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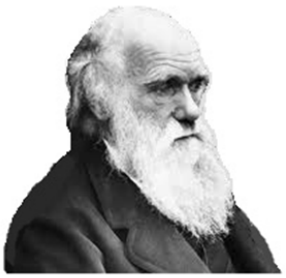

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Abundance and distribution of sea urchins (*Echinoidea* Leske, 1778) on coral reefs in the waters of Latondu Island, Taka Bonerate, South Sulawesi, Indonesia

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ABSTRACT

Sea urchin is one of the key biota of coral reef stability. Research on the abundance and distribution of urchins was carried out from January-August 2019 and field data retrieval occurred in March 2019 on Latondu Island, Taka Bonerate. This study aims to determine the relationship between sea urchin abundance with coral reef conditions and sea urchin distribution patterns in the waters of Latondu Island, Taka Bonerate. Observation of coral reefs and sea urchins was carried out at 3 stations with different criteria of coral reef conditions. Retrieval of coral reef data was done using the Point Intercept Transect (PIT) method, while sea urchin observation came about via a transect belt method. The results showed that in the waters of the island of Latondu, there were 133 sea urchins from 7 species of the Echinoidea class, namely *Diadema setosum, Diadema antillarum, Echinometra mathaei, Echinotrix calamaris, Mespillia globulus, Heterocentrotus mammillatus* and *Echinotrix diadema*. The largest abundance of sea urchins was found in Station 3 on the southern part of Latondu Island with 12 ind / 50m^2, while Station 1 in the northeast and Station 2 in the northwest part showed 5 ind / 50m^2. Sea urchin distribution at Station 1 with a value of 0.79 was uniform, Station 2 with a value of 0.80 was also uniform and Station 3 with a value of 0.91 was uniform as well. The relationship between Sea urchin and coral reef was 0.56, which meant the relationship was moderate and directly proportional.

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Keywords: abundance, distribution, sea urchin, coral reef, Echinoidea, *Diadema setosum*, *Diadema antillarum*, *Echinometra mathaei*, *Echinotrix calamaris*, *Mespillia globulus*, *Heterocentrotus mammillatus*, *Echinotrix diadema*, Latondu Island

1. INTRODUCTION

Taka Bonerate National Park is one of the coastal and marine areas in Indonesia that is protected as conservation zone. It is located geographically in the Flores Sea area, at 06° 17' 15" – 07° 06' 45"S, 120° 53' 30" – 121° 25' 00"E. Taka Bonerate National Park is regulated by Ministry of Forestry Decree No. 92/KPTS-II/2001 dated March 15th 2001, and has a total area of 530.765 ha. It is the third biggest atoll reef globally and possesses high biodiversity and numerous habitats of various endangered and protected sea animal species. One of the habitats is Latondu Island. The coral reef ecosystem of this island is in near pristine condition based on the diversity and abundance of its marine biota.

Reef ecosystems play an important role in ocean biodiversity and biota abundance, and coral reefs also act as barriers to protect coasts from waves and currents. Warm water reefs have optimal growth at annual mean temperature that ranges between 23-25 ºC, though they are able to tolerate temperature at the lower limit of 20 ºC and upper limit of 36-40 ºC. One type of biota that lives on them is sea urchin.

Sea urchins are a key species in the diversity of the coral reef community. Their existence greatly depends on detritus and macroalgae, the availability of which is influenced by reef condition. It is strongly suggested that a decrease in sea urchin densities brings about damage to reef ecosystems, due to macroalgae dominating and covering the reefs. Reefs, therefore, live because of the equilibrium between sea urchins and macroalgae. Indeed, a decrease in urchin population will result in an abundance of macroalgae (blooming) and will certainly inflict negative effects on the lives of coral reefs.

The distribution of oceanic organisms is immensely vital because it is one of the biological factors that influence the diversity of marine life in the intertidal zone. The one that affects sea urchin distribution is the substrate. Under different conditions of coral coverage, differences appear in the availability of food for the urchins, which results in differences in urchin abundance and distribution in Latondu Island waters.

