Relationships Between of Sea Urchins Abundance, Macroalgae and Coral Closure on the Cemara Kecil Island

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Relationships Between of Sea Urchins Abundance, Macroalgae and Coral Closure on the Cemara Kecil Island

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Abstract. Sea urchins are one of the key species for coral reef communities because have the capability for controlling populations of microalgae. The existence of sea urchins in an waters ecosystem influenced by abiotic and biotic environmental factors such as intraspecific or intraspecific interactions. This study aims to determine the relationship between the abundance of Sea Urchins, Macroalga on massive coral, and coral cover on Cemara Kecil Island by PCA analysis. The study was conducted in May 2017 in Cemara Kecil Island. Method of research with Haphazard sampling technique. The results indicate that numbers of sea urchins found ranges from 78-130 ind/m^2, an abundance of macroalgae found are *Sargassum* sp 1.36%, *Caulerpa* sp.7.43% and *Padina* sp 91.21%. The results of substrate cover are living coral 47,21%, dead coral 23.33%, other fauna 2.85% and abiotic element 26,61%. Based on the results of PCA analysis that Sea Urchin abundance has a positive correlation with the closure of Coral Reef and *Caulerpa* sp. While the *Padina* sp and *Sargassum* sp have a positive correlation as well as abiotic factors, dead coral, and other fauna.

Keywords: Sea Urchin, Macroalgae, Coral, Cemara Kecil Island

1. INTRODUCTION

Sea Urchins are marine animals that have no backbone and are classified in Echinoderms phylum, have an important role in ecosystems and high-value [1]–[3]. Organisms in the class Echinoidea is a determinant of the abundance and spread of marine plants in the sea waters dangka and has a variety of species that are abundant and almost occupy all the habitats on earth [4]. Sea Urchin plays a role in regulating algae communities and affect the percentage of coral cover, this is because the habitat of sea urchin other than algae ecosystem is also found in coral reef ecosystem [5]

In the State of Indonesia, Sea Urchins have local names such as Bulu Babi, Landak Laut, Tayum dan Tehe-tehe. They are included in the phylum Echinodermata in which there are also Sand Dollars, Sea Cucumber, Sea Stars. Sea Lilies, Sea Biscuits, and Brittle Star [6]. The habitat of the sea urchins includes algae-covered rocky areas, seagrass ecosystems and coral reef ecosystems [7], [8] and has a color that varies between species such as brown, black, green, white, or red [9]. They also act as predators of marine vegetation where their habits eat macroalgae and microalgae, so they have the ability to control the growth and spread of vegetation at sea [10], [11]. Sea Urchins on coral reefs, altering algae communities from fleshy algae, hostile to corals, to nourish coral algae that facilitate coral recruitment and coral reef resistance [12].

Sea Urchins is a class Echinoidea phylum Echinodermata and a variety of species in shallow seas [13]. Based on the shape of the body, the class of Echinoidea is divided into two main subclasses, regular and irregular sea urchin [14]. The Sea Urchin is one of the marine organisms that have important economic and ecological values [15]. At this time only regular Sea Urchins that has a consumption value. The main part used from these sea urchins is gonads/eggs [16].

Sea Urchins are the main herbivorous animals that mantle algae in shallow seas around the world [17]. A balance between sea urchins, algae, kelp and coral reef productivity. Good coral reef ecosystem conditions will be followed by abundance of sea urchins as a balancing of coral reefs and inhibitors of algae expansion [18], [19]. The abundant Sea Urchin can damage the kelp fields [20]. Certain types of

Sea Urchins such as *Strongylocentrotus droebachiensis* increased can result in the kelp fields [21], [22]. However, when the kelp fields are destroyed by storms or El Niño events, the remaining Sea Urchins are feeding on young kelp, thus preventing the re-establishment of kelp forest [23]. However, Sea Uchins may be destroyed by storms or disease, allowing kelp forests to return to the area [24].

