

Conditions Of Phytoplankton Community Structure In Lake Toba Ajibata, Toba Samosir Regency

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Abstract

The research was conducted with the aim of knowing the condition of the phytoplankton community structure based on diversity index criteria in the waters of Lake Toba, Ajibata District, Toba Samosir Regency. This research was conducted in February -March 2021. This type of research was ex post de facto, carried out at 5 observation stations with 3 repetitions. Phytoplankton samples were taken using Net plankton No. 25. Identification of phytoplankton was carried out in the Biology Laboratory of the Faculty of Mathematics and Natural Sciences, Medan State University. Phytoplankton found in 12 genera, namely: Achnantes, Aulacoisera, Encyonema, Claphora, Stigeoclonium, Dictyosphaerium, Staurastrum, Monoraphidium, Oscillatoria, Microcystis, Nostoc, and Chroococcus. The diversity index at Station I was 1.35, II was 1.36, III was 1.31, IV was 1.36, and V was 1.72. The condition of the phytoplankton community structure is stable in the moderate category. The temperature of the waters ranges from 22°C-25°C, the light transparency to the waters ranges from 4-4.5 m, the pH of the waters ranges from 7.36-8.85, the DO of the waters ranges from 6.84-8.25 mg/l, the BOD of the waters ranged from 1.01 to 3.42 mg/l. Lake Toba water quality based on physical and chemical parameters is within the normal range.

Keywords: Community, Phytoplankton and Lake Toba.

I. INTRODUCTION

Plankton are aquatic organisms whose movements follow the flow of water. Plankton is divided into two, namely phytoplankton and zooplankton. Phytoplankton are organisms that belong to plants, while zooplankton are classified as animals. Phytoplankton are producers that act as the basis of the food chain and food source for aquatic animals. Phytoplankton are the primary producers of food in every aquatic ecosystem, serve as a food source for fish and most other aquatic organisms [1]. According to [2], the phytoplankton community has an important ecological role in aquatic ecosystems as the main producer and is the basis of the aquatic food chain to support the community of aquatic organisms. Lake Toba is at an altitude of 905 above sea level and has a water area of 1,124 km², water volume of 256.2 x 10⁹ m³, and an average depth of 228 m [3]. Lake Toba is water tourism object and it's also used as a place for fish farming in floating net cages (KJA). These activities have the potential to provide input in the form of organic and inorganic materials which result in a decrease in the quality of the waters of Lake Toba. The floating net cages (KJA) have received a lot of attention from the public, especially environmentalists. There is controversy between the socio-economic needs of the community and environmental sustainability, as well as between the achievement of production and the carrying capacity of waters. Floating net cages (KJA) produce high organic waste and eventually produce high nitrite compounds which can cause pollution.

Visits by domestic and foreign tourists to enjoy water transportation vehicles, such as speedboats, ferries, Ihan ships, and passenger ships on Lake Toba, have the potential to generate waste which will cause pollution.

According to [4], that Phytoplankton is one of the biological parameters used as an indicator to evaluate the quality and productivity level of waters. It is necessary to study the community structure of the phytoplankton and its relationship to water quality in the Lombok Strait, North Lombok Regency. The above is the basis for research entitled " Conditions of Phytoplankton Community Structure in Lake Toba Ajibata, Toba Samosir Regency". Lakes are a critical part of the hydrological budget as a source of water, and provide valuable habitats for biological species [5]. The purpose of this study was to know the ecology of any phytoplankton found in Lake Toba Ajibata, Toba Samosir district. Indonesia has more than 700 lakes with a total area of more than 5000 km² or about 0.25% of Indonesia's land area [6]. Lake Toba is one of

them which is a water ecosystem that has undergone many changes, due to various human activities around this water ecosystem. Phytoplankton can act as an ecological parameter that gives an idea of the condition of the waters. Changes in size, type and number of aquatic plankton populations can describe the state of aquatic community structure. Phytoplankton having sizes ranging from 0.2–2.0 μm are called picoplankton, phytoplankton ranging from 2.0–20 μm are called ultraplankton, phytoplankton larger than 20–200 μm are called microplankton [7].

II. METHODS

The area of Ajibata district is 72.8 km² and has a total population of 7,297 people. One of the rivers that generates waste is the Naiborsah River. The naiborsahan river is used by local residents as a place to wash, bathe, etc. There were 5 stations in the study, namely: (I) Ihan Ship Harbor, (II) Floating Net Cages, (III) Blue Tent Baths, (IV) Naiborsahan River and (V) there was no community activity around as a sampling site. The distance at each sampling station is ±1 km.

Fig 1. Sampling locations



The population in this study were all the phytoplankton found in Lake Toba Ajibata and the samples were the phytoplankton taken using net plankton, this type of research is ex post facto. Phytoplankton were identified using [8] and the physico-chemical parameters of the waters were measured in-situ and ex-situ.

