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COMMUNITY STRUCTURE OF MACROZOOBENTHOS AS BIOINDICATOR OF WATER QUALITY IN THE OGAN RIVER AROUND BATURAJA CITY

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Abstract

Macrozoobenthos has an important role in the waters. The river is one example of a water body where macrozoobenthos can be used as an indicator of water pollution. This study aims to calculate the community structure of macrozoobenthos and the water quality in the Ogan River around Baturaja City. Sampling was carried out by purposive sampling method in 5 stations, in which each station had 5 sampling points determined based on differences in microhabitat, namely stonny, gravel, sandy, and litter conditions around the edge of vegetation. The results revealed that macrozoobenthos found in the Ogan River consisted of 6 classes (i.e., Bivalvia, Crustacea, Gastropods, Insecta, Oligochaeta, and Turbellaria), 12 orders, 21 families, and 30 genera. The density of macrozoobenthos species ranged from 598 to 1367 ind/m2. The diversity index value in the Ogan River around Baturaja City ranged from 1.117 to 2.22 with a moderate category. In addition, the community similarity index of the five stations reached ≥ 50%, except for stations III and V (44%). Seemingly that the macrozoobenthos community in the waters of the Ogan River around Baturaja City was relatively the same. Therefore, the community structure of the Ogan River around Baturaja City was relatively stable.

Keywords : Distribution; habitats; type; species; richness.

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1. Introduction

Rivers have a very important meaning for the community because their existence in nature can be used for free. Ogan Ilir Regency is an example of a regency in South Sumatra which is traversed by a large river, namely the Ogan River which has a large potential as water resources [4]. In addition, the Ogan River is the largest in Ogan Komering Ulu (OKU) Regency with a water discharge of 136,614 m^3/hour and a length of 170 km in OKU Regency. The Ogan River is a very important river for the people of OKU Regency because the water from this river can be used to support their daily activities, such as toileting, agriculture, fishing, and others [5]. This river has experienced a lot of pollution loads in the river body due to negative behaviors carried out by the community, such as disposing of domestic and non-domestic waste. The addition of large quantities of waste materials from upstream to downstream continuously due to human activities (e.g., heavy metals, dyes, drugs, pesticides, fluorides, and detergents) poses the biggest threat (80 percent) to the world's population [6].

Benthos is organism that is attached to the bottom or live at the surface of substrate. Meanwhile, zoobenthos is animals that part or all of their life cycle is occured at the bottom of the waters by sessile, crawling, or digging holes [7]. Polluted waters will affect the survival of macrobenthos because they are aquatic organisms that are easily affected by the presence of pollutants, both physical and chemical pollutants. Therefore, macrozoobenthos in the balance of an aquatic ecosystem plays a role as an indicator of the current status of the ecological conditions [8]. Macrozoobenthos also have an important role in the nutrient cycle at the bottom of the waters and also act as one of the links in the

energy flow and planktonic algae cycle to higher consumers [9]. A decrease in the composition, abundance, and diversity of macrozoobenthos is principally an indicator of disturbance to the ecosystem in the water body [10]. Apart from being an indicator of water quality, the contribution of macrozoobenthos is also quite large to aquatic ecosystems in the process of sediment mineralization and organic material cycles and acts as a nutritional balancer in aquatic ecosystems [11]. Macrozoobenthos as a bioindicator is related to aquatic environmental factors, such as brightness that affects water temperature and the presence of chemical elements (e.g., hydrogen ion content (pH), dissolved oxygen (DO), TSS, BOD, and COD) [12]. For example, if many Oligochaeta species are found in industrial areas but no other species are found, it indicates that the area has begun to be polluted [13].

The substrate acts as a living habitat for macrozoobenthos. The bottom substrate of estuary waters generally has mud and clay types. The substrate in the form of mud shows that the estuary area has a fairly high sedimentation rate. This sediment comes from the upstream area of the river that carries eroded land material downstream. In addition, it can also be caused by the presence of fairly high abrasion, contributing to sediment carried to the estuary [14]. In addition, the content of organic matter has a very close relationship to the abundance of macrozoobenthos as a source of nutrients [15]. Sandy sediments generally contain less organic matter than mud sediments because muddy bottoms tend to accumulate organic matter carried by water flows [16]. The content of the total suspended solids also affects aquatic life because sunlight entering the waters is blocked by this suspension so that photosynthesis conducted by phytoplankton is disturbed [17]. If the content of organic matter in the substrate shows a value of > 35%, then the sediment has very high organic matter [18]. Current velocity also determines the type and volume of sediment found on the riverbed. Current velocity has a significant effect in determining the distribution of the type of bottom particle or river rock [7].

