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Composition and Diversity of Macrozoobenthos in Seagrass Areas in Pulau Pahawang Village

Darma Yuliana[1,✉], Abdullah Aman Damai[1], Muhamad Gilang Arindra Putra[1], Rara Diantari[1], Nur Afni Afrianti[2], Inggar Damayanti[3], Yuliana Saleh[4], David Julian[1], Muhammad Reza[1], Berta Putri[1]

[1] Fisheries and Marine Department, Faculty of Agriculture, University of Lampung, INDONESIA.
[2] Department of Soil Science, Faculty of Agriculture, University of Lampung, INDONESIA
[3] Department of Forestry, Faculty of Agriculture, University of Lampung, INDONESIA
[4] Department of Agribusiness, Faculty of Agriculture, University of Lampung, INDONESIA

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Corresponding Author:
✉ darma.yuliana@fp.unila.ac.id
(Darma Yuliana)

ABSTRACT

Seagrass beds, particularly those found in Pulau Pahawang Village, serve as vital marine ecosystems that support diverse marine life. This study aims to investigate the composition and diversity of macrozoobenthos within these seagrass ecosystems. Seagrass and macrozoobenthic data were gathered through a 30 m line transect and 1m×1m. The samples were identified to the species or genus level, and the data were analyzed for composition and diversity using the Shannon-Wiener (H'), Dominance (C), and Evenness (E) indices. To assess the relationship between seagrass cover and macrozoobenthic density, a Pearson correlation test was performed. The seagrass species found is Enhalus acoroides. The macrozoobenthic community found in the seagrass ecosystem consists of 2 classes: 22 Gastropoda and 16 Bivalvia. The diversity index of macrozoobenthos (1.47-2.81) show moderate diversity, with high similarity (0.638–0.917), amd low dominance (0.059–0.265) indicates a balance community. The environmental conditions, including water temperature (30.8°C–31.8°C), salinity (30–31), and dissolved oxygen (5.8–6.8 mg/L), strongly support the growth of seagrasses and macrozoobenthos. This study emphasizes the importance of monitoring water quality and species diversity to ensure the sustainability of the seagrass ecosystem and other in Pulau Pahawang Village.

1. INTRODUCTION

Seagrass beds are marine ecosystems found in coastal regions (Kawaroe *et al*., 2019). The calm waters and sandy substrate of Pulau Pahawang Village create an ideal environment for seagrasses. These seagrasses are *Angiospermae* plants that thrive in waters with high salinity and often form expansive growth patterns (Sarinawaty *et al*., 2020). Seagrass meadows support a wide variety of organisms, including fish, crustaceans, mollusks, and echinoderms (Miftahudin *et al*., 2020).

Pulau Pahawang Village, as one of the famous coastal tourist destinations, also has a fairly extensive seagrass ecosystem and many other animals are found that depend on the seagrass ecosystem on Pahawang Island. The existence of macrobenthos in this area is very important, because they play a crucial role in maintaining the balance of the seagrass ecosystem, as well as being an indicator of the health of the surrounding aquatic environment. They play a role in nutrient cycling by decomposing organic material and releasing nutrients back into the water, where they become available for uptake by seagrass and other aquatic organisms (Srivastava *et al.,* 2023). The diversity of macrobenthos in the seagrass area of Pulau Pahawang Village is one of the most important groups in the aquatic ecosystem as a reference in assessing environmental quality. One of the functions of macrobenthos is as a bioindicator of water quality in the long term, because they have an important role in the food chain, slow mobility, the ability to tolerate changes in the aquatic environment, and can accumulate chemical compounds in the water. Several groups of macrozoobenthos found in seagrass ecosystems include gastropods, bivalves, asteroidea, crustaceans, polychaeta, echinoidea, and others (Wahab *et al*., 2018; Tasabaramo & Nugraha, 2023).

