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Research Article

Structure and Dominance of Macrozoobenthos as Biomonitoring Instrument in the Reuleng River, Leupung, Aceh Besar, Indonesia

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Abstract.

The Reuleng River is a mangrove area located in Aceh Besar district. Environmental changes that occur in the structure and composition of the mangrove ecosystem in the Reuleng River affect the macrozoobenthos conditions in the area. This study aims to determine the structure of the makrozoobenthos community as a biomomonitoring instrument in the mangrove ecosystem area. The study was conducted from February 2021 to May 2021. Determination of the sampling location was carried out using the purposive sampling technique and sampling was determined in three areas, namely upstream, middle stream, and downstream. The results showed that there were 19 species grouped into 4 genera and 12 families. The Macrozoobenthos Diversity Index in the Reuleng River area ranges from 2.62. The species that dominate the mangrove ecosystem area is the *Faunus ater* species with a dominant index value (0.16) and the lowest dominant species in the mangrove ecosystem is *Thalassina anomala* (0.01). No specific species were found that dominate the area. Based on descriptive observations, there is a group of Makrozoobenthos that has a relationship with the psychochemical quality of the air. The results show that the balance of the community in the area is still vulnerable and experiencing the impact of environmental pressures.

Keywords: Structure, dominant, macrozoobenthos, biomonitoring, reuleng river, Leupung

1. INTRODUCTION

Watershed is a land area that is separated from other areas because of the separation of natural topography, namely ridges or mountains that hold rainwater then accommodate and flow it through the main river to the sea [1]. Water conditions greatly affect environmental conditions indicating the input of liquid organic matter into the water [2]. The water quantity, quality, and new supply sources affect animals such as benthic animals. There are many researchers who study about estuarine or sea with macrozoobenthos as bioindicator with (richness, diversity, similarity, and domination) [3].

Benthic animals are a group of animals that occupy the bottom of the water. Based on their body size, benthic animals are classified into several groups of Macrofauna, which is often called as Macrozoobenthos. The state at the bottom of the water, it that creep at the bottom of the water surface are called epifauna such as crustaceans and insects, while that live in soft substrates in the mud are called infauna such as Bivalvia and Polychaeta. Macrozoobenthos diversity is influenced by nature that can affect the degree of diversity of other organisms. They are organisms that live at the bottom of water and sedentary habitats. The one of various disturbances that exist continuously occurring at different levels is the changes in the water quality [4]. Macrozoobenthos play a key role in functioning of freshwater ecosystems and include various taxonomic groups with often narrow and specific demands related to habitat conditions [5]. In addition, Macrozoobenthos have an important role as a key on the food chain that serve as predators, suspension feeders, detritivore, and parasites [6]. Changes in the water quality and habitat substrates greatly affect the composition of the environment, which are indicated as one of the main causes of changes in environmental physics chemicals [7]. Muddy and rocky fine substrates are the best habitat for macrozoobenthos to obtain food, shelter from currents and attach themselves, while gravel and sand substrates are easily carried away by water currents, making it difficult for macrozoobenthos to stick or settle on the substrate [8].

Reuleng River flow is characterized as estuaries area with a mangrove forest ecosystem. Estuary is an important habitat in coastal areas, where freshwater meet and mix with sea water. It is an ecosystem that is important for the life of coastal biota and is one of the most productive systems and functions as a breeding ground for various organisms [9]. Most of the estuaries are dominated by a muddy substrate. This muddy substrate is sediment carried by fresh water and sea water which in turn changes the type of bottom sediment from sandy and muddy to muddy [10].

The role of the estuary ecosystem is very important. Apart from being a food source for the surrounding organisms, estuary is also useful as a habitat (a place to live), a nursery, and a place to lay eggs. Macrozoobenthos plays an important role in the food chain. The larval phase becomes the food source for most of the organisms that live in the estuary area. In addition, Macrozoobenthos also increases oxygen levels in the sediment or substrate by making holes in the substrate (bioturbation).

