Community Structure of Periphyton on Seagrass Beds (*Enhalus acoroides*) in the Waters of Balikpapan Bay, East Kalimantan

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ABSTRACT

Periphyton are animals or plants that live below the surface of the water, attached to rocks, twigs, soil or other substrates. Periphyton which is classified into the animal group generally consists of protozoa and rotifers, while periphyton which is classified as plant consists of microalgae. The purpose of this study was to determine the structure of seagrass and the role of the Periphyton community. Measurement of water quality parameters was carried out at the Water Quality Laboratory, Faculty of Fisheries and Marine Sciences, while substrate research was carried out at the Soil Laboratory, Faculty of Agriculture. This research was conducted from November to March 2023 using the quadratic transect method while determining the stations and observation points using the purposive sampling method. Observation locations were determined based on seagrass density and using the transect method with a 50×50 cm quadrant. data were analyzed by calculating the Periphyton Community Structure. The abundance of periphyton in the Bay of Balikpapan, East Kalimantan, consists of seven classes, namely Bacillariophyceae, Ulvophyceae, Mediophyceae, Copepoda, Gastropods, Diplopoda, Dinophyceae. while the highest abundance was at station 3 of 36.1667. The high abundance of Periphyton at station 3 was caused by the sandy substrate and good water quality parameters. Based on the Diversity Index value indicates low Index status, Uniformity Index value indicates low Index status, Dominance Index value indicates low Index status.

INTRODUCTION

Balikpapan Bay is a small bay in Indonesia, situated near Kalimantan Island and the city of Balikpapan, East Kalimantan, Indonesia. Indonesia's Pertamina company has its largest oil refinery located on the eastern shore of the bay. Balikpapan Bay is positioned to the west of the Makassar Strait, or roughly southwest of the Pacific Ocean. The bay shares borders with several areas.

Seagrass beds are one of the shallow marine ecosystems that contribute to nutrient cycling by utilizing nitrates and phosphates. They also provide various microhabitats for a diverse range of marine organisms. Seagrass beds are a valuable marine resource with potential uses, and ecologically, they play a crucial role in coastal areas.

Periphyton is a photosynthetic microorganism that grows attached to submerged substrates such as plants, wood, and rocks in flowing water bodies like rivers. This group of algae typically adheres using adhesives like gelatin on the basal parts of cells and stalks, such as diatoms, making them less susceptible to being carried away by currents.

METHODOLOGY

This research was conducted in the seagrass ecosystem area in the waters of Balikpapan Bay, Balikpapan City, East Kalimantan. The study was carried out from November to March 2023. Sampling of periphyton and water quality analysis was done in situ. The analysis of periphyton was conducted at the Aquaculture Laboratory of the Faculty of Fisheries and Marine Science. Subsequently, water quality identification was performed at the Water Quality Laboratory of the Faculty of Fisheries and Marine Science.

