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MACROZOOBENTHOS ABUNDANCE IN BEACH OF TANAH MERAH SAMBOJA KUTAI KARTANEGARA EAST KALIMANTAN

Kelimpahan Makrozoobentos Di Pantai Tanah Merah Samboja Kutai Kartanegara Kalimantan Timur

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ABSTRACT

Samboja beach is one of the coastal areas in Kutai Kartanegara Regency, which has various fisheries and marine resources such as macrozoobenthos. One of the ecological functions of macrozoobenthos is that it is a biological bioindicator in the waters and transfers energy in the food chain. This study aims to determine the type and abundance of macrozoobenthos, sediment texture type, organic carbon, nitrate and phosphate content, sediment type and abundance of macrozoobenthos at Tanah Merah Beach Samboja. Sediment samples were taken at the surface (0-10 cm) by placing quadrant plots on a 120 m long transect line (50x50 cm²). 50 macrozoobenthos species were found, consisting of Gastropoda, Bivalvia and Schapopoda. Macrozoobenthos abundance ranged from 60 to 268 ind/m2. Sequential ecological indices of diversity included the medium category with high uniformity and low dominance. The sediment texture at points near the coast was sandy loam while towards the sea textured sand. Sediment content in organic carbon ranged from 0.41% to 1.18% (very low), nitrate between 6.63 and 16.69 mg/L (high) and phosphate from 29.01 to 71.27 mg/L (high). There was a positive relationship with a moderate correlation between organic carbon and macrozoobenthos abundance. The relationship between nitrate and macrozoobenthos abundance was a low correlation. In contrast, a positive correlation was found between phosphate and macrozoobenthos abundance. Water quality is still normal and supports the survival of macrozoobenthos.

Keywords: Phosphate, Organic Carbon, Macrozoobenthos, Nitrate, Sediment Texture

ABSTRAK

Pantai Samboja merupakan salah satu kawasan pesisir di Kabupaten Kutai Kartanegara yang memiliki berbagai sumber daya perikanan dan kelautan seperti makrozoobentos. Salah satu fungsi ekologis makrozoobentos adalah sebagai bioindikator biologis di perairan dan transfer energi dalam rantai makanan. Penelitian ini bertujuan untuk mengetahui jenis dan kelimpahan

Makrozoobentos, jenis tekstur sedimen, kandungan karbon organik, nitrat dan fosfat, jenis sedimen dan kelimpahan Makrozoobentos di Pantai Tanah Merah Samboja. Pengambilan sampel sedimen dilakukan pada permukaan (0-10 cm) dengan menempatkan plot kuadran pada garis transek sepanjang 120 m (50x50 cm²). Ditemukan 50 spesies makrozoobentos yang terdiri dari Gastropoda, Bivalvia dan Schapopoda. Kelimpahan makrozoobenthos berkisar antara 60 sampai 268 ind/m2. Indeks keanekaragaman ekologi berurutan termasuk dalam kategori sedang dengan keseragaman tinggi dan dominasi rendah. Tekstur sedimen di titik dekat pantai adalah lempung berpasir, sedangkan ke arah laut bertekstur pasir. Kandungan sedimen pada karbon organik berkisar antara 0,41% hingga 1,18% (sangat rendah), nitrat antara 6,63 hingga 16,69 mg/L (tinggi) dan fosfat antara 29,01 hingga 71,27 mg/L (tinggi). Terdapat hubungan positif dengan korelasi sedang antara karbon organik dengan kelimpahan makrozoobentos. Hubungan antara kelimpahan nitrat dan makrozoobentos mempunyai korelasi yang rendah. Sebaliknya, ditemukan korelasi positif antara kelimpahan fosfat dan makrozoobentos.

Kata kunci: Fosfat, Karbon Organik, Makrozoobentos, Nitrat, Substrat Sedimen

INTRODUCTION

Macrozoobenthos is one of the important groups of aquatic organisms in the food web. This group can play a role in recycling organic materials and mineralization in waters. As a result, organic matter in the water column can affect water quality, for example nitrate and phosphate parameters. These two parameters can influence the life of aquatic biota in coastal areas (Yulandari et al., 2019). The existence of macrozoobenthos can also be seen from the bottom substrate of waters which can support the development of aquatic organisms. In addition, the abundance and diversity of macrozoobenthos may depend on varying environmental tolerance and sensitivity to environmental change. Then, several types of aquatic organisms as producers can become a food source for macrozoobenthic organisms and predators which influence the abundance of macrozoobenthic organisms in coastal areas (Gultom et al., 2018).

