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Plankton Diversity at Telaga Biru, District Turi, Lamongan

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Abstract
Telaga Biru is a natural lake located in Balun Village, Turi District, Lamongan. The lake is located in the middle of the village settlement. The local community uses the lake water as a source of HIPAM (Himpunan Masyarakat Pemakai Air Minum) flow. The purpose of this study was to analyze the diversity of plankton in Telaga Biru, Turi District, Lamongan. Plankton sampling was carried out at 3 stations. Sampling of each station was taken from each three sub-station points, and each sampling point was made 3 times a repetition. Plankton sampling using a plankton net with a size of 200 mesh. Samples obtained were identified to species using a microscope. Identification of plankton species based on morphological characters. The plankton data obtained were calculated using the plankton diversity index formula by Shannon-Wienner. The results showed that the plankton diversity index in Telaga Biru was classified as moderate, with 2.475. There were 14 species of phytoplankton and 2 species of zooplankton. The species of phytoplankton found are *Aulacoseira* sp, *Merismopedia* sp, *Stephanodiscus* sp, *Cyclotella* sp, *Cocconeis* sp, *Cymatopleura* sp, *Ankistrodesmus* sp, *Pinnularia* sp, *Pleurosigma* sp, *Microcytis* sp, *Asterionella* sp, *Gomphonema* sp, *Ropalodia* sp, and *Stigeoclonium* sp. In comparison, the genus of zooplankton found are *Brachionus* sp and *Amphileura* sp. Moderate plankton diversity has a positive impact on the environment, especially the dissolved oxygen (DO) parameter.

Keywords: Freshwater; Pollution; Shannon–Wiener index
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INTRODUCTION

Telaga Biru is one of the lakes located in Balun Village, Turi District, Lamongan Regency. This lake has an area of 15 meters × 20 meters which is located in the middle of a community settlement. According to local residents, this lake is a naturally formed lake that has existed for a long time. This lake is utilized by the Balun Village community as a source of spring water for HIPAM (Himpunan Masyarakat Pemakai Air Minum). The Balun Village community also utilizes Telaga Biru as a rainwater reservoir by the community to prevent flooding. From these functions, Telaga Biru plays a very important role in the daily life of the Balun Village community and its benefits can be felt directly by the local community.

The location of Telaga Biru in the middle of a community settlement makes these waters prone to contamination with domestic waste or household waste. All community activities carried out on the edge of the lake or the area around the lake will affect the condition of the waters. This is due to the continuous elevation or buildup, causing degradation of water quality and threats to aquatic ecosystems (Jumari and Soeprobowati, 2024).

The physical conditions of Telaga Biru are calm (lentic water) where there is no water flow or current also affects water quality. Because slow water currents or almost no currents cause the accumulation of water masses to last long (Frans and Nurfalaq, 2019). The amount of water flow also affects the amount of dissolved oxygen levels where the greater the flow of a body of water, the greater the dissolved oxygen content in the water (Pratama et al., 2016).

The name plankton is taken from Greek which means "wandering," referring to all pelagic organisms or those whose movements are more influenced by water currents than their own swimming ability or activity (Dewi, 2020). According to Halidah (2016) plankton is divided into two main categories, namely phytoplankton and zooplankton. Phytoplankton is a type of plankton that has plantlike properties that can carry out photosynthesis and is a primary producer in aquatic ecosystems (rivers, lakes, seas, etc.) (Dewi, 2020). Meanwhile, zooplankton is a type of plankton that has animal-like properties, namely having a means of movement so that it can move independently (Suwandana et al., 2018). In addition, zooplankton plays an important role in aquatic ecosystems as primary consumers that transfer energy from producers to higher trophic levels (Mariyati et al., 2020).

Plankton have an important role as bioindicators in the environment, especially in aquatic ecosystems (Akbarurrasyid et al., 2023). Plankton ecologically has a role as primary producers and primary consumers of the food chain which makes it a bioindicator of fertility and quality of a water body (Soliha and Rahayu, 2018). According to Aruan and Siahaan (2017) plankton also affects environmental factors, namely the amount of dissolved oxygen levels in water measured based on environmental parameters. The source of dissolved oxygen in water can come from several mechanisms that contribute to the availability of oxygen for aquatic organisms (Suhadi et al., 2020).

