



Distribution pattern of benthos based on substrate in the mangrove area of Labuhan Haji District, South Aceh Regency

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ABSTRACT

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Mangrove areas can function as habitats for spawning, rearing, and foraging for various species in them. Benthos is an organism that lives on the bottom of the water. Research on benthos distribution patterns based on substrate was carried out with the aim of studying benthos species, types of substrates, and analyzing benthos distribution patterns based on substrates in Labuhan Haji District, South Aceh District, Aceh Province. The method used in this study is the method of observation and field work. The benthos distribution pattern based on the substrate was calculated using the morphic index. Identification results found 31 species of benthos consisting of 3 classes, namely gastropods with 7 orders, bivalves with 4 orders, and malacostraca with 1 order and the type of substrate analyzed obtained 4 types of substrate namely dusty loam, sandy loam, silt and sand. The benthos distribution pattern based on the substrate obtained 2 categories, namely uniform on sandy loam and sandy clay substrates, and clustered on dusty and dusty clay substrates.

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Introduction

Mangrove forests in the world reach an area of around 16,530,000 ha which are spread across Asia 7,441,000 ha, Africa 3,258,000 ha and America 5,831,000 ha, while in Indonesia it is reported to be 3,735,250 ha and is one of the countries that has mangrove forests. widest in the world. The area of Indonesian mangrove forests is almost 50% of the area of Asian mangroves and almost 25% of the world's mangrove forests (Onrizal in Khairunnisa *et al.*, 2020).

Mangrove ecosystem is a typical ecosystem in coastal areas that has high productivity. As an ecosystem that has high productivity, the process of decomposition of organic matter in the mangrove ecosystem is very dependent on the biota in it. One of the biota that influences activities in the mangrove ecosystem is the benthos. Benthos is a group of organisms that live on the bottom (benthic) both at the top and in the substrate which is known as the benthic zone (Komala, 2023).

Benthos is a species that has a high tolerance to the environment. Benthos functions in the decomposition process and helps maintain the balance of the mangrove forest ecosystem. Based on its function, benthos is often used as an indicator of environmental balance (Destiana *et al.*, 2022). These organisms are considered to be important ecosystem bioindicators and have been utilized to screen pollution and other anthropogenic levels (Steyaert *et al.*, 2020; Akbar and Rahayu, 2023).

Benthos organisms belong to one of the aquatic ecosystem organisms which are very important as key organisms in food webs. Benthos organisms have the characteristics of a larger habitat so they tend to have a variety of species. Diversity is also affected by the penetration of sunlight reaching the bottom of shallow waters (Hanibe *et al.*, 2022).

Apart from being a physical and economic function, mangrove ecosystems have ecological functions, namely as a habitat for various species of biota, as spawning grounds, shoreline protectors,

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places to find food and rearing various species of aquatic biota (Bia'un et al., 2021).

The distribution pattern of biota in nature can be arranged into three basic patterns, namely random, regular and grouped (Odum, 1994). Individual distribution patterns can describe species characteristics or environmental characteristics (Sumarto & Koneri, 2016). The distribution pattern is influenced by several factors, namely the availability of food, the substrate as a living habitat, the influence of ecological factors such as physics, chemistry and the environment (Adi et al., 2014).

According to the National Survey and Mapping Coordinating Agency, Aceh Province has forest areas spread across 10 districts. The mangrove forests are scattered in the coastal area of East Aceh, Aceh Tamiang, North Aceh, Langsa City, Pidie, Simeulue, Singkil and small spots in Aceh Jaya, West Aceh and Aceh Besar districts (Ali et al., 2020). Meanwhile, in South Aceh District, precisely in Labuhan Haji District, there is a mangrove area that has various species of benthos in it. However, there is no data available on the benthos distribution pattern based on the substrate in that area.

Information on benthos distribution patterns based on substrate in Labuhan Haji District, South Aceh District has not been recorded and is not known for certain. This research is important to do to obtain the latest data in studying benthos distribution patterns as information material that can be utilized in the management of mangrove ecosystems.