2. METHODS

The research was conducted from January to August 2019. Data retrieval was conducted in March 2019 (March 14th, 15th and 16th, 2019). The location was in the waters of Latondu Island, Taka Bonerate District, Kepulauan Selayar Regency, South Sulawesi Province. There were 3 sampling stations (Figure 1):

- Station 1 (north-east of Latondu Island): 6°29'35"S, 120°59'38"E
- Station 2 (north-west of Latondu Island): 6°29'46"S, 120°59'07"E
- Station 3 (south of Latondu Island): 6°30'18"S, 120°59'25"E.

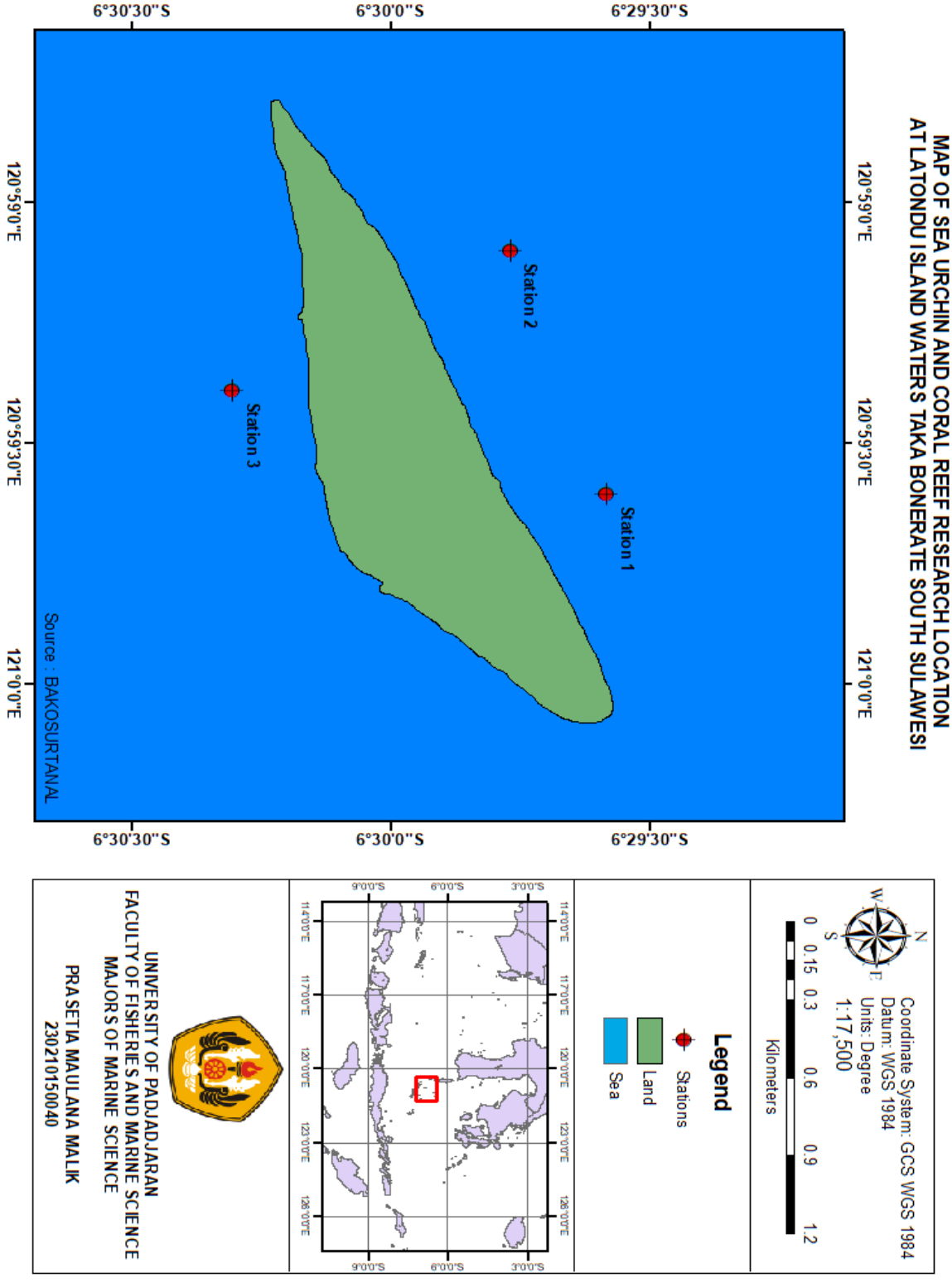

Figure 1. Sampling stations at Latondu Island waters, Taka Bonerate

The tools used in this research were scuba sets, slate paper, thermometer, refractometer, Secchi disk, pH-meter, roll meter, hand-cart, underwater camera, sea urchin identification forms, and reef identification forms (PIT). Physical-chemical parameter data was collected by in situ measurements at every station. These parameters include temperature, transparency, salinity and pH.

The research method used was survey. The survey method is a research technique conducted on large and small populations, wherein the data studied are from samples taken from these populations, so that the distribution and relationships between variables could be determined. The survey data obtained included abundance data, distribution and sea urchin/ coral reef relationship assessments, coral coverage and water quality data. The results were in the form of quantitative and qualitative data which was then processed via data analysis.

Sea urchin data were collected using the Belt Transect method. This method uses a 50 m transect of a 1 m wide corridor. The Belt Transect method can be used to describe biota that has a relatively diverse size or has a maximal size such as coral reefs and sea urchin presence (Figure 2).

