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Original research article

The Abundance of Megabentos in Coral Reef Ecosystems in the Waters of Gelasa Island, Central Bangka Regency

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ABSTRACT

Megabenthos is a group of fauna that inhabits the benthic zone, which is the bottom or substrate of aquatic environments (both infauna and epifauna), with a body size exceeding 10 mm (1 cm). This study aims to analyze the abundance of megabenthos in the coral reef ecosystem, examine the relationship between megabenthos abundance and the physical and chemical parameters of the aquatic environment in the coral reef ecosystem, and analyze the relationship between megabenthos abundance and coral life forms in the waters of Gelasa Island. This research was conducted in September 2022 in the waters of Gelasa Island. Megabenthos data were collected using the Bentos Belt Transect (BBT) method, while coral data were collected using the Underwater Photo Transect (UPT) method. The study identified 10 species of megabenthos in the coral reef ecosystem of Gelasa Island. The species found at the research site include Diadema setosum, Diadema antillarium, Echinothrix calamaris, Drupella cornus, Drupella rugosa, Trochus conus, Tectus pyramis, Tridacna squamosa, Tridacna crocea, and Acanthaster planci. The percentage of live coral cover at the research site ranged from 26.60% to 71.00%. Megabenthos abundance was analyzed using Principal Component Analysis (PCA) to examine the relationship between megabenthos and the physical and chemical parameters of the aquatic environment and the relationship between megabenthos and coral life forms.

Introduction

Pulau Gelasa Island is situated between Bangka and Belitung Islands. It falls within the jurisdiction of Central Bangka Regency and covers an area of approximately 210 hectares (Adi, 2019). Gelasa Island boasts a substantial

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potential for coastal resources. Its waters serve as a livelihood source for the local community, particularly fishermen, due to the rich marine biodiversity, including coral reef ecosystems. However, certain fishing activities pose a threat to the coral reef ecosystem in Gelasa Island's waters, such as the use of coral reefs as anchor points for boats and ships.

Coral reef ecosystems are distinctive features of tropical waters known for their fertility, biodiversity, and high aesthetic value. Additionally, coral reef ecosystems are highly sensitive to environmental changes (Mutaqin, 2020). Coral reefs provide diverse benefits, making their preservation crucial. These ecosystems serve various ecological functions, including providing habitat for a wide range of organisms, with one of them being Megabenthos.

Megabenthos refers to organisms larger than 1 cm that inhabit the seabed, encompassing attached and crawling biota like Crustacea, Mollusca, and Echinodermata. Megabenthos comprises several organisms, including Acanthaster planci, Echinoidea, Holothuroidea, Linckia laevigata, Tridacninae, Drupella spp, Trochidae, and Panulirus sp (Arbi, 2017). Megabenthos in coral reef ecosystems often serve as indicators of the health of the coral in a given location, whether the coral is still thriving or has suffered damage (Mutaqin, 2020). Megabenthos can be used as indicators of water quality, helping to detect environmental changes.

Materials and Methods

Time and Place

The research was conducted in September 2022 on Gelasa Island, Beriga Village, Tanjung Berikat Hamlet, Lubuk Besar Sub-district, Central Bangka Regency. Data collection was carried out directly in the field, and sample identification (megabenthos and coral, in the form of photographs) was performed at the Laboratory of Aquatic Resource Management, Bangka Belitung University. The equipment and materials used in this study included diving equipment, underwater cameras, waterproof stationery, frames (44x58), Secchi disk, current meters, stopwatch, TSS bottles, filter paper, thermometer, pH paper, refractometer, GPS, permanent markers, roll meters, and the CPCE application.

