Dinoflagellata Community Structure In The Waters Of Juata Permai Village, Tarakan City

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Abstract: Dinoflagellates are a class of phytoplankton and are divided into two groups, namely autotrophs and heterotrophs. This research aims to analyze the structure of the phytoplankton community, especially from the dinoflagellate class, namely in terms of the number of species, and the abundance of dinoflagellates in the waters of Tarakan, Juata Laut Village, Tarakan City. There are 7 types of dinoflagellates found in waters, namely: Ceratium spp., Noctiluca sp., Protoperidinium spp., Prorocentrum spp., Gymnodinium sp., Gonyaulax sp., and Dinophysis sp. This research was conducted for 2 months by using descriptive analysis. The results showed that the index values for diversity, uniformity, and dominance of dinoflagellates ranged from 0.06 to 1.53, uniformity from 0.09 – 0.80, and dominance from 0.23 - 0.95. The highest diversity index value is at Station 3 of 1.63 and the lowest diversity index is at Station 5 of 0.07, the highest uniformity index value is at Station 3 of 0.90 and the lowest diversity index is at Station 5 of 0.10, while The highest dominance index is at Station 3 of 0.97 and the lowest dominance index is at Station 9 of 0.23. Water quality parameters still show the optimum value with temperatures ranging from 27-30°C, brightness 53-63 cm, salinity 16-2 4 ppt, and Ph 7.2 – 7.4. Optimum concentrations of chlorophyll a, b, and c from morning to afternoon with sampling at 08.00 – 12.00 with chlorophyll a value of 0.3447 µg.L-1, chlorophyll b 0.2081 µg.L-1 and chlorophyll c 0.03 µg.L-1.
Keywords: Community Structure; Dinoflagellates; Waters Of Juata Permai

1. Introduction

Dinoflagellate community structure is one of the ecological studies that studies a dinoflagellate ecosystem and its relationship to environmental factors in the waters. Dinoflagellates are a class of dangerous phytoplankton found in sea and river waters [1]. Dinoflagellates are derived from the Greek words dinos "spin" and flagella "whip", meaning the rotating motion of the two flagella in a vertical groove which later became the basis for naming the organism. Dinoflagellate's characteristic is that it grows rapidly, ranging from 1-15 days in multiples, and can be doubled [2]. Dinoflagellates can be

dangerous if the danger exceeds the threshold in waters which is commonly known as blooming. Dinoflagellates are a class of phytoplankton and are divided into two groups, namely autotrophic and heterotroph dinoflagellates. Heterotrophic dinoflagellates are predators of autotrophic dinoflagellates in the waters. Autotroph dinoflagellates contain chlorophyll which is used in the process of photosynthesis and is one of the components of primary productivity in waters other than diatoms. The overall abundance of dinoflagellates is strongly influenced by autotrophs of dinoflagellates containing chlorophyll [3]. Dinoflagellates can harm coastal

ecosystems.

Dinoflagellate is a causative organism to the incidence of HABs, as has happened in the last few decades. Dinoflagellate population explosion can be a problem because it contains toxins and discoloration of the waters (discoloration). Toxins produced by dinoflagellates can enter the food chain, change the color of the water, produce foam, cause unpleasant odors, and reduce the oxygen content in water. This poses a threat to coastal ecosystems and human health. Types of poison that can be produced, such: Paralytic Shellfish Poisoning (PSP), Diarrehetic Shellfish Poisoning (DSP), Neurotoxic Shellfish Poisoning (NSP), Amnesic Shellfish Poisoning (ASP), and Ciguatera Shellfish Poisoning (CSP) [4].

Tarakan City is one of the cities in North Kalimantan Province with an area of 250.80 km2 with a population of 239,787 people. Various human activities can cause water pollution such as ports, aquaculture, industry, and settlements. In addition, there are various shipping and industrial activities around scenic waters that will produce aquatic waste. The resulting impact can be indirect on the survival of marine organisms such as an explosion in the population of aquatic organisms. [5] stated that the population explosion that occurs from toxic algae species will pose a very significant threat to human health and fishery resources for fishermen's catches. Furthermore, there are negative impacts on aspects of ecology, tourism, biodiversity, and public health. Thus, it is necessary to conduct an assessment to determine the structure of the dinoflagellate community in the sea waters of Juata Permai Village, Tarakan, so that it can be used as a basis for management in Tarakan City. This study aims to analyze the structure of the phytoplankton community, especially from the dinoflagellate class, namely in terms of the number of species, and the abundance of dinoflagellates in the waters of Tarakan, Juata Laut Village, Tarakan City.

