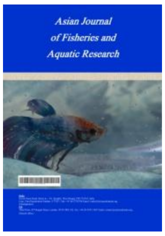

Asian Journal of Fisheries and Aquatic Research

15(1): 36-49, 2021; Article no.AJFAR.74704
ISSN: 2582-3760

Plankton Community as a Bio-indicator of Water Quality in Situ Ciburuy Padalarang, West Bandung Regency, West Java

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJFAR/2021/v15i130321
Editor(s):
(1) Dr. Vijai Krishna Das, Kamla Nehru Institute of Physical and Social Sciences, India.
(2) Dr. Luis Enrique Ibarra Morales, State University of Sonora, Mexico.
Reviewers:
(1) Amit Kumar Verma, Jai Prakash University, India.
(2) Yayan Mardiansyah Assuyuti, State Islamic University, Indonesia.
Complete Peer review History: https://www.sdiarticle4.com/review-history/74704

Original Research Article

Received 30 July 2021
Accepted 05 October 2021
Published 09 October 2021

ABSTRACT

This research was conducted to determine the water quality of Situ Ciburuy based on the plankton community as water quality bio-indicator. This research used the survey method and the observation result data were analyzed descriptively. The abundance of phytoplankton is about 340 – 8913 ind/L indicates that the abundance of phytoplankton is moderate and the abundance of zooplankton is about 7 – 30 ind/L indicates that the abundance of zooplankton is low. The Simpson diversity index for the phytoplankton group ranged from 0.29 – 0.33 and the Simpson Diversity Index for the zooplankton group ranged from 0.42 – 0.56 while the Simpson Dominance Index for the phytoplankton group ranged from 0.67 – 0.71 and the Simpson Dominance Index for zooplankton ranged from between 0.44 – 0.58 which indicates Situ Ciburuy is in an unstable condition. Based on the value of the Saprobic Index ranged between (-0.2) to (0). Situ Ciburuy belongs to α / β – mesosaprobic phase and categorized in the moderately polluted category.

Keywords: Phytoplankton; situ ciburuy; water quality; zooplankton.

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1. INTRODUCTION

Situ Ciburuy is one of the water bodies in West Bandung Regency, about 25 km from the center of Bandung City, precisely in Padalarang District, West Java. The waters of Situ Ciburuy are used by the surrounding community for tourism activities, irrigation of rice fields and other anthropogenic activities. Various activities of utilizing water and land around Situ Ciburuy, produce waste that increases the amount of nutrients in the water bodies of Situ Ciburuy. This condition can lead to eutrophication which decreases the quality of the aquatic environment.

Eutrophication is water pollution caused by the entry of excessive nutrients into the aquatic ecosystem which results in uncontrolled growth of aquatic plants. This can cause an increase in plankton in the waters (blooming algae) [1]. Plankton has an important role in freshwater ecosystems related to the flow of energy and nutrient cycles in the waters. The planktons have property to induce very sensitive changes in the aquatic environment, so it is suitable to use it, as an indicator organism in a water body, to determine the quality of a waters.

The increase in phytoplankton is caused by organic waste in water and lake sediments undergoing decomposition and increasing the concentration of nitrogen (N) and phosphorus (P) elements which can encourage the growth of phytoplankton. At the optimum concentration, the nutrients N and P are beneficial for the growth of phytoplankton which is fish food so that it can increase fish production in the lake. Excessive growth of phytoplankton and pollution can occur in the lake if the concentration of these elements is high. If it is severe, water quality will decrease, the water turns cloudy, dissolved oxygen is low, toxic gases and toxic materials (cyanotoxin) arise [2].

The abundance of plankton in a water body is related to the availability of nutrients in these waters. The difference in sensitivity of each genus of plankton to the nutrient content in a water causes the dominance and diversity of the plankton genus [3]. The abundance, diversity, and dominance of the plankton genus determine the structure of the plankton community which is influenced by the physical and chemical parameters of the waters which are natural limiting factors for plankton life. Plankton community structure is a concept that studies the composition, the abundance and diversity of plankton in a community [4].

The abundance and diversity of plankton in Situ Ciburuy is influenced by physical and chemical parameters of the water which are natural limiting factors for plankton life. Another factor that can be controlled in terms of quality and quantity is water supply and input of organic and inorganic materials. Inventory and identification of plankton in Situ Ciburuy is carried out to study the types of plankton that can support fishery activities, that may lead to maintain stability and management of these waters.

2. RESEARCH METHODS

2.1 Time and Place

The research was conducted from January 28, 2021 to March 3, 2021 in rainy season. The research was conducted at Situ Ciburuy, West Bandung Regency, West Java and laboratory analysis was carried out at the Water Resources Management Laboratory, Faculty of Fisheries and Marine Sciences, Padjadjaran University.

2.2 Methods

The research was carried out by survey methods at stations that have been selected on the basis water flow and activities at the Ciburuy Lake location. Counting and identification of plankton using the counting cell method and calculated the abundance, diversity, dominance, and saprobic index. Water was collected from the surface of each station, as much as 10 L using a dipper. The water was filtered with a plankton net and then put into a sample bottle and given a preservative in the form of Lugol's solution until the water turns brownish yellow. Plankton observations were carried out using a microscope with a magnification of 10x which was carried out in the laboratory. Measurements of the degree of acidity, CO_2 and temperature were carried out in situ while water samples for the measurement of other chemical variables were analyzed in the laboratory. The research materials used were plankton sample, water sample, lugol 0.5%, methyl orange, HCl 0.025 N, phenol disulfonic acid, NH_4OH and nitrate standard solution and research tools used were plankton net, microscope, counting chamber, cover glass, secchi disk, thermometer, bottle sample 30 ml, titration equipment, dropper pipette, spectrophotometer, pH meter, DO meter and rowing boat.

