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Structure And Community Of Dinoflagellata In The Bungus Bay Kabung Waters Area

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Abstract – Dinoflagellates have both beneficial and detrimental roles in the ecosystem. Marine dinoflagellates play an important role in aquatic ecosystems as primary producers and grazing is experienced by some dinoflagellates. One of the detrimental roles of dinoflagellates is the occurrence of algal blooms that cause changes in the color of seawater. This research was carried out from December 2020 to July 2021 in the Bungus Bay Kabung area, Padang City. This study aimed to analyze the composition and structure of the Dinoflagellate community in the Bungus waters area of Kabung Bay, Mota Padang. This study used a survey method and the sampling was determined by purposive random sampling. Based on this research, 17 species of Dinoflagellates were found with 2 classes, namely Dinophyceae and Noctilucophyceae. The Dinoflagellate diversity index in the Bungus Bay Kabung waters area is included in the medium category with an uneven distribution. 8 species of Dinoflagellates could potentially cause algal blooms, namely Blixaea quinquecornis, Prorocentrum gracile, Prorocentrum micans, Protoperidinium brevipes, Protoperidinium pellucidum, Protoperidinium subpyriforme, Scrippsiella acuminate, and Noctilans scintilans.

Keywords – blooming algae, diversity, density

I. Introduction

Dinoflagellates are also known as Dinophyceae which are a class of the phylum Pyrrophyta. Dinoflagellates generally consist of single-celled phytoplankton species that are capable of swimming. The ability to move of Dinoflagellate species is due to the presence of flagella embedded in circular grooves in the cell (Sulastri, 2018). Dinoflagellates can be found in all types of aquatic ecosystems. Nearly half of the species in this group are photosynthetic, the other half are heterotrophic (Hoppenrath and Saldarriaga, 2012). Dinoflagellates live cosmopolitan scattered throughout the world's waters, both cold and warm waters (Turkoglu, 2013).

Dinoflagellates have both beneficial and detrimental roles in the ecosystem. Marine dinoflagellates play an important role in aquatic ecosystems as primary producers and *grazing* experienced by some dinoflagellates (Hinder *et al.,* 2012). One of the detrimental roles of dinoflagellates is the occurrence of *algal blooms* that cause changes in the color of seawater. *Blooming algae* from the Dinoflagellate group which are toxic can cause death to other marine organisms, and can even cause human death due to the accumulation of toxins they contain (Sediadi, 1999).

Dinoflagellate reproduction can take place in a short time. Double cleavage depending on the type takes place in the range of 1-15 days. During multiple divisions, Dinoflagellates will form cysts during the *non-motile period.* The dynamics of the growth of this organism can rapidly multiply in a relatively short time, grow with high density, and abundance, and spread wide so that it can cause a population explosion *(algae blooming)* (Sediadi, 1999).

Blooming algae is an increase in the population of phytoplankton that can cause harm, to humans, marine biota, and the surrounding ecosystem (Wiadnyana, 1996). Dinoflagellates are best known for causing harmful *algal* blooms. About 75-80% of the toxic phytoplankton species are dinoflagellates which often kill fish or shellfish directly (Hoppenrath and Saldarriaga, 2012). The increase in the frequency and intensity of *algal blooms* can be influenced by anthropogenic pressure in coastal areas. This *blooming* alga causes mass death in fish due to the large number of cells that clog the gills, depleting oxygen. In addition, *algal blooms* also have a direct impact on human health who consume fish as a source of protein (Berdalet *et al.,* 2016). Dinoflagellate venom is one of the most dangerous biotoxins known that often accumulate in shellfish or fish. When eaten by humans, it will cause diseases such as *paralytic shellfish poisoning* (PSP), *neurotoxic shellfish poisoning* (NSP), *diarrheal shellfish poisoning* (DSP), and ciguatera. It has been associated with major human health problems, particularly in estuarine environments (Hoppenrath and Saldarriaga, 2012), and also negatively affect human well-being, particularly in coastal ecosystem services such as fisheries, tourism, and recreation (Berdale *et al.,* 2016). Some of the genera of Dinoflagellates that cause *blooms algae* are *Prorocentrum* spp. and *Alexandrium* spp. (Hinder *et al.,* 2012).

