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Diversity and Distribution Patterns of Macrozoobenthos in the Intertidal Zone of Pasumpahan Island, Padang City, West Sumatra Province

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ABSTRACT

Macrozoobenthos are organisms that live sedentary (sessile) and have varying adaptability to environmental conditions. In addition, the level of diversity found in the aquatic environment can be used as an indicator of pollution. The purpose of this study was to determine the type, abundance, diversity, and distribution pattern of macrozoobenthos in the intertidal zone. This research was conducted in the waters of Pasumpahan Island. The method used in this study was a survey method, while sampling was carried out using three stations and each station consisted of 3 transects and three sub-zones using a 1m x 1m quadrant map. The results of this study found that the abundance value at each station was 4.22-5.78 ind/m^2, while the abundance in the sub-zone ranged from 3.00-7.67 ind/m^2, the diversity index (H') at the study sites ranged from 1.65-2.31, which means $1.0 \leq H' < 3.0$ and the diversity of macrozoobenthos at the study site was categorized as moderate. The distribution pattern (Id) of macrozoobenthos at locations was clustered with a value of 1.05-1.28. The results of the One Way ANOVA test between stations obtained a value of 0.001 where $p < 0.05$, which means H0 was rejected and there was a significant difference between the 3 stations, followed by the LSD test to find out which average between stations was the most different real.

Keywords: Diversity, Macroozoobenthos, Pasumpahan Island

1. INTRODUCTION

The intertidal zone is the most abundant area narrow. Still, it has a higher diversity and abundance of organisms compared to other marine habitats because this zone has types of varied substrates and exposure to sunlight up to the primary substrate. Pasumpahan Island is one of the islands in the administrative area of Bungus Teluk Kabung District, Padang City, West Sumatra Province. Pasumpahan Island is about 200 m from Sikuai Island. This island is a tourist spot in great demand by local and foreign tourists.

Macrozoobenthos is an essential group in aquatic ecosystems. Macrozoobenthos live in mud, sand, gravel, rocks, and organic waste at the bottom of the sea, lake, or river. Several types of macrozoobenthos have high economic value, and several types of macrozoobenthos can also be processed into traditional medicine, and their shells are taken as jewelry (Arby, 2012).

The role of macrozoobenthos in marine ecosystems is quite essential, including balancing the life of marine ecosystems because it occupies several trophic levels in the food chain, helps speed up the decomposition process of organic matter, has different sensitivities to environmental changes, and acts as a bioindicator of water quality (Rahman, 2009).

Considering the importance of macrozoobenthos for aquatic ecosystems, macrozoobenthos also has a crucial role in the survival of other aquatic organisms. Therefore, research on "the diversity and distribution patterns of macrozoobenthos in the intertidal zone on Pasumpahan Island.

Padang City, West Sumatra Province "needs to be carried out so that later it can be used as a reference for further research and to provide information in planning the management of coastal areas in the waters of Pasumpahan Island, Padang City, West Sumatra. This research was conducted to know the type, abundance, diversity, and distribution patterns of macrozoobenthos in the intertidal zone in Pasumpahan Island, Padang City, West Sumatra waters.

2. RESEARCH METHODS

Time and Place of Research

The research was conducted in the period July 2022. The research location is on Pasumpahan Island, Padang City, West Sumatra Province (Figure 1). The research was divided into two stages; namely, macrozoobenthos sampling and sediment in the field, identification and counting of macrozoobenthos was carried out at the Marine Biology Laboratory, and analysis of sediment and organic material samples was carried out at the Marine Chemistry Laboratory, Department of Marine Science, Faculty of Fisheries and Marine, Universitas Riau. In situ, salinity, temperature, and pH measurements were carried out at the research location in the waters of Pasumpahan Island, Padang City, West Sumatra Province.

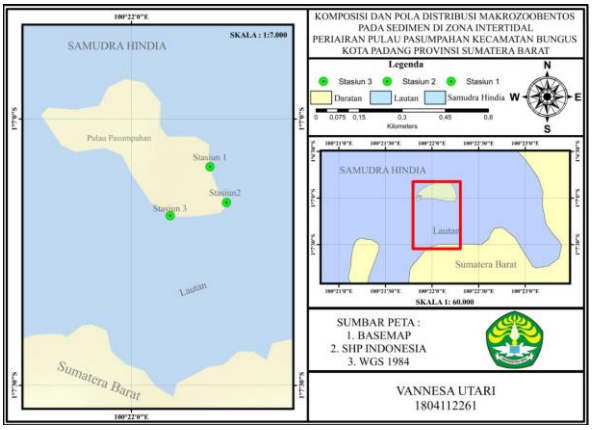

Figure 1. Map of research locations

Method

The method used in this research is a survey method where the waters of Pasumpahan Island are used as the research location, and the macrozoobenthos is used as the research object.

