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THE DISTRIBUTION AND ABUNDANCE OF TOXIC BENTHIC DINOFLAGELLATES IN MALANG RAPAT COASTAL WATERS OF BINTAN ISLAND, KEPULAUAN RIAU

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ABSTRACT

This research was conducted in May - June 2018 by surveying and taking a sample from Malang Rapat water on the East Coast of Bintan Island, Kepulauan Riau to determine the abundance and distribution of toxic benthic dinoflagellates associated with seaweed (*Sargassum* sp) and seagrass (*Enhalus accoroides*). Samples were taken from four sampling locations which were carried out purposively by taking into account the different anthropogenic activities that occurred in each region. The results of the study found 3 genera of toxic benthic dinoflagellates, namely *Gambierdiscus* sp, *Ostreopsis* sp, and *Prorocentrum* sp. The highest abundance of toxic benthic dinoflagellates associated with *Sargassum* sp was found in station 3, which was 302.279 cells/g, and the lowest at station 4 with (133.529 cells/g), while *E. accoroides* has the highest abundance at station 1 which was 620.65 cells/g). The abundance of toxic dinoflagellates in *Sargassum* sp has a positive correlation with nitrate concentration, but on the contrary, it was negatively correlated with the concentration of nitrate and phosphate in these waters to *E. accoroides.* The measured water quality parameters were still within the tolerance range for the marine organism. Further research is still needed to answer the cause of these differences and whether there are any fluctuations of abundance and the specific appearance of the toxic dinoflagellate.

Keywords: Dinoflagellates, *Sargassum* sp, *E. accoroides*, Kepulauan Riau

1. INTRODUCTION

Dinoflagellates are one of the phytoplankton groups that besides being planktonic and benthic they were also living in association with seagrass, macroalgae, and on coral fractures, sand, and detritus[1]. The abundance of toxic benthic dinoflagellates may cause an increase in ciguatera toxins (ciguatoxin). Ciguatera toxin is produced by dinoflagellates which can then be moved to carnivorous animals through the food chain process. Fish that eat algae that have been attached to benthic microorganisms will become toxins and through the process of biomagnification in the food chain, the largest predatory fish will have the largest accumulation. This toxin is believed to come from several species of dinoflagellates.

Seaweed and seagrass ecosystems are places that can provide protection as well as the substrate for various types of organisms to attach. The density of seaweed and seagrass will increase the abundance of organisms that live in them. The abundance of toxic dinoflagellates in marine ecosystems can cause blooming so which can be detrimental and cause changes in the colour of seawater to red, brownish red, green, or yellow-green so that it covers the surface of the water and inhibits the penetration of incoming sunlight. The resulting consequences are damage to seaweed and seagrass ecosystems and disrupt the balance of aquatic ecosystems[1].

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Malang Rapat is one of the villages in the eastern region of Bintan Island where seaweed (*Sargassum* sp) and seagrass (*E.accoroides*) ecosystems are found in sandy substrates that are scattered in several locations. No study on the presence, distribution, and abundance of toxic dinoflagellates in those marine habitats which are also used by local fishermen to do their fishing activities as well as tourist resorts by both local and international companies.

This study aims to determine the abundance of benthic toxic dinoflagellates in *Sargassum* sp and *E.accoroides* and identify which substrate that is preferred by dinoflagellates to attach. The results of this study could be used as information on the poisonous benthic dinoflagellates on *Sargassum* sp and *E. accoroides* in the coastal water of Malang Rapat, Bintan Regency, Kepulauan Riau Province.

2. RESEARCH METHOD

This research was carried out in May - June 2018 in the Malang Rapat Waters, Bintan Regency, Kepulauan Riau Province. Analysis of nitrate and phosphate and the abundance of toxic benthic dinoflagellates was carried out at the Marine Chemistry Laboratory, Department of Marine Science, Faculty of Fisheries and Marine Sciences, Universitas Riau. The sampling location is divided into 4 stations and each station consists of 3 sampling points (Figure 1).

