El-Hayah Vol. 10, No.4 (2026) 193-207

El-Hayah

JURNAL BIOLOGI

Journal Homepage: http://ejournal.uin-malang.ac.id/index.php/bio/index

e-ISSN: 2460-7207, p-ISSN: 2086-0064

Original research article

Plankton Diversity of Welang River in the Mount Baung Nature Tourist Park, Pasuruan Regency East Java Province

Nur Patria Kurniawan[1*], Luvi Andari[1], Liris Lis Komara[2]

[1]*Conservation Division of East Java, Ministry of Environment and Forestry, Juanda Airport Highway, Sedati subdistrict. Sidoarjo regency 61253 Indonesia*

[2]*Forestry Study Programe, East Kutai Agricultural College School, Sukarno Hatta Street No 1, Sangatta, 75387 Indonesia*

*Corresponding author

Email: nurpatriakurniawan81@gmail.com

DOI: 10.18860/elha.v10i4.36794

Article Info

Article history:

Received 19 December 2025

Received in revised form 21 February 2026

Accepted 16 March 2026

Keywords:

Diversity, Plankton, Quality, River, Water

Abstract

The Welang River in the Gunung Baung Nature Tourism Park (TWA), Pasuruan, plays a vital role as a source of clean water, irrigation, and ecotourism, but is vulnerable to contamination from upstream areas with high activity level. This water quality degradation requires monitoring, and biological analysis using plankton as a bioindicator is a holistic method due to the sensitivity of these organisms to environmental changes. This study aims to determine the structure and plankton community (phytoplankton and zooplankton) in the Welang River and analyze its ecological condition based on the plankton diversity index. The method used is descriptive quantitative with a purposive sampling technique at three stations. Sampling was conducted using a volume sampler technique and abundance was calculated using a Sedgewick Rafter counting cell. Ecological indices were calculated for each station individually to identify spatial variations and then averaged to represent the overall condition of the river. Data analysis included calculations of abundance, Diversity Index (H'), Evenness (E), Richness (R), and Dominance (D). The results showed that the plankton community as a whole was in the category of moderate diversity, high evenness, and very low dominance. This value indicates that the Welang River waters are in a stable ecological condition and are not heavily polluted. In conclusion, the water quality of the Welang River is stable but shows an early warning of nutrient enrichment from anthropogenic activities, especially from the upstream.

1. INTRODUCTION

A river is a large, elongated stream of water that flows continuously from upstream to downstream (Estuary) (estuary) [1] and is part of the hydrological cycle. Water in rivers is generally collected from precipitation, such as rain, dew, springs, underground runoff, and in some countries, also from melted ice or snow [2]. Morphologically, river basins are divided into three parts: upstream, middle, and downstream downstream [3]. Rivers play a vital role as the backbone of terrestrial ecosystems and provide essential water resources for life of flora, fauna, and surrounding communities [4]. Indonesia has many rivers, including the Welang River, which flows through Mount Baung. Mount Baung is a conservation forest area called the Baung Mount Nature Tourism Park, located in Pasuruan, East Java Province. This conservation area is under the management of the Nature Conservation Division of East Java [5], demonstrating its status as a natural asset that must be preserved.

The Welang River that flows through Mount Baung is utilized as a source of clean water for daily life by the holder of the Water Energy Utilization Business Permit PT. Kanz Capital, a water source for the surrounding community's agriculture, mini-hydro energy, recreation and tourism activities, such as river cruising using rubber boats, which is an attraction for visitors to the Mount Baung area and supports the ecosystem and biodiversity because the River is a habitat for various species of fish, aquatic plants, and other animals, which play an important role in maintaining the balance of the ecosystem. However, the location of the Welang river before entering the TWA area has crossed dense areas of activity such as residential, agricultural, and industrial areas, making this river very vulnerable to pollution. Various reports indicate that river water, especially during the rainy season, is often polluted by agricultural, livestock, market, industrial, and household waste, which is characterized by water conditions that are full of garbage, sticky, slimy, and smelly. This degradation of water quality not only threatens the Mount Baung TWA ecosystem but also has the potential to trigger conflicts between wildlife and the buffer community, as well as disrupt the operation of water utilization facilities.

Water quality is crucial for a river to function effectively, its serves as an indicator of a river's health and determines its suitability for various ecological functions and human use. Quality assessment can be conducted through physical and chemical parameters (such as temperature, pH, dissolved oxygen, nitrate, and phosphate) and biological analysis [6]. Biological analysis, particularly through the study of living organisms, provides a more holistic and integrated picture of the cumulative impacts of various environmental changes over a longer period. Certain living organisms that are sensitive to environmental changes can act as effective bioindicators. One group of aquatic organisms widely recognized as a bioindicator of water quality is plankton, because they are highly sensitive to environmental changes and form the foundational level of the aquatic food web [7]. Plankton are microscopic organisms that live floating or move passively with water currents. Due to its inability to resist currents [8] and sensitivity to changes in environmental parameters (such as temperature, nutrients, and pollution levels), the structure of the plankton community (including diversity, abundance, and species composition) will change rapidly and significantly in response to changes in water quality [9] [10]. The role of plankton in a river habitat or ecosystem is fundamental [10]. At the base of the food chain, phytoplankton are the initiators of primary productivity, providing the energy that sustains the entire aquatic food web[11]. Without phytoplankton, the food chain would cease to function, and most aquatic life would be unable to survive. Zooplankton then transmit this energy to higher trophic levels [12]. Furthermore, because the plankton community as a whole plays a crucial role in nutrient cycling and water oxygenation, changes in plankton structure and composition, such as blooms of certain pollution-tolerant species [13], can lead to drastic decreases in dissolved oxygen (DO) levels as the biomass dies and decomposes, ultimately negatively impacting all life in the river. Therefore, studies of plankton provide rich information regarding the ecological status and extent of river pollution [14].

The presence of plankton in a body of water can provide information about the condition of a body of water, so plankton is a biological parameter that can be used as an indicator to evaluate the quality and fertility level of a body of water [7]. However, there is no information on the diversity and composition of plankton in the Welang River, therefore it is necessary to conduct research on the structure of the plankton community in the Welang River that crosses Mount Baung. This research was conducted with the main objective to determine the structure and community of plankton (both phytoplankton and zooplankton) in the Welang River that crosses the Mount Baung Nature Tourism Park area. Through species identification, abundance calculation, and analysis of plankton diversity indices, the results of this study are expected to describe the ecological conditions of the Welang River based on biological indicators of plankton

2. MATERIALS AND METHODS

Study area

Sampling locations were taken at three points along the Welang River, at Baung Mount Nature Tourist Park designated Station 1 (ST 1), Station 2 (ST 2), and Station 3 (ST 3). Stations were spaced 1 km apart, and each station was replicated three times (Figure 1). This study used a purposive sampling method to determine the study locations in April 2025 (Figure 1).