Anthropological activities in coastal areas such as residential housing, tourism aquaculture activities, ferry port activities, Ocean Fishing Ports, Pertamina ship activities, coal ships for PLTU, and passenger transport ships can cause an increase in nutrients in the waters. The waters of Bungus Kabung Bay have recently become the center of attention because at the end of 2019 there was an *algae blooming event. Bloom* The *algae* that occurred in Bungus Teluk Kabung was caused by *Noctiluca scintillans* associated with *Pedinomonas noctilucae*. The events in the bay can be related to several things, namely the change of seasons and the movement of ocean currents in coastal areas, global climate change which causes warmer seawater temperatures and increased acidity of seawater, as well as high levels of nutrients in the form of nitrates and phosphates carried from the mainland. such as runoff from agricultural land and household waste. The occurrence of *algal blooms* is further strengthened by a weak bay current so that all nutrients accumulate in the area (Rakyatsumbar. id, 2019).

Noctiluca scintilans does not produce toxins but accumulates toxic ammonia, which is then excreted into the surrounding waters so that this species acts as a killer agent in *blooms* (Turkoglu, 2013). The abundance of this species covers the surface of the waters of the Teluk Kabung which causes many fish to die due to lack of oxygen. Mass death of fish certainly harms aquatic ecosystems and the economy of the community. Therefore, it is necessary to research the structure of the Dinoflagellate community in the Bungus Bay Kabung area.

II. RESEARCH METHODS

This research was conducted from December 2020 - July 2021. A sampling of Dinoflagellates was carried out in the Teluk Kabung Coastal Area with 3 sampling points. Dinoflagellate identification was carried out at the Laboratory of Animal Ecology, Department of Biology, Faculty of Mathematics and Natural Sciences, Andalas University. This research method uses a survey method. Determination of the sampling location of Dinoflagellates was carried out by *purposive random sampling.* The tools used in this study were net plankton no. 25, GPS, *lammote water sampler*, sample bottle, dropper, gloves, mask, digital camera, and microscope. The materials used are 40% formalin.

Dinoflagellate sampling at each location (Figure 1) using a 100 l *Lammote bottle sampler*, then filtered using plankton net No. 25. At each location three replicates were carried out. The filtered sample was put into a sample bottle and then given 40% formalin which was diluted so that the formalin solution in the sample became 4% and labeled with label paper, and the data were analyzed.

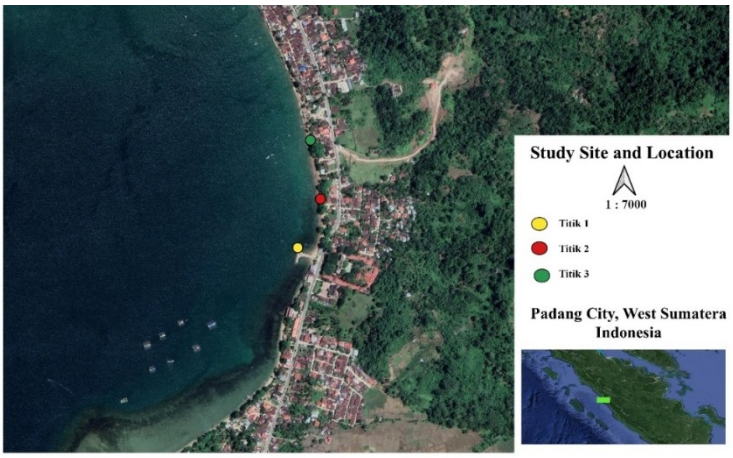


Figure 1. Research Location (GIS)

Data analysis

a. Density of Dinoflagellates

$$K = \frac{axc}{l}$$

Information:

K = Number of Dinoflagellates per liter (ind./l)

a = The average number of individuals of a Dinoflagellate species in 1 ml

c = Volume of sample concentrate (ml)

l = Volume of filtered water (l)

b. Shannon-Wienner Diversity Index (Michael, 1984)

$$H' = -\sum_{i=1}^{s} \text{pilnpi}$$

Information:

H' = Diversity index

ln = Natural logarithm

pi = (the ratio of the number of individuals of a species to the whole species)

S = Number of all species

c. Equitability Index (E)

$$E = \frac{H'}{\ln(S)}$$

Information:

E = Equitability Index

H'= Shannon-Wienner diversity index

S = number of species

III. RESEARCH RESULT

The composition of Dinoflagellates found in the Bungus waters of Teluk Kabung consisted of 17 species and 2 classes with a relative density of 5%, 3 species were found, namely *Blixaea quinquecornis, Protoperidinium pellucidum*, and *Prorocentrum micans*.