This study aims to calculate the community structure of macrozoobenthos and the water quality in the Ogan River around Baturaja City.

2. Materials and Methods

Research Design

In this study, the researchers used a direct survey method conducted on the Ogan River. Determination of sampling points and sample collection was carried out using the purposive sampling method at five stations with each station having 5 sampling points. Furthermore, 25 samples were taken at each sampling point in the field. It was continued by measurements of environmental parameters through morphological observation and identification in the laboratory.

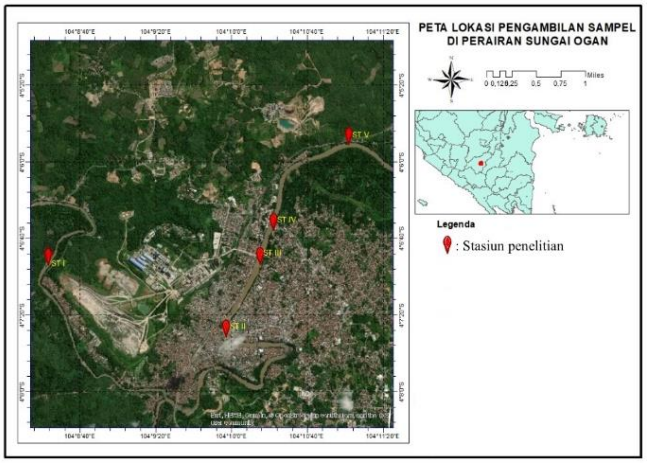

Figure 1. The Map of Research Location

Determination of Sampling Points

The sampling points were chosen by considering the utilization of the river with expectations and the relationship between environmental factors and the community of macrozoobenthos. In some places, there are buildings, such as cement factories, hospitals, and residential areas. Sampling was done by purposive sampling method, which is based on the consideration of the area that represents the research location. Sampling was carried out at five stations with each station consisting of 5 sampling points which were determined based on differences in microhabitat, namely rocky, gravel, sandy, and litter conditions around the edge of the vegetation.

1. Station I : Located in Batu Kuning Village which is the upstream part of the river around Baturaja city with unspoiled vegetation types. The type of substrate is rocky and gravel. The distance between station I and station II is ± 5 km.
2. Station II : Located in the Ogan Bridge 1 which is the area of the General Hospital and City Park with a densely populated area. The type of substrate is rocky and gravel. The distance between station II and station III is ± 1.5 km.
3. Station III : Located in the Ogan River area where there is a cement factory industrial activity. The type of substrate is gravel and sandy. The distance between station III

and station IV is ± 1 km.

4. Station IV : Located in the Ogan Bridge 2 which is a densely populated area and has many community activities. The type of substrate is gravel and sandy. The distance between station IV and station V is ± 2 km.
5. Station V : Located in Tanjung Kemala Village which is the downstream part of the river around Baturaja City where this area still has natural vegetation types. The type of substrate is gravel and sandy.

Data Analysis

Density of Macrozoobenthos

The density of macrozoobenthos is based on the number of individuals per unit area, calculated using the following formula (Soegianto, 1994).

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

Where:
D : density (ind/m^2)
ni : number of Individuals obtained
A : area of observation (m^2)

Diversity Index

The species diversity index (H') of macrozoobenthos is calculated based on the Shannon-Wienner formula (Krebs, 1985), as follows.

$$H' = -\sum Pi \ln Pi$$

Where:
Pi : ni/N
ni : the number of individuals of each type
N : total number of individuals

Criteria: Krebs (1985) in Barus (2002).
H' < 1 : the diversity is low.
1 ≤ H' ≤ 3 : the diversity is medium.
H' > 3 : the diversity is high and the ecosystem is stable.

