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THE ROLES OF MACROBENTHIC MOLLUSCS STRUCTURE IN ASSESSING ECOLOGICAL STATUS AT MANGROVE AND AQUACULTURE AREAS

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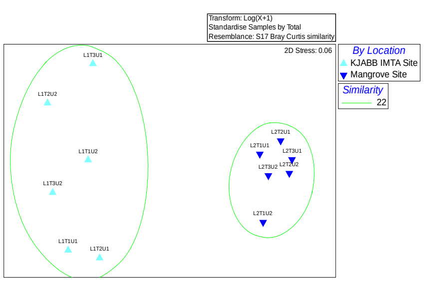
Graphical abstract



Abstract

Macrobenthic molluscs is well-known for their ecological role in food chain. The stability of Coastal water ecosystem could have an effect on mangrove vegetation and anthrophogenic activities. This stability correlates significantly with the structure of the macrobenthic mollusk community in the area, some of this biota are bioindicator agents. This study aims to assess the ecological functions of macrobenthic molluscs, evaluate the spatial and temporal differences in their community structure, and analyze their correlation to environmental parameters in aquaculture and mangrove areas in the Karimunjawa Islands, Jepara, Central Java, Indonesia. Purposive random sampling method was conducted at KJABB-IMTA aquaculture and mangrove areas between July and September 2021. Collected data were analyzed using k-dominance curve, NMDS ordination, PCA, and BIO-ENV using Primer 6.1.5 software. Based on Paired T Test result, comparison between each location showed significant difference ($t=15.916$, $P<0.05$, $dF=5$) meanwhile comparison between each sampling period showed insignificant result. The highest abundance and diversity were found in the aquaculture area and dominated by gastropods. Significant differences occurred in the structure of macrobenthic molluscs between the two study locations ($t=15.916$, $P<0.05$, $df=5$), while the comparison between their composition and abundance between sampling times was not significant. The abiotic elements that primarily impact the structure of macrobenthic mollusks are the particle size composition of the substrate (mud) and dissolved oxygen (DO) based on PCA and BIO-ENV analysis (BIO-ENV; $r=0.733$).

Keywords: Comparative study, macrobenthic molluscs, aquaculture, coastal ecosystem, Karimunjawa

1.0 INTRODUCTION

Human's interest on fulfilling daily needs impacted the environment. Rapid urbanization of the world's major cities and population live in coastal area, putting a huge toll on ecological pressures affecting ecosystem function and biodiversity loss in coastal area [1]. In addition, human activities and aquaculture activities threatens coastal zone, wetlands, intertidal zones causing habitat fragmentation [2]. Aquaculture activities influence the encompassing biological system and demonstrated in various studies [3]. One of the consequences of aquaculture activities such as feed residue, urine and feces of farmed fish can cause enrichment of organic matter to the substrate layer [4].

Macrobenthos organism all well-known to do a various task in water such as, part of the food web, improving sediment strcuture, nutrient cycles, translocation of materials and decomposition in the ecosystem, macrobenthos in several studies is used as biomonitoring and contaminants quality, macrobenthos are inhabiting the same locality throughout their life [5-6]. Conducted studies using macrobenthic as bioindicator is a popular method in determining environmental changes in coastal area, macrobenthos are known as animals without spines living on the sediment [7-8]. About 80% communities of benthic organism are epifauna, which live on solid sediment, while endofauna animals live buried in soft seidment [9]. Each of this organism is particularly adjusted to their niche as they share common functional structure, can be seen throught their behaviour and morphological features [10].

In this paper, macrobenthic molluscs are the main key for assessing ecological status. In intertidal zone, Gastropod is a living being whose life is exceptionally delicate to changes in quality in a water, so it can be utilized as a bioindicator to degree water quality, gastropods have a relatively sedentary life and slow movement, and can respond to disturbances that occur [11]. Bivalvies also known for their sensitiviness to environmental pertubations and recording the environmental fluctuations within thier shell [12].

