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# COMMUNITY STRUCTURE OF MACROZOOBENTHOS AS AN INDICATOR QUALITY OF COASTAL WATERS IN TANAH MERAH VILLAGE

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## ABSTRACT

This research was conducted in January 2022 in the coastal waters of Tanah Merah Village and at the Marine Biology Laboratory and Marine Chemistry Laboratory, Department of Marine Science, University of Riau. The purpose of the study was to analyze the structure of macrozoobenthos communities in the coastal waters of Tanah Merah Village which includes the type, abundance, diversity, uniformity, dominance index, and similarity of communities. As supporting data in this study, several environmental parameters were also measured which included water quality, sediment type, and sedimentary organic matter content. The research method used is the survey method, where sampling using the squared transect method is carried out at 3 stations. Based on the results of the study found 13 species of macrozoobentos. A species that is found at all stations is *Nerita articulate.* The abundance of macrozoobenthos is 12,300 ind/ha. The diversity index value (H') of 1.42, indicates a moderate category, namely water quality is still maintained, a uniformity index (E) of 1.66, is classified as a high category, namely water quality is still supportive for macrozoobenthos life, the dominance index (C) 0.17, is included in the low category. In the community similarity index between I and II, 25% of types are not the same, inter-station I and III 43% of types are almost the same, and inter-station II and III 16% of types are not the same. Water quality parameters are as follows: temperature 27-29$^{o}$C; salinity 30-31 ppt; pH 6-7; DO 3.6-7.6 mg /l. Sedimentary organic matter 4.47-23.53%, muddy sediment type. Based on the value of the aquatic quality biological index at the research site, it is still in good condition.

**Keywords:** Community Structure, Makrozoobenthos, Tanah Merah Village

## 1. INTRODUCTION

Community structure has several ecological indices including diversity index, evenness index, and dominance. These indices are interrelated and influence each other[1]. Macrozoobenthos are organisms that live on the bottom of the waters that can be used to see the water quality in a body of water because benthos cannot move widely so they are less able to avoid the effects of sediment and other pollutants that reduce water quality. Macrozoobenthos are key in the food web because in aquatic systems macrozoobenthos function as predators, detritivores, and parasites. This makes macrozoobenthos a good indicator to determine water quality.

The condition of the waters in Tanah Merah Village at this time has experienced a lot of pollution caused by community activities such as transportation, factories, and the bad habits of people who make the sea a final waste disposal site. Activities such as the following result in polluted waters where the pollution enters the aquatic environment then dissolves in water and accumulates in sediments over time the water quality deteriorates. Pollutants enter

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the body of aquatic organisms mostly through the food chain and then marine organisms are consumed by humans, thus adversely affecting humans.

Research on macrozoobenthos community structure as an indicator of water quality in various regions has been widely conducted including Meisaroh et al.[2] in Serangan Beach, Bali Province. Fisesa et al.[3] in Belumai River, Deli Serdang Regency, North Sumatra Province and Siahaan et al.[4] on Lekang Island, Belakang Padang District, Batam City, Riau Islands Province. Seeing the condition of the waters in Tanah Merah Village which is experiencing pollution caused by various community activities, besides that, there has been no research on the structure of the macrozoobenthos community as an indicator of water quality, therefore the authors are interested in conducting research on the structure of the macrozoobenthos community as an indicator of water quality in Tanah Merah Village.

## 2. RESEARCH METHOD

### Time and Place

This research was conducted in January 2022 in the coastal waters of Tanah Merah Village (Figure 1) and in the Marine Biology Laboratory and Marine Chemistry Laboratory of the Department of Marine Science, Universitas Riau.

