Biodiversity of megabenthos and coral reef condition in Tuan Island, Aceh Besar

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Abstract. The existence of megabenthos has an important role in maintaining sustainability of coral reef ecosystems and in the food web process. Megabenthos is also often used as an indicator of the health condition of coral reefs. The purpose of study was to analyze the biodiversity of megabenthos associated with coral reef in Tuan Island. This research was conducted in July - September, 2020. There were four research stations determined by purposes method based on four wind directions. Megabenthos data collection carried out by benthos belt transect method and coral reef data collected by using the Line Intercept Transect (LIT) method. The results were found 8 species of megabenthos target, namely spiny starfish (Acanthaster planci), blue starfish (Linckia laevigata), sea urchins (Diadema setosum), sea cucumbers (Holothuria atra), clams (Tridacna squamosa), Drupella snails (Drupella sp.), lola clams (Tronchus niloticus) and lobster (Panulirus versicolor). Totally, there were 190 individuals of megabenthos with the abundance ranged from 0.18 to 0.52 individuals/m². Diadema setosum had the highest abundance with the value 0.9 individuals/m² followed by Drupella sp. (0.3 individuals/m²). The highest diversity index was station 4 followed by station 3, 2, and 1 with the value of 2.21, 0.85, 0.64, and 0.41, respectively. The diversity index was categorized as low and medium. The average of evenness and dominance indices were 0.04 and 0.62, both was medium category. The highest percentage of coral cover was at station 1 followed by station 3, 4, and 2, the coral cover value were 50.44%, 29.20%, 18.14%, and 9.29%, respectively. The correlation (r) between the percentage of coral reef cover and megabenthos abundance has a positive correlation, but the level of correlation was low (0.215 %). The density of megabenthos on Tuan Island did not have a major influence on coral reef cover where the determination value (R²) was 0.0462 which indicated that the megabenthos abundance was influenced by the percentage of coral reef cover only 4.62%.

1. Introduction
Tuan Island is a small island which is administratively located in the waters of Ujong Pancu, Peukan Bada District, Aceh Besar (5° 33' 52.104” North Latitude and 95° 14' 58.643” East Longitude). Tuan Island has several types of potential ecosystems that are complete habitat for aquatic fauna i.e. coral reef ecosystems and seagrass beds. The coral reefs ecosystem is one of tropical ecosystems characterized by high fauna diversity and macrobenthos contribute to the diversity of coral reef [1; 2; 3]. Rudi [4] stated...
that the people in the Ujong Pancu area depend on the natural resources around them, especially from marine resources. However, the lack of education and empowerment of the local community making utilization of natural resources has not been carried out an environmentally manner i.e. they use of poisons in fishing activities at the coral reef ecosystems. Aldyza and Afkar [5] mentioned that fishing activities by fishermen around Tuan Island had been carried out using explosives (bombs), bottom nets (trawlers), and poison (potassium). This community activities have negative impact and the disturbance of existence not only coral reef but also megabenthos life. Benthic fauna have varied in size and size of megabenthos might be important ecological relationships among groups. There are four groups benthos based on size, namely microbenthos, meiobenthos, macrobenthos, and megabenthos. Moreover, marine benthic megafauna can reach 0.5–1 cm in size [6, 7].

Megabenthos is one of groups an organisms found around Tuan Island and it has a role as a source of food for other organisms, and some megabenthos are consumed by local communities. Megabenthos are also used as an indicator for monitoring coral health conditions and they are divided into three major groups based on their benefits to humans and coral reef ecosystems, namely echinoderms, molluscs, and crustaceans [8]. Commonly, some species of megabenthos target that inhabit coral reef ecosystem such as sea cucumbers, giant clams, lobsters, sea snail, spiny starfish, sea urchins, and blue sea stars [9,10]. Furthermore, megabenthos have roles in the cycle nutrients and secondary producers, supporting food chain in an ecosystem as food for demersal fish and marine mammals [11].

There are several studies about megabenthos associated in coral reef ecosystems [12-15]. The megabenthos as sample target included aquatic biota that have high economic value and have an ecological role in the coral reef ecosystem. Therefore, an assessment of megabenthos and coral reef community structure are needed and taking into consider that Tuan Island is one of the places for local people to fishing area, and this place also has a great potential as marine tourism. More specifically, the objective of the present study was to analyze the megabenthos abundance and their composition inhabit at coral reef ecosystem, Ujong Pancu sub district, Aceh Besar.