Mangrove ecosystem is widely known for the important role they play, such as carbon cycling and habitat provider, the concept of mangrove ecosystem as a conservation areas are having an objective to protect the output of this ecosystem along with the biotas that inhabit it [13]. Monitoring attempt plays an important role in preserving ecosystem. Publication by Imam (2014) shows the environmental quality of the tracking Mangrove Kemujan indicates insignificant differences in gastropods composition and the environmental parameters due to the conservation attempt. The Karimunjawa Islands National Park in Indonesia is archipelago consisting of many types of zoning [14].

Karimunjawa Islands is established as a National Park based on Decision of The Ministry of Environment and Forestry No. 78/Kpts-II/1999. The rich diversity of the Karimunjawa Islands increases the urgency to protect the area, maintaining the ecological stability. The National Park is categorized into several zonation, including Tracking Mangrove Kemujan as terrestrial utilization zone and Menjangan Besar Island as maritime utilization zone [15]. The aim of this study is to assess the ecological functions of macrobenthic mollusks, evaluate the spatial and temporal differences in their community structure, and analyze their correlation to environmental parameters in aquaculture and mangrove areas in the Karimunjawa Islands, Jepara, Central Java, Indonesia.

2.0 METHODOLOGY

Sampling sites were located in Karimunjawa Islands in two stations, Menjangan Besar Island aquaculture area and Tracking Mangrove Kemujan. Sampling period were done in two times, July 2021 and September 2021. Applied method for this study is Random Sampling Method with three replications in each station, map of sampling can be seen in Figure 1.

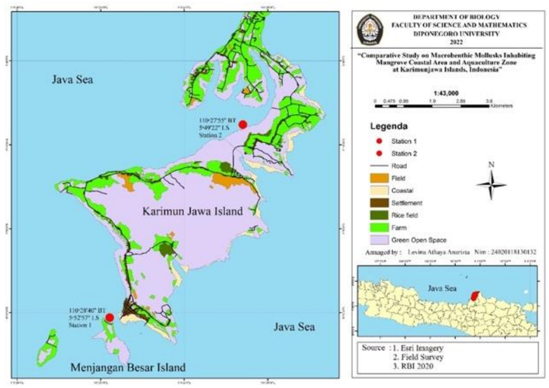


Figure 1 Map of Sampling station in Karimunjawa Island

Sediment samples were collected at each station using an Ekman grab (152 mm × 152 mm × 152 mm). Sediment from each grab was sieved through a 1000-µm of stainless-steel mesh and organisms were placed in separate 2000 mL plastic jar, containing mixed solution of 10% formalin and 70% ethanol. The measurement of the physical-chemical water parameters was done three times in each station. A fourth grab was collected at each station for chemical analysis of the sediment. Measured water parameters in this study were pH, temperature (°C), DO, salinity, and water current, recorded using Water Quality Checker U-50 Horiba. Sediment samples from each station were further tested at soil mechanics laboratory for sediment composition and organic content (organic carbon and total nitrogen).

Biotic and abiotic data obtained were presented in forms of table, pie diagrams, and histogram with standard deviation. Macrobenthic mollusc species was identified to the genus taxonomic level using identification book as reference, total abundance and number of species were calculated.

Macrobenthic mollusc abundance were analyzed further using Shannon-Wiener diversity index (H'), Pielou's Evenness Index (E) to analyze similarity, and Dominance index (C) to assess dominance level by particular taxa.

Diversity level of macrobenthic mollusc composition was analyzed by Shannon-Wiener Diversity Index (H'), using the following formula:

$$H' = -\sum_{i=1}^{s} pi \ \ln pi$$

$$pi = \frac{ni}{N} \quad \text{.......................................} \quad (i)$$

Where pi=fraction of the entire population made up of species ni; N=numbers of species collected; ∑= sum from species i to species s. The following criteria are taken into account when determining species diversity, if H'>3, diversity of species is high. If 1,6>H'>3, species diversity is moderate. If H'<1, the species diversity is low [16].

Pielou's Evenness Index (E) analyzed individual composition of each species in the same sampling area. The formula of E as followed:

$$E = \frac{H'}{lnS} \quad \text{.......................................} \quad (ii)$$

Where InS= maximum diversity. The Evenness value ranges between 0-1. Furthermore, the evenness value following categories: if 0<E≤0.5, the community is depressed, if 0,5<E≤0.75, the community is unstable, and if 0.75<E≤1, the community is stable [17].