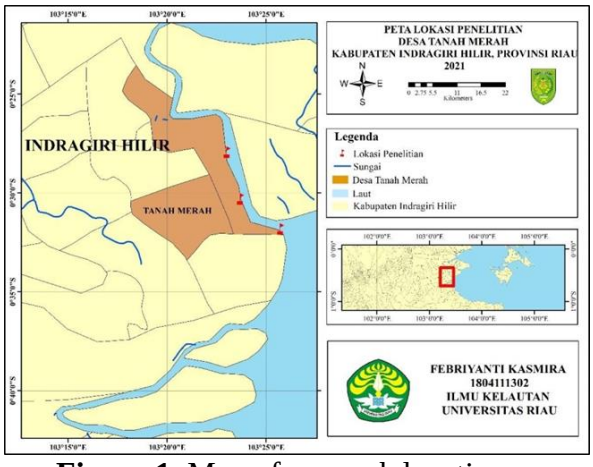


**Figure 1.** Map of research locations

### Methods

The method used in the study was the survey method, which is a direct observation of the study area and conducts sampling and measurement of water quality parameters in the field. Parameters measured include macrozoobenthos species, abundance, diversity, uniformity, dominance index, and community structure. Then supporting data such as water temperature, salinity, acidity, dissolved oxygen, total organic matter, and sediment fraction. Then the samples were identified and analyzed at the Marine Biology Laboratory, Department of Marine Science, Faculty of Fisheries and Marine Sciences, Universitas Riau.

### Procedure

The determination of the research station was chosen by considering the use of waters to represent the research area and there is a relationship between environmental factors and benthic animal communities. The sampling location is determined to be 3 stations, for station 1 is located in Tanah Merah Village where in this area there is a PT. Pulau Sambu this factory does a lot of activities related to the waters of Tanah Merah Village. Station 2 is located on the border between Tanah Merah Village and Kuala Enok Village where these waters are far from residential areas so that the activities carried out in these waters are few. Then station 3 is located in Tanah Merah Village, where this area is an area away from residential areas. Each research station is divided into three sub-zones, namely: 1) upper intertidal zone, 2) middle intertidal zone, and 3) lower intertidal zone (Figure 2).

Water quality parameters measured were temperature, pH, DO, and salinity. Each research station has 3 transects, each transect consists of 3 plots with a quadrat size of 5 x 5 $m^2$ and subplots measuring 1 x 1 $m^2$ with a distance between zones of 20 m and a distance between transects of 50 m. Each sample found on the surface of each

quadrat plot was picked up, while those in the substrate were dug ± 10 cm deep.

In this study, sediment samples were also taken to measure organic matter and sediment fraction. Sediment samples were taken using a 10 cm diameter pipe that was stuck with a depth of 10 cm.

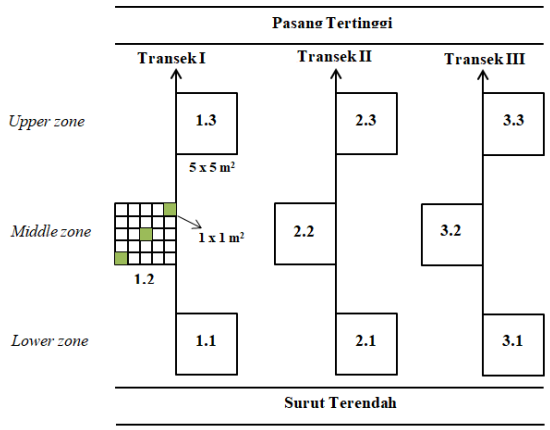


**Figure 2.** Schematic of the quadratic mapping

## Data Analysis

Samples obtained in the field were brought to the laboratory and then cleaned, grouped, and identified based on the form obtained using the identification book Sidik et al.[5] in the Marine Biology Laboratory. Furthermore, the number of species obtained was counted, then analyzed and calculated.