The sampling stations were located in four locations which were determined based on environmental factors and land use around Situ Ciburuy, Padalarang District, West Bandung Regency. Station 1 is the Inlet, this part is formed from artificial situ. There are many fishing activities such as floating net cages and the first collection of factory waste and household activities.

Station 2 is an open zone for the flow of water flowing from the inlet to the outlet, the presence of waste from restaurants in the middle of the island and the activities of boats going back and forth.

Station 3 is an open water flow zone, but the mass of water stays longer because there is no outlet in the basin. This area is busy being used as a place for rowing water sports.

Station 4 is the outlet zone, the outlet channel from the waters there in Ciburuy where in this zone the state of the outlet is filled with garbage. Map of Plankton observation can be seen in Fig. 1.

2.3 Data Analysis

Parameters observed and analyzed were plankton samples as the main parameters, namely abundance, diversity, dominance, saprobic index, physical parameters, namely temperature, transparency and depth. Also chemical parameters include pH, DO, nitrate, phosphate and BOD.

The abundance of plankton was calculated using the modified formula [5]:

$$\mathbf{N} \quad = \mathbf{n} \times \frac{Vr}{Vo} \times \frac{L}{Vs}$$

Information:

N = Abundance of plankton (Ind/L)
n = ∑ Observed plankton
Vr = Filtered plankton volume (ml)
Vo = Observed plankton volume (ml)
Vs = Observed plankton volume (L)

The diversity index was calculated using the Simpson formula [6] as follows:

$$\mathbf{D} \quad = 1 - \sum (Pi)^2$$
$$\mathbf{Pi} \quad = ni / N$$

Information:

D = Simpson's Diversity Index
Pi = Proportion of individuals to total population
N = Total number of individuals
ni = Number of individuals in the 1st genus

The Dominance Index is calculated using the Simpson Index formula (Magurran 1988) as follows:

$$\mathbf{C} \quad = \sum (Pi)^2$$

Information :
C = Simpson's Dominance Index
Pi = ni/N
Ni = Number of individuals of the 1st genus
N = Total number of individuals

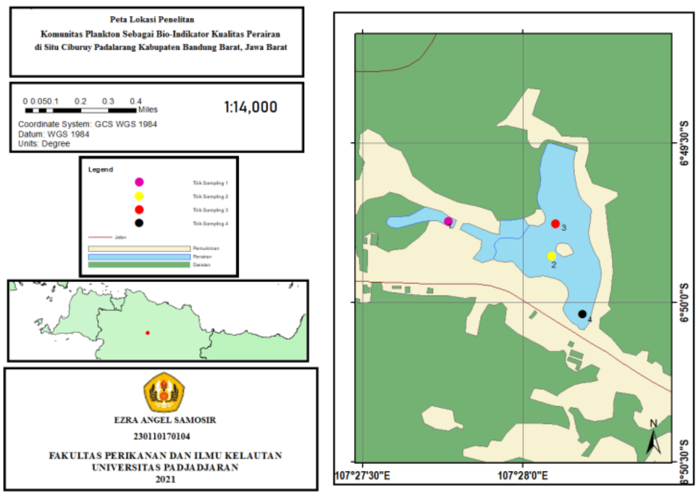

Fig. 1. Map of Plankton Observation Station

Saprobic Index (SI) can be calculated using the formula of Dresscher & H van der Mark [7] :

SI = (C + 3D - B – 3A) / (A + B + C + D)
Information:

SI = Saprobic Index
A = Ciliates group exhibits polysaprobity
B = Euglenophyta group showing Mesosaprobity
C = Chlorococcales and Diatomae groups show Mesosaprobity
D = Groups Peridinae, Chrysophyceae, Conjugatae show Oligosaprobity

The data obtained were analyzed descriptively, namely describing and explaining the conditions and situations of the observed variables and the relationship between each variable. The variables are the structure of the plankton community, namely the composition, abundance, diversity, dominance and physical and chemical parameters of the waters.

3. RESULTS AND DISCUSSION

3.1 Water Quality Parameters

Environmental conditions greatly affect the development of plankton. The results of measurement of physical and chemical parameters of waters that affect the survival of plankton include temperature, salinity, dissolved oxygen (DO), biochemical oxygen demand (BOD), degree of acidity (pH), nitrate and phospate. The results of the average calculation of 6 times of sampling for each station of physical and chemical parameters can be seen in Table 1.

3.1.1 Temperature

According to Handayani et al [8], water temperature is one of the physical factors of waters that affect the life of aquatic animals and plants, one of which is plankton. Based on the results of calculating the average temperature, the temperature value of Situ Ciburuy during the study at stations 2,3 and 4 had the same average value of 26.17C±1.17, while at station 1 it was 25.67C±1.21. This is due to the implementation of research at station 1 between 09.00-10.00 WIB while the implementation of research at stations 2.3 and 4 between 11.00-13.00 WIB. This time difference could cause differences in the entry of sunlight or the amount of sunlight received by the water. Solar radiation to the water affects temperature fluctuations in these waters, because the incoming sunlight will turn into heat energy. In addition, the influence of the weather during the study also affects the temperature in the waters. The water temperature at station 1 was relatively lower due to cloudy weather causing less solar radiation to enter the water. The temperature obtained as a whole can also be said to be not too high because at the time of measurement the weather temperature was unstable due to rain, cloudy and sometimes sunny weather so that the water temperature was also unstable.

According to Barus [9], the temperature pattern of aquatic ecosystems is influenced by various factors such as the intensity of sunlight, heat exchange between water and the surrounding air, geographical altitude and also by the canopy factor (coverage by vegetation) from trees growing on the edge. The temperature of Situ Ciburuy at each station with an average range of 25.67^0C – 26.17^0C was included in the optimum temperature category for plankton growth. This is in accordance with the statement of Barus [9] that the optimum temperature range for plankton growth is between 20^0C - 30^0C.