Data analysis

Phytoplankton abundance

Calculation of the abundance of the Phytoplankton population is carried out to determine the number of individual Phytoplankton contained in a certain area with Individual units/l. The abundance of the Phytoplankton population is determined using the following formula .

$$N = \frac{a \times c}{l} \tag{1}$$

Phytoplankton Diversity Index

The calculation of the Phytoplankton diversity index is carried out to determine the number of each individual Phytoplankton of different species in a population. Formula is used to compare and determine the diversity index of phytoplankton at each station (Shannon-Wiener) .

$$H' = -\sum PiLnPi \tag{2}$$

H' = Diversity Index Shannon-Wiener

Table 1. Diversity Index Criteria

Diversity Index (H')	Conditions of Community Structure	Categori
>2,41	Very Stable	Very Good
1,81-2,4	More Stable	Good
1,21-1,8	Stable	Better
0,61-1,2	Prety Stable	Bad
<0,6	Unstable	Very bad

Attendance frewuensi

$$\text{Frequency} = \frac{\text{Numbers of Occupied Plot}}{\text{Total Number of Plots}} \times 100\%$$

Where is the value FK :
 0 – 25% = very rarely
 25 – 50% = rare
 50 – 75% = often
 > 75% = very often

III. RESULT AND DISCUSSION

The research locations on Lake Toba Ajibata are at 5 research stations, as shown in Table 2.

Table 2. Station Positions (Coordinate Points) on Lake Toba

No	Station	Coordinate point	Location
1	Statsion I	2°39'33" 98°56'0"	Ihan Ship Harbor, Ajibata District
2	Station II	2°39'18" 98°56'2"	Floating Net Cage, Ajibata District
3	Station III	2°39'21" 98°56'3"	The estuary of the Naborsahan River on Lake Toba, Ajibata District
4	Station IV	2°39'6" 98°55'53"	Blue Tent Baths, Ajibata District
5	Station V	2°40'42" 98°55'42"	Waters in Jambu Village, Ajibata District

Phytoplankton Community

Phytoplankton in Lake Toba, Ajibata District, Toba Samosir Regency is presented in Figure 2.

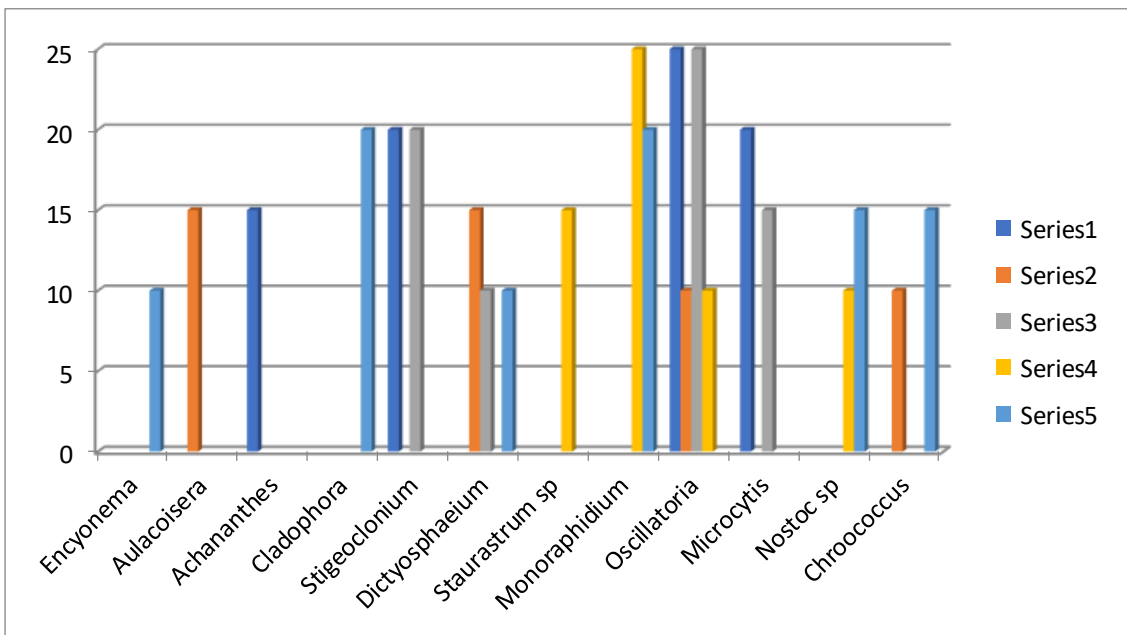


Fig 2.Number of Phytoplankton Found at Each Station.

Phytoplankton found in Lake Toba Ajibata, Toba Samosir district as shown in Figure 2.