One of the areas of water in Indonesia that have an appropriate ecosystem as a habitat for Echinodermata is the waters around Karimunjawa Islands [25]. One of the small islands of Karimunjawa Island is called Pulau Cemara Kecil. The ecosystems found on this island are macroalgae and coral reef ecosystem. In contrast to other major islands, research on the diversity of fauna in the mouse island is relatively limited. The limited information on Echinodermata particularly the sea urchins on the island led to the need to conduct a study to identify the sea urchin biota and analyze its abundance with the abundance of macroalgae and coral closure on the island.

2. MATERIALS AND METHODS

Sea Urchin, Macroalga, and Coral closure sampling are conducted around Pulau Cemara Kecil consisting of 4 observation stations (Figure 1). The study took was conducted in May 2017.

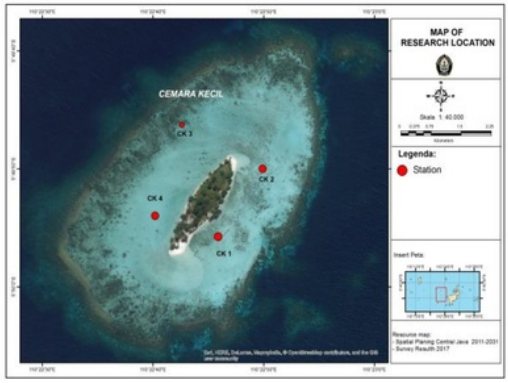

Figure 1. Map of Location

Sampling Coral closure using line transect method. There are 4 line transects that determined in accordance with the number of research stations with a length of 50 meters. Determination of the location of this research is done by Haphazard sampling method that creates a random sample by haphazardly choosing items in order to try and recreate true randomness. The sampling process is done when the sea water receded at around 11:00 am until 00:30 pm. Each Sea Urchin and Macroalga sample was found and then immediately observed. Sample calculations are performed by counting the number of individual sea urchins present and macroalgae in a frame every one meter on a line transect. Statistical procedure and data analysis used PCA (*Principal Component Analysis*) that determined correlation variable between macroalgae, sea urchin and coral closure.

3. RESULT AND DISCUSSION

The result are the number of sea urchins was found in the range of 78 - 130 ind/m^2 with dominant *Diadema setosum* species and *Echinotrix calamaris*. Sea Urchins are herbivores organism so that the presence of sea urchins determines the abundance and distribution of marine plants such as algae in shallow sea waters [26]. The results showed correlation value (r) it is reinforforced that's mean strong correlation between the density of sea urchins and the habitats containing algae or a combination of dead corals and algae, it is reinforced by [27] there is a significant correlation between the density of sea urchins and habitats that contain algae or a combination of rock and algae.