3.1.2 Transparency

The results of the calculation of the average transparency at each station ranged from 22.83 – 27.67 cm. The lowest transparency was at station 2, which was 22.83 cm±2.14. This may be due to the input of waste originating from residential areas and restaurants, so that, it was suspended in the waters and can block the penetration of sunlight into water bodies. This is in accordance with Odum [4] that the penetration of light is often blocked by substances dissolved in water, thus limiting the photosynthetic zone. If the brightness in a water is low, it means the water is cloudy. Turbidity occurs due to the presence of plankton, mud and dissolved substances in the water. Boyd [10] stated that a good transparency for plankton growth is optionally 30 – 50 cm. On the basis of results of the transparency calculation, Situ Ciburuy was less than optimal in supporting the growth of plankton.

3.1.3 Acidity (pH)

The results of the calculation of the average pH at each station ranged from 6.25 to 8.00. The highest pH value was at station 3, namely 8.00±0.27 and the lowest pH value was at station

1, which was 6.25±0.65. Stations 2, 3 and 4 indicate that the pH value was ideal and station 1 indicates that the pH value was not ideal. This is in accordance with Barus [9], which states that the ideal pH value for the life of aquatic organisms is generally 7 to 8.5. Water conditions with a certain pH affect metabolism and respiration for the survival of organisms. Station 1 had the lowest pH value due to the high amount of population and industrial waste discharges into water bodies which affects the abundance and diversity of plankton in these waters. This is in accordance with Hamuna et al [11], who states that very acidic or very alkaline water conditions will endanger the survival of organisms, because it will cause metabolic and respiratory disorders.

3.1.4 Dissolved Oxygen (DO)

The results of the calculation of the average DO at each station ranged from 6.27 to 7.05 mg/L. The highest DO concentration was at station 3, which was 7.05 ± 0.36 mg/L and the lowest DO concentration was at station 1, which was 6.27 ± 0.31mg/L. Based on the average calculation results, the DO value in Situ Ciburuy was considered ideal for plankton growth. This is supported by the statement of Barus [9] that ideally the dissolved oxygen content in a waters to support the growth of aquatic organisms is >5 mg/l. The DO value at station 1 with a value of 6.27 was the lowest compared to other stations due to the high amount of population and industrial waste discharges into water bodies. In addition, station 1 had the deepest average depth of 215 cm, resulting in a decrease in the oxygen supply resulting from photosynthesis. The DO value at station 3 was high, presumably due to the photosynthetic process carried out by phytoplankton. This is stated by Salmin [12] that the presence of sunlight in the surface layers of the water can help the process of photosynthesis in supplying oxygen to the waters. Station 3 was also the station that has the shallowest average depth of 153 cm so that there was no decrease in oxygen supply from the photosynthesis process. Dissolved oxygen concentration generally decreases with increasing depth. This is thought to occur because the oxygen supply from the photosynthesis and diffusion processes decreases because the photosynthesis process decreases and the available oxygen levels are widely used for respiration and oxidation of organic and inorganic materials [13].

Table 1. Calculation of the Average Physical and Chemical Parameters of Situ Ciburuy

Parameters	Station			
	1	**2**	**3**	**4**
Physical				
Temperature(^{0}C)				
Avarage	25.67±1.21	26.17±1.17	26.17±1.17	26.17±1.17
Range	24 - 27	25 - 28	25 - 28	25 - 28
Transparency(cm)				
Avarage	27.67±3.33	22.83±2.14	24,33±3,2	25,17±4,49
Range	23 - 33	20 - 25	19 - 28	17 - 30
Chemical				
pH				
Avarage	6.25±0.65	7.94±0.21	8±0.27	7.36±0.61
Range	5.31 – 7.15	7.65 – 8.23	7.71 – 8.37	7.01 – 8.21
DO (mg/L)				
Avarage	6.27±0.31	6.58±0.34	7.05±0.36	6.45±0.2
Range	5.9 – 6.8	6.2 – 7.1	6.4 – 7.3	6.2 – 6.6
BOD (mg/L)				
Avarage	9.73±2.05	12.16±2.24	8.65±4.06	7.84±1.9
Range	8.11 – 12.97	8.11 – 14.59	3.24 – 12.97	4.86 – 9.73
Nitrate (mg/L)				
Avarage	0.25±0.06	0.25±0.07	0.27±0.04	0.33±0.06
Range	0.21 – 0.24	0.20 – 0.37	0.21 – 0.32	0.26 – 0.44
Phospate (mg/L)				
Avarage	0.17±0.05	0.16±0.06	0.16±0.06	0.17±0.07
Range	0.14 – 0.28	0.11 – 0.29	0.12 – 0.28	0.14 – 0.31

3.1.5 Biochemical Oxygen Demand (BOD)

The results of calculating the average BOD at each station ranged from 7.84 to 12.16 mg/l. The highest BOD concentration was found at station 2, which was 12.16 ± 2.24 mg/L and the lowest was at station 4, which was 7.84 ±1.90 mg/L. The higher BOD value can be caused by the high amount of resident waste such as domestic waste and the presence of high community activities around water bodies, thereby increasing the amount of organic matter at station 2. This is in accordance with the statement of Hatta [14] that the BOD value will be higher with the increase in organic matter in the waters. On the other hand, the lower the amount of organic matter in the water, the lower the BOD value. The high BOD in a water body results in the amount of oxygen needed by decomposers (bacteria) to decompose organic materials into inorganic materials (aerobic decomposition) [15].

