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COMPARISON OF MACROZOOBENTHOS ABUNDANCE BETWEEN COASTAL AND MANGROVE AREAS OF TANJUNG LIMAU KUTAI KARTANEGARA DISTRICT

Perbandingan Kelimpahan Makrozoobentos Antara Wilayah Pantai dan Mangrove Tanjung Limau Kabupaten Kutai Kartanegara

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ABSTRACT

Makrozoobenthos have played an important role in coastal ecosystems, especially in beaches and mangrove areas, as indicators of environmental health and as important components of the food chain. However, the presence of human activities such as industrial waste, households, fisheries and agriculture could affect the abundance of macrozoobenthos in coastal areas. The purpose of this study was to assess and analyze the type, abundance, diversity, uniformity and dominance of macrozoobenthos and sediment substrate conditions in the beach and mangrove areas in Tanjung Limau village, Kutai Kartanegara Regency. This research was conducted from December to March 2024. This research method uses descriptive methods with sampling techniques using purposive random sampling. Macrozobenthos sampling sites were divided into 2 (two) stations. Station 1 was located at beach area, while station 2 was located in the mangrove ecosystem area. The results showed that the abundance of macrozoobenthos in the mangrove area (13 species) was higher compared to the beach (18 species), with groups of snails and bivalves. Abundance at station 1 (43.3 ind/m²) was lower than at station 2 (58.0 ind/m²). The diversity index value at station 1 (2.16) and station 2 (2.57) was classified as moderate. Uniformity at stations 1 and 2 was 0.84 and 0.87 (high category), respectively. Then the dominance index values found at stations 1 and 2 were 0.17 and 0.10 (non-dominant category), respectively. The sediment texture in the coastal area of Tanjung Limau at both stations 1 and 2 is a clayey loam, which is one of the main causes of the differences in macrozoobenthos abundance.

Keywords: Abundance, Macrozoobenthos, Mangrove, Muara Badak

ABSTRAK

Makrozoobentos memiliki peran penting dalam ekosistem pesisir, terutama di pantai dan kawasan mangrove, sebagai indikator kesehatan lingkungan dan komponen penting dalam rantai makanan. Namun, adanya aktivitas manusia seperti limbah industri, rumah tangga, perikanan dan pertanian dapat mempengaruhi kelimpahan makrozoobentos di wilayah pesisir. Tujuan dari penelitian ini adalah untuk mengkaji dan menganalisis jenis, kelimpahan, keanekaragaman, keseragaman dan dominansi makrozoobentos serta kondisi substrat sedimen di kawasan pantai dan mangrove di Desa Tanjung Limau, Kabupaten Kutai Kartanegara. Penelitian ini dilakukan pada bulan Desember hingga Maret 2024. Metode penelitian ini menggunakan metode deskriptif dengan teknik pengambilan sampel menggunakan purposive random sampling. Lokasi pengambilan sampel makrozobentos dibagi menjadi 2 (dua) stasiun. Stasiun 1 terletak di daerah pantai, sedangkan stasiun 2 terletak di daerah ekosistem mangrove. Hasil penelitian menunjukkan bahwa kelimpahan makrozoobentos di kawasan mangrove (13 jenis) lebih tinggi dibandingkan dengan di pantai (18 jenis), dengan kelompok siput dan bivalvia. Kelimpahan di stasiun 1 (43,3 ind/m²) lebih rendah dibandingkan dengan stasiun 2 (58,0 ind/m²). Nilai indeks keanekaragaman di stasiun 1 (2,16) dan stasiun 2 (2,57) tergolong sedang. Keseragaman di stasiun 1 dan 2 masing-masing sebesar 0,84 dan 0,87 (kategori tinggi). Kemudian nilai indeks dominansi yang ditemukan di stasiun 1 dan 2 masing-masing sebesar 0,17 dan 0,10 (kategori tidak dominan). Tekstur sedimen di kawasan pesisir Tanjung Limau baik di stasiun 1 maupun 2 adalah lempung berlempung yang merupakan salah satu penyebab utama perbedaan kelimpahan makrozoobentos.