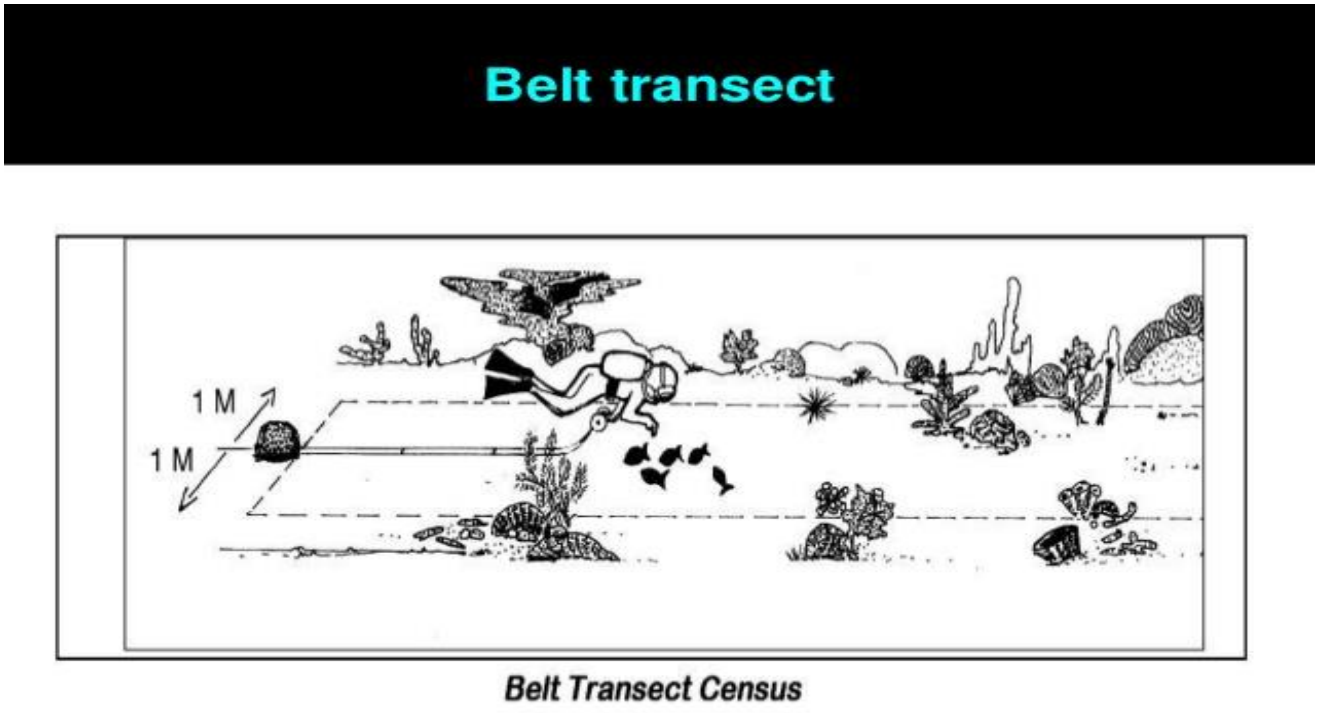

Figure 2. Sea urchin data retrieval scheme

Observation of coral reef condition was accomplished using the Point Intercept Transect (PIT) method by calculating live coral coverage. The Point Intercept Transect (PIT) method was done by pulling a 50 m Line Transect, recording coral reef data under the line at 0.5 meter intervals along the transect, starting at 0.5 meters and continuing up to 50 meters.

Data obtained from the field were data from the transect using the PIT method, and then stored in a computer with the help of the Ms.Excel program. The coral measurement results were processed into the percentage value of coral cover using the formula:

$$L = \frac{Li}{N} \times 100\%$$

with:

L = Percentage of live coral coverage
Li = Sum of each component
N = Total components (50m)

Reef condition was determined based on percentage of live coral coverage (Table 1).

Table 1. Coral reef assessment criteria.

Category	Live Coral Coverage (%)
Poor	0 – 24,9
Moderate	25 – 49,9
Good	50 – 74,9
Excellent	75 – 100

Abundance was calculated using the following formula:

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

with:

D = abundance (ind/m^2)
Ni = total sum of individuals (ind)
A = total sum of transects (m^2)

Data analysis to determine the dispersion of sea urchins applied Morisita Index:

$$Id = n \frac{\sum x^2 - \sum x}{(\sum x)^2 - \sum x}$$

with:

Id = Morisita Index
n = number of sampling quadrats
∑x = sum of individuals in each transect ($x_1+x_2+\ldots$)

The result of Morisita Index calculation was compared with the following criteria:

Id < 1: Distribution patterns of individual types are uniform
Id = 1: Distribution patterns of individual types are random
Id > 1: Distribution patterns of individual types are clustered

Data analysis in this study was done using Bivariate Correlation Analysis, via the Ms. Excel program. Bivariate Correlation Analysis was performed to measure the degree of association between two variables.

The implemented formula being:

$$r_{xy} = \frac{n\sum XY - \sum X \sum Y}{\sqrt{[n\sum X^2 - (\sum X)^2][n\sum Y^2 - (\sum Y)^2]}}$$

with:

r_{xy} = coefficient of correlation between two variables
N = number of samples
$\sum X$ = sum of individuals in each station ($x_1+x_2+\ldots$)
$\sum Y$ = sum of live coral reefs in each station ($y_1+y_2+\ldots$)

The result is interpreted with the help of a guide (Table 2):

Table 2. Interpreted numbers.

Interpreted number	Correlation
0 – 0,199	Very Weak
0,20 – 0,399	Weak
0,40 – 0,599	Moderate
0,60 – 0,799	Strong
0,80 – 1,0	Very Strong

3. RESULTS AND DISCUSSION

Based on observations at the three stations, the results obtained for the quality of Latondu Island waters can be seen in Table 3.

Temperature is one of the important parameters in the growth and development of sea urchins and coral reefs, as sea urchins will experience death at 35˚C within 12 hours. Water

temperature can also affect embryonic development. The temperature measured at each station shows a value that was not much different, namely, 30 °C for stations 1 and 2, 29 °C for Station 3. The temperature being not much different at each station indicates that, during the study, the temperature distribution tended to be homogeneous. Of note, data collection was executed in the morning until noon (Table 3).