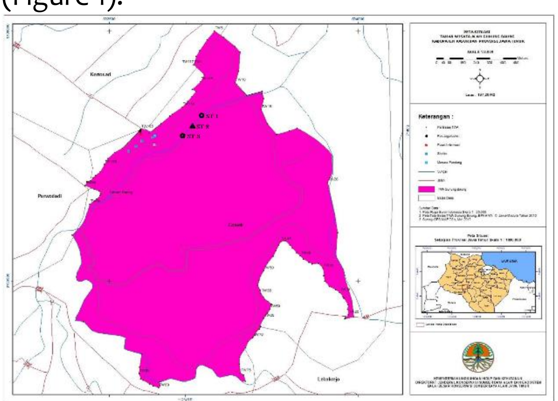

Figure 1. Baung Mountain Nature Tourist Park (ST 1, ST 2 dan ST 3)

Procedures

This method employed a vertical plankton net to filter the water. A total of 50 liters of water was collected from each sub-station using a bucket and poured into the plankton net. The filtered water was then transferred into a film bottle and then transferred into a 100 mL sample bottle. The plankton samples in the bottles were then preserved using a 1% Lugol's solution [15]. The plankton samples were observed and analyzed in the laboratory. Observations of both phytoplankton and zooplankton were obtained using an Olympus CX21 binocular microscope with a magnification of 10x10. The method used was the census method. Phytoplankton abundance was calculated using a Sedgewick Rafter Counting Cell (SRC) tool. Plankton identification refers to the identification book of [16]. Due to logistical constraints, in-situ physical and chemical water quality parameters (such as temperature, pH, and Dissolved Oxygen) were not measured during the sampling period. Consequently, the analysis focuses primarily on the biological composition and abundance of the plankton communities.

Data analysis

Phytoplankton abundance is expressed in cells/m3 which is calculated using the following formula [17]:

$$N = n \times \frac{Vt}{Vsrc} \times \frac{Asrc}{Aa} \times \frac{1}{Vd}$$

Where:

N is the abundance of plankton (cells/m3),

n is the observed organism (cells),

Vd is the volume of filtered water ($\pi r2$ x depth) (m^3),

Vt is the volume of filtered water (mL),

Vsrc is the volume in one SRC (1 mL),

Asrc is the cross-sectional area of the SRC (1000 mm^2) and

Aa is the observed area (mm2)

This research uses descriptive quantitative methods aimed at describing and drawing conclusions from observed phenomena through numbers. The data obtained are then analyzed and processed using abundance, diversity, evenness, and dominance indices, and the results are then interpreted descriptively. Plankton depth is the number of individuals or cells per unit volume (in liters). Phytoplankton are measured in cells/L and zooplankton in individuals/L.

The quantity of phytoplankton and zooplankton can be grouped to indicate the trophic level of a water body. There are trophic level categories based on the number of plankton, namely

1. if the number of phytoplankton (<2000 cells/L) and zooplankton (<1 ind/L) is included in the Oligotrophic Waters category,
2. if the number of phytoplankton (2000-5000 cells/L) and zooplankton (1-500 ind/L) is included in the Mesotrophic Waters category, and
3. if the number of phytoplankton (>15000 cells/L) and zooplankton (>500 ind/L) indicates Eutrophic Waters [7] [9]

This species diversity index is used to determine the diversity of a community or species richness [18]. The calculation directly performed between phytoplankton and zooplankton In addition to flora diversity, this index is also used to calculate fauna diversity, namely mammals, birds, herpetofauna, and arthropods, as well as to calculate the diversity of aquatic biota.

$$H' = -\sum pi \ln pi$$

$$pi = \frac{ni}{N}$$

Where:

- Ni is the number of individuals in a species, and
- N is the total number of individuals.

After calculating H', the level of diversity is determined using the criteria of the species diversity index [19] as follows: H' < 1 indicates low species diversity, low distribution of individuals per species, and low community stability. If 1 < H' < 3: Medium diversity, moderate distribution of individuals per species or genera, and moderate community stability. If H' > 3: High diversity, high distribution of individuals per species.

The species evenness index (E) indicates the level of evenness of individuals per species. The closer the E value is to 1, the higher the evenness value. The E value [20] is calculated using the following mathematical formula:

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

Where:

- E is the Species Evenness Index,
- H' is the Species Diversity Index, and
- S is the total number of species.

According to Magurran (1988), the level of evenness of individuals per species is determined by a value where

0 < E ≤ .5 indicates low species evenness and 0.5 < E < 1 indicates high species evenness.

The species richness index is calculated using the Margallef formula [21] with the following calculation:

$$R = \frac{S - 1}{\ln N}$$

Where:

- R is the Species Richness Index,
- S is the number of species found, and
- N is the total number of individuals.

Species richness is determined using the following criteria:

R < 2.5 indicates low species richness.

2.5 > R > 4 indicates moderate species richness, and

R > 4 indicates high species richness.

The dominance index indicates the dominance of species in a community. The dominance index is calculated using Simpson's dominance index formula [21]:

$$D = \sum(\frac{ni}{N})^2$$

Where:

- Ni is the number of individuals in one species, and
- N is the total number of individuals.

The dominance index value ranges from 0 to 1.

- 0 < D ≤ 0.5 indicates that no species dominates
- 0.5 < D < 1: indicates the dominance of a particular species

3. RESULTS

Structure phytoplankton

The phytoplankton species and quantities Analysis in the Welang River, Gunung Baung, at three observation stations (ST 1, ST 2, and ST 3) showed a diverse composition of three main classes: Chlorophyceae (green algae), Cyanophyceae (blue-green algae), and Chrysophyceae (golden algae/diatoms). These phytoplankton communities serve as important indicators of water quality and river ecosystem productivity.