3.1.6 Nitrate

The results of the calculation of the average nitrate at each station ranged from 0.25 to 0.33 mg/L. The highest nitrate concentration was at station 4, which was 0.33±0.06 mg/L and the lowest nitrate concentration was at stations 1 and 2, which was 0.25±0.06 mg/L. The nitrate value in Situ Ciburuy was influenced by the input of resident and industrial waste into the water body. Based on this value, Situ Ciburuy was not yet an ideal category for plankton growth. This value is in accordance with what was stated by Mackentum (1969) (cited in [16], that for optimal growth of plankton requires a nitrate content in the range of 0.9 to 3.5 mg/l.

3.1.7 Phosphate

The results of calculating the phosphate value at each station ranged from 0.16 to 0.17 mg/L. The highest concentrations were at stations 1 and 4 and the lowest concentrations were at stations 2 and 3. Based on these values, Situ Ciburuy was in the ideal category for optimum plankton growth. The value of phosphate concentration is in accordance with what was stated by Mackentum (1969) [16], that the optimum phosphate content for plankton growth is 0.09 - 1.80 mg/l. High phosphate values at stations 1 and 2 can be caused by the input of resident and industrial waste into water bodies. The phosphate value at Station 1 Situ Ciburuy was also influenced by the presence of lime content because this location was a waste storage area from the lime factory industry.

3.2 Plankton Community Structure

3.2.1 Plankton Abundance and Composition

The composition of plankton found in Situ Ciburuy during the study consisted of 29 genera divided into 20 phytoplankton genera and 9 zooplankton genera. Phytoplankton is divided into 7 classes, namely Bacillariophyceae, Chlorophyceae, Cyanophyceae, Dinophyceae, Euglenophyceae, Mediophyceae and Zygnematophyceae, while zooplankton is divided into 5 classes, namely Branchipoda, Entomostraca, Magnoliopsida, Maxillopoda and Monogononta. The results of the identification of the plankton community structure in Situ Ciburuy can be seen in Table 2.

The abundance of phytoplankton that dominates the research at Situ Ciburuy was the class Bacillariophyceae with a percentage of 83%. The Bacillariophycea class was spread in almost all stations because this group of phytoplankton had a high growth rate, high tolerance, and was able to adapt to environmental changes and was able to utilize nutrients properly [17]. The genus Cyclotella was spread at all stations because this genus had a wide tolerance of waters in various habitats with different physical and chemical parameters [18]. The genus Spirogyra was only found at Station 1, this was due to the presence of pollutants in the form of organic matter. The Cyanophyceae class was spread in almost all stations because several species have properties that can grow in toxic waters and can grow in waters that have high nitrate. In addition, the adaptability of Chlorophyceae to freshwater habitats was much more successful than to life in marine or salt water. This is evidenced by the number of species of Chlorophyceae which are much higher in freshwater than in marine waters [19]. Several genera such as Microcystic, Oscillatoria and Coelastrum were not distributed at station 1 because they were intolerant of too high CO_2 content.

The results of the percentage of phytoplankton abundance by class in Situ Ciburuy can be seen in Fig. 2.

The abundance of Zooplankton that dominates the study in Situ Ciburuy was the Monogononta class with a percentage of 69%. Monogononta class was spread in almost all stations because it had a wide tolerance for acidic or alkaline conditions of a waters, because it could still survive at pH 5 and pH 10, while the optimum pH for growth and reproduction ranges from 7.5 to 8.0 [20]. Class Entomostraca only spread at stations 2 and 4 and Class Branchiopoda only spread at station 1 for the genus Ceriodaphnia and station 4 for the genus Chydorus. This could be due to the unfavorable physical and chemical parameters for the growth of these genera. The results of the percentage of zooplankton abundance by class in Situ Ciburuy can be seen in Fig. 3.

Table 2. Plankton Composition by Class and Genus

Group	Class	Genus	Station			
			1	2	3	4
Phytoplankton	Bacillariophyceae	Nitzchia	-	√	√	√
		Navicula	√	√	√	√
		Synedra	√	-	-	√
	Mediophyceae	Cyclotella	√	√	√	√
	Chlorophyceae	Eudorina	-	√	√	√
		Actinastrum	√	√	√	√
		Pediastrum	√	√	√	√
		Scenedesmus	√	√	√	√
	Zygnematophyceae	Selenastrum	-	√	-	√
		Spyrogira	√	-	-	-
	Cyanophyceae	Microcystic	-	√	√	√
		Lyngbya	√	√	√	√
		Oscilatoria	-	√	√	√
		Coelastrum	-	√	√	√
		Spirulina	√	√	√	√
		Merismopedia	√	√	√	-
	Euglenophyceae	Euglena	√	√	√	√
		Phacus	√	√	√	√
		Trachelomonas	-	√	√	√
	Dinophyceae	Ceratium	-	√	√	-
Total	**7**	**20**				
Zooplankton	Branchiopoda	Ceriodaphnia	√	-	-	-
		Chydorus	-	-	-	√
	Maxillopoda	Cyclops	-	√	√	√
	Entomostraca	Moina	-	√	-	√
	Monogononta	Brachionus	√	√	√	√
		Keratella	√	√	√	√
		Polyartha	√	√	-	√
		Pompholyx	√	√	√	√
	Magnoliopsida	Nauplius	-	√	√	√
Total	**5**	**9**				
Total Number	**12**	**29**				