Given the background above, it is essential to carry out a study that investigates the composition and diversity of macrozoobenthos within seagrass ecosystems. The main objective of this research is to examine the variety and composition of macrozoobenthos in these habitats, as understanding their variation can provide important insights into their presence and the species they consist of. Identifying these variations is vital because macrozoobenthos act as biological indicators, reflecting both the water quality and the substrate in which they live. Furthermore, the composition and density of macrozoobenthos are determined by their ability to tolerate or respond to environmental changes, which underscores their role in assessing ecological health. This study provides a focused local assessment of the seagrass ecosystem in the Pulau Pahawang Village area, a site that has been largely underexplored in terms of the relationship between seagrass cover and macrozoobenthic communities. Unlike previous studies that primarily concentrated on species identification, this research specifically analyzes the correlation between seagrass cover and the structure of macrozoobenthic communities. Ultimately, this study aims to enhance environmental conservation, foster sustainable management practices, and support the livelihoods of the surrounding communities, while ensuring the long-term preservation of the seagrass ecosystem in Pulau Pahawang Village.

2. RESEARCH MATERIALS AND METHODS

2.1. Study Area and Sampling Station

This research was conducted at Pulau Pahawang Village, Marga Punduh District, Pesawaran Regency (Figure 1). Observation and sampling of macrozoobenthos were carried out at 3 stations according to the existence of seagrass beds.

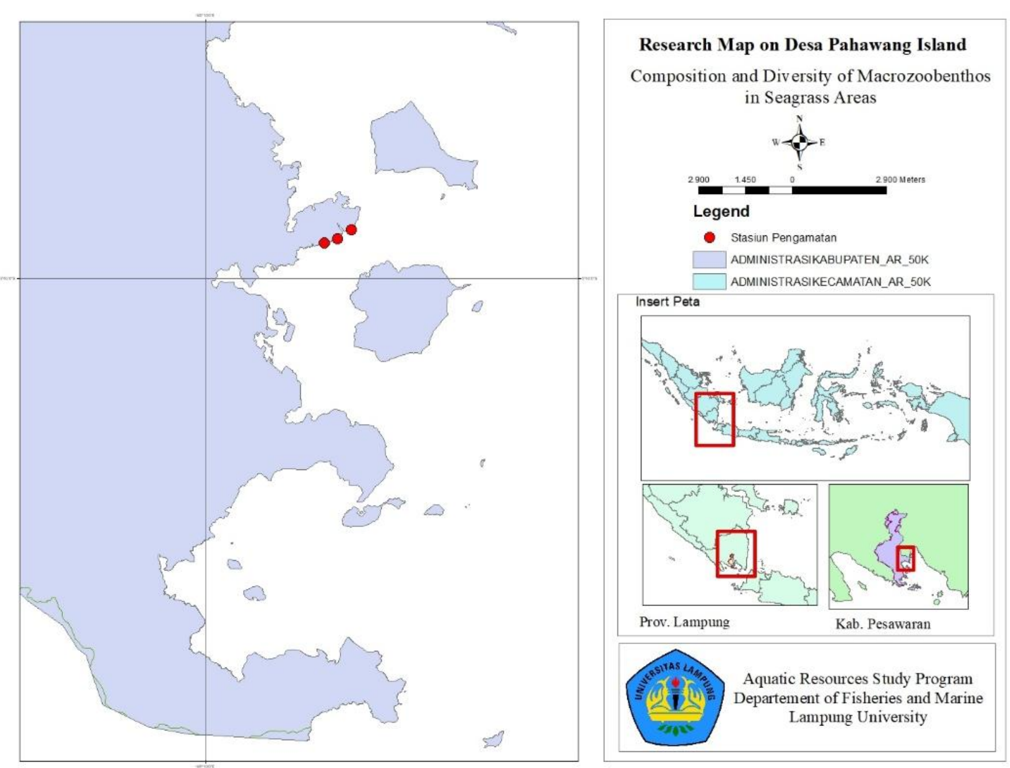

Figure 1. Research Location

Table 1. Coordinates of Sampling Points in the eastern part of Pulau Pahawang Village