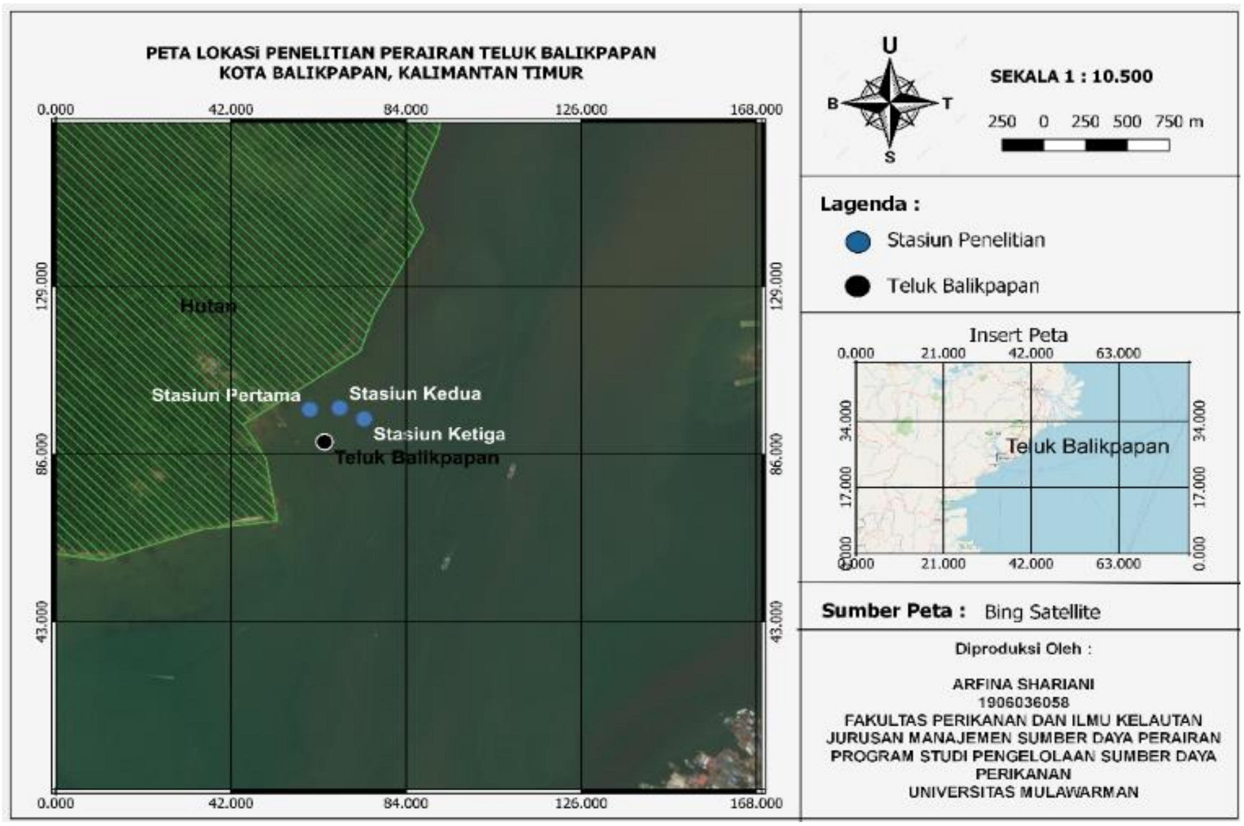

Figure 1. Research Location Map

1. The tools and materials used in this research are as follows:

The tools used include a motorboat, scissors, spoon, coolbox, Secchi disk, thermometer, titration set (Erlenmeyer flask, measuring pipette, measuring cylinder), label paper, camera, rope, stationery, roll tubes. The materials used for sampling are periphyton samples, water samples, substrate samples, Lugol's solution, and distilled water (aquades).

2. Sampling Stations

In this research, three sampling locations were designated based on each observation point.

3. Sampling Period

The seagrass sampling was conducted during low tide conditions at the 3 stations, with 3 sampling periods at 15-day intervals. Four sampling points were established at each sampling station.

4. Seagrass Sampling

Seagrass sampling was carried out at 3 stations, with seagrass present in each 50 cm x 50 cm quadrant. The seagrass was then cut and placed into labeled bottles.

5. Periphyton Sampling

Periphyton sampling is conducted by selecting young or mature leaves of *E. acoroides* seagrass. The composition of periphyton on seagrass is greatly influenced by age, location, and habitat. In mature seagrass, such as the tip of the leaves, the composition and density of periphyton will differ from young seagrass, which is found at the base of the leaves. This is due to the time required for attachment and colony formation of periphyton, similar to fouling organisms. Subsequently, *E. acoroides* seagrass leaf samples are cut along a 5 cm section using scissors. The sampled seagrass leaves are scraped along a 5 cm section of the leaf surface using scissors. The scraped material is then placed into a labeled sample bottle with a capacity of 30 ml and diluted with distilled water (20 ml). Next, it is preserved with 5 drops of Lugol's solution.

