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Ecological Index of Macrozoobenthos in Panorama Park River, Jantho, Aceh Besar

Yulia Variska¹, Rannisha Camila Zharrin^{1*}, Syifa Qalbi Nisa¹, Dinatun Nufus¹, Silvi Nabila Putri¹, Aliffah Apriani Dewi Hartanty¹, Aulan Dzuhra Aprillya¹

¹Marine Sciences and Fisheries Faculty, Universitas Syiah Kuala, Indonesia.

* Corresponding author: rannishaarin@gmail.com

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ABSTRACT

Panorama Park River, located in Jantho, Aceh Besar, has high ecological potential; however, human activities such as agriculture, settlement, and industry can exert pressure on its aquatic ecosystem. This study aims to analyse the ecological index of macrozoobenthos in the river using the Shannon-Wiener diversity index (H'), Pielou's evenness index (E), and Simpson's dominance index (C). Sampling was conducted using purposive sampling. The results of the study indicate that there are 14 macrozoobenthos species with a total of 67 individuals identified. The Shannon-Wiener diversity index (H') of 2.15 indicates a high level of diversity, suggesting that the river ecosystem is still stable and not dominated by a single species. The species with the highest density was *Filopaludina sumatrensis* (53.84 Ind.m⁻²), while the species with the lowest density was *Odonata libellula* (2.56 Ind.m⁻²). Overall, the results of this study indicate that the water quality of the Jantho Panorama Park River is still quite good and capable of supporting a diverse macrozoobenthos community. Regular monitoring is still needed to maintain the balance of the aquatic ecosystem and anticipate potential environmental changes that could affect the survival of macrozoobenthos in the future.



INTRODUCTION

The Panorama Park River in Jantho, Aceh Besar, has considerable ecological value; however, increasing human activities in the surrounding area, including agriculture, settlements, and industrial activities, may impose pressure on the aquatic environment. Such activities can alter the physicochemical characteristics of the water and subsequently influence the composition, abundance, and survival of macrozoobenthos. Assessing the ecological condition of the river is therefore important for understanding the extent to which these environmental pressures affect the benthic community. This study evaluates the ecological condition of the Panorama Park River using macrozoobenthos community indices, including the Shannon-Wiener diversity index, Pielou's evenness index, and Simpson's dominance index. In addition, selected

physicochemical water parameters were examined in relation to macrozoobenthos occurrence to provide baseline information for sustainable river conservation and management.

Macrozoobenthos are important components of freshwater ecosystems because of their roles in food-web dynamics, organic-matter decomposition, nutrient cycling, and energy transfer to higher trophic levels. Their relatively limited mobility and sensitivity to changes in environmental conditions also make them useful biological indicators of aquatic ecosystem quality. Consequently, variations in macrozoobenthos diversity, abundance, evenness, and dominance can provide information on habitat conditions and potential environmental disturbance. The Panorama Park River contains heterogeneous habitat characteristics, particularly variations in substrate and water flow, making it a relevant system for evaluating macrozoobenthos community structure and its potential use in assessing river ecological condition.

Zulfiati et al. (2021) investigated macrozoobenthos diversity in several rivers in Aceh to evaluate aquatic environmental quality using benthic community diversity as an indicator. Similarly, Fastawa et al. (2019) examined macrozoobenthos diversity in the Krueng Aceh estuary as a biological indicator of pollution and used the resulting diversity patterns to assess the ecological condition of the estuarine waters. This study is expected to provide a clearer picture of the ecological conditions of Panorama Park River and the importance of preserving the river ecosystem as a natural resource that supports the lives of the surrounding community.

RESEARCH METHODS

Research Location. This study was conducted in February 2025 in the waters of Jantho Panorama Park, Jantho District, Aceh Besar Regency, Indonesia (Figure 1). Identification of biota and substrates was carried out at the Marine Biology Laboratory, Faculty of Marine Sciences and Fisheries, Syiah Kuala University. Sample collection sites were selected based on environmental characteristics such as current speed and human activity around the area. The research location coordinates are 5°22'18"N and 95°38'14"E.

