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TYPES AND ABUNDANCE OF PHYTOPLANKTON AT DIFFERENT DEPTHS IN THE COASTAL WATERS OF TELUK MAKMUR VILLAGE, DUMAI CITY, RIAU

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ABSTRACT

This study aims to identify the types and abundance of phytoplankton at different depths and research stations in the coastal waters of Teluk Makmur Village, Dumai City, Riau Province. Samples were taken from three different locations, namely estuary areas, tourist areas, and areas far from settlements. The number of phytoplankton samples from the three stations at three depths was 27 samples. Water quality parameters such as temperature, salinity, pH, DO, TSS, nitrate and phosphate were measured to determine the condition of the aquatic environment and the effect on phytoplankton growth. Phytoplankton were analyzed using a microscope and identified using a phytoplankton identification book. The results showed that 27 species of marine phytoplankton were found in the Bacillariophyceae, Dinophyceae, Cryptophyceae, and Conjugatophyceae classes. The most common phytoplankton found came from the Bacillariophyceae class. The highest abundance of phytoplankton between depths was obtained from a depth of 3 m, namely 368,558.0441 ind/L, while the highest abundance of phytoplankton between stations was obtained from station III, namely 360,000.452 ind/L. The abundance of phytoplankton between depths and between stations showed no significant difference ($p>0.05$).

Keywords: Phytoplankton, Parameter measurement, Abundance

1. INTRODUCTION

Plankton are microscopic organisms that live floating in the water column, and currents influence their movements in addition to their role, which is very important in aquatic life, their biological function, as natural food for various marine organisms, especially for fish. Types of plankton consist of phytoplankton and zooplankton. Phytoplankton are autotrophic and act as primary producers that utilize solar energy to produce glucose and oxygen. Zooplankton are heterotrophic, whose main food is phytoplankton[1].

The vertical distribution of phytoplankton in waters varies greatly at different depths because they have various levels of brightness, thus affecting photosynthesis activity. The vertical distribution of phytoplankton is optimal if it is still in the euphotic zone because this zone is a layer that can still be penetrated by sunlight effectively. Therefore, as the depth increases, light penetration will decrease. This will affect the existence of phytoplankton[2].

Teluk Makmur Village is one of the coastal tourism areas in Medang Kampai District, Dumai City. Physically, the waters of Teluk Makmur have a brown and slightly oily color, causing the level of water clarity to decrease, possibly due to the entry of various sources of pollution, both from human activities and water flow through factory canals around this coastal area. There is a need for further research to investigate

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how the physical and chemical conditions of the waters affect the phytoplankton community. Previous studies have shown that phytoplankton are more abundant at the surface, but there has been no clear study of their distribution at deeper depths, especially in this area.

Based on the statement above and the absence of specific research on the types and abundance of phytoplankton at various depths on this beach, the author is interested in researching the types and abundance of phytoplankton in maintaining the balance of the food chain and primary productivity of waters which ultimately affects the ecosystem as a whole at different depths on the Teluk Makmur Village Beach, Dumai City, Riau Province.

2. RESEARCH METHOD

Time and Place

The research was conducted in October - December 2024 in the coastal waters of Teluk Makmur Village, Dumai City, Riau Province. Sample identification was carried out at the Marine Biology Laboratory of Marine Sciences, Universitas Riau.

Procedures

Determination of Sampling Stations

The sampling location was determined using a purposive sampling method which is considered to represent several existing conditions such as the estuary area as station I in the Koneng Beach area (Lat 1.643050, Long 101.547225), the tourist area as station II in the Marina Beach area (Lat 1.650395, Long 101.545083) and an area far from settlements as station III in the Puak Beach area, Teluk Makmur Village, Dumai City (Lat 1.651392, Long 101.534219). One station has 3 different depths consisting of a surface layer of 1 m, a middle layer of 3 m and a layer near the bottom of 5 m

Phytoplankton sampling

Phytoplankton sampling was carried out at high tide by taking 10 L of seawater using a Van Dorn Water Sampler, then filtered using a Plankton net no.25. Then the filtered water sample was transferred into a 125 ml sample bottle with 3-4 drops of 4% Lugol preservative. Three repetitions were carried out at each depth with a total of 27 water samples.

Phytoplankton Identification

Observation and identification of phytoplankton types in this study were carried out ex-situ. The samples that had been obtained were homogenized, taken with a dropper pipette and dropped into an object glass as much as one drop, then covered with a cover glass to be observed under a microscope. Furthermore, it was analyzed using the 12 field of view method on a binocular microscope using a magnification of 10 x 10. Plankton were identified using identification books[3-4], https://www.algaebase.org/ and https://www.marinespecies.org/photogallery.php.