2. Material and Methods

2.1 Time and Place

Sampling was carried out four times in April-May 2022. The sampling point is close to Juata Permai waters. There are human activities around this location such as parking lots of coal pontoon ships, a shipyard, transportation routes, and close to mangrove areas. Sampling time followed the pattern of seasonal differences which were closely related to differences in the amount of monthly rainfall (mm) in 2022 from the One-Stop Service of the Meteorology, Climatology and Geophysics Agency (BMKG), City Tarakan. Dinoflagellate abundance analysis was carried out at the Laboratory of Nutrition and water quality laboratory, Faculty of Fisheries and Marine Sciences, University of Borneo Tarakan.

2.2 Data collection

Data Collection of water quality parameters measured in situ includes temperature, pH, salinity, and brightness. Ex situ includes nutrients such as nitrate, phosphate, and chlorophyll. Dinoflagellate abundance was defined as the number of dinoflagellate individuals or cells per unit volume (L) obtained through water samples filtered using a plankton net with a mesh size of 30 m by the towing method with a distance of 5 m. Dinoflagellate samples were stored in dark bottles, then preserved with a 4% formalin solution. Data collection for calculating the abundance of autotrophic and heterotrophic dinoflagellates using the following equation [6].

$$N= n \text{ x} \frac{vt}{VSRC} \text{x} \frac{ASRC}{Aa} \text{x} \frac{1}{Vd}$$

Information:

N: the abundance of dinoflagellates (cells/m3)

n: the number of organisms observed (cells)

Vt: volume of filtered water (mL)

VSRC: volume of one SRC (sedgewick rafter-counting Cell)(1 mL)

ASRC: SRC cross-sectional area (mm2)

Aa: area of observation (mm2)

Vd: volume of filtered water (m3)

Diversity is a description of a number of species in a community. The species diversity index was calculated using the following formula [7]:

$$H' = -\sum P_i \ln P_i; \quad P_i = n_i/N$$

Information:

H': diversity index

ni: the number of individuals of type i

N: total number of individuals

The range of diversity index values is classified as follows.

H' < 2.3026 : low diversity and low community stability

2.3026 < H' < 6.907 : moderate diversity and moderate community stability

H' > 6.9078 : high diversity and high community stability

The uniformity index (E) is used to explain how much the number of individual distributions of each species is similar at the community level. The calculation of the species uniformity index is carried out using the following formula [7]:

$$E = H'/H_{max}$$

Information:

E : uniformity index

H' : diversity index

Hmax : maximum diversity index (= ln S, where S = Number of species)

Both types of dinoflagellates are often .

The range of uniformity index values is classified as:

E > 0.6 : high specificity uniformity

0.4 E 0.6 : medium type uniformity

E < 0.4 : low specificity

The dominance index is used to determine the quantity of a species or genus that dominates in a population. The calculation method used is the dominance index formula which is presented as follows [7]:

$$D = \sum (n_i/N)^2$$

Information:

D : Simpson dominance index

ni : the number of individuals of the ith genus

N : total number of individuals

The dominance value (D) ranges from 0 – 1 with the following criteria: D < 1 : means that there is no dominant species or stable community D = ∞1: means that there is a dominance of a certain species or the community is in an unstable condition.