Station	Geographical Location	
	Latitude	Longitude
1	5°39’25’’ LS	105°11’60’’ BT
2	5°39’20’’ LS	105°12’12’’ BT
3	5°39’11’’ LS	105°12’26’’ BT

2.2. Data Collection

The sampling method used purposive sampling technique, which is a data collection technique based on strategic research that focuses on certain characteristics (Palys, 2008). This technique is used in the study to select species or habitats that are considered important for understanding the relationship between environmental conditions and a community, in this case, between the seagrass ecosystem and the macrozoobenthic community. Data collection on seagrass and macrozoobenthos communities was carried out by determining observation points first. The selection of observation points was carried out by examining areas that were considered to represent the distribution of seagrass beds at the research location.

Seagrass and macrozoobenthos data were collected using the line transect method (perpendicular to the coastline) and plots (quadrants) measuring 1x1 m. The line transect used was 30 m long, drawn perpendicular to the beginning of the seagrass ecosystem facing the sea. The collection of macrozoobenthos samples at each station was taken at 3 points and the interval between point one to point two and point three was 10 m. The samples that have been taken are then put into a plastic sample bag (plastic clip). After all samples are taken from the location, the samples are sieved using a 0.5 net sieve. Next, the organisms filtered in each transect are put into a sample bag and given 70% diluted alcohol so that it can be easily sorted and identified. Each species of macrozoobenthos found was recorded and documented for identification including information such as species name, abundance, distribution within the seagrass beds, and any relevant environmental factors. Macrozoobenthos attached to seagrass and those on the substrate were taken.

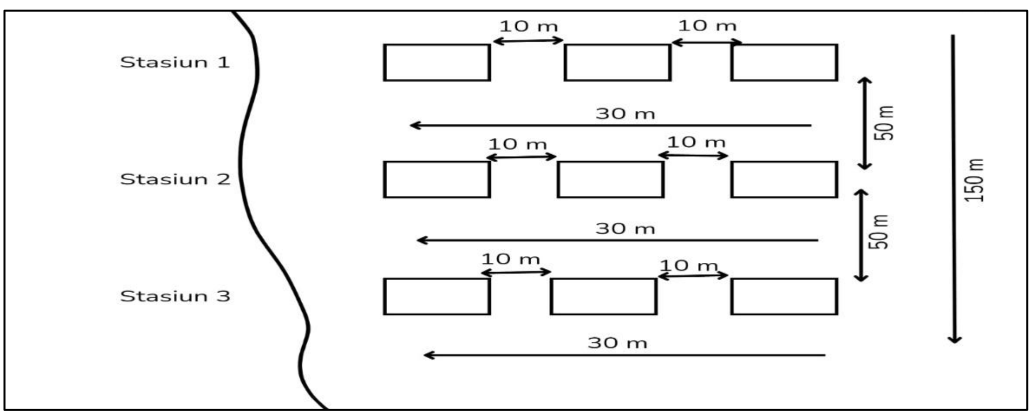

Figure 2. Transect Sampling Point

Measurements of physical and chemical environmental parameters carried out in this study include water temperature, DO, salinity, Nitrate and Phosphate which were carried out at the start, middle and end points of the transect.

2.3. Data Analysis

The parameters for macrozoobenthos data included species composition (*Kj*), which is the comparison between the number of species of each tribe (*ni*) and the total number (*N*) of species found using the following formula:

$$Kj = \frac{ni}{N} \quad (1)$$

Diversity Index (H')

Diversity index (*H*') is also called as Shannon-Wiener index. This index was calculated as follows (Odum, 1993):

$$H' = -\sum (pi \cdot \ln(pi)) \quad (2)$$

where $pi = ni/N$.

***Dominance Index* (C)**

The dominance index (C) was calculated from Equation 3 (Odum, 1993):

$$C = \Sigma\, pi^2 \quad (3)$$

***Evenness Index* (E)**

Evenness index (E) was calculated based on Odum & Garett (1996) as the following:

$$E' = H' ln\ S \quad (4)$$

where *E* has values between 0 – 1, and *S* is number of types.

