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Study of Phytoplankton Abundance in Waters of Baruta Analalaki Village, Sangia Wambulu District, Central Buton District

Studi Kelimpahan Fitoplankton di Perairan Desa Baruta Analalaki Kecamatan Sangia Wambulu Kabupaten Buton Tengah

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ABSTRACT

Phytoplankton is one of the autotrophic microorganisms that play an important role in converting inorganic materials into organic materials that live floating on the surface of the waters. Changes in water conditions can be caused by the activity of crossing fishing vessels which allows a decrease in water quality so that there is a need for knowledge about the existence of a microorganism. This study aims to determine the abundance, diversity, uniformity, and dominance of phytoplankton in the waters of Baruta Analalaki Village, Sangia Wambulu District, Central Buton Regency. The research was conducted from October to November 2022. The method used in this study was a purposive random sampling method, which is a method used to make it easier for researchers to determine sampling locations according to the criteria desired by researchers (Hadi, 2004). The results showed that three classes of phytoplankton were found, namely those from the Bacillariophyceae, Chlorophyceae, and Dinophyceae classes. The average diversity index was in the moderate category, but at 14.00 a high diversity index was found. The Pearson correlation test between the abundance of phytoplankton and water quality parameters has a very strong relationship. The results of the regression analysis show that the coefficient of comparison of brightness and temperature is positive, which means that if there is an increase of 1 cm, the level of abundance of phytoplankton will increase by 183 or 126 assuming other parameters are constant. The abundance of phytoplankton in the waters of Baruta Analalaki Village did not show a significant difference even though the brightness and temperature values were high.

ABSTRAK

Fitoplankton adalah salah satu mikroorganisme autotrof yang perperan penting dalam mengubah bahan anorganik menjadi bahan organik yang hidup melayang di permukaan perairan. Perubahan kondisi perairan dapat disebabkan karena adanya aktivitas lintas kapal nelayan yang memungkinkan terjadinya penurunan kualitas perairan sehingga perlu adanya pengetahuan tentang keberadaan suatu mikroorganisme. Penelitian ini bertujuan untuk mengetahui kelimpahan, keanekaragaman, keseragaman, dan dominansi fitoplankton di Perairan Desa Baruta Analalaki, Kecamatan Sangia Wambulu Kabupaten Buton Tengah. Penelitian dilaksanakan mulai bulan Oktober sampai dengan November 2022. Metode yang digunakan dalam penelitian ini adalah metode *purposive random sampling,* yaitu Metode yang digunakan untuk memudahkan peneliti dalam menentukan lokasi sampling sesuai dengan kriteria yang diinginkan oleh peneliti (Hadi, 2004). Pengambilan sampel dilakukan pada pagi, siang dan sore hari. Hasil penelitian Menunjukkan bahwa ditemukan tiga kelas fitoplankton yaitu dari kelas *Bacillariophyceae, Chlorophyceae,* dan *Dinophyceae*. Indeks keanekaragaman rata-rata masuk kategori sedang, namun pada jam 14.00 ditemukan indeks keanekaragaman tinggi. Uji korelasi *Pearson* antara kelimpahan fitoplankton dan parameter kualitas air memiliki kaitan yang sangat kuat. Hasil Analisis regresi menunjukkan koefisien perbandingan kecerahan dan suhu bernilai positif yang artinya jika terjadi peningkatan sebesar 1 cm maka tingkat kelimpahan fitoplankton akan naik sebesar 183 atau 126 dengan asumsi parameter lainnya konstan. Dengan demikian kelimpahan fitoplankton diperairan Desa Baruta Analalaki tidak menunjukkan perbedaan yang signifikan meskipun nilai kecerahan dan suhu tinggi.

Kata Kunci	*Fitoplankton, Kelimpahan, Kualitas Air, Uji Korelasi Pearson.*
Keywords	*Phytoplankton, Abundance, Water Quality, Pearson Correlation Test*
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INTRODUCTION

The waters of Baruta Analalaki Village are estuarine waters located in Sangia Wambulu District, Central Buton Regency. These waters are dominated by mangrove forest areas and there is a river estuary that directly faces the sea. This situation makes the waters of Baruta Analalaki Village a potential natural resource for fisheries. The waters of Baruta Analalaki Village also contain many living organisms which play an important role in constructing a food chain system at the bottom of the waters, making it possible for many local residents to use them as a cultivation and fishing area. One of the organisms that has an important role in these waters is phytoplankton.