Kata Kunci: Kelimpahan, Makrozoobentos, Mangrove, Muara Badak

INTRODUCTION

Macrozoobenthos are aquatic organisms in coastal areas that can act as a source of food chains, food recyclers, and increase water productivity (Barus et al., 2019). Macrozoobenthos also functions as an indicator of changes or disturbances in an ecosystem. This is because the diversity of biota in waters is proportional to the stability of the ecosystem, so ecosystems with high diversity tend to be more stable. Water temperature, concentration of chemical elements, such as hydrogen ions (pH), and salinity are some of the physical and chemical components of the aquatic environment that can affect the presence of macrozoobenthos. In addition, the type of substrate including texture can also affect the type of macrozoobenthos. For example, a coarser substrate or one that contains more organic matter can support different macrozoobenthos communities (Suryana et al., 2024). Because the sediment substrate is where macrozoobenthos live in coastal areas, observing physical conditions such as the type and type of substrate on the structure of the macrozoobenthos community is very important (Jani et al., 2024).

One of the coastal areas of East Kalimantan that has water productivity is Tanjung Limau Beach. This area has a beach and also a mangrove ecosystem in which there are several organisms, one of which is macrozoobenthos. Apart from being known as a tourist destination, around this area there are several human activities such as settlements, fisheries, plantations, mining, sea transportation and industry (Noor et al., 2023). Some of these activities are feared to be able to release waste into coastal areas and can affect the health of animals and plants such as bacteria, algae, mangroves, sediments, organic materials, and biota, one of which is macrozoobenthos (Bia'un et al., 2020; ELTurka et al., 2018; Irawan et al., 2024; You et al., 2021).

Basically, research on macrobenthos diversity has been conducted in several coastal areas of East and North Kalimantan, such as in the Mahakam Delta estuary (Makri, 2018), Bontang Kuala seagrass beds (Irawan, 2003), Samboja coastal and mangrove areas (Jani et al., 2024;

Ritonga et al., 2024; Suryana et al., 2024) and Tarakan mangroves (Taqwa, 2013). However, these studies have focused more on macrobenthos diversity in certain areas or regions. Based on this, research is needed that can provide information and data on the types of abundance, diversity, uniformity, and dominance of macrobenthos. In addition, the condition of the sediment substrate in the coastal and mangrove areas in Tanjung Limau Village, Muara Badak District, Kutai Kartanegara Regency also needs to be investigated.

METHODS

Time and Place

This research was conducted from December to March 2024. Macrobenthic sampling was carried out at 2 stations. Station 1 is on the coast with coordinates 0°16'19.6" South Latitude and 117°26'56.5" East Longitude. Then at station 2 is located in the mangrove area with coordinates 0°17'49.4" South Latitude and 117°26'30.1" East Longitude, Kutai Kartanegara Regency, East Kalimantan Province (Figure 1).

Materials and Tools

There are several materials and tools used in this study, such as macrobenthos samples, sediment, 70% alcohol, water samples, Global Positioning System (GPS), 50 cm x 50 cm quadrant, 120 meter transect rope, refractometer, thermometer, pH meter, camera, sample bag, shovel, zip-lock plastic, 1 mm sieve net, and caliper ruler.