Water Quality Measurement

Temperature, pH, and dissolved oxygen (DO) measurements were measured using a DO meter. Salinity was measured using a Hand refractometer. Brightness using a Secchi disk. Nitrate, phosphate, and total suspended solids (TSS) were further analyzed in the Marine Chemistry Laboratory.

Data Analysis

The calculated data will be presented in the form of tables and graphs. The abundance between depths and between stations will be tested using ANOVA statistics to compare.

Phytoplankton Abundance

Plankton abundance in liter can be calculated using the APHA[5] formula, namely:

$$N = \frac{T}{L} x \frac{P}{p} x \frac{V}{v} x \frac{1}{w}$$

Information:

N = Number of phytoplankton / L

T = Area of cover glass (625 mm^2)

L = Area of field of view (1.306 mm^2)
P = Number of phytoplankton counted.
p = Number of observed fields of view (12)
V = Volume of filtered phytoplankton sample (125 mL)
v = Volume of phytoplankton sample under cover glass (0.06 mL)
w = Volume of filtered phytoplankton sample (10 L)

Relative Abundance (KR)

Relative abundance (KR) is the comparison between the number of species i and the total number of all species calculated in percentage units, using the Odum & Barret[6] formulation. Calculated in percentage units, Information:

$$KR = \frac{Ni}{N}\ x\ 100\%$$

Description:
KR = Relative abundance
ni = number of individuals in the genus
N = total number of individuals

3. RESULT AND DISCUSSION

General Conditions of the Research Location

Dumai is one of the cities located in Riau Province, which was formed based on Law Number 16 of 1999, dated April 20, 1999, concerning the Establishment of New Regencies/Cities in Riau Province. Law Number 22 of 1999 concerning Regional Government. Dumai has 7 (seven) Districts, including West Dumai, East Dumai, Bukit Kapur, Sungai Sembilan, South Dumai, Dumai City and Medang Kampai.

Figure 1. Research location map

Koneng Beach is one of the beach tourism sites in Riau, located in Teluk Makmur Village, Medang Kampai District, Dumai City. The distance is about 19 km from the center of Dumai City. Starting in 2017, there was an opportunity for the Dumai city seaside land, which eventually became one of the beautiful beaches in Dumai City. The natural potential of Pasir Koneng Beach is known as a tourist attraction rich in natural potential, with white sandy beaches and calm waves. This beach also has a long coastline, fine sand and is a magnificent natural panorama, which is the main tourist attraction for tourists[2]. Administratively, the Village located in Medang Kampai District, Dumai City has boundaries covering the North: Rupat Island, South: Mandau, East: Bukit Batu, West: Rokan Hilir[7].

Table 4. Water quality parameters of Makmur Bay

Station	Depth	Parameter							
		Temperature (0C)	Salinity (ppt)	DO (mg/l)	pH	Brightness (cm)	Nitrate (mg/l)	Phosphate (mg/l)	TSS (mg)
I	1	28	18	6,7	3,9	75	0,053	0,131	0,144
	3	29	25	10,6	6,2	-	0,073	0,126	0,2
	5	25	24	10,5	7,3	-	0,052	0,103	0,246
Average		27,33	22,33	9,26	5,8	75	0,059	0,12	0,196
II	1	26	23	6,5	7,3	112,5	0,040	0,140	0,202
	3	25	23	6,2	7,2	-	0,055	0,102	0,278
	5	29	24	7,3	7,2	-	0,072	0,126	0,22
Average		26,66	23,33	6,66	7,23	112,5	0,055	0,122	0,23
III	1	24	20	5,9	6,9	73	0,044	0,099	0,226
	3	29	22	5,7	7,3	-	0,065	0,116	0,226
	5	30	23	5,2	6,9	-	0,070	0,102	1,132
Average		27,66	21,66	5,6	7,03	73	0,059	0,105	0,528

Types of Phytoplankton

A total of 27 species of marine phytoplankton were found in the Bacillariophyceae, Dinophyceae, Cryptophyceae, and Conjugatophyceae classes.

