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Diversity of Sea Cucumber Based on the Characteristics of Habitat Sikakap Strait Water Area, Mentawai Island District, Indonesia

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ABSTRACT

This research was conducted to determine the species of sea cucumber and some aspects of ecology and water quality of the substrate, total organic matter, and habitat distribution patterns of sea cucumber in Sikakap strait waters. The method used in this research was survey method, by spreading the transect out as long as 50 meters with a width of 20 meters parallel shoreline. The result was obtained 4 genera which are included in one family. The highest Diversity of Index Value (H') was found at Station 2 about 1.012, Station 3 about 0,004 and the lowest is found at Station 1 about 0. The highest Equitability of Index Value (E) was found at Station 2 about 0.271, Station 3 about 0.063 and the lowest was found at Station 1 about 0. The pattern of spread of species at Station 1 was included in the pattern of spread of the group about 1.037, Station 3 and 2 were included in the distribution pattern of uniform. Habitats of sea cucumbers in the waters of Sikakap Strait was included in the category of sand (Station 1), rocky sand (Station 2), and muddy sand (Station 3) the total organic matter (TOM) each station about 16.10 %, 14.71%, and 20,48%. The differences in each Station are caused by the differences in habitat and food sources in the waters. Parameter as temperature, salinity, pH and Dissolved Oksigen at Sikakap Strait waters linked to the quality standard of Ministry of Environment Decree No.51/2004 for marine water quality was still quite good for the existence of sea cucumbers.

***Keywords*:** Sea Cucumber, Genus Diversity, Sikakap Strait, *Holothuria atra, Holothuria leucospilota, Stichopus variegatus, Actinopyga miliaris, Bohadschia argus*

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1. INTRODUCTION

Sikakap Strait has biodiversity in coastal and marine areas, including the diversity of ecosystems and the diversity of species of biota that live in it. The Sikakap Strait has been designated as a Regional Marine Conservation Area (RMCA) based on Regional Regulations (Mentawai Islands Regency Act No.14, year 2006). This stipulation is intended to realize the management of biological resources whose utilization is carried out wisely to ensure the sustainability of its supplies while maintaining and improving the quality of diversity and its value in a sustainable manner [1].

One of the marine fishery biological resources found in the Strait of Sikakap is sea cucumbers or sea cucumbers which have recently received special attention to be developed, in addition to fish and shrimp. Sea cucumbers have a high economic potential and are one of the marine biota producing foreign exchange. Sea cucumbers are widely used by the community as food and consumed to support health because they have high nutritional and protein content and are used as medicine. The results of the study [2-4] showed that the nutrient content or nutrient of sea cucumbers (the type of sea cucumber sand) in dry conditions consisted of 82% protein, 1.7% fat, 8.9% water content, 8.6% ash content and carbohydrate 4 8%.

Fig. 1. Map of Sikakap Strait Waters

Sea cucumbers are sediment-eating organisms that occupy sandy substrates because sea cucumbers generally deposit feeders that eat anything that is in the bottom waters especially those associated with microorganisms such as bacteria [4,5]. Sea cucumbers can live in a variety of habitats in the sea. These habitats have different ecological conditions and will cause differences in species composition, abundance, and distribution and are closely related to food supplies [4, 6].

Some types of sea cucumbers are marine commodities that are currently being given special attention by the government in order to support the development of the marine fisheries sub-sector. In Indonesian waters, there are various types of sea cucumbers, but only a few can be consumed and have high economic value, namely sea cucumber species from the Holothuroidea and Stichopodidae families which include the genera Holothuria, Actinopyga, Bohadschia, Thelenota, and Stichopus [2, 3, 6]. Good prospects for sea cucumber commodities cause the capture of these animals to continue to increase and carried out on a large scale without regard to its sustainability. An increase in sea cucumber extraction from its natural habitat will result in a decrease in the stock of sea cucumber populations which is characterized by increasingly difficult to obtain sea cucumbers in nature [4, 7].