6. Substrate Sampling

Substrate sampling is carried out using a shovel, which is then placed into a polyethylene plastic bag for analysis. The analysis is conducted at the Soil Science Laboratory of the Faculty of Agriculture, Mulawarman University.

7. Measurement of Water Quality Parameters

Measurement of several physico-chemical parameters of water is conducted during each periphyton sampling at every station. Methods and instruments for measuring these physico-chemical parameters are employed. The physical parameters include temperature, turbidity, water current velocity, and depth. The chemical parameters encompass pH, dissolved oxygen (DO), salinity, phosphate, and nitrate.

RESULT AND DISCUSSION

1. Water Quality Parameters

The water quality parameters measured at each research station encompass the physical properties of the water, including Temperature, Turbidity, and Water Current Velocity. Meanwhile, the chemical properties encompass Phosphate, Nitrate, Salinity, Dissolved Oxygen (DO), and pH. The results of water quality measurements at the four stations can be seen in Table 1 below.

Tabel 1. Water Quality Analysis Results

Parameter	Units	Station 1	Station 2	Station 3	Quality Standards
Temperature	ºC	30	30	29	20 - 30
Salinity	$^{0}/_{00}$	25	24	21	30 - 34
Turbidity	m	1	1.15	1.20	3
Water current velocity	m/sec	0,20	0,23	0,28	-
Depth	m	1	1.5	1.20	-
pH	-	7,55	7,80	7,63	7-8,5
Dissolved Oxygen	mg/L	6,08	6,25	5,91	5
Nitrate	mg/L	0,015	0,027	0,018	0,008
Phosphate	mg/l	0,021	0,029	0,032	0,015

Quality standards: KEPMEN-LH No.22 Tahun 2021

2. Substrate Analysis

Based on the analysis conducted at the Soil Science Laboratory, Faculty of Agriculture, Mulawarman University, the results are obtained as presented in Table 2.

Table 2. Substrate Analysis Results

No.	Sample Code	Particle Distribution (%)			Texture
		Clay	Dust	Sand	
1	Station 1	18,10	24,57	57,33	SL
2	Station 2	7,24s	52,17	40,59	SiL
3	Station 3	2,22	2,09	95,69	S

Based on the analysis of the underlying water substrate samples as shown in Table 5 above, at Station 1, which is Sandy Clay, the particle distribution consists of 18.10% Clay, 24.57% Dust, and 57.33% Sand. At Station 2, which is Dusty Clay, the particle distribution is 7.24% Clay, 52.17% Dust, and 40.59% Sand. At Station 3, which is Sandy, the particle distribution is 2.22% Clay, 2.09% Dust, and 95.69% Sand.

Water current velocity can affect the distribution of substrate particles. The distribution of substrate can be influenced by the water current velocity; it is known that larger substrate particles are found in waters with moderate to high flow rates. Slow currents cause fine particles such as silt and mud to settle at the bottom of the water, resulting in substrate formation dominated by clay, which has a relatively high organic content.

3. Temperature

The temperature in marine waters is an important factor for the survival of organisms, as temperature affects the photosynthesis process of seagrass and periphyton. Different water temperatures at each station are suspected to be due to differences in water depth and the density of seagrass vegetation. Therefore, the results of water temperature measurements at Station 1 were 30°C, at Station 2 were 30°C, and at Station 3 were 29°C. Referring to KEPMEN-LH No.22 of 2021, the optimal temperature range for seagrass growth is 28 - 30°C. This indicates that the temperature in the waters of Balikpapan Bay meets the quality standards.

4. Salinity

An optimal salinity range for seagrass life is within 10 - 40‰. According to Short and Coles (2003), excessively high salinity can be a limiting factor for seagrass distribution, hinder seed germination, cause osmotic stress, and reduce resistance to diseases. The salinity conditions observed at the observation stations indicate a suitable range for seagrass growth and development. The salinity values obtained from observations were 25.0 ppt at Station 1, 24.0 ppt at Station 2, and 21.0 ppt at Station 3. Based on these salinity observations, it can be concluded that the salinity conditions in the waters of Balikpapan Bay are optimal for seagrass life, in accordance with KEPMEN LH No. 22 of 2021.

