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Diversity and Abundance of Epiphytic Diatoms on Seagrass Leaves (*Enhalus acoroides*) in Poncan Gadang Island Sibolga City, North Sumatra

Keanekaragaman dan Kelimpahan Diatom Epifitik pada Daun Lamun (*Enhalus acoroides*) di Pulau Poncan Gadang Kota Sibolga Sumatera Utara

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ABSTRACT

The seagrass ecosystem is one of the marine ecosystems that has an important role, namely as a source of life for organisms in the sea. Diatoms are microalgae widely distributed throughout the aquatic environment and are even found in plants, including seagrass leaves. Diatoms greatly influence life in the waters because they play an essential role as a food source for various marine organisms and play a role in the transfer of carbon, nitrogen, and phosphate. This research was conducted in February 2023 on Poncan Gadang Island, Sibolga City, North Sumatra. The study aims to determine the density, relative abundance, abundance, and diversity of epiphytic diatom species on seagrass (*Enhalus acoroides*) leaves in Poncan Gadang Island. The method used is the survey method, using three stations to take samples. The determination of 3 stations is based on the density of the seagrass beds ecosystem. Sampling of diatoms was carried out by brushing the surface of seagrass leaves about 5x2 cm on the front and back of the leaves. The samples obtained were then analyzed in the laboratory. There were 12 types of diatoms found, consisting of *Cocconeis* sp., *Rhizosolenia* sp., *Biddulphia* sp., *Amphipluera* sp., *Thalassiotrix* sp., *Nitzchia* sp., *Synedra* sp., *Melosira* sp., *Pleurogosigma* sp., *Skeletonema* sp., *Licmiphora* sp., and *Thalassionema* sp. the average value of epiphytic diatom abundance in seagrass leaves ranged from 2160.85 – 4649.94 ind/cm². The epiphytic diatom diversity (H') values ranged from 2.53 to 2.72.

Keywords: Epiphytic Diatoms, Seagrass Ecosystem, *Enhalus acoroides*

ABSTRAK

Ekosistem lamun merupakan salah satu ekosistem laut yang mempunyai peranan penting yaitu sebagai sumber kehidupan organisme yang ada di laut. Diatom merupakan mikroalga yang tersebar luas di seluruh lingkungan perairan bahkan terdapat pada tumbuhan, termasuk daun lamun. Diatom sangat mempengaruhi kehidupan di perairan karena berperan penting sebagai sumber makanan berbagai organisme laut serta berperan dalam transfer karbon, nitrogen, dan fosfat. Penelitian ini dilakukan pada bulan Februari 2023 di Pulau Poncan Gadang, Kota Sibolga, Sumatera Utara. Penelitian bertujuan untuk mengetahui kepadatan, kelimpahan relatif, kelimpahan, dan keanekaragaman jenis diatom epifit pada daun lamun (*Enhalus acoroides*) di Pulau Poncan Gadang. Metode yang digunakan adalah metode survei, dengan menggunakan tiga stasiun untuk mengambil sampel. Penentuan 3 stasiun tersebut didasarkan pada kepadatan ekosistem padang lamun. Pengambilan sampel diatom dilakukan dengan cara menyikat permukaan daun lamun sekitar 5x2 cm pada bagian depan dan belakang daun. Sampel yang diperoleh kemudian dianalisis di laboratorium. Terdapat 12 jenis diatom yang ditemukan, terdiri dari *Cocconeis* sp., *Rhizosolenia* sp., *Biddulphia* sp., *Amphipluera* sp., *Thalassiotrix* sp., *Nitzchia* sp., *Synedra* sp., Melosira sp., *Pleurogosigma* sp., *Skeletonema* sp., *Licmifora* sp., dan *Thalassionema* sp. nilai rata-rata kelimpahan diatom epifit pada daun lamun berkisar antara 2160,85 – 4649,94 ind/cm². Nilai keanekaragaman diatom epifit (H') berkisar antara 2,53 hingga 2,72.

Kata Kunci: Diatom Epifit, Ekosistem Lamun, *Enhalus acoroides*

INTRODUCTION

The seagrass ecosystem is one of the marine ecosystems that has an important role, namely as a source of life for organisms in the sea. The vast expanse of seagrass plants forming a seagrass bed is called a seagrass bed

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ecosystem (Ghufron, 2011).