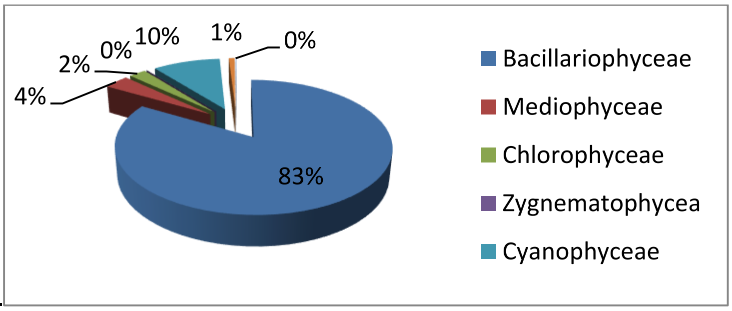

Fig. 2. Percentage of Phytoplankton Abundance by Class in Situ Ciburuy

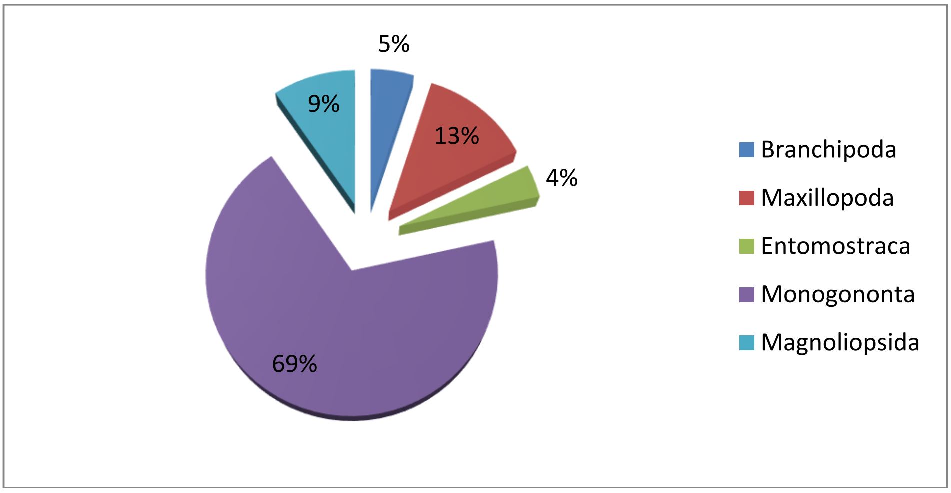

Fig. 3. Percentage of Zooplankton Abundance by Class in Situ Ciburuy

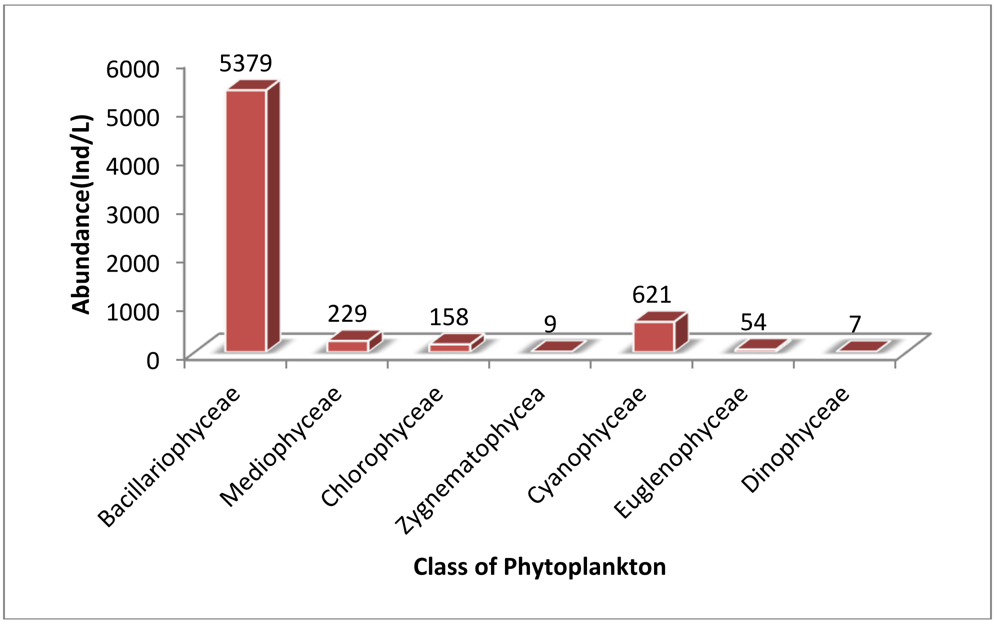

Fig. 4. Average Abundance of Phytoplankton by Class in Ciburuy Lake

Based on the results of the calculation of the average abundance of individuals, the largest abundance of the phytoplankton group was the Bacillariophyceae class, which was 5379 ind/L with the genus most commonly found was Nitzhia with an average abundance of 5359 ind/L, while the smallest average abundance was the Dinophyceae class namely 7 ind/L with the genus found was Ceratium. The Bacillariophycea class had the highest abundance, supported by the statement of Goldman and Horne [17] that Bacillariophyceae was a group of phytoplankton that had a high growth rate, high tolerance, and was able to adapt to environmental changes and was able to utilize nutrients properly. The results of the average abundance of phytoplankton can be seen in Fig. 4.

Based on the results of the calculation of the average abundance of individuals, the largest abundance of the zooplankton group was the Monogononta class, which was 17 ind/L with the genus most commonly found was Brachionus with an average abundance of 13 ind/L, while the smallest average abundance was the Entomostraca class namely 1 ind/L with the only genus Moina found. Class Monogononta from the Phylum Rotifera has the highest abundance supported by the statement of Goldman and Horne [17] that the reproduction of Rotifers is only a few days so that it can produce many generations in each year. This causes the Monogononta class to have the highest abundance. The results of the average abundance of zooplankton can be seen in Fig. 5.