Knowledge of the magnitude of the potential of sea cucumbers and the presence in their natural habitats is important to obtain. Therefore, it is necessary to conduct research on the diversity of sea cucumber species based on the characteristics of the waters of the Sikakap Strait, the Mentawai Islands Regency for ecocentric management based on conservation so that they can support efforts to conserve and cultivate sustainable sea cucumbers. Based on the background description, the purpose of this study is to find out the abundance and diversity data of sea cucumber species and their relationship with the sea cucumber habitat based on the condition of the substrate base in the waters of Sikakap Strait Mentawai Islands Regency.

2. MATERIALS AND METHODS

The research method carried out is a survey method by conducting direct observations at predetermined stations starting in the morning. Sikakap Strait waters consist of various kinds of substrates in each zone of the region. This research was conducted at 3 stations with the following descriptions:

A) Station one is located in the southern part of the Sikakap Strait with coordinates 5º56'59.31" South Latitude and 108º23'7.05" East Longitude. This station has the characteristics of a fine sand substrate.
B) Station two is located in the eastern part of the Sikakap Strait with coordinates 5º55'32.70 " South Latitude and 108º22'51.60" East Longitude. This station has sand substrate characteristics accompanied by live and dead corals.
C) Station three is located west of the Sikakap Strait with coordinates 5º56'1.90" South Latitude and 108º22'33.60" East Longitude. This station has the characteristics of a muddy sand substrate.

2. 1. Research procedure

2. 1. 1. Measurement of Aquatic Environmental Parameters

Measurement of water Physico-chemical parameters such as temperature, depth, current velocity, water brightness, dissolved oxygen content, pH and salinity are done in situ at each station with each repetition of three times then the average value is taken.

2. 1. 2. Sampling of Substrate

Observation of substrate samples was carried out in 3 stages, namely visual observation in the field by taking 500 gram substrate samples, followed by granulometry analysis in the ITB

Sedimentography Lab. Lab results were tested using a substrate test with *kummod* software, then TOM (Total Organic Matter) analysis was performed in the FPIK Lab, and IPB Lab which aims to determine the total organic in water.

2. 1. 3. Observation of Sea Cucumber Samples

Each station is made a transect line from the coast to the coast along 50 meters and 20 meters wide. Each transect line is made of 10×10 meter^2 plots and each plot is given afloat at the corner. The number of plots is 10 plots, then all species of sea cucumbers that have been found are counted and then identified using a sea cucumber identification book (Secretariat of the Pacific Community 2004 and sea cucumber research documents by Indonesian Research Agency). Identification results that have been obtained are then carried out data processing in order to know the abundance, diversity, uniformity, sea cucumber species distribution patterns at each station.

2. 2. Observed Parameters

2. 2. 1. Sea Cucumber Abundance

Sea cucumber abundance is defined as the number of individuals who have taken up a large union (m^2). The example that has been identified is then calculated as abundance by the formula [4,5] as follow:

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

where: K is the amount of sea cucumber abundance (species/m^2), Ni is the number of similar species, and A is the area of quadratic transects (m^2)

2. 2. 2. Sea Cucumber Diversity

Species diversity is a characteristic of community structure, its purpose is to measure the level of order in a system. Diversity is calculated by the Shannon-Winner Diversity Index formula [2, 4, 5] which is formulated as follow:

$$\boldsymbol{H'} = -\sum pi.Lnpi$$

where: H' is an index of species diversity, pi is ni/N, ni is number of species types-i, and N is the total number of species

The Shanon Wienner diversity index is classified as follow:

H'< 1,0 is a low diversity

1,0 < H'< 3,322 is a moderate diversity

H' > 3.322 is a high diversity

2. 2. 3. Sea Cucumber Uniformity

Uniformity can be said to be a balance, ie the individual components of each species contained in a community, calculated by the Uniformity Index formula [2, 4, 5] as follow:

$$E = \frac{H'}{H\,\max}$$

where: *E* is the uniformity index, *H'* is the diversity index, *Hmax* is Ln S, and S is the number of species.