Seagrasses are flowering plants that have total adaptability in waters with high fluctuations in salinity, live immersed in water, and have true rhizomes, leaves, and roots. Seagrass is also a very productive ecosystem. According to Asriyana and Yuliana (2021), this high productivity comes not only from the seagrass but also from algae and autotrophic organisms that attach to seagrass as epiphytes.

Diatoms are microalgae widely distributed throughout the aquatic environment and are even found in plants, including seagrass leaves. Diatoms greatly influence life in the waters because they play an essential role as a food source for various marine organisms and play a role in the transfer of carbon, nitrogen, and phosphate. The more oxygen the diatoms produce, the better the condition of the waters.

Based on the nature of life, there are four types of diatoms, one of which is epiphytic diatoms. Epiphytic diatoms are diatoms that live in association with aquatic plants and carry out photosynthesis because epiphytes are phytoplankton living in water. Epiphytic organisms are essential for aquatic productivity because they can carry out photosynthetic processes that form organic matter from inorganic substances (Rambe et al., 2019). Based on the description above, the authors are interested in conducting research on the diversity and abundance of epiphytic diatoms on seagrass leaves (*Enhalus acoroides*) in Poncan Gadang Island, Sibolga City, North Sumatra, with the aim of this research to determine the diversity and abundance attached to seagrass leaves which include types of diatom species, abundance, relative abundance and diversity in seagrass (*Enhalus acoroides*) leaves.

MATERIALS AND METHOD

This research was carried out in February 2023. Sampling was conducted on seagrass leaves (*Enhalus acoroides*) in Poncan Gadang Island, Sibolga City, North Sumatra. Diatom identification activities were conducted at the Marine Biology Laboratory, Department of Marine Science, Faculty of Fisheries and Marine Science, University of Riau.

The method used in this study was a survey method, namely direct observation and sampling in the field. Parameters measured included measuring water quality (temperature, pH, brightness, salinity, nitrate, and phosphate). Epiphytic diatom sampling was on seagrass leaves, where repetition was taken at the middle and base ends (Figure 1).

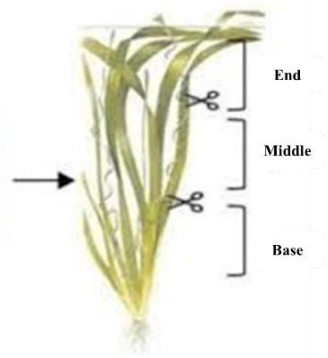

Figure 1. Schematic sampling of diatoms in seagrass leaves

Sampling stations for epiphytic diatoms on seagrass leaves (*Enhalus acoroides*) were determined by purposive sampling, namely by looking for samples in the field that are considered representative for sampling. While at the research location, it was determined that the sampling was divided into three sampling points per ecosystem, and the distance of each sampling point was 5 m. Each station has different characteristics of each (Figure 2). The criteria for station distribution on Poncan Gadang Island, Sibolga City, North Sumatra are Station I: Located around a dense habitat of seagrass beds of the type *Enhalus acoroides*; Station II: Located around the habitat of seagrass species *Enhalus acoroides*; Station III: Located around rare seagrass habitats of the type *Enhalus acoroides.*

Sampling of epiphytic diatoms was carried out on Poncan Gadang Island by taking a leaf of *Enhalus acoroides* seagrass and then cutting it 5 x 2 cm using scissors purposively with the leaves in a vertical position during high tide.

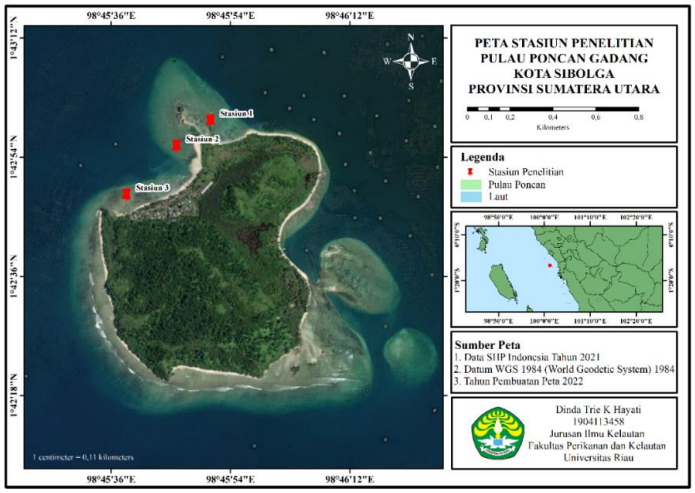

Figure 2. Research map locations

The seagrass leaves that have been taken are brushed on the spot. The surfaces of the brushed seagrass leaves were the front and back sides of the seagrass leaves, which were brushed as a whole. The seagrass leaves were brushed slowly using a brush, which was then sprayed with a sprayer filled with distilled water and collected in a sample bottle until the concentrate volume became 100 ml. Then, the samples were labeled and preserved using two drops of 4% Lugol for observation in the laboratory (Siregar, 1995).

