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THE RELATIONSHIP BETWEEN ORGANIC MATERIAL CONTENT IN SEDIMENTS AND THE ABUNDANCE OF EPIPELIC DIATOMS IN THE INTERTIDAL ZONE OF THE WATERS OF DUMAI CITY, RIAU PROVINCE

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ABSTRACT

This research was conducted in March 2023, located in Koneng Beach, Dumai City. The purpose of this study was to determine the organic matter content and abundance of epipelic diatoms vertically and to analyze the relationship between the organic matter content in sediments and the abundance of epipelic diatoms vertically in the intertidal area of Dumai City Waters. The method used is the survey method. The sampling point is determined using a purposive sampling method. Sampling of epipelic diatoms was carried out using a modified corer, which was then brought to the laboratory to identify and calculate the abundance of diatoms and the sediment samples to calculate the content of organic matter and sediment fractions. Water quality measurements accompanied sampling with a brightness value of 0.57 m, temperature of 33 °C, current speed of 0.33 m/s, salinity of 28 ppt, and pH of 8.13. The results of the analysis of organic matter are 2.55 – 13.38%. The results of the sediment fraction analysis show that the research location is dominated by sandy silt. Nineteen genera of epipelic diatoms were found in the waters of Koneng Beach, Dumai City, with abundance values between 5,291–39,983 ind/cm^2. The one-way ANOVA test results obtained an average value of 0.000, meaning there is a significant difference in the abundance of epipelic diatoms between the sediment layers. The results of the linear regression test showed that the effect of sediment organic matter on the abundance of epipelic diatoms was 50.85%.

Keywords: Organic material, Epipelic diatom, Intertidal zone, Dumai

1. INTRODUCTION

Diatoms (Bacillariophyceae) are very common microalgae in tropical marine waters, are the most abundant primary producers in marine waters, and are present in all the waters. Areas with sufficient light intensity and rich in nutrients (nutrients) are most occupied by diatoms. According to Bracher in Nurimansyah et al.[1], diatoms affect about 40% of primary productivity in marine waters, making diatoms the microalgae with the highest abundance in waters.

Organic matter is one of the indicators of environmental fertility both on land and at sea. The content of organic matter in terrestrial ecosystems reflects the quality of soil that will flow into waters. In contrast, organic matter in waters benefits the biota that lives in it. Hawari et al.[2] stated that organic matter is a food source for marine life generally found in substrates, so its dependence on organic matter is substantial. Therefore, organic matter is important for the life of benthos organisms in sediments. Therefore, organic matter will also affect the abundance of epipelic diatoms in sediments. According to Bengen[3], organic matter in the intertidal zone is a tidal area influenced by coastal

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and marine activities and heavily inhabited by organisms. Intertidal zones are generally divided into three types of beaches: coral, sandy, and muddy. The intertidal zone has sandy beach types, one of which is in the waters of Koneng Beach, Dumai City. Koneng Beach is a tourist spot with a muddy sand substrate and mangrove forests around it.

So, it is necessary to conduct research related to epipelic diatoms by looking at the relationship between the content of organic matter in sediments and the abundance of epipelic diatoms in the intertidal zone of Dumai City Waters, Riau Province.

2. RESEARCH METHOD

Time and Place

This research was conducted in February-April 2023. Sampling was carried out at the Vaname Shrimp Ponds Task Implementation Unit (UPT) of the Fisheries Service, Tanjung Punak Village, Rupat Utara District, Bengkalis Regency, Riau and sample analysis was carried out at the Marine Microbiology Laboratory, Department of Marine Science, Faculty of Fisheries and Marine, Universitas Riau.