One of the coastal areas in the East Kalimantan region is Tanah Merah beach, Samboja. This area is well known to the public as a tourist destination. Apart from that, this area is relatively close to several community activities such as settlements, livestock, fisheries, plantations, home industry, mining and coal shipping routes (Noor et al., 2023). The large number of activities is thought to have an influence on changes in water quality and the balance of coastal ecosystems, one of which is macrozoobenthos (Putra et al., 2020).

Basically, research on the abundance of macrozoobenthos has been carried out in several coastal areas of East and North Kalimantan, such as in the Mahakam Delta Estuary (Makri & Supriyadi, 2018), Muara Badak (Mukin et al., 2022) and Tarakan (Taqwa et al., 2013). . However, this research mostly examines macrozoobenthos diversity without relating it to the type of sediment texture, organic carbon and nutrients in the sediment. Based on this, there is a need for research that can provide information and data about the relationship between macrozoobenthos types, sediment texture types, organic carbon and nutrient content in sediments in the Tanah Merah Samboja Beach area, Kutai Kartanegara Regency, East Kalimantan Province.

METHODS

Place and Time

This research was conducted for 3 months from April to July 2023 at Tanah Merah Samboja Beach, Kutai Kartanegara, East Kalimantan (Figure 1).

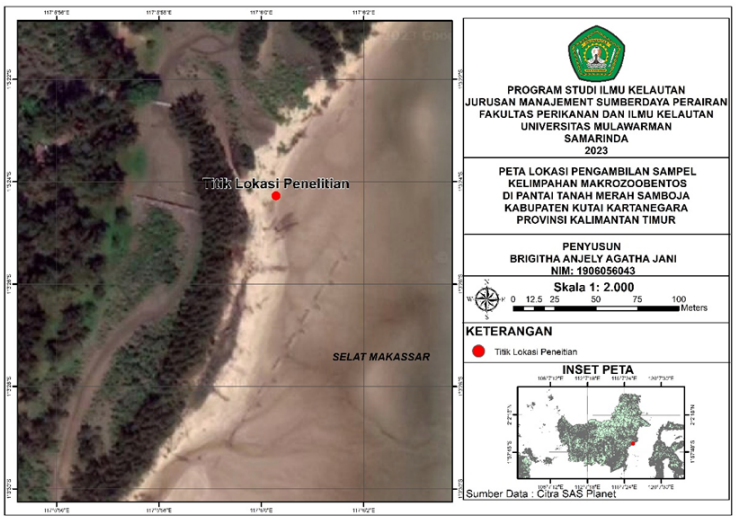

Fig 1. Map of Macrozoobenthos Sampling Locations

Tools and Materials

Some of the tools used include a pH meter, 50x50cm² quadrant, DO meter, refractometer, identification book, artificial filter, meter, cellphone camera, refractometer, marker, shovel, sample holder, cool box and PVC pipe. Materials used include 70% alcohol, distilled water, macrozoobenthos samples, and sediment samples.

Procedure

The research location was carried out at the lowest tide using a modified purposive sampling method according to Alwi et al., (2020). First of all, the 120 m long transect line is divided into 6 points with a distance of about 20 m in a zig zag manner. Macrozoobenthos and sediment samples were taken at points sequentially using a 50x50 cm² square quadrant. Macrozoobenthos samples were taken using 2 methods, namely hand sorting and shoveling sediment on the surface (±10 cm) to obtain submerged macrozoobenthos. Apart from that, the separation process between macrozoobenthos and sediment was also carried out using a simple 1 mm sieve. Then, each macrozoobenthos sample was put into an empty bottle containing a mixture of 70% alcohol and distilled water.

Sediment samples were taken using the coring technique with paralon or PVC pipes to a depth of ± 15 cm, covered with a pipe cover. Macrozoobenthos and sediment samples were put in a cool box before being identified and analyzed further in the laboratory.

