.3%, sand 46.2%, and silt 40.5%. Station 4 had a sediment fraction of 17% gravel, 41.9% sand and 31.2% silt. The high currents strongly impacted the sediment fraction in Station 3 and 4. Coarse-sized sediment fractions were generally deposited in the intertidal zone. The waters with high currents, relatively have sand fraction (Nybakken, 1992).

Total Organic Matter

Total organic matter (TOM) on Coastal Waters in Tunda Island ranged from 7.1 – 9.2%. The highest TOM value was reported on Station 1 (Table. 3).

Table 3. Total organic matter in each station

Station	Substrate	TOM (%)
1	Muddy-sandy, rubble substrate	9.2
2	Muddy, rubble substrate	8.1
3	Sandy-muddy, rubble substrate	7.1
4	Sandy-muddy, rubble substrate	7.5

Station 1 has high currents which allowed suspended particles e.g organic matter simply trapped on muddy substrate. The type of sediment and its size is one of the ecological factors and affect the total organic matter where the finer substrate fraction, it potentially traps organic material (Nybakken, 1992).

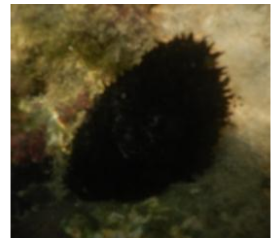
Community Structure of Sea Cucumber

The species of sea cucumber was reported on Coastal Waters in Tunda Island had various species. Observation found 6 species with total number of 50 individuals sea cucumber. The species is classified in order Apodida (e.g *Synapta maculata)* and the species were classified in order Aspidochirotida (i.e *Actynopiga miliaris*, *Bohadshcia similis*, *Holothuria nobilis*, and *Holothuria atra)* (Figure 2).

GSJ: Volume 7, Issue 9, September 2019
ISSN 2320-9186


Synapta maculata


Bohadshcia similis


Actynopiga miliaris


Holothuria nobilis


Holothuria atra

Figure 2. Five Spesies are sampled in the study

Density, Diversity, Uniformity and Morisita Index of Sea Cucumber

The density of sea cucumber obtained from the observation was relatively low, the highest sea cucumber density was *Synapta maculata*. Sea cucumber was surveyed in Station 1 consisted of 4 species. The density of *S. maculata* (476 individuals/ha)*, A. miliari*s (76 individuals/ha)*, B. similis* (38 individuals/ha), and *H. nobilis* (19 individuals/ha) in Station 1. Sea cucumber was surveyed in Station 2 consisted of 2 species. The density of *S. maculata* (210 individuals/ha) and *A. miliaris* (19 individuals/ha) in Station 2. Sea cucumber was surveyed in Station 3 consisted of 1 species. The density of *A. miliaris* (38 individuals/ha) in Station 3. Sea cucumber was surveyed in Station 4 consisted of 2 species. The density of *H. atra* (57 individuals/ha) and *S. maculata* (19 individuals/ha) in Station 4.

The diversity of species describes the existence of a species in the ecosystem. The higher total number of spcies and individuals would slightly impact higher diversity in the community. The diversity of sea cucumber index at four stations were relatively low (Table 4). The diversity index of organisms in the community is generally examined by the number of species and the number of individuals (Weber, 1973 ; Uni et al., 2016). The diversity index will reach its maximum if the density of individuals distribute prevalently, which means the number of individuals are relatively similar. The highest diversity was 0.73 in Station 1. The diversity index was 0 in Station 3 due to only one species was found (e.g *A. miliaris*).

Table 4. Diversity, Uniformity, Dominance, and Morisita Index

Station	H’	Category	E	Category	C	ID	Category
1	0.73	Low	0.53	Moderate	0.63	1.58	Cluster
2	0.29	Low	0.41	Moderate	0.85	2.23	Cluster
3	0	Low	-	-	1	3	Cluster
4	0.56	Low	0.81	High	0.63	0.67	Dispersed

The uniformity of sea cucumber was reported in moderate uniformity (Station 1 and 2) (Table 4). Station 3 could not report the category (1 species) and Station 4 was reported in high uniformity. The high uniformity indicated that the difference between the total numbers of *H. atra* and *S. maculata* was more uniform. The lower the uniformity of species in the community, it means the distribution of individual of each species is not similar and dominates by the particular species (Weber, 1973).

GSJ: Volume 7, Issue 9, September 2019
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The dominance index was 0.63 (Station 1), 0.85 (Station 2), 1 (Station 3), and 0.63 (Station 4) (Table 4). *S. maculata* dominates in Station 1 and 2 with the highest number of individual. Station 3 was only reported *A. miliaris* which dominated in Station 3. *H. atra* dominated in Station 4. The higher the dominance index, the lower the diversity and vice versa (Basmi, 1999).

The Morisita Index was cluster pattern (Station 1, 2, 3) and dispersed pattern (station 4). The cluster pattern is the most common of distribution pattern due to the individuals of the population tend to gather in the various sizes (Odum, 1971).