## Abundance

Macrozoobenthos abundance was calculated using the formula according to Fachrul[6] as follows:

$$Di = ni/A$$

Description:

At = The abundance of the i-th individual species (ind/$m^2$)

$ni$ = Number of individuals of the i-th species obtained

A = Plot area of the i-th species found ($m^2$)

## Diversity Index

The diversity index was calculated using the Shanon-Wienner index[7].

$$H' = -\sum_{i-1}^{s} pi\ (\ln pi)$$

Description:

H' = Diversity index

pi = ni/N

ni = Number of individuals of all species

N = Total number of individuals of all species

s = Number of species

## Uniformity Index

The uniformity index can be calculated using the Shanon-Wiener formula[7] as follows:

$$E = \frac{H'}{H'max} = \frac{H'}{\ln (s)}$$

Description:

E = Uniformity index

H' = Shannon-Wiener diversity index

S = Number of species

## Dominance Index

The dominance index was calculated using Simpson's formula[7].

$$C = \sum_{i=1}^{s} (ni/N)^2$$

Description:

C = Simpson's dominance index

ni = Number of individuals of each species

N = Total number of individuals of all species

s = Number of species

## Community Similarity Index

Community similarity between stations was calculated with a community similarity index based on the Sorensen formula[8] as follows:

$$S = \left(\frac{2C}{A+B}\right) \times 100\%$$

Description:

A = Number of species at location 1

B = Number of species at location 2

C = Number of the same species at both sites

S = Index of similarity between two communities

**Sediment Fraction and Total Organic Matter**

Two methods were used to analyze the sediment fraction, namely the wet sieving method and the pipette method. The graded sieve method was used to obtain Ø-1 - Ø4, while for the pipette method, a volumetric pipette was used to obtain Ø5-Ø7. To analyze the type of sediment fraction, Rifardi[9] was used.

The concentration of total organic matter in the sediment was carried out with the formula referring to Heiri et al.[10] as follows:

$$BOT = \frac{(Wt-C)-(Wa-C)}{Wt-C} \times 100\%$$

Description:

Li = Organic Material

Wo = Weight after drying at 105°C / before burning (g)

Wt = Weight after combustion at 550°C (g)

The environmental parameters measured in this study are chemical and physical, while the physical parameters measured are temperature, salinity, and the chemical parameters measured are pH.

Macrozoobenthos community structure data was obtained in the form of calculations using Microsoft Excel and presented in the form of tables and graphs. Then conducted way ANOVA test using Statistical Program for Social Science (SPSS).

## 3. RESULT AND DISCUSSION

**Water Quality**

The measured water quality parameters include physical parameters (temperature and salinity) and chemical parameters acidity (pH) and dissolved oxygen (DO) which are useful to see how the water conditions in Tanah Merah Village at the time of the research. The results of the measurement of water quality parameters can be seen in Table 1.

**Table 1.** The average quality of coastal waters of Tanah Merah Village

| Parameters | Station | | | Quality Standard |
|---|---|---|---|---|
| | I | II | III | |
| Temperature (°C) | 27 | 28 | 29 | 25-36 |
| Salinity (ppt) | 30 | 30 | 31 | 18-32 |
| pH | 6 | 6 | 7 | 6,5-8,5 |
| DO (mg/l) | 7,6 | 3,6 | 7,2 | > 5 |

The measured temperature is worth about 27-29$^{o}$ C and can be said to be the temperature at each research station that can support the life of macrozoobenthos. This is in line with the opinion of Pelealu et al[11], macrozoobenthos can live at a temperature range of 25-36ºC, with these temperatures the waters can be said to be suitable for the survival of macrozoobenthos. Salinity at the research site ranged between 30-31‰, the range of salinity measured is still feasible for the survival of macrozoobenthos. According to MENLH[12], the quality standards of seawater salinity range for marine biota is 18-32‰.

Measurement of acidity (pH) at each research station ranging between 6-7 indicates the abundance of macrozoobenthos organisms. Some marine biotas are sensitive to changes in pH. According to MENLH[12], the quality standards of seawater acidity degree range (pH) 6.5-8.5. The results of dissolved oxygen measurements at each research station obtained values in the range of 3.6 - 7.6. According to MENLH[12]. In the year 2004, the quality standard of seawater range of DO values that is good for marine biota is > 5.