3. Results And Discussion

3.1 Identification Of Dinoflagellate Type And Abundance In Juata Permai Waters

Research in Juata waters found seven types of dinoflagellates, namely: *Ceratium* spp., *Noctiluca* sp., *Protoperidinium* spp., *Prorocentrum* spp., *Gymnodinium* sp., *Gonyaulax* sp., and *Dinophysis* sp. In general, the percentage of dinoflagellate abundance describes a fairly varied species abundance. Two types of dinoflagellates were found in this study, namely *Ceratium* spp and *Noctiluca* sp. have the highest value at each sampling time.
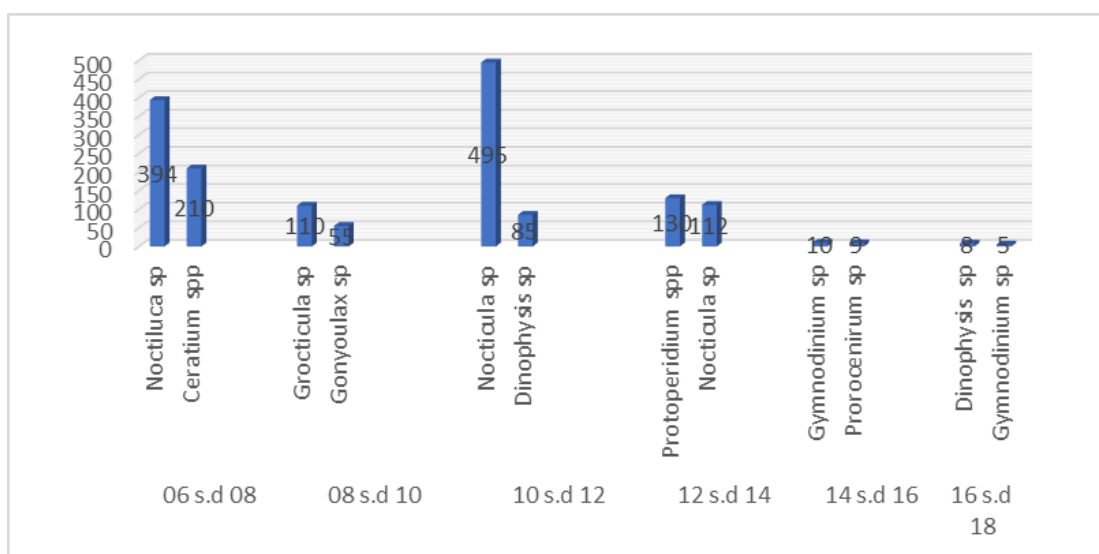
found in tropical waters

Figure 1. Image of Average species abundance *dinoflagellate* cell.L^{-1}

The highest average dinoflagellate abundance was at the third sampling time of the *Noctiluca* sp. species, while the lowest was at the second incubation period of the species. Sampling time is carried out in the morning to afternoon with a sampling duration of every 2 hours.
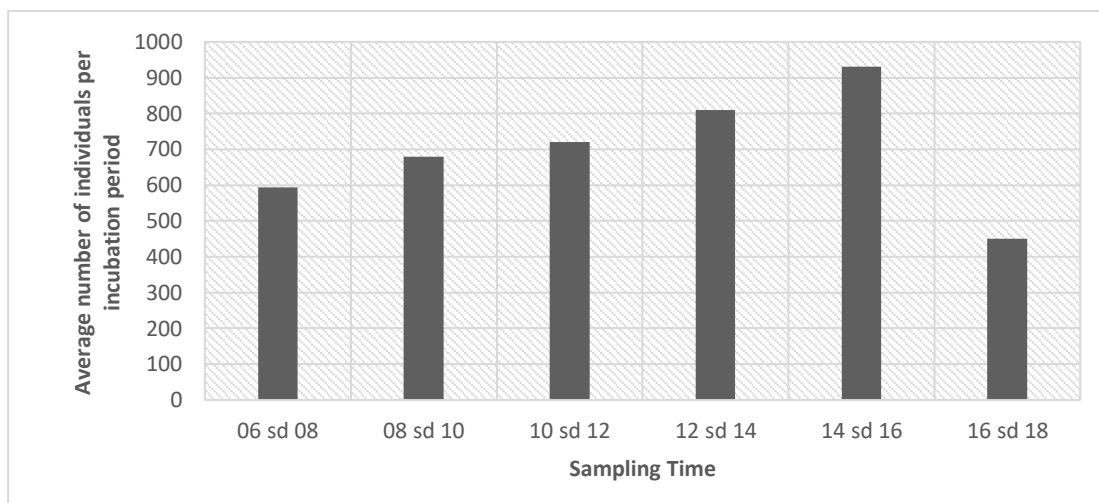