3. RESULTS AND DISCUSSION

3.1. Seagrass Cover

The seagrass community at the research location is a monospecific vegetation, namely a seagrass community consisting of one type, that is *Enhalus acoroides*. However, the presence of only one type of seagrass on Pahawang Island may indicate the potential vulnerability of the ecosystem to environmental changes. Decreased water quality, pollution, and climate change can negatively impact the growth of seagrass, which in turn will affect the entire food chain in the ecosystem. Data shows that in Pulau Pahawang Village, the percentage of seagrass cover is around 18.75–24.65%, the results of the percentage of seagrass cover can be categorized as poor/damaged seagrass health status. A limited number of seagrass species and low levels of seagrass coverage can significantly impact ecological processes and the overall condition of coastal marine ecosystems. As key structural elements, seagrasses offer essential ecosystem services, including habitat provision, nutrient recycling, and carbon storage. A decline in species diversity within seagrass meadows can weaken the resilience of the ecosystem. According to Widagti *et al*. (2023), indicators such as species richness and seagrass coverage are commonly used to assess the ecological status of seagrass habitats.

Enhalus sp. can grow on various types of substrates, but is usually found in deeper waters with muddy sand substrates (Wangkanusa *et al*., 2017). The presence of only one type of seagrass on Pahawang Island may indicate the potential vulnerability of the ecosystem to environmental changes. Decreased water quality, pollution, and climate change can have a negative impact on seagrass growth, which in turn will affect the entire food chain in the ecosystem.

3.2. Physico-Chemical Status

Water conditions play a crucial role in the survival of organisms in the marine environment. Factors in the water determine the extent to which organisms can develop and spread, although each species has different environmental needs and preferences, according to the characteristics of the environment (Tomascik *et al*., 1997). This can be observed from the measured parameters of water quality presented in Table 2, which illustrate the physical and chemical conditions influencing the presence and distribution of seagrass in the study area.

The presence of macrozoobenthos is influenced by various physical factors such as temperature, salinity, sediment texture, chemical conditions, and biological factors like pH, as well as the amount of organic matter present in the sediment (Niar *et al*., 2022). Rahman *et al*. (2023) state that macrozoobenthos thrive in temperatures ranging from 20°C to 30°C. The temperature in the Pulau Pahawang Village between 30.7‒31.9°C, variations in temperature readings across the three stations may be due to differences in the timing of temperature measurements during the water quality data collection. The temperature range observed at the research stations supports the survival of macrozoobenthos. While the salinity at the eastern station of Pulau Pahawang Village is between 30‒31, which is still within the acceptable range for

Table 2. Physical and Chemical Parameters of the Station

Parameter	Station		
	1	2	3
Temperature (°C)	31.8	30.7	31.9
Salinity (‰)	30	31	31
DO	5.8	6.6	6.8
pH	7	7	7
Depth (m)	0.48	0.54	0.43

the species to thrive. According to Rugebregt *et al*. (2023), the salinity in Indonesian coastal waters typically ranges from 30 to 31. Dissolved oxygen (DO) in this study ranged from 5.8 to 6.8 mg/l. The dissolved oxygen content in seagrass waters showed consistent fluctuations. This fluctuation is likely caused by the use of dissolved oxygen by seagrass for root and rhizome respiration, respiration of aquatic biota including macrozoobenthos, and use by nitrifying bacteria in the nitrogen cycle process in seagrass beds (Felisberto *et al*., 2015). However, the oxygen value measured in the waters of Pulau Pahawang Village is still sufficient to support the growth of seagrass and macrozoobenthos. According to the environmental parameter test data, the pH at the all station is 7. This pH level is appropriate for the growth and development of seagrass, which thrives in the 7‒8.5 range (Alexandre *et al*., 2020). The variations in diversity, both high and low, as well as dominance at each observation station, are influenced by factors such as temperature, salinity, pH, dissolved oxygen, and the ability of organisms to adapt to these environmental conditions (Alwi *et al*., 2020).