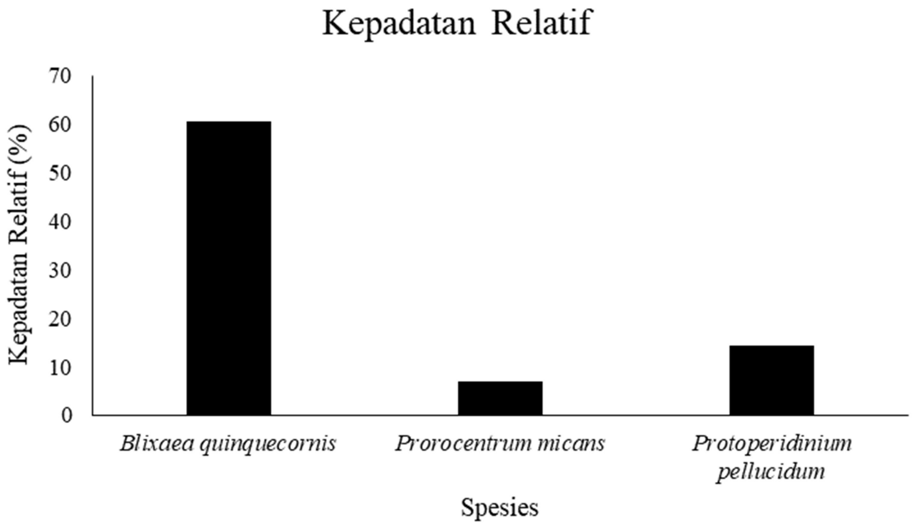
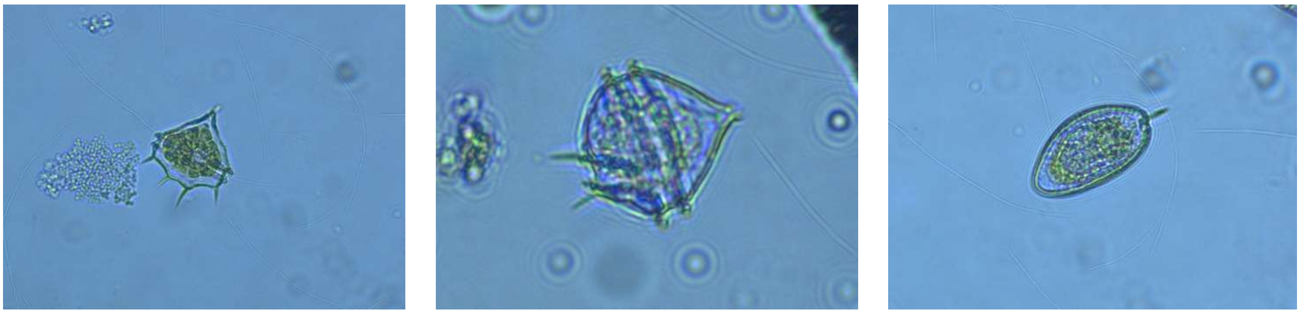


Figure 2. Relative Density (KR) of Dinoflagellate Species 5% in Bungus Waters Area of Kabung Bay



Blixaea quinquecornis *Protoperidinium pellucidum* *Prorocentrum micans*

Figure 3 . Species with the highest relative density in the Bungus Bay Kabung area, Padang City

Table 1. Distribution of Dinoflagellate species that have the potential to cause *algal blooms* in the waters of Bungus Small Islands, Teluk Kabung, Padang City