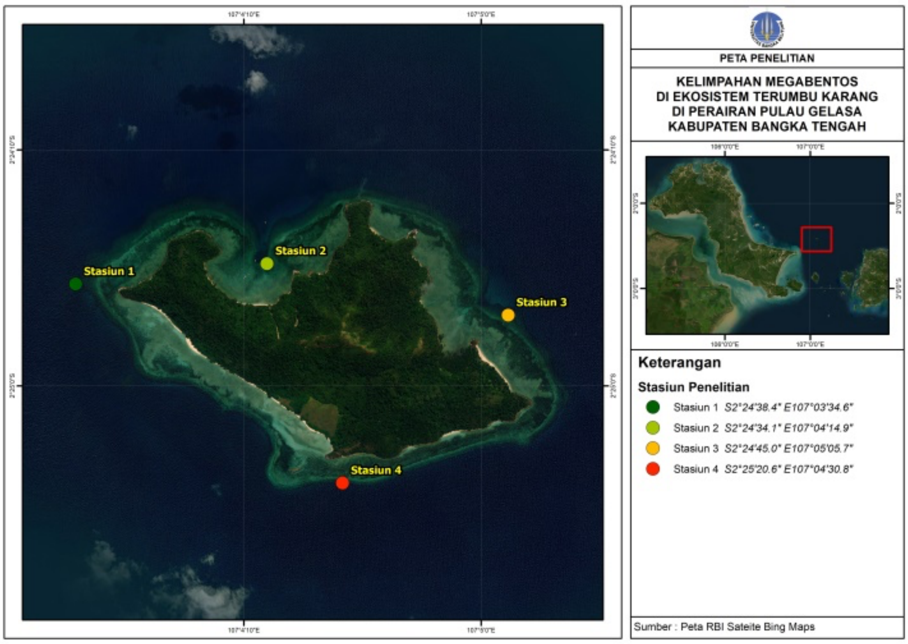

Figure 1. Research Location

Tools and Materials

The tools and materials used are diving equipment, underwater cameras, waterproof stationery, frames (44x58), secchi disks, kite currents, stopwatches, TSS bottles, filter paper, thermometers, pH paper, refractometers, GPS, permanent pegs, roll meters, laptops, CPCE applications.

Data Collection Method

The collection of coral data was conducted using the Underwater Photo Transect (UPT) method, which involves laying out a 50-meter line parallel to the shoreline and placing square frames at every meter interval. The placement of frames started at the first meter, with frames positioned to the left of the line for odd meters.

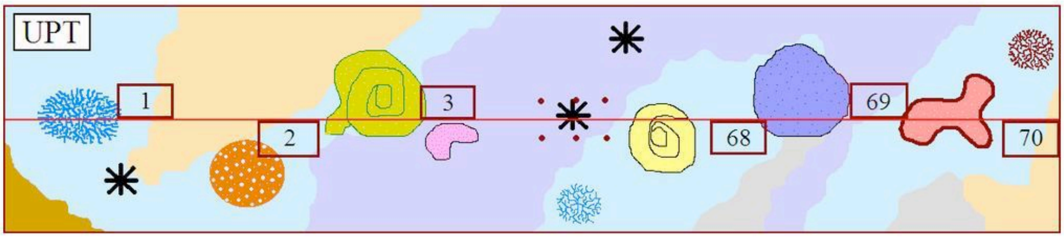

Figure 2. Coral data collection scheme (Giyanto, 2014)

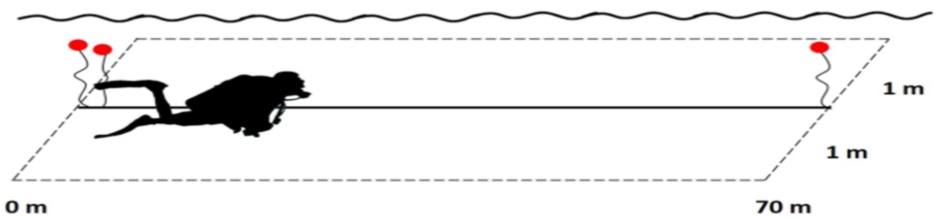

Figure 3. The scheme for collecting megabenthos data (Arbi and Sihaloho, 2017)

Megabenthos data collection was conducted using the Bentos Belt Transect (BBT) method (Arbi, 2017). The Bentos Belt Transect (BBT) method is a modification of the Belt Transect method combined with the Reef Check Bentos method. This method involves laying out a 70-meter transect line parallel to the shoreline. The technical aspect of laying the line always keeps the shoreline to the left of the diver. Recording of megabenthos species and the number of individuals begins at the 0-meter point and continues up to 70 meters, with observations extending 1 meter to the left and right of the line. The observation area covers a total of 140 square meters (2×70 meters) (Arbi and Sihaloho, 2017).