Table 3. Physical and chemical parameters

Station	Observed parameters				
	Temperature (ºC)	**Salinity (ppt)**	**pH**	**Depth (m)**	**Transparency (%)**
1	30	30	7	2-7	100
2	30	30	7	2-6	100
3	29	31	7	3-8	100

Salinity measurement results at the site found that salinity ranged from 30-31 ppt. Sea urchins in general are not resistant to low salinity. Exceptions apply to species that live in the tidal area. If the salinity ranges from 23-26 ppt, it will result in changes in color pigments, thorns will fall out and urchins will become inactive, stop eating and eventually die (Table 3).

The results of the measurement of the degree of acidity (pH) found that the pH at each station was 7.2, while the distribution of pH values was homogeneous. For reef organisms, particularly coral and sea urchin, a good pH value is 7-8, thus it can be said in terms of acidity (pH) that the waters of Latondu Island was fit both for reef corals and sea urchins (Table 3).

For Station 1, the depth taken was around 2-7 meters and for Station 2, it was around 2-6 meters, while Station 3 was at 3-8 meters depth (Table 3).

Based on the results of brightness measurement, in Latondu Island waters, the waters brightness was 100%. The high percentage of brightness in Latondu Island waters indicates the level of penetration or entry of sunlight to the bottom of the waters. According to the Ministry of Environment Decree for marine biota, the in water brightness of Latondu Island is considered ideal. In deep and clear waters, the process of photosynthesis and light penetration can reach depths of around 200 meters (Table 3).

3. 1. Coral Coverage

Referring to Minister of Environment Decree No.51 of 2004 concerning the quality standard of seawater for marine biota, the waters of Latondu Island had waters conditions suitable for viable coral reef ecosystems. However, there were differences in the condition of the coral reef at each station due to other factors such as docking sites, sedimentation and fishing activities.

With reference to Figure 3, the percentage of live coral cover in Station 1 was 38.33% and hence, 'moderate', for Station 2, the percentage of live coral cover value was 41.33% and 'moderate', for Station 3, the percentage value of live coral cover was 58.67% and 'good'. The results of live coral cover in Latondu Island waters from the three stations averaged 46.11% and hence, 'moderate'. Based on the Ministry of Environment's Regulation No. 4 of 2001, moderate coral cover ranges from 25% - 49.9% (Figure 3).

Coral fracture at Station 1 in the northeast and Station 2 in the northwest consecutively reached 61.67% and 58.67% in the waters of Latondu Island, caused by the activities of people who catch fish using fish bombs. The damage to coral reefs is largely caused by human activities.