After thoroughly stirring, the diatom sample in the sample bottle was taken using a dropper. Then, one drop was taken and observed under a binocular microscope with 10 x 10 magnifications using the 12 field of view method with three repetitions, and this was done for all samples.

After sampling, the diatoms were brought to the marine biology laboratory to identify diatom species. The observed epiphytic diatoms were identified with the help of Davis (1955); Yamaji (1976) identification books and recent journals on the web. The modified formula of the Lackey Drop Microtransactions Methods (APHA, 1992) was used to calculate the abundance of diatoms and to calculate the area of the drilled area. The formula for the area of the conical blanket was used:

$$N = \frac{3Oi}{Op} \times \frac{Vr}{3Vo} \times \frac{1}{A} \times \frac{n}{3p}$$

Information:

N = Number of epiphytic diatoms per unit area (ind/cm²)
Hey = Cover glass area (625 mm²)
On = Area of view of the Olympus CX 21 microscope magnification 100 ×(1.306)
Vr = Volume of sample water in the sample bottle (100 ml)
Vo = Volume of 1 drop of sample (0.06 ml)
A = Excavation field area (0.006)
n = Number of epiphytic diatoms counted
p = Total Field of View (12)

The relative abundance of epiphytic diatoms is calculated using the formula according to Fachrul (2007) as follows:

$$KR = \frac{ni}{N} \times 100\%$$

Information:

KR = relative abundance
ni = Number of individual species to 1/cell
N = Total number of individuals/cells

To see the diversity of types of epiphytic diatoms, the Shannon-Winner formula is used in Odum (1998), as follows:

$$H' = -\sum_{i=1}^{s} pi\ log_2\ pi$$

Information:

Log2 = 3,319

H' = Species diversity index

pi = Proportion of individuals from the i-th species to the total individuals of all species (pi = ni/N)

in = total number of individuals of the i type (individuals/cm²)

N = Total individuals of all types (individuals/cm²)

s = Sum of all individuals

Criteria: H' < 1 (Unbalanced biota community or heavily polluted water quality); 1 ≤ H' ≤ 3 (the balance of the biota community is moderate, and the water quality is moderately polluted); H' > 3 (balance of biota in prime condition and clean water quality).

RESULT AND DISCUSSION

General site conditions

The waters of Poncan Gadang Island are located in Sibolga City, North Sumatra Province. Poncan Gadang Island is geographically located at coordinates 01º 42' 38 "N and 98º 45' 52" E. Administratively, there is still debate between the City of Sibolga and Central Tapanuli for the position of Poncan Gadang Island. Based on the results of the island toponym survey in 2006 and the results of the National Team for Standardizing Topographical Names verification in 2007, Poncan Gadang Island did not change its name.

The plant vegetation is dominated by coconut trees, grass, shrubs, mangroves, and higher plants. Poncan Gadang Island, with its beautiful beaches, clear water, and white sand and surrounded by beautiful sea plants with various types of fish, coral reefs, and seagrass beds, has great potential for marine tourism such as fishing, snorkeling, and diving. This island can be reached from Sibolga City in about 15 minutes by using a speed boat.

Water quality measurement

Temperature has an essential role in determining the presence of diatoms in water. Temperature is very influential on the growth rate of phytoplankton. Salmi (2022) states that higher temperatures will increase the maximum photosynthesis rate. Based on the research results, the average temperature range in the waters of Poncan Gadang Island ranges from 27.7 to 30 0C (Table 1). This temperature range supports the high growth of phytoplankton. The optimum temperature for the growth of phytoplankton in the waters is around 20-30 0C (Sari, 2018).