Data Analysis

Species abundance is the number of individuals of wide unity. The abundance of megabenthos can be calculated using the following formula: (Arbi and Sihaloho, 2017).

$$Density\ X = \frac{Number\ of\ individuals\ X}{Wide\ belt\ transect} \quad \text{.............(1)}$$

Result and Discussion

Results

Abundance of Megabenthos

There are 10 types of megabenthos found at the observation site. The highest megabenthos density is Diadema setosum with an average density value of 0.452 individuals/m². The megabenthos density in the waters of Gelasa Island can be seen in the following Table 1.

Table 1. Density of megabenthos species (ind/m²) in the Waters of Gelasa Island

No.	Megabentos	Density (ind/m²)				Averange
		Station 1	Station 2	Station 3	Station 4	
1	*Diadema setosum*	0,136	0,764	0,186	0,721	0,452
2	*Diadema antilarium*	0,050	0,057	0,029	0,386	0,130
3	*Echinothrix calamaris*	0	0	0,114	0,264	0,095
4	*Drupella rugosa*	0,021	0	0,043	0,029	0,023
5	*Drupella cornus*	0,086	0	0,043	0,021	0,038
6	*Tectus pyramis*	0	0	0,007	0	0,002
7	*Trochus conus*	0	0	0,014	0	0,004
8	*Tridacna squamosa*	0	0,014	0	0	0,004
9	*Tridacna crocea*	0	0,036	0,014	0,086	0,034
10	*Acanthaster planci*	0	0,007	0	0,007	0,004

Coral Reef Cover Percentage

The coral reef ecosystem coverage in the waters of Gelasa Island, after analysis using the CPCE (Coral Point Count With Excel Extensions) software, revealed that there are 2 stations categorized as 'good,' namely stations 1 and 3, with values ranging from 64.40% to 71.00%. Meanwhile, stations 2 and 4 fall under the 'fair' category, with values ranging from 26.60% to 41.33%. The data for live coral reef cover results are presented in the following Table 2.

Table 2. Percentage of Live Coral Reefs

No	Category	Location			
		Station 1	Station 2	Station 3	Station 4
1	Coral (HC)	64,40	41,33	71,00	26,60
2	Recent Dead Coral (DC)	0,00	0,00	0,07	0,00
3	Dead Coral with Algae (DCA)	27,20	47,13	21,20	37,40
4	Soft Coral (SC)	0,80	0,47	0,60	1,20
5	Sponge (SP)	0,00	0,00	0,00	0,20
6	Fleshy Seaweed (FS)	0,07	0,07	0,00	0,13
7	Other Biota (OT)	2,73	3,27	2,73	5,93
8	Rubble (R)	4,60	5,80	4,40	16,60
9	Sand (S)	0,20	1,93	0,00	11,93

Water Quality Parameters

The water quality data comprises physical and chemical parameters collected during coral and megabenthos data collection, including temperature, pH, salinity, clarity, water depth, current velocity, and TSS. The processed results are presented in the following Table 3.

Table 3. Physical and Chemical Water Data

No	Parameters	Station 1	Station 2	Station 3	Station 4
1	Temperature (℃)	29	30	31	30
2	Salinity (‰)	28	26	30	30
3	Current Velocity (m/s)	0,0453	0,0182	0,0584	0,0267
4	Clarity (%)	100	100	100	100
5	Depth (meters)	6	5	6	6
6	*Potensial of Hydrogen* (pH)	9	8	8	8
7	*Total Suspended Solid* (TSS) (mg/liter)	19,4667	17,8667	26,7333	43,8

The Relationship Between Megabenthos Abundance and Water Physics and Chemistry Parameters

The analysis results indicate the presence of correlation information on axes F1 = 46.67% and F2 = 34.87%. The results of Principal Component Analysis (PCA) for megabenthos abundance with water physics and chemistry parameters can be seen in the following Figure 4.

