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INTERSPECIFIC ASSOCIATION OF SEAGRASS ENHALUS ACOROIDES WITH MACROZOOBENTHOS IN SEAGRASS MEADOW ECOSYSTEMS IN THE EASTERN PART OF PRAMUKA ISLAND

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ABSTRACT

The seagrass community structure on Pramuka Island is declining due to human activities. The condition of the seagrass community structure can be seen from the stability of the ecosystem, where the diversity of macrozoobenthos in it can be one of the indicators that describe the condition of the seagrass. This study aimed to investigate the association between seagrasses and macrozoobenthos, as well as the distribution of macrozoobenthos in the eastern part of Pramuka Island. The quadrant transect method was used at three observation points with a 100 m transect and 1x1 m² plots at 10 m intervals. The physical and chemical parameters were measured at the start, middle, and end points of each transect using water and sediment samples. Enhalus acoroides dominated four seagrass species found in three transects. Plots near the shoreline and mangrove ecosystems harbored Macrozoobenthos due to sediment richness in the organic matter. The results showed that the correlation between Enhalus acoroides and the macrozoobenthos Holothuria atra had a perfect level of association. Enhalus acoroides plays an important role in providing habitat and food for macrozoobenthos on Pramuka Island. This symbiotic relationship maintains the balance of the seagrass ecosystem on Pramuka Island. The diversity of macrozoobenthos species found on Pramuka Island indicates that this ecosystem is relatively healthy and able to provide various resources for organisms residing in seagrass beds.

***Keywords**: Association, macrozoobenthos, seagrass beds.*

INTRODUCTION

Kepulauan Seribu National Park (TNKpS) is one of the marine conservation areas in Indonesia. This conservation area geographically consists of small islands and shallow marine waters (Ningsih *et al.,* 2021). Seagrass beds, coral reefs, and mangroves are the three main ecosystems that build the ecological system in the Taman Nasional Kepulauan Seribu (Afifah *et al.,* 2019). Seagrass beds are a marine aquatic ecosystem located in coastal areas (Kawaroe *et al.,* 2019). Pramuka Island has calm waters and sandy substrate, making it a great habitat for seagrasses. The favorable environmental conditions of Pramuka Island result in a high accumulation of sand on the substrate. Under these conditions, only certain species can grow in the eastern part of Pramuka Island, one of which is *Enhalus acoroides* (Jalaluddin, 2020).

Seagrasses are Angiospermae plants that are commonly found in waters with high salinity levels and tend to have a pattern of life in the form of expanses (Sarinawaty *et al.,* 2020). Seagrass ecosystems have a high level of productivity and diversity; therefore, these ecosystems have various functions that are beneficial to living things and the environment. According to Kawaroe *et al.* (2019), The ecological functions of seagrass ecosystems include providing oxygen to both water and sediment, improving water quality, maintaining sediment stability and reducing coastal erosion, offering various microhabitats essential for the diversity of fauna around coral reef ecosystems, and contributing to climate change mitigation (Listiawati and Kurihara, 2021), and as a significant global carbon sink that can support climate change mitigation (Stankovic *et al.,* 2021). In addition, seagrass meadow ecosystems are associated with various groups of organisms, such as fish, crustaceans, mollusks, and echinoderms (Miftahudin *et al.,* 2020).

The seagrass *Enhalus* plays a crucial role in aquatic ecosystems by providing a complex and stable habitat for various organisms, including macrozoobenthos. Its dense root and rhizome structure helps reduce current speed and maintain sediment stability, which is essential for protecting benthic ecosystems and supporting the life of macrozoobenthos. Additionally, *Enhalus* contributes to the food chain by producing detritus from its decaying leaves, which serves as a primary food source for macrozoobenthos (Robinson & Kulbicki, 2019).

Macrozoobenthos, on the other hand, function as indicators of the health of aquatic ecosystems. Their diverse presence is often considered a sign that the ecosystem is stable and healthy, as macrozoobenthos are sensitive to environmental changes such as pollution, temperature shifts, and oxygen levels. Moreover, macrozoobenthos play an important role in the food chain, both as primary consumers feeding on detritus and as prey for larger predators, such as fish and birds. They also contribute to nutrient cycling by breaking down organic matter and returning nutrients to the aquatic system, which can then be utilized by seagrasses and other organisms (Thomson *et al.,* 2022)

The symbiotic relationship between *Enhalus* seagrass and macrozoobenthos demonstrates that the presence of *Enhalus* not only supports biodiversity but also maintains the stability and function of the overall aquatic ecosystem. By providing a safe habitat and food source, *Enhalus* enables macrozoobenthos to thrive and fulfill their ecological roles, ultimately supporting the balance of the ecosystem (Thomson *et al.,* 2022). In addition, many studies in Pramuka Island in the last 5 years have shown that one of the species of the seagrass – *Enhalus acoroides*, is the most common seagrass found in Pramuka Island (Haviarini *et al.,* 2019; Marceyl *et al.,* 2023; Sosiawan *et al.,* 2022).

