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THE EFFECT OF PLASTIC COVERS WITH DIFFERENT COLOR ON THE TYPE AND ABUNDANCE OF EPIPELIC DIATOMS IN THE NATURAL LOVERS INTERTIDAL AREA (PAB) CITY OF DUMAI

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ABSTRACT

The purpose of this study was to determine the effect of the plastic cover with different colors on the type and abundance of epipelic diatoms. This research was conducted in March 2022 which is located in the Pecinta Alam Bahari (PAB) area of Dumai City. The method used is an experimental method with plastic cover treatment with different colors. This experiment has one factor, namely plastic color, with four levels of treatment, namely no plastic (control), clear, red, and black colors. The type of plastic used is the same type of plastic. The experimental units are made of iron which is assembled with a size of 1x1m and 12 subunits are measuring 10x10 cm. Observations were made every day for three consecutive days. The results showed that there were 15 species of epipelic diatoms, where the species that were often found every day were *Cosdisnodiscus* sp., *Gyrosigma* sp., *Navicula* sp., and *Pleurosigma* sp., *Skeletonema* sp, *Striatella* sp, *Synedra* sp. The abundance of diatoms in the treatment without plastic ranged from 38993.8 - 68239.2 ind/cm^2, the clear plastic cover ranged from 39880.04 to 67353.0 ind/cm^2, the red plastic cover ranged from 31904.0 to 69125.4 ind/cm^2, and the black plastic cover ranged from 28359.14 – 54945.83 ind/cm^2. The results of the One Way Anova test between treatments showed a significant difference every day, except on day 0 which was not significantly different.

Keywords: Plastic color, Epipelic Diatoms, Abundance, Intertidal Zone, Dumai

I. INTRODUCTION

Phytoplanktons are microscopic organisms whose lives float or float in water, both fresh and marine waters. The existence of phytoplankton is very necessary for maintaining the survival of aquatic ecosystems and plays an important role in the food chain in the sea. Phytoplankton is the basis of the food chain (primary producer) and can be used as a parameter of the fertility level of water. The most common group of phytoplankton found in tropical marine waters is the diatoms (*Bacillariophyceae*). Diatoms can live floating in the water column and attach to certain substrates; one of the living diatoms attached to the substrate is the epipelic diatom.

Epipelic diatoms are diatoms that live attached to the surface of bottom sediments, therefore their types and abundance are strongly influenced by bottom conditions[1]. These diatoms can describe changes in water conditions because of their relatively sedentary existence, so they can be used as bioindicators of the aquatic environment. Epipelic diatoms are often found in the intertidal zone. The intertidal zone or tidal zone is that part of the coast that is inundated with water during high tide (turns into water) but dry during low tide (turns into land)[2].

Community structure is an ecological study that studies an ecosystem and its relationship with environmental factors.

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Community structure examines the composition, abundance, and diversity of a body of water concerning the environment and disturbances, physical, chemical, and biological factors. Several parameters that are usually used to describe community structure are species composition, species abundance, species diversity, species uniformity, and species dominance.

The Pecinta Alam Bahari (PAB), also known as Bandar Bakau, is a mangrove conservation area located in Pangkalan Sesai Dumai Barat District, with an area of up to 20 ha[3]. From observations made on the bottom of the waters in PAB, there are many different types of waste, including plastic waste that have different colors and sizes. The presence of plastic waste in the PAB area is thought to originate from the activities of the people who visit the area around the beach.

Plastic waste is a serious threat to marine ecosystems. More than 690 marine species have been affected by this plastic waste, both in the size of debris (debris) and small ones (microplastics) which were observed in the digestive tract of organisms from various trophic levels of the food chain[4]. Various plastic wastes in rivers and seas can threaten the sustainability of diatom resources found around the bottom of the waters.

