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Population Density and Distribution Pattern of Sea Urchin (*Diadema Setosum*) in Abang Island, Batam

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Abstract
This research aims to describe the population density of Sea Urchin (*Diadema setosum*) and it's distribution pattern in the waters of Abang Island, Galang District, Batam City - Indonesia. Carried out in June 2023. Observations at 3 stations, using survey methods. Sampling was carried out using 3 line transects 20 meters long at each station, placing the transects from the shoreline towards the sea and placing observation plots 1m x 1m on the left and right of the transects. Data obtained from observations were analyzed qualitatively and quantitatively. Qualitative data analysis includes the scientific name and describes the sea urchin based on its morphological characteristics, while quantitative analysis calculates population density using the Krebs (1998) formula and distribution patterns are calculated using the Morisita 1962 distribution index in Krebs 1998.Measurement of water quality parameters; pH, salinity, depth, Dissolved Oxygen (DO), and temperature. The highest density was 2.28 ind/m^2 found at station I with several 228 individuals and the lowest was 0.81 ind/m^2 found at station II with same 81 individuals. The distribution pattern of sea urchins (*Diadema setosum*) was in clustered were found at all stations.
Key Words: *Abang Island, distribution pattern, population density, Sea Urchin (Diadema setosum),*

INTRODUCTION

Abang Island is a small island located south of Batam City, Riau Islands Province. This area is a marine tourist spot, and has beautiful beaches, with the existence of coral reefs that are still well maintained and naturally make various marine biota grow and develop properly. Marine biota that can be found on Abang Island includes fish, crabs, squid, sea cucumber,and also sea urchins.

Sea urchins (*Diadema setosum*) belong to the class Echinoidea of the Phylum Echinodermata (Telford et al., 2014). This animal has a spine or is an invertebrate (Azwir, et al., 2019) the body has a shell, and its body also has spines Padang et al., 2019

One of the famous species of sea urchins is *Diedema setosum*, these animals usually live on rocks or coral. (Hersiana et al.,2017). Young and Bellwood, (2011) reported that most Diadema species are herbivores and omnivorous detritus eaters, eating substrate and eroding algae from hard substrates, these animals are usually active at night, but sometimes during the day.

Sea urchins live in colonies that function to defend themselves. Those who live alone are more vulnerable to predators. It is a key species for coral reef communities. This is because sea urchins are one of the microalgae population controllers. The existence of sea urchins in an ecosystem cannot be separated from the influence of physical and chemical factors in the environment. Sea urchins have physical defenses (thorns) and that makes them suitable for defending against and protecting themselves from marine organisms such as mollusca, shrimp, crabs, polychaeta (annelid worms), copepods (small crustaceans), and fish (Prasetyo et al., 2019).

Many benefits can be drawn from sea urchins, apart from being important for water, sea urchins are also used as food by coastal communities by taking the eggs and gonads of sea urchins for consumption (Kresnamurti et al.,2017) Sea urchins are one economically important marine organisms because their gonad are highly nutritious food ingredients that are consumed or sold (Lewerissa et al.,2021; Hadinoto et al.,2017) state that the sea urchin species *D. setosum* is a type of sea urchin that has economic value. The dominant species that has the potential to be used as food is *D. setosum*. (Hadinoto et al.,2017) This organism can be used as a source of nutritious food. The gonads of the *D. setosum* type of sea urchin contains 18 types of unsaturated fatty acids, including omega-3 and omega-6 and 15 types of amino acids. Aprilia et al.,(2012) said sea urchin gonads can be used as an alternative food source because they contain 28 kinds of amino acids, B complex vitamins, vitamin A, minerals, omega-3 and omega-6 fatty acids. Abubakar et al., (2012) reported that sea urchins have potential as anti-cancer, anti-tumor, anti-microbial, and anti-biotic

According to information obtained from the people of Abang Island, traditional use of sea urchins on the coast continues to increase, where this species is easy to catch and is common around coral reefs, seagrass with a substrate that tends to be sandy in the intertidal zone. If utilization is not carried out in a balanced and sustainable manner, there is a high possibility of over-fishing (over-exploitation).