Species	Station 1	Station 2	Station 3	Danger posed
Blixaea quinquecornis	√	√	√	Anoxia
Prorocentrum gracile	-	√	-	
Prorocentrum micans	-	√	√	Hypoxia and Anoxia
Protoperidinium brevipes	-	√	-	
Protoperidinium pellucidum	-	√	√	
Protoperidinium subpyriforme	-	-	√	Producing toxic Azapiracids
Scripsiella acuminata	-	√	-	Anoxia
Noctiluca scintilans	-	-	√	Anoxia

Description : √ = Found

- = Not found

Table l 3. Physical and Chemical Parameters of Water in the Waters of Bungus Small Islands, Kabung Bay

No.	Parameter	Station 1	Station 2	Station 3
1	Temperature (°C)	33	28	27
2	Salinity (ppm)	35	29	30
3	pH	7	7	7
4	Brightness (m)	1.5	1.7	2
5	DO (ppm)	9.95	12.23	8.06
6	CO2 (ppm)	Signed	signed	signed
7	TSS (mg/l)	0.14	0.33	0.19
8	Phosphate (PO_4) (mg/l)	0.011	0.006	0.009
9	Ammonia (NH3) (mg/l)	0.012	0.012	0.012
10	Nitrite (NO2) (mg/l)	0.003	0.003	0.005
11	Nitrate (NO_3) (mg/l)	0.19	0.19	0.19

IV. Discussion

The Dinophyceae class was more commonly found in the Bungus Bay area than the Noctilucophyceae class. The high-class Dinophyceae because the class Dinophyceae can form cysts as a resting stage. This cyst settles on the seabed and rests until environmental conditions support it again to grow (Choirun, Sari, and Iranawati, 2015). The only species found in the class Noctilucophyceae is *Noctiluca scintilans*. In *algabase.org* (2021), *Noctiluca scintilans* have been classified in the Class Noctilucophyceae. At least species from the Noctilucophyceae class were obtained because this class did not have the pigment to carry out photosynthesis, so this Dinoflagellate could not survive as an autotrophic organism. The occurrence of the Noctilucophyceae population explosion must be supported by the availability of adequate food (Praseno and Adnan, 1978). It is known that temperature and salinity gradients are the main physical forces influencing the population dynamics of *N. scintillans* (Redden *et al.* 2009).

The highest species density obtained was *Blixaea quinquecornis*. This is contrary to the *blooming event* that has occurred in that location. When it *bloomed* in 2019, the most dominating species was *Noctiluca scintilans*. The number of activities carried out in these locations such as aquaculture and tourism activities which are quite crowded can provide nutrient input to the waters to trigger the growth of *B. quinquecornis*. In addition, shallow waters in the Teluk Kabung Coast will affect the density of Dinoflagellates. The relatively shallow waters make it easier for the water to stir quickly so that the nutrients at the bottom of the water will rise to the surface. The stirring of water can also be affected by the activities of ferry ports, Ocean Fisheries Ports, Pertamina ship activities, coal ships for PLTU, and passenger transport ships. This will trigger the growth of *B. quinquecornis species*. According to Horstmann (1980), *B. quinquecornis* prefers a eutrophic environment, especially in polluted conditions, and is always found in abundance near the coast with high nutrient content. The abundance of *B. quinquecornis* can reduce water quality by depleting oxygen, causing fish to die when the cell count is very high (Alkawri, Al Areeki, and Alsharaby, 2016).

Species that have the potential to cause *algal blooms* in the Bungus Small Islands Waters, Teluk Kabung, Padang City include *Blixaea quinquecornis, Prorocentrum gracile, Prorocentrum micans, Protoperidinium brevipes, Protoperidinium pellucidum, Protoperidinium subpyriforme, Scrippsiella acuminate. Prorocentrum micans* may *bloom* but are considered harmless. These species can secrete chemicals that inhibit the growth of diatoms, but these substances do not affect organisms at higher trophic levels. The high concentration of *P. micans cells* can cause hypoxia and anoxia for aquatic biota (GEOHAB, 2001). An abundance of *B. quinquecornis* can degrade water quality by depleting oxygen, causing fish to die when cell counts are very high.