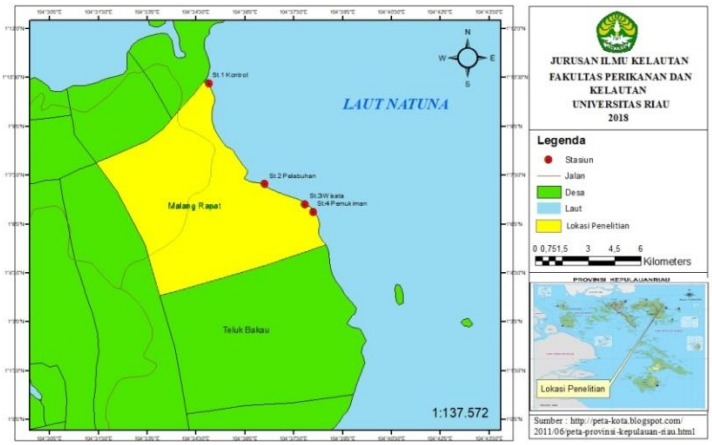


Figure 1. Map of research location in Malang Rapat

The collection of toxic benthic dinoflagellates samples attached to *Sargassum* sp and *E. accoroides* was carried out by following the procedure of Yesou[2], as follows:

Samples are taken perpendicularly to the coastline and heading towards the sea at a distance of 10 m. Samples of dinoflagellates on seaweed and seagrass leaves were taken by cutting at the ends of the clump slowly and then inserted into plastic bags were shaken for 3-4 minutes beforehand to release the dinoflagellates from *Sargassum* sp and *E.accoroides,* then the sample was filtered using a 350-micron sieve to separate the dinoflagellate samples from seaweed and seagrass leaves. The filtered sample was taken as much as 100 ml and filtered again using a vacuum pump with 20-micron filter paper. Filter paper containing dinoflagellate sample were put in 15 ml of filtered water into the sample bottle. Then the samples were added with 4% Lugol 4 - 5 drops and then closed tightly. The sample bottles were labeled according to the station and the sampling point respectively. Then the sample bottles were put into the ice box and brought back for further analysis in the laboratory. The collection of water samples for nitrate and phosphate as well as the measurement of other water quality abundance of benthic dinoflagellates in the samples was done by referring to Yesou[2]. All data analyses were performed by SPSS 16 Software.

3. RESULT AND DISCUSSION

General Conditions of Research Locations

Malang Rapat is located in Gunung Kijang District of Bintan Regency and administratively bordered inland by neighboring villages of Berakit, Toapaya, and Teluk Bakau, while the east side is in the area of the South Cina Sea. Judging from the topography, the altitude is 0-20 m above sea level, the area of Malang Rapat Village is 771,225 Ha with an average rainfall of 20 mm/year, and the average temperature per year is 30ºC.

Malang Rapat waters are located along residential areas, tourist resorts, and fisheries activity areas. In these areas, there are many types of seaweed, corals, and other marine plants. These waters have sand substrates in almost all coastal areas.

Water Quality Parameters

Water quality measurements were carried out in conjunction with toxic dinoflagellate benthic sampling around the station area for dinoflagellate sampling. Measurements are made during the day during high tide. The measured water quality parameters are shown in Table 1

Table 1. The average measurement of water quality parameters for each station

Station	Water quality parameters					
	Temperature (^oC)	salinity (‰)	pH	Current (m/det)	Nitrate (mg/l)	Phosphate (mg/l)
1	33	30	9	0,18	0,019	0,059
2	31	30	9	0,07	0,026	0,037
3	33	35	8	0,06	0,047	0,063
4	33	32	8	0,07	0,026	0,046

The measurement results of water quality parameters show differences in each station. This difference indicates that each station has different water characteristics. The measurement results of nitrate and phosphate obtained have exceeded the quality standards. Based on MENKLH Decree No. 51 of 2004[3], stated that the quality standards for nitrate and phosphate concentrations of seawater that are feasible for the life of marine biota are 0.008 mg/l and 0.015 mg/l. The high nitrate and phosphate concentrations were not followed by the high abundance of benthic dinoflagellates. Chateau-Degat et al.[4] stated that factors affecting the abundance of benthic dinoflagellates are toxic not only to nutrients, but also to water quality factors such as temperature, salinity, pH, light intensity, and competition with other benthic microorganisms.