According to Lupitasari and Kusumaningtyas (2020), several factors that affect dissolved oxygen levels are caused by air diffusion, water agitation, light intensity, and the photosynthesis process which can be influenced by plant activity (density) and plankton activity (phytoplankton). The photosynthesis process carried out by phytoplankton causes dissolved oxygen levels in the water to increase so that water quality is maintained in an aquatic ecosystem (Rahmah et al., 2022). Conversely, respiration carried out by zooplankton will reduce dissolved oxygen levels in water, so it can reduce dissolved oxygen levels if the number of zooplankton is excessive (Wilda et al., 2020).

The lack of plankton diversity data in Telaga Biru makes it impossible to analyze water quality with plankton bioindicators. The purpose of this study is to determine the quality of Telaga Biru waters seen with plankton diversity as a bioindicator. This study also requires Telaga Biru dissolved oxygen data to support the plankton data obtained.

MATERIALS AND METHODS

This research was conducted in October 2023 at Telaga Biru, Balun Village, Turi District, Lamongan Regency (7°05'14.0 "S 112°24'30.9" E) (Figure 1). Plankton sampling in this study was carried out using the Belt Transect method. According to Kowiati et al. (2019), the Belt Transect method was expected to provide an overview of an organism's population conditions, especially plankton populations with a relatively diverse size or a specific maximum size. This approach allows estimation of the number of individuals and colonies of plankton and provides information on the diversity of species and their distribution in the waters under study. The Belt Transect method was expected to be an effective instrument for understanding and representing plankton population structure, providing a solid foundation for more in-depth ecological analysis (Dewi, 2020).

Figure 1. Location and sampling site

The plankton sampling technique used a 200-mesh Plankton Net adjusted to the maximum plankton size. Hence, the plankton can be sampled in a quadrant. Plankton sampling was carried out at three predetermined stations. Each station had three plots or sampling points, each approximately 3 meters apart. Each sampling point or plot was repeated three times. Sampling was conducted in the morning within a day to ensure variations do not influence the data obtained in sampling time. Dissolved oxygen levels were tested directly at each sampling point using a calibrated DO meter.

Testing was carried out directly at the location to avoid oxygen diffusion when testing was carried out in the laboratory.

Station 1 was located at coordinates 7°05'12.7 "S 112°24'30.5" E and had the characteristics of not being covered by vegetation (not blocked by trees), hence sunlight could directly shine into the waters. Station 2 was at coordinates 7°05'14.0 "S 112°24'30.3" E and had the characteristics of water covered by aquatic plants in the form of water lilies so that these plants blocked sunlight. Station 3 was at the coordinates 7°05'15.1 "S 112°24'31.4" E and had the characteristics of closed vegetation (shaded by trees) so that sunlight could not directly illuminate the waters.

Plankton observations were made using a binocular microscope (Olympus CX23) with a magnification of 100, then identified to species level using a book by Edmondson entitled "Fresh Water Biology" second edition 1959. Plankton identified with morphological physical characteristics were analyzed using the Shannon-Wiener diversity index. The Shannon-Wiener diversity index formula is as follows:

$$H' = -\Sigma Pi \ln Pi$$

Where:

H' : index of species diversity
Pi : S/N (proportion of plankton species)
S : number of individuals of one type of plankton
N : number of plankton species

The criteria for classifying the value of the species diversity index (H') according to Michael (1994) are:

a. H' > 3,0 : High Diversity Index
b. 1,0 < H'< 3,0 : Moderate Diversity Index
c. H' < 1,0 : Low Diversity Index

RESULTS

Plankton diversity was observed in Telaga Biru Balun Village, Lamongan, and water samples were collected at three stations. The results of plankton identification in Telaga Biru Balun Village found 16 different species namely *Aulacoseira* sp., *Merismopedia* sp., *Stephanodiscus* sp., *Cyclotella* sp., *Cocconeis* sp., *Cymatopleura* sp., *Ankistrodesmus* sp., *Pinnularia* sp., *Pleurosigma* sp., *Microcytis* sp., *Asterionella* sp., *Gomphonema* sp., *Ropalodia* sp., *Stigeoclonium* sp., *Brachionus* sp., and *Amphileura* sp. (Table 1).

Stations 1 and 3 were dominated by plankton with the species *Ankistrodesmus* sp., while station 2 was dominated by plankton with the species *Stephanodiscus* sp. Station 1 found 13 different plankton species, while stations 2 and 3 found 14 different plankton. The number of plankton individuals found at stations 1, 2, and 3 were 118, 112, and 114, respectively.

