Original Research Article

Structure Community PhytoplanktonIn Cikidang River, Pangandaran City,Indonesia

ABSTRACT

This research aims to determine the structure of the phytoplankton community in the waters of the Cikidang River, which can use as a bioindicator of water quality. The research began in November 2021-February 2022 using a survey method. Sampling does at four stations. The determination of the stations does by considering land use and river orders. The water parameters analyzed are transparency, temperature, Salinity, pH, Carbon Dioxide (CO_2), Biochemical Oxygen Demand (BOD), Dissolved oxygen (DO), Nitrate (NO_3^{-}), Phosphate (PO_4^{3-}), Nitrate NH_3, phytoplankton abundance, diversity index, and dominance index. The results showed the identification of 21 genera from 6 classes and four phyla such as Chrysophyta, Cyanophyta, Chlorophyta, and Euglenophyta. Abundances index ranging from 17.2-104.6 Ind/L. The diversity index ranged from 0.49 to 0.72. At the same time, the dominance index ranges from 0.28 to 0.51 and belongs to the category of low to moderate dominance. The water quality in the Cikidang River generally meets the requirements of class II and Class III quality standards, according to Government Regulation 22 of 2021 concerning Water Quality Management and Water Pollution Control.

Keywords:Pangandaran, River, Phytoplankton, Structure Community

1. INTRODUCTION

A river is a natural or artificial water flow container from the upstream to the estuary, limited on the right and left by a borderline (Law No. 38 of 2011). In Pangandaran, there is one river, namely the Cikidang River. This river plays an essential role in community activities. Especially for people who live on the outskirts of the river, the community uses the river for agricultural irrigation activities and as a place to dispose of household (domestic) waste such as bathing, washing, and latrines (MCK). These activities produce various highly organic and inorganic materials that can pollute the river. Organic materials in the form of nitrogen (proteins, polypeptides, amino acids, urea), phosphorus (particulates), detergents, phenols, and fecal coli bacteria (Salim, 2002). Inorganic materials in the form of water runoff from inorganic fertilizers from agriculture. As time goes by, the pollutant input load will increase, resulting in physical, chemical, and biological changes in river waters and eventually causing pollution (Sihombing et al., 2015).

The existence of aquatic organisms that will be directly affected by a load of pollutant inputs is phytoplankton. Phytoplankton has a short life cycle. Responding quickly to environmental and species composition conditions can indicate water quality (APHA 1995 in Nugroho 2006). In waters that have experienced pollution, phytoplankton organisms usually have lower diversity and the dominance of certain species (Muchlisin, 2000 in Andriani et al., 2015).

2. MATERIAL AND METHOD

2.1 Study Area

This research does in the Cikidang River, Pangandaran, West Java, Indonesia, from November 2021-February 2022. Observations for sampling used purposive sampling (Amelia et al., 2012; Rumanti et al., 2014; Setiawan., and R. Mohadi, 2018), divided into four stations. The determination of the stations does by considering land use and river orders (Rahman et al., 2016; Zahidah, 2017). (Fig. 1).

Station 1: Located in the village of Sidomulyo, is an upstream river there are agricultural activities.

Station 2: River flow used for agricultural irrigation and located around residential areas.

Station 3: Located in Pananjung Village, a river near residential areas and used for agricultural irrigation.

Station 4: The estuary area is affected by the tides.