Relationship between Nitrate and Phosphate Content with Toxic Benthic Dinoflagellates Abundance in *Sargassum sp* and *E.accoroides*

Generally, the abundance of dinoflagellate is affected by nutrients, that is, in water rich in nutrients, dinoflagellate abundance will also be high[5]. The relationship between nitrate concentration and the abundance of toxic benthic dinoflagellates in *Sargassum* sp can be seen in Figure 2.

The results of simple linear regression analysis showed that the relationship of nitrate concentration with dinoflagellate abundance had a positive relationship with the equation y = 187.3 + 323.6x with a coefficient of determination (R^2) with a value of 0.008 and a correlation coefficient (r) with a value of 0.089 (very weak relationship). This means that the determination coefficient value shows that nitrate concentration has an effect of 0.8% on the abundance of dinoflagellate while

99.2% is influenced by other factors such as water quality parameters.

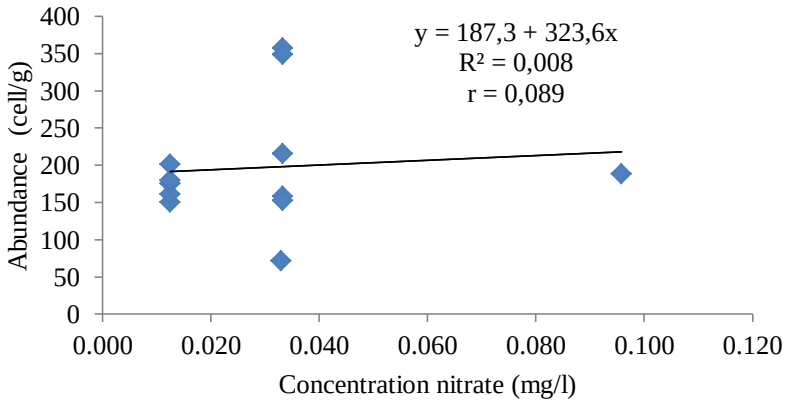


Figure 2. Relationship of nitrate concentration with toxic benthic dinoflagellate abundance in *Sargassum* sp

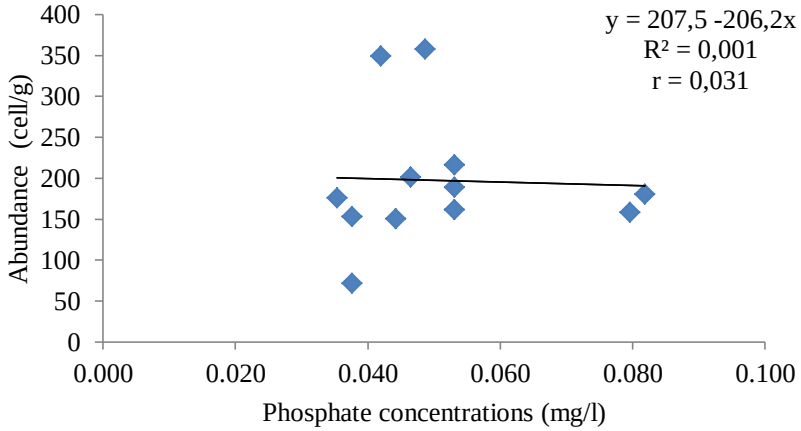


Figure 3. Relationship of phosphate concentration with toxic benthic dinoflagellate abundance in *Sargassum* sp

The results of simple linear regression analysis showed that the relationship between phosphate concentration and dinoflagellate abundance (Figure 3) had a negative relationship with the equation y = 207.5-206.2x with a coefficient of determination (R^2) of 0.001 and the correlation coefficient (r) with a value of 0.031 (very weak relationship). The coefficient of determination shows that the phosphate concentration has an effect of 0,1% on the abundance of dinoflagellate and 99.9% is influenced by other factors.

The results of simple linear regression analysis of the relationship between nitrate concentration and dinoflagellate abundance have a negative relationship with the regression equation y = 486.32-3961.4x with a coefficient of determination (R^2) with a value of 0.154 and a correlation coefficient (r) with a value of 0.392. This means that the coefficient of determination shows that nitrate concentration has an effect of 39.2 on the dinoflagellate abundance while 60.8% with a correlation coefficient of 0.329 which indicates that the correlation relationship is moderate (Figure 4).