Phytoplankton has an important role in the aquatic food chain. This organism has chlorophyll which is able to convert inorganic materials into organic materials through the process of photosynthesis (Nontji 2008). The organic material from phytoplankton is used by zooplankton, fish larvae and other aquatic organisms as a food source.

Plankton are small organisms whose lives drift along with the movement of water. Plankton in waters can be grouped into two, namely phytoplankton and zooplankton. Phytoplankton are microorganisms whose lives drift following the movement of water originating from vegetable bodies, while zooplankton are organisms whose lives drift following the movement of water originating from animal bodies (Rahayu, 2009). Just as phytoplankton act as primary producers (energy providers at higher tropical levels), the role of zooplankton is actually to continue this energy at higher tropical levels (Castro & Huber, 2007).

Plankton with varying amounts and composition can be found in almost all aquatic ecosystems. Its quantity and composition change depending on the environment. Abiotic environmental elements such as physico-chemical parameters (temperature, light intensity, salinity and pH) play an important role in influencing the growth of phytoplankton in waters. In addition, biotic variables such as the availability of food (phytoplankton), the number of predators, and the behavior of zooplankton species fighting for food are factors that can influence the abundance and diversity of zooplankton species (Arinardi, 1997).

Thus, information regarding the abundance of phytoplankton is very important because it is a food source for fish at low trophic levels. The presence of phytoplankton in waters greatly determines the survival rate of fish, especially tilapia, whose main food source is phytoplankton. This is in line with water conditions which, if disturbed, the level of phytoplankton abundance will decrease. Therefore, information regarding the abundance of phytoplankton in the waters of Baruta Analalaki Village which is used as a food source by fish is the basis for conducting an analysis of the phytoplankton abundance study in Baruta Analalaki Village, Sangia Wambulu District, Central Buton Regency.

METHODS

This research was carried out for two months starting from October to November 2022 in the waters of Baruta Analalaki Village, Sangia Wambulu District, Central Buton Regency. Data collection was carried out in two stages, namely measurements of physical and chemical parameters of waters carried out in the field such as pH, temperature, salinity, brightness, DO, phosphate and nitrate. Phytoplankton was sampled in a water volume of 20 liters then filtered using a plankton net with a mesh of 53 microns, 1.5 m long and 40 cm in diameter and laboratory analysis to identify the calculation of phytoplankton abundance. The filtered phytoplankton samples were placed in 25 ml bottles and preserved using three drops of 70% alcohol for identification at the Biology Laboratory, Muhammadiyah University of Buton.

Water Quality Analysis

Water quality is measured directly in the field (in situ). Water quality parameters include PH, Temperature, Salinity, DO (Dissolved Oxygen), and brightness. Water quality parameters were taken to support data on the abundance of phytoplankton in the waters of Baruta Village. The obtained water parameter data is then analyzed and linked to quality standards in accordance with the Decree of the Minister of Environment Number 51 of 2004 concerning Sea Water Quality Standards.

Phytoplankton abundance analysis

The initial stage carried out to observe phytoplankton samples was using a Sedwick rafter counter (SRC), namely shaking the sample bottle until the water containing the sample was homogeneous, then one drop of the water containing the sample was taken using a pipette and placed on an object glass and covered with a cover glass. SRC cells were then examined under a microscope at 40 or 100 times magnification. Each sample was observed 5 times (Nontji, 2006). The types of phytoplankton found were then identified using the reference book Davis (1955), Mizuno (1979), and Edmondson (1963). Phytoplankton abundance is the number of individuals or cells per unit volume (m3) which is calculated using the formula (Boyd, 1979) as follows:

$$Number\ of\ Individuals/ml = \frac{\text{C x 1000}}{\text{L x D x W x S}}$$

Information :

C : Number of individuals found
L : Groove length S-R (50 mm)
D : Groove height S-R (1 mm)
W : Groove width (20 mm)
S : The number of flows calculated (1000 alur)

Diversity, Uniformity and Dominance Index Analysis

The phytoplankton composition and abundance data that were obtained were then used to calculate the Diversity Index, Uniformity Index and Dominance Index with the help of Microsoft Excel software. The index obtained describes the biodiversity of the phytoplankton community found in the waters of Baruta Village. The Diversity Index (H") is used to determine the level of diversity in a phytoplankton community.