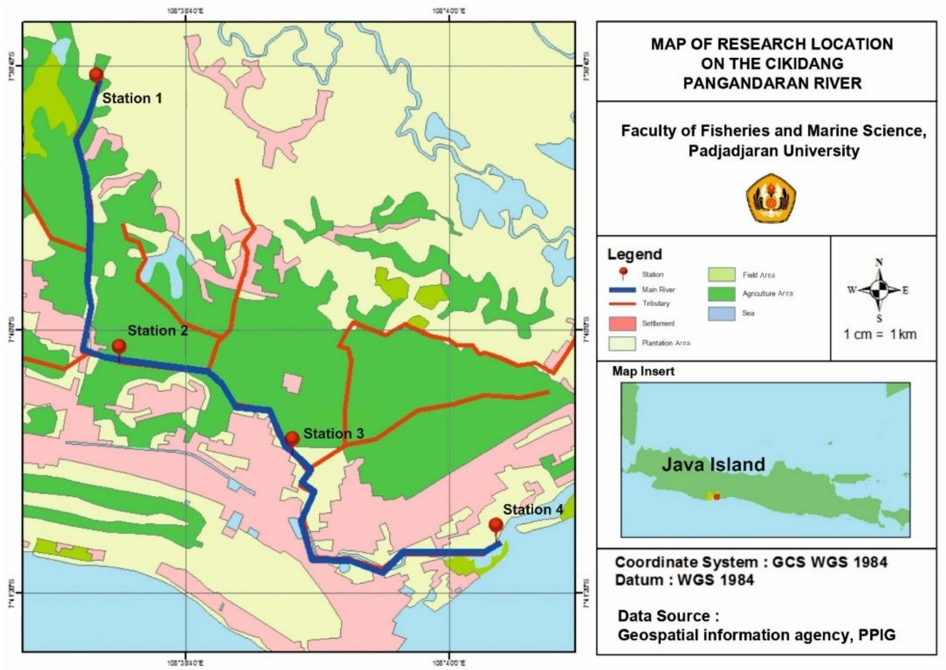

Figure 1. Map of Cikidang River Research Station

2.2 Sampling And Measurement

A sampling of water and phytoplankton was carried out over fourteen days four times of the sampling. A sampling of water and phytoplankton at the four stations does on the water's surface to a depth of ± 35 cm. Phytoplankton samples were taken by filtering 10 liters of water, then filtered using plankton-net No. 25 (Andriani et al., 2015). The sample obtained was transferred to a sample bottle with a volume of 50 ml and given 10% Lugol 10-15 drops or until brownish. Identification was made following Sachlan (1982), Sulastri (2018), and Bellinger and Sigee (2010). Physico-chemical parameters measured in the field include water, temperature, light transparency, salinity, pH, DO, CO_2 BOD, NO_3^- and PO_4^{3-}.

2.3 Sample Analysis

Phytoplankton data analysis was performed in a comparative descriptive method with the following observational parameters.

2.3.1 Phytoplankton Abundance

Phytoplankton abundance is the number of phytoplankton individuals per unit volume. Phytoplankton abundance quantitatively is based on abundance expressed in individuals/liters. Phytoplankton abundance is calculated according to the following formula (APHA, 1989).

$$N = N \times (Vr / Vo) \times (1 / Vs)$$

Information:

N = Abundance (Ind /L)
N = Number of phytoplankton observed
Vr = Filtered phytoplankton volume (ml)
Vo = Volume of water at Sedgewick rafter chamber (SRC)
Vs = The volume of filtered water

2.3.2 Diversity Index

This diversity index analysis is used to determine the diversity of aquatic organisms. The equation used to calculate this index is the Simpson equation.

$$D = 1 - C$$

Information:

D = Simpson diversity index

C = Simpson dominance index The Simpson

Simpson's diversity index value ranges from 0-1. Suppose the diversity index value is close to 1. In that case, the distribution of individuals is said to be even, and the stability of the ecosystem is good if it has a Simpson diversity index value between 0.6-0.8 (Odum, 1993).

2.3.3 Dominance Index

The dominance index is used to determine the extent of dominance of a species or genus in other groups. The calculation method used is the Simpson dominance index formula.

$$C = \sum [(PI)]^2$$

Information:

C = Dominance
Pi = ni / N
Ni = Number of individuals in one type
N = Total number of individuals of all

The domination index criteria are:

$0 < C < 0.5$ = Low dominance
$0.5 < C < 0.75$ = Moderate dominance
$0.75 < C < 1$ = High dominance

3. RESULTS AND DISCUSSION

3.1 Physical And Chemical Parameters Of Water

Table 1. Physical-Chemical Parameters of Waters

Parameters	Station				Unit
	1	2	3	4	
Physical Parameters					
Temperature	26,75±1,5	27,57±1,65	28,5±1,73	29,57±1,89	^{0}C
Transparency	16,37±8,67	16,12±6,3	22,25±10,98	135,75±59,48	cm
Salinity	0±0	0,5±0,57	2±2	9,5±4,12	ppt
Chemical Parameters					
pH	7,43±0,12	7,48±0,34	7,44±0,31	7,38±0,11	-
CO_2	47,3±6,6	23,65±4,87	19,8±11,5	28,05±12,23	mg/L
BOD	14,75±1,52	16,36±3,32	10,41±0,9	11,48±4,37	mg/L
DO	5,06±0,88	4,92±0,5	5,02±0,53	4,38±0,45	mg/L
Phosphate	0,009± 0,00	0,0135± 0,003	0,015± 0,006	0,0297± 0,0035	mg/L
Nitrate	0,37±0,02	0,25±0,04	0,31±0,08	0,32±0,02	mg/L

Based on the measurement results of water quality parameters, the average water temperature at the four stations ranging between 26.75^{0}C-29.57^{0}C (Table 1). Temperature measurement is important because phytoplankton has an optimum temperature with a certain tolerance range (Zahidah, 2017). The lowest temperature is at station 1 at 26.75^{0}C, while the highest is at station 4 at 29.57^{0}C. The range of temperature values obtained is still within the tolerance limit of deviation three according to Government Regulation 22 of 2021. The optimum temperature range for water phytoplankton growth is 20-30^{0}C (Effendi, 2003).