Data Analysis

Analysis of the macrozoobenthos abundance index uses several formulas as follows:

Individual abundance, using Odum's (2020) formula:

$$Di = \frac{\sum Ni}{A}$$

Information :
Di = Macrozoobenthos abundance (ind/m^2)
∑Ni = Number of macrozoobenthos on the plot (ind)
A = Transect area (m^2)

Diversity Index (H'), uses the Shannon-Wiener formula based on the formula used by Makri & Supriyadi (2018):

$$H' = \sum_{i=1}^{s} pi \; ln \; pi$$

Infomation :
H' = Species diversity index
Ni = Number of individuals of the type
N = Total number of individuals
Pi (ni/N) = Number of individuals of each type (i = 1,2,3,…)

Diversity index categories:
H' = < 1 = low
1 < H' > = Medium
H' > 3 = high

Uniformity Index (E), using the formula Srigandono et al., (1993):

$$E = \frac{H`}{\text{In S}}$$

Information:
E = Species uniformity index
H' = Species diversity index
In S = Number of types of organisms

Uniformity index category:
E > 0,6 = high
0,4 < E < 0,6 = medium
E < 0,4 = low

Dominance Index (C) uses the Dominance of Simpson formula following the formula of Swary et al., (2020):

$$C = \sum[\frac{ni}{N}]^2$$

Information:
C = Dominance index
ni = Number of individuals of each type
N = Total number of individuals

Dominance index value category:
0 < Di < 0,5 = no one type dominates
0,5 < Di < I = there is a dominating type

Analysis of organic carbon and nutrients (nitrate and phosphate) in sediment was carried out using a spectrophotometer with wavelengths of 560, 460 and 700 nm respectively. The data obtained were processed and analyzed using Microsoft Windows Excel 2019. The relationship between nutrients and organic carbon and macrozoobenthos abundance was analyzed using polynomial regression with a significance value of α=0.05 and a confidence level of 95%. Then, the results of data analysis are presented in the form of pictures and tables which will be studied and explained descriptively.

RESULT

Identification of Macrozoobenthos

The results of the analysis at 6 observation points identified 50 species from 27 families which were divided into 3 classes, namely gastropods, bilvavia and scaphopoda (Table 1). Then, 26 species from 17 Gastropod families were also found, including Strombida, Cerithidae, Olividae, Buccinidae, Trichotropidae, Coniidae, Cypracidae, Costellaridae, Mitridae, Potamididae, Terebridae, Naticidae, Nassaridae, Muricidae, Epitoniidae, Bursidae and Cencellariidae. Apart from that, there are 24 species from 9 Bivalvia families, namely Mactridae, Cardiidae, Chamidae, Veneridae, Arcidae, Tellenidae, Glycymerididae, Noetidae, Solecurtidae. 1 species was found from 1 Scaphopoda family, namely Tusk sheels.

Table 1. Identification description.

No.	Family	Description
1	 *Strombidae*	Strombus haemastoma has a white shell with a conical shell shape and has a small indentation in the cone, there are protrusions on the surface of the shell. The shell is 3.6 cm long and 1.7 cm wide. The following is the classification of Strombus haemastoma*:* *Kingdom : Animalia* *Phylum : Mollusca* *Class : Gastropoda* *Family : Strombidae* *Genus : Strombus* *Spesies : Strombus haemastoma* (Linnaeus, 1758)
2	 *Cerithiidae*	Rhinoclavis kochi has a brown conical tower-shaped shell with irregular white protrusions. Length 1.4 cm and width 0.5. The following is the classification of Rhinoclavis kochi*:* *Kingdom : Animalia* *Phylum : Mollusca* *Class : Gastropoda* *Family : Cerithiidae* *Genus : Rhinoclavis* *Spesies : Rhinoclavis kochi* (Linnaeus, 1758)
3	 *Olividae*	Olivia Sayana, which has a shell measuring 2.2 cm long and 1 cm wide, is brownish white in color and has yellowish spots, while the shape of the shell is tapered. The following is Olivia Sayana's classification*:* *Kingdom : Animalia* *Phylum : Mollusca* *Class : Gastropoda* *Family : Olividae* *Genus : Olivia* *Spesies : Olivia Sayana* (Linnaeus, 1758)