Procedure

Determination of Observation Stations

Sampling points were carried out using the purposive sampling method. Where the determination of sampling points is based on the criteria of the area around the research site. This research location is divided into three stations. Station I is in a tourist area, Station II is near the harbor for fishing boats and tourist boats, and Station III is near an area dominated by coconut trees. Each station consists of 3 transect, and each transect consists of 3 zones: lower, middle, and upper zone.

Macrozoobenthos Sampling

Sampling of epifauna and infauna macrozoobenthos was carried out at low tide using the quadrant transect sampling method, namely the method of determining sampling points by dividing the transect into plots measuring 1m x 1m and selecting plots to be used as sampling points where samples were taken. A sampling of epifauna macrozoobenthos is directly entered into a plastic bag. At the same time, the infauna macrozoobenthos is taken by scraping the sediment using a shovel and then put into a 1mm sieve to separate the macrozoobenthos from the substrate. Next, the macrozoobenthos separated from the substrate are put into a plastic bag labeled and given 10% formalin. The samples of the macrozoobenthos that have been taken are stored in an ice box. The macrozoobenthos is identified in the Marine Biology Laboratory, Department of Marine Science, Faculty of Fisheries and Marine, Universitas Riau.

Sediment Sampling

Sediment sampling to determine the type of sediment and organic material content was carried out using a paralon pipe. Sediment collection is carried out at each station. Sediment sampling used a random method: ±500 g of sediment samples was taken. The sediment samples were put into plastic samples labeled and then stored in an ice box. The sediment samples were analyzed to determine the marine chemistry laboratory's fraction of sediment and organic matter.

Measurement of Water Quality Parameters

Water quality parameters were measured

three times at each station, aiming to ensure the measurement results obtained were close to the truth and reduced the occurrence of too large a bias. Water quality parameters measured include temperature, salinity, and water pH.

Data processing

Several parameters are studied to determine the yield of macrozoobenthos, namely the type, abundance, diversity, and pattern of distribution of macrozoobenthos, sediment fraction, and organic matter. The number of individuals per m^2 expresses species abundance. According to Yulihatul et al. (2019), the abundance of each type at each observation location is calculated using the following formula:

$$D = \frac{Ni}{A}$$

Information :

D = Abundance of Species (Individual /m^2)
Ni = Total number of individuals of the type (Individual)
A = Area of the sampled area (m^2)

Macrozoobenthos diversity is calculated using the Shannon – Wienner index (Hamidy, 2010) as follows:

$$H' = \sum_{i=0}^{n} pi \log 2\, pi$$

Information :

H' = species diversity index
ni = Number of individuals of each species
N = The number of individuals

Moricity index is used to determine the distribution of macrozoobenthos (Yulihatul et al., 2019) with the formula:

$$Id = \frac{n\,(\sum X2 - 1) - n}{N\,(N-1)}$$

Information:

Id = Morisita Spread Index
n = Number of Plots
N = Total Number of Individuals
Σx^2 = Sum of Squares of Individual Plots

Calculation of organic matter content uses the Loss on Ignition formula (Mucha et al., 2003).

$$Organic\ matter = \frac{a-c}{a-b}\ x\ 100$$

Information:

a = Weight of cup and sediment sample before or after burning drying (g)
b = Weight of cup (g)
c = Weight of the cup and sample after burning

The classification of sediment fractions is based on the proportion of particle size of gravel, sand, and mud by plotting the percentage values of sediment particles into Sheppard's triangle contained in Rifardi (2008) (Figure 2).

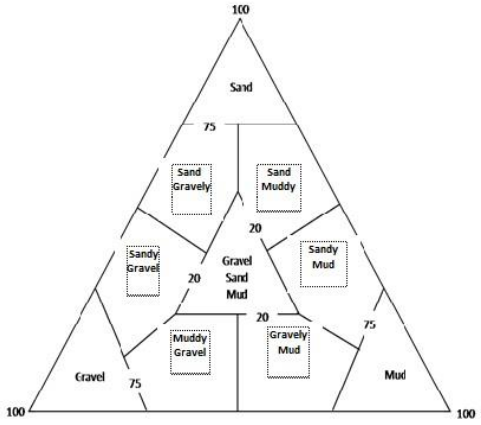

Figure 2. Sheppard's triangle

3. RESULT AND DISCUSSION

General Condition of Research Location

Pasumpahan Island is one of the islands in the waters of Bungus Teluk Kabung District, Padang City, West Sumatra Province, which is quite close to the mainland of Pasumpahan Island and is around 200 m from Sikuai Island. Geographically, this island is located between the coordinates 1°7'5.68" LS and 100°22'3.66" BT. Based on the Mayor of Padang's Decree No. 224/2011, Pasumpahan Island has been made one of Padang's regional marine conservation areas (KKLD).