Enhalus acoroides is a ribbon-like seagrass with thick textures and rhizome. The leaf blade has a length of up to 88 cm and a width ranging from 0,3 to 3,1 cm (Harum *et al.,* 2023). As previously mentioned, seagrass ecosystems are home to a diverse range of organisms, including macrozoobenthos that are associated with *Enhalus acoroides*. This is because these seagrass beds have a sandy substrate, which makes them an ideal habitat for finding food and as a spawning ground for these macrozoobenthos (Wahab *et al.,* 2019).

The existence of seagrass and macrozoobenthos has a close and mutually beneficial relationship in the marine ecosystem. Macrozoobenthos are organisms that live on the surface of the bottom sediment of waters that act as detritivores that help in the decomposition process of organic matter in the water (Fatmawati *et al.,* 2020). The benthic infauna is a group of species that live beneath the seafloor, whereas the benthic epifauna is those living on or attached to the seafloor (Walag, 2022). The existence and diversity of macrozoobenthos in seagrass beds are often used as indicators of the health of seagrass ecosystems, where healthy seagrass beds tend to have more diverse and abundant macrozoobenthos communities (Elfami and Efendy, 2020). Macrozoobenthos can react to changes or disturbances in aquatic ecosystems so that it can be used as a biological indicator to monitor water quality, because changes in the macrozoobenthos community often reflect changes in environmental conditions such as pollution or habitat destruction. Macrozoobenthos usually includes various species and different tolerances to certain environmental conditions, so that when pollution or environmental changes occur, the composition of the macrozoobenthos community can change significantly (Julians *et al.,* 2023).

Research by Sosiawan *et al.* (2022) conducted on Pramuka Island stated that seagrass density is positively correlated with macrozoobenthos abundance. The denser the seagrass cover, the more abundant the macrozoobenthos in the waters. However, there is no known interspecific association between *Enhalus acoroides*, which is found in Pramuka Island, and macrozoobenthos in the same location. *Enhalus acoroides* was found in the eastern part of Pramuka Island (Marceyl *et al.,* 2023). Therefore, this study aims to determine the relationship between *Enhalus acoroides* and macrozoobenthos in the eastern part of Pramuka Island by calculating seagrass cover and identifying the types of macrozoobenthos associated with it, its effect on seagrass community dynamics, and water quality in seagrass ecosystems in the eastern part of Pramuka Island.

MATERIALS AND METHODS

Study Area and Sampling Station

This research was conducted in July 2023 on Pramuka Island in the Kepulauan Seribu Regency of DKI Jakarta, Indonesia. The research was conducted at a single research station, located in the eastern region of Pramuka Island, with three sampling points.

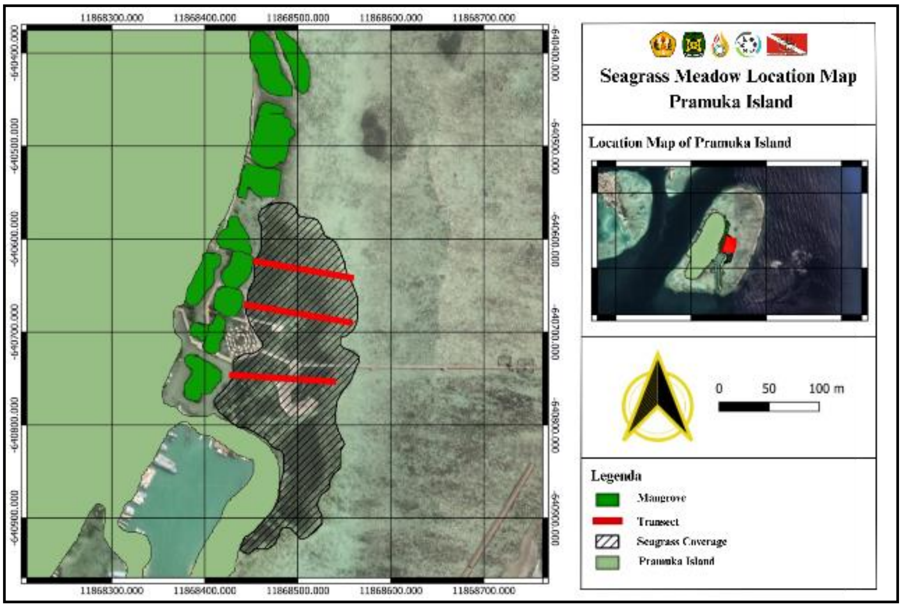

Figure 1. Map of Seagrass Meadow Research Site in Pramuka Island

Table 1. Coordinates of Sampling Points in the eastern part of Pramuka Island

Transect	Geographical Location	
	Latitude	Longitude
1	S05º44.772'	E106º36.961'
2	S05º44.739'	E106°36.965'
3	S05°44.713'	E106°36.967'