Table 1. Index diversity of plankton from Telaga Biru

Species	Number of Individuals per Station			Number of Individuals
	1	2	3	
Aulacoseira sp	12	10	7	29
Merismopedia sp	7	0	5	12
Stephanodiscus sp	16	21	16	53
Cyclotella sp	6	4	5	15
Cocconeis sp	11	13	13	37
Cymatopleura sp	11	11	3	25
Ankistrodesmus sp	24	18	21	63
Pinnularia sp	5	3	6	14
Pleurosigma sp	0	3	4	7
Microcytis sp	0	2	1	3
Asterionella sp	0	0	8	8
Gomphonema sp	2	1	0	3
Ropalodia sp	3	1	0	4
Stigeoclonium sp	7	8	9	24
Brachionus sp	8	9	6	23
Amphileura sp	6	8	10	24
Total Number	118	112	114	344
Index of Species Diversity				**2.475**

Plankton found in the waters of Telaga Biru, Lamongan, consisted of phytoplankton and zooplankton. There were 14 species of phytoplankton, namely *Aulacoseira* sp., *Merismopedia* sp., *Stephanodiscus* sp., *Cyclotella* sp., *Cocconeis* sp., *Cymatopleura* sp., *Ankistrodesmus* sp., *Pinnularia* sp., *Pleurosigma* sp., *Microcytis* sp., *Asterionella* sp., *Gomphonema* sp., *Ropalodia* sp., and *Stigeoclonium* sp. Additionally, there were also 2 species of zooplankton, namely *Brachionus* sp. and *Amphileura* sp.

There were 344 individuals of plankton found during the sampling (Table 1). The plankton diversity index in the waters of Telaga Biru Balun Village, Lamongan, amounted to 2.475. The diversity index is classified as moderate (Michael, 1994).

Table 2. Measurement results of water Dissolved Oxygen (DO)

Station	Plot	DO (ppm)
1	1	8.99
	2	9.50
	3	9.69
Average		**9.40 ± 0.36**
2	1	9.05
	2	8.32
	3	8.56
Average		**8.65 ± 0.37**
3	1	9.85
	2	9.85
	3	8.92
Average		**9.54 ± 0.54**
Quality Standard PP No. 22 Year 2021		**6 (Minimum Limits)**

The lowest average dissolved oxygen (DO) parameter measurement results at station 2 are 8.65 (SD + 0.37) ppm then station 1 is 9.40 (SD + 0.36) ppm, and the highest results are at station 3, which is 9.54 (SD + 0.54) ppm (Table 2). When compared with quality standards based on Government Regulation No. 22 of 2021, the results are in compliance (more than 6 ppm).

DISCUSSION

In the waters of Telaga Biru, Lamongan, 344 plankton individuals were found, and 16 different species were identified. The 16 species consisted of 14 phytoplankton species and 2 zooplankton species. After the calculation, the diversity index value was obtained at 2.475. Based on Michael (1994), the diversity index value is classified as moderate.

Observations showed that the number of phytoplankton was too far above that of zooplankton. The ratio was 1:7. This is very reasonable because phytoplankton are producers in the food chain sequence while zooplankton are primary consumers. According to Tambaru (2014), dense phytoplankton populations will hinder the vertical movement of zooplankton. Therefore, zooplankton will choose to move to locations with less dense phytoplankton. Some phytoplankton also produce compounds that are harmful to zooplankton, which can result in Harmful Algal Bloom (HAB) (Gurning et al., 2020).

The results of plankton observations that have been made at Telaga Biru, Balun Village, Turi District, Lamongan Regency, East Java Province that the identification of the most plankton found at station 1 with a total of 118 individuals and the least number of plankton found at station 3 with 112 individuals. The difference in the number of plankton found can be influenced by the environmental conditions of these waters to activities in these waters (Widiyanti et al, 2021). Water conditions that are covered by trees and many activities from various sectors will affect the number of plankton found (Haliza et al., 2023). Handayani and Nuzapril (2024) stated that the diversity and abundance of plankton in aquatic ecosystems are influenced by environmental conditions and human activities. This is also caused by differences in water quality parameter factors such as temperature, dissolved oxygen, and pH. The occurrence of variations in plankton differences is caused by activities around these waters that have the potential to produce waste that can disrupt aquatic ecosystems and plankton productivity (Putri et al., 2023).