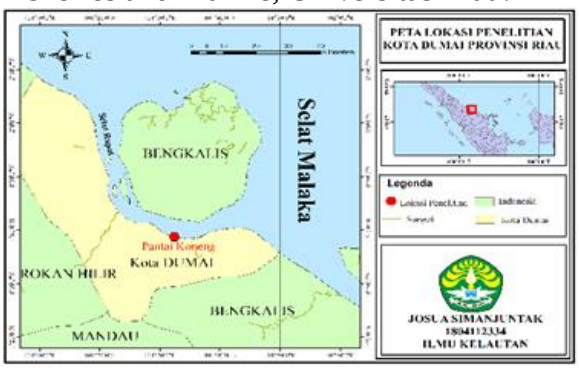

Figure 1. Map of Research Location

The survey method is used; data is obtained through observation and measurement in the field. Epipelic diatom and sediment samples are taken to the laboratory to identify and calculate the abundance amount and see the relationship between sedimentary organic matter and the abundance of epiphytic diatoms.

Epipelic diatom sampling was conducted daily, around 10.00 WIB to 12.00 WIB. Diatom sampling by taking sediment at depths taken per layer, namely at depths of 0-5 cm, 10 cm, 15 cm, 20 cm, 25 cm, 30 cm, 35 cm, 40 cm, 45 cm and 50 cm using a modified corer (Figure 2), then transferred into a sample bottle, then given a 4% Lugol solution as much as 3-4 drops.

Figure 2. Corer Sample Taker

A sample of epipelic diatoms is taken to the laboratory for analysis. The method used to calculate the number of diatoms is the field of view method with the number of field of view 12, then observed using an Olympus CX 21 microscope with a magnification of 10 x 10 and identified using[4].

In addition to epipelic diatom samples, sediment samples are also used as organic matter and sediment fractions samples. Water quality measurements are carried out on the same day, namely at high tide, and measurements are made in brightness, temperature, current speed, salinity, and pH.

3. RESULT AND DISCUSSION

Water Quality Parameters

The observed water quality parameters include physical and chemical water parameters, as seen in Table 1.

According to KLH No. 51 of 2004 concerning sea water quality standards, good water brightness is >3 m. At the research location, the brightness value obtained is 0.55 – 0.57 m, which means the water is not good. Temperature directly affects organisms and indirectly affects the solubility of CO_2 used for photosynthesis

and the solubility of O_2 used for the respiration of marine animals. According to Effendi in Supono[5], diatoms grow well at 20–30°C. In this study, the temperature value obtained ranged from 33°C. So, at the research site, the temperature is classified as less optimal for the growth of diatoms.

Table 1. Water Quality Parameters

Parameters	Value
Brightness (m)	0,57
Temperature (^oC)	33
Current speed (m/s)	0,33
Salinity (ppt)	28
pH	8,13

Current speed can affect the abundance of phytoplankton, including diatoms, which are passive organisms that move according to the movement of currents. Epipelic diatoms dominate the waters, with current speeds ranging from 0.2–1 m/s[6]. The current speed in the waters of Dumai City obtained ranges from 0.33 m/s. The current speed at this research site is still under normal conditions. The salinity of the waters at the study site is 28 ppt, but according to Nontji in Sinurat[6], good salinity for plankton growth in the sea is 30-35 ppt. Based on the study results, the salinity value obtained in the field is still relatively less optimal for the growth and development of diatoms.

The value of the degree of acidity (pH) of a water describes the level of acidity or alkalinity of a water. According to Hasrun et al. in Sinurat[6]. Conditions of very alkaline and highly acidic waters will endanger the survival of organisms because it will cause metabolic and respiratory disorders. If the pH value is 6.0 –6.5, the diversity of diatoms will decrease. From the research results in the field, the pH in the waters of Dumai City ranges from 8.13, and the value is certainly not good for the growth of diatoms in these waters.

Sediment Fraction

The results of the sediment fraction analysis showed that the sandy mud fraction dominated the study site. The highest percentage of gravel fraction is found in the 10 cm layer (27.54%) and the lowest percentage in the 25 cm layer (2.53%). The highest percentage of sand fraction was found in the 45 cm layer (52.16%) and the lowest percentage in the 15 cm layer (19.39%). The highest percentage of mud fraction was found in the 50 cm layer (74.43%) and the lowest percentage in the 40 cm layer (21.99%).