4	 *Mactridae*	Mactra antiquata has an almost symmetrical shell shape, with a slight curve to the left on the surface of the shell, smooth and shiny with a white color. Measures 4.7 cm long and 5.2 cm wide. The following is the classification of Mactra antiquata*:* *Kingdom : Animalia* *Phylum : Mollusca* *Class : Bivalvia* *Family : Mactridae* *Genus : Mactra* *Spesies : Mactra antiquata* (Linnaeus, 1758)
5	 *Cardiidae*	Trachycardium flavum has a rough, wrinkled surface that matches its patterned surface, with a white base color. Measures 3.3 cm long and 3 cm wide. The following is the classification of Trachycardium flavum*:* *Kingdom : Animalia* *Phylum : Mollusca* *Class : Bivalvia* *Family : Cardiidae* *Genus : Trachycardium* *Spesies : Trachycardium flavum* (Linnaeus, 1758)
6	 *Arcidae*	Anadara granosa has a triangular shell shape and the edges of the shell are serrated, grayish white in color. Measures 2 cm long and 2.6 cm wide. The following is the classification of Anadara granosa*:* *Kingdom : Animalia* *Phylum : Mollusca* *Class : Bivalvia* *Family : Arcidae* *Genus : Anadara* *Spesies : Anadara granosa* (Linnaeus, 1758)
7	 *Tusk sheels*	Dentalium aprinum has a small, elongated body shape resembling a tusk, slightly curved and hollow inside. Measures 5.8 cm long and 0.8 cm wide. The following is the classification of Dentalium aprinum*:* *Kingdom : Animalia* *Phylum : Mollusca* *Class : Scapophoda* *Family : Tusk sheels* *Genus : Dentalium* *Spesies : Dentalium aprinum* (Linnaeus, 1758)

Macrozoobenthos Composition

In this research, from point 1 to point 6, the most abundant macrozoobenthos composition was found, namely from the Cerithidae family of the Gastropoda class. Mactridae and Cardiidae from the class Bivalvia. Then, the lowest composition is from the Trichotropidae family from the Gastopoda class, Chamidae from the Bivalvia class and Tusk sheels from the Scaphopoda class (Figure 2).