In Table 1 it can be seen that the plankton species found at station 1 there are 13 species of plankton with diversity index at station 1 obtained H' value of 2.38. This value, when compared to the

Shanon-Wierner diversity index criteria, is classified into a moderate diversity index. The value of the diversity index can be caused by the location of station 1 which is in an open topography that is not shaded by trees above the water surface. This is in accordance with research conducted by Fauzia et al. (2016), which states that the plankton diversity index shows a moderate category because the topography of the river is open and not shaded by trees, causing aquatic organisms to be exposed to direct sunlight. The high and low intensity of light entering the waters will affect the primary productivity carried out by phytoplankton (Nurmalitasari and Sudarsono, 2023).

In Table 1 it can be seen that the plankton species found at station 2 there are 14 species of plankton with diversity index at station 2 obtained H' value of 2.35 so that it is classified into a moderate diversity index based on Shanon-Wierner criteria. Based on Table 2, the results of dissolved oxygen measurements at station 2 have the lowest dissolved oxygen levels, which obtained an average value of 8.65 (SD + 0.37) ppm. Dissolved oxygen levels at station 2 can be caused by the location of station 2, which is in the topography of the water surface covered by aquatic plants such as lotus (*Nymphaea*). This is in accordance with research conducted by Pagoray and Udayana (2018) which states that the presence of aquatic plants such as lotus (*Nymphaea*) can affect dissolved oxygen levels in water and also cause plankton diversity to moderate-low levels in ponds and aquaculture ponds. Dissolved oxygen levels in an aquatic ecosystem affects productivity rate and plankton diversity (Ainalyaqin and Abida, 2024).

In Table 1 it can be seen that the plankton species found at station 3 there are 14 species of plankton with the highest diversity index at station 3 which is obtained H' value of 2.44 so that it is classified into a moderate diversity index based on Shanon-Wierner criteria. Based on table 2, the results of dissolved oxygen measurements at station 3 have the highest dissolved oxygen levels, which are obtained at an average value of 9.54 (SD + 0.54) ppm. The value of the diversity index can be caused by the location of station 3 which is in the topography of the water surface shaded by trees so that the water surface is not exposed directly to sunlight. This is in accordance with research conducted by Halidah (2016) which states that plankton diversity is higher in mangrove ecosystems so that the waters in the ecosystem are not exposed to direct sunlight because of the shade of the trees. Tree shade can protect the surface of the water from being exposed to direct sunlight so as not to threaten plankton productivity (Kartika et al., 2024).

Plankton diversity in Telaga Biru, Balun Village, Turi District, Lamongan Regency has an average diversity index value of 2.475 with the most plankton species namely *Ankistrodesmus* sp as many as 63 individuals and the least species including *Microcytis* sp and *Gomphonema* sp with each species as many as 3 individuals. *Ankistrodesmus* sp. is a phytoplankton often referred to as green algae and belongs to the *Selenastraceae* family (Mansa et al., 2018). This species is a small chlorophyte with a cell volume of about 100 μm^3 and can be found in various freshwater waters (lakes, rivers, ponds) around the world (Rinanti and Purwadi, 2018). *Ankistrodesmus* sp. is a primary producer in aquatic ecosystems because it is one of the main foods for several zooplankton species and can be used to study the effects of toxins on certain aquatic communities (Schomaker and Dudycha, 2021).

With the diversity of plankton that produces oxygen, dissolved oxygen levels in Telaga Biru waters meet the quality standards for class 1 waters set by the government. The quality standard is stated in Government Regulation No. 22 of 2021. According to Saraswati et al (2017) emphasizes the importance of understanding dissolved oxygen in the ecology and biology of organisms. Monitoring and maintaining adequate dissolved oxygen levels in the aquatic environment is key to supporting the sustainability of aquatic ecosystems and the survival of organisms that inhabit these ecosystems.

CONCLUSION

Based on the research, results, and discussion, the plankton diversity index in Telaga Biru, Lamongan waters was classified as moderate (the diversity index was 2.475). Moderate plankton diversity positively impacts the environment, especially the dissolved oxygen (DO) parameter.

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CONFLICT OF INTEREST

There is no conflict of interest.

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