The Chlorophyceae class is represented by four species: *Closterium striolatum*, *Scenedesmus dimorphus*, *Stigeoclonium* sp, and *Spirogyra ionia*. The total abundance of this class tends to be dominant at Station 3, followed by Station 2, and is lowest at Station 1. *Closterium striolatum* was not found at ST 1 (-) but had a similar number of cells (63 cells/L) at ST 2 and ST 3. The genus Closterium is known as a freshwater indicator [22], often found in clear waters [23], although tolerant to different organic levels [24] *Scenedesmus dimorphus* was found at ST 1 and ST 3 in equal numbers (126 cells/L), and was not detected at ST 2 (-). Scenedesmus is a common genus and is often abundant in nutrient-rich (eutrophicated) waters. *Stigeoclonium* sp had the highest abundance at ST 1 (189 cells/L), followed by ST 3 (126 cells/L), and was not found at ST 2 (-).

Table 1. Structure of Phytoplankton

No.	Species	Cell Unit		
		ST 1	ST 2	ST 3
	Chlorophyceae			
1	*Closterium striolatum*	-	63	63
2	*Scenedesmus dimorphus*	126	-	126
3	*Stigeoclonium* sp.	189	-	126
4	*Spirogyra ionia*	-	189	252
	Cyanophyceae			
5	*Chroococcus* sp.	126	-	189
6	*Merismopedia convoluta*	63	126	-
7	*Oscillatoria* sp.	189	189	126
	Crysophyceae			
8	*Navicula* sp.	-	126	-
9	*Neidium* sp.	126	-	-
10	*Surirella robusta*	-	-	189
11	*Pleurosigma* sp.	126	189	-

Stigeoclonium is known to grow in polluted or fast-flowing environments, indicating adaptation to specific river conditions. *Spirogyra ionia* showed the highest overall cell abundance among all identified phytoplankton, reaching 252 cells/L at ST 3. At ST 2, the number was 189 cells/L, while it was not found at ST 1 (-). Spirogyra, with its filamentous form, is often found in clear, slow-flowing, or still waters. The total abundance of Chlorophyceae at each station: ST 1 (315 cells/L), ST 2 (252 cells/L), and ST 3 (567 cells/L). The dominance of Chlorophyceae at ST 3, especially by *Spirogyra ionia*, suggests the possibility that the water conditions at that station may be more stable or have nutrient availability that supports the growth of green algae, which generally dominate relatively clean or temperate freshwater.

The Cyanophyceae class is represented by three species: *Chroococcus* sp. *Merismopedia convoluta,* and *Oscillatoria* sp. Cyanophyceae are often associated with nutrient-enriched (eutrophic) waters and have a high tolerance to certain environmental conditions. *Chroococcus* sp. was found in ST 1 (126 cells/L) and ST 3 (189 cells/L) but was not found in ST 2 (-) (Table 1). The Chroococcus genus can be an indicator of eutrophic waters. *Merismopedia convoluta* had an abundance of 63 cells/L in ST 1 and 126 cells/L in ST 2 but was not detected in ST 3 (-). The *Oscillatoria* sp. species was found at all stations with significant abundance: 189 cells/L in ST 1 and ST 2, and 126 cells/L in ST 3. *Oscillatoria* is known to have a high tolerance to drought, certain temperatures, and is a strong indicator of organic pollution or eutrophication conditions. The total abundance of Cyanophyceae showed a relatively even distribution, with ST 1 (378 cells/L) and ST 2 (315 cells/L) slightly higher than ST 3 (315 cells/L). The high presence and abundance of *Oscillatoria* sp at all three stations indicated that the river waters may have a certain nutrient load or organic pollution that can trigger the growth of blue-green algae.

The Crysophyceae class is represented by four species: *Navicula* sp, *Neidium* sp., *Surirella robusta*, and *Pleurosigma* sp. Crysophyceae (diatoms) are generally dominant in clear, well-circulated waters and are important indicators in assessing water quality. The *Navicula* sp. species was only found in ST 2 (126 cells/L) but was absent in ST 1 and ST 3 (-). *Navicula* is a very common diatom genus in fresh and marine waters. *Neidium* sp. was only found in ST 1 (126 cells/L). The *Surirella robusta* species was only found in ST 3 with a total of 189 cells/L. *Surirella* is often found in flowing waters with certain substrates. *Pleurosigma* sp.: Found in ST 1 (126 cells/L) and ST 2 (189 cells/L) but was absent in ST 3 (-). The total abundance of Crysophyceae species at each station: ST 1 (252 cells/L), ST 2 (315 cells/L), and ST 3 (189 cells/L). Diatom abundance shows a variable distribution, indicating variations in the physical and chemical conditions of the water, such as current speed or silica availability, which are specific to each station.

Table 2. Structure of zooplankton

No.	Species	Individu amount (ind/L)		
		ST 1	ST 2	ST 3
	Mastigophora			
1	*Euglena oblonga*	-	126	315
2	*Phacus undulatus*	-	-	126
	Sarcodina			
3	*Arcella vulgaris*	252	189	-
	Rotatoria			
4	*Polyarthra trigla*	126	63	126

The results of the study showed that the species and number of zooplankton in the Welang River, Gunung Baung, have a diverse community consisting of three main groups, namely Mastigophora (flagellated protozoa), Sarcodina (pseudopod protozoa), and Rotatoria (Rotifera). The zooplankton community, as primary and secondary consumers, functions as an important bioindicator that reflects trophic conditions and levels of water pollution. The total abundance of zooplankton showed significant differences between stations: Station 3 recorded the highest number of individuals (567 individuals/L), far exceeding Station 1 (378 individuals/L) and Station 2 (378 individuals/L) (Table 2).

The Mastigophora class was found only at Stations 2 and 3, represented by two species, *Euglena oblonga* and *Phacus undulatus*. This group, which is generally a strong indicator of organic pollution, showed absolute dominance at ST 3. *Euglena oblonga* was absent from ST 1 but was present in moderate numbers at ST 2 (126 individuals/L) and at high abundance at ST 3 (315 individuals/L). The genus Euglena is often mixotrophic and abundant in organic-rich waters and indicates severe eutrophication, making its exceptional abundance at ST 3 an important marker of poor water quality. *Phacus undulatus* was found only at ST 3 (126 individuals/L). Like *Euglena, Phacus* is an indicator of polluted and nutrient-rich waters, further strengthening the indication of a significant organic pollution load at the downstream stations.