Table 1. The average value of physical parameters of Poncan Gadang Island Waters

Parameter	Station 1	Station 2	Station 3
Temperature (^{0}C)	27,7 ± 1,25	29± 0,82	30 ± 0,71
Brightness (cm)	95 ± 0	100 ± 1	100 ± 0,82

The water brightness value during the research on Poncan Gadang Island had a slight difference. The different brightness was because diatom sampling was carried out at the highest tide. The brightness value obtained ranges from 95-100 cm so that diatoms can live well at this brightness. According to Sari (2018), brightness is affected by the presence of suspended and dissolved organic and inorganic materials caused by the influence of higher input loads from the mainland and locations closer to the mainland compared to locations far from the mainland.

Table 2. The average value of chemical parameters of Poncan Gadang Island Waters

Parameter	Station 1	Station 2	Station 3
Salinity (ppt)	32 ± 0.47	26 ± 0,82	26 ± 0
pH	6,40 ± 0,22	6,90 ± 0,08	6,50 ± 0,22
Nitrate (mg/l)	0,77 ± 0,02	0,85 ± 0,03	0,81 ± 0,01
Phosphate (mg/l)	0,63 ± 0.05	0,77 ± 0,02	0,73 ± 0,02

Salinity in the waters of Poncan Gadang Island ranges from 26-32 ppt. Variations of salinity can determine the diversity and abundance of diatoms because salinity is a parameter that determines the types of diatoms found in water. Simanihuruk (2012) states that salinity maintains osmotic pressure between the diatom bodies and the waters.

The results of pH measurements at the time of the study included a low measurement for diatom life but still good for diatom growth, namely 6,40 – 6,90. In comparison, the ideal pH for the survival of diatoms ranges from 6,5 – 8 (Ritonga, 2022). The highest nitrate and phosphate values are found at station 2. According to Bahri (2016), nitrogen in water comes from several human activities that result in waste, such as industrial wastewater, animal waste, agricultural waste, and vehicle emissions, all of which can affect nitrate formation. The highest phosphate value in the study was at station 2, as stated by Mustofa (2015), for the phosphate value for optimal growth of phytoplankton in the waters is 0.09-1.80 mg/l. The highest phosphate in station 2 is because station 2 is close to tourist activities on Poncan Gadang Island.

Density of seagrass

The densest density of seagrass *Enhalus acoroides* was found at station 1, which had an average stand of 135 shoots/m² with a silty sand substrate. According to Feryatun et al. (2012), *Enhalus acorides* can grow well in sandy and muddy substrates. The density of seagrass is estimated because the area is minimal from human activity and more supportive for seagrass to live in that area. Seagrass species *Enhalus acoroides* can even live from silt to coarse sediments or from low salinity near river mouths to relatively high salinity on islands far from the influence of river mouths (Rahman et al., 2016). Seagrass *Enhalus acoroides* has thicker, broader, and longer leaves, so it has a larger photosynthetic space per individual.

Epiphytic diatom abundance at research sites

The abundance of epiphytic diatoms in Figure 3 shows differences in the abundance of epiphytic diatoms found in each seagrass ecosystem; namely, the highest part was at station 2 with a value of 4649.94 ind/cm². Presumably, this area is far from human activity, and seagrass in this area has more oxygen coverage due to the position of seagrass leaves which are not too dense, and the lowest is at station 1 with a value of 2160.85 ind/cm². Presumably, station 1 has water quality that is not very supportive of the life of epiphytic diatoms. Devayani et al. (2019) state that epiphytic microalgae tend not to move because seagrass ecosystems are dense, so their abundance in the waters becomes less.

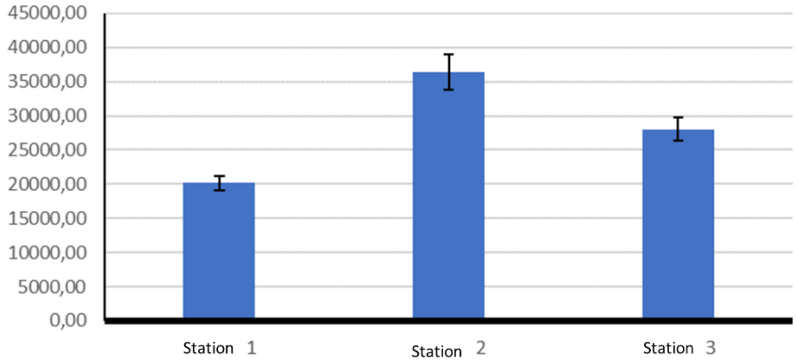

Figure 3. Epiphytic diatom abundance at Station 1, Station 2, and Station 3.