Methods and Data Collection

The method of sampling was carried out using purposive sampling technique, which is a data collection technique based on a series of strategic research on certain characteristics (Palys, 2008). Seagrass and macrozoobenthos data were collected using the line transect method (perpendicular to the coastline) and plot (quadrants) measuring 1x1 m (English et al, 1997; Fachrul, 2007).

Tools and materials used in the observation of seagrass, makrozoobenthos and environmental parameters in this study include a rolling meter used to measure the length of transect, 1x1 m^2 plot used to measure seagrass cover, diving mask, storage box, stationery and worksheet, thermometer used to measure water temperature, refractometer used to determine salinity, bottles for water samples, underwater camera, multiparameter for water quality meter, Global Seagrass Research Methods for seagrass identification guide (Short & Coles, 2003), Global Positioning System Essentials application, and ziplock plastic for sediment samples.

Data collection techniques for seagrass and macrozoobenthos communities were carried out by setting observation points first. Reviewing areas that are representative of the distribution of seagrass beds in the research location helped determine observation points. After that, a 100 m transect was made perpendicular to the shoreline towards the shore, marked with stakes at the start and end points of the transect. Data on seagrass density, percentage of seagrass cover, and macrozoobenthos species diversity were collected using 1x1 m plots divided into 100 small 10x10 cm boxes. Each seagrass and macrozoobenthos species found was recorded and documented for identification. Macrozoobenthos attached to seagrasses and those on the substrate were taken.

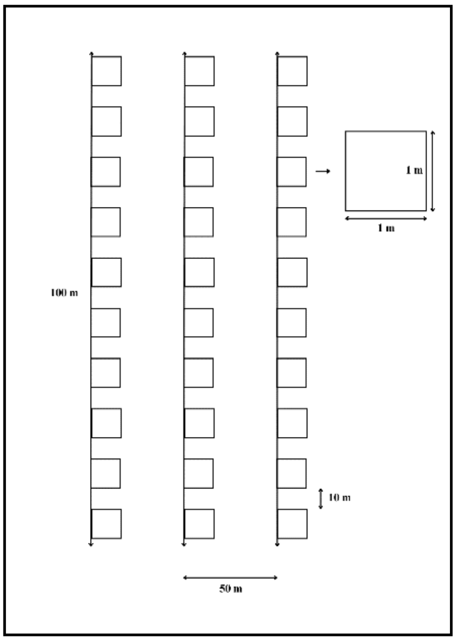

Figure 2. Transect Sampling Point

Measurements of environmental physical and chemical parameters carried out in this study include depth, pH, water temperature, and salinity carried out at the starting, middle, and end points of the transect.

Sediment sampling in this study was only conducted at the surface to a depth of about 5 cm from the surface. Substrate samples were taken to the Aquatic Ecology Laboratory, Faculty of Mathematics and Natural Sciences, University of Padjadjaran for further analysis and then compared with the Wentworth Scale.

Statistical Methods/Analysis

Seagrass Cover Percentage (Fahruddin *et al.,* 2017)

$$Ci = \frac{\Sigma\,(Mi\ x\ fi)}{\Sigma fi} \quad \ldots\ldots\ldots\ldots\ldots\ldots \ (1)$$

Where, Ci = percentage cover; Mi = mid point of the i-th closure class; fi = frequency of occurrence of the i-th species; Σfi= total number of occurrences of all species in the plot

Shannon-Wiener or Diversity Index (H’) (Odum, 1993)

$$H' = -\sum_{i=s}^{s} pi\ ln\ pi \quad \ldots\ldots\ldots\ldots \ (2)$$

$$H' = -\sum \left[\left(\frac{ni}{N}\right) \times ln\left(\frac{ni}{N}\right)\right] \quad \ldots\ldots\ldots \ (3)$$

Where, H'= Diversity index; pi= $\frac{ni}{N}$; ni= Number of individuals of the i-th species; N= Total number of individuals of all species; s= Total number of individuals of all types

Index of Importance (INP) (Haili *et al.,* 2014)

INP = (KR+FR) ………………………………. (4)

Dominance Index (Odum, 1993)

$$C = \Sigma\, pi^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots \ (5)$$