Diversity Index

The Diversity Index is calculated using the "Shannon Index of Diversity" formula (Odum, 1983).

$$H" = -\sum \left(\frac{ni}{N}\right) Ln\ (\frac{ni}{N})$$

Infomation :
H' : Diversity Index
ni : Number of individuals of each type
N : The number of individuals of the entire species

Uniformity Index

The Uniformity Index is calculated using the "Evenness Index" formula (Odum,1971)

$$E = \frac{\text{H"}}{\text{Ln S}}$$

Information:
E : Uniformity Index
H' : Diversity Index
S : Total number of species

The Uniformity Index ranges from 0-1. If the value is close to 1, the distribution of individuals between types is even. The E value approaches 0 if the distribution of individuals between types is uneven or there is a certain type that is dominant.

Dominance Index

The dominance index is calculated using Simpson's "index of Dominance" formula (Odum, 1983).

$$C = \sum \left(\frac{ni^2}{N^2} \right)$$

Information:
C : Simpson Dominance
ni : Number of individuals per species
N : The number of individuals of the entire species

Correlation test

Pearson correlation is used to determine whether or not there is a significant relationship between one variable and another (Usman & Akbar 2006). The correlation coefficient describes the level of closeness of the relationship between two or more variables (Mattjik & Sumertajaya 2006). Pearson correlation is calculated based on the formula presented by Walpole (1993) as follows:

$$r = \frac{n \sum XY - \sum X \sum Y}{\sqrt{n \sum X^2 - (\sum X^2)} \sqrt{n \sum Y^2 - (\sum Y)^2}}$$

Information:
r : Correlation value
X : Phytoplankton abundance
Y : Physico-chemical parameters

n : Number of parameters

The correlation value ranges from 0-1, with specifications according to Walpole (1993) as follows:

Correlation r = 0.00-0.25 weak correlation; 0.25-0.50 correlation is sufficient; 0.50-0.75 strong correlation; 0.75-1.00 correlation is very strong

RESULT AND DISCUSSION

Water Conditions in Baruta Analalaki Village

Oceanographic physical and chemical parameters in the waters of Baruta Analalaki Village have a significant impact on the life of organisms in the water. Based on the results of field measurements, it was found that water quality including temperature, pH, salinity, current, brightness, DO (Dissolved Oxygen), phosphate and nitrate were not significantly different between each hour, except for the current and brightness parameters which were lower in the morning at 06.00-08.00 WITA compared to day time (table 1). The waters of Baruta Village have temperatures ranging between 27.6oC-30.2oC. This temperature range is quite high, but is still included in the optimum temperature to support phytoplankton growth, namely between 20oC-30oC (Effendi 2003). The brightness of Baruta Village waters ranges from 159.8 – 173.9 cm. The high brightness value at 12.00 WITA could be caused by the location experiencing the highest tide which allows the waters to be murkier than in the morning. Then the pH range between 6.5-7.5 is still said to be normal for phytoplankton growth. This was confirmed by Prescott (1970) that the optimum pH range to support phytoplankton life is between 6-8. Low DO values can inhibit the nitrification process in waters, where the nitrification process requires oxygen to convert ammonium compounds into nitrites and nitrates which are needed for the development of phytoplankton (Horrison et al., 2011). The DO (Dissolved Oxygen) range was still quite high at the time of measurement, namely between 4.1-5.9 mg/l while Nitrate ranged between 0.02-0.21 mg/l. Phytoplankton live and develop well at a DO concentration of 3.00-5.00 mg/l (Wijayanti, 2011).