5. Turbidity

Based on the results of the conducted research from the 3 stations, depth values were obtained: 1 meter at Station 1, 1.15 meters at Station 2, and 1.20 meters at Station 3. Brightness also has an influence on the density of periphyton. This difference is likely due to variations in the intensity of sunlight that reaches the water column. For a depth of 1 meter, there is higher sunlight intensity compared to a depth of 1.20 meters. This will affect the phototrophic organisms in their photosynthesis process.

6. Water Current Velocity

Water current velocity has a significant impact on seagrass productivity. Currents do not affect light penetration except when they lift sediments, which can reduce light penetration. The currents in the waters of Balikpapan Bay are categorized as weak or slow currents. Based on surface current velocity data, the results of current velocity at the 3 stations in Balikpapan Bay are as follows: Station 1 - 0.20 m/sec, Station 2 - 0.23 m/sec, Station 3 - 0.28 m/sec. In areas with current velocities less than 0.1 m/s, the current is very weak; velocities of 0.1–1 m/s are considered moderate; and velocities greater than 1 m/s are classified as strong currents. Seagrass bed productivity is also influenced by water current velocity.

7. Depth

Based on the depth measurements at the three research stations, it is shown that the depth at Station 1 is 1 meter, Station 2 is 1.5 meters, and Station 3 is 1.20 meters. This indicates that at these relatively shallow depths, sunlight can penetrate into the water, allowing seagrass to grow and thrive. Water depth has a significant influence on seagrass, as changes in depth can affect other environmental factors in the water, such as temperature and light intensity.

8. Power of Hydrogen (pH)

Based on the research results, the pH values at Station 1 are 7.55, Station 2 is 7.80, and Station 3 is 7.63. A water body with a pH of 5.5 – 6.5 and a pH higher than 8.5 is considered unproductive, while a pH range of 6.5 – 7.5 indicates a productive water body. Water with a pH between 7.5 – 8.5 is considered highly productive. The pH range observed across all stations falls within the normal range for tropical waters.

9. Dissolved Oxygen

At the research locations, the dissolved oxygen (DO) values are as follows: Station 1 is 6.08 mg/l, Station 2 is 6.25 mg/l, and Station 3 is 5.91 mg/l. Reduced penetration of sunlight into the water can disrupt the process of photosynthesis, leading to a decrease in the amount of dissolved oxygen (DO) in the water. The dissolved oxygen (DO) content in the aquatic ecosystem of seagrass beds tends to fluctuate. Fluctuations in dissolved oxygen content in a water body are believed to be caused by the consumption of dissolved oxygen by seagrasses for root and rhizome respiration, respiration of aquatic organisms, and utilization by nitrifying bacteria in the nitrogen cycle within the seagrass ecosystem.

10.Nitrate

Based on the results of nitrate measurements, at Station 1, the value is 0.015 mg/l, at Station 2, it is 0.027 mg/l, and at Station 3, it is 0.018 mg/l. These values exceed the average standard limit set by KEPMEN-LH No. 22 Year 2021, which is 0.008 mg/l. Nitrate is a primary nutrient for both periphyton and plankton in water bodies. Nitrate is essential for algal growth and influences the overall productivity of the water environment.

11.Phosphate

Based on the results of phosphate concentration measurements, at Station 1, the value is 0.021 mg/l, at Station 2, it is 0.029 mg/l, and at Station 3, it is 0.032 mg/l. These values still meet the standard criteria of 0.015 mg/l (KEPMEN-LH No. 22 Year 2021). This condition aligns with the view of Muchtar and Simanjuk (2008) that phosphates are naturally distributed from the surface to the bottom.