The uniformity index category of the water population as follow:

$0 \leq E < 0,4$ is low uniformity

$0,4 \leq E \leq 0,6$ is moderate uniformity

$0,6 \leq E \leq 1$ is high uniformity

2. 2. 4. Spread Pattern

The distribution pattern calculation used the Morisita Spread Index [2, 4, 5] which was formulated as follows:

$$Id = \frac{\left\{n\left(\sum x_i^2\right) - N\right\}}{N(N-1)}$$

where: *n* is the number of sampling units, *xi* is the number of similar species in the *i* sampling, *N* is a total number of species.

The distribution category of morisita from the population in the waters, namely:

Id > 1, is called cluster grouping

Id = 1, is called random

Id < 1, (including negative values), is called uniform.

2. 2. 5. Multiple Linear Regression Analysis

To see the relationship between TOM, waters current, and substrate fraction on the abundance of sea cucumbers in the waters of the Sikakap Strait used multiple linear regression equations. Multiple linear regression analysis is a linear relationship between two or more independent variables (X_1, X_2, ... Xn) with the dependent variable (Y).

This analysis is to determine the direction of the relationship between the independent variable with the dependent variable whether each independent variable is positively or negatively related and to predict the value of the dependent variable if the value of the independent variable has increased or decreased. The data used is usually an interval or ratio scale. The multiple linear regression equation is as follows [7-9]:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3$$

where: Y is the dependent variable (abundance of sea cucumbers), a is constant, *b1, b2, b3* are the regression coefficient, X_1 the is independent variable (TOM), X_2 is the independent variable (water current), X_3 is the independent variable (substrate fraction).

In the regression analysis, there is a correlation value (r) that ranges from 1 to -1, the value is getting closer to 1 or -1 means the relationship between the two variables is getting stronger, on the other hand, a value close to 0 means the relationship between the two variables is getting weaker. To find the correlation value can be found using the formula [7-10] as follows:

$$r_{xy} = \frac{n\sum x_i y_i - \left(\sum x_i\right)\left(\sum y_i\right)}{\sqrt{\left[n\sum x_i^2 - \left(\sum x_i\right)^2\right]\left[n\sum y_i^2 - \left(\sum y_i\right)^2\right]}}$$

A positive value indicates a direct relationship (X goes up then Y goes up) and a negative value shows an inverse relationship (X goes up then Y goes down). Based on the guidelines to provide an interpretation of the correlation coefficient as follows [1, 9, 10]:

0,00 – 0,199 is very low

0,20 – 0,399 is low

0,40 – 0,599 is moderate

0,60 – 0,799 is stong

0,80 – 1,000 is very strong

Correlation analysis in linear regression used the coefficient of determination. The coefficient of determination (DC) shows how much change in the dependent variable (Y) which can be explained by the independent variable (X). Data analyzed were presented in a comparative descriptive manner. Descriptive analysis was carried out by looking at differences and comparisons of species diversity and sea cucumber abundance at each observation station based on different types of substrates. The coefficient of determination (DC) can be found by formula DC = R2 × 100%. Where data calculated by Microsoft Excel software version 2010.

3. RESULTS AND DISCUSSION

3. 1. Parameters of Physical – Chemical of Waters

The condition of the aquatic environment plays an important role in the life of sea cucumbers. The condition or quality of the waters can be seen from the physical and chemical parameters of the waters.

Based on the measurement results of physical and chemical parameters of the waters in the study area, in general, it can be said that the condition of the waters in the three observation stations is still within the range of quality standards for marine biota according to the Minister of Environment Decree No. 51/2004 (Table 1).

Table 1. Conditions of Physical - Chemical of Waters of the Sikakap Strait compared to Sea Water Quality Standards.

Parameter	Unit	Station 1	Station 2	Station 3	Quality standards* Marine biota	Standard** Sea Cucumber [2-6]
A. Physical						
Temperature	ºC	28.67	30	31	28 – 32	28 – 31
Current waters'velocity	Km per hour	6.36	3.28	4,8	-	-
Depth	Cm	59.67	65	68.33	-	-
Water Clarity	%	100	100	100		-
B. Chemical						
pH	-	7.37	8.17	8	7 – 8.5	7 – 8.5
Salinity	$^{0}/_{00}$	30.33	31	32	$\leq$ 34	29 – 34
DO	mg/l	5.3	6	5.7	$\geq$ 5	5 – 7