Plastic waste has a variety of colors, colored plastic types generally come from recycled plastic materials, and black plastic is more dangerous than other colors because this plastic is made from used plastic which has been recycled more than three times[5]. While clear plastic relatively does not use recycled raw materials. The various colors of plastic scattered around the bottom of the PAB waters are likely to affect the community structure of the epipelic diatoms so it is feared that they can interfere with primary productivity. Based on the description above, the authors are interested in researching the effect of various plastic covers (clear, red, and black plastic) on the community structure of epipelic diatoms at the bottom of the waters in the PAB Dumai area.

2. RESEARCH METHOD

Time and Place

This research was conducted in March 2022 which is located in the Marine Nature Lovers (PAB) area of Dumai City. The placement of the experimental unit can be seen in Figure 1.

Figure 1. Placement of the experimental unit (after being placed)

The method used in this study is the experimental method. Species and abundance analyses were carried out at the Marine Biology Laboratory, Department of Marine Science, Faculty of Fisheries and Marine, Universitas Riau.

This experiment has one factor, namely the color of the plastic with four treatment levels, namely control (without plastic), clear, red, and black colors accompanied by three replications. The plastic used is the same type of plastic. Plots made of iron are assembled with a size of 1x1 m subplots measuring 10 x 10 cm with 12 subplots. Observations were made for 3 days (once a day) at low tide accompanied by measurements of water quality in the form of temperature, current speed, brightness, salinity, pH, nitrate, and phosphate.

Observations were made by removing the plastic in the sub-plot and taking diatom samples. Diatom samples were taken using a brush with an area of 5 x 5 cm and then sprayed with distilled water, as well as diatoms that were not covered with plastic.

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Then the sample was collected in a sample bottle until the volume of the concentrate became 100 ml, then labeled and preserved with 4-5 drops of Lugol 4%. Furthermore, nitrate and phosphate samples were taken to the laboratory for analysis. To calculate the number of epipelic diatoms, 12 visual fields were observed. Epipelic diatoms were observed using an Olympus CX 21 microscope with a magnification of 10x10 and identified using the identification book Davis[6].

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

Information :

N = Number of epiphytic diatoms per unit area (Ind/cm^2)
Oi = Area of the cover glass (625 mm^2)
Op = The unit area of view of the microscope is 100x magnification (1.306 mm^2)
Vr = The volume of solution in the sample bottle (50 ml)
Vo = The volume of 1 drop of the sample (0.06 ml)
A = Area of the scraping area (25 cm^2)
n = The number of epiphytic diatoms counted
p = number of visual fields (12)

The results of the calculations are then presented in the form of tables and graphs and then discussed descriptively and related to the existing water conditions, while to see the differences in the abundance of epipelic diatoms in intertidal waters covered with plastic and those that are not covered with various colors of plastic (clear, red and black plastic) using a statistical method, namely one-way ANOVA test using SPSS v.25 software.

3. RESULT AND DISCUSSION

Water Quality Parameters

The results of water quality measurements at each research station can be seen in Table 1.

In Table 1 it can be seen that the range of water quality parameter values every day in the intertidal zone of the Pecinta Alam Bahari (PAB) of the city of Dumai has relatively the same value and can be categorized as still good for supporting diatom life.

Table 1. Average water quality measurement results

Parameter	Day			
	0	**1**	**2**	**3**
Temperature (°C)	26,67	27.5	27,7	28
Current speed (m/s)	0.17	0.18	0.17	0.2
Brightness (m)	0.6883	0.6335	0.6023	0.6051
Salinity (‰)	28	25	26	23
pH	7,1	7,8	8,1	8,23
Nitrates (mg/L)	1.92	1.88	1.90	1.91
Phosphate (mg/L)	0.99	0.97	0.99	1,13

The brightness of Dumai waters shows the ability of light penetration of about 100% to penetrate the water layer at a certain depth. The brightness of the waters is influenced by fine materials floating around in the water, both in the form of organic matter such as plankton, microorganisms, and detritus and in the form of inorganic materials such as mud and sand[5].