Where, C= Dominance index; pi= $\frac{ni}{N}$; ni= Number of individuals of the i-th species; N= Total number of individuals of all species

Evenness Index (Odum, 1996)

$$E' = H'ln\ S \quad \ldots\ldots\ldots\ldots\ldots\ldots \ (6)$$

Where, E= Evenness index (values between 0-1); H’= Shannon-Wiener diversity index; S= Number of types

RESULTS AND DISCUSSION

Seagrass Community Structure

Based on observations from the three transects in the eastern part of the Pramuka Island, 4 species were found with seagrass communities supported by 1 class, namely the Magnoliopsida Class, and 2 families, namely the Cymodocea Family and the Hydrocharitaceae Family.

Physico-Chemical Parameters

The life of seagrass ecosystems is influenced by several environmental parameters, such as temperature, depth, salinity, and pH. Seagrass sampling using the quadrat transect method, where transects are made by drawing a perpendicular line parallel to the coastline along 100 m. Sampling was done by making 1x1 m² plots with 10 m intervals. In addition, measurements of physical and chemical parameters were also carried out at the starting point, midpoint and endpoint of each transect by taking samples in the form of water and sediment.

The table below is the average calculation of the data that has been taken on the Eastern part of Pramuka Island. The physical and chemical parameters of waters in seagrass ecosystems on Pramuka Island are presented in **Table 2**.

Table 2. Data on the Eastern Waters of Pramuka Island

Point	Salinity (‰)	Degree of Acidity (pH)	Temperature (°C)	Depth (m)
Transect 1				
Initial	34,33	7	27	0,4
Middle	32,33	7	26	0,58
End	30,67	7	27	0,45
Transect 2				
Initial	31,00	7	27,5	0,31
Middle	31,33	7	27	0,56
End	31,00	7	27	0,348
Transect 3				
Initial	31,33	7	29,1	0,44
Middle	31,00	7	28,3	0,52
End	30,33	7	28,6	0,43

From the results of data collection, transect 1 obtained salinity ranges from 30.09-34.33‰, pH value of 7, temperature ranges from 26-27°C, and depth ranges from 0.4 - 0.58 m. Transect 2 obtained salinity ranges from 31.00 to 31.33‰, pH value of 7, temperature ranges from 27-27.5°C, and depth ranges from 0.31 to 0.56 m. Then the transect obtained salinity in the Pramuka Island ranges from 30.33-31.33‰, pH value of 7, temperature ranges from 28.3-29.1°C, and depth ranges from 0.43-0.52 m. According to Purwandani and Pribadi (2019), temperature, salinity, depth and pH are environmental parameters that can determine the extent of a seagrass ecosystem. Based on the ecological parameter test data, the temperature ranges for the eastern station of Pramuka Island is 26–29°C. The temperature is suitable for the growth and development of *Enhalus acoroides*, which is in the ranges of 26.5-35.5°C with the optimization of photosynthesis on 27-35.5°C (Parakkasi *et al.,* 2019). The optimal salinity for seagrass is 35‰, with a range of 10–40‰. Seagrass has high adaptability to salinity fluctuation and tolerance to low salinity conditions (Parakkasi *et al.,* 2019). Based on the environmental parameter test data, the salinity range for the eastern station of Pramuka Island is 30–35‰. The salinity is suitable for seagrass growth and development.

According to Firmansyah *et al.* (2022), generally, seagrass habitat is at a depth of 0.5-10 m. In waters with good seawater quality, especially with a turbidity value of <5 NTU, seagrass can still be found up to a depth of 30 m. Based on the environmental parameter test data, the depth range for the eastern station of Pramuka Island is 0,31-0,58 m. The depth is suitable for seagrass growth and development. Meanwhile, Based on the environmental parameter test data, the pH for the eastern station of Pramuka Island is 7. The pH is suitable for the growth and development of seagrass, which is in the range of 7-8,5 (Samson *et al.,* 2020).

Sediment Composition

Sediment composition affects the abundance of macrozoobenthos in it. In that sense, each different sediment particle size will provide extra oxygen and food availability. It causes the distribution, morphology, and behavior of macrozoobenthos to be different depending on the composition of the surrounding sediments (Roem *et al.,* 2022). Sediment composition percentage data are presented in **Figure 3**. The total sediment composition of granules (2.38 mm) was 34.43 grams, coarse sand (0.60-0.71 mm) was 448.83 grams, and fine sand (0.105 mm) was 386.79 grams.