Source: Primary Data; and *Sea water quality standard for marine biota (Ministry of Environment Decree No.51/2004), **Sea cucumber habitat standard based on research references

The physical-chemical parameter values of the Sikakap Strait waters which are still within the range of the standard quality of seawater for marine biota, indicate that the quality of the Sikakap Strait waters is still good and suitable for marine life, in this case including sea cucumbers. This condition is also suitable for sea cucumber habitats [2-6]. It can be said that the quality of the Sikakap Strait waters is still good and has not experienced pollution. In addition, because of its location far enough from the source of pollutants so that its function as a support for the life of marine life can still take place, as evidenced by the many types of marine life found in the waters of the Strait of Sikakap and its surroundings.

Aquatic ecosystems in the Strait of Sikakap are inhabited by many biota associations such as small fish (pellets, etc.), sea cucumbers (*Holothuria atra*, *Bohadschia argus*, etc), macrozoobenthos of *Annelida* fillum, for example, *Cirratulus sp*, from fillum molluscs, for example, *Annadara sp* and *Macoma sp*, Gastropod fillum, for example, *Nassarius sp* and *Terebra sp*, and sea urchins (*Diadema sp*). Based on visual observations, the type of Sikakap Strait substrate is sand, rocky sand, and muddy sand. The composition of the sediment is very

influential in the life of marine biota because it is a source of nutrients available for the growth of marine biota, especially sea cucumbers.

3. 2. Substrates (Habitat) Of Sea Cucumbers

Watershed substrate is a very important factor for the life of coastal and marine biota, especially as the habitat of benthic animals that live at the bottom of the waters, including sea cucumbers.

- Station 1: sand substrate
- Station 2: rocky sand substrate
- Station 3: muddy sand substrate

The Location of Station 1 is in the southern Sikakap Strait waters visually including an open sand area close to the pier. The Location of Station 2 is located in the waters of the Sikakap Strait to the east, visually including areas with live coral and dead coral. Location of Station 3 in the waters of the Sikakap Strait in the west there are mangrove vegetation and mud mixed sand substrate. According to [4-6, 10-17] coarse sized particles will be deposited near shore and fine-sized particles will enter deeper waters. Substrate samples are then taken to the Sedimentography Laboratory of the Department of Geology, Faculty of Earth Science and Technology, Bandung Institute of Technology for granulometry analysis (grain size). The composition and types of basic substrates at the Sikakap Strait study site at the three observation stations are listed in the following Table 2.

Table 2. Composition of Sediment Grains at the Observation Station

Station	Percentage of Substrate Composition (%)			Substrate type
	Sand	Gravel	Silt	
1	95.4	4.6	0.0	Sandy
2	90.0	10.0	0.0	Pebble Sand
3	11.0	0.4	79.9	Muddy Sand

The composition of sediment grains influences the composition of the presence of sea cucumber species that live around the Sikakap Strait. The substrate composition of Station 1, Station 2, and Station 3 is dominated by the sand substrate which shows that the three stations are suitable substrates to support the life of sea cucumbers. Sea cucumbers can be found in various habitat characteristics, as stated [4, 5, 18-20], sea cucumbers live on various types of substrates, ranging from gravel, coarse sand, medium sand, fine sand, very fine sand, and mud. According to [4-5], sediments also have the ability to bind organic material and nutrients needed by marine biota contained in aquatic ecosystems.

Sea cucumber type *H. atra* is one of the sea cucumber species that can live in all types of sandy, rocky and muddy habitats. *H. leucospilota* and *S. horrens* inhabit rocky sediments because life attaches to and is contained in cavities in corals while *B. argus* and *A. miliaris* tend to be in finer sediments and with mud [2-6]. Water quality that includes physical and chemical parameters in the observation in the waters of the Sikakap Strait can be said to be ecologically suitable for sea cucumber life.

3. 3. TOM (Total Organic Matter) Measurement Results

TOM describes the total organic matter content in waters consisting of dissolved, suspended, and colloid organic matter [4-6]. [2, 4-6] states that organic matter in water is more present in the dissolved form than in the suspended or colloidal form. The results of measurements of the total organic matter content of sediments at the study site ranged from 14.71 - 20.48% (Table 3.).