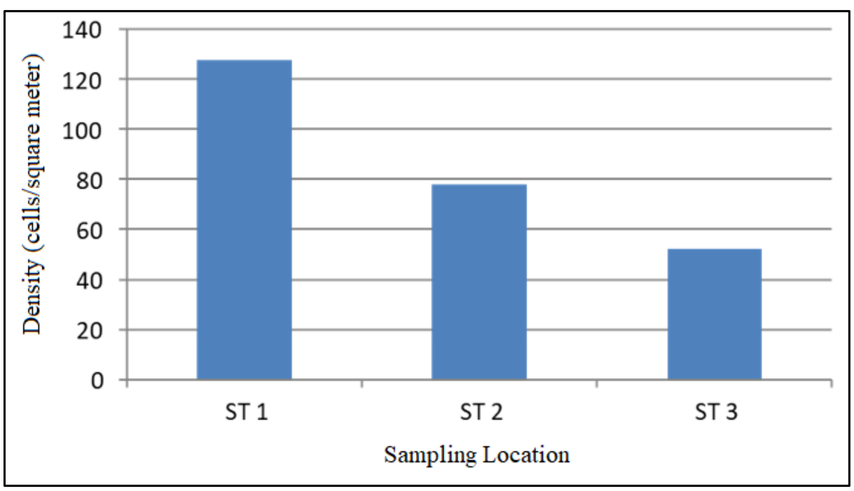

Figure 2. Seagrass Density Graph in Balikpapan Bay Waters

12. Seagrass Density

Based on the analysis of *Enhalus acoroides* density in Balikpapan Bay Waters from each station, it is shown that at station 1, there are 127.5 shoots/m². This is due to the lower turbidity conditions compared to other stations. The lowest seagrass count is observed at station 3, with 52.25 shoots/m². Considering the range of *E. acoroides* density based on stations and connecting it with the criteria, it can be inferred that at station 1, the density is categorized as very dense. The high density of large-sized seagrass such as *E. acoroides* is explained by Setyawan et al. (2012) who mentioned that *E. acoroides* is commonly found on muddy and sandy bottoms, coexisting with other species.

13. Composition of Periphyton Species

Based on the obtained results, it is known that the composition of periphyton species is predominantly found in the class Bacillariophyceae, with a total of 14 periphyton species. Bacillariophyceae is the dominant class, constituting 70% of the composition. Similar results were also found in the study by Pratama (2017) in the Balikpapan Bay area, where the dominant species in the waters belonged to the class Bacillariophyceae, with a composition of 89%. It is suspected that the Bacillariophyceae class is better adapted compared to species in other classes. This is consistent with the findings of Ismail (2016), who conducted research on periphyton and showed that the Bacillariophyceae class dominates over the other classes.