Distribution Pattern of Sea Cucumber

The distribution map of sea cucumber visualizes the distribution and the relative density of each species with substrate preference (Figure 3). Sea cucumber lives in habitats with clear waters, relatively high currents with cluster pattern (Radjab, 1996). The distribution pattern are also affected by food availability, environmental condition and substrate type (Basuki, 2001 ; Uni et al., 2016). Total organic matter also affected the distribution of sea cucumber. The distribution of sea cucumber was cluster with the highest TOM value (9.2%) in Station 1. The Higher of TOM value will be directly relatable the same with the total number of sea cucumber.

S. maculata is the species with the highest density among all species in four stations. This species was found to be sheltering with seagrass beds (*Enhalus acoroides*). The morphology of Enhalus was suitable for *S. maculata* to be attaching on it. *A. miliaris* was found in Station 1, 2, and 3. This species was found to be attaching on rubble in the observation station. the morphology of genus Actinopyga had a long, short body, and small papillae. Actinopyga would be harden and shorten when it got touched. *H. atra* was only reported in sandy-muddy substrate with rubble in Station 4. *H. atra* had a white body covered by the sand. *H. atra* will coat its body with the sand to avoid the sunlight (Aziz, 1995). Station 4 had a distance from the coastline to the edge (± 30 m). it reached 15 m from the coastline, found several spesies of hard coral.

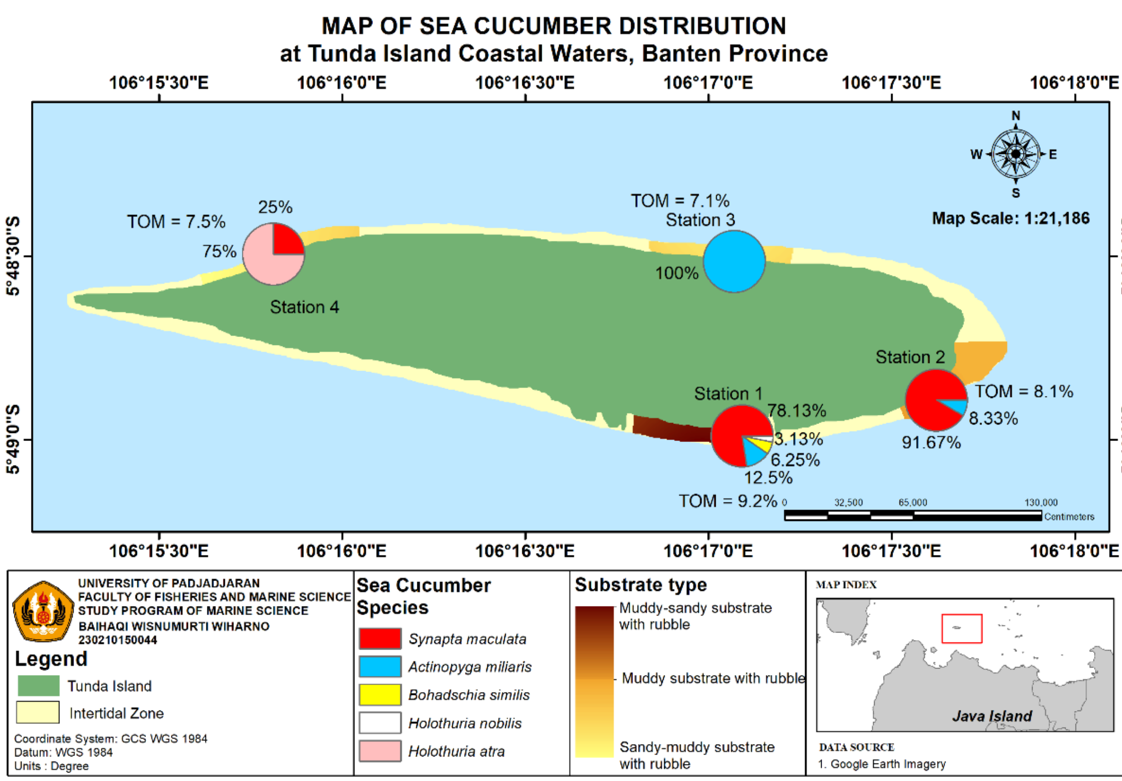

Figure 3. Distribution pattern of sea cucumber on Coastal Waters in Tunda Island, Banten

Most of the sea cucumbers found in the seagrass ecosystem with sandy-muddy, rubble substrate and sandy, rubble substrate. The seagrass beds generally had soft substrate, varying from muddy to coarse sand. The species of sea cucumbers were found in the seagrass beds on the four stations (i.e *S. maculata*, *H. atra*, *B. similis*, *H. nobilis*, and *A. miliaris*).