Macrozoobenthos has been shown to be an efficient indicator group in monitoring water quality and ecological integrity of ecosystems [11]. Macrozoobenthos is one of four biological indicators that have been used for ecological status assessment [12]. Macrozoobenthos, which lives in deep/low water and relatively sedentary living habitats and limited movement, are very well used as the water biological indicator [13]. Biological indicators are effective for supporting the physics-chemical elements used by many countries in ecological status evaluation [14]. Reuleung river area is a water source for people in the area. The water flowing in this river is used to irrigate rice fields and to fulfill the needs of raw water as the needs of the community. The upstream river that borders the sea has the brackish water. This brackish condition causes this area to be overgrown by various types of mangroves. Hence, it is necessary to evaluate the structural and functional attributes of the group which is used to evaluate the biological condition of Macrozoobenthos habitat [15].

There is a lot of mud with various remaining mangrove leaf litter in the basal area of the mangrove ecosystem of the Reuleng River. This mangrove litter is utilized by various aquatic fauna [16] and benthic fauna is a very important link in the estuary ecosystem [17]. The abundance and diversity of Macrozoobenthos are also strongly influenced by changes in water quality and the substrates in which they live and Macrozoobenthos as a bioindicator can be based on biotic index [18].

Macrozoobenthos' response to environmental changes is useful in assessing the impact of municipal, industrial, and agricultural waste, and the impact of the use of other land on the surface water [19]. This may be due to differences in food availability and poor food quality [20]. The information about the relationship of Macrozoobenthos with mangrove ecosystems in the Reuleng River area is still unknown. Therefore, the purpose of this study was to determine the acceptance of the benthos community in the Reuleng River area and its function for the balance of the water area through an assessment of the types of macrozoobenthos species and their impact on the environment.

2. RESEARCH METHOD

The research was conducted from Februari 2021 to Mei 2021 in the mangrove ecosystem of the Reuleng River, Leupung district, Aceh Besar regency. The method used for gastropod observation was a survey method to systematically observe research objects and events closely related to the objects studied. The interpretation of the inconsistency is not easy [21]. The determination of observation stations used purposive random sampling technique, i.e. the determination by selecting an area that represents the observation site based on mangrove conditions and reducing forest conditions. Data collection, laboratory treatment, and statistical analysis of samples were carried out in accordance with standard practices [22]. Macrozoobenthos diversity index calculation was performed descriptively using Shannon-Wiener formula [23] as follows.

 ’= - ∑ *Pi ln Pi* (1)

Where:

Pi = ni/ N

H’ = Shannon–Wiener diversity

n_i = total individual species-i

N = total number of individuals of all species

ln = natural logarithm

Σ = number of individual species, with low diversity criteria (H 4)

In addition, it is also calculated the value of equality, wealth value, density, frequency of attendance, and value of interest.

The dominant index formula was used to indicate the Macrozoobenthos organisms that dominate the Macrozoobenthos community in the cosmos of the mangrove system. The dominant index formula uses Simpson Formula [24] as follows:

$$C = \sum (\frac{ni}{N})2(2)$$

Where:

C = dominant index

ni = number of individuals on i-genus level

N = total number of individuals from all genera

The dominant index score (C) ranges from 0 to 1. A value of C close to 0 indicates that no individual dominates, on the contrary if the C value is close to 1 then there is one

individual who dominates [24]. This research was conducted in the Reuleng mangrove ecosystem area. The location of the research at Figure 1.