The results of simple linear regression negative relationship of phosphate concentration to the abundance of dinoflagellate obtained a relationship with the equation y = 392.43-476.53x with a coefficient of determination (R^2) of 0.001 and a correlation coefficient (r) with a value of 0.031 (Figure 5). The coefficient of determination shows that phosphate concentration has an effect of 3.1% on the

abundance of dinoflagellate and the other 96.9% is influenced by other factors. While the value of the correlation coefficient with a value of 0.031 shows that the phosphate concentration has a weak relationship between phosphate concentration and dinoflagellate abundance.

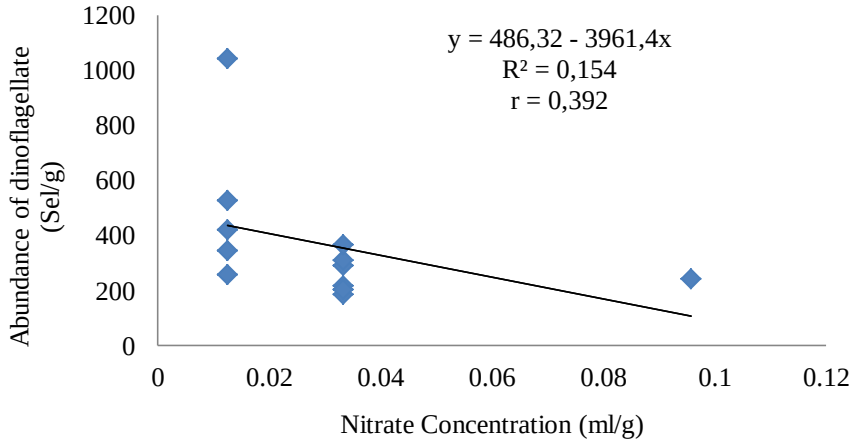


Figure 4. Relationship on nitrate concentration with toxic benthic dinoflagellate abundance on *E.accoroides*

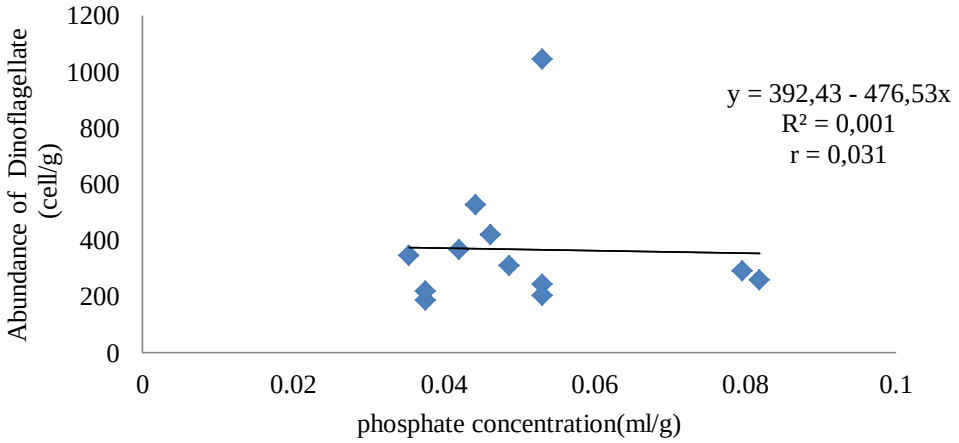
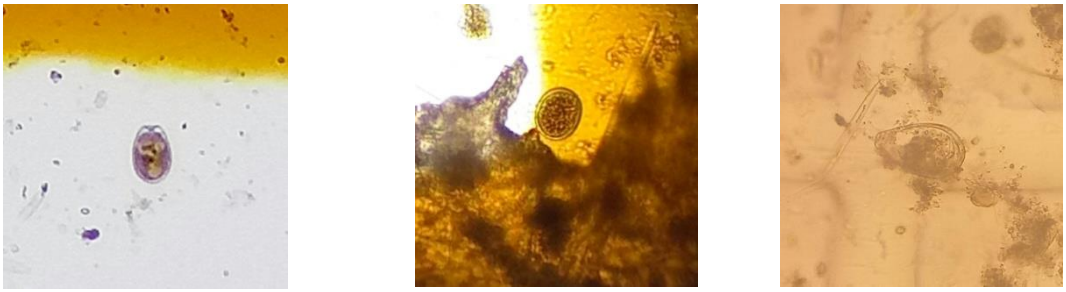