The general condition of Pasumpahan Island is that it is a flat and partly hilly island with white sandy beaches covered with several higher plants such as coconuts, bushes, and grass. This location also has a rest house, which can be used as a tourist attraction.

The intertidal zone of Pasumpahan Island has biota, such as the discovery of aquatic organisms, bivalves, gastropods, and several groups of crustaceans. The Pasumpahan Island area has various human activities such as tourist activities, fishing boats, anchorage, and daily life activities of the people who live on Pasumpahan Island. Pasumpahan Island has facilities and infrastructure that can attract visiting tourists, such as cottages, food and drink stalls, tent rentals, and rest houses that

can be used as tourist attractions and crossing services to other islands, making it an exciting island to visit.

Water Quality Parameters

Each parameter's average water quality measurement value shows that the waters are still in good condition. Stating that the salinity range between 15-30‰ is still suitable for the growth of macrozoobenthos. Aquatic biota generally can live appropriately in the pH range of 5-9 (Satria, 2014). Can be seen in Table 1.

Table 1. Pasumpahan Island water quality parameters

Station	pH	Temperature (^{O}C)	Salinity (ppt)
I	6.5	30	31
II	6.5	30	32
III	6,6	32	31

Sediment Fraction

The sediment types that dominate Pasumpahan Island are gravel and sand. The highest percentage is at station III lower sampling point 79.97% and the lowest percentage is at station II upper sampling point 4.93%. Calculations for each fraction weight percentage and sediment type at each station can be seen in Table 2.

Table 2. Percentage of sediment fraction (%) and sediment type at each station research in Pasumpahan Island waters

Station	Sampling Point	Sediment Fraction (%)			Sediment Type
		Gravel	Sand	Mud	
I	Lower	58.15	35.40	6.45	Sandy gravel
	Middle	39.89	54,89	5,22	Pebble sand
	Upper	35.84	59.23	4.93	Pebble sand
II	Lower	62.20	30.83	6.97	Sandy gravel
	Middle	58.98	34.25	6.77	Sandy gravel
	Upper	15.08	77.45	7.47	Sand
III	Lower	79.97	13.25	6.78	Gravel
	Middle	79.19	14.56	6,16	Gravel
	Upper	16.06	77.09	6.85	Sand

Table 3. Yield of sediment organic matter average (%) at each research station in Pasumpahan Island waters

Point sampling	Station		
	I	II	III
Lower	3.06	3.02	3.79
Middle	3.72	2.90	1.69
Upper	2.48	2.57	2.63

Total Organic Ingredients

Sediment organic matter content at each research station has a different percentage. The highest organic matter content was found at station III in the Lower zone, with a percentage of 3.79 %, while the lowest was at station III in the Middle zone, with a percentage of 1.69% (Table 3).

Types of Macrozoobenthos

The types of macrozoobenthos found in the intertidal zone of Pasumpahan Island consist of 3 classes: 13 families, 14 genera, and 18 species (Table 4).

Observations of macrozoobenthos in Pasumpahan Island waters obtained 18 (eighteen) species from three stations: *C.batillariaeformis, C.moniliferus, R.sinensis, T.argyrostomus, T.castanea, N.polita, N.undata, P.puerpera, P.reticulata, C.tigerina, C.coronatus, C.annulus, O.erinaceus, E.mendicaria, M.granulata, P.scarabaues, T.flavum,* and *T.granifera.* The most common gastropod species found from all stations was *Pythia scarabaues* from the Elobiidae family. According to Kinasih

(2018), *P.scarabaeus* is a gastropod species whose habitat is generally in coastal environments, especially near mangrove forests. *P. Scarabaeus* can also live on medium sandy to muddy substrates. At several points in Pasumpahan Island, there is still mangrove forest vegetation; this is a factor that dominates *P. Scarabaeus* living in that environment. Apart from that, the water environment at the research location, which is still expected, is also why many of these species were found.