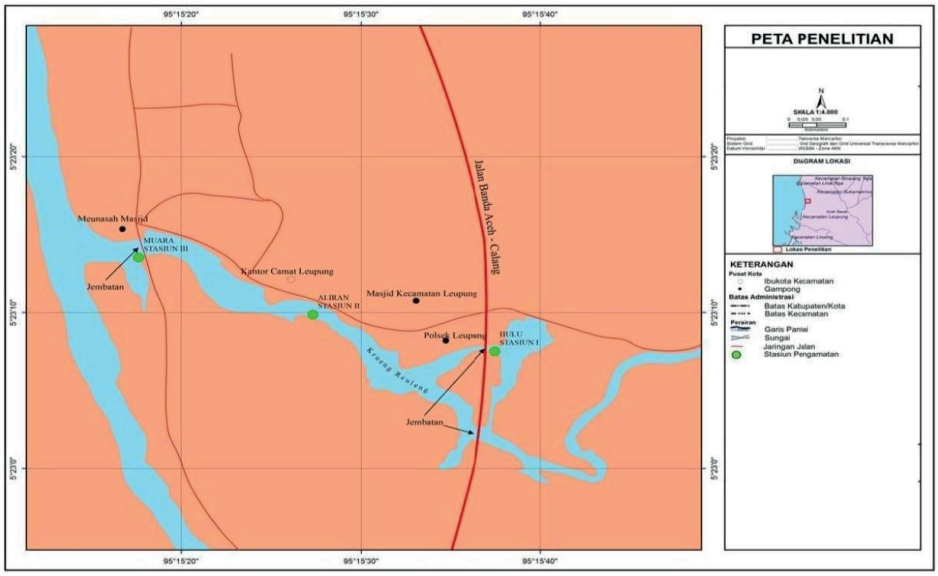

Figure 1: Research location.

Base on Figure 1, the research area was divided into 3 observation stations, namely (Station 1) Upstream of the river at the coordinate point of 5 ° 23 ’7.53 “North Latitude and 95 ° 15’ 37.46” East Longitude; (Station 2) The watershed (middle stream), located between 5°23’9.88” North Latitude and 95°15’27.31” East Longitude; and (Station 3) Estuary (downstream), located between 5 ° 23 ’ 13.54 “North Latitude and 95 ° 15 ’ 17.63” East Longitude. The area of each mangrove ecosystem was 10 m x 5 m**.** Macrozoobenthos sampling was performed by using 1 m x 1 m with purposive sampling technique in each mangrove station.

1. Macrozoobentos on the substrate surface were taken by hands.
2. Macrozoobenthos in the substrate were taken using a shovel about 15 cm deep.

Macrozoobenthos which was found in the mud area were filtered using sifts to separate from the sludge, then it washed and put thoroughly in labeled plastic bags.The movement of macrozoobenthos is very limited, and relatively settled on certain substrates, making macrozoobenthos more sensitive to environmental stresses such as declamation of water and sediment quality. Macrozoobenthos sampling was layered on the waterbed using *kicking* and *purposive random sampling* methods [25]. Each plastic bag containing the sample was given 70% alcohol, then identified at the Biology Education Laboratory, Faculty of Teacher Training and Education, Syiah Kuala University. Each station measured environmental parameters i.e. temperature, salinity, brightness, pH, and DO (dissolved oxygen).

Environmental factors affect the life of aquatic organisms, including the biodiversity of Macrozoobenthos [26]. Most aquatic organisms are reduced/replaced by some specialized organisms, which are tolerant of such conditions. Any changes in physical or chemical conditions also affect the occurrence and abundance of organisms living there [27]. Soil samples were also taken at the research site. The analysis of soil samples was conducted at Laboratory Testing Services, Aceh Assessment Institute for Agricultural Technology, and each type of mangrove is also taken and recorded in the observation table for identification purposes.

3. RESULT AND DISCUSSION

Structure of Macrozoobenthos Community

Makrozoobenthos are the dominant component in aquatic ecosystems and have value as an indicator of environmental quality because they have a short generation time and have a stable cooperative life [28]. Based on the qualitative and quantitative analysis, the composition of macro invertebrate benthic showed the existence of 19 species with a total of 1172 individuals from 3 sampling stations in the mangrove ecosystem of the Reuleng River. These 19 species are classified into 4 classes namely Bivalvia, Gastropods, Crustaceans and Malacostraca. The types of such species are presented in the Table 1.

Table 1 Describe that benthos species found in Leupung mangrove ecosystem have diversity. Macrozoobenthos that lives in this region consists of 4 classes namely Bivalvia, Gastropods, Crustaceae, and Malacostraca. From these 4 classes, there are families including 6 families of Gastropods, 3 families of Bivalvia, 1 family of Crustaceans, and 2 families of Malacostraca. The existence of Makrozoobenthos species in this area had a different index score, as in the Table 2.

