Periphyton Community Structure of *Enhalus acoroides* in Baluran National Park, Situbondo

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ABSTRACT

Research on Periphyton Community Structure was carried out by collecting 3 main data, namely seagrass cover data, field sample periphyton data and water quality parameter data. Seagrass cover data was taken from the type of Enhalus acoroides, because this type of seagrass is found in all research locations, besides that the surface size of Enhalus acoroides is quite large compared to other types of seagrass, making it easier for the sampling process. Seagrass cover data was taken using Seagrass Watch guidelines using a transect size of 50 x 50 cm 2 . the largest seagrass cover was found on Sirondo beach with a cover percentage of 43.09% and was in the moderate category. The periphyton sampling process used the main ingredient Lugol at a concentration of 4% as a preservative solution and used a brush to scrape the surface of seagrass leaves. The results of the paeriphyton sampling will calculate the abundance and structure of the community (diversity, uniformity and dominance). The highest abundance was found in the Bacillariophyceae class with a value of 60% in all study locations. The average value of the highest diversity in all research locations is 2.41, the average uniformity value is 0.92 and the average dominance value is 0.1. Water quality parameter data collection was carried out in-situ, but Nutrient (Nitrate and Phosphate) analysis was carried out in the laboratory. The average temperature in all study locations was around 29.87 oC, the average salinity was around 31.04 0/00, the average pH was around 6.67, the average DO was around 6.7 mg/l, the average nitrate was around 0.030 mg/l and the average -the average phosphate is around 0.035 mg/l

Keywords : *transect, coverage, diversity, uniformity, dominance*

1. INTRODUCTION

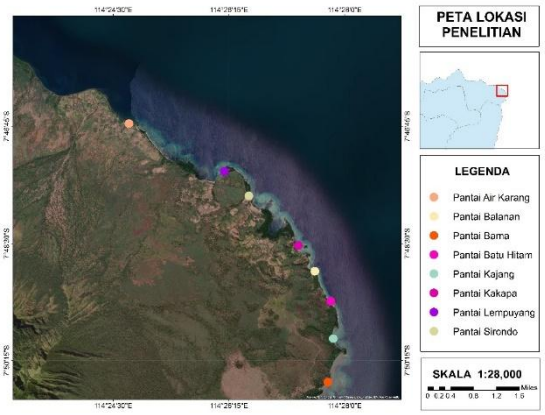
Seagrass is a marine plant that has flowers (Spermatophyta). The estimated area of seagrass in Indonesia is around 30,000 km2, representing about 5% of the total seagrass area in the world (Unsworth et al., 2018). Seagrasses are able to live by adapting to environments with low salinity levels to waters with high salinity levels (Halophytic) (Supriyadi et al., 2018). Many seagrass species are found in Indonesian waters. About 12 seagrass species have been identified in Indonesian waters (Azkab, 2006). One of the seagrasses that has a wide distribution is the type *Enhalus acoroides* (Rahman et al., 2016). *Enhalus acoroides* lives in sandy to muddy substrate areas (Azkab, 2006). This type of seagrass has large leaves, so it is preferred by epiphytic organisms as a place to live and shelter (Wenno, 2004). The leaf area is large enough to support the presence of epiphytic organisms which make it a substrate for attachment (Anggaraini et al., 2013). One type of attachment organism in marine waters is periphyton. Periphyton is a type of microorganism, both animals and plants, whose lives are attached, move freely or attached to the surface of existing objects, such as wood, stems, aquatic plants and so on. Periphyton are generally micro-sized and reside in one place, due to their nature as attachment biota (Pratiwi et al., 2017). Periphyton organisms have a vital role in their role as a supplier of productivity in the waters. Periphyton diatoms function as producers in the food chain, namely as producers of organic matter and oxygen (Novianti et al., 2013). The existence of