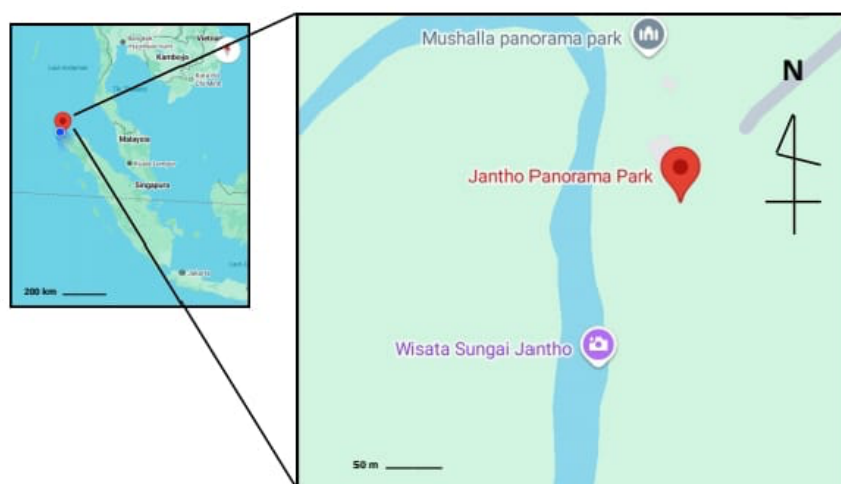


Figure 1. Research Location. The red dots indicate the sampling locations for macrozoobenthos in the Jantho Panorama Park River, (5°22'18"N 95°38'14"E), Aceh Besar, Indonesia.

Collection and Preservation of Macrozoobenthos. Macrozoobenthos samples were collected using purposive sampling at three stations representing different environmental conditions along the river. Station selection was based on environmental factors such as human activity, current speed, and the potential influence of the water substrate on macrozoobenthos presence. Macrozoobenthos sampling was conducted using PVC pipes and sieves. The PVC pipe method was used by inserting a 5-inch diameter PVC pipe into the water

bottom to a certain depth to collect sediment containing macrozoobenthos. The collected sediment was then sieved using a sieve, a filtering device that separates organisms from smaller sediment particles. After separation, the macrozoobenthos samples are placed in sample plastic bags, preserved with a 4% formalin solution, and labelled according to the sampling location at each station.

Macrozoobenthos Identification. The macrozoobenthos obtained are then identified at the marine biology laboratory, Faculty of Marine Sciences and Fisheries, Syiah Kuala University. Macrozoobenthos are identified to the family and species level using <https://www.molluscabase.org/> and other references such as Google Lens. After identification, the data were analysed by calculating several ecological indices to evaluate the quality of the river ecosystem, namely the Shannon-Wiener Diversity Index (H'), the Pielou Evenness Index (E), and the Simpson Dominance Index (D). The results of this analysis were used to interpret the level of macrozoobenthos diversity and the environmental impact on the aquatic ecosystem in the Panorama Park River, Jantho, Aceh Besar.

Water quality measurements. The physical-chemical parameters of the water measured included temperature, pH, dissolved oxygen (DO), salinity, and flow velocity. Measurements were conducted directly (in situ) at each station using instruments such as digital thermometers for temperature, pH meters for acidity levels, DO meters for dissolved oxygen, refractometers for salinity, and the floating method and stopwatch for current velocity. These measurements aim to determine the water environmental conditions that may influence the presence and distribution of macrozoobenthos. The data from these parameters are then analysed to examine their relationship with the benthic community structure found at the study site.

Data Analysis. The formula for calculating the ecological index based on the method described by Arfiati et al. (2019) uses three types of indices. First, the Shannon-Wiener Diversity Index (H') is a tool used to measure species diversity in an ecosystem. The formula is as follows:

$$H' = -\sum (n_i/N) \ln (n_i/N)$$

Where (n_i) refers to the number of individuals of species i , and N is the total number of individuals of all species identified in the sample. This index provides an overview of the species variation in a location. A higher H' value indicates greater diversity, while a lower value indicates the dominance of only a few species.