The Sarcodina class is represented by only one species, *Arcella vulgaris*, which showed dominance at Stations 1 and 2. This species had the highest abundance at ST 1 (252 individuals/L) and a significant number at ST 2 (189 individuals/L), but disappeared at ST 3. Arcella is a shelled protozoan that feeds on detritus and bacteria, often found associated with sediment. Its abundance indicates that STs 1 and 2 have the availability of organic matter and detritus that supports its growth. Its absence at ST 3, which is dominated by Mastigophora, may reflect a drastic change in the physical and chemical conditions of the water that does not support its growth.

The Rotatoria group, which is a microscopic metazoan and phytoplankton consumer, is represented by *Polyarthra triglam*, which its presence is relatively stable in ST 1 (126 individuals/L) and ST 3 (126 individuals/L), with the lowest number in ST 2 (63 individuals/L). Polyarthra functions as a phytoplankton and bacteria feeder, so its presence indicates the presence of adequate food sources in the waters. Fluctuations in its abundance may reflect predation pressure or the population dynamics of the phytoplankton it preys on.

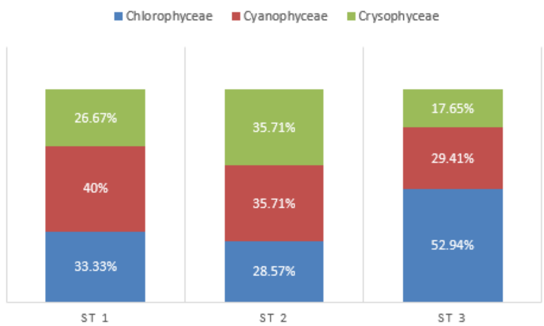

Figure 2. Phytoplankton species presentation (cell/liter).

At Station 1, Cyanophyceae was the most dominant class with a percentage of 40%. This indicates the presence of nutrient pressure or pollution that supports the growth of blue-green algae. Chlorophyceae contributed 33.33%, while Chrysophyceae had the lowest percentage at 26.67% (figure 2). Station 2 showed a relatively balanced composition, but Chrysophyceae (Diatoms) were the highest, reaching 35.71%. Cyanophyceae also had the same percentage, at 35.71%, while Chlorophyceae were the lowest at 28.57%. Dominance or balance with Chrysophyceae is often associated with clearer waters or having good water circulation. Station 3 showed a different dominance pattern, with Chlorophyceae taking the largest portion, reaching 52.94%. Cyanophyceae followed with 29.41%, and Chrysophyceae were the lowest, only 17.65%. This high Chlorophyceae dominance was previously associated with *Spirogyra ionia* abundance, indicating calmer or more stable water conditions for green algae. Overall, the shift from Cyanophyceae dominance at ST 1 to Chlorophyceae dominance at ST 3, with a decline in Chrysophyceae, suggests that ST 3 has very specific conditions perhaps more stable and nutrient-rich that favor green alga blooms, although nutrient stress (indicated by Cyanophyceae) remains at all stations. This increase in nutrients likely stems from the accumulation of domestic and agricultural waste from densely populated residential areas through which the river passes before entering the TWA area. This is in line with the findings of [4] who stated that human activities along the river course increase the organic load, triggering population explosions of green algae and pollution-tolerant species. Furthermore, the decrease in the abundance of Chrysophyceae (Diatoms) at this station is an indication of environmental pressures that limit the growth of sensitive organisms, as explained by [14] that the structure of the phytoplankton community will shift significantly in river zones experiencing nutrient enrichment.

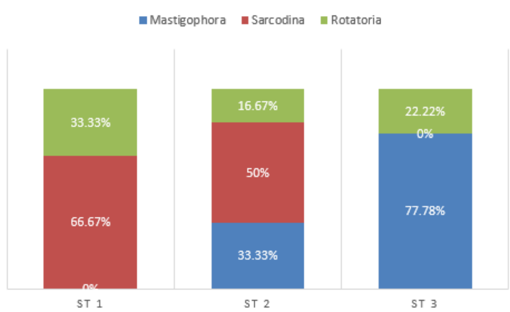

Figure 3. Zooplankton species presentation (cell/liter)

The zooplankton community consists of Sarcodina (Shell Protozoa), Mastigophora (Flagellated Protozoa), and Rotatoria (Rotifera). These percentages reflect which group is most active in consuming organic matter or phytoplankton at each location. Station 1 was completely dominated by Sarcodina with a percentage of 66.67%. This group was previously identified as *Arcella vulgaris*, which is a detritus feeder. Rotatoria (which feeds on phytoplankton) contributed 33.33%, and Mastigophora (organic pollution indicators) were not found (0%) at this station. At Station 2, Sarcodina remained dominant with 50%. However, Mastigophora began to appear significantly with 33.33%, and Rotatoria was at the lowest percentage of 16.67% (figure 3). The increase in Mastigophora indicates an increase in the availability of dissolved organic matter at ST 2. Station 3 showed a drastic pattern, with Mastigophora dominating sharply, reaching 77.78% of the total zooplankton. Rotatoria contributed 22.22%, while Sarcodina disappeared (0%). This very high dominance of Mastigophora (*Euglena oblonga* and *Phacus undulatus*) is the strongest ecological marker for heavy organic pollution and extreme eutrophication conditions. The shift from Sarcodina dominance (detritus feeders) in ST 1 to Mastigophora dominance (pollution indicator) in ST 3 with a percentage of almost 78%, confirms that water quality conditions are progressively deteriorating downstream, mainly due to high organic waste input.

Table 3. Plankton species diversity, evenness, richness and dominance Indeks in every Station

Station	Plankton			
	Species diversity	Eveness	Richness	Dominance
ST 1	2.14	0.97	1,11	0,125
ST 2	2.13	0.97	1.12	0,125
ST 3	2.21	0.96	1,22	0,118
All St	2.60	0.96	1.66	0,080

Plankton index data from the Welang River, Gunung Baung, showed an interesting pattern across the three stations, with a slight increase in diversity toward ST 3, but with consistently high evenness values. The H′ values at all three stations ranged from 2.13 to 2.21 (Table 3), which is ecologically categorized as moderate to high diversity. This value is above the H′>2.0 threshold, which is often interpreted as indicating unpolluted or slightly to moderately polluted waters. The highest H′ value was achieved at Station 3 (2.21), and the overall diversity value was 2.60, indicating high species diversity across all stations. Although the diversity index (H’) at Station 3 reached its highest value (2.21) , the species composition at this location presents a contradictory ecological signal. The absolute dominance of the Mastigophora class (77.78%), specifically *Euglena oblonga* (315 ind/L), serves as a critical biological marker for heavy nutrient enrichment or organic pollution in the downstream section

It is essential to exercise caution when concluding 'good water quality' based solely on the values. While a value of 2.60 suggests a diverse and stable community, it may mask underlying ecological stress. The consistent presence of Oscillatoria sp. across all stations , combined with the high abundance of Euglena and Phacus at Station 3, provides biological confirmation of eutrophication. This indicates that despite the general stability, the Welang River is experiencing significant nutrient loading from anthropogenic activities that cannot be ignored

Evenness (E) values at all three stations were very high, ranging from 0.96 to 0.97. This value is very close to 1, indicating a very even distribution of individuals among plankton species. This means that no single species significantly dominates the total plankton population at any station. The overall evenness value was also high (0.96).