*Scrippsiella trochoidea (*synonym of *Scripsiella acuminata)* is a sexually reproducing and efficient photosynthetic dinoflagellate that produces cysts. *S. acuminata* cysts can grow well in a neritic environment because the cyst acts as a benthic reservoir of the vegetative population (Wang *et al* ., 2007). *S. acuminata* can live in estuaries and neritic (Horner 2002) in various environmental conditions at temperatures ranging from -2°C to 30°C and salinity 5 – 55‰ (Wang *et al.,* 2007). *S. acuminata* is considered to be the cause of dangerous *algae blooms* because it can reach high densities, especially in stratified waters. *Blooming algae* of the species *S. acuminata* can cause changes in water color (Lizárraga *et al.,* 2009).

Protoperidinium subpyriforme is one of the species that cause dangerous *algal blooms.* According to Evangelista (2008), *Protoperidinium* spp. can produce poison-type Azapiracids. The characteristics of the poison are almost similar to the DSP poison *(Diarrhetic Shellfish Poisoning)* which can cause nausea in the sufferer in 3-5 days.

Table 4. Events of algae bloom in several locations in Indonesia

Location	Year	HAB	The impact	Source
Lewotobi Strait, Wulanggitang Village, East Flores	November 1983	*Pyrodinium bahamense* var. *compressum*	240 people were poisoned, and 4 people died (selar fish)	Adnan and Sidabutar, 2005
Binaria Beach, Ancol	January 1985	*Noctiluca scintillans*	mass death of fish	Adnan and Sidabutar, 2005
Edge of View	July 1987	*Pyrodinium bahamense*	4 people died (mussels, *Meritrix meritrix*)	Adnan and Sidabutar, 2005
Nunukan, P. Sebatik South, East Kalimantan	January 1988	*Pyrodinium bahamense*	65 people were poisoned, and 2 people died (shellfish, *Meritrix meritrix*)	Adnan and Sidabutar, 2005
East coast of Lampung P. Pari, Kep. One thousand	April-November 1991	*Trichodesmium erytharaeum*	Mass death of tiger prawns and milkfish Fish death at the bottom of the water	Adnan and Sidabutar, 2005
Ambon Bay	1994	*Pyrodinium bahamense* var. *Compressum*	Some people suffer, 3 people die	Adnan and Sidabutar, 2005
Muara Membrano, Irian Jaya	May 1999	*Trichodesmium thiebautii*	Fish are becoming rare	Adnan and Sidabutar, 2005
Borneo Waters East	September 1999	*Trichodesmium thiebautii*	Fish are becoming rare	Adnan and Sidabutar, 2005
P. Pari, Thousand Islands	October-November 1999	*Trichodesmium erythraeum*	Fish are becoming rare	Adnan and Sidabutar, 2005
North Sulawesi	October 2000	*Trichodesmium thiebautii*	Fish are becoming rare	Adnan and Sidabutar, 2005
Ancol Beach	29-30 November 2015	*Coscinodiscus* spp.	Mass death of fish	Gistrong. WordPress, 2015
Bungus Bay of Kabung, Padang City	December 2019	*Noctiluca scintilans*	Mass death of fish	Rakyatsumbar.id, 2019

The diversity index in the Teluk Kabung Coast is 1.55 with an equity index of 0.28. The diversity index in the Teluk Kabung Coast is moderate. Diversity in the Teluk Kabung Coast is suspected to be due to the influence of activities carried out in the area, such as population activities and tourism activities which are quite crowded, allowing the entry of nutrients into coastal waters that trigger the growth of certain species such as Blixaea quinquencornis. The even distribution of species in the Teluk Kabung Coast is less evenly distributed because in this location there is a very dominant species of B. quinquecornis. Merina (2016), if in a condition there is a large number of species but the level of equality is low, then the diversity index may be low. Therefore, the last condition that occurs can be estimated that in an ecosystem there has been an ecological disturbance. As a result of these ecological disturbances, one member of the community is very dominant (very abundant).

V. Conclusion

Based on the research that has been done, it was found that 17 species with the highest species density were *Blixaea quinquecornis, Protoperidinium pellucidum, and Prorocentrum micans.* The diversity index in the Bungus Bay Kabung waters area is classified as moderate with uneven equity.

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