The lowest abundance of phytoplankton in Situ Ciburuy was found at station 1, which was 340 ind/L. This was due to the input of waste from the lime factory industry which affects the pH and DO values with an average of 6.25 and 6.27 mg/L. This value also showed that pH and DO at station 1 were the lowest values compared to other stations. The low pH and DO values caused a low nitrate value at station 1, which was 0.25 mg/L. According to Effendi [15] nitrification runs optimally at pH 8 and at pH < 7 it decreases significantly. Based on the results of the nitrate concentration at station 1, the abundance of phytoplankton at that station was classified as low because the growth of phytoplankton cannot work optimally. This is in accordance with what was stated by Mackentum (1969) [cited in 16] that for optimal growth of phytoplankton requires a nitrate content in the range of 0.9 to 3.5 mg/l. The results of the average abundance of phytoplankton and zooplankton can be seen in Fig. 6.

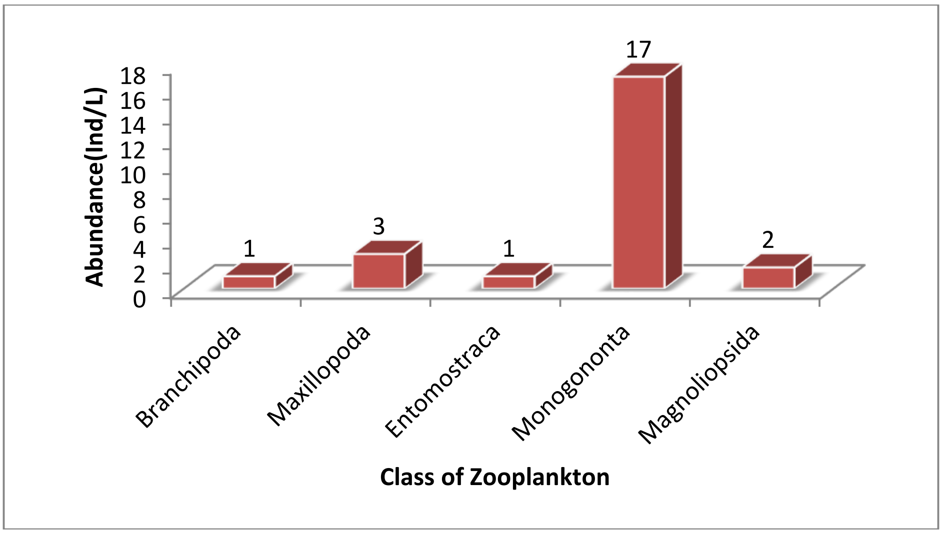

Fig. 5. Average Abundance of Zooplankton by Class in Ciburuy Lake

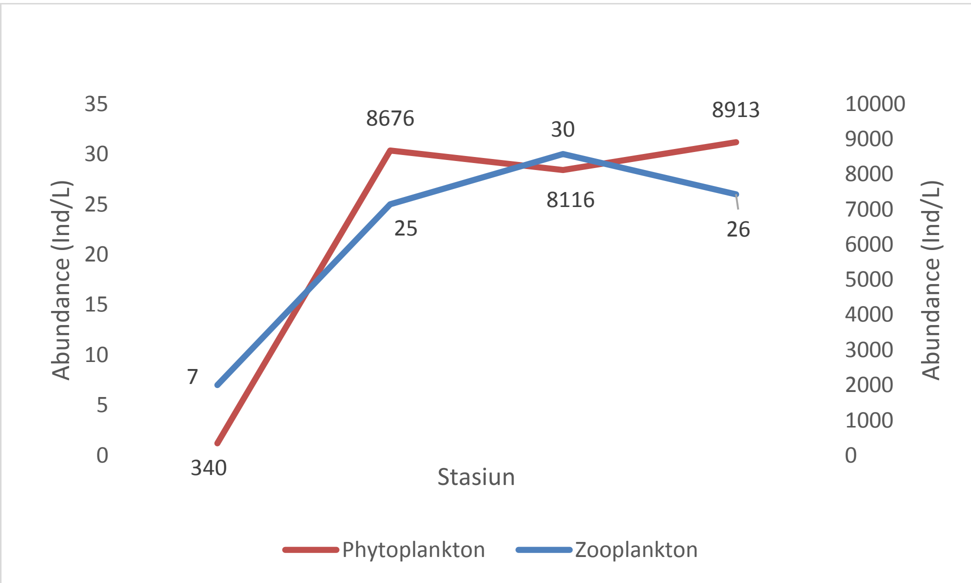

Fig. 6. Average Abundance of Plankton at Each Station in Situ Ciburuy

The type of genus in the phytoplankton group that was found the most during the study was Nitzchia from the class Bacillariophycea (Diatom) at station 4 with an average abundance of 7,472 ind/L. Nitzchia has an important role in maintaining the sustainability of aquatic ecosystems, and it is one of the species that has a high tolerance and adaptation to the aquatic environment, due to this it can live even in a polluted environment. The genus in the phytoplankton group that was mostly found at station 1 was Cylotella which is a diatom. In addition, Synedra and Navicula (both diatoms) were also found. Synedra is known to have the ability to withstand changes in unfavorable environmental conditions and has a layered envelope of cells [21]. In addition, it is also able to survive in an environment that is low in nutrients (oligotrophic) with low nitrate concentrations. This is because Synedra is able to accumulate nutrients and store them as food reserves in the form of insoluble polymers [22]. The nitrate concentration at station 1 indicated that the nitrate value at that station was low, so that several genera from the Bacillariophycea (Diatom) group could survive. The abundance of phytoplankton of the Bacillariophyceae class at station 1 was also thought to be due to the presence of lime content because station 1 was a waste storage area from the lime factory industry. According to Sachlan [5] waters containing a lot of lime will grow many types of diatom plankton which is a class of Bacillariophyceae.