The Species Richness Index (R) showed a slight increase from ST 1 (1.11) to ST 3 (1.22), which correlated with the highest H′ value at ST 3. The overall richness value was 1.66. This increase indicates that more unique species can be found at ST 3, although the differences between stations were not drastic.

Dominance (C) values at all stations and overall were very low, ranging from 0.118 to 0.125, with an overall value of only 0.080. These values, well below 0.5 (the dominance limit), confirm the conclusion from the high evenness values that no single species significantly dominates the plankton community in the Welang River, Gunung Baung.

Station 3 showed the highest diversity (H′=2.21) and evenness (E=0.96), but specific abundance data indicated extreme dominance of certain species. Phytoplankton from the Chlorophyceae class dominated in percentage (52.94%), driven by Spirogyra ionia (252 cells/L), while zooplankton from the Mastigophora class dominated in percentage (77.78%), driven by Euglena oblonga (315 individuals) and Phacus undulatus (126 individuals).

Differences in phytoplankton composition and abundance between stations (ST 1, ST 2, and ST 3) reflect zoning or changes in water quality along the Welang River, Gunung Baung. For example, high levels of *Stigeoclonium* sp. in ST 1 may indicate a different environment (perhaps closer to the upstream or an area with specific pollution) compared to ST 3, which is dominated by *Spirogyra ionia* and *Surirella robusta.* This variation underscores the role of phytoplankton as bioindicators, where community structure (species and number) directly reflects aquatic environmental conditions, in line with the research objectives of this journal.

The total number of cells/L observed at each station was 945 cells/L at ST 1, 882 cells/L at ST 2, and 1071 cells/L at ST 3, indicating that Station 3 had the highest total phytoplankton abundance. This difference in total abundance confirms the heterogeneity of ecological conditions across the three observation points in the Welang River, Gunung Baung.

Water quality in the Welang River, Gunung Baung can be analyzed based on the presence and abundance of key species. The first is the indicator of Eutrophication and Organic Pollution (Cyanophyceae) where the high abundance of species from the class Cyanophyceae (blue-green algae) at all stations (a total of 378 cells/L in ST 1, 315 cells/L in ST 2, and 315 cells/L in ST 3) is a strong indication of high nutrient levels (eutrophication) and potential organic pollution. The stable presence and abundance of *Oscillatoria* sp. at all three stations (189 cells/L in ST 1 and ST 2, 126 cells/L in ST 3) is very important. *Oscillatoria* is known to have high tolerance to temperature and is often abundant in polluted or eutrophicated waters [26]. It's even presence indicates this environmental stress occurs along the observed river segment. The abundance of *Chroococcus* sp. at ST 1 (126 cells/L) and ST 3 (189 cells/L). This genus is often considered an indicator of eutrophic waters. The ability of some species of Cyanophyceae, such as *Oscillatoria*, to fix nitrogen also means they can cause population explosions (blooms) in waters, especially in environments rich in organic nitrogen.

The second is the Varied Water Quality Indicator where the Chlorophyceae Class (green algae) showed the highest overall abundance at Station 3 (567 cells/L), which was largely driven by *Spirogyra ionia* (252 cells/L). *Spirogyra ionia* is often found in relatively clean, slow-flowing, or calm freshwater, its dominance at ST 3 may imply that the water conditions at that station may be more stable and support the growth of green algae compared to other stations. The *Scenedesmus dimorphus* species found at ST 1 and ST 3 (126 cells/L at both stations) is a common genus and is often abundant in nutrient-rich (eutrophic) waters, confirming the indication of high nutrient conditions also suggested by Cyanophyceae. The highest abundance of *Stigeoclonium* sp. at ST 1 (189 cells/L) indicates adaptation to specific river conditions. Stigeoclonium is known to grow in polluted or fast-flowing environments, indicating differences in physical characteristics or pollution loads at ST 1 compared to other stations.

The third is the Special Physical and Chemical Condition Indicator where the

Crysophyceae Class (diatoms) has fluctuating abundance (252 cells/L in ST 1, 315 cells/L in ST 2, and 189 cells/L in ST 3), and each species tends to be specific to certain stations (*Navicula* sp. only in ST 2 *Neidium* sp. only in ST 1, *Surirella robusta* only in ST 3). Diatoms generally require silica and are indicators of well-circulated and clear water conditions. Their presence at all stations indicates that the bottom conditions of the waters still support their existence. Fragmented distribution patterns, such as *Pleurosigma* sp. which are only present in ST 1 and ST 2, indicate the presence of micro-habitat variations or differences in physical factors such as current speed, substrate, and silica availability at each location.

4. Discussion

The table data represents specific observations in the river. In general, these findings align with the general pattern of phytoplankton studies in Indonesian rivers. The presence of three dominant classes (Chlorophyceae, Cyanophyceae, and Chrysophyceae) is common in freshwater bodies such as rivers. The dominance of Chlorophyceae and Cyanophyceae in these data, particularly in ST 3 for Chlorophyceae (*Spirogyra ionia*) and the consistent presence of *Oscillatoria* sp. (Cyanophyceae) at all stations, should be linked to the water quality of the Welang River, Gunung Baung. In general, the abundance of Cyanophyceae (such as *Chroococcus* sp. and *Oscillatoria* sp) is often associated with waters experiencing eutrophication or high organic nitrogen content, as some Cyanophyceae species have nitrogen-fixing capabilities. Increased phytoplankton populations, or blooms, particularly of Cyanophyceae, are indicators of changes in water quality, often due to the input of organic pollutants from activities around the river. Conversely, Chrysophyceae (diatoms) such as *Navicula* sp. and *Pleurosigma* sp were also present. Diatoms are generally sensitive to changes in water quality, and their presence suggests that, despite possible eutrophic stress, the waters at some stations are still capable of supporting diatom growth, which often requires more stable or clear water conditions [25].