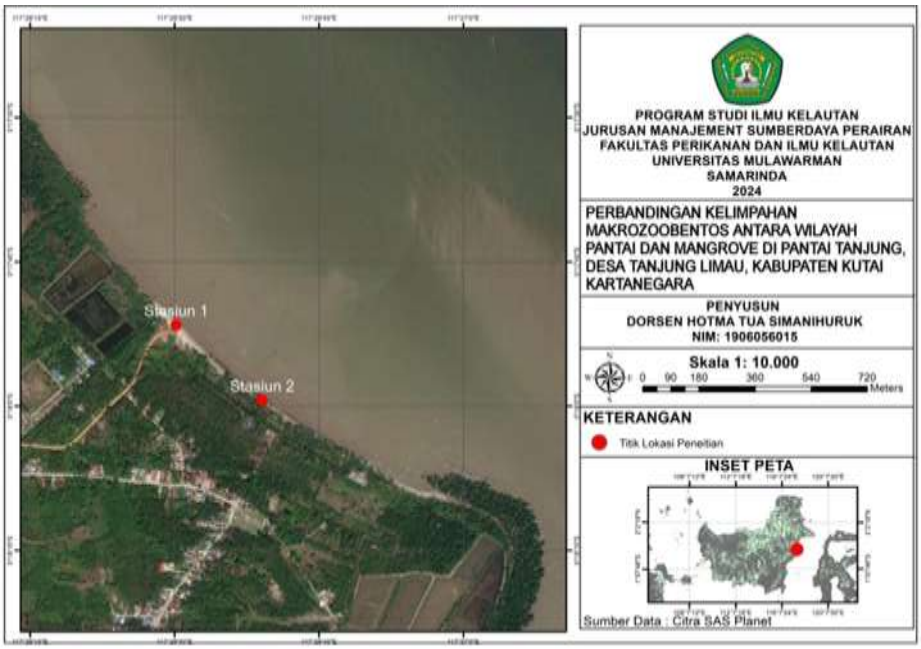


Figure 1. Map of Macrobenthos Sampling Locations

Research Procedure

Macrobenthos sampling at stations 1 and 2 was carried out on the surface up to digging the sediment surface (±10 cm) using a hand shovel. The length of the sampling location is 120 meters parallel to the coast and mangrove in a zigzag manner. Then, the sediment was filtered using a 1 mm sieve net, and was repeated twice at 6 sampling points. Sampling of macrobenthos in the study used the hand sorting method, namely by sorting macrobenthos in quadrants (50 cm x 50 cm) based on Ayuniara et al. (2018). The filtered macrobenthos were put into plastic sample bags that had been previously marked with station codes 1 and 2. Then, the macrobenthos samples that had been obtained from sieving using quadrants were collected and

put into empty bottles that had been given 70% alcohol solution. Furthermore, all macrobenthos samples were taken to the Aquatic Resources Conservation Laboratory, FPIK, Mulawarman University for further analysis.

Sediment samples were also taken from the sieve net results that had been filtered at each station point, to determine the texture results. Identification of macrobenthos was carried out by referring to FAO The Living Marine Resources of the Western Central Pacific Volume 1 (Carpenter & Niem, 1998).

Data Analysis

Diversity Index (H')

The diversity index value is calculated based on the Shannon-Wiener equation used by Jani et al. (2024):

$$H' = \Sigma(Pi)/(In\ Pi)$$

Where:

H’ = Diversity Index

Pi (ni/N) = Ratio between the number of individuals of the i-th species and the total number of individuals

ni = Number of individuals of the i-th species

N = Total number of individuals

If H' is less than 2.0 indicates the diversity of genera or species, the distribution of the number of individuals of each genus or species, community stability, and low and disturbed water conditions. If H' is more than 3.0 indicates the presence of diversity, the distribution of the number of individuals, and moderate and moderately disturbed water stability. Then, if H' is more than 3.0 indicates diversity, the distribution of the population of each species or genera is wide, high community stability, and waters that remain undisturbed.

Uniformity Index (E)

The uniformity index value in this study was calculated based on the Odum (1993) formula:

$$E = \frac{H'}{In\ S}$$

Where:

E = Uniformity index

H’ = Shannon-Wiener diversity index

S = Number of species

If the E value >0.40 (Low population uniformity); 0.40 > E < 0.60 (Medium population uniformity), and E >0.60 (High population uniformity).

Dominance Index (C)

The dominance index value in this study was calculated based on the following Odum (1993) formula:

$$Di = \Sigma \left(\frac{ni}{N}\right)^2$$

Where:

Di = Dominance index

Ni = Number of individuals of each species

N = Number of individuals of all species

The categories of the dominance index value (Di) are: 0 < Di < 0.5 (no species dominates). Meanwhile, if the Di value is 0.5 < Di < 1, then there is a dominant type.

RESULTS

Identification of Macrozoobenthos Based on Class and Species

Based on the results of the study of the composition of macrozoobenthos at station 1 in the coastal area, 2 classes were found, namely gastropods (66%) and molluscs (34%). While at station 2 (mangrove) gastropods (68%) and molluscs (25%) and crustaceans (7%) were found. Then based on the species, at station 1, 13 species were found in the coastal area with a total of 65 individuals (Figure 2A). Then, at station 2, 18 species were found in the mangrove area with a total of 87 individuals (Figure 2B).