3.3. Macrozoobenthos Community Structure

The macrozoobenthos community found in the seagrass ecosystem in the waters of Pulau Pahawang Village consists of 2 classes, namely the Gastropoda and Bivalvia. In the research location there are 2 classes of Gastropoda and Bivalvia, with the composition of the Gastropoda class being found more than other classes (Table 3).

Table 3. Percentage of macrozoobenthos types based on different observation station

Macrozoobenthos type	Sation 1	Sation 2	Sation 3
Gastropoda	67	41	46
Bivalvia	33	59	54

Detail observation reveals that Gastropoda class constitute of 22 species, and the Bivalvia class with 16 species (Table 4). Based on the results of the study of the number of macrozoobenthos in three transects, *Cerithium coralium* which is a gastropod from the Cerithiidae family is the most frequently found individual. This species lives in sandy to soft muddy substrates and is often found in tidal and estuary areas in large populations (Amini-yekta *et al*., 2019). *C. coralium* is commonly inhabiting seagrass ecosystems, especially in areas like Indonesia. This species is distinguished by its conical-shaped shell, which aids in its adaptation to the specific environmental conditions of seagrass habitats, thus enhancing the biodiversity of these regions (Cavallari *et al*., 2020). *C. coralium* is recognized for its feeding behavior, where it scrapes algae and detritus from the substrate or seagrass leaves, positioning it as a key herbivore in its ecological niche (Tasabaramo & Nugraha, 2023). From the Bivalvia class, the most common species found is *Anadara granosa*. *Anadara granosa* is a type of shellfish that lives on the seabed and has a long life cycle. It is often used as a bioindicator to evaluate water quality. *A. granosa* tends to cluster in muddy sediments and soft sediments, therefore it is found at all stations.

The high diversity index is thought to be caused by the large number of species obtained so that no species dominates at station 2. The high diversity is also influenced by the ecological conditions. Meanwhile, the diversity index value at station 1 shows the lowest diversity index value. This can be seen from the low number of individuals of each species at station 1 and low community stability. According to Setiawan (2009), of the three stations based on the criteria for the Shannon-Wiener diversity index value (H'), it is included in the medium diversity category. The results of the evenness index calculation obtained at stations 1, 2, and 3 were 0.638–0.917 (Figure 4). Based on the evenness index category by Brower *et al*. (1990), then the value of $E > 0.6$ indicates a high level of similarity. The high evenness index

Table 4. Macrozoobenthos species of Gastropoda and Bivalvia found in the Pulau Pahawang Village

Gastropoda Species	**Station**			**Bivalvia Species**	**Station**		
	1	**2**	**3**		**1**	**2**	**3**
Battilaria attramentaria		+		*Nicaniella sp*		+	
Nerita grossa		+		*Clinocardium nuttali*		+	
Herpetopoma sp		+	+	*Anadara inaequivalvalis*	+	+	+
Nassarius dorsatus	+			*Mactra grandis*		+	
Littorina sp	+			*Anadara granosa*	+	+	+
Cerithium vulgatum		+	+	*Anadara antiquata*		+	+
Cerithium repandum		+		*Tellina sp*		+	+
Clypeomorus battilaeriformis		+		*Peglypta multicostata*		+	
Cerithiopsis greenii		+	+	*Trachycardium rugosum*		+	
Cerithium adustum	+			*Asperarca nodulosa*		+	
Melanoides granifera		+		*Acrosterigma sp*		+	
Cerithium coralium		+	+	*Parvicardium scabrum*			+
Bittium reticulatum		+		*Psammotetra* sp			+
Xymene plebeius		+		*Gafrarium pectinatum*			+
Canarium labiatum		+		*Diplodonta* sp			+
Euthria cornea		+		*Anomalocardia floridana*			+
Volutopsius norvegicus		+	+				
Conus ventricosus		+					
Xymene plebeius			+				
Pirenella sp			+				
Cerithium lutosum			+				
Tegula aureotincta			+				