Dominance Index (C) was used to determine the community dominance, calculated by formula:

$$C = \sum_{i=1}^{s} (\frac{ni}{N})^2 \quad \text{.......................................} \quad (iii)$$

Where ni= number of the individuals per species; N= total number of individuals per species. The dominance index Index values range from 0 - 1 by the following categories: if 0<C<0.5, the dominance is low, if 0,5<C≤0.75, the level of dominance is moderate, and if 0.75<C≤1,0, the level of dominance is high [16].

The abundance and quantity of species of macrobenthos molluscs were analyzed using a parametric analysis to determine the significance of differences between sampling locations. The Shapiro-Wilk data normality test was performed to obtain normality of data distribution with a significance level of p<0.05. The results of the analysis are presented through the use of tables and narratives to evaluate and describe the significance of the variables studied [18-19]. Furthermore, multivariate analysis using graphical methods was performed using PRIMER v6.1.5 software on macrobenthic mollusk community, sediment substrate composition, sediment chemical content, and water parameters data to determine the ordination of the relationship of environmental factors to macrobenthic mollusk community structure in the form of two-dimensional visual diagrams [19-21]. Forms of data processing performed in this non-parametric analysis include Multi-dimensional Scaling (MDS) analysis, Principal Component Analysis (PCA), BIO-ENV relationship, and k-dominance curve. MDS analysis and k-dominance curves were performed to determine the variability of macrobenthic mollusks based on their abundance, number of species, level of diversity and dominance. The k-dominance curves are plotted from the species abundance distribution, the y-axis is scaled in the range of 0–100, so that the curves are generated from a cumulative frequency of 100% of logistic transformed y-axis with the formula as follow:

$$y_i' = \log[(1 + y_i)/(101 - y_i)] \quad \text{.............} \quad (iv)$$

where yi is the abundance of species i [22].

PCA and BIO-ENV analyzes were carried out to determine the relationship of abiotic factors that most influenced the community structure of macrobenthic molluscs, schematic can be seen in Figure 2.

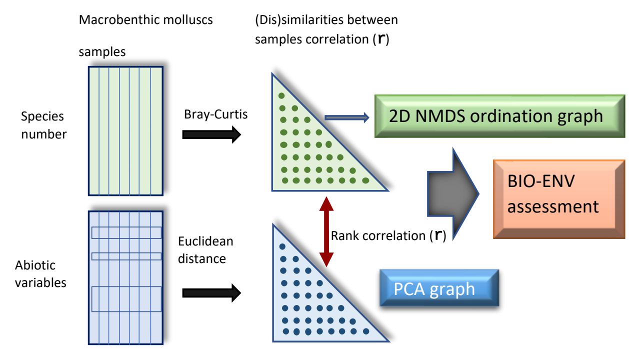


Figure 2 Schematic diagram of the NMDS, PCA and BIO-ENV procedure: selection of the abiotic variable subset maximizing rank correlation (p) between biotic and abiotic dissimilarity matrices (modified from Clarke and Warwick (2001)

3.0 RESULTS AND DISCUSSION

This research found total abundance of 38.184 individuals.m^{-2}, consisting of 19 total genus from 15 families, i.e. Gastropods class consist of 13 genus from 9 families and Bivalvia class consist of 6 genus from 6 families (Table 1).

Table 1 Averages of macrobenthic mollusc abundance at aquaculture and mangrove areas in two different sampling times

No	Family	Genus	Averages of Macrobenthic abundance (ind.m^{-2})			
			Aquaculture		Mangrove	
			I	II	I	II
Gastropods						
1	Cerithiidae	*Cerithium* sp	1978	645	4042	4300
2		*Cerithidium* sp	430	473	0	0
3		*Bittium* sp	903	817	129	387
		Clypeomorus sp	0	0	645	559
4	Potamididae	*Pirenella* sp	0	0	989	1462
5	Rissoidae	*Rissoina* sp	2021	516	688	1462
6	Planaxidae	*Fissilabia* sp	2881	1419	172	43
7	Tornatinidae	*Acteocina* sp	602	903	301	344
9	Littorinidae	*Littorina* sp	2967	3397	0	0
10	Triphoridae	*Triphora* sp	516	86	0	0
11		*Mitrella* sp	301	86	0	0
12	Chilodontaidae	*Euchelus* sp	215	43	0	0
13	Ellobiidae	*Cassidula* sp	43	215	0	0
Bivalves						
14	Lucinidae	*Myrtea* sp	43	172	0	0
15	Semelidae	*Semele* sp	86	215	0	43
16	Veneridae	*Acanthocardia* sp	129	172	0	0
17	Arcidae	*Anadara* sp	43	43	43	0
18	Cardiidae	*Fulvia* sp	43	0	43	0
19	Tellinidae	*Tellina* sp	0	129	0	0
	Total abundance		13201	9331	7052	8600
	Σ Species		16	16	9	8