2. Materials and Methods Implementation

2.1. Research Location and Time
The research was carried out in July to August 2020, and it was done in Pulau Tuan Island, Peukan Bada Sub district, Aceh Besar (Figure 1).

Figure 1. Map showed research location (red dot)
2.2 Study Area
The research station as sampling location was determined by purposive sampling method based on the four wind directions so it can represent the entire waters of Tuan Island. Each station was recorded by GPS (Global Positioning System). Station 1st located in North direction, station 2nd, 3rd, and 4th were West, South, and East direction, respectively (Figure 1).

2.3 Megabenthos data collection
Sampling of megabenthos target carried out by benthos belt transect method [16]. There were 4 (four) stations established in the sampling site and each site had 3 plots as replications. Plot as observation area have transect size applied 20 m in length and 1 m of right and left in width, and interval of each plot was 5 m (Figure 2). Megabenthos observations were carried out more carefully, because most of the target megabenthos were in the crevices of the coral reefs, good buoyancy was needed in order to save the coral reef habitat around the observation area. The megabenthos obtained were identified using the Tropical Pacific Invertebrates identification book [17].

![Figure 2. Benthos Belt transect method applied to assess megabenthos target](image)

Some parameters measured are megabenthos abundance, and biological indices (diversity, evenness, dominance indices) of megabenthos community. Abundance is the number of individual each species in the area. The formula of megabenthos abundance as state following formula [18]: \[ D = \frac{n_i}{A} \], where, \( D \) is the abundance of megabenthos (individuals/m\(^2\)); \( n_i \) is the number of individuals each species found (individuals), \( A \) is the sampling area (m\(^2\)).

The diversity express the number of megabenthos species and how the number of individuals spread in each type and sampling location. The diversity is calculated using the Shannon-Weaver formula [18] as follows: \( H' = -\sum_{i=1}^{t} p_i \log_2 p_i \), where, \( H' \) is the diversity index, \( P_i \) is the proportion of individuals in the- \( i \)th species. \( \log_2 p_i \) is 3.362 log \( p_i \).

Evenness index was calculated by using the formula as follows below [18]: \( (E) = \frac{H'}{\log_2 S} \), where \( E \) is Evenness index, \( H' \) is diversity index, and \( S \) is the number of species.

Dominance index is used to obtain information about the dominant of megabenthos species in a community. The dominance index is calculated using the formula as follows [18]: \( D = \sum_{i=1}^{t} \left( \frac{n_i}{N} \right)^2 \), where \( D \) is Dominance index, \( n_i \) is the number of individual each species, \( N \) is total of individuals.

2.4 Coral reef data collection
Coral reef life form data was collected using the Line Intercept Transect (LIT) method. The length of the transect used was 20 m and it had three replications. Each plot as a segment is limited to 5 meter intervals in each segment. Transects were placed parallel to the shoreline following the contours of the sea bottom at a depth of 3 to 5 m. Coral reef data was recorded on each coral reef intersected with the transect [19]. Furthermore, the results that have been obtained are observed based on the similarity of characteristics and shapes of coral life forms based on the coral identification book Corals of the World Vol. 1 [20] Corals of the World Vol. 2 [21], and the book on coral species in Indonesia [22].
percentage of coral cover is calculated using the following formula: 
\[
\text{Coral reef cover (\%) = } \frac{\text{Total per habitat class (\%) \times Total per transect (\%)}}{100}\%
\]

2.5. Measurement of water environment parameter

The environmental parameters measured were temperature, salinity, and pH. Those parameters were taken in water surface approximately 0-20 cm at each station and three repetition. The environmental parameters were measured by in situ as well as mengabethos and coral reef sampling.

2.6. Data analyses

The relationship between megabenthos in the study area and coral cover percentage analyzed by using linear regression. Linear regression analysis was used to see how big the effect of megabenthos abundance with coral cover percentage.