Table 2. Percentage of Sediment Fraction

Depth (cm)	Sediment fraction (%)			Sediment type
	Gravel	Sand	Mud	
5	22,28	34,75	42,97	Pebbled Sand Mud
10	27,54	31,95	40,50	Pebbled Sand Mud
15	6,26	19,39	74,35	Sandy Mud
20	8,81	28,28	62,91	Sandy Mud
25	2,63	24,06	73,31	Sandy Mud
30	2,71	23,06	74,22	Sandy Mud
35	5,15	49,06	45,79	Muddy Sand
40	5,75	72,26	21,99	Muddy Sand
45	2,62	52,16	45,22	Muddy Sand
50	3,84	21,73	74,43	Sandy Mud

In the waters of Koneng Beach Dumai City, the type of sediment fraction is gravel sand mud, sandy mud and muddy sandThe highest fraction is found in the upper 50 cm layer, which is mud by 74.43%, which is due to muddy beaches occurring in coastal areas where there are many river estuaries which carries large amounts of suspense sediment into the sea. In addition, the wave conditions on the

coast are relatively calm, so they cannot carry (disperse) the sediment to deep waters in the high seas[7]. The suspense sediment can spread over a large water area to form a wide, flat, shallow beach. The slope of the seabed or beach is tiny.

Organic Matter

The results of organic matter analysis can be seen in Table 3.

Table 3. Percentage of Organic Matter

Depth (cm)	Organic matter (%)
5	8,67
10	6,62
15	13,38
20	10,28
25	6,71
30	5,41
35	7,51
40	2,55
45	2,19
50	3,04

Organic matter is important in determining soil fertility, both physically, chemically and biologically[8]. The results of measurements of sedimentary organic matter at the study site showed values between 2.55–13.38%. The highest value of sediment organic matter content is at a depth of 15 cm, which is 13.33%, while the lowest sediment organic matter content is in a layer of 40 cm, which is 2.25%. In Sitindoan et al.[9] research on organic matter in sediments in Teluk Bayur, a lower organic matter content of 6.36% was obtained. This is due to the dominance of Teluk Bayur by the sandy gravel fraction, while in this study, the dominance of sandy mud was observed. Figure 3 shows that each sediment layer's organic matter content in the Koneng Beach Waters of Dumai City experiences an up-and-down pattern.

The organic matter content at depths 15 and 20 is higher than at depths 5 and 10 and at depths of 25, 30, 35, 40, 45, and 50 cm. The higher content of organic matter at depths of 15 and 20 is thought to be caused by the high level of decomposition by mangrove litter located close to the research site. Depths 5 and 10 contain lower organic matter values because the sediment surface is rinsed by tidal activities, resulting in organic matter not being appropriately suspended. At the lowest depth, the low organic matter content is caused by the muddy sand substrate, so it cannot bind the organic matter.

Mucthar[10] states that the presence of organic matter in sediments varies the content of organic matter in the middle and bottom of the waters, which has a higher value than on the surface. The results of measuring organic matter obtained show that organic matter on Koneng Beach is relatively low. This low organic matter is caused by the high content of sandy mud fraction that dominates the waters of Koneng Beach. This situation follows in Sitindaon9, which states that sandy sediments have less organic matter content than than

Epipelic Diatom Classification

All epipelic diatoms in Table 4 belong to the class Bacillariophyceae and comprise 19 general epipelic diatoms at the study site.