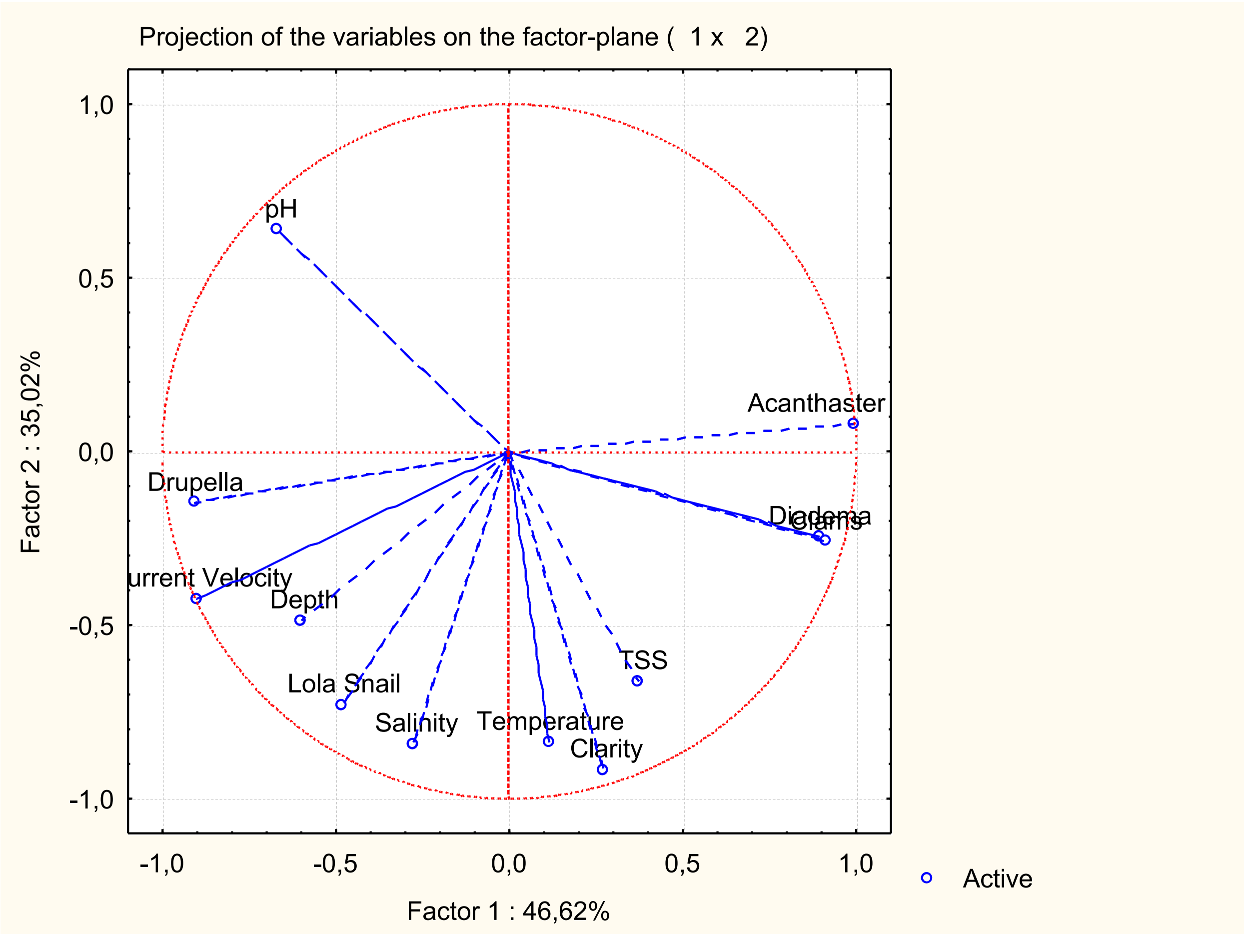

Figure 4. PCA Graph of Megabenthos' Relationship to Water Parameters

The Relationship Between Megabenthos and Coral Reefs

The analysis results indicate the presence of correlation information on axes F1 = 50.15% and F2 = 28.07%. The results of Principal Component Analysis (PCA) for megabenthos abundance with coral reef life forms can be seen in the following Figure 5.