The most common genus in the zooplankton group found at all stations during the study was Brachionus from class Monogononta and phylum Rotifera with an average abundance of 13 ind/L. Rotifers are a group of zooplankton that are commonly found in fresh waters, besides that the Rotifera class has a short life cycle of only a few days. Goldman and Horne [17] stated that the reproduction of Rotifers is only a few days so that they are able to produce many generations in each year. This is what caused Rotifera to be found at station 1. The pH value at stations 2, 3 and 4 ranges from 7.36 to 8.00 which caused many types of the genus Brachionus at these 3 stations while the pH value at station 1 was 5.94. This causes the abundance of the genus Brachionus to be classified as low, even though Brachionus is the genus most commonly found at station 1. Based on Pennak's [20] statement that Brachionus has a broad tolerance for acidic or alkaline conditions in waters, because it can still survive at pH 5 and pH 10, while the optimum pH for growth and reproduction ranged from 7.5 to 8.0. The highest pH value was found at station 3 with an average of 8.0 and indicated high growth for Brachionus with the highest average abundance found at station 3, namely 17 ind/L.

3.2.2 Plankton diversity and dominance index

The average diversity index of phytoplankton in Situ Ciburuy ranged from 0.29 to 0.33 while zooplankton ranged from 0.42 to 0.56. Based on this value, it showed that the plankton diversity index in Situ Ciburuy was low b**e**cause it ranged from 0.29 to 0.56. This is in accordance with Magurran's [6] statement that the range of diversity index (H') 0 < H'< 1.5 indicates that the diversity is low.

The stability of aquatic ecosystems can also be determined by the value of the diversity index. The diversity index of Situ Ciburuy indicated that these waters were unstable because the values obtained were below 0.6. This is supported by Odum [4] which states that the stability of the aquatic ecosystem is declared good if it has a Simpson diversity index value between 0.6 – 0.8. Ecosystems with low diversity are unstable and vulnerable to external pressures compared to ecosystems with high diversity. The pressure can come from human activities around Situ Ciburuy, such as domestic and industrial activities. The average pH value at Situ Ciburuy ranged from 5.94 to 8.00 indicating that there were stations classified as acidic which can affect the growth of plankton in these waters. According to Barus [9] the appropriate pH range for plankton life ranges from 6.8 to 8.0. The results of the plankton diversity index in Situ Ciburuy can be seen in Fig. 7.

The average dominance index of phytoplankton in Situ Ciburuy ranged from 0.67 to 0.71 while zooplankton ranged from 0.44 to 0.58. Based on the value of the dominance index, it showed that there was a genus that dominates at several stations because the value was close to 1. The large role or dominance of a species in a community, whereas if the dominance value (D) is close to 0 then there is no species that dominates other species, this indicates that the community structure is in a stable condition.

The low diversity index was cause by the type or group of species that dominates. The highest dominance index in the phytoplankton group was at station 4 with a value of 0.71. This was caused by the Bacillariophyceae class, the genus

Nitzchia, which had more abundance when compared to other genera at that station, while the highest dominance index in the zooplankton group was at station 2 with a value of 0.58. This was caused by the Rotifera class, namely Genus Brachionus, which had more abundance when compared to other genera at that station.

Environmental conditions that were affected by input loads from human activities around Situ Ciburuy triggered an increase in nitrate and phosphate concentrations and affect the values of other physical and chemical parameters that affect the growth of phytoplankton at the station. The changes that occured in the physical and chemical parameters of the waters affect the abundance and diversity of plankton, because each type of plankton had a different tolerance level. The growth of the Nitzchia genus dominates at Station 4. It is because this genus is a group of phytoplankton that has a high growth rate, high tolerance, and is able to adapt to environmental changes and utilize nutrients properly [17]. The same thing applies to the genus Brachionus which dominates station 2 because it has a broad tolerance level to environmental changes [20]. The results of the average plankton dominance index in Situ Ciburuy can be seen in Fig. 8.

3.2.3 Saprobic Index

The saprobic index is an index used to determine the status of organic pollution in waters. This index uses the presence of organisms present in the waters to determine the status of the aquatic environment [7]. The saprobic index was calculated using the Dresscher and Mark calculation formula with a value between (-3) to (+3). The results of the saprobic index can be seen in Table 3.

The results of the calculation of the saprobic index at the four Situ Ciburuy stations during the study ranged from (-0.2) - (0). The saprobic index value at stations 1 and 4 was (0) and the saprobic index value at stations 2 and 3 was (-2). The results of the calculation of the saprobic index show that Situ Ciburuy was in the moderately polluted category with the α/β – mesosaprobic phase with the range of values belonging to this phase is (-0.5) – (0) (Dresscher and Mark 1974). The dominant saprobity group B (Euglenophyta group) showed α-Mesosaprobity and group C (Diatomae/Bacillarophyceae group) showed β-Mesosaprobity. The saprobitic organism that had the highest number in group B (group Euglenophyta) was Euglena and the highest number in group C (group Diatomae/Bacillarophyceae) was Nitzchia. The saprobic coefficient is used to determine the level of dependence or relationship of an organism with the compounds that are the source of its nutrients so that the relationship between abundance, diversity, and uniformity of plankton can be known [23]. According to Sourina [24] the saprobic coefficient can be seen from the composition and number of plankton types.