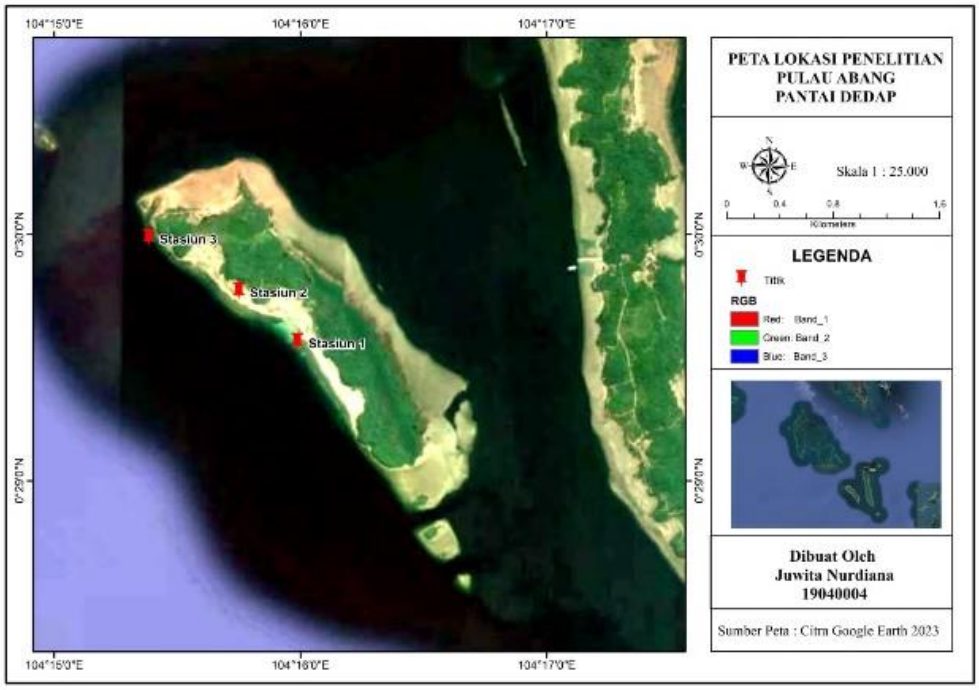

Figure 1. Research Location Map (Google Earth image, 2023)

Given the importance of sea urchins for fisheries in general, it is necessary research on the aspects of population density and distribution patterns of sea urchins. It is hoped that this research can provide information regarding the existence of population densities and distribution patterns of sea urchins of the *Diadema setosum* in the tidal area of Abang Island, Batam City.

MATERIAL AND METHOD

The research carried out was descriptive qualitative research which aimed to provide answers about population density and distribution patterns of sea urchins (*D. setosum*) in the waters of Abang Island, Batam City. Data collection on water conditions is carried out insitu where the physical and chemical parameters of the waters include dissolved oxygen (DO), acidity (pH), temperature, and salinity.

1. Time and place of research

This research was conducted on the Dedap beach in the waters of Abang Island, Galang District, Batam City, Indonesia $0^0$31'2.37' N $104^0$15'4.68' E from June to August 2023. The map of the research location can be seen in Figure 1.

2. Method of collecting data

Data collection was carried out employing an individual census at 3 stations which were determined purposively at the location of the coral reef flat at the study site. Sampling was carried out using 3 line transects 20m long which were drawn perpendicularly from the shoreline towards the sea, along the line transects the left and right observation plots measuring 1m x 1m were placed. Observations were made through snorkeling (surface diving) and skin diving (shallow diving), recording and counting the number of *D. setosum* individuals present in each squared plot at the observation site. The samples found were photographed using an underwater camera (waterproof camera). Water condition data collected directly from the field includes physical and chemical parameters, including water temperature, water salinity.

3. Data analysis

The data obtained from the observations were analyzed qualitatively and quantitatively. Qualitative data analysis was by including the scientific name and describing the sea urchins D. setosum based on their morphological characteristics, while quantitative analysis was by analyzing the population density and distribution patterns of *D. setosum* in their habitat.