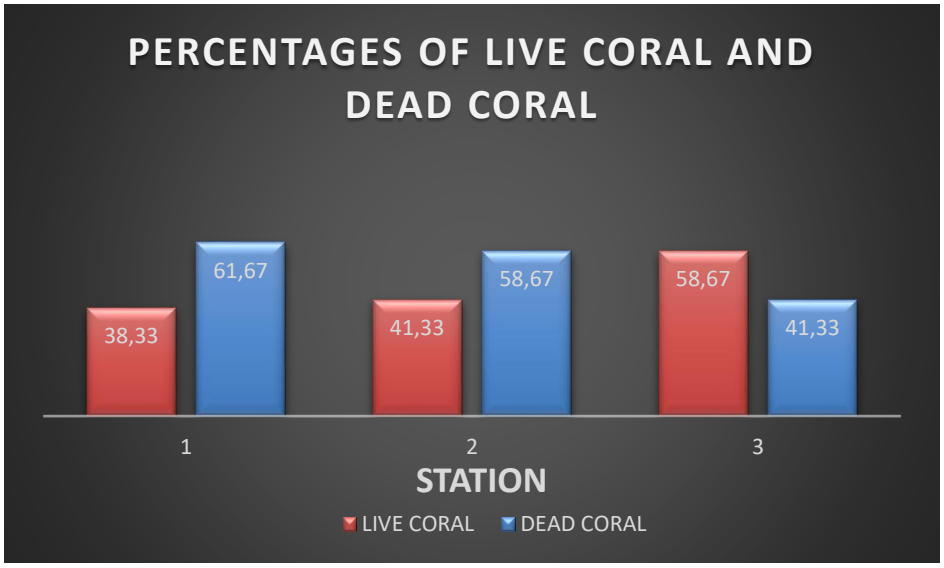

Figure 3. Percentages of Live Coral Coverage

3. 2. Sea Urchin Abundance

The number of sea urchins found in all stations reached 133 individuals that were of 7 different types. The highest abundance of sea urchins (12 individuals / 50m^2) was found at Station 3, south of Latondu Island and the lowest abundance of sea urchin (5 individuals / 50m^2) was found both in Station 2, located northwest of Latondu Island and Station 1 which is northeast of Latondu Island. Current speed is one factor for the existence of sea urchins. The strong current is thought to be the cause of the low abundance of sea urchins in these two areas, due to sea urchins preferring calm waters so that their tube feet can attach to hard substrates (Figure 4).

3. 3. Distribution of Sea Urchins

The calculation result of the Morisita index at each station showed the same distribution patterns. At the three stations, the results were less than one. This implies that the sea urchin distribution patterns were uniform (Figure 4). Stations 1 and 2 had a higher percentage of coral fractures than Station 3, while there was more food available at Station 2. Sea urchins are

generally herbivore, living on algae and sea grasses. However, from the observation results it is suspected that there were not much macroalgae in the three stations, but the distiribution was uniform (Table 4).