3. Result and Discussion

3.1. Composition and Abundance of Megabenthos

The result of present study obtained 8 species from 8 target megabenthos groups in four sampling sites. Megabenthos species found were spiny starfish (*Acanthaster planci*), blue starfish (*Linckia laevigata*), sea urchin (*Diadema setosum*), sea cucumber (*Holothuria atra*), clam (*Tridacna squamosa*), Drupella snails (*Drupella* sp.), lola clam (*Tronchus niloticus*), and lobster (*Panulirus versicolor*). Totally, 190 individuals of megabenthos were recorded, the species distribution within station and their composition of each species was presented in the Table 1 and 2.

The highest presence of megabenthos was at station 4 where all the target megabenthos were found (8 species), followed by station 1 and 3 (4 species), and station 2 (3 species). It has assumed because the substrate of station 4 contained rocky, sand, dead coral and rubble. The substrate condition in station 4 suitable for all megabenthos target, there are wide gap for *Panulirus versicolor*, submassive coral life form liked by *Drupella* sp., and *Holothuria atra* found on the sand. The community structure of macrobenthos was significantly associated with the habitat and substrat types [12]. Syukra et al. [14] reported that in Pasumpahan Island was 218 individuals from four megabenthos, namely *Tridacna* spp. (giant clams), *Diadema setosum* (sea urchin), *Trochus* spp. (sea snails), and *Acanthaster planci* (crown of thorns starfish). Six megabenthos species was reported by Febrianto et al. [23] in Natuna Island.

The abundance of megabenthos obtained in station 1, 2, 3, and 4 ranged from 0.01 to 0.38 individuals/m², 0.01 to 0.18 individuals/m², 0.01 to 0.24, and 0.01 to 0.26, respectively. Muttaqien et al. [24] obtained the megabenthos abundance was 0.14 individuals/m² in National Park, Baluran [24]. The highest megabenthos abundance was at station 4 (0.61 individuals/m²) with the total number was 73 individuals and station 2 had the lowest abundance (0.21 individuals/m²). Station 4 not only had the highest number of abundance but also each species present in all station presumed due to substrate type.

| No. | Family          | Genus    | Species            | 1 | 2 | 3 | 4 |
|-----|----------------|----------|--------------------|---|---|---|---|
| 1.  | Acanthasteridae| Acanthaster| Acanthaster planci | - | - | - | + |
| 2.  | Ophidiasteridae| Linckia  | Linckia laevigata  | - | - | + | + |
| 3.  | Diadematidae   | Diadema  | Diadema setosum    | + | + | + | + |
| 4.  | Holothuriidae  | Holothuria| Holothuria atra    | + | + | + | + |
| 5.  | Cardiidae      | Tridacna | Tridacna squamosa  | - | - | + | + |
| 6.  | Muricidae      | Drupella | Drupella           | + | + | + | + |
| 7.  | Trochidae      | Tronchus | Trochus niloticus  | - | + | + | + |
| 8.  | Palinuridae    | Panulirus| Panulirus versicolor| + | + | + | + |

(+) = present  (-) = absence
The highest number of species was found in the species *D. setosum* as many as 128 individuals with the species abundance was 1.07 individuals/m² and followed by *Drupella* sp. with the abundance was 0.31 individuals/m². In contrast, *Tridacna* spp. has the highest abundance in Pasumpahan Island (0.77 individuals/m²) due to life form in the area dominated by massive reefs [15]. The presence of *D. setosum* in large numbers indicated that unhealthy corals condition [25]. This result was caused by substrate types in each station were dead coral, coral rubble, and sand. According to Noviana et al. [26] substrates in the form of coral fragments, sand, and muddy sand are suitable for the life of *Diadema* sp. because coral fragments can be overgrown by algae. *D. setosum* utilizes seagrass and algae as food sources [27]. *D. setosum* is cosmopolitan species and it was found commonly in the coral reef ecosystem. Moreover, *D. setosum* are widely spread on the Indo-Pacific Ocean and they are can adapt well in many kind of substrat type [28]. *Drupella* sp. is a polyp-eating snail corals and their existence is highly dependent on the condition of the coral reefs that are used as a place looking for food for the organism [29; 30]. Lalang et al. [31] reported that *Drupella* density is negatively correlated with live coral cover, station 4 had bad coral cover percentage and this condition cause high *Drupella* abundance. *A. planci* is low abundance and only found in station 4, the existence of *A. planci* is considered threaten coral reefs if the abundance of 14 individuals/1000 m² or 0.014 individuals/m² [32].