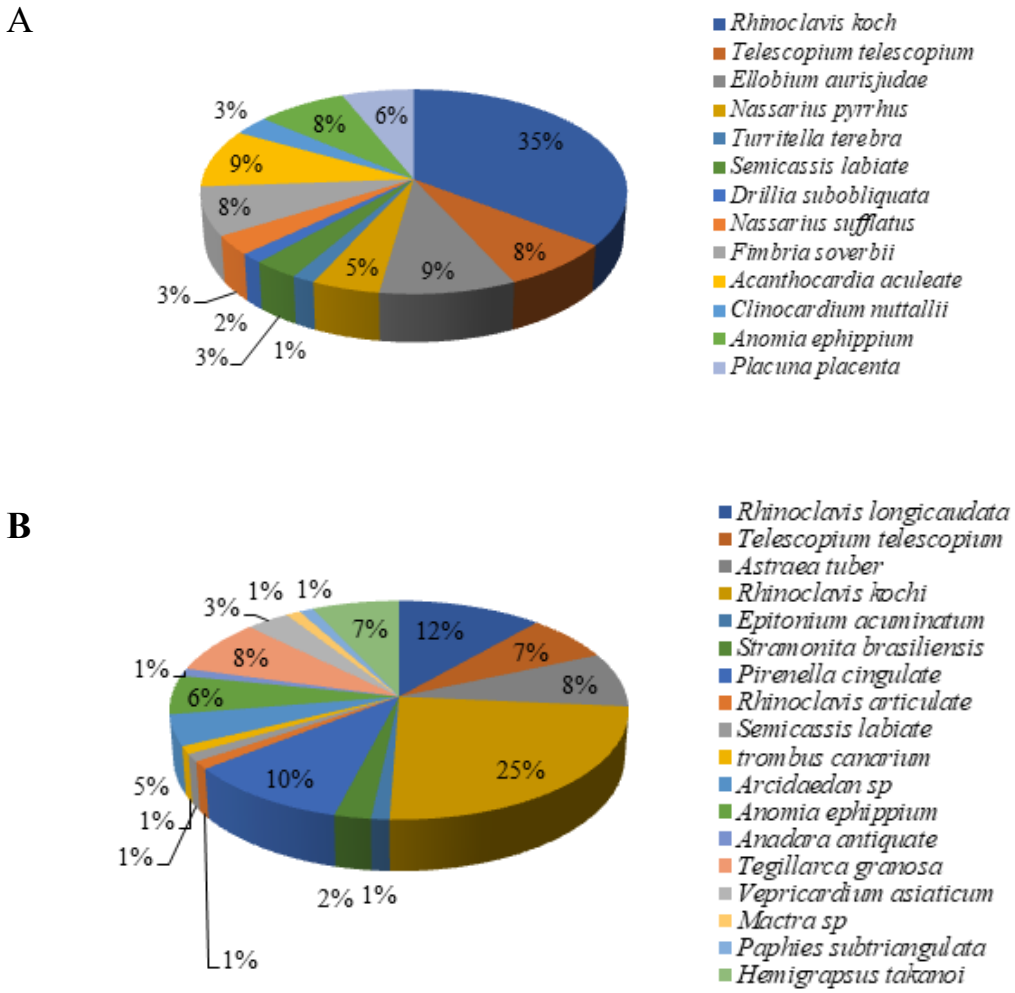


Figure 2. Composition of Macrozoobenthos Per Species at Stations 1 (A) and 2 (B)

Rhinoclavis kochi *Telescopium telescopium* *Ellobium aurisjudae*

Nassarius Pyrrhus

Turritella terebra

Semicassis labiate

Drillia subobliquata

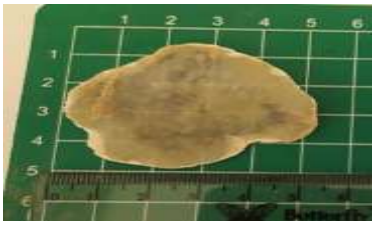
Nassarius sufflatus

Fimbria soverbii

Acanthocardia aculeate

Clinocardium nuttallii

Anomia ephippium



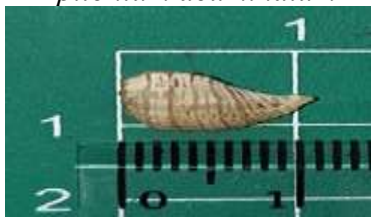
Placuna placenta

Rhinoclavis longicaudata

Epitonium acuminatum

Astraea tuber

Rhinoclavis articulate



Stramonita brasiliensis

Trombus canarium

Arcidaedan sp.