periphyton in the seagrass ecosystem will form a community. Community structure itself is an arrangement of individuals from several types of species that are organized to form a community and can be studied with one or two specific aspects about the organism being studied, such as species diversity index, abundance, and stratification zones (Lestari et al., 2021). Research on community structure of seagrass periphyton in Baluran National Parks which was carried out in the Bama Beach area, was carried out by (Kurniawan, 2017) in 2017. In this research it was concluded that the species Amphora sp., Navicula sp., and Nitzschia sp. is a type of periphyton algae that has the highest abundance value at each station. Thalassia hemprichii is the seagrass with the highest value of periphyton abundance at all stations. Of the 16 types of periphyton algae associated with seagrass *Enhalus acoroides* and Thalassia hemprichii, there are 3 types of periphyton with high abundance values, namely Amphora sp., Navicula sp., and Nitzschia sp. Because research on periphyton community structure in Baluran National Park that was previously conducted by (Kurniawan, 2017) was only conducted in the Bama Beach area, this research will identify periphyton seagrass associations along the coast of Baluran National Park. This is important to do, to know the community structure and condition of periphyton as a supplier of productivity in the waters of Baluran National Park, considering that the National Park area is also a place of conservation and protection. This research was conducted by adding seagrass cover data in all research areas, adding seagrass cover data will strengthen the conclusion at the end which shows the condition of the perifion and seagrass beds as an association.

2. METHOD

The location for data collection was carried out in the Baluran National Park area, Situbondo, East Java, by taking 8 beach locations located in the Baluran National Park resort. Determination of the location for data collection was based on a purposive sampling method and supported by journal literacy regarding the presence of seagrass along the Baluran National Park resort. The time for data collection was carried out in June 2022. Field research was carried out at low tide with the aim of facilitating sampling of seagrass leaves. Laboratory analysis was carried out at the Hydrobiology Laboratory of Brawijaya University and the Sumberpasir Freshwater Fisheries Laboratory. Field sampling locations are shown in the following figure.

Figure 1. Map of Research Locations



The basic tools used in the research included ASD (Basic Diving Equipment), quadrant transects, roll meters, scissors, salinometers, pH meters and DO meters and SRC (Sedgewick Rafter Cell). While the materials used are distilled water, *Enhalus acoroides* seagrass leaves, then tissue and 4% lugol.

Data collection on seagrass cover

Data collection in the field, both for data collection on the percentage of seagrass cover or periphyton sampling plots, used the SeagrassWatch guidelines using a 50 x 50 cm quadrant transect in the shape of a square. The distance between one plot and another plot is 10 meters and the distance between one transect and another is 50 meters. The distance of each transect from the shoreline to the offshore is 100 meters (COREMAP, 2014).

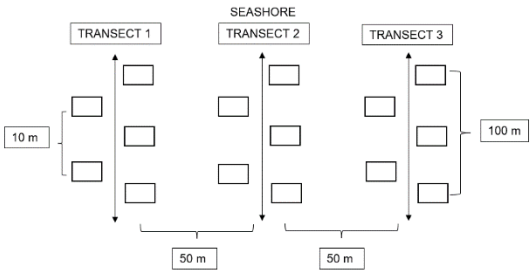


Figure 2. Transect Visualization

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Periphyton Data Collection

Periphyton samples were taken from the *Enhalus acoroides* species with the consideration that this type is found in all sampling locations and has a large enough field for periphyton sample preservation, compared to other types of seagrass. The preservation of periphyton sample using lugol 4% .One leaf of seagrass *Enhalus acoroides* was taken at each substation according to the type found (Ario et al., 2019). The leaves are cut using a cutter approximately 5x2 cm long in the middle, by selecting the size of seagrass leaves that are representative enough to be sampled. The leaf samples that have been taken are put into a sample bottle containing distilled water, and sampling (sweeping) of seagrass leaves is carried out using a brush.

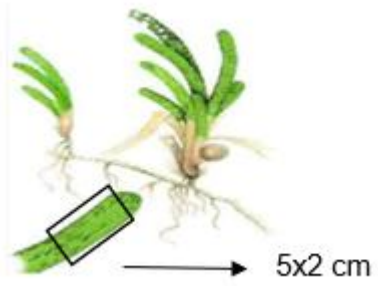

Figure 3. Illustration of Cutting Seagrass Leaves

Water Parameter Data Retrieval

Observation of water parameters using each tool according to their respective uses. Salinometer to calculate the level of salinity of the waters around the study site. pH meter to calculate the pH level of the waters at the study site. A mercury thermometer is used to calculate the temperature of the waters at the research location. DO meter is used to calculate DO levels at the study site. Water parameter data collection was carried out three times at each station. Sampling for measurement of nitrate and phosphate was carried out ex-situ, by taking water samples using a 250 ml sample bottle.