The physical and chemical of water showed that these factor are directly/indirectly affect the present of megabenthos in the sampling area. The salinity of water ranged from 30‰ to 32‰. According to Suryanti & Ruswahyuni [27] salinity of 30-32‰ supports the life of sea urchins. The salinity range for coral growth was 25-35‰ [33]. In addition, the water temperature ranged from 31.5-32°C to support the growth and life of sea urchins.

Some megabenthos targets which have economical value were *H. atra* (sea cucumbers), *P. versicolor* (lobsters) and *Tridacna* sp. (giant clams). Those species have a relatively very low number of individuals and they have a limited distribution. Low the abundance of these economical species assumed because of biota aquatic target exploited by local people not only for market purposes but also as food consumption. The lowest megabenthos abundance was *Tridacna squamosa*, this assumed not only was caused by exploited activity but also substrate type which was not dominated by massive reefs.

### 3.2. Biological Indices

Biological indices are important tool in order to show the community structure of organism. Biological indices consisted of diversity, evenness, and dominance indices. The results showed that the highest megabenthos diversity was found at station 4 with a value of 2.21 categorized medium and the lowest at station 1 (0.41) categorized low diversity (Table 3). The average of diversity index of megabenthos target in Tuan Island was 1.03 (medium category). The category of diversity indices proposed by Odum [18] were low if H'<1, medium if 1<H ≤3, and high if H'>3. Ucu [34] stated that the high and low categorizes of the diversity index can be caused by several factors, including the number of species or

| No. | Megabenthos species | Abundance (individuals/m²) | Total |
|-----|---------------------|-----------------------------|-------|
|     | ni                  | Di                          | ni    |
| 1   | *Acanthaster planci* | 0 0                         | 2     |
| 2   | *Lincia laevigata*  | 0 0                         | 2     |
| 3   | *Diadema setosum*   | 46.38                       | 128   |
| 4   | *Holothuria atra*   | 1 0.01                      | 6     |
| 5   | *Tridacna squamosa* | 0 0                         | 1     |
| 6   | *Drupella sp.*      | 2 0.02                      | 37    |
| 7   | *Tronchus niloticus*| 0 0                         | 11    |
| 8   | *Panulirus versicolor* | 1 0.01                     | 2     |
|     | Total               | 50 0.42                     | 190   | 1.59 |
individuals obtained and the presence of several species found in abundance. \textit{D. setosum} is the most abundant species compared to other species. In line with Tatipata & Mashoreng [35] reported that the diversity index of megabenthos in Spermonde Island was ranged from 0.6365 to 2.528 categorized low to moderate category. Commonly, low diversity is caused by the high dominance of one species found.

### Table 3. The Biological Indices of Megabenthos in study area

| Station | \(H'\) | Category | \(E\) | Category | \(D\) | Category |
|---------|--------|----------|-------|----------|-------|----------|
| 1       | 0.41   | Low      | 0.02  | Low      | 0.85  | High     |
| 2       | 0.64   | Low      | 0.02  | Low      | 0.78  | High     |
| 3       | 0.85   | Low      | 0.03  | Low      | 0.54  | Medium   |
| 4       | 2.21   | Medium   | 0.08  | High     | 0.31  | Low      |

The evenness index is classified as low and high categories, ranged of the value was 0.02 to 0.08. According to Odum [18], the evenness index (E) is low if E < 0.4, and high if E > 0.6. The low category indicated that the number of individuals from each species is uneven and there are one or several types of megabenthos that dominate. According to Gani et al. [36] if a species dominates in the community, it causes the community in unstable condition. Commonly, low evenness index cause high in dominance index. The highest dominance index value was at station 1 with a value of 0.85 and the lowest was at station 4 (0.31). Category of dominance index is divided into 3 category, namely low (0 – 0.50), medium (0.50 – 0.75), and high (0.75 – 1) [18]. The highest dominance index was found at station 1 because this station dominated by \textit{D. setosum} as species that has the highest number of individuals.

### 3.3. Percentage of coral cover

The coral cover percentage at each station was different. The existence each species of megabenthos can’t be separated from the health condition of coral reefs as the habitat of various megabenthos species. Table 4 presented the percentage of coral cover each station in study area. Station 1 has a high percentage of 50.44% followed by station 3, 4, and 2 with the value of 29.20%, 18.14%, and 9.29%, respectively. This condition may affect the diversity of associated biota, including megabenthos. Coral cover percentages were consisted of rocky, hard coral, dead coral, dead coral with algae, rubble, sand and others. Category of coral reef condition based on coral cover percentage was bad, moderate, and god. Febrianto et al. [23] reported that the percentage of live coral cover was in the low to a high category ranged from 10.60 to 36.87%.