Notes: Sampling time period: (I) July 2021; (II) September 2021

Based on the identification result, over all sampling period, aquaculture area had abundance and number of species higher than mangrove area both in gastropods and bivalves species. A total of 8 species of gastropods and 6 species of bivalves were recorded in aquaculture area. A total of 7 species of gastropods and 3 species of bivalves were counted in mangrove area. Gastropods tend to thrive more than bivalves, due to the adaptability of gastropods towards environmental disturbance than bivalves. Bivalves are classified as suspension feeder, this organism is highly dependent on the environment quality, making it less adaptable [23-24].

In aquaculture areas, the most abundant macrobenthic mollusc genera were *Fissilabia* sp and *Littorina* sp, whereas in mangrove areas, the most abundant genera were *Cerithium* sp and *Pirenella* sp. The differences in water characteristics and ecosystems between the two areas explain the differences in macrobenthos community composition in both areas. Genus *Fissilabia* sp and *Littorina* sp both are known as grazers and commonly found in sandy-rocky intertidal region, nutrient enrichment in aquaculture activities in those regions raises the potential to produce algal blooming, increasing the amount of macrobenthic grazers [25-27]. *Cerithium* sp and *Pirenella* sp that was found in mangrove area are known to be a deposit feeder, both genus are highly associated with mangrove ecosystem, this is related to the soft substrate in mangrove area, which is likely to contain organic matter [28-30].

Water Parameters and Sediment Properties

Physical-chemical properties of water parameters were measured for temperature, pH, Dissolved Oxygen (DO), salinity, and current speed. The obtained water parameter data comprises temperature (21.00 – 25.2°C), pH (7.5 – 8.7), DO (6.3 – 10.01 mg/L), salinity (29 – 32.7 ppt), and current speed (6 – 83 cm. s-1). The recorded data of physical-chemical water parameter indicates the number were within normal range in both stations and sampling time, as shown in Table 2.

Table 2 Water Parameter Data

Station	Time	Parameter				
		Temp (°C)	pH	DO mg/L	Salinity (ppt)	Current (cm.s^{-1})
Aquaculture Area	I	24.66	7.50	9.51	32.59	83
	II	25.2	8.7	6.3	29	80
Average		**24.88**	**8.06**	**7.86**	**30.75**	**82**
Mangrove Area	I	21.00	8.06	10.01	30.29	6
	II	24.4	7.7	8.8	32.7	8
Average		**22.65**	**7.83**	**9.36**	**31.45**	**7**

The value of measured temperature and pH in aquaculture area shows higher average value (24.88°C and 8.06) than mangrove area (22.64°C and 7.83). Higher temperature and pH level in aquaculture area can be caused by lacks of shades and aquaculture activities that added free minerals to the ecosystem [13]. The recorded value of DO and salinity in mangrove area (9.36 mg/L and 31.45 ppt) are averagely higher than aquaculture area (7.86 mg/L and 30.75 ppt). According to [31], higher abundance of organisms would decrease DO level in the water column [31]. The current speed in aquaculture area (82 cm.s-1) is averagely higher than in mangrove area (7 cm.s-1), caused by differences geographical condition. Different current speed affects the sedimentation particle distribution and DO content in the water, with faster current will have more coarser sediment and vice versa, and faster current resulting in greater DO levels, as current speed also plays a crucial function in mixing water mass [32-33]. The pH value at two areas in this study has an average of 7.83-8.06. A water pH between 6.5-8.5 are required for gastropods to survive [34].