Based on the bioindication analysis of the phytoplankton community it is known that the dominant class in ST 1 is Cyanophyceae (378 cells/L) with key species and High implications of *Oscillatoria* sp (189 cells/L) and *Stigeoclonium* sp (189 cells/L) so that the general condition and water quality are Eutrophication and possible organic pollution load or physical stress (strong current). The dominant class in ST 1 is Cyanophyceae & Crysophyceae (315 cells/L) with Key Species & High Implications of *Oscillatoria* sp. (189 cells/L) and *Pleurosigma* sp. (189 cells/L) and moderate Eutrophication with General Conditions of Water Quality (Inference) physical conditions of water that support the growth of diatoms. Dominant Class ST 3 Chlorophyceae (567 cells/L) Dominance of *Spirogyra ionia* (252 cells/L) with Key Species & Implications of *Chroococcus* sp. (189 cells/L). Eutrophication but water conditions are more stable or calm, General Conditions of Water Quality (Inference) support the growth of green algae.

measures the complexity and stability of aquatic ecosystems. Plankton H′ values in the Welang River ranged from 2.13 to 2.21 at each station, with an overall value of 2.60. Based on general criteria, this value falls into the Moderate Diversity category ($1<H'\leq3$). Moderate diversity indicates that the plankton community is in a stable and balanced condition. In the context of water quality, an H′ value greater than 1 (one) implies that the Welang River waters are not under severe ecological stress or are heavily polluted. Heavy pollution is usually characterized by a low H′ value ($H'<1$), where only a small number of highly tolerant species are able to survive. A value of 2.60 indicates that although there may be limiting environmental factors (such as nutrient or sediment inputs), these have not caused significant structural damage to the biological community. This stability is important because diverse Communities have better resistance and resilience to disturbances.

The Evenness Index (E) measures the extent to which individual abundance is evenly distributed among all species found. The E value for plankton in the Welang River was very high, ranging from 0.96 to 0.97 at each station, with an overall value of 0.96. An E value close to 1 (one) indicates a very even distribution of individuals among species within the community. This high evenness provides strong support for the conclusion of moderate diversity. Stable and even water quality tends to allow all species to thrive in relatively equal numbers, implying that there are no extreme environmental factors limiting certain species. In the event of pollution or strong stress, the E value will tend to be low, as only highly tolerant species will dominate, while other species will decline drastically.

The Dominance Index (D) measures the extent to which one or more specific species dominates a community. This index is inversely correlated with the diversity index. The D value for plankton in the Welang River was very low, ranging from 0.118 to 0.125 at each station, with an overall value of only 0.080. A D value very close to 0 (zero) indicates that almost no single plankton species dominates the community. Low dominance is an indicator of good water quality and a balanced community. In polluted waters, high dominance ($D \to 1$) is typically found among highly adaptive saprobic (organic pollutant-loving) species. With low dominance, the Welang River ecosystem exhibits good trophic and ecological balance, with no significant population explosions of any particular species due to pollution pressure. Analysis of the diversity index indicates stable water quality. However, a review of the plankton community structure provides a more specific indication of the trophic level of the Welang River waters.

The relative abundance percentage data shows an interesting pattern along the stations where the presence and dominance of Cyanophyceae (represented by *Chroococcus* sp. *Merismopedia convoluta*, and *Oscillatoria* sp.) with the highest percentage in ST 1 (40.00%) and ST 2 (35.71%) is very significant. Cyanophyceae species are generally strong indicators of increased nutrient levels (Nitrate and Phosphate), often associated with eutrophication due to organic waste input (domestic, agricultural). Upstream pattern (ST 1): The dominance of Cyanophyceae (40%) indicates the presence of intense organic input in the upstream or nearby catchment area. The dominance of *Oscillatoria* sp. and *Chroococcus* sp. in the upstream area indicates significant nutrient enrichment, as the Cyanophyceae group is known to respond rapidly to increased nitrogen and phosphorus levels from domestic and agricultural waste [27]. Downstream pattern (ST 3): There was a shift in dominance to Chlorophyceae (52.94%), followed by Cyanophyceae (29.41%). The increase in Chlorophyceae (*Scenedesmus dimorphus, Spirogyra ionia*) downstream indicates that although water quality remains stable (moderate H'), the downstream environment is more fertile and supports the proliferation of green algae. The increased abundance of Chlorophyceae in the downstream section suggests a shift toward more fertile (mesotrophic) yet stable environmental conditions, which support the proliferation of green algae in zones with calmer currents [28]. So, although the diversity index indicates good water quality, the community structure indicates that the Welang River is in a mesotrophic state (moderate fertility) tending towards mild eutrophication due to nutrient enrichment from anthropogenic activities around the river. Water quality can still be maintained because the river's natural capacity mechanisms (such as strong currents or dilution capacity) are still functioning. Zooplankton found included Mastigophora, Sarcodina, and Rotatori. Mastigophora (*Euglena oblonga*) was found abundantly at ST 2 and ST 3. The Mastigophora group, especially the genus Euglena, is often found in waters rich in organic matter and potentially lightly polluted. Rotatoria (*Polyarthra trigla*) was found at all stations. Rotifera are generally abundant in fertile (eutrophic) waters and are an important link in controlling phytoplankton populations. Sarcodina (Arcella vulgaris) was found at ST 1 and ST 2. This group of protozoa is also often associated with the presence of decomposing organic matter. The presence and abundance of these zooplankton groups strengthen the indication from phytoplankton that the Welang River has a sufficient organic load to support organisms that prefer high nutrients, although the level of dominance does not yet threaten the overall diversity.

Based on a comprehensive analysis, the Welang River shows the Main Indication (Ecological Stability) where the water quality of the Welang River is classified as good to lightly polluted, characterized by moderate diversity (H′=2.60) and low dominance (D=0.080). This indicates that the plankton ecosystem is in a stable condition and has not experienced severe degradation. Additional Indication (Fertility/Nutrition) where the waters of the Welang River are heading towards mesotrophic to mild eutrophic conditions. This is indicated by the high proportion of Cyanophyceae (Blue Algae), especially in the upstream (ST 1: 40%), and the presence of zooplankton such as Mastigophora (Euglena) and Rotatoria (*Polyarthra trigla*) which are indicators of organic load and Flow Zone Indication where there is a change in community structure from upstream to downstream, characterized by the dominance of Cyanophyceae in the upstream and a shift to the dominance of Chlorophyceae in the downstream. This indicates a change in the physicochemical conditions of the water (perhaps an increase in temperature, a decrease in current, or a change in input sources) along with the river flow.