Table 3. TOM levels at the Observation Station.

Station	Substrate type	TOM level (%)
1	Fine sand	16.10
2	Rocky sand	14.71
3	Muddy Sand	20.48

The highest percentage of sediment organic matter was obtained at Station 3, which was 20.48%. This station has a rather high depth compared to the other two stations and is dominated by fine sand mixed with mud with calm water conditions causing relatively higher smooth sediments which allow higher accumulation of organic matter, so it has a higher organic matter content compared to the station another observation. The high organic substrate content at this station is presumably due to the location of the station which is close to the mangrove ecosystem, so it gets a lot of supply of organic material carried by the current. Research results [4-6, 21-24] in mangrove forests that have muddy sand substrates have a high diversity value due to the muddy substrate is the most preferred habitat for various types of organisms because muddy substrates have more food and organic matter for example calcium needed by the organism. [4-6] states that the high content of organic matter will affect the abundance of organisms and there are certain organisms that are resistant to the high content of organic matter.

3. 4. Sea Cucumber Diversity in the Sikakap Strait

The results of observations and identification of sea cucumber species found in three observation stations in the Strait of Sikakap, as many as 104 individuals from 5 (five) species of sea cucumbers, namely *H. atra*, *A. miliaris*, *B. argus*, *S. horrens*, and *H. leucospilota*. All sea cucumber species found belong to the order *Aspidochirotida*. [4-6] states that *Aspidochirotida* is an animal that lives in the tropics with clear water characteristics. This shows

that the research location or waters of the Sikakap Strait are still in clear waters. This also corresponds to the physical-chemical parameter conditions of the measurements at the time of the study (Table 1). [4-6] states that the Western Indo-Pacific region is an area rich in sea cucumbers from the genera *Holothuria, Actinopyga,* and *Stichopus*. These three species were also found at the study site (Table 4).

Table 4. Sea Cucumber Composition at Research Location.

No.	Species	Station 1	Station 2	Station 3	Total
1	*Holothuria atra*	28 indv	29 indv	32 indv	89 indv
2	*Holothuria leucospilota*	-	3 indv	-	3 indv
3	*Stichopus variegatus*	-	2 indv	-	2 indv
4	*Actinopyga miliaris*	-	6 indv	-	6 indv
5	*Bohadschia argus*	-	2 indv	2 indv	4 indv

The existence of a type in the waters associated with environmental conditions and habitat biophysical factors. The entire research sampling point has environmental parameter values that are still suitable for marine life, so the distinguishing factor that distinguishes habitat types tends to be due to the biophysical habitat factor, namely the composition of sediment grains. As stated by [21-27] the composition of sediment grains will affect the type of seabed biota groups that live in it.

3. 5. Sea Cucumber Abundance at Observation Station

Only 1 genus of sea cucumber found at Station 1 consists of 1 species. The number of individuals found at Station 1 was found by 28 individuals. Based on statistical calculations of sea cucumber abundance at station 1 that is equal to 0.028 individuals/m^2. Sea cucumbers that dominate and are most commonly found at this station are *H. atra*. The highest frequency of attendance was found in the species of sea cucumber *H. atra* by 100% at Station 1.

Sea cucumbers found at Station 2 consist of 4 genera and consist of 5 types. The number of individuals found at Station 2 was found to be 42 individuals. Based on statistical calculations of sea cucumber abundance at station 2 that is equal to 0.042 individuals/m^2. Sea cucumbers that dominate and are most commonly found at this station are *H. atra* 0.029 individuals/m^2, then *A. miliaris* 0.006 individuals/m^2, *H. leucospilota* 0.003 individuals/m^2, *S. variegatus* and *B. argus* respectively 0.002 individuals/m^2, while the sea cucumbers found at Station 3 are only 2 genera consisting of 1 species each. The number of individuals found at Station 3 was only 34 individuals. Based on statistical calculations of sea cucumber abundance at station 3 that is equal to 0.034 individuals/m^2. Sea cucumbers that dominate and are most commonly found at this station are *H. atra* and *B. argus*. The highest frequency of attendance from all stations was found in *H. atra* (85.58%), *A. miliaris* (5.77%), H. *leucospilota* (2.88%), *S. variegatus* (1.92%) and *B. argus* (3.85%) (Figure 1.)