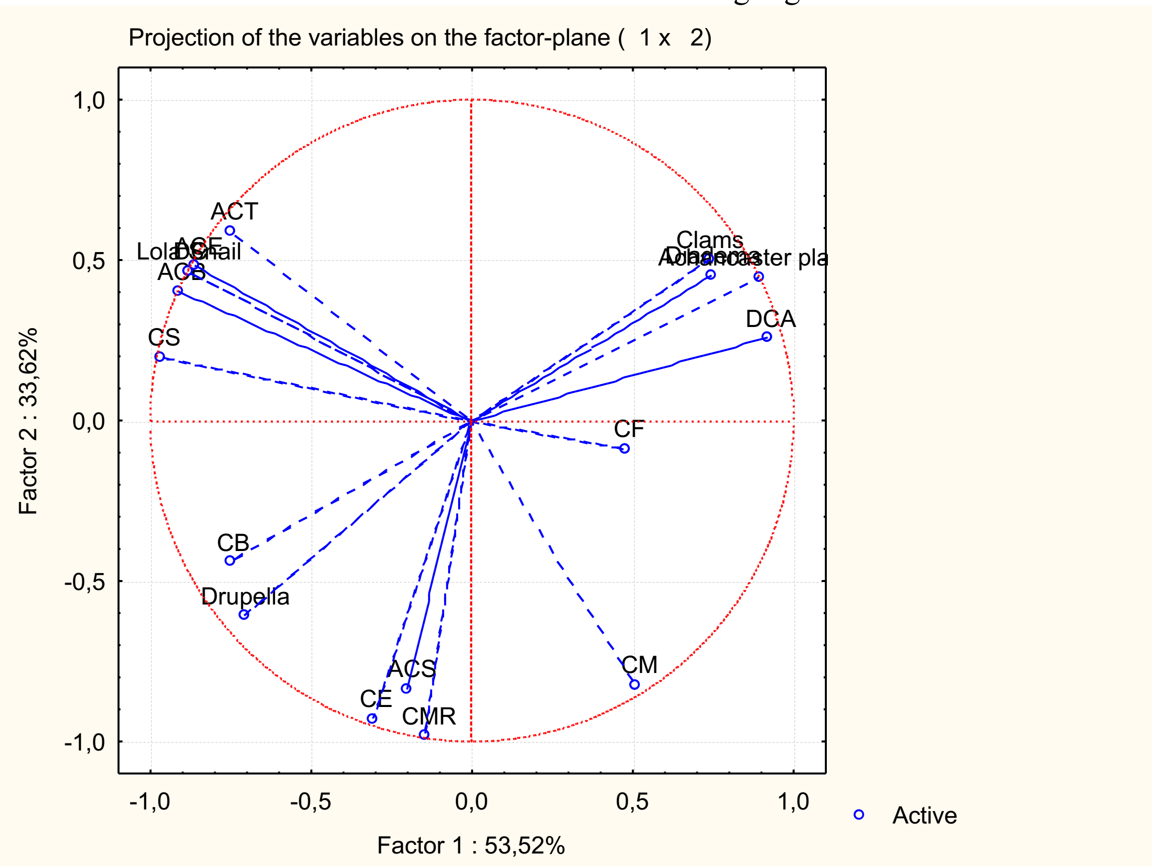

Figure 5. PCA Graph of Megabenthos' Relationship with Coral Reefs

Discussion

Megabenthos Abundance

The megabenthos found in the waters of Gelasa Island consists of 10 species: Diadema setosum, Diadema antillarium, Echinothrix calamaris, Drupella cornus, Drupella rugosa, Tectus pyramis, Trochus conus, Tridacna squamosa, Tridacna corcea, and Acanthaster planci. Diadema sp. was found at all observation stations. There are 3 types of Diadema, namely Diadema setosum, Diadema antillarium, and Echinothrix calamaris. The highest density value of Diadema setosum was found at station 2, which is 0.764 ind/m². The highest density value of Diadema antillarium was found at station 4, with 0.385 individuals/m². Echinothrix calamaris was only found at stations 3 and 4, with the highest density value being 0.264 individuals/m². The presence of Diadema sp. was found at all observation stations because Diadema sp. can thrive in various coral reef ecosystem conditions.