### Table 4. Percentage of live coral cover in study area

| Station | Percentage of live coral cover (%) | Category |
|---------|-----------------------------------|----------|
| 1       | 50.44                             | Good     |
| 2       | 9.29                              | Bad      |
| 3       | 29.20                             | Moderate |
| 4       | 18.14                             | Bad      |

### 3.4. Correlation between megabenthos and percentage of live coral cover

Figure 1 showed the correlation between coral reef and megabenthos abundance. The results of regression analysis were shown through the equation \(y = 0.002x + 0.3449\). The equation showed a positive correlation between megabenthos abundance and the percentage of live coral cover. The results of linear graph explained that megabenthos abundance is increasing with increasing coral reef cover percentage. This indicated that the higher coral cover percentage, the higher megabenthos abundance associated with coral reefs. Bangapadang et al. [37] reported that megabenthos density was high in line with high coral cover percentage in Buton village, Central Sulawesi.
Figure 3. The relationship between megabenthos abundance and coral cover percentage

The correlation value \((r)\) was 0.215 categorized as a low correlation between those variables where according to Sugiyono [38] if the \(r\) value is 0.20 – 0.399 showed a low level of relationship, otherwise Wulandari et al. [39] obtained \(r\) value of 0.929 indicates that the relationship between megabenthos density and coral cover percentage is very strong in the Waworaha waters, Southeast Sulawesi. The determination value \((R^2)\) was 0.0462, this value explained that 4.62% the density of megabenthos was influenced by the percentage of live coral cover, and the rest (95.38%) was influenced by another parameters. Value of \(R^2\) indicated the strength of a relationship which has ranged from 0 to 100% [35]. Appah et al. [13] concluded that higher diversity of bentic fauna in submarine canyons was in non-reef habitat compared with coral reef habitat.

4. Conclusion
Coral reef in Tuan Island consisted of eight megabenthos target dominated by \textit{Diadema setosum} in each research station and station four has the highest megabenthos abundance. The megabenthos target found were \textit{Acanthaster planci}, \textit{Linckia laevigata}, \textit{Diadema setosum}, \textit{Holothuria atra}, \textit{Tridacna squamosa}, \textit{Drupella} sp., \textit{Tronchus niloticus}, \textit{Panulirus versicolor}. In average, the diversity, evenness, and dominance indices were categorized as medium category. The highest percentage of coral cover was at station 1 followed by station 3, 4, and 2 as categorized in good, moderate and bad category, respectively. The correlation \((r)\) between the percentage of coral reef cover and megabenthos abundance has a positive correlation, but the level of correlation was low.

Acknowledgment
We are grateful to all people who helped out in any way during the research. Thanks to Mulyadi, Nanda, Ocean Diving Club member for their field work during the research study. Our deepest thanks to the local people in study area for their supporting and very good cooperation.

References
[1] Abiero A R and Armenteros M 2016 \textit{Marine Biodiversity} 47: 101–111.
[2] Hoegh-Guldberg O, Pendleton L and Kaup A 2019 \textit{Reg. Stud. Mar. Sci} 30(100699): 1–20.
[3] Mahabir R 2016 \textit{J. Mason Grad. Res.} 371–96.
[4] Rudi E 2013 \textit{Biospecies} 6 30-45.
[5] Aldyza N dan Afkar 2015 \textit{Jurnal Biotik} 3 107-115.
[6] Udalov A, Margarita C, Andrey A, Alexander B, Sergey G, Lesya G, Tatyana K, Daria K, Sergei
K, Viacheslav K, Petr M, Daria P, Philipp S, Miloslav S, Andrey V and Vadim M 2021 *Ecological Indicator* **121** 107115

[7] Rybakova E, Kremenetskaia A, Vedenin A, Boetius A and Gebruk A 2019 *PLOS ONE* **14** e0211009

[8] Coremap-LIPI 2014 *Monitoring Kesehatan Terumbu Karang Kabupaten Nias (Lahewa Dan Sawo)* (Jakarta: Coremap Ctli Lipi) p 66

[9] Ghafari M N A and Fitriani 2021 *Indo Pac J Ocean Life* **5** 14-21

[10] Giam, Manuputy A, Abrar M, Siringoringo R, Suhartini S, Sibohow K, Edrus I, Arbi U, Capponi H, Siwaloh H, Tuti Y and Zulfianita D 2014 *Kesehatan Terumbu Karang PT Sarana Komunikasi Utama* Utama Jakarta p 63

[11] Kroncke I and Reiss H 2010 *Mar Pollut Bull* **60** 58-68.