Community Structure Analysis

a. Type Identification

Identification of seagrass species is based on the identification key that has been determined according to the Ministry of Environment Number 200 of 2004 and references to research that has been carried out on the previous Bama beach. The types of periphyton found based on observations in the laboratory will be identified using an identification book belonging to Otto Larink (2011), Coastal Plankton: Photo Guide for European Seas, which is located in the Hydrobiology Laboratory of the Faculty of Fisheries and Marine Sciences, Brawijaya University.

b. Periphyton abundance

Periphyton abundance was calculated by calculating the number of cells found per seagrass leaf area (cells/cm2). Calculation of the number of periphyton using the modified formula Eaton et al., (1995):

$$N = n\,x\,\frac{vp}{vcg}\,x\,\frac{Acg}{Aa}\,x\,\frac{1}{A}$$

c. Shannon-Wiener diversity

The diversity index is calculated to determine community abundance based on the number of species and the number of individuals of each species at the observation site. The more species, the more diverse the community. The calculation refers to a modification of the Shannon-Wiener formula (Odum, 1971), with the following formula:

$$H' = \sum P_i \ ln\, P_i \text{ dimana } P_i \ = \frac{n_i}{N}$$

d. Uniformity

The uniformity index is calculated to determine how similar the distribution of the number of individuals of each species is in an area. The more uniform the distribution of individuals between species, the balance of the ecosystem will increase. The calculation of uniformity values refers to the formula (Odum, 1971), with the following formula:

$$E = \frac{H'}{Hmax\mathrm{H}' \ = \ln(\mathrm{S})}$$

e. Dominance

Dominance index is calculated to describe the type of seagrass periphyton that dominates the most in a community. The greater the dominance index value, the greater the tendency of a species to dominate a particular location. The Simpson dominance index is calculated

according to the formula (Odum, 1971), with the following formula:

$$C = \sum_{i=1}^{n} \left(\frac{n_i}{N}\right)$$

3. RESULT AND DISCUSSION

General Description of Research Locations

Baluran National Park, Situbondo is a National Park area located in the Situbondo area, East Java. This National Park has several parts, including savanna, and water areas. Several water areas have been selected as locations for collecting data on seagrass periphyton samples, including Bama Beach, Kajang, Lempuyang, Sirondo, Kakapa, Macan, Trisik, and Air Karang. At the eight research locations, seagrass had been identified, so that seagrass periphyton sampling could be carried out. On average, all study sites have white sandy to muddy substrates. This type of substrate is optimal for the growth of various types of seagrass.

The eight research locations have almost the same characteristics. Has currents and waves that are not too big and quite calm. Sampling of seagrass cover and sampling of periphyton was carried out at the lowest ebb and the waves and currents were in a fairly calm position, making it easier for the field process. All coastal locations have detected the presence of seagrass in it, so that periphyton sampling can be carried out on *Enhalus acoroides* seagrass leaves. The following is an example of an image from the research location for sampling *Enhalus acoroides* seagrass leaf cover and *Enhalus acoroides* seagrass periphyton sampling. The six research locations apart from those shown in the figure below, have almost the same panorama.

(Figure 4. Sample Panorama 2 Research Locations; A. Bama Beach, B. Kajang Beach

Source: Research Documentation, 2022

Water Parameters

Water parameters here include temperature, salinity, DO (Dissolved oxygen), and nutrients (nitrate and phosphate). Measurement of water parameters is closely related to periphyton productivity found in seagrass areas. Temperature is an important factor affecting the state of biota in a waters.

At the eight data collection locations, relatively the same temperature was obtained with an average of 29,870C. Salinity is the salt content found at the study site, salinity plays an important role in the metabolic processes of aquatic biota. Salinity also influences and plays a role in influencing biota in the waters, the average salinity in all research locations is 31.04 ppt. DO stands for Dissolved Oxygen or dissolved oxygen which is the dissolved oxygen content in a waters expressed in mg/l, the average DO in the research area is 6.7 mg/l. Nutrients and phosphates in waters are also important parameters in influencing the metabolism of the biota that live in them, the average nitrate is 0.030 mg/l and the average phosphate is 0.035 mg/l.