Figure 2. The total abundance of dinoflagellates (cell.L-1) by the time of observation in the Juata Permai Waters of Tarakan

Gymnodinium sp. and the sixth of the Dinophysis type. Dinoflagellate abundance pattern varied at each sampling time. The abundance of *Noctiluca* sp. increased in the third incubation period (10.00-12.00) by 495 cells.L-1 and was the highest abundance found in this study. The lowest decrease (10 cells.L - 1) occurred in the sixth incubation period

(14.00-18.00). *Dinophysis* sp. was found in the third incubation period (10.00-12.00), its abundance increased (85 cells.L-1) in the fifth incubation period (14.00-16.00) and decreased drastically (8 cells.L-1) in the sixth incubation period (16.00-18.00). The value of the total abundance of dinoflagellates will provide an overview of the abundance of dinoflagellates for a day in the Juata Permai Waters of Tarakan. The results of the study (Figure 2) found that the total abundance of dinoflagellates fluctuated at each incubation period. The total abundance of dinoflagellates was at 06.00 – 08.00 (594 cell.L-1) and increased at 08.00-10.00 (680 cell.L-1), at 10.00 – 12.00 (720 cell.L-1), and decreased at 12.00-14.00 (818 cell.L-1). The highest increase in total abundance occurred at 14.00-16.00 (930 cell.L-1), while the lowest decrease occurred at 16.00 -18.00 (450 cell.L-1).

3.2 Diversity Index (H'), Uniformity Index (E), And Dominance Index (D)

Based on the analysis of the diversity index, the uniformity and dominance of dinoflagellates ranged from 0.06 - 1.53, respectively, with 0.09 - 0.80 uniformity and 0.23 - 0.95 dominance. The highest diversity index value is at Station 3 of 1.63 and the lowest diversity index is at Station 5 of 0.07, the highest uniformity index value is at Station 3 of 0.90 and the lowest diversity index is at Station 5 of 0.10, while The highest dominance index is at Station 3 of 0.97 and the lowest dominance index is at Station 9 of 0.23. The results of the diversity index, uniformity index, and dominance index can be seen in the image below
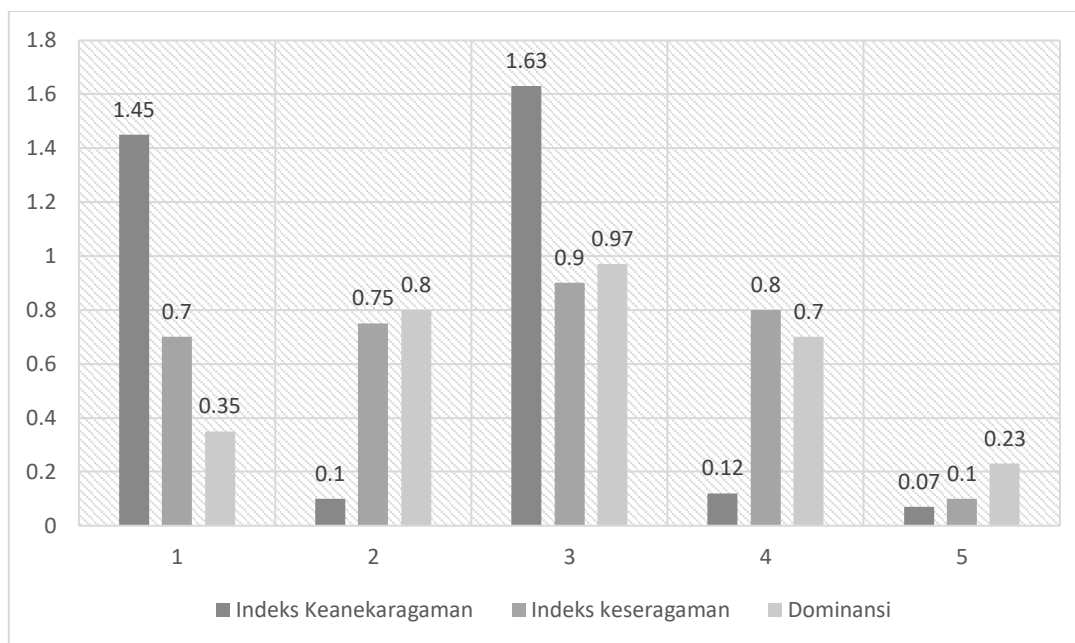