**Macrozoobenthos Species**

Based on the data obtained, several types of macrozoobenthos in the coastal waters of Tanah Merah Village were obtained 13 species from three research stations, namely *Anadara granosa, A.antiquate, Cerithidea cingulate, C.rhizoporarum, Nerita articulate, Trebralia sulcate, Littoraria melanostoma, L.scabra, Metopograpus frontalis, Assimineidae, Chicoreus capucinus, Olivella plana, Telescopium telescopium. N.articulate* is the most species found from all research stations; this is because the substrate at the research site dominates mud and is close to mangroves.

According to Nayak et al. *in* Wahyuni et al.[13], *N.articulate* likes the type of waters that have muddy substrates and rocky areas around the edge of mangrove forest waters. Neritidae is one of the families of the gastropod class. The Neritidae family is a source of energy for the surrounding environment, the presence of this family in the waters can be a source of animal protein sourced from aquatic areas[14].

**Macrozoobenthos Abundance**

The value of macrozoobenthos abundance varies at each station. The highest value of macrozoobenthos abundance at station III is 19,300 Ind/ha and the lowest abundance at station II is 4,100 Ind/ha. The presence of physical and chemical factors is thought to be a factor in the high abundance at station III, namely the muddy substrate which is the habitat of macrozoobenthos, and temperature, pH, salinity, and DO are categorized as good to support the life of macrozoobenthos. The low value of macrozoobenthos abundance at station II is thought to be a social factor. From observations in the field that there are community activities that dispose of household waste directly into the waters, this causes the low abundance of macrozoobenthos at station II. The abundance of macrozoobenthos at each observation station in the coastal waters of Tanah Merah village is presented in Figure 3.

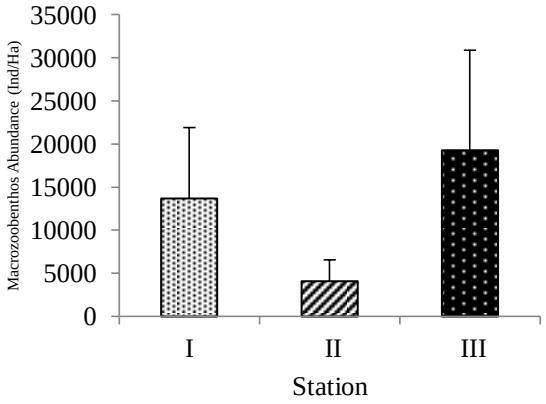


**Figure 3.** Average abundance of macrozoobenthos

The value of macrozoobenthos abundance in the coastal waters of Tanah Merah Village is low compared to other coastal waters or intertidal waters. Compared to research conducted by Meisaroh et al.[2] in Makbon District coastal waters of 46,800 Ind/ha, research by Rosdatina et al.[15] in the waters of Penyengat Island, Kepulauan Riau of 42,000 Ind/ha. This is thought to be the influence of community activities that are directly related to the sea, both utilizing marine products for daily life and disposing of waste.

Abundance in each subzone, in subzone I has the highest abundance of 15,500 ind/ha, while the lowest abundance in subzone II and III is 10,700 ind/ha. According to Nurachmi *in* Choirudin et al.[16], macrozoobenthos is closely related to the availability of organic matter in the substrate, in general, organic matter in the substrate becomes a source of nutrients for biota. However, the high content of organic matter is not always favorable for aquatic bottom organisms; it will result in blockage of the respiratory apparatus[17].

The results of the measured index parameters can be seen in Table 2.

**Table 2**. Index value parameters

| Value index | Observation Location | | | |
|---|---|---|---|---|
| | St I | St II | St III | Research Location |
| Diversity | 1,3 | 0,9 | 2,00 | 1,42 |
| Uniformity | 0,8 | 0,8 | 0,90 | 1,66 |
| Dominance | 0,3 | 0,4 | 0,15 | 0,17 |

The results of the macrozoobenthos diversity index value of the 3 stations range between 0.92-1.99. Station III has the highest diversity index of 1.99%, it is thought to be due to the many species of macrozoobenthos found. The lowest diversity index is found at station II at 0.92%, it is thought that the number of species obtained is less than at stations I and III.