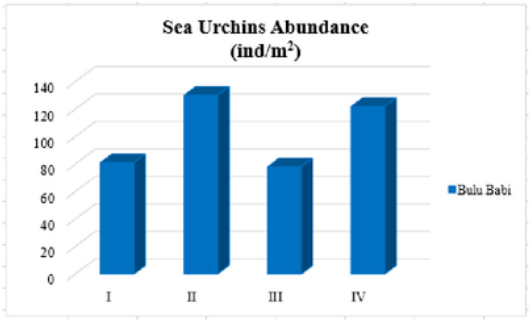

Figure 2. Measurement Result of Sea Urchin Abundance

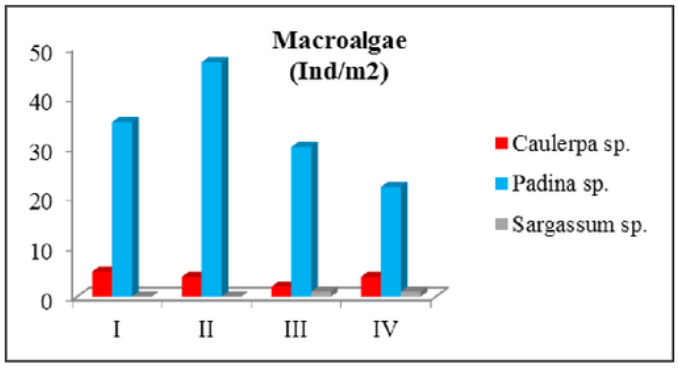

Figure 3. Measurement Result of Macroalgae

Based on figure 3 it can be seen that there are 3 species that is *Caulerpa* sp, *Padina* sp and *Sargassum sp* dominate in research location. This is possible because at the location of the study has characteristics suitable for the growth of *Padina* sp. Seaweed is a macroalga that has a macroscopic size and grows on rocky and sandy substrates [28], [29]. Makroalga is divided into three divisions: Chlorophyta (green algae), Phaeophyta (brown algae), and Rhodophyta (red algae) [30], [31]. Ecologically, macroalgae play an important role, potentially as pollution biomonitoring, can decrease heavy metals [32], spawning sites and food sources for marine organisms [33]. Economically several types of macroalgae an industrial raw material agar-agar, food sources, pharmaceutical, organic fertilizers,carrageenan, cosmetic, and others [34]. Generally macroalgae live in the area of the intertidal zone, the intertidal zone is the area affected by the tides. In these areas macroalgae grow and one of them is influenced by the type of substat. The type of substrate affects the type of benthic organism that lives on the surface. In addition, the distribution and abundance of macroalgae communities is influenced by abiotic variables such as tides, waves, substrate stability, nutrients, and sedimentation [35], [36].

The results of coral cover measurements that have 47,21% of living coral through the percentage can be known that live coral cover has still good. The simple regression results between abundance of sea urchins (ind/ m²) and macroalgae abundance (ind/m²) in obtained equation y = 6,035x-86,982 where "y" is abundance of sea urchins and "x" is macroalgae abundance, at 95% confidence interval with correlation coefficient value of 0.786. This shows that there is a close relationship between them. For the determinant value (R^2) is 0.617, this means that sea urchins abundance is influenced by macroalgae abundance of 69.9% while the rest is another factor.

Coral reefs are ecosystems that have high water productivity. The decrease of coral cover worldwide and sea level rise can harm coral reef ecosystems in particular [37]. Coral products contribute the equivalent of US $ 2213 (±396) annually per respondent, especially in the cash economy, so there needs to be better management, to manage coral reefs and ecosystem services in the Coral Reef Triangle [38]. Coral reefs are likely to be rapidly degraded over the next 20 years, posing a fundamental challenge for the 500 million people who get food, income, coastal protection, and other services from coral reefs [39]. The tropics cover one-third (33.7%) of the planets land surface. They are home to over 35% of the human population, the vast majority of all species, contain over 40% of the world's forests [40].

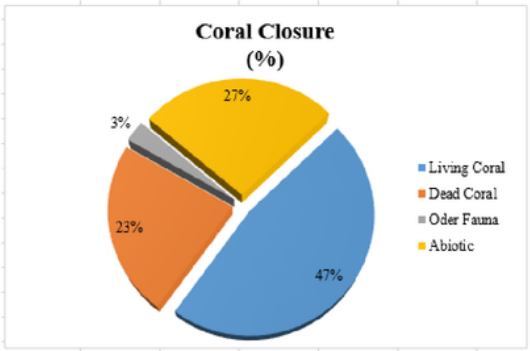

Figure 4. Measurement Result of Coral Closure

The presence of coral species in a location depends on the conditions local waters such as sunlight, salinity, temperature, current movement, substrate and water brightness. The substrate is one important factor in supporting the presence of rock corals in water. A hard and clean substrate of sludge is required for the attachment of the coral larvae that will form a new colony [41]. The mean salinity of seawater in the tropics is about 35 ‰, and coral animals live in a salinity range of about 34-36 ‰ [42]. According to [43], the global, annually tolerance limits for coral reefs are 21.7-29.6 °C for temperature, 28.7-40.4 PSU for salinity.