Table 1. Water Quality Parameters in Baruta Analalaki Village

Parameter	Time						
	06.00	**08.00**	**10.00**	**12.00**	**14.00**	**16.00**	**18.00**
Temperature (^{0}C)	28,2	27,6	29	30,2	29,8	29,4	28,6
Salinity (‰)	28	28	30	31	31	32	32
pH	6,5	7	7	7,5	7,3	7,3	7
Current (m/det)	14,1	14,9	18,2	19,7	18,2	18,3	18,4
Brightness (cm)	160,7	168,2	173,5	173,9	159,8	161,7,8	161,2
DO (mg/L)	4,8	4,6	5,7	5,4	5,9	4,3	4,1
Phosphate (mg/L)	0,99	1,02	1,20	1,32	1,20	1,19	1,20
Nitrate (mg/L)	0,02	0,07	0,07	0,10	0,21	0,17	0,10

(Source: Primary Data 2022)

Abundance of Phytoplankton in Baruta Analalaki Village

The results of the identification of phytoplankton in the waters of Baruta Analalaki Village found 3 classes and each had a different abundance of different types. The phytoplankton classes obtained came from the Bacillariophyceae, Chlorophyceae, and Dinophyceae classes (table 2). The type of phytoplankton that is most commonly found comes from the Bacillariophyceae class because this type of phytoplankton is able to grow quickly even in relatively low nutrient and light conditions. This is supported by Cahyaningtyas et al., (2013) in Anggraini Sukardi & Apri Arisandi, (2020) that the Bacillariophyceae class can regenerate and has a strong and greater reproductive rate in extreme and low conditions compared to other classes.

Table 2. Types of phytoplankton found at the observation point in Baruta Analalaki Village

No.	Class /Genus	Time						
		06.00	08.00	10.00	12.00	14.00	16.00	18.00
1	**Bacillariophycea**							
	Rhabdonema adriaticum	√	√	√	√	√	√	√
	Nitzschia sigma	√	√	√	√	√	√	√
	Navicula sp	√	√	√	√	√	√	
	Surirella sp.	√		√	√	√		√
	Synedra ulna	√	√	√	√	√	√	√
	Thalassiothrix longissima	√	√	√	√	√	√	
	Biddulphia sp	√		√	√	√		
	Triceratium sp	√	√		√	√	√	√
	Rhizosolenia curvirostris	√		√	√	√		
	Guinardia flaccida	√	√			√	√	
2	**Chlorophyceae**							
	Arthrodesmus sp	√	√	√	√	√	√	
	Coenococcus sp	√	√	√	√	√	√	
	Eudorina sp	√	√	√	√	√	√	
	Cosmarium sp	√	√	√	√	√		√
	Oocystis sp	√	√	√	√	√	√	
	Pediastrum sp				√	√		
	Staurastrum sp	√	√		√	√	√	√
	Sphaerocystis sp	√	√		√	√		√
3	**Dinophyceae**							
	Dinophysis	√	√	√	√	√	√	√
	Pyrocystus lunula			√	√	√		
	Ceratium liniatum	√	√	√	√	√	√	
	Ceratium Sp.	√	√	√	√	√	√	√

(Source: Primary Data 2022)

Phytoplankton are positive phototaxis, meaning they will naturally approach sources of light stimulation to carry out the photosynthesis process. This behavior causes differences in phytoplankton abundance in the morning, afternoon and evening. Phytoplankton tend to be on the surface of waters to carry out photosynthesis because the light intensity is maximum at the surface of waters in the morning and afternoon. In the afternoon, phytoplankton begin to move from the surface to deeper waters because the photosynthesis process has been completed due to decreasing light intensity and avoiding predators who become active at night. (Pratama *et al*. 2012).