The orders found at the study site were as many as ten orders. In Dellarossa et al.[11] research, the results of the classification of epipelic diatoms in PAB and Lanal Bangsal Aceh Kota Dumai consist of 21 genera. Based on this, the number of diatom genera found on Koneng Beach is almost the same. Diatoms found in this study are various. This is undoubtedly related to the quality of their living habitat, which supports the growth of diatoms. Diatom species diversity is closely related to environmental stability. The more stable an environment is the higher the species diversity. This is due to a stable environment composed of many species with the same or nearly the same abundance of species[12].

Table 4. Epipelic Diatom Classification

No	Order	Family	Genus/Species
1	Aulacoseirales	Aulacoseiraceae	*Aulacoseira* sp.
2	Achnanthales	Cocconeidaceae	*Cocconeis* sp.
3	Bacillariales	Skeletonemataceae	*Skeletonema* sp
4	Bidddulphiales	Bidddulphiaceae	*Isthmia* sp.
5	Coscinodiscales	Coscinodiscaceae	*Coscinodiscus* sp.
6	Fragilariales	Fragilariaceae	*Synedra* sp.
7	Licmophorales	Ulnariaceae	*Ulnaria* sp.
8	Melosirales	Coscinodiscophycidae	*Melosira* sp.
9	Naviculalaes	Amphipleuraceae	*Amphipleura* sp.
10		Pleurosigmataceae	*Gyrosigma* sp
11		Naviculaceae	*Navicula* sp.
12		Pinnulariaceae	*Pinnularia* sp.
13		Pleurosigmataceae	*Pleurosigma* sp.
14		Sellaphoraceae	*Sellaphora sp*
15	Rhopalodiales	Rhopalodiaceae	*Diplomonera sp*
16	Striatellales	Striatellaceae	*Striatella* sp
17	Thalassiosirales	Stephanodiscaceae	*Stephanodiscus sp*
18		Thalassiosirales	*Thalassiosira* sp.
19	Triceratiales	Triceratiaceae	*Triceratium* sp.

Epipelic Diatom Distribution

Based on Table 5, the results of the identification of epipelic diatoms in the waters of Koneng Beach were obtained, namely 19 genera of diatoms such as *Amphipleura* sp, *Aulacoseira* sp, *Cocconeis* sp, *Coscinodiscus* sp, *Diplomonera* sp, *Gyrosigma* sp, *Isthmia* sp, *Melosira* sp, *Navicula* sp, *Pinnularia* sp, *Pleurosigma* sp, *Sellaphora* sp, *Skeletonema* sp, *Stephanodiscus* sp, *Striatella* sp, Synedra sp, *Thalassiosira* sp, *Triceratium* sp, and *Ulnaria* sp.

Most genera are found at a depth of 5 cm, and there are 14 genera, while for the genus found at least at some depth, which is a depth of 50, there are as many as five genera. In Nisa et al.[13] research, the results of epipelic diatom distribution in PAB Dumai City consist of 15 genera and the highest number of diatoms are found in the upper layer with 12 species. This shows that the genus in Koneng Beach is more numerous than in PAB. The differences in the composition of diatom types in each zone are thought to be caused by several genera that are tolerant of extreme water bottom conditions and prolonged exposure to the open air. According to Mulyadi[14], microalgae that live in intertidal areas are microalgae that live between tides so that periodically they experience dry periods (lowest in the atmosphere), which at low tide cause differences in a genus that appear.

Abundance of Epipelic Diatoms

The abundance of epipelic diatoms can indicate waters due to their sensitivity to environmental conditions. Table 6 shows that the abundance of epipelic diatoms in each sediment layer ranges from 5,291–39,983 ind/cm^2 with an average of 6,859–36,453 ind/cm^2. The highest value of epipelic diatom abundance is found in the 5 cm layer, with a value of 39,983 ind/cm^{2,} and the lowest epipelic diatom abundance value is in the 50 cm layer, which with a value of 5,291 ind/cm^2. Compared to research conducted by Sitindoan et al.[9] in Teluk Bayur, the highest diatom abundance is 10,812 ind/cm^2. Based on this, the abundance of diatoms in Koneng Beach is higher than in Bayur Bay. The higher abundance of epipelic diatoms in Koneng Beach is due to physical and chemical

factors that support the growth of epipelic diatoms.