The abundance of sea cucumbers in the Strait of Sikakap both the abundance of species and their numbers are very small in each station, it is suspected that there has been an imbalance in environmental conditions, the content of organic matter between the rate of recruitment, and the intensity of its uptake. The main difference that affects the existence of sea cucumbers at each station is the organic content of the substrate which is a place to live and find food for sea cucumbers. The high abundance of the types mentioned above is likely due to their ability to occupy a variety of habitats so that more opportunities to develop. [4-6, 28] states that the number of individuals in a community and the abundance of each genus and family causes the smaller the amount of variation if there are several individuals whose numbers are greater the diversity will be smaller.

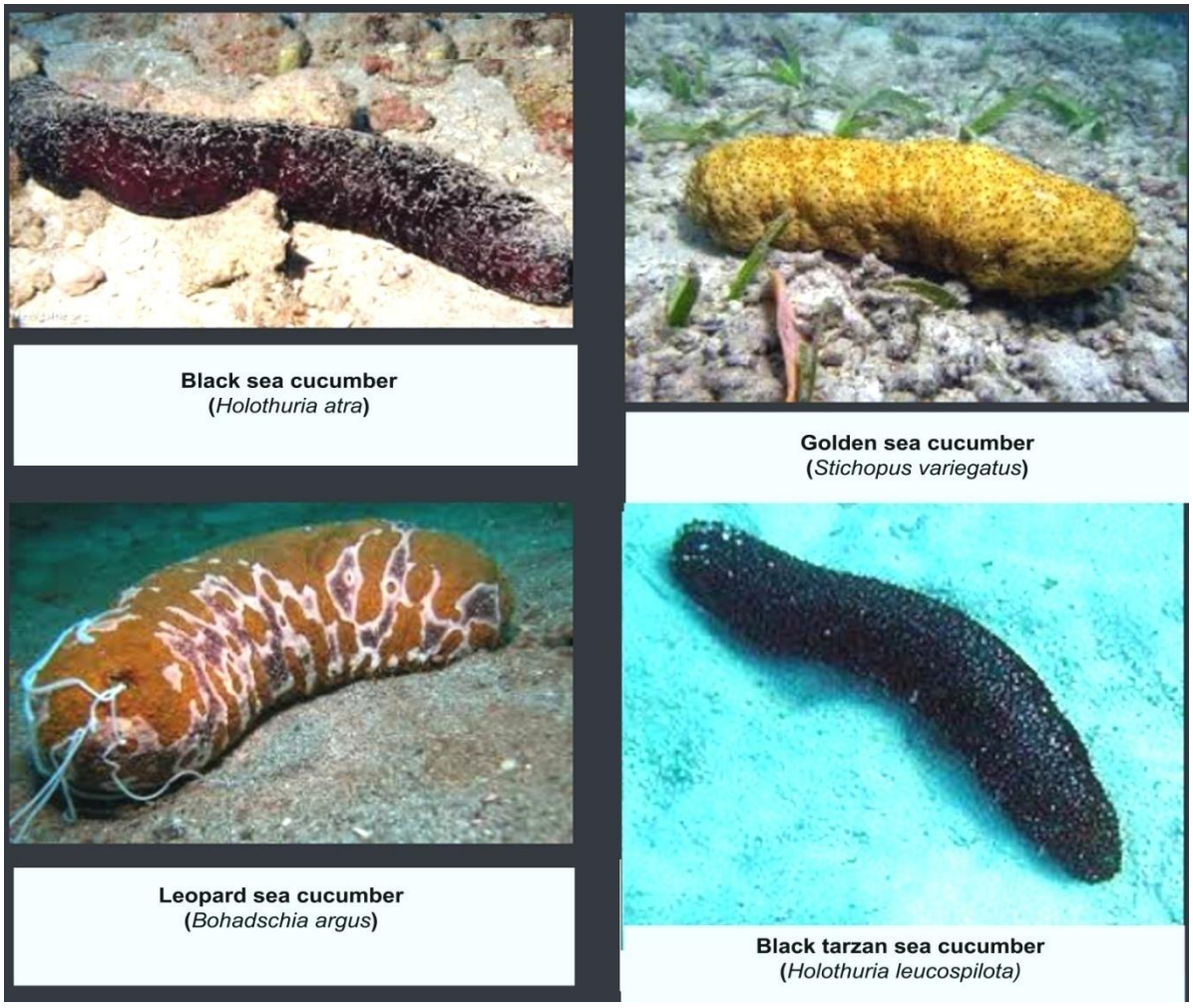

Fig. 2. Types of Sea Cucumbers in Sikakap Strait Waters

3. 6. Diversity Index and Uniformity Index of Sea Cucumber

The sea cucumber diversity index at the three stations is relatively the same and is in the range of the low to moderate diversity category. This is possible because the water quality

conditions are relatively the same based on the physical-chemical parameters of the waters at the three stations (Table 3). The highest diversity was found at Station 2 (1.012) compared to the other two stations namely Station 3 (0.224) and the lowest at Station 1 (0) (Table 5.).

In Table 5 it can be seen that the diversity of sea cucumbers in Station 1 is 0 because only one species of sea cucumber is found, *Holothuria atra*. The sea cucumber diversity in Station 3 is also included in the medium category with 2 types of sea cucumbers, namely *H. atra* and *B. argus*, while in Station 2 the diversity index is higher and includes a medium diversity category and there are more sea cucumber species between the two other stations, there is four sea cucumber type. The high diversity index at Station 2 shows the good condition of the aquatic environment and supports the life of the biota in it. This can be seen from the high levels of dissolved oxygen that are needed by the biota for the process of breathing (respiration) and the oxidation process in waters.