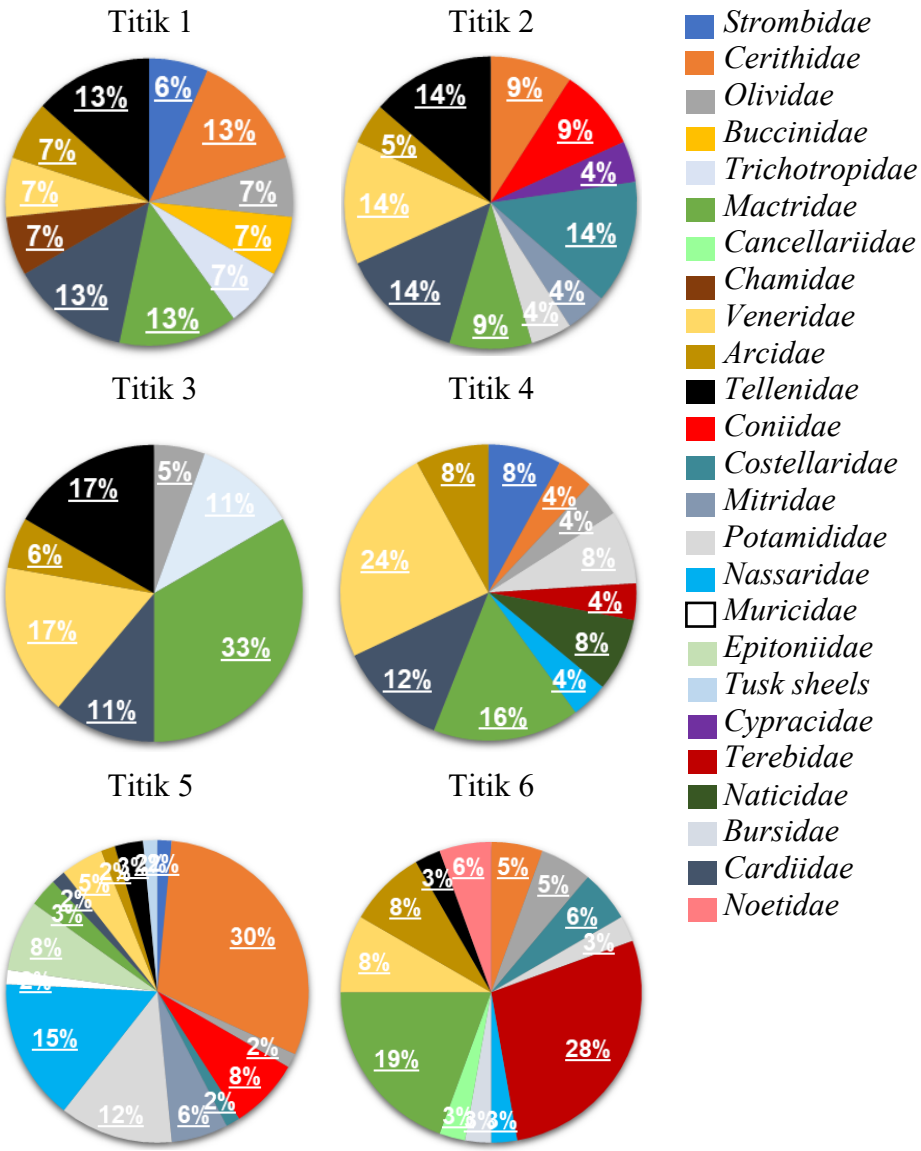

Fig 2. Macrozoobenthos Composition Diagram

Macrozoobenthos abundance

The abundance of macrozoobenthos on Tanah Merah Samboja Beach ranges from 60 to 268 ind/m2. The highest and lowest abundance is found at point 5 (268 ind/m2) and point 1 (60 ind/m2) (Figure 3).

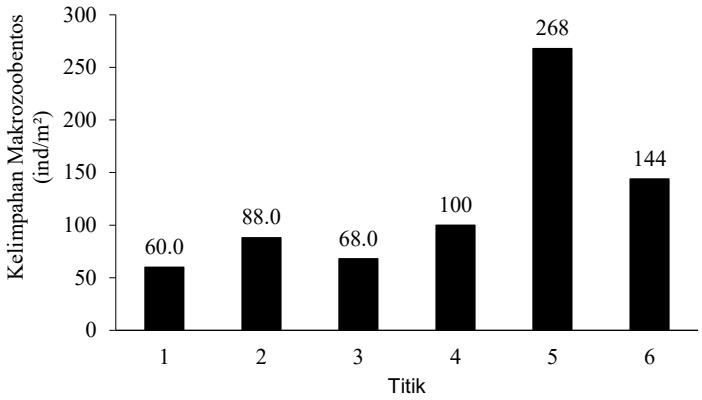

Fig 3. Macrozoobenthos Abundance Graph

Ecological Index

In general, the diversity index (H') value in this study is in the medium category. Then, the uniformity index (E) value is high and the low category is found in the dominance index (C) (Table 2).

Table 2. Diversity Index (H'), Uniformity (E), Dominance (C) Macrozoobenthos.

Point	Index					
	(H')	Category	(E)	Category	(C)	Category
1	2,3384	Medium	0,9752	High	0,1022	Low
2	2,3028	Medium	0,9603	High	0,1074	Low
3	1,9562	Medium	0,8903	High	0,1834	Low
4	2,2134	Medium	0,9231	High	0,1296	Low
5	2,3049	Medium	0,8135	High	0,1459	Low
6	2,2284	Medium	0,8688	High	0,1451	Low

Relationship between Organic Carbon and Macrozoobenthos

In this study, it was found that the value of organic carbon content in sediment was between 0.41% - 1.18% with an average of 0.72%. The mathematical equation for the relationship between organic carbon content and macrozoobenthos abundance is y = y = -129.78x + 245.54. The relationship between these two parameters is positive and has a moderate correlation (r = 0.47) and is not significant (p> 0.05) (Figure 4).

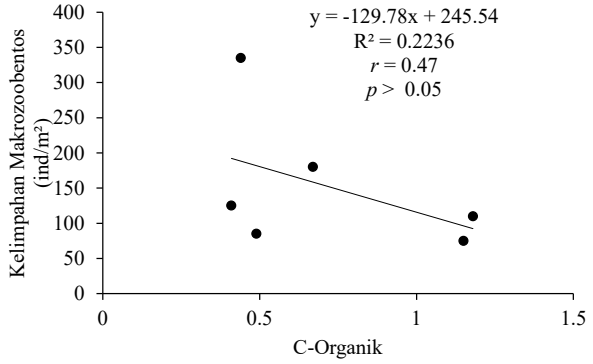

Fig 4. Graph of the Relationship between Organic Carbon and Macrozoobenthos Abundance.