Table 1. Classification of identified phytoplankton

Class	Order	Family	Genus	Species
Bacillariophyceae	Bacillariales	Bacillariaceae	Bacillaria	*Bacillaria paxillafera*
				Bacillaria sp
			Nitzschia	*Nitzschia palea*
	Rhizosoleniales	Rhizosoleniaceae	Guinardia	*Guinardia flaccida*
			Amphisolenia	*Amphisolenia* sp
			Rhizosolenia	*Rhizosolenia setigera*
				R. imbricata
				Rhizosolenia sp
	Rhabdonemales	Rhabdonemataceae	Rhabdonema	*Rhabdonema* sp
		Leptocylindraceae	Leptocylindrus	*Leptocylindrus* sp
		Naviculaceae	Cylindrotheca	*Cylindrotheca closterium*
	Fragilariales	Amphiphoraceae	Amphora	*Amphora* sp
		Epithemiaceae	Neidium	*Neidium affine*
			Helicotheca	*Helicotheca tamensis*
		Surirellaceae	Surirella	*Surirella* sp
				S. ovalis
		Fragilariaceae	Synedra	*Synedra* sp
	Isthmiales	Isthmiaceae	Isthmia	*Isthmia* sp
	Licmophorales	Licmophoraceae	Licmophora	*Licmophora* sp
	Melosirales	Melosiraceae	Melosira	*Melosira varians*
	Thalassiosirales	Stephanodiscaceae	Cyclotella	*Cyclotella* sp
Dinophyceae	Gonyaulacales	Gonyaulacaceae	Gonyaulax	*Gonyaulax hyalina*
		Dinophysiaceae	Alexandrium	*Alexandrium catenella*
	Gymnodiniales	Gymnodiniaceae	Gymnodinium	*Gymnodinium instriatum*
				G.uberrimum
Cryptophyceae	Cryptomonadales	Cryptomonadaceae	Cryptomonas	*Cryptomonas* sp
Conjugatophyceae	Desmidiales	Mesotaeniaceae	Spirotaenia	*Spirotaenia* sp

Based on Table 1, it is known that the most commonly found phytoplankton genus comes from the Bacillariophyceae class. The largest species composition was found at station I at a depth of 1 m with 15 species, and at station III at a depth of 5 m with 17 species. The largest species were obtained from the Bacilliophyceae class.

The dominance of Bacillariophyceae (Diatoms) is thought to be because phytoplankton included in this class have high adaptation and survival in various water conditions, including extreme conditions. The Bacillariophyceae class is the type of diatom that is most tolerant of water conditions, such as temperature and is able to adapt well to the aquatic environment, so that it can reproduce rapidly, namely three times in 24 hours, and can utilize nutrient content well. It can be assumed that the Bacillariophyceae class has a high level of adaptation and tolerance so that it is better able to survive[8-11]. This is reinforced by Hutabarat & Evans[12] statement that the Bacillariophyceae class is able to grow rapidly even in low nutrient and light conditions.

Phytoplankton Abundance

The results of observations that have been carried out show that each station and depth has varying abundance values. Calculation of phytoplankton abundance using the formula according to APHA[5]. The phytoplankton abundance values for each station and depth can be seen in Figures 2 and 3.

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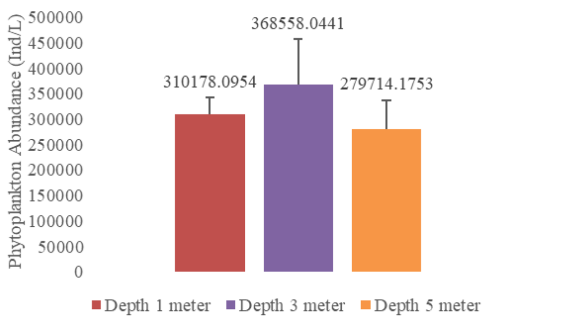

Figure 2. Average (± SD) phytoplankton abundance at each depth

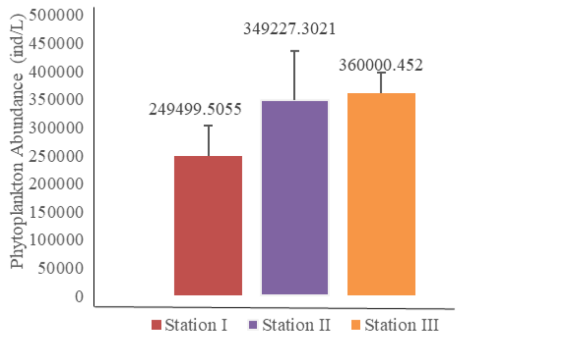

Figure 3. Average abundance (± SD) of phytoplankton at each station

The image above shows the abundance values between depths. The highest abundance value is shown in the 3 m depth graph. The abundance data was tested using Anova One Way on SPSS software and obtained a significance of 0.850. A significance level greater than 0.05 in the Anova One Way test indicates that there is no statistically significant difference in phytoplankton abundance across the depth groups compared.