Anomia ephippium

Anadara antiquate | *Tegillarca granosa* | *Vepricardium asiaticum*

Mactra sp. | *Paphies subtriangulata* | *Hemigrapsus takanoi*

Figure 3. Results of Macrozoobenthos Identification at Stations 1 and 2

Comparison of Macrobenthos Abundance

The results of the analysis found that the abundance of macrobenthos at station 1 (43.3 Ind/m^2) and station 2 (58.0 Ind/m^2). In general, the abundance of macrobenthos at station 2 (mangrove) was relatively higher than at station 1 (coast). However, there was no significant difference in macrobenthos abundance between stations 1 and 2 (p>0.05) (Figure 4).

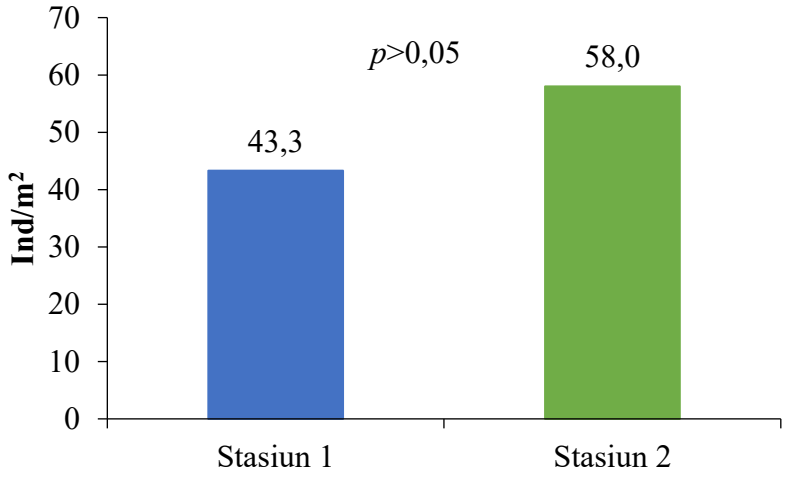
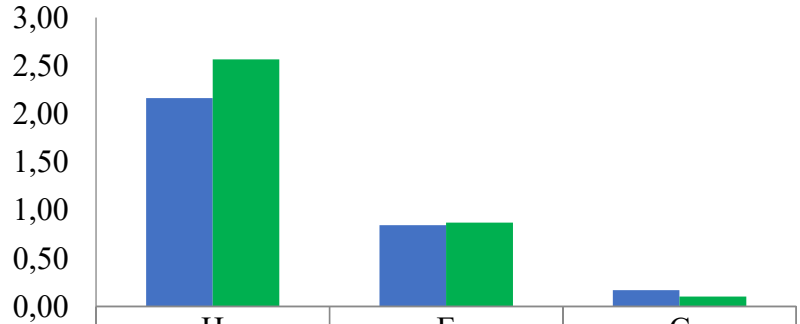


Figure 4. Diagram of Macrobenthos Abundance Index at Stations 1 and 2

Diversity Index (H'), Uniformity (E), and Dominance (C)

The average value of each diversity index (H'), uniformity (E) and dominance index (D) is shown in Figure 5. In general, the H' and E values at station 2 are relatively higher than at station 1, except for the C value.