Two types of Drupella were found at the observation stations: Drupella cornus and Drupella rugosa. The highest density value of Drupella cornus was found at station 1 with a value of 0.085 ind/m². The highest density value of Drupella rugosa was found at station 3 with a value of 0.042 ind/m². The high density values of Drupella at these stations can be attributed to the favorable condition of the coral reefs, providing an abundant food source for Drupella.

The keong lola was only found at station 3. There are 2 types of keong lola found at the observation site: Tectus pyramis and Trochus conus. Keong lola is difficult to find because they are active at night, and during the day, they hide behind the corals. This behavior is consistent with their nocturnal lifestyle (Arbi and Sihaloho, 2017).

There are 2 types of giant clams (kima) at the observation site: Tridacna squamosa and Tridacna crocea. Tridacna squamosa was only found at station 2 with a density of 0.014 ind/m². The highest density value of Tridacna crocea was at station 4, with a value of 0.085 ind/m². Giant clams were almost found in all research stations because they are relatively easy to find in clear waters. Clear waters allow maximum sunlight penetration, facilitating photosynthesis for zooxanthellae living in the mantle tissues of giant clams (Rivanda et al., 2020).

Acanthaster planci was only found at stations 2 and 4, with a density of 0.0071 ind/m². This type of starfish preys on coral polyps, especially branching or table-shaped corals, such as Acropora species. Acanthaster planci lives in coral reef areas, following the distribution pattern of its coral prey (Arbi and Sihaloho, 2017).

Coral Reef Ecosystem Condition

The research results indicate that at station 1, there is a live coral cover percentage of 64.40%, station 2 has a live coral cover percentage of 41.33%, station 3 shows a live coral cover percentage of 71%, and station 4 has a live coral cover percentage of 26.60%. According to the Minister of Environment Decree No. 4 of 2001 regarding the Standard for Coral Reef Damage, the coral reef condition in Gelasa Island's waters can be classified as being in moderate to good health, as evidenced by the percentage of live coral cover. This is also attributed to the penetration of light into the water column, allowing Zooxanthellae to undergo photosynthesis, along with favorable physical and chemical water factors (Fajri, 2014).

Physical and Chemical Water Parameters

The water temperature obtained from data collection ranged from 29°C to 31°C, which is considered normal and suitable for organisms living in coral reefs. The salinity values ranged from 26 to 30‰. The salinity values at the research location are still within the supporting category for marine life. According to Hartoni (2012), salinity in coral reef ecosystem waters typically falls within the range of 27 - 40‰.

The current velocity ranged from 0.0182 to 0.0584 m/second, which falls into the calm category. Calm to moderate current speeds typically range from 0.1 to 1 m/s. Calm currents are advantageous for benthic organisms as they promote the renewal of organic and inorganic materials without accumulation. Water clarity data indicated 100% clarity, with water depths at each station ranging from 5 to 6 meters during data collection. Water clarity is one of the important factors in an aquatic environment.

The values of Total Suspended Solids (TSS) ranged from 17.8667 to 43.8 mg/liter. The water's pH levels at the research stations ranged from 8 to 9, indicating a basic nature, which is typical of seawater. High pH values in a water body indicate good water quality in that location (Susana, 2019).

The Relationship Between Megabenthos Abundance and Water Physical and Chemical Parameters

The abundance of Drupella correlates with pH, current velocity, depth, and salinity because these parameters have a significant impact on the presence of Drupella in the waters of Gelasa Island. pH can influence the presence of Drupella in a water body (Istiqomah et al., 2019). pH plays a role in the survival and reproduction of gastropods. Low pH levels can lead to a decrease in the dissolved oxygen content in a water body, causing an increase in gastropod respiratory activity and a decrease in their feeding.

Slow current velocity can support the growth of gastropods that prefer slower currents because they can grow and move undisturbed. Depth affects the organisms that live in the water. Deeper waters have lower dissolved oxygen levels due to lower light penetration, which hinders the process of photosynthesis (Siswansyah and Kuntjoro, 2023). Salinity is also a critical parameter in marine life, as changes in salinity can affect the density of organisms in the water.