Conclusion

Observations found 50 (fifty) individuals consisted of 5 (five) species. *Synapta maculata* was classified in order Apodida and *Actynopiga miliaris, Bohadshcia similis, Holothuria nobilis,* and *Holothuria atra* were classified in order Aspidochirotida. The highest density of *S. maculata* was reported on the muddy-sandy, rubble substrate in Station 1. Station 2 The highest density *S. maculata* was reported on the muddy, rubble substrate in Station 2. The highest density of *A. miliaris* was reported on the sandy-muddy, rubble substrate in Station 3. The highest density of *H. atra* was reported on the sandy-muddy, rubble substrate in Station 4.

References

[1] Mulyono, M., Apriandeni, N.S., Nurbani, S.Z., Waluyo, A.S., Hidayat, T.T. 2017. Community structure of sea cucumber on coral reefs in Togean Islands national park central Sulawesi, Indonesia. *International Journal of Fisheris and Aquatic Studies.* 5 (6): 201- 204 p.

[2] Darus, et al. 2011. Biodiversity of Coastal Ecosystems on Tunda Island, Serang Regency, Banten. *Proceedings of Marine National Seminar*.

[3] Pamungkas, E., Riyantini, I., Ihsan, Y. N. 2017. The Community Structure of Macrozoobenthos and Its Implications for the Environment in the Waters of Lada Bay and Tunda Island, Banten. *Proceedings of the National Seminar on Aquatic Ecosystems of Lada Bay and Tunda Island*. 87 – 96 p.

[4] Darsono, P. 2007. Sea cucumbers (Holothuroidea): Natural Wealth in the Diversity of Marine Biota. *Oseana.* 32 (2): 1-10 p.

[5] Bruckner. AW, KA. Johnson, JD. Field 2003. *Convention strategies for sea Cucumber: Can CITES Appendx II listing promote sustainale Internasional trade Beche- de-mer inform.* Bull 18: 24-33 p.

[6] Sarmawati, Ramli M, and Ira. 2016. Distribution and Density of Sea Cucumbers (Holothuroidea) in Tanjung Tiram Waters, North Moramo District, South Konawe Regency. *Journal of Water Resource Management*. 1 (2): 191 p.

[7] Directorate of Marine Conservation and Biodiversity. 2015. *General Guidelines for Identification and Monitoring of Sea Cucumber Populations.* Marine and Fisheries Ministry. Directorate of Marine Conservation and Biodiversity. Marine and Fisheries Ministry.

[8] Allen, S.E., Grimshaw, H.M., Parkinson, J.A. and Quarmby, C. 1974. *Analysis of Soil in Chemical Analysis of Ecological Materials*. Oxford, Blackwell Scientific Publication Oxford.

[9] Brower, J. E. and J.H., Zar. 1977. *Field and Laboratory Methods for General Ecology*. W. M. C. Brown Company Publisher. Lowa.

[10] Derrmawan Wibisono, 2005. Research Methods & Data Analysis. Jakarta: Salemba Medika.

[11] Odum, E. P., 1971. *Fundamental of Ecology. 3 Eds*. W. B. Saunders Company, Philadelphia. 574 p.

[12] Odum, E. P. 1993. *Basics of Ecology*. Gadjah Mada Universty Press. Yogyakarta. 574 p.

[13] Soegianto, A. 1994. Quantitative Ecology. National Business Publisher, Surabaya.

[14] Nybakken, J. W. 1992. *Marine Biology : An Ecologycal Approach*. Gramedia, Jakarta.

[15] Basmi, H. J. 1999. Aquatic Ecosystems: Habitat and Biota. Faculty of Fisheries and Marine Science. Bogor Agricultural University. 64 p.

[16] Basuki, R., Hartati, S. T., and Darmadi. 1999. Research on Sea Cucumber Fisheries Business through Stock Enrichment (Stock Enhancement). *Marine Fisheries Research Center*. 1-10 p.

[17] Aziz, A. 1999. Some Notes on Sea Cucumbers Aspidochirotides. National Institute of Oceanology-LIPI. *Journal of Oceanography.* XX (4): 11-23 p.

[18] Weber CI. 1973. *Biological Field and Laboratory Methods for Measuring the Quality of Surface Water and Effluents*. U.S. Environmental Protection Agency, Office of Research and Development, Cincinnati, Ohio. EPA 670-4: 73-001 p.

[19] Radjab A.W. 1996. *Sea cucumbers in Teluk Un, Dullah Island, North Maluku*. Sea Resources, Research Center for Oceanography - LIPI. Jakarta.
[20] Yusron E. 2001. Structure of a Sea Cucumber Community (Holothuroidea) on the flat reef of Morella coastal waters, Ambon. Indonesian Coastal and Coastal Journal. IV. P20-LIPI: 227-233 p.
[21] Uni W., Ramli M., Ishak E. 2013. Diversity and density of sea cucumbers in the waters of Tanjung Tiram, North Moramo District, South Konawe Regency. Journal of Water Resource Management. 1 (2): 201-211 p.