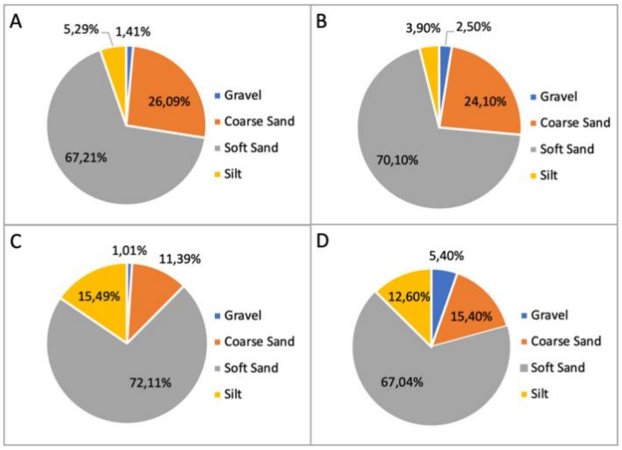


Figure 3 Sediment properties Diagram: A) Aquaculture Site Time I; B) Aquaculture Site Time II; C) Mangrove Site Time I; D) Mangrove Site Time II

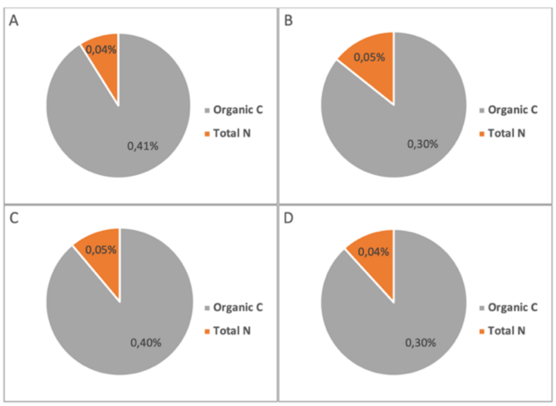


Figure 4 Substrate Organic Matters Content Diagram: A) Aquaculture Site Time I; B) Aquaculture Site Time II; C) Mangrove Site Time I; D) Mangrove Site Time II

Aquaculture sites have coarser sediments than mangrove sites, as shown in Figure 6. It's related to faster current speed in aquaculture, causing softer sediment easily carried away by the current. Due to the area's slower water current, sediments at mangrove sites are softer. Substrate particles with smaller sizes that contain organic matter are more likely to accumulate in areas with a slower water current [35].

The organic carbon ranged between 0.30 – 0.41% and total nitrogen ranged between 0.04 – 0.05%. The amounts of organic matters in both stations and sampling time were similar, because in aquaculture area there was organic enrichment from aquaculture activities thus deposited within the sedimentation. Organic matter is nutrient supply for macrobenthic mollusc, where it would affect the community structure in certain area. Other factor that would contribute on determining macrobenthic mollusc composition is sediment fraction [36].

Diversity Index, Evenness Index, and Dominance Index

Results of the diversity index (H'), dominance index (C), and Evenness index (E), respectively, can be seen in Figure 3, Figure 4, and Figure 5.

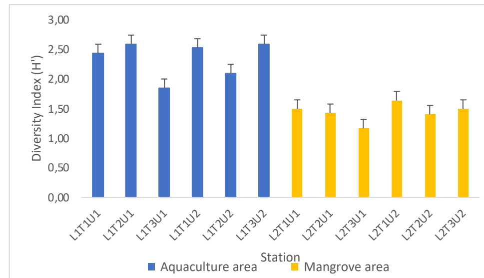


Figure 3 Histogram of Diversity Index

Based on the Shannon-Wiener diversity index (H'), The highest value of diversity index (H') was in the second sampling time in aquaculture area with the value of 2.40 categorized as medium [16]. While the lowest was in the first sampling time in mangrove area with the value of 1.36, mangrove area have a diversity value range of 1.17-1.63 indicating low-medium diversity, based on [16] category. The Aquaculture area has a higher H' index value than the Mangrove area. The higher diversity in aquaculture area effected by aquaculture activities. According to Ref [37], activities within the aquaculture area causing significant additional of nutrition supply in form of organic matters [37]. Organic matter that increase in related coastal area will also raise the abundance and diversity of macrobenthic molluscs, while the lower H' index is caused by the lack of adaptability of macrobenthic organisms to environmental disturbances and accelerate the competition with more adaptive biota [27]. The diversity in mangrove site was known to be lower, because mangrove ecosystem itself has an extreme change of environmental parameters and there was no organic enrichment that happened in the site [38].