The lowest diversity index (H') value is found at Station 1 with a value of 0. This diversity index is thought to be caused by a small number of species results in an ecosystem imbalance that is likely due to ecological stress or disturbance from the surrounding environment. According to [29-45] diversity includes two important things, namely the number of species in the community and the abundance of each species so that the smaller the number of species and the variation in the number of individuals of each type has an uneven distribution, then the diversity will decrease.

Table 5. Diversity index and Uniformity index of Sea Cucumber.

Station	H’	Category	E	Category
1	0	Low diversity	0	Low uniformity
2	1.012	Low diversity	0.271	Low uniformity
3	0.224	Low diversity	0.063	Low uniformity

Uniformity is the balance of the individual components of each genus contained in a community. Based on Table 5, it can be seen that the highest index of sea cucumber uniformity is found in Station 2 (0.271) and Station 3 (0.063) compared to Station 1 (0). The uniformity of sea cucumbers at Station 2 is thought to be due to ecological factors within the tolerance limits for the survival of sea cucumbers. This situation illustrates that the community structure between Station 1 and 3 is unstable compared to Station 2, where the species composition consists of relatively more individuals in each genus, although there are several types whose numbers are different but not too significant.

3. 7. Spread Pattern Type

Distribution patterns according to [4-6] there are three types, namely uniform / evenly distributed, random and clustered. The distribution pattern of clusters shows the proportion of the total abundance of species that is not balanced. Sea cucumber distribution index from the results of research in 3 (three) observation stations can be seen in Table 6.

Table 6. Sea Cucumber Distribution Index at Observation Station.

Sea Cucumber Type	Observation Station		
	1	**2**	**3**
Holothuria atra	1,037	0.397	0.856
Stichopus variegatus	-	-0.044	-
Actinopyga miliaris	-	-0.105	-
Bohadschia argus	-	-0.044	-0.053
Holothuria leucospilota	-	-0.063	

Based on Table 6 it can be seen that in general the value of sea cucumber distribution index at station 1 is that the distribution pattern is clustered because the index value is more than 1 this is because the total dominant individuals found at Station 1 are only one genus whereas at Station 2 and Station 3 the observation is negative, meaning the pattern the distribution of sea cucumbers in the two research locations has a uniform / even distribution pattern. This pattern of distribution is largely due to the low population of each species and the positive competition between species.