Table 4. Types of macrozoobenthos found at each research station on Pasumpahan Island

Class	Family	Genus	Species
Gastropods	Cerithiidae	Clypeomorus	*Clypeomorus batillariaeformis*
			C . moniliferus
		Rhinoclavis	*Rhinoclavis sinensis*
	Turbinidae	Turbo	*Turbo argyrostomus*
			Q. castanea
	Neritidae	Nerita	*Nerita polita*
			N . undata
	Pisaniidae	Engine	*Engina mendicaria*
	Muricidae	Morula	*Morula granulate*
	Ellobiidae	Pythia	*Pythia scarabaeus*
	Thiaridae	Tarebia	*Tarebia granifera*
	Conidae	Conus	*Conus coronatus*
	Cypraeidae	Cypraea	*Cypraea annulus*
Bivalves	Veniridae	Periglypta	*Periglypta puerpera*
			P. reticulate
	Lucinidae	Codakia	*Codakia tigerina*
	Cardiidae	Trachycardium	*Trachycardium flavum*
Ophiuroidea	Ophiocomidae	Ophiocoma	*Ophiocoma erinaceus*

Macrozoobenthos Abundance

The abundance of macrozoobenthos between stations in the waters of Pasumpahan Island was found to be 4.22 – 5.78 ind/m^2. The highest abundance was at station III, namely 5.78 ind/m^2, while the lowest was at station II, namely 4.22 ind/m^2 (Table 5)

Table 5. Abundance of Macrozoobenthos at the Research Station

Station	Mean ± Std. Deviation
I	4.89 ± 1.41
II	4.22 ± 0.25
III	5,78 ± 0,38

Differences in macrozoobenthos abundance between stations were analyzed using the One-way ANOVA test. The results of the ANOVA test obtained a significant value of 0.001 where $p < 0.05$, so H0 was rejected, and the abundance of macrozoobenthos between stations was significantly different. Then, a further LSD test was carried out to find out which average between stations was the most different between the three stations.

The results of further LSD test analysis showed a significant value of $p < 0.05$, which means that the abundance between station I and station III has a significant difference (significantly different), and the abundance between station II and station III has a significant difference (significantly different). The abundance between station I and station II is similar.

The abundance of macrozoobenthos at stations I and II is relatively low compared to station III, namely 4.89 ind /m 2 and 4.22 ind/m 2. The abundance of macrozoobenthos is because station I is in the tourist area of Pasumpahan Island, and station II is where fishing boats and tourist boats dock, where human activities affect the area so that the macrozoobenthos habitat is disturbed, but the organic matter in the sediments at stations I and II is 3.08% and 2.83% which is high compared to station III (2.70%), this is because the type of substrate at the location of station III is the type that dominates gravel. Based on the sediment fraction analysis in Table 4, the dominant sediment types on Pasumpahan Island are gravel and sand. Gravel and sandy sediment types are generally poor in nutrients,

and vice versa. Finer substrates are rich in nutrients. Even though the organic matter at stations I and II is high, due to community activities, it causes ecological pressure and affects the abundance of macrozoobenthos.

The abundance of macrozoobenthos between subzones in the waters of Pasumpahan Island was also calculated, with results obtained from 3–7.67 ind/m^2. The highest abundance is found in the upper subzone, namely 7.67 ind/m^2, while the lowest abundance is in the lower subzone, namely 3 ind/m^2 (Table 6).

Table 6. Macrozoobenthos abundance (ind/m^2) between sub zones in the intertidal zone

Sub Zone	Mean ± Std. Deviation
Upper	7.67 ± 1.97
Middle	4, 22 ± 1.13
Lower	3 ± 0.9 0

Macrozoobenthos abundance between subzones was also analyzed using the ANOVA test. The results of the ANOVA test obtained a significant value of 0.529, which means p = value >0.05, which shows that the abundance between sub-zones was not significantly different. Several factors, such as organic material, substrate, and other environmental factors, influence the abundance of macrozoobenthos in a body of water.

According to Riniatsih (2007), the high or low abundance values are also supported by the percentage of organic matter content in the waters. This is because organic materials are essential in providing food sources for organisms. Biotic and abiotic environmental conditions greatly influence the existence of macrozoobenthos in waters. Environmental factors that can influence the existence of macrozoobenthos are temperature, salinity, pH, substrate, and organic matter.

At the observation station, the temperature on both substrates is relatively the same, namely 30-32^{0}C. Rahman (2009) states that the optimum temperature for the development of macrozoobenthos ranges from 20^{0}C-30^{0}C, at a high-temperature range of around 33-50^{0}C causes disturbances in the development of the life cycle, and a decrease in temperature can cause an extension of the generation change time. So, the temperature at the observation station at both station I and station II is very suitable for the continuity of macrozoobenthos life at the observation station.