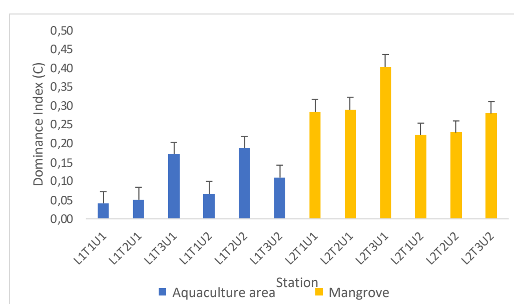


Figure 4 Histogram of Dominance Index

Simpson's dominance index (C) ini the aquaculture area has a range of 0.04-0.19 and in the mangrove area has a range of 0.22-0.40, indicate the absence of dominance from certain species in both area. The low value of C index can be interpreted that the ecosystem in the aquaculture and mangrove area are relatively balanced and there is no environmental disturbance that causes species dominance. Based on research by [39], the C index number at all research areas valued close to 0, indicates that the research environment is in a state of balance and suitable for supporting the survival of organisms that inhabit the location [39].

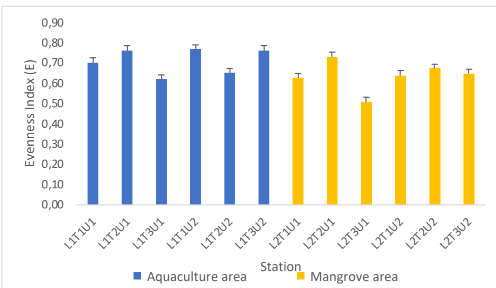


Figure 5 Histogram of Evenness index

The results of Pielou's evenness index (E) calculation at the aquaculture area had a value range of 0.62-0.77 and at the mangrove area had a value range of 0.51-0.73, indicating that both stations had moderate evenness. The E index in the medium category indicates that the distribution pattern of organisms is moderate and there is no dominance of species. According to Ref [39], the higher the E index value, the more evenly distributed pattern of organisms in the area and the absence of environmental disturbances, in conclusion, it does not affect the reduction or increase in the number of species [39]. It can be observed from the findings that the index value in each area, namely: the aquaculture area station has moderate diversity, low dominance, and moderate evenness, while mangrove area has a low-medium diversity, low dominance, and moderate evenness.

Further analysis using the k-dominance curve (PRIMER v6.1.5) shows a curve based on the abundance of the macrobenthic mollusc community at the station at each station and period. The results of the k-dominance curve analysis in Figure 6.

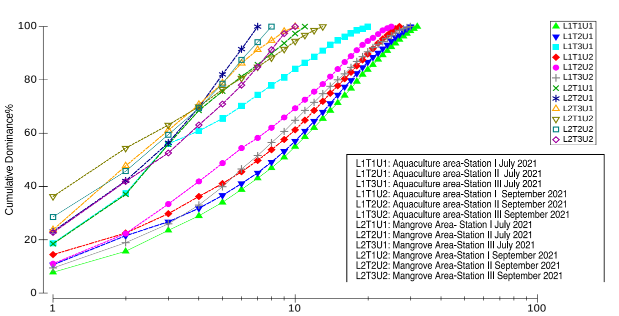


Figure 6 Results of K-Dominance Curve Analysis Using Macrobenthos Mollusc Community Abundance

It is known that Station 1 at the Aquaculture area for the July 2021 (L1T1U1) station shows a curve that is below the other curves. While Station 2 of the Mangrove area for the July 2021 (L2T2U1) station shows a curve above the other curves. Station 1 of the Aquaculture area for the July 2021 station has the highest diversity and the lowest dominance, thus station 2-mangrove area-July 2021 has the lowest diversity and evenness, Based on Ref [40] statement, if the k-dominance curve is below the other curves, means that the station has the highest value of evenness and diversity, while the curve's position station above the other curves, indicates that the station has the lowest value of evenness and diversity [40]. Aquaculture area had a high diversity rather than mangrove area as a result of aquaculture activities, according on research conducted by Ref [41] shows that Aquaculture activities such as excess feed and unfed pellets will degrade and provide a greater source of organic matter (OM), resulting in an increase in benthic respiration and biological production [41-42]. In addition, aquaculture is one of the activities that degraded the environmental quality of the nearby mangrove ecosystem, resulting in a decrease in macrofaunal diversity [32].