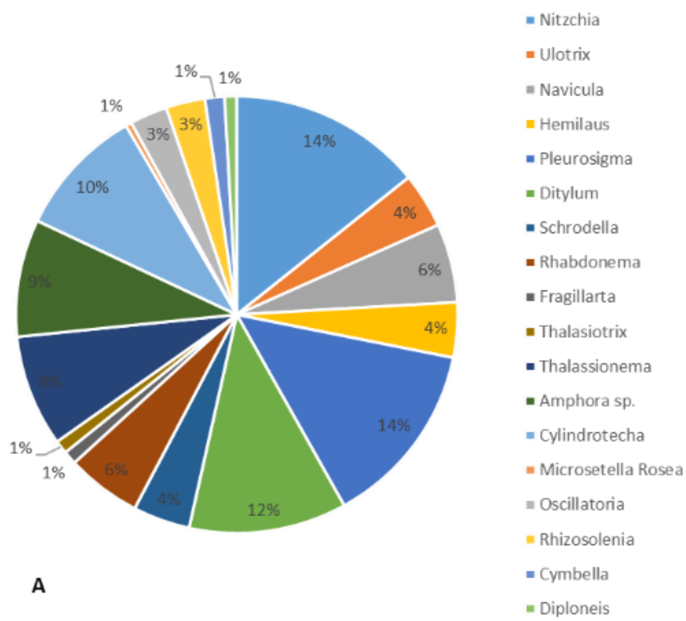

Figure 3. Percentage of Periphyton Species at Station 1

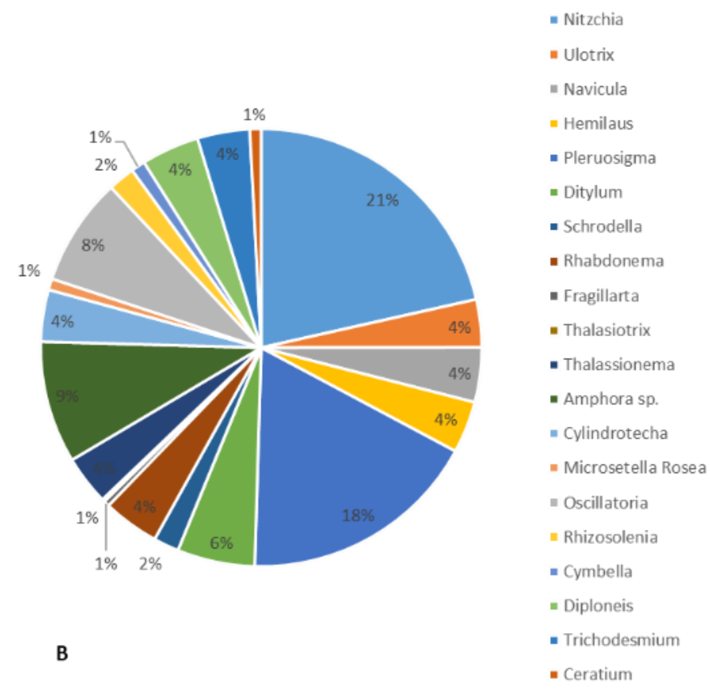

Figure 4. Percentage of Periphyton Species at Station 2

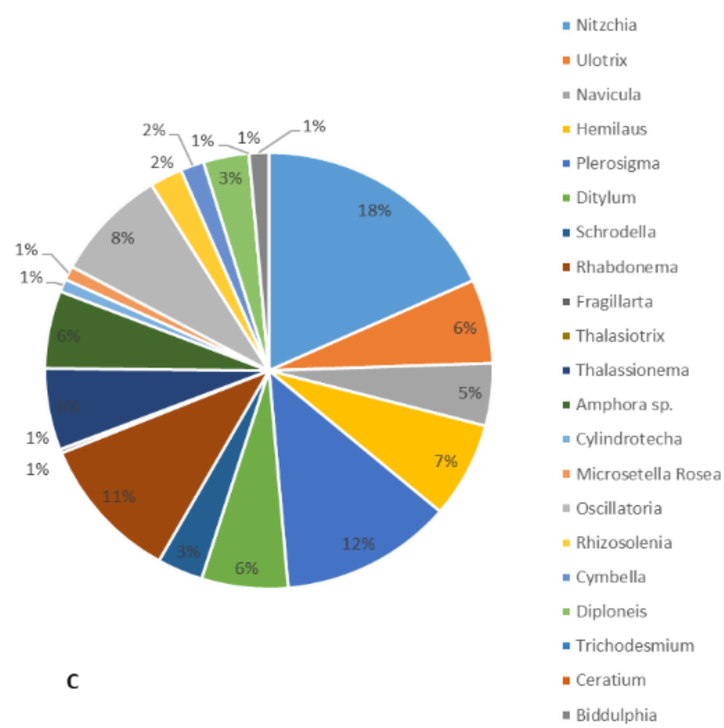

Figure 5. Percentage of Periphyton Species at Station 3

Based on the composition of periphyton species in the above images, which were found on the leaves of *E. acoroides* in Balikpapan Bay, there are 20 species identified. The highest occurring species is the Nitzchia genus in each station, comprising 14% at station 1, 21% at station 2, and 18% at station 3. This is likely due to the environmental conditions greatly influenced by the life of periphyton in the Bacillariophyceae class. The water pH in this study ranged from 7 to 8.5. The Bacillariophyceae class can thrive well within a pH range of 6.4 to 8.5, and its growth will decrease at pH levels greater than 9. The optimal water temperature for the Bacillariophyceae class is between 20°C and 28°C, as within this temperature range, cell division occurs more rapidly (Welch, 1980). The abundance of Bacillariophyceae species can adapt well to chemical and physical environmental factors with sufficiently high organic content (Yazwar, 2008).