Table 5. Epipelic Diatom Distribution

No	Species	Depth (cm)									
		5	10	15	20	25	30	35	40	45	50
1	*Amphipleura* sp	+	+	+	+	+	+	+	+	+	+
2	*Aulacoseira* sp	-	-	-	-	-	+	+	-	+	-
3	*Cocconeis* sp	+	+	+	+	+	+	+	+	-	-
4	*Coscinodiscus* sp.	+	+	+	+	+	+	-	+	+	-
5	*Diplomonera sp*	+	-	+	-	+	+	-	-	-	-
6	*Gyrosigma* sp	-	-	-	+	-	+	-	+	-	-
7	*Isthmia* sp	+	+	+	+	+	+	+	+	+	+
8	*Melosira* sp	-	+	-	-	-	-	-	-	-	-
9	*Navicula* sp	+	+	+	+	+	+	+	+	+	+
10	*Pinnularia* sp	+	+	+	+	+	+	+	+	+	-
11	*Pleurosigma* sp	+	+	+	+	-	-	-	+	-	-
12	*Sellaphora* sp	+	-	+	+	+	-	+	+	-	-
13	*Skeletonema* sp	+	+	-	+	+	+	-	-	-	-
14	*Stephanodiscus* sp	+	+	+	+	+	+	+	+	+	+
15	*Striatella* sp	-	-	+	-	-	+	-	-	-	-
16	*Synedra* sp	+	+	+	+	+	+	+	-	-	+
17	*Thalassiosira* sp	+	+	-	-	-	+	+	+	-	-
18	*Triceratium* sp	-	+	-	-	-	-	+	-	-	-
19	*Ulnaria* sp	+	-	+	+	+	-	-	-	+	-
Total	19	14	13	13	13	12	14	11	11	8	5

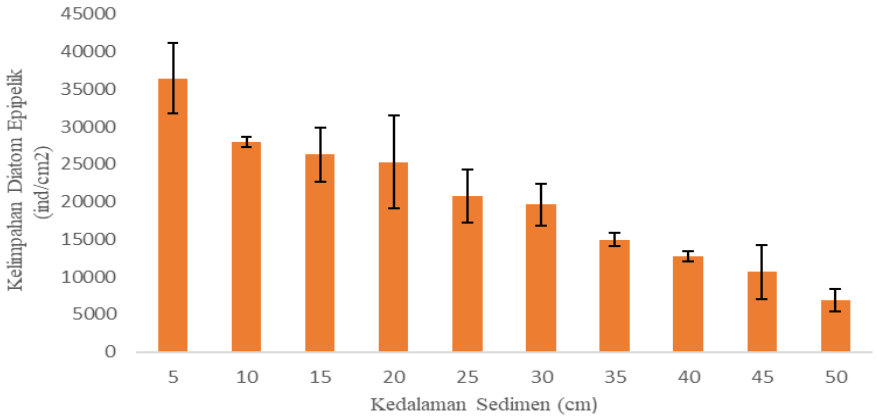

Figure 3. Abundance of Epipelic Diatoms

Figure 3 shows that the average abundance of diatoms in each layer is different and experiences a decreasing graph pattern. The average abundance of diatoms is the more profound the sediment layer, the less the abundance of epipelic diatoms is. The difference in abundance in each layer is due to the intensity of light that is more received by the upper layer (surface). Therefore, the lower layers receive less light intensity, which leads to a lower chance of photosynthesis. Fajrina et al.[15] explain that light intensity and depth affect the abundance of diatoms vertically. In the lower layers, due to the absence of sunlight, the abundance of epipelic diatoms is influenced by other factors, such as organic matter, nitrates, phosphates, and others.