Materials and Methods

Location and time of research

This research was conducted in 3 (three) locations, namely Gampong Ujung Padang, Labuhan Haji Barat District, Gampong Padang Bakau, Labuhan Haji Tengah District, and Gampong Kemumu Hilir, Labuhan Haji Timur District, South Aceh District, Aceh Province. This research was conducted in January 2022.

Research Methods

The method used in this study is the method of observation and field work which was carried out for direct observation of benthos species, and calculation of benthos distribution patterns at the study site. This study used a combination of two transect methods, namely the line transect method and the quadratic transect method. The line transect is used to describe community structure in the waters, while the quadratic transect is used to monitor benthos in the

waters. Stations and sampling points were determined using purposive sampling method.

Research Procedure

Each station is determined by a 100 m line transect. Each line transect consists of 5 sample plots measuring 10 x 10 m and the distance between one sample plot and another is 10 m. Each sample plot has 5 quadrant plots measuring 1x1 m. The location and study sample plots are presented in Figure 1 and Figure 2.

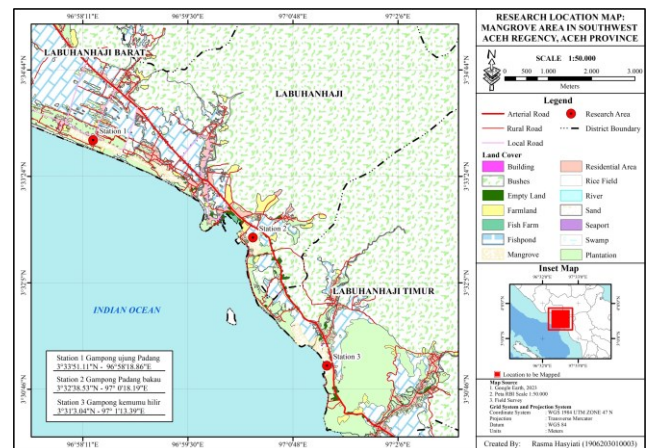


Figure 1. Research map of the mangrove area of Labuhan Haji District, South Aceh Regency.

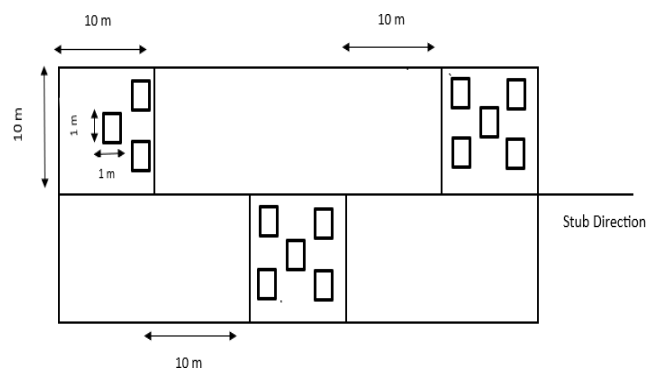


Figure 2. Station positioning design and observation points.

Research parameters

The parameters observed in this study included the number of species, number of individuals, benthos species, type of substrate, calculation of benthos distribution patterns based on the substrate in Labuhan Haji District, South Aceh District.

Data analysis

The data obtained was described quantitatively by calculating the distribution pattern of benthos species using the morphic index. Whereas Observation of the type of substrate was carried out by testing soil

analysis carried out at the Soil and Plant Research Laboratory at Syiah Kuala University using the substrate category from Miller's Triangle.

Table 1. Benthos diversity and uniformity Labuhan Haji District.