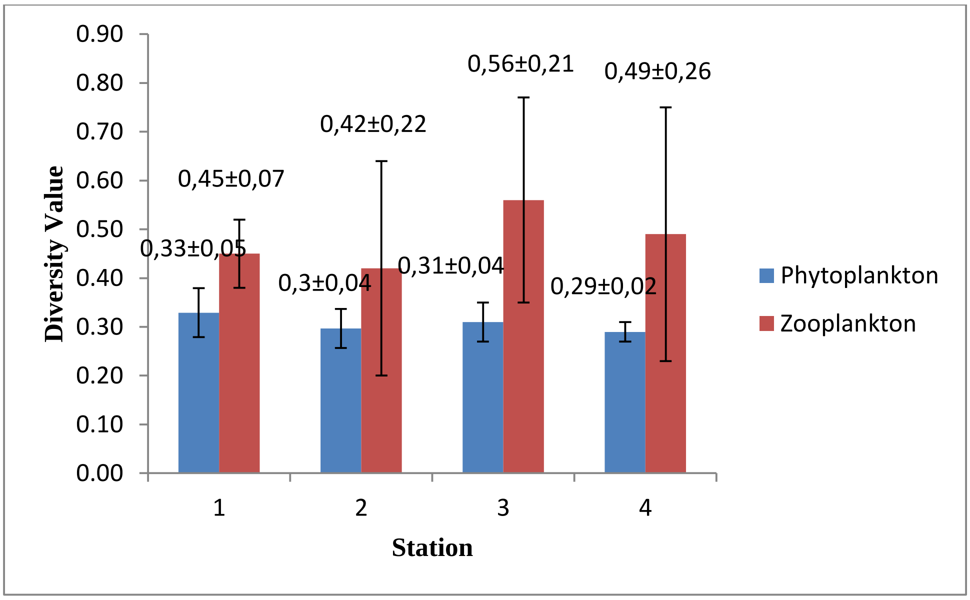

Fig. 7. Average Plankton Diversity Index in Situ Ciburuy

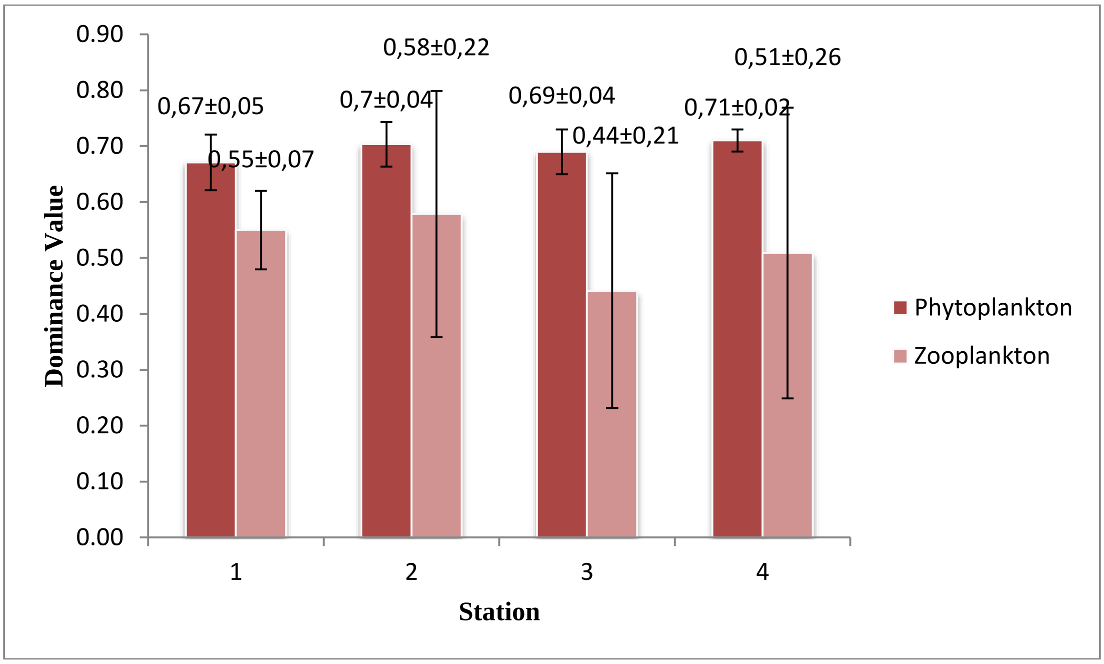

Fig. 8. Average Dominance Index of Plankton in Situ Ciburuy

Table 3. Saprobic Index Results

Station	Number of Group		Saprobic Index Results	Level Saprobity	Pollution Status
	Eugleno-phyta	Bacillario-phyceae			
1	2	2	0	α/β – mesosaprobic {(-0.5) - (0)}	Moderate
2	3	2	-0.2	α/β – mesosaprobic {(-0.5) - (0)}	Moderate
3	3	2	-0.2	α/β – mesosaprobic {(-0.5) - (0)}	Moderate
4	3	3	0	α/β – mesosaprobic {(-0.5) - (0)}	Moderate

The value of the saprobic index is influenced by the presence of pollutants from organic and inorganic materials. The level of pollution at the four stations was categorized as moderate pollution due to the input of lime load and domestic waste at station 1 and waste originating from residential areas, domestic waste, restaurant waste and daily activities back and forth at stations 2,3 and 4. Each type of saprobitic organism will occupy certain waters and its existence is determined by the quality of the waters, namely the physical and chemical properties of the waters. This is in accordance with the statement of Suwondo [25] that the saprobity index at a value of (-0.5) to (+0.5) is at a moderate level of pollution with pollutants from light organic and inorganic materials.

4. CONCLUSION

The average abundance of phytoplankton ranged from 340-8913 ind/L and the average abundance of zooplankton ranged from 7-26 ind/L. The Simpson Diversity Index for the phytoplankton group ranged from 0.29–0.33 and the Simpson Diversity Index for the zooplankton group ranged from 0.42–0.56 while the Simpson Dominance Index for the phytoplankton group ranged from 0.67–0.71 and the Simpson Dominance Index for zooplankton ranged from between 0.44–0.58. The saprobic index value of plankton ranges from -0.2 to 0 which belongs to the /β – mesosaprobic phase and indicates that Situ Ciburuy is in the moderately polluted category.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
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