Abundance at a depth of 3 m is influenced by the high penetration of light entering the waters (Table 1), and this area has culinary tourism destinations such as cafes and river flows. This can cause organic waste from the cafe to enter the waters and increase the abundance of phytoplankton. The presence of phytoplankton at a depth of 3 m is also thought to be due to the phytoplankton sampling process being carried out after rain and cloudy weather. Therefore, the entry of fresh water into the seawater column can change the vertical distribution of phytoplankton, which was initially in the surface layer, to a deeper layer. So this allows phytoplankton to tend to be found randomly at depth compared to on the surface of the water.

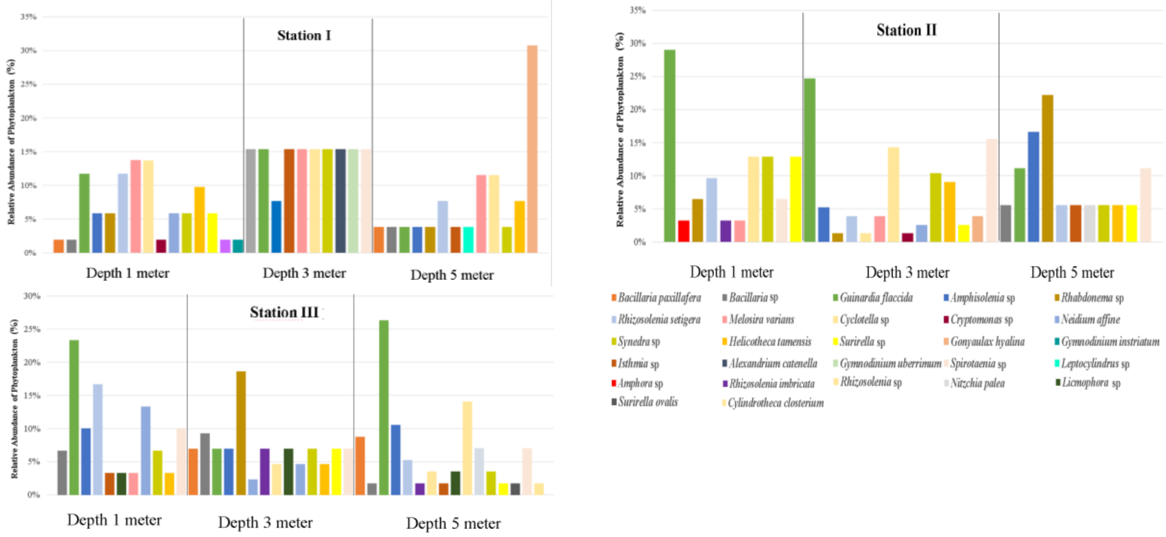

Figure 4. Relative Abundance of Phytoplankton

The lowest inter-depth abundance at a depth of 5 meters is thought to be because one of the water quality measurement data (TSS) obtained showed the highest value at this depth. This is believed to be because these waters are in a peat area. Water flowing from peat areas tends to be acidic. So, only a few types of phytoplankton can live in these conditions. Kurniawan et al.[13], stated that the metabolic processes and community structure of phytoplankton are significantly affected by low pH, but they can still function as primary producers in the food web. In addition, the low abundance at this depth is also due to the lack of light penetration to a depth of 5 m. This is because the physical condition of the water is turbid, making it difficult for light to penetrate the water layer.

Relative abundance of phytoplankton is a measure of how much of a particular type of phytoplankton is present in a water sample compared to other types of phytoplankton in the same sample. In other words, it is the ratio of the number of individuals of a kind of phytoplankton to the total number of individuals of all types of phytoplankton found. *Gonyaulax hyaline*, *Guinardia flaccida*, and *Rhabdonema* sp became the highest percentage of relative abundance.

The *G. flaccida* species dominates at every depth and every station. This is because *G. flaccida* thrives in turbid waters due to several ecological factors that support its growth and survival. The presence of suspended solids can create a better environment for Guinardia by reducing competition from other phytoplankton that require clearer water for optimal growth[14]. Turbid waters are often caused by runoff from land that carries sediment and nutrients (such as nitrogen and phosphorus). Although turbidity reduces light, the increase in these nutrients can stimulate the growth of phytoplankton, including *G. flaccida*.

4. CONCLUSION

Phytoplankton types are a collection of several types of phytoplankton found in a layer of water. Based on the research results, 27 species of phytoplankton were obtained from the Bacilliophyceae class (21 species), from the Dinophyceae class (4 species), from the Cryptophyceae class (1 species) and the Conjugatophyceae class (1 species). Abundant data from Teluk Makmur Beach waters, Dumai City, is stated to be in high abundance. The highest station abundance was obtained from station III, and the abundance at the highest depth was obtained from a depth of 3 m. The results showed no significant difference at each depth and research station. The highest relative abundance at station I was dominated by the species *G. hyaline*, stations II and III were dominated by the species *G. flaccida*.

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