The factor that supports the growth of diatom abundance is the temperature that supports it. Diatoms have a wide tolerance to the temperature where the diatoms attach. The optimum temperature for the growth of diatoms is 20-30°C. Besides temperature, nutrients such as nitrate and phosphate also play an essential role in diatoms' survival. These nutrients play a role in marine primary productivity, nutrient cycles, and food webs (Mohammad et al., 2015).

Relative abundance of epiphytic diatoms

The highest relative abundance of epiphytic diatoms in seagrass leaves at station 1 is the type of *Synedra* sp., which is 23% (Figure 4). Based on Figure 5, it can be seen that the highest relative abundance of epiphytic diatoms in seagrass leaves is *Synedra* sp. 20%.

Based on Figure 6, it can be seen that the relative abundance of epiphytic diatoms in seagrass leaves is *Synedra* sp., which is 29%. The highest relative abundance of all types of diatoms found was *Synedra* sp. *Synedra* sp is a plankton that can live in moderately polluted water conditions. This type of plankton also can survive unfavorable environmental conditions (Isti'anah et al., 2014).

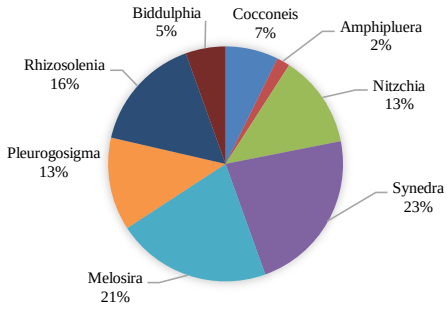

Figure 4. Relative abundance diagram at station 1

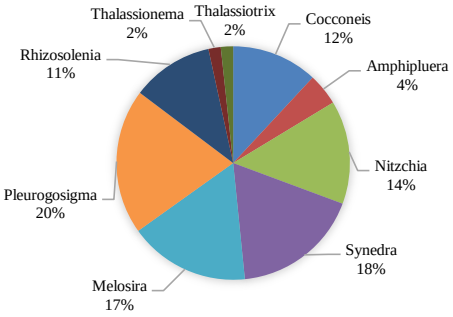

Figure 5. Relative abundance diagram at station 2

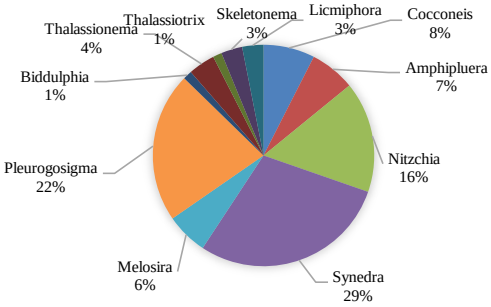

Figure 6. Relative abundance diagram at station 3

Epiphytic diatom diversity

The results of observing the epiphytic diatom diversity index values obtained have different average values at each research location station, as seen in Table 3.

Table 3. Epiphytic diatom diversity index at study sites

Station	Sampling Point	Diversity	Average value
1	1	2,55	2,53
	2	2,68	
	3	2,36	
2	1	2,73	2,72
	2	2,79	
	3	2,65	
3	1	2,90	2,58
	2	2,41	
	3	2,43	

The diversity index of epiphytic diatoms on seagrass leaves shows that the diversity of epiphytic diatoms on seagrass leaves of the *Enhalus acoroides* type belongs to the moderately polluted biota community balance category and moderately polluted water quality. Suppose there are several species whose numbers are much more significant. In that case, the diversity value of the plankton in the waters will be smaller. Conversely, if there are not several species whose numbers are far greater than the other species in the waters, then the diversity of the plankton is classified as moderate to high (Megarani, 2016).

CONCLUSION

Based on the results of the study, it can be concluded that there were 12 species of epiphytic diatoms on the leaves of seagrass *Enhalus acoroides* consisting of *Cocconeis* sp., *Rhizosolenia* sp., *Biddulphia* sp., *Amphipluera* sp., *Thalassiotrix* sp., *Nitzchia* sp., *Synedra* sp., *Melosira* sp., *Pleurogosigma* sp., *Skeletonema* sp., *Licmiphora* sp., and *Thalassionema* sp. The highest abundance was found at station 2, while the highest number of individuals was found at station 3. The research results obtained a moderate level of species diversity because, based on H', it is almost close to 3. The water quality on Poncan Gadang Island is stable. Therefore, the water quality on Poncan Gadang Island waters is classified as good for the growth of diatoms.

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