Population Density

Analysis of the population density of sea urchins (*D. setosum*) is the number of individual species divided by the total sampling area (Krebs, 1998) with the equation:

$$Di = ni / A$$

Information:
Di = Type population density
ni = Total Number of Individuals of type i
A = Total area of sampling area

Distribution Pattern

Analysis of the distribution pattern of sea urchins can be calculated using the Morisita Distribution Index (Fitriani et al., 2022 ;Krebs, 1998)

$$I_{d=n} \frac{\Sigma x^2 - \Sigma x}{(\Sigma \times)^2 - \Sigma \times}$$

Where;
Id is Morisita Distribution Index
n is the number of sampling points
∑x is the number of individuals at each point (x1 + x2 + …)
$\sum x^2$ is the number of individuals in each point squared (x12 + x22 +...).

The criteria for the index value are:
id = 1 distribution pattern is random
id > 1 distribution pattern is clustered
id < 1 distribution pattern is uniform

RESULTS AND DISCUSSION

Population density

The research location is in Dedap Beach, Abang Island Waters, geographically located at 0°31'2.37'N and 104°15'4.68'E. This area is included in the Abang Island Village, Galang District, Batam City, Riau Islands Province - Indonesia. Located in the south of Batam Island, is a fishing village. Some community activities around the waters of Abang Island are fishing, tourism, and research activities. Sampling locations are carried out in areas that are not used for fishing activities and shipping traffic lanes, to facilitate observation and sampling. At the sampling location, sand, rock, and a thriving coral community were found growing in the seagrass beds.

The results of observations and individual censuses of *D. setosum* sea urchins that were carried out on the Dedap beach in the waters of Abang Island showed that the number of individuals at each station placed 3 line transects with an area of 100 m2 was different from one station to another. The stationI have 228 individuals. The Station II has 81 individuals. The Station III has 87 individuals. The total number of individual *D. setosum* sea urchins found was 396. The population density of *D. setosum* can be calculated as presented in the Table. 1.

Table 1. Population density of *D. setosum* per station

	Research Station		
	I	II	III
Number of individuals	228	81	87
Density (ind/m)	2.28	0.81	0.87

Based on Table 1, it can be seen that station I has the highest density, namely 2.28 individuals/m^2, then station II 0.81 individuals/m^2 , and station III 0.87 individuals/m^2. The difference in population density found at each research station is thought to be due to differences in place and living habits. This shows that the habitat or substrate at each observation station plays a role in determining the presence of sea urchins in these waters. This is presumably because station I has a suitable habitat for the growth and development of this type of sea urchin *D. setosum*. The high density at station I is thought to be related to environmental conditions suitable for the life of *D. setosum*, namely on sandy substrates, fertile coral rocks, and little seagrass.

Different densities were found at stations II and II where the relative density values were the same, namely at 0.81 individuals/m^2 and 0.29 individuals/m^2, from field observations the habitat conditions were slightly different, whereas at stations II and III the habitat was dominated by sand and seagrass and a few corals, different from station I which has lush corals. The population of *D. setosum* plays an important ecological role, because its relative numbers will greatly influence the population dynamics of corals, reef fish, and algae (Yokes and Galil, 2006a; McClanahan and Muthiga, 2001)

Diadema populations are known to fluctuate in a particular area (Ogden, 1989). This appears to be a characteristic feature of the species. Factors controlling these fluctuations are the availability of food and shelter and disruption of human activities, such as loss of predators due to overfishing on coral reefs (McClanahan and Muthiga, 2001). Besides that, the low density at these two stations is also suspected because at these locations people often catch *D. setosum* sea urchins for consumption and sale.

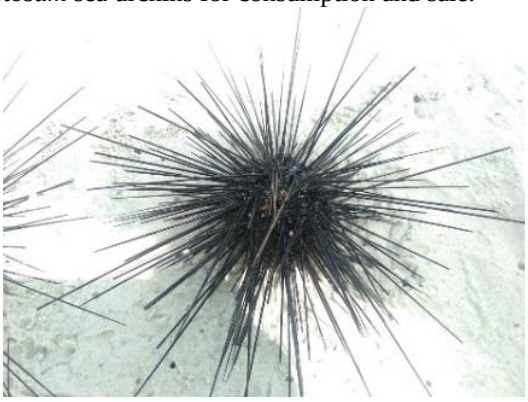

Figure 2. Sea urchin *Diadema setosum*

Figure 3. Sea Urchin's gonad

Table 2. Distribution Pattern of *D. setosum*

Station	Morisita Distribution Index (Id)	Category
Station I	1.59	Clustered
Station II	1.98	Clustered
Station III	1.91	Clustered