Relationship of Nutrients (nitrate and phosphate) with Macrozoobenthos

The relationship between nitrate content and macrozoobenthos abundance can be represented in the equation y = 6.7086x + 74.351. Nitrate content and macrozoobenthos have a positive relationship and have a moderate correlation (r = 0.26), but not significant (p> 0.05) (Figure 5A). Meanwhile, the relationship between phosphate content and macrozoobenthos abundance can be represented in the equation y = 4.5442x – 39.916. This relationship is included in the positive and strong category (r = 0.72), but not significant (p> 0.05) (Figure 5B).

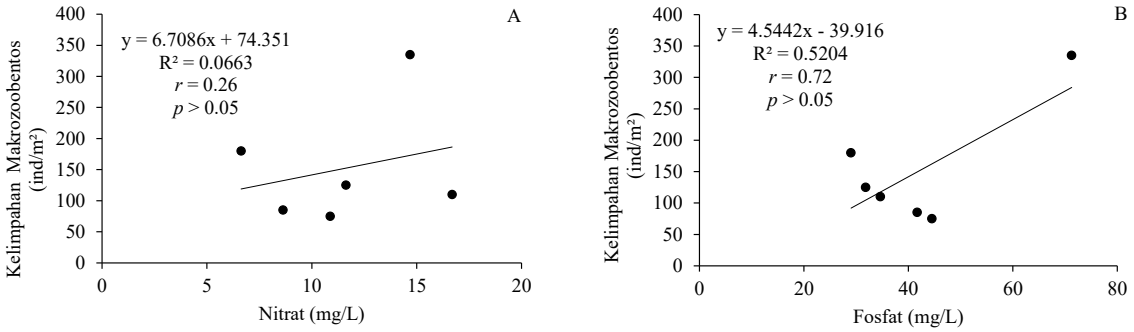

Fig 5. Graph of the Relationship between Nitrate (A) and Phosphate (B) and Macrozoobenthos Abundance.

Water Quality (Physics and Chemistry)

In general, the water quality in this study still complies with water quality standards based on Government Regulation Number 22 of 2021 in Appendix VIII (for marine biota) (Table 3).

Table 3. Water Quality at Tanah Merah Beach, Samboja.

Physical and Chemical Parameters	Mark	Quality Standard Value *
Temperature (°C)	29,0	28-32
Salinity (ppm)	30,0	Natural
pH	8,19	7 – 8,5
DO (mg/L)	6,40	>5

*Government Regulation Number 22 of 2021 in Appendix VIII.

DISCUSSION

Basically, the Gastropoda class in this study has 26 species from 17 families which are widely distributed on rocky, sandy or muddy substrates. However, Gastropods tend to like muddy substrates. This may be influenced by environmental factors such as temperature, salinity and water depth which have an important role in determining the abundance and distribution of Gastropods in waters (Yunitawati et al., 2012). Apart from the Gastropoda class, there is also the Bivalvia class which consists of 24 species from 9 families. Sediment texture is one of the factors that influences the distribution of Bivalves in waters because it is related to the availability of nutrients in the sediment substrate. Some types of Bivalves prefer the texture of sandy mud sediments to breed, while others prefer substrates with a higher percentage of sand because they can provide a lot of oxygen. Likewise, the behavior of shellfish also determines their distribution according to environmental conditions (Syahputra et al., 2017). The Scaphopoda class only has 1 species from 1 family, where the number of species is not as many as other groups. Scaphopods are sensitive to low-oxygen environments and

reproduce less in areas with high concentrations of organic matter. If found in such areas, the species may die or be carried away by currents (Ibrahim, 2019).

Basically, the number and composition of macrozoobenthos in coastal areas can vary depending on how sensitive or resistant they are to environmental fluctuations. Each group of aquatic organisms has a different response due to changes in environmental quality by changing their community structure (Gultom et al., 2018). From point 1 to point 6, the highest Macrozoobenthos composition was found, namely from the Cerithidae family from the Gastropoda class, Mactridae and Cardiidae from the Bivalvia class and the lowest composition was from the Trichotropidae family from the Gastopoda class, Chamidae from the Bivalvia class and Tusk sheels from the Scaphopoda class. The results of this research are different from research conducted by Putra et al., (2020) in that the macrozoobenthos found did not vary or there was one that dominated the waters, namely Cerithium sp. from the gastropod class. This may occur more because substrate factors greatly influence the diversity of macrozoobenthos and the habitat of macrozoobenthos groups.