Positive competition supported by the availability of sufficient space has encouraged each species to share the same space. The total proportion of species abundance at several observation stations shows an unbalanced tendency and illustrates the dominance of a species. These dominant species have a positive spread index value, but the value is still below one, meaning that the distribution pattern is still uniform / evenly the same as other species. Dominant species with a uniform distribution pattern found at several research stations include *H. atra* and *B. argus* which are dominant at stations 2 and 3. In general, sea cucumber distribution patterns are influenced by environmental conditions related to adaptability, food availability, and protection of wave effect.

3. 8. The Relationship Between Total Organic Matter (TOM), Flow and Substrate Faction of Sea Cucumber Abundance

To find the relationship between sea cucumber abundance and TOM, current and substrate fraction are used multiple linear regression analysis. Multiple linear regression analysis was used to further see the model of the relationship between sea cucumber abundance and TOM, current, and substrate fraction where the independent variable as a predictor factor for more than one variable. The independent variables used in the regression analysis are TOM (X1), Flow (X2) and Substrate Fraction (X3) while the dependent variable is the abundance of sea cucumbers (Y). Correlation between sea cucumber abundance with TOM variable, current and substrate fraction obtained R2 value of 0.61, which means 61% dependent variable (sea cucumber abundance) is influenced by the three independent variables (TOM, current and substrate fraction while the other 39% is influenced by other factors. Correlations between sea cucumber abundance and TOM, substrate currents and fractions are included in the strong

category by using multiple linear regression equations, based on the calculation, the regression model is obtained:

$$Y = 20.4141 – 0.1629(X_1) – 1.3012(X_2) + 0.00065(X_3)$$

Based on regression equation, a constant value of (a) of 20.4141 is obtained, meaning that if the sea cucumber abundance variable is not influenced by the three independent variables namely TOM, the current and substrate fraction is zero, then the average abundance of sea cucumbers will be 20.4141. The regression coefficient sign of the independent variable shows the direction of the relationship of the variable concerned with the abundance of sea cucumbers. The regression coefficient for the independent variable TOM and the current is negative, indicating a unidirectional relationship between TOM and the current with the abundance of sea cucumbers. TOM variable regression coefficient of (-0.1629) implies that for each increase in% TOM of 1% will cause a decrease in sea cucumber abundance of 0.1629%. The regression coefficient for the variable current of (-1.3012) implies that for each acceleration of the current of one unit will cause a decrease in sea cucumber abundance of 1.3012%.

The regression coefficient for the substrate fraction variable is positive, indicating a direct relationship between the substrate fraction and the abundance of sea cucumbers. The regression coefficient of the substrate fraction variable of 0.00065 implies that for each increase in the size of the substrate fraction of one unit will cause an increase in sea cucumber abundance by 0.00065%.

4. CONCLUSIONS

Sea cucumbers are found in the waters of the Sikakap Strait as many as 104 individuals consisting of 5 species with an abundance of sea cucumbers ranging from 28 - 42 individuals / 1000 m^2 and the highest average is the species of sea cucumber *Holothuria atra*. The diversity and uniformity of sea cucumbers in the study location are in a low category. Distribution patterns between species at Station 1 belong to the grouping category, while stations 2 and 3 belong to the uniform / even category.

Characteristics of habitat in the waters of the Sikakap Strait are classified as a habitat with fine sand substrate, rocky sand, and muddy sand. The composition of sediment grains also influences the composition of the presence of sea cucumber species. Sea cucumbers are species of *H. atra* including sea cucumber species that can live in all types of sandy, rocky or muddy habitats. *H. leucospilota* and *S. variegatus* inhabit rocky sediments because life attaches to coral substrates and is contained in cavities in corals while *B. argus* and *A. miliaris* tend to be in finer sediments and with mud. There is a strong relationship between TOM, current, and substrate fraction with the abundance of sea cucumbers, if the independent variable levels increase / the higher the sea cucumber abundance will be lower and vice versa.

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