Based on the results obtained, seagrass growth on the Pramuka island is dominated by coarse sand substrate. According to Kilminster *et al.* (2015) in Chrismanola *et al.* (2024) *Enhalus acoroides* seagrass is a persistent species and easily adapts to environmental conditions with a variety of different substrate types. However, the growth rate of seagrass *Enhalus acoroides* is better on muddy substrates than fine sand or coarse sand, because muddy substrates have a fine texture so that the process of absorption of nutrients by the roots is easier (Chrismanola *et al.,* 2024). As stated by Moningka *et al.* (2018) in Chrismanola *et al.* (2024), the suitability of the type of substrate plays an important role because sufficient nutrient content can improve the process of seagrass growth and development.

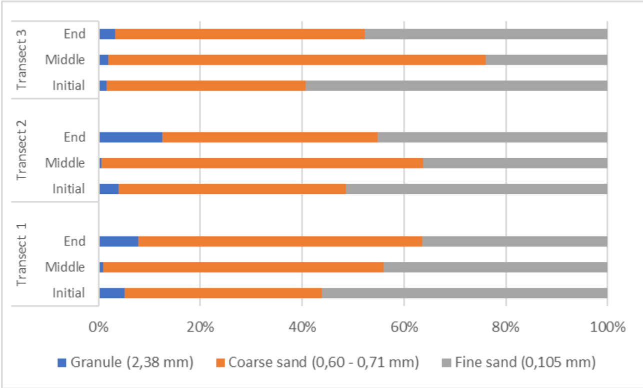

Figure 3. Diagram of sediment composition percentage in the eastern part of Pramuka Island

In addition, according to Piranto (2019), there are three types of sand found in the eastern part of Pramuka Island based on particle size, including gravel, sand, and mud. Where, in this study sediments were taken close to the mangrove ecosystem, and it was found that the dominating sediment types were sand.

Seagrass Cover

Based on the three transects at the eastern station of Pramuka Island, *Enhalus acoroides* seagrass has a good seagrass cover category with a total percentage of 71.74%. According to Waycott et al (2004), *Enhalus acoroides* is widely distributed in estuarine, coastal, intertidal to subtidal and coral areas, because it can grow on various types of substrates such as muddy, sandy, and coral rubble. Meanwhile, other seagrass species have a poor seagrass cover category, with a full percentage value range of 0.1–3.97% (Widagti *et al.,* 2021). This is in accordance with the research of Miftahudin *et al.* (2020) explaining that the high density of *Enhalus acoroides* in the waters of Pramuka Island is suspected to be due to the environmental conditions of the waters in accordance with the living needs of *Enhalus acoroides* species. *Enhalus acoroides* is one of the species of seagrass with high productivity. These plants often coexist with a variety of other aquatic organisms, including algae, meiofauna, and mollusca. Some of these organisms have important economic value. In addition, seagrass plays a role in preventing coastal erosion and recycling nutrients. The interaction between seagrass and these organisms forms a complex seagrass ecosystem. If the quality of the environment decreases, the productivity of seagrass ecosystems including *Enhalus acoroides* will be disturbed. This also has an impact on all animals that depend on seagrass ecosystems, which ultimately reduces the productivity of seagrass itself (Dahuri, 2003).

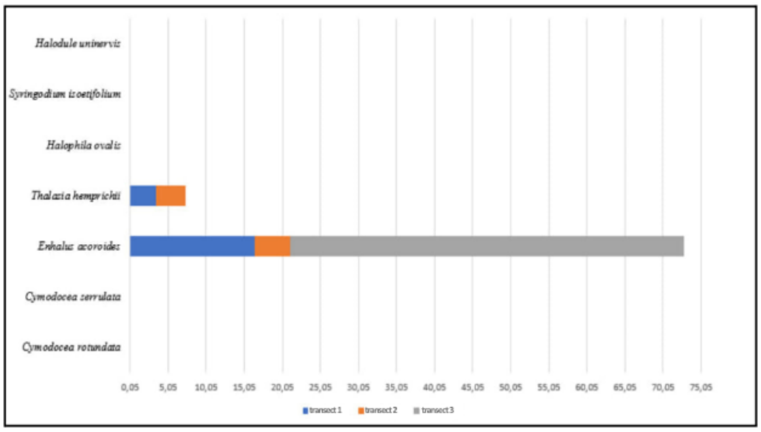

Figure 4. Diagram of Seagrass Cover Percentage in the Eastern Part of Pramuka Island

Macrozoobenthos Community Structure

Macrozoobenthos found in the eastern part of Pramuka Island consisted of 19 species with a total of 439 individuals. The macrozoobenthos community comes from 6 classes with 15 different families presented in **Table 3**, which are as follows:

Table 3. Macrozoobenthos Found in the Eastern Part of Pramuka Island

No	Family	Class	Species
1.	Cerithiidae	Gastropoda	*Rhinoclavis vertagus*
			Cerithium coralium
2.	Tellinidae	Bivalvia	*Tellina remies*
3.	Cardiidae	Bivalvia	*Fragum fragum*
			Fragum unedo
4.	Laganidae	Echinodermata	*Laganum laganum*
5.	Varunidae	Crustacea	*Varuna yui*
6.	Epitoniidae	Gastropoda	*Epitonium clathratulum*
7.	Buccinidae	Gastropoda	*Kelletia keleti*
8.	Muricidae	Gastropoda	*Urosalpinx cinerea*
9.	Mysidae	Malacostraca	*Mysis* sp.
10.	Strombidae	Gastropoda	*Canarium urceus*
			Canarium mutabile
11.	Cymatiidae	Gastropoda	*Monoplex corogatus*
			Cymatium lotorium
12.	Lucinidae	Bivalvia	*Codakia orbicularis*
13.	Holothuriidae	Holothuroidea	*Holothuria atra*
14.	Cypraeidae	Gastropoda	*Cypraea annulus*
15.	Pyramidellidae	Gastropoda	*Turbonilla rushii*

Research conducted on the three transects in the eastern part of Pramuka Island found several species of macrozoobenthos in seagrass ecosystems. The macrozoobenthos came from the Gastropoda, Bivalvia, Echinodermata, Crustacea, Malacostraca, and Holothuroidea classes. These six classes inhabit the seagrass ecosystem at the study site, with the composition of the Gastropoda Class often found more than other classes.

Gastropods are invertebrates from the phylum Mollusca that are associated with seagrass beds. Ecologically, gastropods are important components in the food chain in seagrass beds, where they live as infauna on sediment substrates or attached to seagrass leaves (Laraswati *et al.,* 2020). Gastropods have a relatively strong association with seagrass vegetation and increase in density as seagrass vegetation density increases (Latuconsina *et al.,* 2013; Latuconsina & Samal 2020; Fajeri *et al.,* 2020). According to Laraswati et al (2020), Gastropods live on the bottom substrate of the water or attached to seagrass leaves. Thus, the presence of seagrass vegetation supports the abundance and biodiversity of gastropods, which are generally classified as herbivores, but also act as food filters by absorbing organic particles on the substrate. Differences in the density of various types of macrozoobenthos found at each research sampling point are due to differences in substrate, conditions, and research locations.

Macrozoobenthos Composition

The composition of macrozoobenthos found in the three transects at the eastern station of Pramuka Island can be easily found in plots adjacent to the shoreline and mangrove ecosystem. In contrast, plots that are far from the shoreline have very little macrozoobenthos composition; even some of them are not present at all. This could be due to the availability of organic matter in the sediment, in addition to the fact that the bottom of the water has a varied sediment size. Sediment particle size greatly affects the availability of oxygen and food needed by macrozoobenthos. This condition causes macrozoobenthos to have a different distribution according to the condition of their habitat waters (Niar *et al.,* 2022).

According to the chart showing the number of macrozoobenthos in the three transects, *Cerithium coralium* has the most individuals, with 407. *Cerithium coralium* is a gastropod from the Cerithiidae family that lives in sandy to soft muddy substrates. This species is often found in tidal zones and estuaries in large populations. The adult shell is elongated tower-shaped with a height ranging from 16.5 to 25 mm. The shell color varies from dark brown to dirty gray, with brown or dirty white stripes and dark spots. The shell has 12 straight whorls on the sides with four engraved whorls and sinusigeral grooves (Amini-yekta *et al.,* 2019).

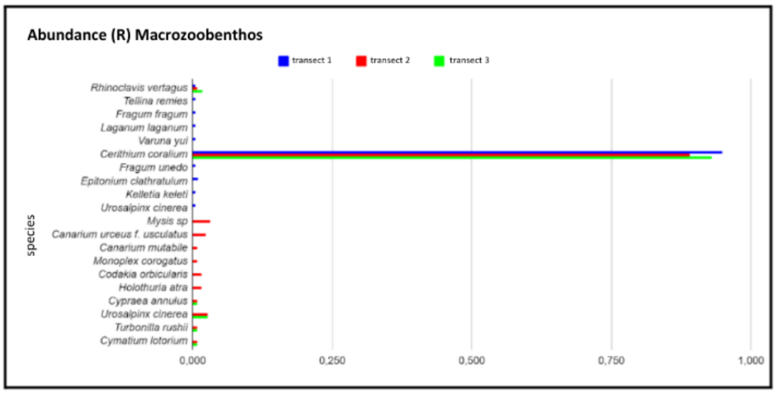

Figure 5. Abundance diagram of macrozoobenthos that dominate the seagrass ecosystem at the eastern stage of Pramuka Island