Types of Seagrass Found

The seagrasses found at the study sites were quite diverse, out of 12 species of seagrasses found in Indonesia, 8 of them were found in all study locations. The diversity of seagrass species found in Table 3 is indicated due to the varied substrate conditions in all study

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locations. The diversity of these species is also influenced by

there is still a minimum of external influences that can interfere with the existence and diversity of sea grass in all research locations. The following are the types of seagrass found (Table 1).

Table 1. Types of Seagrass Found

No.	Type of Seagrass	Bama	Kajang	Kakapa	Simacan	Sirondo	Air Karang	Lempuyang	Tri sik	TOTAL *
1.	*Cymodocea rotundata*	✓	✓	✓	-	-	✓	✓	✓	**6**
2.	*Enhalus acroides*	✓	✓	✓	✓	✓	✓	✓	✓	**8**
3.	*Halodule pinifolia*	-	✓	-	-	-	✓	-	-	**2**
4.	*Halodule uninervis*	✓	-	-	-	✓	✓	-	-	**3**
5.	*Halophila ovalis*	-	✓	-	-	✓	✓	✓	✓	**5**
6.	*Halophila spinulosa*	-	-	-	-	-	-	✓	-	**1**
7.	*Syringodium isoetifolium*	✓	-	-	-	-	-	✓	-	**2**
8.	*Thalassia hemprichii*	✓	✓	✓	✓	✓	✓	✓	✓	**8**
TOTAL**		**5**	**5**	**3**	**2**	**4**	**6**	**6**	**4**	

Based on the information in Table 1, seagrass species *Enhalus acoroides* and Thalassia hemprichii were found in all study locations, while Halophila spinulosa species were found at least in all study locations. The morphological conditions of the beach, which are predominantly characterized by sloping and muddy substrates, greatly influence the optimal growth of seagrass Enhalus acroides (Rahman et al., 2016). *Enhalus acoroides* can also survive in tolerating a range of water temperatures up to 38^0C at low tide, and can tolerate an optimum salinity range of up to 35 $^0/_{00}$, allowing this species to adapt well to its environment. This is indicated by the average temperature at the study site of 29.87 ^{0} C and an average salinity of 31.04 $^0/_{00}$. The characteristics of the Thalassia hemprichii seagrass which is able to live in a range of substrate conditions from sandy to muddy substrates affect their presence and distribution and dominance in a location (Sarinawaty et al, 2020). The most abundant species of Halophila spinulosa was found due to its distribution which has very little coverage in Indonesia. Of the 12 species of seagrass in Indonesia, the species Halophila spinulosa was recorded in only 4 places, namely on Kep. Riau, Anyer (Java Island), North Baluran (Besuki), and Irian (Azkab, 1999).

The main indications are seagrass found the most species in Air Karang and Lempuyang Beach due to the condition of the beach which is far from human activity and the conditions of the water parameters are optimal for seagrass growth. Human activities in coastal areas such as fishing, recreation, ports, housing and others can affect the existence of seagrasses either directly or indirectly. All forms of uncontrolled human activity in coastal areas can cause disruption of

the function of the seagrass ecological system (Tangke, 2010).

Coverage of seagrass *Enhalus acoroides*

Based on seagrass cover calculations at each research location, it was found that seagrass cover for *Enhalus acoroides* at Bama Beach had seagrass cover of 25.28%, Kajang Beach was 32.39%, Kakapa Beach was 26.99%, Simacan Beach was 25%, Sirondo Beach by 43.09%, Air Karang Beach by

18.18%, Lempuyang Beach 7.39%, and Trisik Beach 10.15%. The average cover of seagrass *Enhalus acoroides* in all study locations was 23.56%. Coverage of seagrass *Enhalus acoroides* varied in all study locations, from rare to moderate cover.