Table 3. Presence of Phytoplankton at each station and frequency of presence

No	Genera	Station					FK
		I	II	III	IV	V	
1	Achnantes	☐					20
2	Aulacoisera		☐				20
3	Encyonema					☐	20
4	Claphora					☐	20
5	Stigeoclonium	☐		☐			40
6	Dictyosphaerium		☐	☐		☐	60
7	Staurastrum				☐		20
8	Monoraphidium				☐	☐	40

9	Oscillatoria	□	□	□	□	80
10	Microcystis	□		□		40
11	Nostoc				□	40
12	Chroococcus		□		□	40

Based on table 3, it can be seen that Oscillatoria has the highest attendance frequency by occupying 4 research stations, it can be said that Oscillatoria is found more often.

Table 4. Phytoplankton Abundance and Diversity Index

Value	Station				
	I	II	III	IV	V
Abundance	532	444	665	444	800
Diversity Index (H')	1.35	1.36	1.31	1.36	1.72

Based on table 4. it can be seen that the highest Phytoplankton abundance and the highest diversity index (H') were found at station V. Fertility (trophic status) of waters by nutrients, can be shown by the high abundance or biomass of phytoplankton [9] Functional diversity as a predictor of ecosystem properties is better used than taxonomic diversity such as for phytoplankton communities. in the Fennoscandian lake [10]. The alteration in the phytoplankton community depends on different environmental factors and anthropogenic effects [11].

The results of measuring the physical and chemical parameters of the waters can be seen in Table 5.

Table 5. Observation of Physical and Chemical Parameters

Nu	Parameters	Unit	Station I	Station II	Station III	Station IV	Station V
1	Temperature	°C	25	24	22	25	24
2	Light transparency	Cm/m	4	4	4,5	4	4
3	pH		8,09	7,36	7,96	8,85	8,68
4	DO	mg/L	6,84	6,84	7,25	8,25	7,04
5	BOD	mg/L	3,42	3,42	3,42	1,01	2,84

Based on table 5, it can be seen that the temperature values at all research stations ranged from 22°C-25°C. This temperature is in the range of research results which state that the optimal temperature for plankton growth is 20°-30°C. Phytoplankton community structure, composition and species diversity in aquatic ecosystems influenced by several physico-chemical parameters [12]. Each species of phytoplankton has a different response to physicochemical parameters [13, 14]. Phytoplankton community structure is a good indicator of water quality because it is very sensitive to environmental pressures [2].The results of measuring the transparency of light at each observation station range from 4 – 4.5m. The difference in brightness values is thought to be due to the influence of the quantity and quality of water.The results of pH measurements at each observation station ranged from 7.36 to 8.85. The normal pH value according to [15] for the growth of phytoplankton ranges from 6.0 to 8.0. Based on the results of these measurements, the waters in Lake Toba have a normal pH and are still supportive for the growth of phytoplankton, water conditions that are very basic or very alkaline will endanger the survival of aquatic organisms because it can cause disturbances of metabolism and respiration of phytoplankton.

The DO (Disolved Oxygen) measurement results at each observation station ranged from 6.84 to 8.25 mg/L.The results of BOD (Biological Oxygen Demand) measurements at each observation station ranged from 1.01 to 3.42 mg/L. High BOD indicates that the amount of oxygen needed by microorganisms that grow in water is due to the large amount of available food (organic matter). Therefore, BOD is always indirectly related to the levels of organic matter in water. According to [16,17], the range of physical and chemical parameter values for water is temperature (13°C-30°C), light transparency (94cm-275cm), pH (7-8.2), and dissolved oxygen (6-9 mg/L).Based on table 4 it can be seen that the abundance obtained at the five research stations is different. The abundance index at each station ranged from 444 ind/L – 756 ind/L. The highest abundance index was found at station V of 756 ind/L and the lowest abundance value was at stations II and IV. The diversity index (H') obtained at the five stations ranged from 1.31 to 1.72. The highest diversity index value was found at station V of 1.72 and the lowest diversity index was found at station III of 1.31. The highest frequency of phytoplankton presence was oscillatoria with 80%.

IV. CONCLUSION

Phytoplankton found in 12 genera, namely: Achnantes, Aulacoisera, Encyonema, Claphora, Stigeoclonium, Dictyosphaerium, Staurastrum, Monoraphidium, Oscillatoria, Microcystis, Nostoc, and Chroococcus. The diversity index at Station I was 1.35, II was 1.36, III was 1.31, IV was 1.36, and V was 1.72. The condition of the phytoplankton community structure is stable in the moderate category. The temperature of the waters ranges from 22°C-25°C, the light transparency to the waters ranges from 4-4.5 m, the pH of the waters ranges from 7.36-8.85, the DO of the waters ranges from 6.84-8.25 mg/l, the BOD of the waters ranged from 1.01 to 3.42 mg/l. Lake Toba water quality based on physical and chemical parameters is within the normal range.

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