The location of macrozoobenthos is affected by physical factors like temperature, salinity, the texture of the sediment, chemical and biological factors like pH, and the amount of organic matter in the sediment (Niar *et al.,* 2022). According to Ali *et al.* (2020), a good temperature for macrozoobenthos organisms is between 25 °C and 30 °C. The optimal temperature for the growth and development of *Cerithium coralium* is 25 °C (Yallapragada & Rao, 1983). The temperature at the eastern station of Pramuka Island is 26–29 °C, so the temperature is optimal for the growth and development of *Cerithium coralium*. Different temperature measurement times during the collection of water quality data can be the cause of the difference in temperature between the three stations. The temperature range found at the research station is the range that can support the life of macrozoobenthos. Meanwhile, the optimal salinity for *Cerithium coralium* ranges from 24-31% (Wahab *et al.,* 2019). Meanwhile, the salinity at the eastern station of Pramuka Island is 30-32. The salinity range still supports the life of *Cerithium coralium*, so it can live well at the station. Rugebregt *et al.,* (2023) said that Indonesia saltwater surface acidity ranges from 6.0 to 8.5. This means that pH 7 is still a good pH level for the Cerithiidae to live in seagrass ecosystems in the eastern station of Pramuka Island.

Gastropod species from the Cerithiidae family are the most commonly found gastropod species, and this family has the widest distribution in marine ecosystems (Arfiati *et al.,* 2019). The family is a dominant group of gastropod inhabitants that are found living on sand and mud substrates and have a high abundance (Al-Kandari *et al.,* 2020).

Ecological Index of Macrozoobenthos

The abundance, density, diversity index, dominance index, evenness index, and importance value index (INP) of macrozoobenthos found in all three transects at the eastern station of Pramuka Island can be analyzed. High macrozoobenthos abundance occurs in seagrasses with high seagrass cover density when compared to seagrasses with low cover density (Niar *et al.,* 2022). The findings showed that different types of macrozoobenthos species from the classes Gastropoda, Bivalvia, Echinodermata, Crustacea, Malacostraca, and Holothuroidea were present in seagrass ecosystems. These six classes inhabit the seagrass ecosystem at the study site, with the composition of the Gastropoda Class being more often found than that of other classes. Differences in the density of various types of macrozoobenthos found at each research station are due to differences in substrate, conditions, and research locations. In all three research transects, all macrozoobenthos in seagrass ecosystems in the eastern station of Pramuka Island were found on the substrate. This is because the substrate provides nutrients needed for macrozoobenthos (Ariawan *et al.,* 2019).

The largest abundance value in the three transects was found in *Cerithium coralium* species, with a value of 0.949 in transect 1, 0.891 in transect 2, and 0.930 in transect 3. For example, the species found in *Enhalus acoroides* seagrass, which has a high cover density, is very common, which is why there are so many of them (Roem, 2021). However, according to Alsaffar *et al.,* (2020), dense seagrass vegetation does not fully support the diverse and abundant presence of benthic. More influential are environmental factors in these waters. In addition, the type of substrate is one of the ecological factors that greatly affects the presence of macrozoobenthos (Clarito *et al.,* 2020).

The importance value index (INP) is an index used to determine the relative dominance of a species in an ecosystem community by calculating the sum of three main ecological parameters, namely relative density, relative frequency, and relative cover of a species (Ezulike *et al.,* 2020). Based on the results obtained, there are similarities in the index of important values. The highest important value index (INP) obtained was *Cerithium corallum*, with a value of 132.398 in transect 1, 120.397 in transect 2, and 142.982 in transect 3. The important value index (INP) shows that *Cerithium coralium* plays a great role in an ecosystem. Factors such as a greater number of species, greater density, and greater percentage cover can cause the species importance index to be lower. However, if all three factors have common values, then the importance index of a species will also be lower (Hidayah *et al.,* 2019).

Table 4. Macrozoobenthos Community Structure

Transect	H`	Criteria	E	Criteria	C	Criteria
1	0,312	Low	0,031	Low	0,901	High
2	0,555	Low	0,062	Low	0,797	High
3	0,359	Low	0,866	High	0,060	Low

Based on the calculation, the diversity index (H') of macrozoobenthos in transects 1, 2, and 3 is still relatively low, with a diversity index of 0.312, 0.555, and 0.359, respectively. It indicates that the types of macrozoobenthos found on Pramuka Island are relatively low (few). According to Rahman *et al.* (2023), macrozoobenthos diversity in each transect is also related to environmental factors.