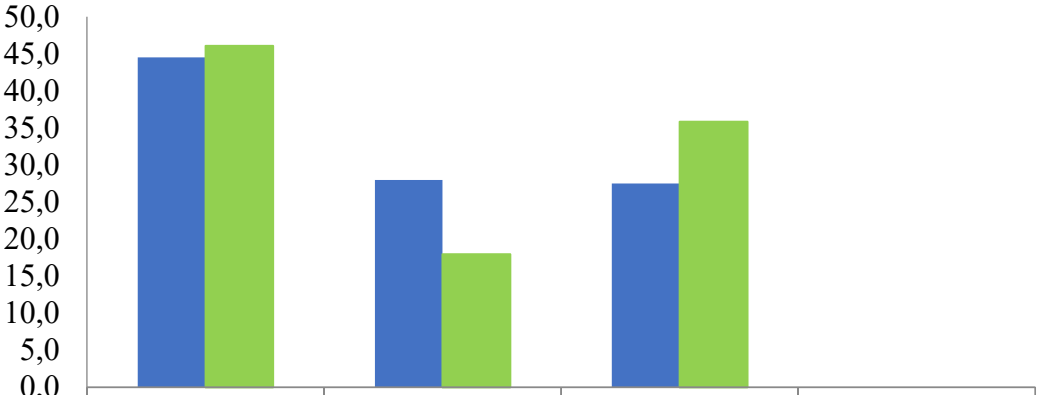


	H Sedang	E Tinggi	C Tidak Mendominasi
Stasiun 1	2,16	0,84	0,17
Stasiun 2	2,57	0,87	0,10

Figure 5. Macrobenthos Diversity Index at Stations 1 and 2

Sediment Texture

Based on the calculation results, the percentage of sediment fractions, namely sand and dust at station 1 is relatively lower than at station 2, except for the clay fraction. In general, the sediment texture at both stations 1 and 2 is clayey clay (Figure 6).



	Pasir	Debu	Liat	
Stasiun 1	44,5	28,0	27,5	Lempung Berliat
Stasiun 2	46,1	18,0	35,8	Lempung Berliat

Figure 6. Sediment Fraction Diagram at Stations 1 and 2

Water Quality

The results of the analysis show that in addition to salinity parameters, several physical and chemical parameters of the waters, such as temperature and pH, are still in accordance with the quality standards set by the Decree of the Minister of Environment of the Republic of Indonesia in 2021 (PPRI, 2021) (Table 1).

Table 1. Physical and Chemical Parameters of Waters

Parameter	Station		Quality Standards*
	1	2	
Salinity (ppt)	26.0	26.0	33.0 – 34.0
Temperature (°C)	28.0	29.0	28.0 – 32.0
pH	7.00	7.00	7.00 – 8.50

*PP RI Number 22 of 2021 Attachment VIII

DISCUSSION

Based on the results of the previous analysis, at station I (coast) the *Rhinoclavis kochi* species was found to be more dominant, because *Rhinoclavis kochi* has a special adaptation to live on sand or muddy sand substrates, which are the main characteristics of the beach. Its body structure supports digging and movement on the substrate to find food and shelter from other predators, then in the *Rhinoclavis kochi* habitat it supports their behavior in searching for food, such as organic particles and microorganisms that are suspended or buried in the sand (Ardyatma et al., 2020). At station I, it has a clay substrate type and this type of sediment fraction is more dominated by the sand fraction (44.5%) than dust (28.0%) and clay (27.5%). Sandy sediment provides a stable substrate and allows gastropods such as the *Rhinoclavis kochi* species to move and search for food more efficiently than muddy or rocky substrates. The gastropod class in the coastal area, including the *Rhinoclavis kochi* species, tends to adapt to sandy sediments that have medium to coarse particles. This is also associated with the ability of this species to survive in salinity, temperature and ocean current dynamics which are usually

stronger in areas with sandy sediments (Kalay & Lewerissa, 2019). The distribution of *Rhinoclavis kochi* species in habitats with sandy sediments is likely influenced by a combination of several important interacting factors, namely substrate characteristics, water quality, and the ecological tolerance of this species to various coastal environmental conditions (Piranto et al., 2019).

When compared, the composition of macrobenthos at station 2 (mangrove ecosystem) was significantly higher compared to station 1 (open coastal habitat). This may be because the mangrove ecosystem has a higher habitat structural complexity than the open coast (Rachmansyah et al., 2018). The existence of spreading mangrove roots, muddy substrates, and accumulation of leaf and twig litter form diverse ecological niches, providing suitable microhabitats for various macrobenthos species to live and reproduce. In addition, mangrove litter decomposition also provides an abundant source of nutrients and supports a complex food chain for the macrobenthos community (Bayudana et al., 2022).