The abundance of Turbo Snails has a strong correlation with temperature, salinity, current velocity, and water clarity. Temperature is a supporting factor for Turbo Snail life, with an ideal temperature of 31°C. Temperature influences the abundance and quality of their natural food sources. Salinity affects the distribution of Gastropod organisms. Turbo Snails are active at night and move slowly. During their activities in search of food and shelter, they move slowly, sometimes aided by the movement of ocean currents (Sadili et al., 2015).

Acanthaster planci correlates with Total Suspended Solids (TSS). Total Suspended Solids (TSS) is related to water clarity and sedimentation. The research results show a positive correlation between Total Suspended Solids (TSS) and water clarity. Sunlight penetration into the water is influenced by the sedimentation level.

The abundance of Diadema and Tridacna correlates with water clarity and Total Suspended Solids (TSS). Water clarity and TSS are closely related because high TSS levels in a water body can hinder the penetration of light into the water. Light is a critical factor needed for coral growth. Water clarity values indicate the amount of light entering the water to support productivity in the coral reef ecosystem.

The Relationship Between Megabenthos Abundance and Coral Reefs

Diadema, Tridacna, and Acanthaster Planci have a strong correlation with Dead Coral Algae (DCA). Sea urchins, such as Diadema, feed on algae (Thamrin et al., 2011). Dead coral serves as a substrate for algae growth and is utilized by sea urchins as a foraging ground (Quanita, 2018). Tridacna abundance depends on the condition of the coral reef habitat; if the coral reef is damaged, it can impact the number of Tridacna clams. Acanthaster Planci heavily relies on coral growth or can be found under dead coral rubble, with a preference for microalgae as their food source (Arbi and Sihaloho, 2017).

Drupella has a strong correlation with the growth forms of coral, such as ACB, ACS, CB, CE, CMR, and CS. Kanela et al. (2018) mentioned that Drupella sp. has a habit of feeding on branching coral polyps, especially from genera like Acropora, Pocillopora, and Montipora. Riska et al. (2013) stated that Drupella prefers coral species like Acropora branching, Acropora encrusting, Acropora tabulate, Coral branching, Coral Encrusting, Coral foliose, Coral massive, and Coral submassive for their diet but can consume other coral types if their preferred choices are unavailable.

Keong Lola has a strong correlation with the growth forms of coral, including ACB, ACE, ACT, CB, CS, and DC. Keong Lola typically resides among broken coral, dead coral, and crevices in shallow subtidal and intertidal reef areas

(Arbi and Sihaloho, 2017). The highest population density of Keong Lola is found in dead coral areas (Sadili et al., 2015). A suitable habitat for Keong Lola consists of large, hollow, and creviced coral structures. These conditions are related to the nocturnal feeding behavior of Keong Lola, which actively forages for food during the night (Sadili et al., 2015).

Conclusion

A total of 10 megabenthic species were found in Pulau Gelasa, including Diadema setosum, Diadema antilarium, Echinothrix calamaris, Drupella cornus, Drupella rugosa, Tectus pyramis, Trochus conus, Tridacna squamosa, Tridacna corcea, and Acanthaster planci, with the species density dominated by Diadema setosum with an average density value of 0.452 ind/m². Drupella showed correlations with pH, depth, current velocity, and salinity, while Keong Lola exhibited strong correlations with temperature, salinity, current velocity, and brightness. Acanthaster planci had a moderate correlation with Total Suspended Solid (TSS), and Diadema and Kima correlated with brightness and Total Suspended Solid (TSS). Megabenthos related to the life form of coral, namely Diadema, Kima, and Acanthaster planci, showed correlations with Dead Coral Algae (DCA), while Drupella correlated with Acropora branching (ACB), Acropora submassive (ACS), Coral branching (CB), Coral encrusting (CE), Coral mushroom (CMR), Coral Submassive (CS), and Keong Lola correlated with Acropora branching (ACB), Acropora encrusting (ACE), Acropora tabulate (ACT), Coral branching (CB), Coral Submassive (CS), and Dead coral (DC).

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