The research results on measuring salinity in the waters of Pasumpahan Island found values ranging from 31 - 32 ppt, where the salinity is classified as supporting macrozoobenthic life. According to Febrita (2015), high or low salinity levels do not affect the existence of gastropod species because gastropods can adapt or tolerate salinity. The optimal salinity for gastropod life ranges from 28 - 34 ppt (Satria, 2014). The pH value in the waters of Pasumpahan Island ranges from 6.5 to 6.6, which means the waters are still not polluted and do not disturb the biota found in these waters. Based on the measurements of water quality parameters, it can be concluded that the waters of Pasumpahan Island have a water environmental quality that is classified as standard and is still in a condition that supports the life and survival of macrozoobenthos.

Macrozoobenthos Diversity

The macrozoobenthos diversity index value between stations in the intertidal zone on Pasumpahan Island is 1.65-2.31. The highest diversity index value is at station III, 2.31, and the lowest is at station II, 1.65. The diversity index value at each station can be seen in Table 7.

Table 7. Macrozoobenthos diversity in the intertidal zone of Pasumpahan Island

Station	H'
I	1.71
II	1.65
III	2.31

Based on the diversity criteria at Station I, Station II, and Station III, it can be concluded that the diversity index category at all stations is in the medium category, namely where the index value ranges between $1.0 \leq H' < 3.0$: moderate diversity, sufficient productivity, condition ecosystem is relatively balanced, ecological pressure is moderate. An ecosystem can be considered normal if a high level of community diversity characterizes it without a dominant species and a relatively uniform distribution of the individuals of each species.

A moderate level of diversity indicates that the distribution of individuals of each type is uneven. This is because the number of

species is smaller, and there are more individuals, making the ecosystem unstable.

Arbi (2012) argues that the level of the species diversity index can be caused by the number of species or individuals obtained from the substrate conditions and ecosystem conditions in coastal areas. This interpretation supports the research results, as some species are more abundant than others.

According to Barus (2004), the diversity index is influenced by the type of species and the distribution of the number of individuals of each species. The large number of individuals of each species and the even distribution of each species will automatically increase the diversity index Ba'iun et al. (2021). The diversity value at the research location is in the moderate category, presumably because the water quality at this location is average and according to water quality standards.

Macrozoobenthos Distribution Pattern

In this observation, the macrozoobenthos distribution pattern in the intertidal zone of Pasumpahan Island ranged from 1.05 - 1.28. Station I with a morisita index value of 1.28, Station II with a morisita index value of 1.17, and Station III with a morisita index value of 1.05. The distribution pattern between observation stations obtained results of 1.05 - 1.28, where Id>1, which means the distribution pattern is clustered. Calculations of macrozoobenthos distribution patterns between stations can be seen in Table 8.

Table 8. Distribution Pattern of Macrozoobenthos

Observation Station	id	Distribution Pattern
I	1.28	Grouping
II	1.17	Grouping
III	1, 05	Grouping

Based on the morisita index criteria for station I, station II, and station III with Id values >1, it can be concluded that the distribution of macrozoobenthos in the intertidal zone of Pasumpahan Island shows a clustered distribution pattern. According to Werdiningsih (2005), this is under the statement that a pattern with a clustered distribution is a pattern of organisms or biota in a habitat that live in groups in specific numbers. The distribution pattern of each species and habitat type is very distinctive.

The cause of this distribution pattern is due to differences in response to habitat. Distribution patterns with various grouping levels are the most common form of distribution because individuals in a population tend to form groups of varying sizes.

4. CONCLUSIONS

Macrozoobenthos are found in the waters of Pasumpahan Island. The abundance of macrozoobenthos between stations in Pasumpahan Island waters was 4.22 – 5.78 ind/m^2. The macrozoobenthos diversity index value between stations in the intertidal zone on Pasumpahan Island is 1.65-2.31. The diversity index value $1.0 \leq H' < 3.0$: (1.65-2.31) at all stations is moderate. The distribution pattern of macrozoobenthos in the intertidal zone of Pasumpahan Island in this observation ranged from 1.05 -1.28, the value of Id>1, it can be concluded that the distribution of macrozoobenthos in the intertidal zone of Pasumpahan Island shows a clustered distribution pattern.

Based on the research, further research is needed on other environmental factors that affect the abundance of macrozoobenthos, including dissolved oxygen, brightness, and total suspended solids, so that an explanation of good water conditions can be obtained. In addition, the research results showed a moderate level of macrozoobenthic diversity, so it is necessary to monitor detrimental tourism activities to maintain the diversity and richness of macrozoobenthos at the study site.

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