The highest abundance of macrozoobenthos in this study was found at point 5, namely 268 ind/m2, in the gastropod class Cerithidae family. This may occur due to substrate factors. Based on the results of the analysis, the substrate condition at point 5 is a sand substrate type. This is in accordance with the habitat of the gastropod class which is widespread on rocky, sandy and muddy substrates. The results are in accordance with research conducted by Martuti & Rahmadhani (2023) that it is easier for gastropods to obtain the water and nutrients needed for survival on sandy substrates. On the other hand, the low abundance of macrozoobenthos type point 1 (60 ind/m2) may be more due to the type of substrate found being a muddy sand substrate and thought to contain little oxygen. This result is in line with Fikri (2014) who stated that muddy substrates usually have a low amount of oxygen. As a result, the organisms that live in it must be able to adapt to these conditions.

The organic carbon content in the sediment was found to range from 0.14% to 1.18% with an average of 0.72%. Based on the classification, the percentage of organic carbon content in the sediment found on Tanah Merah Samboja Beach is in the low level category. The low organic carbon content is thought to be due to the difficulty of accumulating organic material in the sediment. Apart from the composition being unsuitable for binding organic materials, it is also caused by currents and waves during ebb and flow. The relationship between organic carbon and macrozoobenthos abundance has a negative trend, has a moderate correlation ($r=0.47$) and is not significant ($p>0.05$). These findings indicate that the higher the organic material, the more macrozoobenthos abundance decreases. This may be due to current patterns that carry organic carbon from land to the waters. Based on the sampling location, points 1 and 2 tend to be high close to land which is influenced by the mangrove ecosystem and then decrease towards the sea. This finding is consistent with the results of the investigation by Barus et al., (2019) that there is a positive relationship between the abundance of macrozoobenthos and organic carbon, although the trend is negative.

Basically, nitrate and phosphate compounds are nutritional elements that can be used as a sign of nutrient richness in aquatic ecosystems. These nutrients usually come from nature, and also come from several human activities from land (domestic and industrial waste) carried by river currents to sea waters (Noor et al., 2023; Saleky et al., 2022). In waters, these compounds can be distributed by hydrooceanography such as tides, currents, waves (Sumantra et al., 2020).

Based on the analysis results, the relationship between nitrate and phosphate and macrozoobenthos abundance is positive, has a weak and strong correlation, but is not significant ($p>0.05$). These findings indicate that nutrient compounds in the form of nitrate and phosphate play an important role in improving the structure of the macrozoobenthic community, thereby increasing the abundance of macrozoobenthic at the research location.

This finding is in accordance with the results of research conducted by Swary et al., (2020) that nitrate and phosphate compounds in waters can increase the abundance of macrozoobenthos in aquatic ecosystems.

Basically, macrozoobenthos relatively settles on certain substrates in the coastal environment. As a result, macrozoobenthos is very sensitive to environmental changes such as water quality and sediment which can affect its abundance, diversity and distribution. The results of measuring several water quality parameters show that all water quality parameter values are still normal and support the life of aquatic biota based on Government Regulation Number 22 of 2021 in Appendix VIII. This finding is relatively similar to the results found by Makri & Supriyadi (2018) on the coast of the Mahakam Delta, that water quality still supports macrozoobenthic life in coastal areas.

CONCLUSSION

Tanah Merah Samboja Beach has 50 species from 36 genera which are divided into 3 classes, namely gastropods, bivalves and scaphopoda. The average abundance of macrozoobenthos on the beach ranges from 60 – 268 ind/m2. The most abundant macrozoobenthos composition is from the Cerithidae family from the Gastropoda class, Mactridae and Cardiidae from the Bivalvia class. Meanwhile, the lowest composition is from the Trichotropidae family from the Gastopoda class, Chamidae from the Bivalvia class and Tusk sheels from the Scaphopoda class. Macrozoobenthos diversity is in the medium category with high uniformity and low dominance. The sediment texture near the beach is clayey sand, while towards the sea it has a sand texture. The sediment content in organic carbon is between 0.41% to 1.18% (very low), nitrate with 6.63-16.69 mg/L (high) and phosphate between 29.01-71.27 mg/L (high). There is a positive relationship with a moderate correlation between organic carbon and macrozoobenthos abundance. There is a low correlation between nitrate and macrozoobenthos abundance. Meanwhile, the relationship between phosphate and macrozoobenthos abundance has a strong correlation. The water quality at Tanah Merah Samboja Beach is still normal and supports the survival of macrozoobenthos.

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