Table 1. Result of PCA Analysis on Rotated Component Matrix

	Component		
	1	**2**	**3**
Caulerpa sp	-.992	.005	.127
Living Coral	.983	-.103	-.155
Sea Urchin	.887	-.306	.346
Other Fauna	-.042	.996	-.075
Dead Coral	.137	-.986	-.093
Abiotic	-.668	.709	.227
Padina sp	.149	-.124	.981
Sargassum sp	-.346	.294	.891

The results of PCA analysis shown that Abundance of sea urchins has a positive correlation with live coral cover but both have a negative correlation with the abundance of *Caulerpa* sp (Table 1. and Figure 5.). Given the correlation of the three factors above can be estimated coral ecosystem health at the research location is still fairly good. This is due to the correlation between the three. Sea Urchins of the genus Diadema is one of the most abundant and ecologically important ecological echinoderms in the

sea especially in coral reef ecosystems. Sea Urchins plays a very important role in the structure of coral reef and algae ecosystems. The herbivorous activity of *D. antillarum* has been reported to affect the diversity, abundance, and productivity of algal communities. *D. antillarum* also influences coral recruitment by consuming algae and opening new reef substrates, making them available for coral larval settlement. Urchins are also known to be major bioeroders on reefs, influencing benthic community structure.

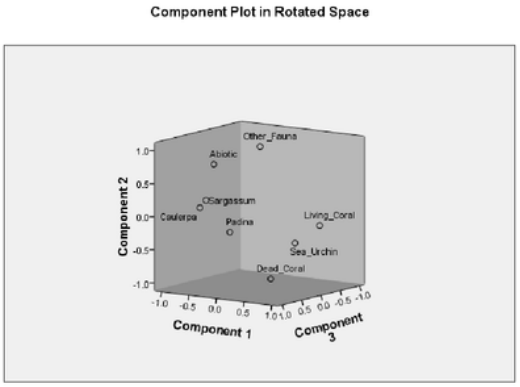

Figure 5. Result of PCA Analysis on Rotated Space

The spines of *D. antillarum* erves as a shelter for their own teenage colonies, and other teenage species colonies, such as lobsters and grunts [44]. However, at high densities, D. *antillarum* is known to inhibit coral recruitment by preying live coral tissue of adult colonies [45]. Populations of *D. antillarum* is critically important grazers that maintain coral reef health by eating algae, keeping existing corals from being smothered and leaving clean substrate for new coral larvae to settle [46].

If in the sea there is dominant algae the abundance of sea urchins on the system is and there is no herbivor fish or fish other than herbivor fish. Removal of top predators such as sea urchins through fishing, encouraging algae to grow dominating in waters [12]. The temperate regions and predators of sea urchins resulted in the abundance of sea urchins becoming less and algae ecosystems increasingly abundant [47].

The functional roles herbivores play on coral reefs may reflect their mobility, feeding preferences, life history characteristics [48], or resistance and recovery responses to disturbances, such as fishing and coral bleaching [49]. Sea urchins are commonly found in coral reef ecosystems, especially *Diadema setosum* species because the abundance of species populations is important for coral reefs as a counterweight. It is said to be a balancer of coral reefs due to the sea urchins themselves which generally eat algae found on coral reefs [50]. Macroalgae is a competitor for coral animals in fighting for space resources (sunlight) so that if there is no sea urchin there will be an increase in the number of macroalgae and will result in the closure of coral reef living space, so the waters become eutrophic. The presence of species populations *D. setosum* is important for coral reefs as a counterweight. Diadema population equilibrium will keep the equilibrium of algae and coral populations. *D. setosum* species research is most dominant because the species is one of type of sea urchin (Echinoidea) that live in the reef ecosystem coral and seagrass.

4. CONCLUSION

The conclusion that can be obtained are the species of sea urchin found in research site is *Diadema setosum* and *Echinotrix calamaris*. The relation between abundance of sea urchins, macroalgae, and the coral closure that the sea urchin abundance causes the presence of macroalgae maintained and causes coral closure to increase

5. ACKNOWLEDGEMENTS

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