Overall, the value of the macrozoobenthos diversity index between stations is different. The value obtained is greater than the results of research conducted by Safitri et al.[18] in the waters of Senggarang Besar Tanjung Pinang City which ranged between 0.93-1.94. According to Rijaluddin et al.[19], the low value of the macrozoobenthos diversity index illustrates the level of heavy pollution by domestic waste accumulated into the waters; besides that macrozoobenthos diversity is also influenced by the capture of macrozoobenthos by the community and the factors of predation, competition, and a more complex niche.

Based on the diversity index criteria, it can be concluded that the diversity of macrozoobenthos in the coastal waters of Tanah Merah Village is categorized as moderate where the index value of $1 \leq H' \leq 3$ indicates that, the diversity of macrozoobenthos species is moderate, productivity is sufficient, ecosystem conditions are quite balanced, moderate ecological pressure.

The diversity of macrozoobenthos in the coastal waters of Tanah Merah Village is supported by the quality of coastal waters of Tanah Merah Village where the values of temperature, salinity, pH, and dissolved oxygen (DO) are in line with the quality standards of seawater for the growth of marine biota according to MENLH[12].

The results of the lowest macrozoobenthos uniformity index value at station I and station II is 0.83. The highest macrozoobenthos uniformity index at station III is 0.90; of the three research stations macrozoobenthos uniformity index in the coastal waters of Tanah Merah Village is $0.6 \leq E \leq 1.0$ which shows that the uniformity is high. It is suspected that the type of macrozoobenthos found at each station no type dominates. This indicates that the water quality in the waters of Tanah Merah Village is still in good condition.

The uniformity index value is greater than the research conducted by Meisaroh et al.[2] which ranges between 0.60-0.81. Station III has a high category because the value of E is closer to 1, which means that the evenness between species is relatively even or the number of individuals of each species is relatively the same. According to Budi et al.[20], the uniformity index value is thought to be good for determining the dominance of an aquatic environment. If there are one or several species that are abundant, the uniformity index value will be low.

Based on the Krebs[7] uniformity criteria, it can be concluded that the category of uniformity index (E) in macrozoobenthos in coastal waters of Tanah Merah Village is in the high category where the index value of $0.6 \leq E \leq 1$ indicates the uniformity of species in coastal waters of Tanah Merah Village is high or evenly distributed with a relatively equal number of individuals of each type.

The dominance index value obtained from the analysis in the coastal waters of Tanah Merah Village ranges between 0.15 - 0.32, it can be categorized as no dominating species from the three stations because C is close to 0 (zero) in line with Odum's statement Walbet et al.[21]. A low dominance index identifies that the ecosystem has a population balance. Population balance can be said that the ecosystem has not been polluted. This value is smaller than the

dominance value in the research of Walbet et al.[21] on Gosong Beach, Sungai Raya Islands District, Bengkayang Regency, West Kalimantan, which is in the range of 0.430-0.679.

The value of the species diversity index is inversely proportional to the dominance index, if the species diversity index is low, then at the study site there is no dominant species and vice versa. The value of water quality parameters at the research site is categorized as feasible to support the growth of macrozoobenthos by the quality standards of seawater for the life of marine biota, according to MENLH[12].

**Community Similarity Index**

The highest similarity index value is found at stations I to III which is 43% with almost similar species, while the lowest value is found at stations II to III which is 16% with no similar species. The similarity index value can be said to be high if close to 100%, for low similarity index value if close to 0 (zero). The similarity index of macrozoobenthos communities in the coastal waters of Tanah Merah village can be seen in Table 3.