These findings highlight three important points for the management of the Welang River: first, the need to control nutrient input (N and P) into the river. Although diversity is maintained, the dominance of Cyanophyceae is an early warning sign. If the organic load continues to increase, algal blooms can occur, leading to a drastic decrease in dissolved oxygen (DO), triggering fish deaths, and significantly reducing the diversity index. Second, the determination of Biological Quality Standards (BQS), where the results of this study can be used as baseline data for determining the biological quality standards for the Welang River. The H′ value of 2.60 must be maintained, and any future decrease in this value should be considered a serious indication of pollution. Third, the focus on upstream sources, where the high percentage of Cyanophyceae in ST 1 implies that the main source of organic input may come from activities in the upstream area. Pollution mitigation and prevention efforts should focus on upstream areas, such as the management of domestic and agricultural waste. In conclusion, while the diversity indices (H’) categorize the Welang River as ecologically stable and not heavily polluted, this stability is accompanied by clear signs of environmental pressure. The abundance of pollution-indicator species such as *Oscillatoria* and *Euglena* highlights a transition toward a mesotrophic or mild eutrophic state. Therefore, the current biological diversity should be viewed as an early warning, necessitating immediate control of nutrient inputs from upstream domestic and agricultural sources to prevent further degradation. It is acknowledged that this study did not include the measurement of physicochemical water parameters. While these factors are known to influence plankton dynamics, this research primarily aims to provide a baseline inventory of plankton diversity in the study area. The absence of these data is recognized as a research limitation, and further studies should incorporate environmental variables to provide a more comprehensive assessment of the ecosystem's trophic status.

5. Conclusion

Based on research on plankton diversity in the Welang River as an indicator of river quality, the following conclusions were drawn:

1. The plankton community in the Welang River consists of a diverse composition including three main classes of phytoplankton (Chlorophyceae, Cyanophyceae, and Chrysophyceae) and three main groups of zooplankton (Mastigophora, Sarcodina, and Rotatoria). The distribution shows spatial variations, where phytoplankton abundance peaked at Station 3 (1071 cells/L) and zooplankton reached their highest individuals at the same station (567 individuals/L).
2. Analysis of ecological indices shows that the Welang River is in a stable and balanced condition. This is evidenced by the Shannon-Wiener Diversity Index (H') ranging from 2.13 to 2.21 (moderate diversity), high evenness values (E) between 0.96 and 0.97, and very low dominance values (D) ranging from 0.118 to 0.125.
3. While the diversity indices suggest the water is not heavily polluted, the community structure indicates that the river is in a mesotrophic state tending toward mild eutrophication. The significant abundance of Cyanophyceae (such as *Oscillatoria* sp.) at all stations and the dominance of organic pollution indicators like *Euglena oblonga* and *Phacus undulatus* at Station 3 serve as an early warning of nutrient enrichment from anthropogenic activities, particularly from the upstream areas.

6. REFERENCES

[1] A. S. Villia and R. Adeko, "Perilaku Masyarakat Pinggir Sungai Air Bengkulu Dalam Mengelola Sampah Rumah Tangga," *J. Nurs. Public Helath*, vol. 13, no. 1, pp. 396–400, 2025.

[2] A. F. Zulhusni, C. Ikhsan, and S. Suyanto, "Analisis Distribusi Kecepatan Aliran Pada Daerah Sudetan Wonosari Sungai Bengawan Solo," *Matriks Tek. Sipil*, vol. 5, no. 2, pp. 368–376, 2017, [Online]. Available: https://matriks.sipil.ft.uns.ac.id/index.php/MaTekSi/article/view/739

[3] M. Y. Fadhil, Y. Hidayat, K. Murtilaksono, and D. P. T. Baskoro, "Identifikasi Perubahan Penggunaan Lahan dan Karakteristik Hidrologi DAS Citarum Hulu," *J. Ilmu Pertan. Indones.*, vol. 26, no. 2, pp. 213–220, 2021, doi: 10.18343/jipi.26.2.213.

[4] A. A. Tuzzaman, A. D. Puspitasari, M. R. Hakim, M. Zanah, N. A. Wigati, and N. C. Joana, "Kondisi Ekosistem Sungai Ciliwung : Dampak Aktivitas Manusia Terhadap Keanekaragaman Hayati Dan Kesadaran Ekologis Masyarakat," *J. Ilm. Penelit. Mhs.*, vol. 3, no. 4, pp. 307–314, 2025, doi: https://doi.org/10.61722/jipm.v3i4.1086.

[5] A. H. Sudrajat, S. Surjono, and J. Batoro, "Various Community Motivations for the Success of Ecosystem Restoration in Mount Baung Nature Park, Pasuruan Regency," *J. Presipitasi Media Komun. dan Pengemb. Tek. Lingkung.*, vol. 20, no. 2, pp. 390–401, 2023, doi: 10.14710/presipitasi.v20i2.390-401.

[6] M. S. Yusal and A. Hasyim, "Kajian Kualitas Air Berdasarkan Keanekaragaman Meiofauna dan Parameter Fisika-Kimia di Pesisir Losari, Makassar," *J. Ilmu Lingkung.*, vol. 20, no. 1, pp. 45–57, 2022, doi: 10.14710/jil.20.1.45-57.

[7] N. A. Patang, M. Hendra, R. Kurniati, A. Fudiantoro, and N. Hariani, "Studi Struktur Dan Komunitas Plankton Di Sungai Jembayan Kecamatan Loa Kulu, Kutai Kartanegara," *BIOPROSPEK J. Ilm. Biol.*, vol. 15, no. 2, p. 1, 2023, doi: 10.30872/bp.v15i2.1212.

[8] Ilmawati, Mursidi, and D. B. Embong, "Keanekaragaam Plankton Waduk Benanga Di Kota Samarinda," *J. Aquarine*, vol. 9, no. 2, pp. 38–45, 2022.

[9] D. F. Tamama and M. A. As'adi, "Analisis Struktur Komunitas Plankton di Sungai Brantas," *Environ. Pollut. J.*, vol. 4, no. 2, pp. 1075–1085, 2024, doi: 10.58954/epj.v4i2.198.