Furthermore, the Simpson Dominance Index (C) is used to measure the extent to which certain species dominate within a community. The formula is:

$$C = \sum (n_i/N)^2$$

Where (n_i) is the number of individuals of species i , and N is the total number of individuals in the community. The Simpson's dominance index provides a value between 0 and 1, where higher values indicate greater dominance of certain species, and lower values indicate a more even distribution of individuals among species.

The Evenness Index (E) measures how evenly the distribution of individuals among species in a community is spread out. The formula is:

$$E = H'/H' \text{ max.}$$

Where H' is the calculated Shannon diversity value, and $H' \text{ max}$ is the maximum diversity value that can be achieved, calculated by $\ln S$, where S is the total number of species in the community. An E value close to 1 indicates a more even distribution of individuals among species, while a lower value indicates the dominance of certain species.

These three indices—Diversity Index, Dominance Index, and Evenness Index—complement each other in providing an overview of the structure of the macrozoobenthos community and species dynamics in an aquatic ecosystem.

RESULTS AND DISCUSSION

Macrozoobenthos Ecological Index. The ecological assessment of macrozoobenthos in the Jantho Panorama Park River recorded 14 species comprising 67 individuals. The Shannon-Wiener diversity index (H') was 2.15, indicating a relatively high level of diversity. Although several species, particularly those belonging to the families Thiaridae and Ampullariidae, contributed a greater proportion of individuals, the overall community remained relatively well distributed, with no single species showing excessive dominance. This diversity pattern suggests that environmental conditions in the river are generally suitable for supporting macrozoobenthos communities. Based on the ecological index interpretation, the Jantho Panorama Park River can be considered relatively stable and subject to low ecological pressure. These findings indicate that habitat conditions and resource availability remain favorable and that the ecosystem has not experienced substantial disturbance capable of markedly reducing benthic biodiversity. The ecological index values of the macrozoobenthos community are presented in Table 1:

Table 1. Macrozoobenthos ecological index values (H' , E, C)

No	Macrozoobenthic		ni	D (Ind.m ⁻²)	pi ln pi	H'	E	C
	Family	Species						
1	Ampullariidae	<i>Filopaludina sumatrensis</i>	21	53.8461538	-0.3636	0.36	0.81	0.16
2	Thiaridae	<i>Tarebia granifera</i>	13	33.3333333	-0.3182	0.32		
3	Pachychlidae	<i>Sulcospira tetudinaria</i>	3	7.69230769	-0.1391	0.14		
4	Palaemonidae	<i>Macrobrachium lanchesteri</i>	6	15.3846154	-0.2161	0.22		
5	Thiaridae	<i>Thiara scabra</i>	5	12.8205128	-0.1937	0.19		
6	Hydrophiloidea	<i>Hydrophilus piceus</i>	1	2.56410256	-0.0628	0.06		
7	Libelluloidea	<i>Orthemis nymph</i>	1	2.56410256	-0.0628	0.06		
8	Hirudinidae	<i>Barbronia weberi</i>	1	2.56410256	-0.0628	0.06		
9	Hydrocharitaceae	<i>Hydrilla verticillata</i>	4	10.2564103	-0.1683	0.17		
10	Semisulcospiridae	<i>Semisulcospira libertina</i>	2	5.12820513	-0.1048	0.10		
11	Chironomidae	<i>Metriocnemus knabi</i>	1	2.56410256	-0.0628	0.06		
12	Thiaridae	<i>Melanoides tuberculata</i>	3	7.69230769	-0.1391	0.14		
13	Planorbidae	<i>Mieniplotia scabra</i>	5	12.8205128	-0.1937	0.19		
14	Libellulidae	<i>Odonata libellula</i>	1	2.56410256	-0.0628	0.06		
N			67			2.15		
s			14					
LOG s			1.15					

Relationship with Water Quality. The physical and chemical quality of the water in the Jantho Panorama Park River is generally in a condition that supports macrozoobenthos life. The high flow velocity of 28.37 m.s⁻¹ indicates dynamic water and can increase oxygen supply. The water temperature of 26.9°C is still within the optimal range for macrozoobenthos metabolism. The neutral pH value (7.6) and dissolved oxygen levels exceeding 5 mg.L⁻¹ indicate good water hardness and sufficient oxygen for the respiration of bottom-dwelling organisms. The low salinity (0.5 ppt) is consistent with freshwater characteristics. Based on these conditions, the

results of the macrozoobenthos ecological index indicate that the Jantho River water body is still supportive of life, as evidenced by the presence of 14 macrozoobenthos species with a total of 67 individuals. The moderate to high values of diversity and evenness indices reflect water conditions that are not heavily polluted, indicating that water quality can still support the biodiversity of bottom-dwelling organisms. Water quality data are presented in the Table 2 as follow:

Table 2. Physical-Chemical Parameters of the Jantho River at Panorama Park

No	Parameter	River
1	Flow (m.s ⁻¹)	28.37
2	Temperature (°C)	26.9
3	pH	7.6
4	Dissolved Oxygen (mg. L ⁻¹)	>5
5	Salinity	0.5

Based on the results of research conducted in the Jantho Panorama Park River, 14 species of macrozoobenthos were found with a total of 67 individuals. The species diversity in this river shows a varied distribution pattern, which can be associated with environmental factors such as water quality, substrate, and flow velocity.

The analysis results showed that the Shannon-Wiener diversity index (H') was 2.15, indicating a fairly high level of diversity. This indicates that the macrozoobenthos community at the study site is quite diverse and not dominated by a single species. The species with the highest density was *Filopaludina sumatrensis* from the family Ampullariidae with 53.84 Ind.m⁻², followed by *Tarebia granifera* (33.33 Ind.m⁻²) and *Sulcospira testudinaria* (7.69 Ind.m⁻²). Meanwhile, the species with the lowest density is *Odonata libellula* with only 2.56 Ind.m⁻². The Simpson dominance index indicates that no species dominates extremely, meaning that the ecosystem is still relatively balanced. The evenness index (E) also shows a fairly even distribution of species, indicating that there is no excessive environmental pressure causing certain species to dominate significantly.

Based on the measured physical-chemical parameters of the water, the current velocity reached 28.37 m.s⁻¹, which is quite high and may limit the presence of certain species that cannot survive in strong currents. The pH of the water was 7.6, indicating neutral to slightly alkaline conditions, which generally still support macrozoobenthos diversity. Water temperature was recorded at 26.9°C, which is still within the optimal range for many benthic organisms. Dissolved oxygen levels were >5 mg.L⁻¹, indicating that water conditions are still adequate for macrozoobenthos.

Overall, the results of this study indicate that the Jantho Panorama Park River has relatively good water conditions to support macrozoobenthos life. The relatively high diversity index suggests that the river ecosystem is still stable and capable of supporting various types of benthic organisms. However, despite the water quality supporting macrozoobenthos, other external factors can also influence the results found. For example, human factors such as pollution or land-use changes around the river can alter the composition of the macrozoobenthos community over time. Therefore, although the physical and chemical conditions of the river water are quite supportive, proper environmental management is still necessary to maintain and even enhance the biodiversity in the river. Higher macrozoobenthos diversity can serve as an indicator of better ecosystem health, which in turn contributes to overall ecological balance.

CONCLUSION

Based on research conducted in the Jantho Panorama Park River, 14 species of macrozoobenthos were found, with a total of 67 individuals. The Shannon-Wiener diversity index (H') of 2.15 indicates that species diversity in this river is quite high, indicating a stable

aquatic ecosystem that is not dominated by any one species. The species with the highest density was *Filopaludina sumatrensis* (53.84 Ind.m⁻²), followed by *Tarebia granifera* (33.33 Ind.m⁻²), while the species with the lowest density was *Odonata libellula* (2.56 Ind.m⁻²). The uniformity index indicates a relatively even distribution of species, while the dominance index shows that no species dominates extremely. Environmental factors such as flow velocity (28.37 m.s⁻¹), pH (7.6), temperature (26.9°C), and dissolved oxygen (> 5 mg. L⁻¹) are still within the range that supports macrozoobenthos life. Therefore, it can be concluded that the water quality of the Jantho Panorama Park River is still in fairly good condition to support macrozoobenthos diversity. However, regular monitoring is still necessary to maintain ecosystem balance and anticipate potential environmental changes that may affect the macrozoobenthos community in the future.

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