Types of Epipelic Diatoms in Each Treatment during the Study

The types of epipelic diatoms found in each treatment can be seen in Table 2. There were 15 species of epipelic diatoms found in all treatments, namely Amphipleura sp, Cosdisnodiscus sp, Cymbella sp, *Ephitemia* sp, *Gyrosigma* sp, *Ithsmia* sp, *Melosira* sp, *Navicula* sp, *Pinnularia* sp, *Pleurosigma* sp, *Sellaphora* sp, *Skeletonema* sp, *Striatella* sp, *Synedra* sp, and *Tricetarium* sp, where the species that are often found every day are *Cosdisnodiscus* sp., *Gyrosigma* sp., *Navicula* sp., and *Pleurosigma* sp., *Skeletonema* sp, *Striatella* sp, *Synedra* sp.

The types of epipelic diatoms found varied in number between treatments, namely 7-12 species. The highest type of epipelic diatoms was found on day 0 treatment without plastic, day 1 on the clear plastic cover, black plastic, and day 3 on the clear and black plastic cover, namely 12 species, while the lowest was on day 2 on closed clear colored plastic, namely 7 species.

Table 2. Types of epipelic diatoms in each treatment during the study

No	Species	Observations (Days)															
		TP				PB				PM				PH			
		0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
1	*Amphipleura* sp	+	+	-	-	-	-	-	+	-	-	+	-	+	+	-	-
2	*Cosdisnodiscus* sp	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
3	*Cymbella* sp	+	+	+	-	+	+	+	+	+	-	+	-	-	+	+	+
4	*Epitheemia* sp	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-
5	*Gyrosigma* sp	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
6	*Ithsmia* sp	+	+	-	-	+	+	+	+	+	-	-	+	-	+	-	+
7	*Melosira* sp	-	+	-	-	-	-	-	+	+	+	-	-	-	-	-	+
8	*Navicula* sp	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
9	*Pinnularia* sp	-	+	-	+	+	+	-	+	-	-	+	+	-	+	-	-
10	*Pleurosigma* sp	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
11	*Sellaphora* sp	+	+	+	+	+	+	+	+	+	+	-	+	+	+	-	+
12	*Skeletonema* sp	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
13	*Striatella* sp	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
14	*Synedra* sp	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
15	*Tricetarium* sp	+	-	+	+	+	+	+	-	-	-	+	-	+	+	-	-
	Total	12	12	12	10	9	11	11	10	12	11	9	10	9	9	12	7

Description: TP = No Plastic; PB = Plastik Bening; Pm = Red Plastic; PH = Black Plastic; 0 = Day 0; 1 = Day 1; 2 = Day 2; 3 = Day 3; + = Found; - = Not Found

Table 3. The abundance of epipelic diatoms in each treatment

Day	Color Plastic	Abundance Diatoms	± Std. Dev Diatom
0	TP	68239,18	± 7623.58
	PB	67352.96	±14687.44
	PM	69125,4	± 7826.91
	PH	54945.83	±13381.61
1	TP	50514.72	±1821.02
	PB	46083.6	±11697.55
	PM	40766,26	±10708,27
	PH	30131.59	±25756.44
2	TP	43424.93	±8723,29
	PB	45197.38	±5133,64
	PM	35448.93	±4188,13
	PH	29245,36	±6839.18
3	TP	38993.82	±7970.54
	PB	39880.04	±9824.25
	PM	31904.03	±5414.91
	PH	28359,14	±4708.02

The abundance of Epipelic Diatoms in Each Treatment

The results of calculating the abundance of epipelic diatoms in the waters of Pecinta Alam Laut (PAB) found different abundances between treatments, which can be seen in more detail in Table 3.

Based on Table 3, it can be seen that the average value of the abundance of epipelic diatoms in the treatment in PAB waters of the city of Dumai has a different abundance value for each treatment. Where the average value of diatom abundance ranges from 64916 - 34784 in/cm^2.

The results of the one-way ANOVA statistical test were carried out to determine the difference in the abundance of epipelic diatoms between treatments in the intertidal zone in the PAB area of Dumai city, which can be seen in Table 4.