Table 3. Water Quality Measurement Results

Station	Salinity (0/00)	pH	Depth (m)	DO (mg/l)	Temperature (^{o}C)	Substrate
Station I	29.5	8,4	1 - 2	7.4	30	Coral and sand
Station II	29.5	8,4	1 - 3	7.4	30	Stones, coral and sand
Station III	30	6,6	1 - 2	7.4	30	Rocks, coral and a little seagrass

People catching sea urchins (*D. setosum*) in the waters of Abang Island are used as food for their gonads (Figure 3.). Sea urchin gonads are one of the potential aquatic products. Silaban and Srimariana (2014) said that sea urchins have been used as food for a long time and generally consumed them fresh and some have been cooked by frying, steaming or baking. (Nane et al., 2020) stated that food-based sea urchin gonads have been widely consumed by Europeans, Japanese, Chileans, Americans, and Canadians.

Distribution Pattern

The results of calculations of the distribution pattern of sea urchins (*D. setosum*) using the Morisita Index show that in general, the distribution pattern of the sea urchin D. setosum population is clustered. The results of the calculation of the distribution pattern are presented in Table 2.

The distribution pattern of *D. setosum* at station I with a Morista index value of 1.59 is in by criterion of an Id value > 1. The distribution pattern is clustered, as is the distribution pattern at station II with an Id value = 1.98 and station III with an ID value = 1.91 is > 1, categorized as clustered distribution. The a clustered distribution pattern is thought to be due to the type of substrate and the availability of food at all stations suitable for this type of sea urchin. (Maretik et al., 2022) The habitat of D. setosum is on coral reefs, sandy areas , and coral fragments. This species is the species which is most commonly found in the 3 research locations. This happens because the coral reef substrate is an important habitat for the growth of *D. setosum* and is easy to adapt to the environment, especially food in the form of seagrass and corals. (Yokes and Galil, 2006b) This species is commonly seen around coral reefs and shallow rocky habitats (mostly at depths of 1-6 m), where it hides in crevices and under cover during the day. Occasionally, they are found in large groups on adjacent sand flats. Sea urchins that live in the sand flat zone, algae growth areas, and coral reefs usually live in large groups, while in coral reef areas they live in small groups or live alone in dead coral holes and coral rubble.

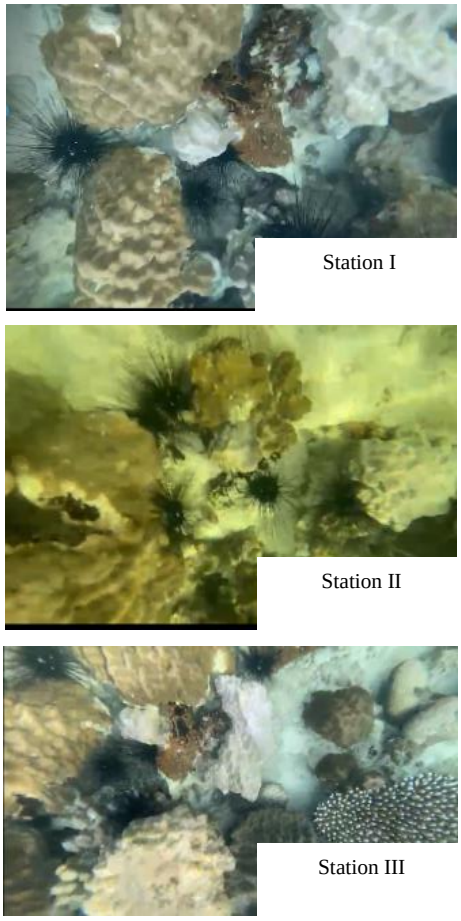

Figure. 4 Distribution at Station I, II and III

In general, at all research stations, the substrate was found to be covered with coral reefs and seagrass beds in good condition. The presence of *D. setosum* populations is important for coral reefs as a counterbalance. Its population balance will maintain the balance of algae and coral populations. According to Clark (Clark, 1976), coral reefs are a complex ecosystem and have high aesthetic value, and are inhabited by various types of fauna, including echinoderms, one of which is sea urchins which are quite dominant inhabitants of coral reefs.