Figure 3. The value of diversity index (H'), uniformity index (E), and dominance index (D) of dinoflagellates at each sampling in Juata Permai Tarakan waters based on research time

Diversity is a description of the presence of a number of species in a community. The diversity index value at stations 1 and 3 is in category $1 < H' < 3$, meaning that it is included

in the criteria for species diversity and moderate community stability, while at stations 2, 4, and 5 it is in the category H´ < 1, which means it is included in the criteria for species diversity and low community stability. [8] said that the more individuals or species, the greater the number of plankton diversity in water, and vice versa, if there are no individuals or species that dominate or the number, is much greater, the value of the diversity of plankton in the waters is moderate to high.

The uniformity index (E) is used to explain how much the number of individual distributions of each species is similar at the community level. The uniformity value at stations 1 – 4 is classified in the category of high uniformity (> 0.6) or evenly distributed. The high uniformity index at each plankton sampling location is due to the absence of individuals or species that dominate the waters or their distribution is evenly distributed, while at station 5 the uniformity value is low (<0.4) which indicates that some individuals or species dominate the waters so that the distribution of the number of each type not the same. If the

diversity value is low, the uniformity value is also low. [9] said that if the uniformity value is close to zero, the uniformity between species in the community is low or the distribution is not the same, and if the uniformity value is close to 1, the uniformity between species is said to be even or the same.

The dominance index is used to determine the quantity of a species or genus that dominates in a population. The value of the dinoflagellate dominance index found in the Juata scenic waters of Tarakan City at stations 1 – 5 got a value of D < 1. [10] said that the dominance index that was close to 0 means that no particular individual or species dominates, on the contrary, if the index value is close to 0 then no particular individual or species dominates. dominance is close to 1 or equal to 1 then some certain individuals or species dominate in the waters. At station I, the mangrove area, and station II near residential areas, during the observation at both locations, no species dominated in the two sampling locations

3.3 Water Quality Parameters

Table 1. Water Quality Measurement Results

Station	Temperature (^{0}C)	Brightness (Cm)	Salinity (PPT)	PH
1	28	57	18	7,2
2	28	63	15	7,5
3	30	53	18	7,4
4	28	65	24	7,5
5	27	58	23	7,2

From the results of water quality measurements, the temperature at stations 1 – 5 ranges from 27 – 30°C which shows that the temperature in the waters in the study area is still in optimal conditions for the life of organisms. Water temperature is one of the

factors that affect the life of organisms in it, including phytoplankton, an increase in temperature can affect the rate of metabolism and the photosynthetic process of phytoplankton. Water temperature is affected by sunlight. The higher the temperature and the

higher the light intensity, the higher the photosynthesis process. The minimum temperature for phytoplankton to carry out photosynthesis is 5°C while the optimal temperature for phytoplankton to carry out photosynthesis is 25-30°C.

From the results of water quality measurements, the brightness at stations 1 – 5 ranges from 53 - 63 cm which indicates that the brightness in the research area is still classified as good. A good brightness value for the survival of aquatic organisms is > 45 cm. Brightness is a measure of water transparency and measurement of sunlight in water. Brightness can be affected by high tide, low tide, and the intensity of sunlight entering the waters. The brightness of water is very much needed by phytoplankton in carrying out photosynthesis, this is an important part of phytoplankton in absorbing energy and then using it to produce food.

From the results of measurements of water quality Salinity at stations 1 – 5 ranges from 18 – 24 ppt. Salinity is the level of dissolved salt in water, the distribution of salinity is influenced by several factors such as water circulation patterns, evaporation, rainfall, and river flow. Salinity in estuaries fluctuates dramatically over time. When seawater with a salinity of about 35ppt mixes with fresh water from rivers with a salinity of 0 ppt. This mixing process then forms a salinity gradient of 5-30 ppt which is the salinity value in normal estuaries.