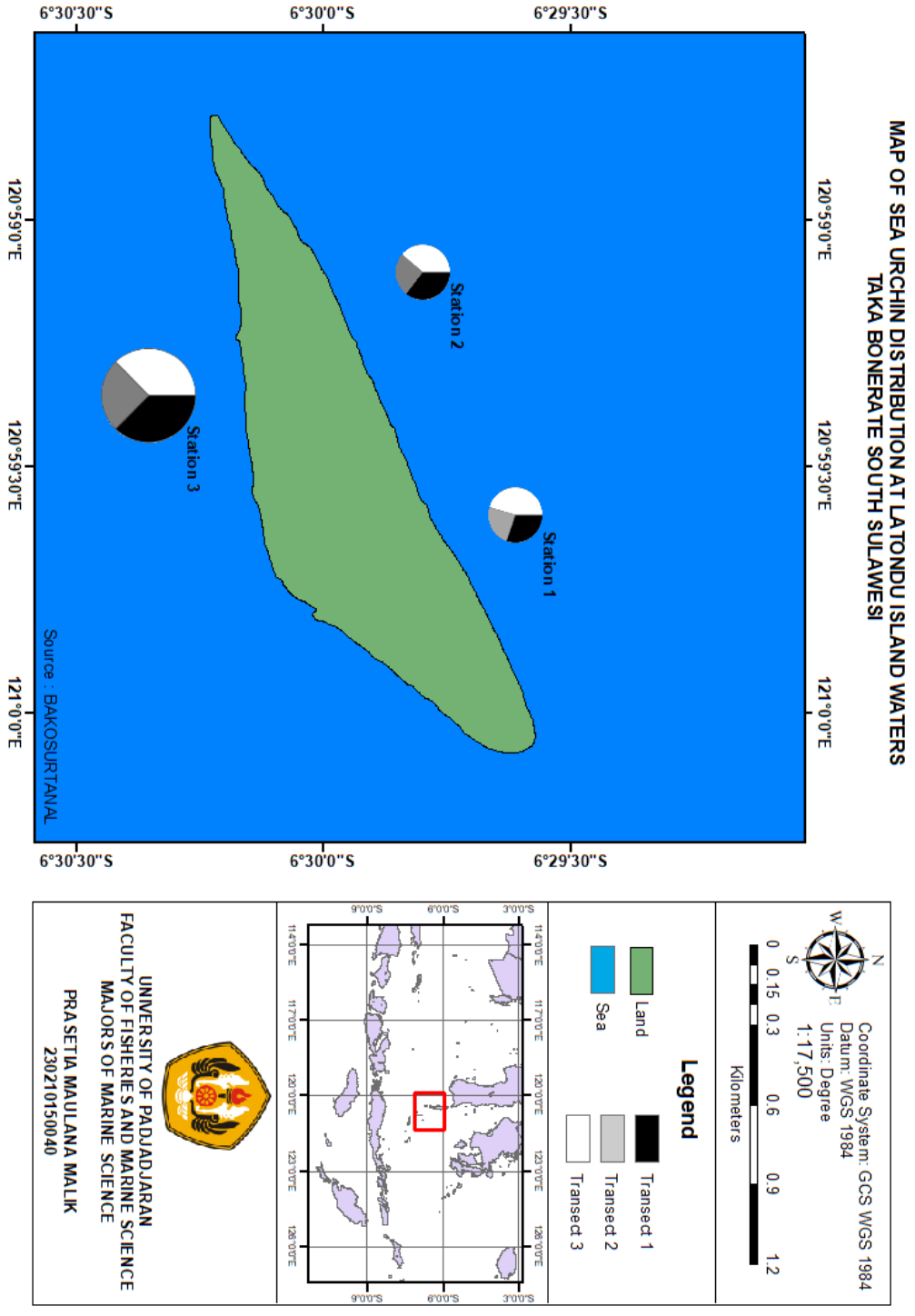

Figure 4. Chart of sea urchin distributions

Table 4. Values of sea urchin distribution.

Station	Morisita Index (Ip)	Comparison	Distribution
1	0,79	Ip < 1	Uniform
2	0,80	Ip < 1	Uniform
3	0,91	Ip < 1	Uniform

At the three stations, the calculation results of the Morisita Index were smaller than 1 indicating the sea urchin distribution patterns at that location were uniform. The uniform distribution patterns that occur indicate that there was neither dependence nor competition over food at the location, but that the algae amount was poor. Still, the growth of corals in a current would be better than in calm waters, as the current serves to supply nutrients that are needed by organisms in coral reef areas. Sea urchins found at Stations 1 and 2 were in the coral reef crevices so as to protect themselves from strong currents and strong sunlight exposure. It should be noted that certain types of urchins are sensitive to excessive sun exposure.

3. 4. Relations between sea urchins and coral reefs

The result of the sea urchin correlation analysis with live coral cover in Latondu Island waters obtained from the whole transect was 0.56, which meant that sea urchins have a moderate relationship (Appendix 7), but showed a relationship with a positive relationship direction. A positive correlation coefficient (r) means that there is a relationship between variables X and Y that is directly proportional: Increasing the value of variable X will increase the value of variable Y. Thus, sea urchin is one of the key species (keystone species) for coral reef communities. This is due to it being one of the macroalgae population controllers. It is strongly asserted that if the density of sea urchins decreases coral reefs will be damaged, because macroalgae will dominate and cover the coral, thus inhibiting the process of coral photosynthesis, eventually resulting in mass coral mortality.

4. CONCLUSIONS AND SUGGESTIONS

4. 1. Conclusions

The number of sea urchins found in Latondu Island waters was 133 individuals of 7 types of sea urchins. Abundance at Station 1 was found to be 5 individuals / 50m^2, at Station 2 - 5 individuals / 50m^2, and at Station 3 - 12 individuals / 50m^2. According to the anaylsis undertaken, sea urchins have a positive relationship to coral reefs with a value of 0.56, which means a moderate correlation. Furthermore, sea urchin distribution in Latondu Island waters is uniform, namely, Sation 1 - 0.79, Station 2 - 0.80 and Station 3 - 0.91.

4. 2. Suggestions

Suggestions from this research are the need to add other parameters such as quantitative macroalgae data collection, determinants, growth and mortality from sea urchins, as well as water quality parameters such as DO and current speed. Future studies on the economic and biological value of sea urchin would also suffice.

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