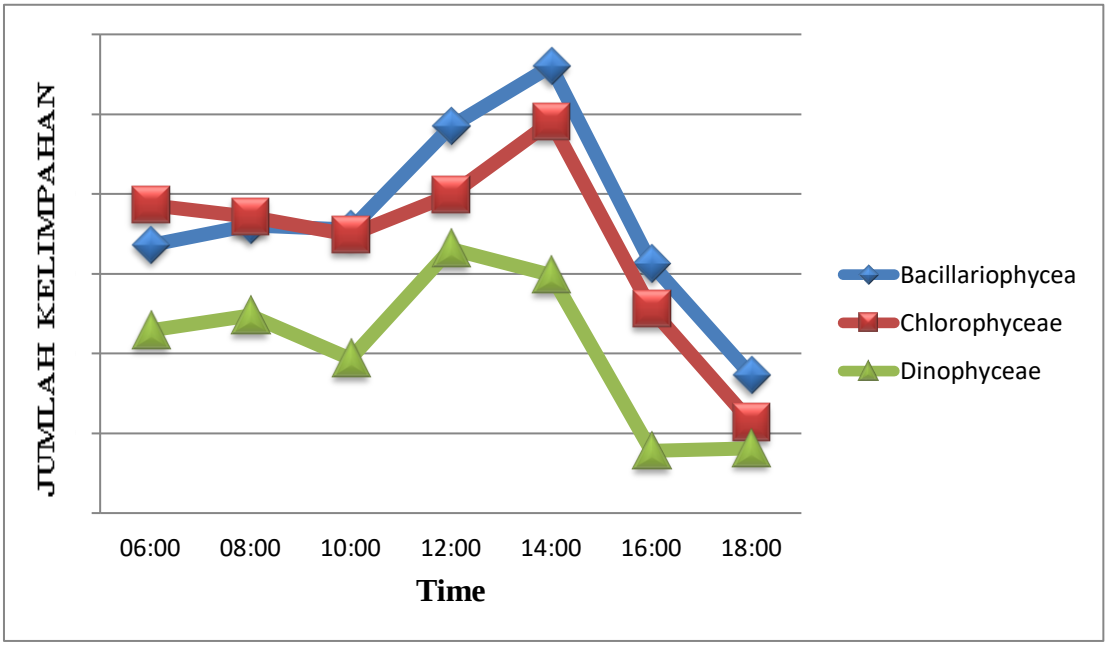

Figure 1. Graph of Phytoplankton Abundance in Baruta Analalaki Village in the Morning, Afternoon and Evening

Based on the graph above, it shows that the level of plankton abundance in Baruta Analalaki Village is quite fertile. Where the abundance of Bacillariophyceae class phytoplankton found in the morning was 672-710 types, Chlorophyceae class 697-772 types, and Dinophyceae class 387-495 types. Then, during the day, the abundance of plankton is actually higher, namely the Bacillariophyceae class 968-1120 types, the Chlorophyceae class 797-981 types, and the Dinophyceae class 597-662 types. The high abundance of phytoplankton is closely related to normal water quality as found by measurements of water physical parameters, namely normal brightness and temperature between 27-300C, causing the concentration of phytoplankton abundance to be stable. This is in line with the opinion of Sulastri, et al that there is a relationship between land use, water quality and the abundance of phytoplankton. Furthermore, in the afternoon the abundance of phytoplankton was found to decrease, namely the Bacillariophyceae class 345-625 types, the Chlorophyceae class 227-511 types, the Dinophyceae class 156-162 types. The fertility level of a body of water is a benchmark for the level of presence of phytoplankton organisms. The higher the abundance of phytoplankton, the higher the fertility level of the water, and vice versa. Several

physico-chemical parameter factors are also indicators that influence the level of phytoplankton abundance in an aquatic ecosystem. This is supported by Anggraini Sukardi & Apri Arisandi, (2020) that the level of fertility of a body of water can be seen from the level of presence of plankton organisms (phytoplankton).