3.4 Chlorophyll

Chlorophyll is one indicator of the fertility level of water. The distribution of chlorophyll is closely related to the abundance of phytoplankton, especially dinoflagellates. The content of chlorophyll a experienced the highest increase of 0.3447 g.L-1 at 10.00 –

12.00 and the lowest decrease at 0.02412µg.L-1 at 12.00 – 14.00. The content of chlorophyll-a ranged from 0.00069 - 0.50321 g.L-1 . The content of chlorophyll found in this study was low. This is reinforced by the statement of [11] that the concentration of chlorophyll-a in coastal and coastal waters is relatively high compared to the high seas, due to the supply of nutrients through river run-off from the mainland. Al-Hashmi et al. (2014) also stated in Muscat Arabian Coastal Waters that the value of chlorophyll content in offshore waters is also low. In this study, the chlorophyll content in offshore waters was lower (0.2 – 1.0 g.L-1) when compared to coastal areas (1.1 – 2.7 g.L-1). The content of chlorophyll b increased to 0.20813 g.L-1 at 08.00 – 10.00 and decreased to 0.05432 g.L-1 at 10.00 – 12.00. The content of chlorophyll c was only found at 0.04154 g.L-1 at 10.00 – 12.00 and 0.02642 g.L-1 at 12.00 – 14.00. At other sampling times, no chlorophyll c content was found in these waters.

The main pigment in this study was chlorophyll a so there was a decrease in chlorophyll b and c. Several types of dinoflagellates at the time of the fourth sampling had different pigment content in their chloroplasts (chlorophyll and additional pigments). Where each pigment has a different ability to absorb solar energy. Chlorophyll a has the highest value and fluctuates at each incubation period so that it has the same pattern as the abundance of dinoflagellates, with this similarity the content of chlorophyll a affects the abundance of dinoflagellates in the Juata Permai waters of Tarakan. In the process of photosynthesis, the content of chlorophyll a is very necessary. The figure displayed the average concentration of several types of chlorophyll can be seen below:
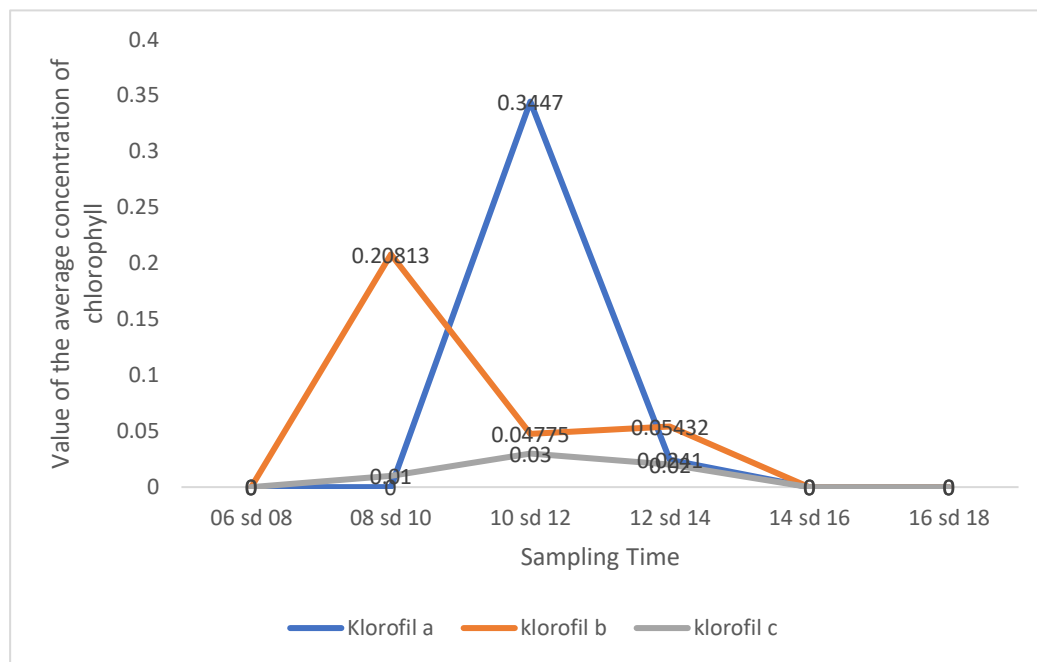
Figure 4. The average concentration of several types of chlorophyll (µg.L-1) according to the time of observation in the Juata Permai Waters of Tarakan