Makrozoobenthos are an aquatic organism that lives at the bottom of the water [29]. The results showed that there were 19 species of Macrozoobenthos in the mangrove ecosystem of the Reuleng River in Leupung. The presence of Macrozoobenthos is strongly influenced by the type of aquatic conditions and habitats where Macrozoobenthos live. In addition, the results of the dominance calculation showed that *Faunus ater* has the largest dominant score i.e. 0.16 and the lowest dominant score are *Thalassina anomala* and *Melanoides admirabilis* with the score is 0.01**.** If the dominant index score is close to zero, then no particular organism dominates the waters [30].

Physical-Chemical Conditions of Reuleung River

Table 1: Species of macrozoobenthos in the Reuleng River, Leupung , Aceh Besar.

Class	Family	Species
Bivalvia	1.1 Corbiculoidae	*1.1.1 Geloina erosa*
	1.2 Mytilidae	*1.2.1 Modiolus auriculatus*
	1.3 Ostreidae	*1.3.1 Crassostrea sp.*
Gastropoda	2.1 Pachyllidae	*2.1.1 Faunus ater*
	2.2 Pillidae	*2.2.1 Pomaceae canaliculata*
	2.3 Neritidae	*2.3.1 Nerita maxima*
		2.3.2 Neritina semiconica
		2.3.3 Neritina muntah
		2.3.4 Theodoxus vespertinus
		2.3.5 Clithon korona-Kuning
		2.3.6 Clithon korona-Hitam
		2.3.7 Clithon spinosus
	2.4 Septaridae	*2.4.1 Septaria lineata*
	2.5 Potamididea	*2.5.1 Cerithidae cingulata*
		2.6.1 Thiara winteri
	2.6 Thiaridae	*2.6.2 Melanoides admirabilis*
Crustaceae	3.1 Penaeidae	*3.1.1 Panaeus indicus*
	4.1 Ocypodidae	*4.1.1 Uca sp.*
Malacostraca	4.2 Thalassinidae	*4.1.2 Thalassina Anomala*

In observing the condition of the impact of Macrozoobenthos in the research location, biomonitoring is carried out on the species that dominate the region. Biomonitoring is an assessment conducted by studying benthic organisms, so that these organisms can be used as bioindicators to monitor and analyze the water quality. The existence of Macrozoobenthos can predict the status of physicochemical parameters that determine the water quality. The abundance of families from highly intolerant species indicates the water quality is good, meanwhile the presence of highly tolerant species indicates poor water quality. Physical measurement is the most impactful factor in the life cycle of the aquatic biota. The approach to determining water conditions will be carried out using two methods, namely using the response of biota to environmental pressures, describing water quality and environmental conditions and known as bioindicators. Interactions in river ecosystems change due to human activity in water flows [31]. Table 3 is the measurement of physical factors in the mangrove ecosystem area of the Reuleng River carried out at 3 (three) stations.

Based on Table 3, it can be seen that the environmental conditions in 3 (three) observation stations had different scores. The water salinity at the research site ranges from 0‰ to 4‰. The difference in salinity score was due to the flow of fresh water from

Table 2: Index Score of macrozoobenthos diversity at the research location.

No	Species Name	I (Upstream)	II (Watershed)	III (Estuary)	Number	H'	C
1	*Geloina erosa*	18	19	19	56	-0.15	0.05
2	*Faunus ater*	56	67	67	190	-0.29	0.16
3	*Pomaceae canaliculata*	10	0	0	10	-0.04	0.01
4	*Modiolus auriculatus*	30	34	34	98	-0.21	0.08
5	*Crassostrea sp.*	18	16	16	50	-0.13	0.04
6	*Nerita maxima*	0	29	29	58	-0.15	0.05
7	*Neritina semiconica*	16	24	24	64	-0.16	0.05
8	*Neritina gagates*	19	31	31	81	-0.18	0.07
9	*Septaria lineata*	35	24	24	83	-0.19	0.07
10	*Theodoxus vespertinus*	24	0	0	24	-0.08	0.02
11	*Clithon korona-Kuning*	33	39	39	111	-0.22	0.09
12	*Clithon korona-Hitam*	0	33	33	66	-0.16	0.06
13	*Clithon spinosus*	0	20	20	40	-0.12	0.03
14	*Cerithidae cingulata*	51	64	64	179	-0.29	0.15
15	*Thiara winteri*	14	0	0	14	-0.05	0.01
16	*Melanoides admirabilis*	0	6	0	6	-0.03	0.01
17	*Panaeus indicus*	0	7	12	19	-0.07	0.02
18	*Uca sp.*	8	0	15	23	-0.08	0.02
19	*Thalassina Anomala*	0	6	0	6	-0.03	0.01
	Total	H '= - $\sum$ Pi ln Pi				2.62	