The uniformity index values of macrozoobenthos on Pramuka Island on transects 1, 2, and 3, respectively, are 0.031, 0.062, and 0.866. In transects 1 and 2, the uniformity index is still relatively low, but in transect 3, the uniformity index is high, with a value close to 1 (the maximum value). According to Mariyati *et al.* (2020), the smaller the uniformity index value in a community, the distribution of the number of individuals of each genus is not the same, and there is a tendency for species or families to dominate the community. Then, the high uniformity index illustrates that the distribution of macrozoobenthos populations is quite good.

The value of uniformity is inversely proportional to the value of dominance. If the uniformity value is high, the dominance index value is low. From **Table 4**, it can be seen that the dominance index of macrozoobenthos in transects 1 and 2 is high, while the dominance index of macrozoobenthos in transect 3 is low. The dominance index value obtained is generally close to 0, which means low dominance or the absence of dominating biota; thus, transects 1 and 2 are classified as poor waters, and transect three is classified as good because there is no dominating biota (Prihatin *et al.,*2021).

Seagrass Association with Macrozoobenthos

Association analysis was conducted using the Pearson correlation test. This test is used to determine whether the two variables in the study are connected linearly or do not have a causal relationship. The objective is to determine if there is a significant correlation between the independent variable and the dependent variable, as well as the degree to which the independent variable influences the dependent variable (Supriadi, 2021). The association data used is obtained by comparing seagrass cover with macrozoobenthos density.

Correlations

		Ea	Holothuria. atra
Ea	Pearson Correlation	1	.810**
	Sig. (2-tailed)		.005
	N	10	10
Holothuria.atra	Pearson Correlation	.810**	1
	Sig. (2-tailed)	.005	
	N	10	10

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 6. Correlation of Seagrass *Enhalus acoroides* with Macrozoobenthos *Holothuria atra*

Holothuria atra is the most abundant sea cucumber species in the Indo-Pacific region, spread across the globe, and massively harvested (Hamamoto, 2021). In general, sea cucumbers are important in ecology for their feeding habit of foraging by consuming other organisms, such as plankton, the remains of dead organisms, and organic matter contained in silt or sand (Hartati *et al.,* 2020). In addition, seagrass beds are generally the best place for sea cucumbers to live because they break seawater current and carry nutrients in it (Setiawan *et al.,* 2024). However, this benthic was only found in one transect. Substrate characteristic, nutrient content, other species, and human activities may interfere with and affect this (Manuputty *et al.,* 2019). *Holothuria atra* was found at the starting point of Transect 2, near the coast, and had a fine sand substrate. These conditions are similar to those found by Hartati *et al.* (2017) and Setyastuti (2014), who found *Holothuria atra* in seagrass meadows of *Enhalus acoroides* with a fine sand bottom. **Figure 6** shows that the correlation of seagrass *Enhalus acoroides* with macrozoobenthos *Holothuria atra* has a perfect association level. The Pearson correlation value of 0.810 with macrozoobenthos *Holothuria atra* (Sudjana, 1996) demonstrates the significant and positive relationship between seagrass *Enhalus acoroides* and macrozoobenthos. This is because seagrasses are large, which can provide more nutrients (Luhulima *et al.,* 2020). In addition, the mangrove ecosystem near the *Holothuria atra* discovery site also provides nutrients for the sea cucumber's life.

CONCLUSION AND SUGGESTION

There are four types of seagrass species found in the three transects at the eastern station of Pramuka Island, namely *Enhalus acoroides*, *Thalassia hemprichii, Cymodocea rotundata, and Cymodocea serrulata*. *Enhalus acoroides* seagrass is the most dominant species in seagrass cover in the eastern part of Pramuka Island with a total percentage cover of 71.74%. The high density of *Enhalus acoroides* in the Pramuka Island is suspected to be due to the environmental conditions of the waters in accordance with the living needs of *Enhalus acoroides* species. Macrozoobenthos found in the eastern part of Pramuka Island consisted of 19 species with a total of 439 individuals. The macrozoobenthos community comes from 6 classes with 15 different families. *Cerithium coralium* from the Cerithiidae family is the most dominant species, with 407 individuals found across the three transects. The species is a dominant group of gastropod inhabitants that are found living on sand and mud substrates and have a high abundance making it the most dominating benthic species compared to the other species found. The results of the Pearson correlation test show that the correlation between seagrass *Enhalus acoroides* with macrozoobenthos *Holothuria atra* has a perfect association level with a value of 0.810. It demonstrates the significant and positive relationship between seagrass *Enhalus acoroides* and macrozoobenthos *Holothuria atra*. This high correlation value is because seagrass *Enhalus acoroides* has a large size so that it can provide more nutrients to support the nutrient needs of sea cucumbers.

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