Uniformity Index

To determine the community uniformity between stations, the researchers used the following formula (Odum, 1996).

$$S = \frac{2C}{A+B}$$

Where:
A : number of species in sample A
B : number of species in sample B
C : number of the same species in both samples

3. Results and Discussion

Density of Macrozoobenthos

The density of macrozoobenthos can be seen in Figure 3. The obtained average density value was 598-1367 ind/m^2, in which the highest total density was found at station IV, while the lowest was found at station V. The high-density value at station IV is presumed because this station has various types of substrates, namely rocky, gravel, sandy, and litter conditions around the edge of the vegetation. Overall, the most common order was the Mesogastropod order found on rocky, gravel, and sandy substrate types.

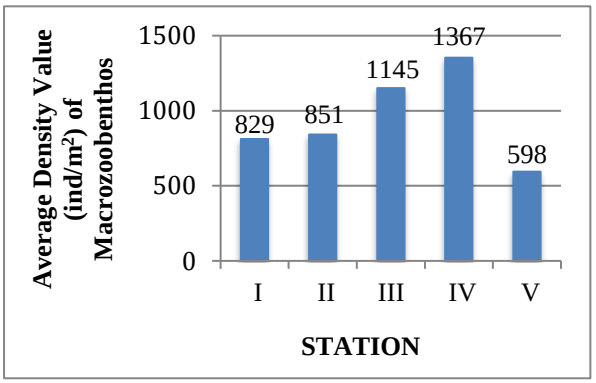

Figure 2. Bar Graph of Average Density (ind/m^2) of Macrozoobenthos in Five Stations in the Ogan River around Baturaja City

Gastropods are most commonly found on sandy substrates and other substrates around the edges of vegetation. According to Barnes (1987), what determines the abundance and composition of macrozoobenthos is the basic substrate structure. Odum (1996) also explains that the basic substrate or soil texture is the main component for the life of organisms. The high density of macrozoobenthos at station IV is presumed due to the high organic content of the substrate that is very supportive for the growth of macrozoobenthos because the organic substrate which becomes their food is quite available. In addition, Nybakken (1988) states that several ecological factors (e.g., adaptability and substrate that supports life) also affect the density of a species. According to Odum (1996), a substrate rich in organic matter is usually supported by an abundance of deposit feeder fauna, such as snails or gastropods. Macrobenthos, which have deposit-eating digging natures, such as gastropods, tend to be abundant in mud sediments and soft sediments which are areas that contain high organic

matter (Fajri, 2013).

Station V was the station with the lowest density value of all stations, namely 598 ind/m^2. This is presumed to occur due to the disruption of the physical condition of the riverbed substrate. According to Mulia & Sri (2015), the type of basic substrate also determines the number and types of benthic animals in a water body. Any disturbance to the physical condition of the riverbed substrate will affect the organisms found in the water body and can also affect the quality of the water.

Based on the results of the measurement of the macrozoobenthos density in five stations at the Ogan River around Baturaja City, the water quality of this river is still relatively good. This is because there is still abundant macrozoobenthos. As widely known, macrozoobenthos are bioindicators that can provide information about the status of water quality in a water body. The decline in river quality can affect the lives of macrozoobenthos. The quality of water and its living substrate is very important. Macrozoobenthos are also very sensitive and intolerant to environmental changes (Wilhm, 1975).

Diversity of Macrozoobenthos

The diversity value that has been obtained at the five stations is classified as moderate. The diversity index value on the Ogan River around Baturaja City ranges from 1.117 to 2.22. The results of a study conducted by Putri (2013) on the Ogan River showed that the diversity index ranged from 1.09 to 2.36 with the highest value being at station III and the lowest being at station IV. It shows that the diversity index value in 2013 and 2022 is not too different. The diversity index of the five stations does not show a very significant value. According to the Shannon-Wiener category in Fachrul (2007), the ranges of the diversity index value are H' < 1 (indicating low diversity), 1 ≤ H' ≤ 3 (indicating moderate diversity), and H' > 3 (indicating high diversity).

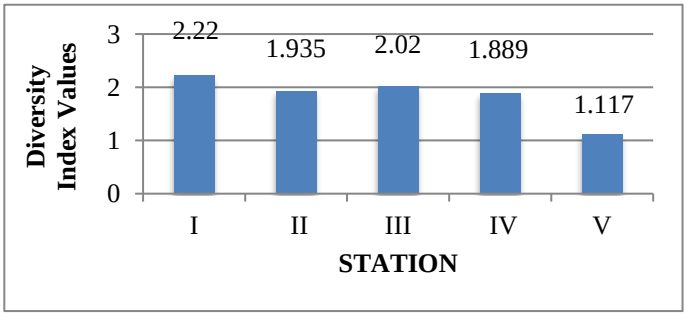

Figure 3. Graph of Total Macrozoobenthos Diversity Index at Each Station on the Ogan River around Baturaja City

The highest diversity index was found at station I, indicating a score of 2.22. This is presumably because station I is dominated by the rocky substrate type in which macrozoobenthos species are mostly found in this type of substrate which is the best place for macrozoobenthos to take shelter from strong currents by attaching themselves to the rocks.