[12] Abienro C A R and Armenteros M 2016 *Mar Biodiv* DOI 10.1007/s12526-016-0553-7

[13] Appah J K, Lim M A, Harris K, O’Riordan R, O’Reilly L and Wheeler A J 2020 *Frontiers in marine science* **7** 1-16

[14] Satyawanan M and Atringruum N T 2019 *Jurnal Biologi Tropis* **19** 172 – 179

[15] Syukra R A, Indra J Z and Nofrita 2019 *World Journal of Pharmaceutical and Life Sciences* **5** 166-168

[16] Arbi U Y and Siwaloho H F 2017 *Panduan Pemantauan Megabenthos* Edisi 2 (Jakarta: Media Sains Nasional)

[17] Colin P L and Arneson C 1995 *Tropical Pacific Invertebrates* (California: The Coral Reef Press)

[18] Odum E P 1983 *Basic Ecology* (New York: Saunders College Publishing) p 613

[19] English S, Wilkinson C and Baker V 1997 *Survey Manual for Tropical Marine Resources* Australian Institute of Marine Science

[20] Veron J E N 2000a *Corals of the World* Vol 1 Australian Institute of Marine Science Townville

[21] Veron J E N 2000b *Corals of the World* Vol 2 Australian Institute of Marine Science Townville

[22] Suharsono 2008 *Jenis-jenis karang di Indonesia* (Jakarta: Pusat Penelitian Oseanografi – LIPI)

[23] Febrianto T, Siringoringo R M, Putra R D, Kurniawan D, Sari N W P, Jumsurizal, Khairunnisa, Firdaus M and Abrar M 2021 *IOP Conf. Series: Earth and Environmental Science* **744**-012019

[24] Mutajin B W, Emy P Y, Bagas A, Isfi N R, M. Ilham F, Shinta I D, Sufia N A, Novanda N A dan Puspitasari 2020 *Jurnal Enggano* **5** 181-194.

[25] Vimono I B 2007 *Journal Oseana* **3215**-21.

[26] Noviana L, Arifin H S, Adrianto L and Kholil 2018 *Journal of Natural Resources and Environmental Management* **9** 352-365

[27] Suryanti S and Ruswahyuni R 2014 *Jurnal Saintek Perikanan* **10** 62-67.

[28] Nader M R and Indar S E 2011 *Aquatic Invasions* **6S23**-S25.

[29] Hoeksema B W, Scott C and True J D 2012 *Coral Reefs* DOI 10.1007/s00338-012-1005-x

[30] Boneka F B, Gustaf N and Mamangkey F 2013 *Aquatic science & management* **1** 17-20

[31] Lalang, Sadarun B dan Haya L O M Y 2013 *Jurnal Mina Laut Indonesia* **1** 12-22

[32] Endean R 1987 *Antenne Museum* E P H E French Polynesia Australia

[33] Supriharyono 2007 *Pengelolaan Ekosistem Terumbu Karang* (Jakarta: Djambatan)

[34] Ucu Y A 2011 *Oseanologi dan limnologi di Indonesia* **37** 71 – 89.

[35] Tatipata K P B and Mashoreng S 2019 *Toranti: J F Mar Sci* **3** 37-50.

[36] Gani A, Rosyida E and Serdiati N 2017 *Jurnal Agrisains* **18** 38-45.

[37] Bangapadang S, Emiartia E dan Nuryayah W 2019 *Sapa Laut* **4** 89-97

[38] Sugiyono 2015 *Metode Penelitian Kombinasi* (Mix Methods) (Bandung: CV Alfabeta)

[39] Wulandari A T, Sadarun B dan Palupi, R P 2020 *Sapa Laut* **5** 131-138.