Relationship of Organic Matter to Epipelic Diatom Abundance

The results of the linear regression analysis conducted using Microsoft Excel software on the relationship between organic matter content and epipelic diatom abundance can be seen in Figure 4.

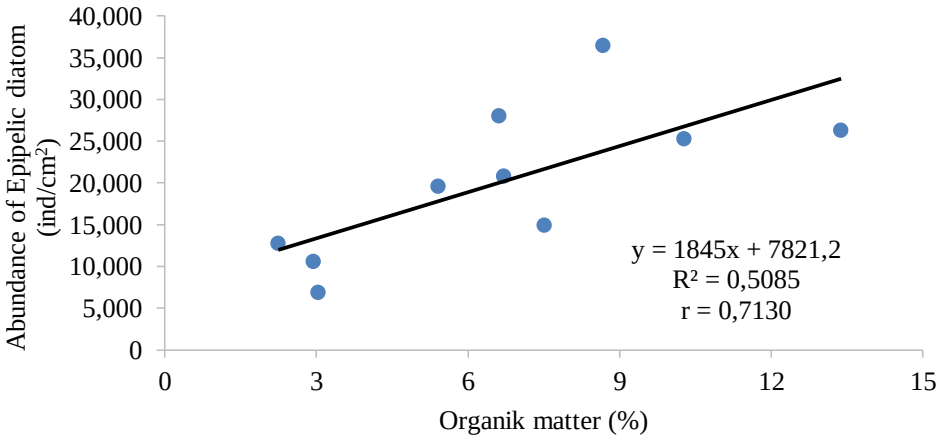

Figure 4. Relationship of Organic Matter to Epipelic Diatom Abundance

The results of linear regression analysis conducted using Microsoft Excel software between the content of organic matter and the abundance of epipelic diatoms in the waters of Koneng Beach obtained regression equation y = 1845x + 7821.2 (Figure 3). The value of R^2 is 0.5085, which means that the influence of organic matter content on the abundance of epipelic diatoms is 50.85%. While the r value is 0.7130, the relationship of organic matter content to the abundance of epipelic diatoms is strong. Sitindaon et al.[9] obtained the results of the relationship between organic matter content and epipelic diatom abundance in Teluk Bayur with the regression equation y = - 462.16 + 1520.5x. The value of R^2 = 0.5178 and the value of r = 0.7175. Based on these results, it can be seen that the relationship between organic matter and the abundance of epipelic diatoms in Koneng Beach and Teluk Bayur is almost the same.

Based on Figure 4, it can be seen that organic matter in sediments has a solid relationship with the abundance of epipelic diatoms. Organic matter is one of the food sources for biota in sediments such as epipelic diatoms. The organic matter in Koneng Beach has a 50.85% effect on the abundance of epipelic diatoms, and this suggests that other factors, such as nitrates and phosphates, influence some of it.

Nitrates and phosphates are important nutrients for the growth and metabolism of phytoplankton. Phosphates and nitrates are very important because they are limiting factors and affect phytoplankton productivity, but their levels in seawater are trim. Phosphate and nitrate nutrients are needed to maintain cell membrane function and silica for cell wall formation, especially in diatoms[16]. Hawari et al.[2] stated that organic matter is a food source for marine life generally found in substrates, so its dependence on organic matter is substantial. Therefore, organic matter is important for the life of benthos organisms in sediments.

4. CONCLUSION

The sedimentary organic matter content in Koneng Beach waters is 2.55–13.38%. Diatomaceous identification found 19 species of epipelic diatoms. Then, the average value of epipelic diatom abundance in Koneng Beach ranged from 6,859–36,453 ind/cm^2. Based on the results of linear regression analysis between the content of organic matter and the abundance of epipelic diatoms in the waters of Koneng Beach.

Further research is needed to analyze the vertical content of phosphate, nitrate, and epipelic diatom silicate. The government and surrounding communities should continue to protect the marine environment from environmental pollution.

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