Figure 5. Relationship on phosphate concentration with toxic benthic dinoflagellate abundance on *E.accoroides*



(a) (b) (c)

Figure 6. a.*Prorocentrum*, b. *Gambierdiscus*, c. *Ostreopsis*

Distribution and Abundance of Toxic Benthic Dinoflagellates

Dinoflagellates identified in Malang Rapat water were found in 3 genera, namely genus *Prorocentrum, Gambierdiscus*, and *Ostreopsis* (Figure 6).

The total abundance of benthic poisonous dinoflagellates Malang Rapat waters of the genus *Prorocentrum*,

Gambierdiscus, and *Ostreopsis* on the *Sargassum* sp substrate is 196,939 cells/g wet weight while the total abundance of benthic dinoflagellates is toxic on the *E.accoroides* substrate 364.01 cell/g wet weight. The average abundance of toxic dinoflagellate benthic on *Sargassum* sp and *Enhalus* sp substrates can be seen in Table 2.

Table 2. The abundance of toxic benthic dinoflagellates on *Sargassum* sp and *Enhalus accoroides* (cell/g)

Genus	Substrat	Stasiun				Rata-rata
		1	2	3	4	
Prorocentrum	*Sargassum* sp	79,836	75,016	108,425	168,972	108,062
	E. accoroides	415,11	163,68	164,39	203,02	236,55
Gambierdiscus	*Sargassum* sp	48,329	31,216	55,639	86,166	55,337
	E. accoroides	160,25	60,24	41,32	74,9	84,18
Ostreopsis	*Sargassum* sp	28,449	27,297	30,765	47,652	33,540
	E. accoroides	45,29	26,49	13,62	87,72	43,28

The abundance of the highest amount of benthic poisonous dinoflagellates found in the genus *Prorocentrum*. This is because this genus has a wide distribution in waters around the world, from subtropical to tropical regions, and is associated with sediments, detritus, coral fractures, sand, the surface of macroalgae, seagrasses, and algae that float (Fukuyo *in* [6]) and this genus is more like aquatic habitats that are affected by strong water shock or movements. The genus *Prorocentrum* is included in toxic dinoflagellate which can cause various stomach ailments and the nervous system diseases *Diearrethic Shelfis Poisoning* (DSP). Widiarti[7] also found the genus Prorocentrum attached to *E.accoroides* seagrass in Panggang Island, thousand Islands with the number of individuals reaching 355 cells/10 cm^2 of seagrass leaves. While the few genera found is *Ostreopsis*. For more details, the abundance in each epiphytic dinoflagellates genus can be seen in the graph in Figure 7.