3.5 Nitrate And Phosphate

The highest nitrate content was found in the fourth incubation period (0.376 mg.L-1) and the lowest at the first sampling time (0.243 mg.L1). Meanwhile, the highest phosphate content was obtained during the fourth incubation period (0.529 mg.L-1) and the lowest at the first sampling time (0.015 mg.L-1). The value of nitrate and phosphate content has a similar value where the highest and lowest values are the same at the first and fourth sampling times, although they do not show a proportional pattern. Phosphate shows a highly volatile pattern compared to nitrate. The content of nitrate and phosphate in Juata Permai Tarakan waters is classified as eutrophic waters with a concentration of nitrate 0.243-0.326 mg.L-1 and phosphate 0.015- 0.529 mg.L-1. Nutrient elements in the waters of Juata Play Tarakan are quite high. However, the high level of nutrients in the waters does not cause blooming because it is still categorized as a normal abundance. Graphs of nitrate and phosphate can be seen in the image below:
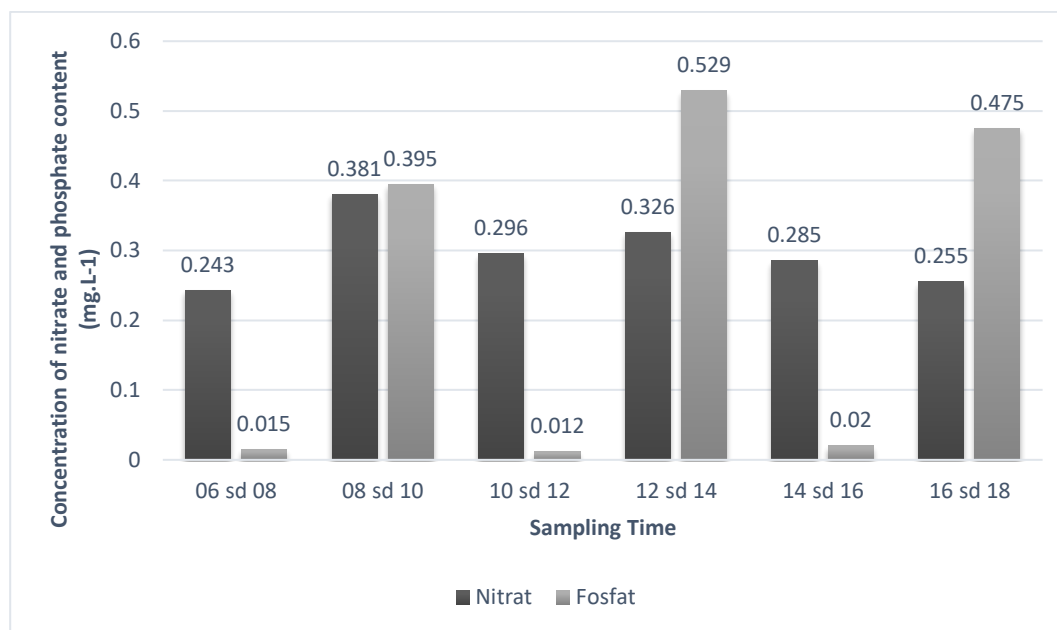
Figure 5. The concentration of nitrate (mg.L-1) and phosphate (mg.L-1) according to time of observation in Juata Permai Tarakan Waters

4. Conclusion

Based on the results of the study, it can be concluded that the percentage of dinoflagellate is quite varied in abundance species in Juata Permai waters of Tarakan city. The two most common types of dinoflagellates found are *Ceratium* spp. and *Noctiluca* sp. The water quality parameters are still suitable for the life of aquatics organism.

Acknowledgments

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