Table 3: The results of physical-chemical environmental factors measurement.

Parameter	Station I	Station II	Station III
Water Salinity (a.m.)	0-3	2-4	2-4
Water Temperature (0C)	27-31	30-32	31-34
pH of Water	7.3-8.23	7.1-7.59	7.2-7.59
DO (mg/L)	4.15-4.20	4.60-4.66	4.42-4.50
Light Penetration (cd)	9-48	6-17	4-18

the mountains. The salinity of the surface and base of the water layer shows different seasonal and spatial variations [32]. The salinity score is still in accordance with the growth of mangroves. The fact that the water flow is high and varied then the content

of suspended particles is high cause great disruption to the basic sediment affecting benthic fauna [33]. Salinity also affects the spread of benthos in mangrove ecosystems.

The most dominant class of Gastropods that found in the Reuleng River is assumed to be able to adapt to the environment. The intertidal zone is the most suitable area for many shellfish, shorebirds and benthic macroinvertebrates to colonize for feeding and breeding processes. Aquatic biota especially Gastropods that have *mobile* characteristic are able to move to avoid low salinity, but Bivalvia that have *sessile* characteristic will die if the occurrence of low salinity lasts a long time. Based on Table 3, Station 1 had lower water salinity than Stations 2 and 3. In addition, the water temperature, pH and DO in Station 1 were lower than other stations, while for the light penetration Station 1 is higher than Station 2 and 3. Station 2 is a station located in the area of watershed with the score of salinity, water temperature, pH, and DO almost resembled to Station 3, where the only difference was the score of the light penetration.

Based on observations at the three stations, DO (dissolved oxygen) score ranged from 4.15 mg/L to 4.66 mg/L. The range of DO score was still considered suitable for Macrozoobenthos habitat in the Reuleng River. The amount of oxygen in mangrove area is generally lower than in the open space, because the oxygen is absorbed for the needs of decomposition of organic matter. Intensive utilization of oxygen occurs in the process of decomposition of organic matter [34]. However, the lack of oxygen can be overcome by the presence of holes made by aquatic biota such as crabs. The physical-chemical characteristics of the water that changed along with the emergence of pollution indicators of Macrozoobenthic species conclude that the Reuleng River region, as a eutrophic ecosystem, requires urgent attention for a sustainable ecorestoration and management [35]. This indicates that lotic and lentic habitats in rivers are different in taxonomic composition, ecological properties, and Macrozoobenthos biotic index [36].

4. CONCLUSION

The dominance of macrozobenthos that dominates the Reuleung Leupung river area is a species of *Faunus ater,* macrozoobenthos associated with the mangrove ecosystem in the Reuleng River, Aceh Besar as many as 19 species with the dominant species being *Faunus ater, Cerithidae cingulata, Clithon corona-Kuning, Modiolus auriculatus* and *Neritina gagates*. Biomonitoring of mangrove ecosystem areas in the Reuleng River shows that the Makrozoobenthos species are strongly influenced by water conditions. The results showed that there was no flowering of certain species which indicated that the area was in a safe condition. The level of human threat to damage to the mangrove

ecosystem in the Reuleng River is more than serious or in the high category. Efforts to preserve the mangrove ecosystem in the Reuleng River, Aceh Besar Regency have not been carried out by the community.

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