Table 2. Closure of Seagrass *Enhalus acoroides*

Seagrass type	Location	(%) Coverage	Category
Enhalus acoroides	Bama Beach	25.28	Moderate
	Kajang Beach	32.29	Moderate
	Kakapa Beach	26.99	Moderate
	Simacan Beach	25	Rare
	Sirondo Beach	43.09	Moderate
	Air Karang Beach	18.18	Rare
	Lempuyang Beach	7.39	Rare
	Trisik Beach	10.15	Rare
– Average		**23.56**	

The condition of the substrate found at the research location is generally muddy sand, sand mixed with rubble and sandy mud. The substrate condition which is dominated by muddy sand is a suitable habitat for the life of the *Enhalus acoroides* species (Yusniati, 2015). This is in line with the results of the study, that the species *Enhalus acoroides* was found in all study locations. Although the *Enhalus acoroides* closure categories varied and there were no dense closures, the distribution was even in each location.

In addition to the physical conditions that affect the seagrass growth cycle and the percentage differs at each location, chemical factors also have a major influence on the seagrass growth cycle and its distribution at each location, as explained in the previous sub-chapter regarding the quality standards for optimal water quality parameters for seagrass growth.

Types of Periphyton Found

Periphyton samples were taken from *Enhalus acoroides* seagrass leaves because this type of seagrass was found in all research locations and these seagrass leaves are larger in size than other types of seagrass leaves, making it easier for the process when sweeping seagrass leaves for periphyton sampling.

Periphyton identification was carried out using a microscope by first documenting it using a cellphone camera then the images obtained were identified and matched according to the morphological visualization of each species using an identification book. The results of the identification of periphyton on *Enhalus acoroides* seagrass leaves at 8 research sites in the waters of Baluran National Park, Situbondo, East Java found 26 species from 7 classes.

a. Class *Bacillariophyceae*

Periphyton class *Bacillariophyceae* was found as many as 12 species in all study locations (Figure 10). This class is commonly called the diatoms. This class is able to adapt well to the surrounding conditions. This class is also cosmopolitan, tolerant and highly adapted to its environment (Munthe & Aryawati, 2012).

b. Class *Cyanophyceae*

Cyanophyceae class periphyton types were found as many as 6 species in all study locations. This class is a division of the Cyanophyta class, where this class is a microalgae that has a habitat in fresh water areas. The existence of the *Cyanophyceae* class in marine areas is thought to be due to the carrying of species from this *Cyanophyceae* class from freshwater areas and carried towards the estuary (Triawan & Arisandi, 2020).

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c. Class *Euglenoidea*

Two types of periphyton class *Euglenoidea* were found in all study locations. This class has the characteristics of having a single cell, having a flagellum that grows at the anterior end, functioning as a means of locomotion. At the anterior end there is a narrow slit that supports towards the posterior or back, the majority of species in this class have an oval shape, and can live as autotrophs or heterotrophs (Swary et al., 2014).

d. Class *Dinophyceae*

The type of periphyton class *Dinophyceae* was found as many as 1 species in all study locations. Class *Dinophyceae* or dinoflagellates have 2 flagella with transversal and longitudinal positions. The transverse flagella function is to move water backwards while the transverse flagella function is for rotational movement forward and backward (Ario et al., 2019). Several types of *Dinophyceae* or dinoflagelata can cause red tides if their growth is not controlled (Ramadhanty et al., 2020). The *Dinophyceae* class is relatively small in size, has chlorophyll, is unicellular, has a thin cell wall and has reddish and yellow-green pigments (Munthe et al., 2012).

e. Class *Chrysophyceae*

There were 2 types of periphyton class *Chrysophyceae* found in all study locations. This class is a unicellular organism, while there are very few multicellular organisms compared to unicellular ones. This class can be found both individually and in colonies. *Chrysophyceae* resemble diatoms which can be formed from silica material, but the silica is stored in bubbles filled with secretory fluid rather than in the cell wall area. This class is often found in waters with lower temperatures, but will grow significantly at higher temperatures. These organisms can change themselves from heterotrophic to autotrophic if food availability runs low, to do so, organisms of this type develop their pseudopods to catch small protists (Microbewiki, 2022).