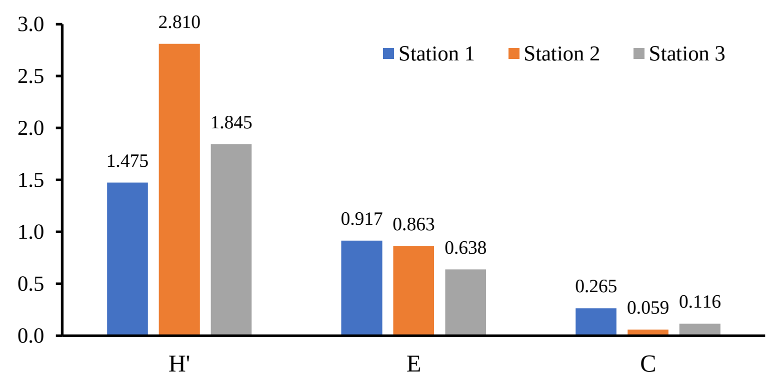

Figure 4. Value of diversity index (H'), evenness index (E), and dominance index (C) of macrozoobenthos in Pulau Pahawang

indicates that the distribution of macrozoobenthos populations is relatively well-balanced. The evenness index value can be affected by ecological and physicochemical factors at the research site. When ecological characteristics are similar, the species composition in a region tends to show high similarity. The results of the dominance index calculation obtained at stations 1, 2 and 3 were 0.059–0.265, which is included in the criteria for no dominant species. The dominance index value obtained is generally close to 0, which means low dominance or the absence of dominant biota; thus, three station are classified as good because there are no dominant biota (Prihatin *et al*., 2021).

3.4. Association of Seagrass Cover and Macrozoobenthos Density

An association analysis was conducted using the Pearson correlation test to examine the relationship between seagrass cover and macrozoobenthos density. The analysis determines whether the two variables are linearly related and evaluates the impact of the independent variable on the dependent variable (Enwin & Ikiriko, 2023). The results of this analysis are shown in Table 5, which details the correlation coefficients between seagrass cover and macrozoobenthos density, providing a thorough evaluation of their relationship. The correlation between seagrass cover and macrozoobenthos has a perfect association level. The Pearson correlation value of 0.894 indicates a significant and positive relationship. This is because good seagrass cover can provide more nutrients (Lamb *et al*., 2017). Seagrass beds offer crucial habitats and ecological functions that sustain macrozoobenthic populations, whose diversity and health can reflect the condition of the seagrass beds. The relationship between these two ecosystem elements emphasizes their interdependence and underscores the need to preserve healthy seagrass habitats to ensure the stability of aquatic ecosystems.

Table 5. Correlation of seagrass cover and macrozoobenthos density

		Seagrass	Macrozoobenthos
Seagrass	Pearson Correlation	1	0.894
	Sig. (2-tailed)		0.005
	N	9	9
Macrozoobenthos	Pearson Correlation	0.894	1
	Sig. (2-tailed)	0.005	
	N	9	9

4. CONCLUSION

The seagrass beds in Pulau Pahawang Village, Marga Punduh District, are dominated by *Enhalus acoroides*, with a seagrass cover percentage ranging from 18.75% to 24.65%, indicating poor or damaged conditions. Despite this, the macrozoobenthos community shows moderate diversity (index 1.47–2.81), high similarity (0.638–0.917), and low dominance (0.059–0.265), suggesting a relatively balanced community without dominant species. A strong positive correlation ($r = 0.894$) between seagrass cover and macrozoobenthos highlights their ecological interdependence, where healthier seagrass beds support richer macrozoobenthic communities. These findings emphasize the importance of conserving seagrass habitats to ensure the sustainability and stability of aquatic ecosystems.

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