Table 4. Results of ANOVA Abundance Diaepipelic tom

One-way ANOVA test	F	p.s. value	p
Day 0	.771	.542	Not significant
1st day	1,199	039	Significant
Day 2	4,483	040	Significant
3rd day	9,353	005	Significant

Based on Table 4, the abundance of diatoms in each treatment has a different value, on treatment day 0 the resulting value is not significantly different (not significant), while on treatment days - 1, 2, and 3 the resulting value is significantly different (significant), so it is necessary to carry out further LSD tests (*Least Significant Difference*).

Plastic waste that enters waters is very easily carried away by currents due to its light mass and water resistance. Plastics that enter the waters will then settle to the bottom of the waters covering the sediment in the waters. Plastic waste that is in the waters enters through human activities such as sea transportation activities, enters through small rivers, the wind blows, and garbage left on the beach[7].

From the results obtained, it can be seen that the average abundance of diatoms in the intertidal zone covered by plastic is lower than that not covered by plastic. intertidal which is covered in plastic has a lower opportunity to carry out photosynthesis due to lack of sunlight, as according to Padang[8], different sunlight intensities can affect the abundance of diatoms.

The diatom abundance value in the clear plastic treatment was higher compared to other plastic treatments because the clear plastic could still transmit sunlight to the surface of the sediment. Light is the main source of energy for photosynthesis and abundance growth. Differences in light characteristics such as spectrum composition (wavelength), intensity, length, and direction of incident light affect the growth of diatoms. In several previous studies, filtering of sunlight using a plastic cover was carried out and the results obtained were that there were differences in the yield of diatom growth due to the color of the plastic.

According to Sulistyaningsih et al.[9], if visible light passes through a clear plastic sheet, the radiation that is released will have the same color as the color of the plastic. So the diatoms under the clear plastic will receive radiation according to the color of the lid. Furthermore, Agnestika et al.[8] stated that the wavelength of light correlates with the color spectrum of visible light, where each color has a different wavelength interval.

The abundance of diatoms in the red and black plastic treatments showed lower abundance values compared to other treatments because the top surface of the black plastic was reflective, so the temperature of the black plastic increased and the intensity of light absorbed by the diatoms was lower. Thus, the metabolic process of diatoms in the black plastic treatment decreased, thus affecting the abundance of diatoms. Therefore, in the black plastic treatment, the abundance of diatoms resulted in a lower abundance value compared to the other treatments.

According to Pakpahan[11], the difference in diatom abundance is caused by differences in the influence of activities around the waters and conditions every day, where every day of observation has a different anthropogenic effect and the supply of nutrients affects the growth of diatoms in the waters. The abundance of diatoms in the waters is also directly influenced by physiological processes such as respiration and photosynthesis such as light, temperature, salinity, and nutrients. The same thing was explained by Rudiyanti[12], stating that the abundance of diatoms in waters is also influenced by the availability of nutrients found in the environment. Influential factors include temperature, pH, and light intensity.

Another factor that supports abundance is optimum temperature. According to Sachlan[13], diatoms have a wide tolerance to temperature. The optimum temperature for the growth of diatoms according to Warner[14] is 20-30 °C. The characters of the genus can be used as water indicators.

In addition to blocking sunlight, the plastic around the PAB area of Dumai City can block seawater which carries nutrients such as nitrate and phosphate which play an important role in the survival of diatoms. These nutrients play a role in marine primary productivity, nutrient cycles, and food webs[15]. On day 3, the nitrate concentration was 1.13 mg/L and phosphate 0.91 mg/L, this was the highest on each research day, this was alleged because it was near the estuary. This is following the opinion of Radiarta & Nyoman[16], namely areas near estuaries or waters near residential areas generally have high levels of nitrate and phosphate.

4. CONCLUSION

The results of identifying the types of diatoms in all treatments found as many as 15 species of epipelic diatoms where the species that are often found every day are *Cosdisnodiscus* sp., *Gyrosigma* sp., *Navicula* sp., and *Pleurosigma* sp., *Skeletonema* sp, *Striatella* sp, *Synedra* sp. The abundance of epipelic diatoms was influenced by different plastic color coverings.

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