**Table 3**. Macrozoobenthos community similarity index in coastal waters of Tanah Merah Village

| Station | CSI (%) | Similarities |
|---|---|---|
| I against II | 83 | High |
| I against III | 15 | Low |
| II against III | 17 | Low |

The high value of the macrozoobenthos similarity index at stations I and III is thought to be an environmental factor, one of which is the same type of substrate, namely mud. So that the types of species of organisms found are almost similar. The smooth substrate is more likely to be able to accumulate organic matter so that a lot of food can support the growth of macrozoobenthos. Mud sediments are generally rich in nutrients.

According to Purnami et al.[22], a similarity index is a form of biological index that can show how much the level of similarity of community structure in an ecosystem. The low value of the macrozoobenthos similarity index at each station is due to differences in physicochemical factors. The low value of similarity can be caused by relatively extreme environmental conditions so that the types of macrozoobenthos that can survive are limited[23].

**Macrozoobenthos as an Indicator of Aquatic Quality**

Macrozoobenthos have been analyzed for abundance, diversity, uniformity, dominance, and community similarity, as well as data on environmental parameters such as temperature, salinity, pH, DO, organic matter, and sediment fraction. The analysis results show the relationship of macrozoobenthos community structure with water quality in line with the condition of the study site, where the status of water quality at stations I and III is not polluted and at station II is lightly polluted.

Water quality parameters that affect the value of macrozoobenthos abundance at the study site are temperature, pH, salinity, DO, BOT, and sediment fraction which is in line with the quality standards of seawater for the life of marine biota, according to MENLH[12]. The relationship between the value of total organic matter (BOT) and the abundance of macrozoobenthos has a very strong relationship. The value of good total organic matter (BOT) is 0.01-30 mg/l, according to MENLH[12]. High abundance due to the content of organic matter in the sediment.

The diversity value at the study site is 1.42. Macrozoobenthos diversity is closely related to temperature, salinity, and pH. The relationship between water quality parameters of temperature, salinity, and pH with macrozoobenthos diversity is showing a low relationship, this is indicated by the difference in temperature values are not

much different from the three research stations so as not to affect the level of macrozoobenthos diversity.

The value of macrozoobenthos uniformity at the study site is 1.66. Macrozoobenthos diversity affects the value of macrozoobenthos uniformity in which the relationship is inversely proportional; if the value of diversity is high then the value of uniformity is low. In addition, the value of macrozoobenthos diversity is inversely proportional to the value of dominance. If the value of species diversity is low, then at the study site there is no dominant species, and vice versa.

The similarity value at the study site ranges from 16-43% which is classified in the category of not similar - almost similar. The low value of macrozoobenthos similarity is thought to be the influence of physical and chemical factors that are relatively extreme for the life of macrozoobenthos

## 4. CONCLUSION

Based on the research that has been done, the type of macrozoobenthos found in the coastal waters of Tanah Merah Village consists of 13 (thirteen) species from three research stations *A.granosa, A.antiquate, C.cingulate, C.rhizoporarum, N. articulate, T.sulcate, L.melanostoma, L.scabra, M.frontalis, Assimineidae, C. capucinus, O.plana, T.Telescopium. N.articulate*. The most abundant species found was *N.articulate*. The value of the diversity index (H') in the study site is macrozoobenthos diversity is closely related to temperature, salinity, and pH, showing a low relationship, this is indicated by the difference in temperature values are not much different from the three research stations so as not to affect the level of macrozoobenthos diversity. The value of the uniformity index (E) is high and the value of the dominance index (C) there is no dominant species. The similarity index of macrozoobenthos station I to station II is the same as station II to station III with unequal species and station I to station III with less similar species, the low value of macrozoobenthos similarity is thought to be the influence of physical and chemical factors that are relatively extreme for the life of macrozoobenthos. Based on the value of the biological index that has been associated with water quality can be concluded that the water quality at stations I and III are not polluted and at station II is lightly polluted.

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