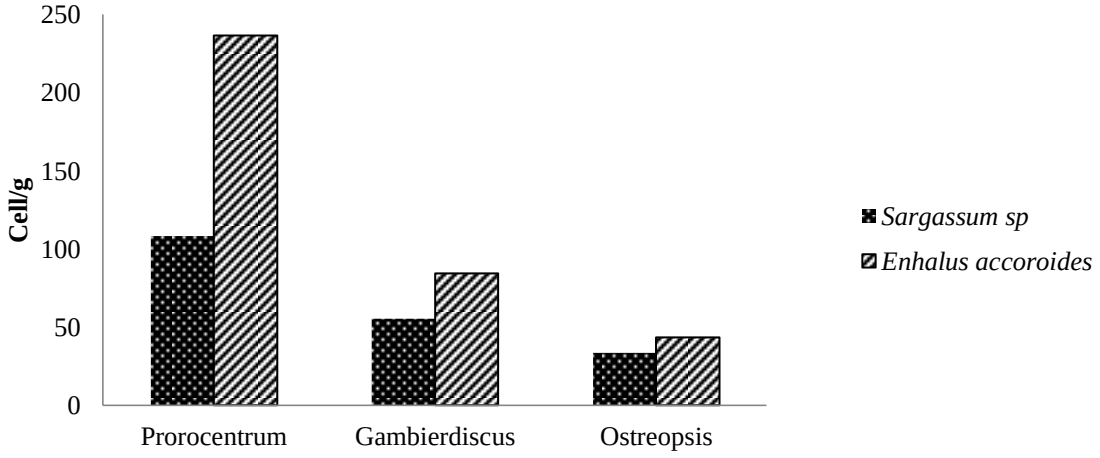


Figure 7. The abundance of toxic benthic dinoflagellate

In Figure 7, it can be seen that the benthic abundance of poisonous dinoflagellates from the genera *Prorocentrum*, *Gambierdiscus*, and *Ostreopsis* in the Malang Rapat Waters was found more on *Enhalus accoroides* substrate than *Sargassum* sp. Anderson and Lobel[8] stated that benthic dinoflagellates

can also attach to seagrasses. Like macroalgae, seagrasses are also good attachment places for some benthic organisms, because seagrass leaves are substrates with nutrients, exchange of water, and access to light needed by benthic organisms. As a habitat, seagrass biota provides protection attachment because the leaves can support a large number of benthic species with a substrate suitable for attachment[9].

T-test results, obtained t-count = 3.1206; p. value = 0.0446; t table = 2.9200. This value is known that the t-count value is greater than the t-table value while the p-value is smaller than the alpha value, so the accepted hypothesis is H_1 is the *E.accoroides* substrate *is* better than the substrate of *Sargassum* sp.

4. CONCLUSION

In the waters of the Malang, Rapat found 3 toxic dinoflagellate benthic genera namely *Prorocentrum*, *Gambierdiscus*, and *Ostreopsis*. The most dominant found in each station was Prorocentrum. Based on its abundance value at each station, it was found that the abundance of *Enhalus accoroides* substrate was higher than *Sargassum* sp.

5. ACKNOWLEDGEMENTS

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REFERENCES

1. Anggraini F, Soedjiarti T, Widiarti R. Dinoflagellata epifitik pada lamun *Enhalus acoroides* di rataan terumbu karang Pulau Pari, Kepulauan Seribu. *Jurnal Akuatika,* 2012; 1(1): 35-45.
2. Yeosu Project Information and Methods. Use of an artificial substrate to asses field abundance of benthic HAB (BHAB) dinoflagellates, 2013.
3. KEPMEN LH. Pedoman Penetapan Baku Mutu Lingkungan Hidup. Kantor Menteri Negara Kependudukan dan Lingkungan Hidup 2004. Keputusan Menteri Negara Kependudukan dan Lingkungan Hidup No 51 Tahun 2004 Tentang Baku Mutu Air Laut. Sekretariat Negara, Jakarta, 2004; 10p.
4. Chateau-Degat M, Chinain M, Cerf N, Gingras S, Hubert B, Dewailly E. Seawater temperature *Gambierdiscus* spp. variability and incidence of ciguatera poisoning in French Polynesia. *Harmful Algae,* 2005; 4: 1053-1062
5. Lalli CM, Parsons T.R. *Biological Oceanography: An introduction*. Elsevier,Oxford, 2006; 307p
6. Nitajohan YP. *Kelimpahan dinoflagellata pada lamun Enhalus acoroides*. Institut Pertanian Bogor, 2008.
7. Widiarti, R. Dinoflagellata penyebab ciguatera fish poisoning (CFP) di Perairan Pulau Belitung, Bangka Belitung. Prosiding Pertemuan Ilmiah Nasional Tahunan VII ISOI 2010. Ikatan Sarjana Oseanologi Indonesia (ISOI), Jakarta, 2010; 17-24
8. Anderson DM, Lobel PS. The continuing enigma of ciguatera. Biological Bulletin, 1987; 172(1): 89-107.
9. Pratiwi R, Al-Hakim I, Aswandy I, Genisa AS, Mujiono. Komunitas fauna epifitik Padang Lamun Pulau Pari, Kepulauan Seribu. Pusat Penelitian dan Pengembangan Oseanologi (P3O-LIPI), Jakarta, 1997; 62-71.