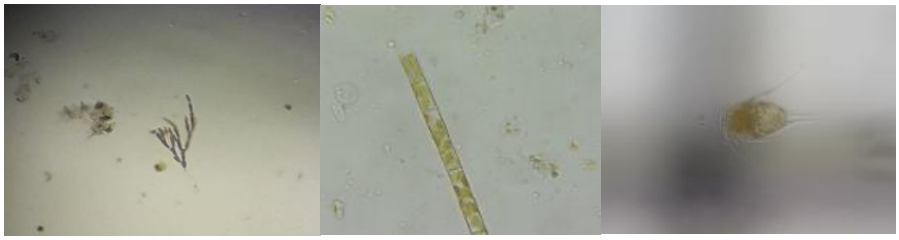
f. Class *Coscinodicsophyceae*

Periphyton class *Coscinodiscophyceae* was found as many as 1 species in all study locations. This class is part of the diatoms. This class has approximately 1123 species. The habitats of this class are scattered in freshwater, marine, benthic, pelagic and other parts. This class is unicellular and has a mineral framework in the form of biogenic silica material (EOL, 2022). In some taxonomic schemes, centric diatoms are known as part of *Coscinodiscophyceae* and Biddulphiales. However, this taxonomy is subject to change due to the development of new molecular and genetic analysis tools (WEBOT, 2022).

g. Class *Eurotatoria*

Eurotatoria class periphyton was found as much as 1 species in all study sites. This class is a zooplankton that belongs to the phylum Rotifera. This phylum is known as a mixed predator and can consume nutrients dissolved in water. Phylum rotifers are characterized by their small size and slow swimming speed (Khalifa et al., 2017). One of the limiting factors to the existence of the *Eurotatoria* class is the presence of light and phosphors. Light and phosphorus greatly affect the existence of the *Eurotatoria* class in nature, both in fresh and marine waters. The following are examples of species from each class that have been identified.

(A) (B) (C) (D)



(E) (F) (G)

Figure 5.) A. Class *Bacillariophyceae*; Isthmia sp. ; B. Class *Cyanophyceae*; *Mycrocystis aeruginosa* C. Class *Euglenoidea*; *Euglena oxyuris* D. Class *Dinophyceae*; *Glochidium* sp. E. Class *Chrysophyceae*; *Dynobrion cilindricum* F. Class *Coscinodiscophyceae*; *Melosira granulata* G. *Eurotatoria* class; *Euchlanis dilatata*

Periphyton abundance

The abundance of periphyton here indicates individuals/cm2 of seagrass leaves or the number of cells in the Sedgewick Rafter Cell field of view. Based on diagram 1, the highest abundance of periphyton species was found at all stations from the species *Nitzschia obtusa* (*Bacillariophyceae*), then *Rhizosolenia longiesta* (*Bacillariophyceae*), then *Isthmia* sp. (*Bacillariophyceae*).