Water Quality

Water quality measured includes salinity, pH, depth, DO, temperature, and type of substrate. Based on measurements during the research on the coast of Abang Island, the calculation results have been obtained which can be seen in Table 3.

The results of water quality measurements at station 1 recorded a salinity of 29.5 $^{0}/_{00}$, a pH of 8.4, a depth of 1 meter, coral and sand substrates. Station 2 recorded a salinity of 29.5 $^{0}/_{00}$, pH 8.4. And depth of 1 meter, stone, coral, and sand substrate. Station 3 recorded a salinity of 30 $^{0}/_{00}$, pH 6.6, depth of 3m. Stone substrate, shells, and a little seagrass. DO 7.4 mg/L the highest is station 3 with and depth of 3m.

to the surrounding waters (Sutcliffe,1978). Salinity at the three observation stations has values ranging from 29-30 0/00. The station with the highest salinity is located at station 3, namely 30 0/00. Meanwhile, station 1 and station 2 have the same salinity value, namely 29.5 $^{0}/_{00}$. The salinity value is still within the threshold for the life of sea urchins. Echinoidea cannot tolerate low salinity, and low salinity will result in changes in color pigment and the spines will fall (Russel, 2023). Nomleni et al., (2020) said Sea urchins are intolerant to low salinities, and cannot survive in estuaries because of freshwater influences.

The pH value at each observation station ranged from 6.6 to 8.4. According to most aquatic organisms are easily affected by changes in pH, the pH value that supports the survival of marine biota including sea urchins is in the range of 7 - 8.5.

Dissolved oxygen (DO) value 7.4 mg/L. Based on the Decree of the (Kementerian Lingkungan Hidup Republik Indonesia, 2004), the quality standard for dissolved oxygen for marine biota is >5 ppm. Based on this, it can be concluded that the range of dissolved oxygen (DO) values at the research location supports the life of sea urchins. The high value of dissolved oxygen (DO) is thought to be due to DO measurements carried out during the day and when the sun shines brightly during the day, the release of oxygen by the photosynthesis process which takes place intensively in the euphotic layer is greater than the oxygen consumed by the respiration process.

Environmental temperature plays a vital role in determining when and where aquatic species may survive and prosper, such as ectotherms (Salas et al., 2012) The temperature values obtained are 30ºC. The temperature obtained is good for the life of sea urchins (*D.setosum*). Suryanti and Ruswahyuni, (2014) reported cold temperatures below the maximum threshold could result in the mass death of marine life. Therefore the temperature in the waters is in line with the abundance of sea urchins.

The depth at the three observation stations is 1m-3m. Some species of sea urchins tend to have a very high sensitivity to sunlight. The intertidal area of Abang Island beach which is used as the location for While station 1 and station 2 have the same depth of 1m. Depth is related to the penetration of sunlight The results of water quality measurements at station 1 recorded salinity of 29.5 $^{0}/^{00}$, pH 8.4, depth of 1 meter, coral, and sand substrate. Station 2 recorded salinity of 29.5 $^{0}/_{00}$, pH 8.4, depth of 1 meter, rock, coral and sand substrate. Station 3 recorded a salinity of 30 $^{0}/_{00}$, pH 6.6, a depth of 3m. Stone substrate, shells, and a little seagrass. DO 7.4 mg/L. Temperature 30^{0}C.

Salinity is a primary determinant of aquatic species distributions, with organisms required to maintain homeostasis by balancing body fluid ion concentrations relative

the observation station has several types of subrates namely stone, coral, sand, and a little seagrass. Station 1 has coral, and sand substrates. Station 2 has rock, coral, and sand substrates. Meanwhile, station 3 has a substrate of rocks, coral and a little, and sea grass.

CONCLUSION

Based on the results of research conducted at the research location, it can be concluded that *Diadema setosum* is a species of sea urchin found in the waters of Abang Island, Galang District, Batam City. Station I, has the highest density with a density value of 2.28 individuals/m2. The lowest density was at station II with a density value of 0.81 individuals/m2. The distribution pattern of *Diadema setosum* found at the study site was clustered.

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