Nonmetric Multi-Dimensional Scaling (NMDS) analysis was conducted using macrobenthic mollusc abundance and genus count data transformed using Log(x+1). The Bray-Curtis matrix was used to determine the similarity of the data. The ordination plot of the MDS analysis results can be seen in Figure 7.

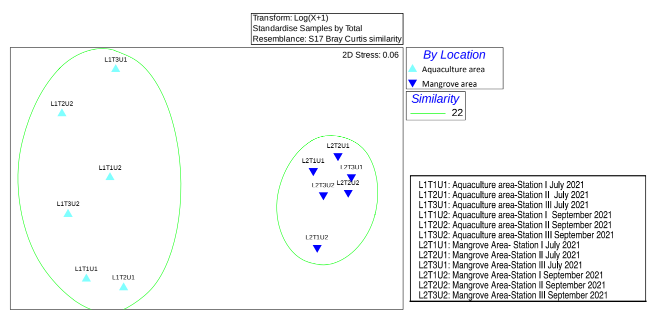


Figure 7 Results of MDS Analysis with Abundance and Number of Macrobenthic Mollusc Species

Macrobenthic mollusc community groupings were formed at each station. Aquaculture and mangrove areas have significanlly different variability in macrobenthic mollusc composition shown in the ordination of the MDS plot. The variability of organisms based on the sampling period did not form groupings. Sampling periods that are too close in the same season cause similarities in the variability of the macrobenthic mollusc community. variation occurs in environmental parameters and anthropogenic pollution can affecting the benthic structure [32]. Furthermore, sediment local characteristics also have an effect toward macrofauna communities [43].

Statistical analysis was conducted using the Paired T Test to determine the significance of differences based on the abundance of macrobenthic molluscs found in the aquaculture and mangrove areas in July and September 2021. The used data has been normalized using the Shapiro-Wilk normality test. Paired T Test with a P value> 0.05 indicate that there is no significant difference. Details of the data results of the Paired T Test analysis can be seen in Figure 8.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	KJABB_IMTA - TRACKING_MANGROVE _KEMUJAN	.48847692	.07517700	.03069088	.40958349	.56737034	15.916	5	.000
Pair 2	JULI_2021 - SEPTEMBER_2021	-.07817479	.19464797	.07946470	-.28244530	.12609573	-.984	5	.370

Figure 8 Paired T Test Results Using the H' Index

The results of the Paired T Test between stations showed that the macrobenthic mollusc communities in the aquaculture and mangrove areas had significant differences (t=15.916, P<0.05, df=5). Environmental parameters at both stations have different characteristics. The difference in environmental parameters creates a different composition of macrobenthic mollusc variability. Paired T-test analysis between periods (July and September 2021) showed no significant differences in macrobenthic mollusc communities (t=-984, P>0.05, df=5). samples were taken with adjacent time periods, so the environmental parameters at each station were not significantly different.

The results of MDS analysis and Paired T Test showed that the composition of macrobenthic mollusc variability between the aquaculture and mangrove area was significantly different. The composition of macrobenthic mollusc variability was not significantly different between July 2021 and September 2021. Similarities in the variability of organisms in a location are common if the sampling period is not far away. Samuel [46] stated that differences in the variability of tropical organisms can be found if sampling is carried out in two different seasons [44]. da Silva *et al*. [45] stated that seasonal changes in the tropics cause changes in the variability of organisms in an ecosystem [45].

Environmental parameters were analyzed using Principal Component Analysis (PCA). PCA analysis provides visualization of environmental data in the form of two-dimensional plots. The environmental data matrix was analyzed using Euclidean Distance. The results of PCA analysis at each station and period can be seen in Figure 9.