[10] A. Nazar, E. Utami, and U. Umroh, "Korelasi Keanekaragaman Plankton Dengan Parameter Fisika-Kimia Perairan di Estuari Sungai Selan Kabupaten Bangka Tengah," *J. Mar. Res.*, vol. 13, no. 3, pp. 485–492, 2024, doi: 10.14710/jmr.v13i3.39310.

[11] A. V. Putrisia, C. Ain, and A. Rahman, "ANALISA PRODUKTIVITAS PRIMER SEBAGAI UPAYA PENGELOLAAN KUALITAS AIR DI WADUK JATIBARANG , SEMARANG (Primary Productivity Analysis as an Effort to Manage Water Quality in The Jatibarang Reservoir , Semarang)," *J. Trit.*, vol. 18, no. April, pp. 1–9, 2022.

[12] A. A. P. Febrianti, H. M. Manik, and Wijopriono, "Pengukuran Kelimpahan Dan Sebaran Spasial Zooplankton Menggunakan Scientific Echosounder Di Semenanjung Utara Pesisir Banyuasin, Sumatera Selatan," *J. Ilmu dan Teknol. Kelaut. Trop.*, vol. 14, no. 1, pp. 47–68, 2022, doi: 10.29244/jitkt.v14i1.36218.

[13] L. F. P. Gurning, R. A. T. Nuraini, and Suryono, "Kelimpahan Fitoplankton Penyebab Harmful Algal Bloom di Perairan Desa Bedono, Demak," *J. Mar. Res.*, vol. 9, no. 3, pp. 251–260, 2020, doi: 10.14710/jmr.v9i3.27483.

[14] M. Ulpa, M. Ihsan, and D. Suprayogi, "Analisis Keanekaragaman dan Kelimpahan Fitoplankton di Sungai Rawas, Sumatra Selatan," *Biosel Biol. Sci. Educ.*, vol. 14, no. 1, pp. 22–36, 2025, doi: 10.33477/bs.v14i1.8146.

[15] H. Salwa, C. E. Larasati, and Paryono, "Sebaran Spasial Plankton Dan Klorofil-A Sebagai Idikator Penentuan Daerah Potensial Pengangkapan Ikan Di Perairan Gili Trawangan," *Jurna Ilmu dan Teknol. Kelaut. Trop.*, vol. 16, no. December, pp. 343–352, 2024, doi: https://doi.org/10.29244/jitkt.v16i2.57446 Available online at https://journal.ipb.ac.id/index.php/jurnalikt SEBARAN.

[16] E. G. Bellinger and D. C. Sigee, *Freshwater Algae - Identification and Use as Bioindicators*, 1st ed. West Sussex: |Willey-BlackWell, 2010. [Online]. Available: https://onlinelibrary.wiley.com/doi/epdf/10.1002/9781118917152.ch3

[17] E. W. Rice, R. B. Baird, and A. D. Eaton, *Standard Methods for the Examination of Water and Wastewater , 23rd Edition*. American Public Health Association, American Water Works Association, Water Environment Federation, 2017. [Online]. Available: https://yabesh.ir/wp-content/uploads/2018/02/Standard-Methods-23rd-Perv.pdf

[18] R. Kuswandi, R. Sadono, N. Supriyatno, and D. Marsono, "Keanekaragaman Struktur Tegakan Hutan Alam Bekas Tebangan Berdasarkan Biogeografi Di Papua," *J. Mns. dan Lingkung.*, vol. 22, no. 2, pp. 151–159, 2015, doi: https://doi.org/10.22146/jml.18737.

[19] M. Ulfah, S. N. Fajri, M. Nasir, K. Hamsah, and S. Purnawan, "ICFAES 2019," in *Diversity , evenness and dominance index reef fish in Krueng Raya Water , Aceh Besar Diversity , evenness and dominance index reef fish in Krueng Raya Water , Aceh Besar*, IOP Publishing, 2019, p. 348 (2019)012074. doi: 10.1088/1755-1315/348/1/012074.

[20] R. N. Wanjari *et al.*, "Heliyon Exploring temporal and spatial patterns of fish diversity in a tropical reservoir in relation to environmental parameters," *Heliyon*, vol. 11, no. 14, p. e43826, 2025.

[21] M. P. Ali, *et al.*, "Landscape diversity in fl uences the arthropod species diversity in the rice fi eld," *Environ. Sci.*, no. October, pp. 1–15, 2022, doi: 10.3389/fenvs.2022.740287.

[22] A. A. A. Ugwumba and I. K. Esenowo, "Anthropogenic Impact on Plankton and Benthos Assemblage in the Lagos Lagoon, Nigeria," *Ribar. Croat. J. Fish.*, vol. 78, no. 4, pp. 173–182, 2020, doi: 10.2478/cjf-2020-0017.

[23] H. Wang, R. Sathasivam, and J. S. Ki, "Physiological effects of copper on the freshwater alga Closterium ehrenbergii Meneghini (Conjugatophyceae) and its potential use in toxicity assessments," *Algae*, vol. 32, no. 2, pp. 131–137, 2017, doi: 10.4490/algae.2017.32.5.24.

[24] N. S. Khan and N. A. Tisha, "Freshwater algal tolerance to organic pollution: A review," *Pollut. Res.*, vol. 39, no. 4, pp. 1297–1301, 2020.

[25] R. A. Ladera *et al.*, "Diatom-based Index: A tool for Assessing Water Quality in A Southeast Asian Tropical River Basin," *Pollution*, vol. 11, no. 2, pp. 298–311, 2025, doi: https://doi.org/10.22059/poll.2024.378540.2437.

[26] Hasim, T. Rahim, and M. R. F. H. Sumani, "Phytoplankton and Chlorophyll-a: Distribution, Abundance, and Trophic State Index (TSI) in the Transitional Season in Limboto Lake," *Egypt. J. Aquat. Biol. Fish.*, vol. 27, no. 17, pp. 407–422, 2023.

[27] M. M. de Li. Pinbeiro *et al.*, "First monitoring of cyanobacteria and cyanotoxins in freshwater from fish farm Rondonia State, Brajil," *Heliyon*, vol. 9, no. July, 2023, doi: 10.1016/j.heliyon.2023.e18518.

[28] E. D. Masithah and R. A. Islamy, "Checklist of freshwater periphytic diatoms in the midstream of Brantas River , East Java , Indonesia," *Biodiversitas*, vol. 24, no. 6, pp. 3269–3281, 2023, doi: 10.13057/biodiv/d240621.