The lowest occurring periphyton species at each station includes Cymbella, Diploneis, Microsetella Rosea, Fragillaria, Thalassiotrix, Rhizosolenia, and Cylindrotecha, each constituting 1%. This can be attributed to the fact that carbon dioxide (CO_2) present in these periphyton species at each station is utilized in the photosynthesis process. The CO_2 levels can decrease due to the photosynthetic processes in the water.

14. Abundance of Periphyton

Based on the analysis of the above images, it can be observed that station 1 has the lowest abundance, which is 309,667 cells/m2. Station 2 has an abundance of 324,333 cells/m2, while station 3 exhibits the highest abundance at 361,667 cells/m2. The high abundance can be attributed to the natural conditions and the robust and rigid structure of the *E. acoroides* leaves, which possess thick leaf veins.

The lowest periphyton abundance at the station is caused by competition for space, sunlight, and nutrients, resulting in reduced abundance. Strong periphyton presence indicates high abundance in a water body. Ismail (2016) explained that the abundance of periphyton attached to the leaves of seagrasses is due to the higher intensity of sunlight received compared to the roots or stems, leading to the thriving growth of periphyton.

15. Analysis of Diversity Index (H'), Evenness (E), and Dominance (C) of Periphyton

The Diversity Index values of periphyton show that the diversity index value at station 1 is 2.579, station 2 is 2.541, and station 3 is 2.576. According to Odum (1993), the Shannon-Wiener diversity index values range from 0 to 3, with the following criteria: $H' \leq 2.0$ indicates low diversity, $2.0 < H' < 3.0$ indicates moderate diversity, and $H' > 3.0$ indicates high diversity. This indicates that from station 1 to station 3, the diversity index status is low, implying a moderate distribution of individuals in those areas.

Based on the evenness index values of periphyton in Balikpapan Bay waters, the evenness index value at station 1 is 0.143, station 2 is 0.127, and station 3 is 0.846. According to Krebs (1989), the evenness index values fall within the range $E < 0.4$ indicating low evenness, $0.4 < E < 0.6$ indicating moderate evenness, and $E > 0.6$ indicating high evenness. This indicates that from station 1 to station 3, the evenness index status is low.

Based on the dominance index values of periphyton in Balikpapan Bay waters, the dominance index value at station 1 is 0.089, station 2 is 0.108, and station 3 is 0.092. The dominance index values fall within the range < 0.5 indicating low dominance, $0.5 < C < 1$ indicating moderate dominance, and $C > 1$ indicating high dominance. This indicates that from station 1 to station 3, the dominance index status is low.

CONCLUSION

1. The results of the identification of periphyton types on the leaves of seagrass *E. acoroides* in the waters of Balikpapan Bay revealed 20 species, consisting of 7 classes: Bacillariophyceae, Ulvophyceae, Mediophyceae, Copepoda, Gastropoda, Diplopoda, Dinophyceae.
2. The highest abundance calculation was recorded at station 3, with a value of 36.1667, while the lowest was at station 1, with a value of 30.9667. The most abundant species was Nitzchia, while the least abundant species were *Cymbella*, *Diploneis*, *Microsetella Rosea*, *Fragillaria*, *Thalassiotrix*, *Rhizosolenia*, *Cylindrotecha.*
3. The diversity index of periphyton species ranged from 2.579 to 2.541, indicating a moderate diversity of periphyton on the *E. acoroides* seagrass species. The uniformity index of periphyton species ranged from 0.127 to 0.846, indicating low uniformity. The dominance index of periphyton species ranged from 0.089 to 0.108, indicating low dominance.

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