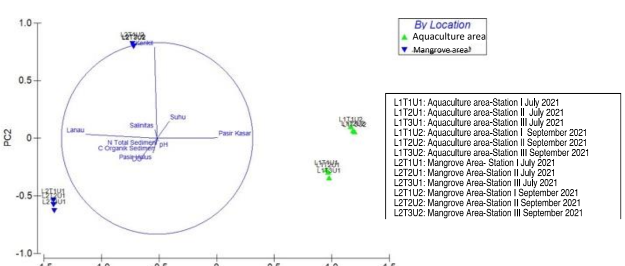


Figure 9 PCA analysis results in July and September

Each station in both periods were influenced by different environmental parameters in PCA analysis. The aquaculture area for the July and September 2021 periods were influenced by sediment substrates (coarse sand). Mangrove area in July 2021 period were influenced by silt and fine sand sediment substrates, while in September 2021 period were influenced by sediment substrates (gravel). The differences between substrates in those two locations are due to the sampling location, aquaculture area is located in intertidal zone and mangrove located in estuary zone. There are differences in environmental parameters between intertidal and estuary areas, intertidal areas have a coarser substrate texture and lower organic matter content, the estuary environment has a finer substrate texture and higher organic matter content, differences in sediment fraction composition and organic matter content create differences in the variability of benthic organisms between intertidal and estuary areas [36 & 46]. Coarser sands have larger angle of repose than finer ones, due to their higher permeability and roughness, coarser materials tend to be more stable in dynamic conditions [47].

Correlation Analysis of Macrobenthic Mollusc Community Structure with Environmental Parameters

BIO-ENV (Primer v6.1.5) was conducted to analyze the level of correlation between physical-chemical data of sediment and water to the abundance of macrobenthic mollusc. A square root transformation was applied to sediment and water data as abiotic data. The data were then normalized using the Euclidean Distance Similarity and Weighted Spearman correlation value methods. Details of the BIO-ENV analysis results can be seen in Table 3.

Table 3 BIO-ENV analysis results. Relationship between biotic and abiotic parameters

Variable Total	Correlation Coefficient (r)	Selected Variables
2	0.733	4, 9
5	0.732	3, 4, 8 – 10
3	0.732	4, 6, 9
4	0.732	4, 6, 8, 9
4	0.732	3, 4, 8, 9
4	0.732	4, 7 – 9
5	0.731	3, 4, 7 – 9
5	0.731	4, 6 – 9

Silt fraction as one of the sediment structures and dissolved oxygen content (DO) were the most influential for the abundance of macrobenthic mollusc, shown in the relationship analysis between biotic and abiotic parameters (r=0.733). Therefore, silt and DO have the strongest influence towards macrobenthic mollusc community structure. Research conducted by Ref [48] showed that water currents will affect substrate texture, coarse substrates will be found in waters with strong currents, and vice versa, fine substrates will be found in waters with weak currents [48]. Gastropods tend to favor fine substrates because of the higher organic matter content compared to coarse substrates [49]. Supported by the statement of Ref [50], that DO waters have an important role in the metabolism of living things and have a direct impact on the distribution and density of gastropods [50].

4.0 CONCLUSION

Total abundance of macrobenthic mollusc that was collected is 38.184 individuals.m^{-2}, consisting of Gastropoda class with 13 genus from 9 families and Bivalvia class with 6 genus from 6 families. The composition of the microbenthic mollusc community varies spatially, *Fissilabia* sp and *Littorina* sp was abundant in aquaculture area, while *Cerithium* sp and *Pirenella* sp was abundant in mangrove area, due to their substrate sediment, coarser substrate was found in aquaculture area, while mangrove area contained of softer substrate. The amount of organic carbon and total nitrogen were similar in both sites. Temporally, Aquaculture area for the July 2021 station has the highest diversity and the lowest dominance, thus station 2-mangrove area-July 2021 has the lowest diversity and evenness, differences between sampling times in two areas was not different significance. Diversity and evenness indices showed higher value in aquaculture area, due to organic enrichment in the area. Silt fraction, one of the sediment structures, and dissolved oxygen content (DO) are the environmental variables that correlate the most between two areas.

Conflicts of Interest

The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper.

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