The lowest diversity index value was found at station V, namely 1.117. The low diversity value of this station is presumed due to the unsupportive substrate type for macrozoobenthos. The type of substrate at this station is predominantly sandy. According to Ulfah (2012), sandy substrates tend to make macrozoobenthos easier to shift and move to other places, especially for the gastropod class. According to Odum (1996), a low level of diversity indicates that the distribution of individuals of each species tends to be uneven and the condition of community stability tends to be low. This is due to the smaller number of species and the presence of several individuals whose numbers are greater, resulting in an ecosystem imbalance that may be caused by disturbances from the surrounding environment.

From the five research stations, water insects of the order EPT (Ephemeroptera, Plecoptera, and Trichoptera) were found in abundance. This indicates that the water quality of the Ogan River around Baturaja City is classified as very good. Ephemeroptera, Plecoptera, and Trichoptera (EPT) are insect orders that are most sensitive to environmental changes in waters. According to Odum (1996), rocky or gravel substrates usually produce a large variety of benthic organisms. In addition, the rocky substrate also indirectly affects DO. The high DO in the waters is one of the factors that cause a large number of EPT individuals to be found.

The obtained data from the five stations presented that the composition of the high EPT order density is directly proportional to the diversity index. In this case, it is in high upstream and low downstream. In addition to these physical and chemical conditions, heterogeneity and high vegetation cover on the riverbanks are two of the factors that lead to the abundance of EPT insects. According to Arisandi (2012), the number of aquatic insects found is directly proportional to the level of heterogeneity of the vegetation that grows around the river because the fallen leaves from various vegetation will become a varied food source for aquatic insects. In addition, the dense vegetation cover on the banks of the river will reduce the air temperature and river water temperature.

Community Uniformity Index

From the data obtained, the percentage value of the five stations is between 42% and 75%. The lowest community uniformity index was found in stations III and V, namely

42%. This value is based on the difference in substrate types between the two, in which station III has five different types of substrates, while station V only has three types of substrates.

Table 1. The Uniformity Index Values of the Makrozoobentos Community in the Five Stations on the Ogan River around Baturaja City

Station	II	III	IV	V
I	75%	50%	69%	57%
II		50%	66%	52%
III			58%	42%
IV				62%

Overall, all the uniformity index values obtained indicate that the community uniformity in the five stations reaches 50%, except for stations III and V, which are only 42%. It shows that the macrozoobenthos community in the waters of the Ogan River around Baturaja City is relatively the same. A community can be considered to be relatively close to the same if the community uniformity index value reaches ≥ 50%. The high value of the community uniformity index from the five stations is presumed because the five stations have substrate types that are not much different, in which the more diverse the microhabitat is, the higher the species diversity will be.

4. Conclusion

The results of this study showed as follows.

1. The results of this study indicated that the macrozoobenthos found came from 6 classes, 12 orders, 21 families, and 30 genera. The highest composition was found at station IV (29 types), then followed by stations I and III (26 types), station II (22 types), and station V (16 types).
2. Station IV occupied the highest individual density (i.e., 1,367 ind/m^2), sequentially followed by station III (1,151 ind/m^2), station II (842 ind/m^2), station I (811 ind/m^2), and station V as the lowest (598 ind/m^2). The distribution of data between stations I, II, III, IV, and V had a normal relationship and there was no significant difference.
3. The diversity index value in the Ogan River around Baturaja City ranged from 1.117 to 2.22. The five stations had diversity classified in the medium category.
4. The community similarity index of the five stations reached 50%, except for stations III and V. It indicates that the macrozoobenthos communities in the waters of the Ogan River around Baturaja City are relatively the same.
5. The composition of the obtained density value of the EPT orders as a bioindicator of clean water indicated that the quality of the waters of the Ogan River around Baturaja City is better upstream. On the contrary, if getting downstream, the quality will be less good.

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