Class Name	No	Ordo	Species Name	Σ	\hat{H}	E	D
Gastropod	1	Cycloneritida	<i>Neritina turrita</i>	46	0.0784	0.0205	0.6133
			<i>Nerita albicilla</i>	75	0.1119	0.0259	1.0000
			<i>Nerita chamaeleon</i>	220	0.2249	0.0417	2.9333
			<i>Clithon coronate</i>	127	0.1603	0.0331	1.6933
	2	Caenogastropoda	<i>Fannus ater</i>	241	0.2368	0.0432	3.2133
			<i>Rhinoclavis sinensi</i>	105	0.1412	0.0303	1.4000
			<i>Terebralia palustris</i>	170	0.1929	0.0376	2.2667
			<i>Cherithidea cingulate</i>	135	0.1668	0.0340	1.8000
	3	Littorinimorpha	<i>Cypraea declives</i>	7	0.0177	0.0091	0.0933
			<i>Cypraea aurantium</i>	13	0.0293	0.0114	0.1733
			<i>Strombus ureceus</i>	9	0.0218	0.0099	0.1200
			<i>Strombus labiatus</i>	4	0.0111	0.0080	0.0533
			<i>Littorina undulata</i>	1	0.0061	0.0089	0.0267
			<i>Littorina Araucana</i>	81	0.1181	0.0269	1.0800
	4	Ellobiida	<i>Cassidula aurisfelis</i>	89	0.1261	0.0281	1.1867
			<i>Cassidula nucleus</i>	124	0.1578	0.0327	1.6533
	5	Neogastropoda	<i>Terebra</i> sp.	24	0.0477	0.0150	0.3200
	6	Pattellogastropoda	<i>Lottia gigantean</i>	89	0.1261	0.0281	1.1867
	7	Trocida	<i>Calliostoma zizyphinum</i>	100	0.1366	0.0297	1.3333
Amount				1,660			
Bivalvia	1	Cardiida	<i>Gari elongata</i>	134	0.1660	0.0339	1.7867
			<i>Tellina palatam</i>	97	0.1338	0.0293	1.2933
	2	Venerida	<i>Polymesoda expansa</i>	96	0.1329	0.0291	1.2800
			<i>Polymesoda erosa</i>	80	0.1171	0.0267	1.0667
	3	Lucinida	<i>Codakia tigerina</i>	13	0.0293	0.0114	0.1733
	4	Arcida	<i>Anadara antiquata</i>	13	0.0293	0.0114	0.1733
Amount				433			
Malacostraca	1	Decapoda	<i>Coenobita violascens</i>	11	0.0256	0.0107	0.1467
			<i>Uca vocans</i>	24	0.0477	0.0150	0.3200
			<i>Uca forcipata</i>	15	0.0329	0.0122	0.2000
			<i>Clibanarius longitarsus</i>	77	0.1140	0.0262	1.0267
			<i>Parathelphusa convexa</i>	21	0.0430	0.0141	0.2800
			<i>Varuna litterata</i>	50	0.0834	0.0213	0.6667
Amount				198			
Total Amount				2291	3.0673	0.39643	30.56

Table 2. Substrate types and distribution patterns based on the substrate in Labuhan Haji District

Station	Transect	Substrate Type	Morsita Index	Spread Pattern
1	1	Dusty loam	0.1768	group
	2	Dusty loam	0.3040	group
	3	Sandy loam	0.0035	Uniform
	4	Dusty loam	0.4896	group
2	5	Dusty loam	0.4939	group
	6	Dusty loam	0.4983	group
	7	Dusty loam	0.4985	group
	8	Dust	0.1874	group
3	9	Sand	0.0371	Uniform
	10	Sand	0.4546	group
	11	Sand	0.3792	group
	12	Sand	0.2242	group

The formula for calculating the Morisita Spread Index (Metananda et al., 2016) is as follows:

$$id^2 = n \frac{(\sum xi^2 - \sum xi)}{(\sum xi)^2 - \sum xi}$$

Information:

- Id : Morisita Distribution Index
- n : $\sum f(x)$ = the number of observed frequencies
- N : Total number of individuals in (n)
- $\sum x^2$: Square of the number of individuals per observation point

This standardized Morisita Index (IP) ranges from -1 to 1.

- If: IP = 0 then the scatter pattern is random.
- If: IP < 0 then the distribution pattern is uniform
- If: IP > 0 then the distribution pattern is grouped.

Results

Benthos species found in mangrove areas based on substrate in Labuhan Haji District, South Aceh Regency obtained 31 benthos species consisting of the gastropod class with 7 orders and 19 species of 1660 individuals, bivalves with 4 orders and 6 species of 433 individuals, and the malacostraca class with 1 order and 6 species with 198 individuals. Benthos species found in the mangrove area of Labuhan Haji District, South Aceh Regency are presented in Table 1.