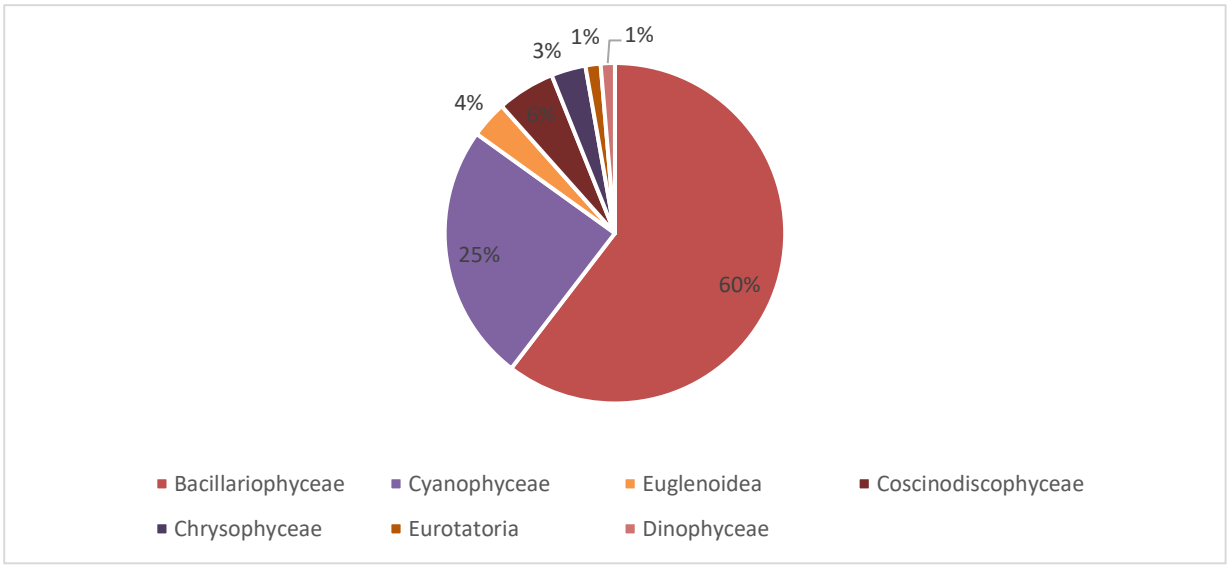


Diagram 1. Percentage Distribution of Periphyton Types Based on Class

Based on diagram 1, it can be concluded that the percentage of periphyton presence from the *Bacillariophyceae* class has the highest percentage with a value of 60%, then from the *Cyanophyceae* class by 25%, the *Coscinodiscophyceae* class by 6%, the *Euglenoidea* class by 4%, the *Chrysophyceae* class by 3%, the *Eurotatoria* class by 1% and class *Dinophyceae* by 1%.

Periphyton Community Structure

The indices of diversity, uniformity and dominance at the eight study sites show relatively different values but are still within a range that is not too far away. The periphyton

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diversity index is included in the moderate category, while the uniformity index is included in the high category and the dominance index is included in the low category.

Table 3. Periphyton Community Structure

Location	H'	Category	E	Category	C	Category
Bama Beach	2.75	Moderate	0.97	High	0.07	Low
Kajang Beach	2.34	Moderate	0.94	High	0.11	Low
Kakapa Beach	2.46	Moderate	0.96	High	0.09	Low
Simacan Beach	2.53	Moderate	0.93	High	0.09	Low
Sirondo Beach	2.19	Moderate	0.85	High	0.14	Low
Air Karang Beach	2.01	Moderate	0.92	High	0.14	Low
Lempuyang Beach	2.38	Moderate	0.90	High	0.09	Low
Trisik Beach	2.61	Moderate	0.92	High	0.08	Low

Diversity values in the medium category indicate that ecosystem conditions are quite stable and balanced, productivity is sufficient, and ecological pressures are moderate or not too threatening to the existence and survival of biota. This shows that the condition of the ecosystem in all research locations is in a balanced condition, has sufficient productivity to support the life of the biota in it, and has ecological pressure in a low range. The high uniformity value is close to 1, indicating that there is uniformity of species in all study locations which is relatively even with the number of individuals in each species being relatively the same. Meanwhile, if the uniformity value is low or close to 0, it indicates that the area has been dominated by certain species (Nurul et al., 2010). The tendency for dominance of a particular species in an area can be caused by an imbalance in population factors and environmental factors (Wahyuni, 2018). The dominance value is closely related to the uniformity index value, if the dominance index value is close to 0, it indicates that there are no species that dominate in an area and the level of uniformity is high, and vice versa if the dominance value is close to 1, it indicates that there is a type of individual that dominates and results in a low uniformity value. (Saptarini et al., 2010).

4. CONCLUSION

The condition of all study sites is quite stable with the parameters that have been measured and compared with the quality standards of water quality parameters. Even though there were some parameter values that were too low, this indicated that there would be fluctuations in weather conditions, especially dominated by rainy weather during data collection.

The average cover of seagrass *Enhalus acoroides* is in the moderate category, even though there is no dense cover at one location, it is present in all study locations. This type of seagrass exists in all study locations because the type of sandy to muddy substrate found in all study locations is very supportive for its growth and development.

In total, 8 species of seagrass and 25 species of periphyton were found from 6 classes. The values of diversity, diversity and dominance of periphyton in all study locations obtained the same results for each indicator. Diversity is included in moderate conditions, uniformity is included in the high category and dominance is included in the low category. These three indicators may indicate that the periphyton community structure in all study sites is stable and the environmental conditions are sufficiently balanced for the existence of periphyton and indicate that there is no significant ecological pressure at each study site.

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