Index of Diversity, Uniformity and Dominance of Phytoplankton in Baruta Analalaki Village

The naturalness of phytoplankton in Baruta Analalaki Village has values ranging between 2.26-3.05, which means it is still in the medium category but there is a high diversity index category, namely during the day at 14.00. This is supported by Basmi, (1999) in Anggraini Sukardi & Apri Arisandi, (2020) that the level of phytoplankton diversity index is divided into three categories, namely 0< H'<1 including low, the second category 1< H' <3 including low, and the third category H'>3 which means a high nationality index. Furthermore, the uniformity index is still relatively low, ranging between 0.34-0.39. The low uniformity value is caused by competition between types of phytoplankton, both for space and for food. This is supported by Odum, (1998) in Khasanah et al,. (2013) less than 0.5 is low, which means that equality between genera is relatively low or that the wealth of individuals belonging to each genera is very different. The dominance index is in the low category, ranging between 0.05-0.11, which means that no one dominates between species. This is supported by Odum (1998) in Khasanah (2013) that if the dominance index value is close to zero and far from 1 then there is no species that dominates..

Table 3. Diversity Index, Uniformity Index, and Phytoplankton Dominance Index in Baruta Analalaki Village

No.	Index	Time						
		06.00	08.00	10.00	12.00	14.00	16.00	18.00
1	Diversity Index	2,89	2,75	2,77	2,98	3,05	2,65	2,26
2	Uniformity Index	0,38	0,36	0,37	0,38	0,39	0,37	0,34
3	Dominance Index	0,06	0,07	0,07	0,05	0,05	0,07	0,11

(Primary Data Analysis, 2022)

Relationship between Phytoplankton Abundance and Physico-Chemical Parameters

The results of the Pearson correlation test show that brightness and temperature have the strongest relationship to phytoplankton abundance with values of r = 0.715 and r = 0.526. The close relationship between DO (r = 0.372), phosphate (r = 0.225) and nitrate (r = 0.341) with phytoplankton abundance is relatively moderate and the close relationship between pH and salinity is relatively weak with plankton abundance. Next, a linear regression analysis test was carried out to determine how much influence the

independent variables (brightness and temperature) had on the dependent variable (phytoplankton abundance).

Table 4. Results of the Pearson correlation test between phytoplankton abundance and physicochemical parameters of the waters of Baruta Analalaki Village.

No	Parameter	Pearson correlation value (r)
1	Temperature	0,526
2	Salinity	0,141
3	Brightness	0,715
4	pH	0,012
5	DO	0,372
6	Phosphate	0,225
7	Nitrate	0,341

(Primary Data Analysis, 2022)

The results of the regression analysis between phytoplankton abundance (ind/L) with brightness (cm) and temperature obtained the regression equation Y = 1761+183X1+126X2. These results show that the ratio coefficient of brightness and temperature is positive, which means that if there is an increase of 1 cm, the level of phytoplankton abundance will increase by 183 or 126 assuming other parameters are constant. Based on these results, a high brightness value indicates that the abundance of phytoplankton is also high in the waters of Baruta Analalaki Village. A high brightness value indicates that light penetration into the water body is optimal with normal temperature conditions, as a result phytoplankton can photosynthesize and develop well so that the abundance of phytoplankton will also increase.

CONCLUSSION

Based on research on the Study of Phytoplankton Abundance in the Waters of Baruta Analalaki Village, Sangia Wambulu District, Central Buton Regency, 3 types of phytoplankton from the classes Bacillariophyceae, Chlorophyceae, Dinophyceae were found. Of the three classes, the most commonly found is the Bacillariophyceae class. The level of abundance of phytoplankton is quite fertile, namely during the day from 12.00-14.00, 968-1120 species were found. The average diversity index is classified as moderate, but at 14.00 the diversity index was found to be high because naturally light intensity is needed to carry out the photosynthesis process. The phytoplankton uniformity index is relatively low, thought to be due to competition for space and food. Meanwhile, the dominance index is also relatively low, meaning that no one dominates between species. The results of the Pearson correlation and regression tests show that there is a very strong relationship between the abundance of phytoplankton and

physico-chemical parameters, which means that if there is an increase in temperature and brightness it will affect the abundance of phytoplankton in Baruta Analalaki Village.

Thus, the diversity, uniformity and dominance indices of phytoplankton abundance in Baruta Analalaki Village do not show significant differences even though the results of measuring physicochemical parameters are high. For this reason, regular research is needed to determine the distribution pattern of phytoplankton. Apart from that, it is necessary to measure other water quality parameters such as depth, BOD and COD contained in the water.

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