The results of the study found that the abundance of macrobenthos at station 1 (43.3 Ind/m^2) was relatively lower than station 2 (58.0 Ind/m^2). The high abundance of macrobenthos at station 2 may be due to the higher texture of the sand sediment compared to other sediments. Sediments dominated by sand are usually less stable, making it difficult for some macrobenthos species that require denser substrates to survive (Zakiawati et al., 2021). Station 2 (mangrove) has the highest abundance or number of macrobenthos species with a clayey clay substrate that is not much different from station 1. The factor that causes the high abundance at station 2 is due to the high clay sediment, which is 35.8% compared to station 1 (27.5%). This substrate provides sufficient food sources as well as a place of protection from disturbances in water currents and predators. A denser soil structure also helps several species of macrobenthos such as gastropods and bivalves to attach or adapt to the environment (Sofiyani et al., 2021). Clay substrates have a fine texture that is able to maintain moisture, provide protection from strong currents, contain high organic matter, increase environmental stability, thus supporting the availability of food for macrobenthos, such as detritus, which is the main source of energy for macrobenthos (Farid et al., 2023). In addition, the abundance of macrobenthos in the mangrove ecosystem may also be associated with the processes of deposition, acclimation, competition, and predation (Simanjuntak et al., 2018). Based on these findings, the mangrove ecosystem at this research location needs to be maintained by policy makers (local communities, village government and the fisheries and marine services) for the sustainability of the Muara Badak coastal environment.

In this study, the most important difference was found, namely the discovery of the *Hemigrapsus takanoi* species from the crustacean class only at station 2 (mangrove). This is because at station 2 the sediment conditions are generally richer in organic matter and have a more stable texture, such as clayey clay. This sediment provides a better habitat for crustaceans, which often require a stable substrate to survive and reproduce. In contrast, at Station 1, which is on an open coast, the sediment may be sandier and less stable, affected by strong waves and ocean currents that can disrupt crustacean habitat (Maulana et al., 2023).

The results of the previous analysis showed that the level of macrozoobenthos diversity was moderate at stations 1 (coast) and 2 (mangrove). This may be because the distribution of the number of individuals from marozoobenthos is moderate, so that each type is uneven. In addition, the existence of supporting factors for appropriate water quality such as temperature (28.0 - 29.0ºC), pH (7.00) and substrate at the sampling location may also affect the diversity of macrobenthos. Although the salinity value at the side location is below the quality standard (26.0 ppt) due to previous rain, it still supports the life of macrobenthos. Basically, differences in temperature and pH can affect the activity of oxygen, metabolism, growth, and sustainability of the macrobenthos community at the sampling location (Yunita et al., 2018). However, if the

pH value is too acidic or alkaline, it can inhibit the existence of macrobenthos species (Safitri et al., 2021).

From the results of the research that has been carried out, the uniformity index value at the observation station was in the range of 0.84 - 0.87, which is quite high. This finding indicates that the condition of the Tanjung Limau Beach waters is still balanced, because the index value obtained is close to one. According to Herawati et al. (2017), no individuals are more numerous than other individuals if the evenness index category value approaches 1. This finding is also supported by the absence of macrobenthic species that dominate both at stations 1 and 2. The low dominance of species in the macrobenthic community in this study indicates that the coastal and mangrove areas at the sampling location are still safe and unpolluted. This is because no species dominates because each type of macrobenthic has a level of evenness that is not too different. The likelihood that one species will dominate the population increases with its index value. A dominance value approaching one indicates organisms that dominate the aquatic ecosystem. Conversely, a dominance value approaching zero indicates that no organisms dominate (Trimadhona et al., 2022).

CONCLUSION

The number of macrobenthos species at station 1 (coast) with 13 species is lower compared to station 2 (coast) with 18 species with gastropod and bivalve groups. The abundance of macrobenthos in the mangrove area (58.0 ind/m²) is relatively higher than the coast (43.3 ind/m²). The diversity index (H') of macrobenthos in the coast and mangrove areas ranges from 2.16 - 2.57 (included in the moderate category), and the uniformity value (E') ranges from 0.84 to 0.87 (included in the high category). While the dominance value (C') is between 0.17 - 0.10 (included in the low category). The sediment texture in the Tanjung Limau coastal area both in the coast and mangrove areas is clayey clay.

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