The types of substrates that have been analyzed in the laboratory yielded 4 types of substrates namely dusty loam, sandy loam, silt, and sand. While the benthos distribution pattern based on the substrate obtained 2 categories, namely uniform and grouped. Substrate type data on benthos distribution patterns

based on the substrate found in the mangrove area of Labuhan Haji District, South Aceh Regency are presented in Table 2.

Discussion

The benthos species found consisted of 31 species belonging to the class gastropods, bivalves, and class malacostraca. Species from the gastropod class are the most commonly found species. The most common species found is the *Faunus ater* species. This species is commonly found on the surface of the sediments. The most common species found is the *Faunus ater* species. This species is commonly found on the surface of the sediments. According to Any (2022), that *Faunus ater* is a water snail that is commonly found in abundance in fresh, near brackish waters. *Faunus ater* species were only found at station 1 and station 2, with the type of substrate at that station being dusty loam and sandy loam. In accordance with the statement of Sarong et al. (2017) which stated that *Faunus ater* chooses and uses a muddy sand bottom with gravel litter as its habitat. The abundance of *Faunus ater* at the two adjacent stations indicates that there is ample availability of food or nutrition to support the needs of the *Faunus ater* species. In accordance with the statement of Any (2022), that the condition of the habitat close to shrimp ponds causes a high organic matter content resulting in the dominance of the *Faunus ater* species.

While the species that was found the least was the species *Littorina undulata* with a total of 1 individual. This species was only found at station 2 with a dusty clay substrate. Station 2 is directly related to the tides in accordance with the statement of Tuheteru et al. (2014) that this family from *Littorina* really likes mud surfaces or areas with sufficient standing water. Low level of occurrence of the species *Littorina undulata* at the station can be influenced by various environmental factors. *Littorinidae* gastropods have

different abundances or densities according to the height of the tides.

Based on the results of the analysis of the types of substrates in Labuhan Haji District, South Aceh Regency, the analysis was carried out at the Soil and Plant Research Laboratory of Shia University, the results obtained for different substrate criteria on each transect. Based on [Table 2](#), 4 types of substrate were obtained which at station 1 and station 2 were dominated by dusty clay substrate types while at station 3 were dominated by sand substrate types. Based on the 4 types of substrates, it is the preferred habitat for macrozoobenthos from the gastropod, bivalves, and malacostraca classes found. [Muliawan et al. \(2016\)](#) stated that the majority of macrozoobenthos prefer to live in silt to sand sediments. [Azham & Bahtiar \(2016\)](#) stated that the type of substrate greatly determines the composition and density of benthos. [Oetami & Achmad \(2020\)](#), states that locations with high mangrove thickness have a dusty clay loam texture, while mangrove locations without vegetation have a sandy soil texture so that the presence of mangrove vegetation greatly influences the formation of soil texture.

Based on [Table 1](#), the overall diversity index values obtained from the 3 stations are included in the high category with a diversity value (\hat{H}) of 3.0673. Analysis of the distribution patterns using these indices obtained 2 categories of distribution patterns, namely uniform and grouped. Based on [Table 2](#), a uniform distribution pattern is known at station 1 on transect 3 with a sandy loam substrate type, and at station 3 on transect 9 with a sandy substrate type, while the most dominant is the clustered distribution pattern at each station.

[Nurhia et al. \(2021\)](#), stated that the type of substrate is related to the oxygen content and the availability of food or nutrients in the sediment which will have an impact on the abundance of benthos. In sand substrates, the oxygen content is relatively large compared to finer types of substrates. This is because in this type of sand substrate there are air pores which allow more intensive mixing with the water above it. However, nutrients are not abundant in sandy substrates. Meanwhile, on a smooth substrate, oxygen is not so much but nutrients are usually available in very large quantities.

Conclusion

Benthos species found totaled 31 species consisting of 3 classes namely gastropods, bivalves, and malacostraca. The most common species found was Faunus ater with 241 individuals and the least species was Littorina undulata with 1 individual.

Analysis of the type of substrate obtained there are 4 types of substrate namely dusty clay, sandy loam, silt, and sand. The benthos distribution pattern based on the substrate obtained 2 categories, namely uniform on sandy loam and sand substrates while those that were clustered on dusty clay, silt and sand substrates.

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