Waters with 30-50 cm transparency are considered optimal for supporting plankton life (Boyd, 1990). The results of the measurement of light transparency in the Cikidang River have an average transparency value ranging from 16.12 cm-135.75 cm(Table 1). The low light transparency value is at station 2 at 16.12 cm, and the highest light transparency is at station 4 at 135.75 cm. The value of light transparency can be influenced by several factors, such as the time of measurement, weather conditions, turbidity, suspended solids, and the accuracy of the person taking the measurement (Effendi, 2003).

The average salinity value in the Cikidang River ranges from 0 ppt-9.5 ppt (Table 1). The low salinity value of 0 ppt is at station 1, and the highest salinity value is at station 4 of 9.5 ppt. The obtained salinity value of 9.5 ppt indicates a good value for the survival of phytoplankton organisms in the waters. Effendi's (2003) salinity values for fresh waters are usually less than 0.5%0, brackish waters are between 0.5%0-30%0, and marine waters are 30%0-40%0.

Research results show that the average pH value in the Cikidang River ranges from 7.38-7.48 (Table 1). The highest degree of acidity (pH) is at station 2, 7.43, while the lowest is at station 4, 7.38. According to Government Regulation No. 22 of 2021, the range of suitable pH values for fisheries is between 6-9 at all research stations following class II and III quality standards.

Based on the data obtained, the highest average carbon dioxide concentration value was at station 1 at 47.3 mg/L. The lowest carbon dioxide was found at station 3 at 19.8 mg/L (Table 1). The higher the carbon dioxide, the more oxygen is needed. The high carbon dioxide in the waters will cause dissolved oxygen in the waters to become so that will cause the death of organisms. Aquatic organisms' good carbon dioxide value is approximately 12 mg/L. If the carbon dioxide content is more than this value, it can be dangerous because of the binding of oxygen (O_2) (Idrus, 2018).

The results of the BOD measurement ranged from 10.41 mg/L-16.36 mg/L. The highest BOD value came from station 2, at 16.36, and the lowest BOD value came from station 3, at 10.47 mg/L (Table 1). According to Government Regulation No. 22 of 2021, the BOD values range at all stations does not follow the class II and III quality standards.

The average value of dissolved oxygen in the Cikidang River has a range of 4.38 mg/L-5.06 mg/L (Table 1). The highest DO value is at station 1 of 5.06 mg/L, while the lowest DO value is at station 4 at 4.38. Aquatic organisms, namely phytoplankton, can live in DO value > 3 mg/L (Wijayanti, 2008 in Utami, 2020). Oxygen concentrations from the five stations are still within the limits of class II and III water quality standards in PP 22 of 2021.

The results of nitrate measurements at the four stations averaged from 0.25 mg/L-0.37 mg/L. The highest nitrate content comes at station 1 at 0.37 mg/L, and the lowest nitrate content is at station 2 at 0.25 mg/L (Table 1). According to Karyono and Pandi (1977) in Sidaningrat et al., (2018b), nitrate value content > 0.03 mg/L is the optimum content for phytoplankton growth. According to PP 10, class I and 20, class III.

The results of phosphate measurements at the four stations showed an average value ranging from 0.009 mg/L-0.029 mg/L. The highest results from station 4 of 0.029 mg/L and the lowest phosphate content from station 1 of 0.009 mg/L (Table1) in class I and II Government Regulation No. 22 of 2021. The optimum phosphate value content for phytoplankton growth is 0.09-1.80 mg/L Malaha (2004) (Sidaningrat et al., 2018b).

3.2 Abundance Of Phytoplankton

Phytoplankton identified during the research were 21 genera, 6 classes, and 4 phyla Chlorophyta, Cyanophyta, Chrysophyta, and Euglenophyta. Based on (Figure 2), phytoplankton from the Bacillariophyceae class were the most commonly found phytoplankton, with a percentage of 92% of the total phytoplankton found in this class identified in the genera Synedra, Stauroneis, Chaetoceros, Bacteriastrum, Nitzschia, Cyclotella, Gyrosigma, Navicula, Surirella, and Gomphonema. Phytoplankton from the phyla Chrysophyta is the most commonly found phytoplankton, with 94% of the total phytoplankton.

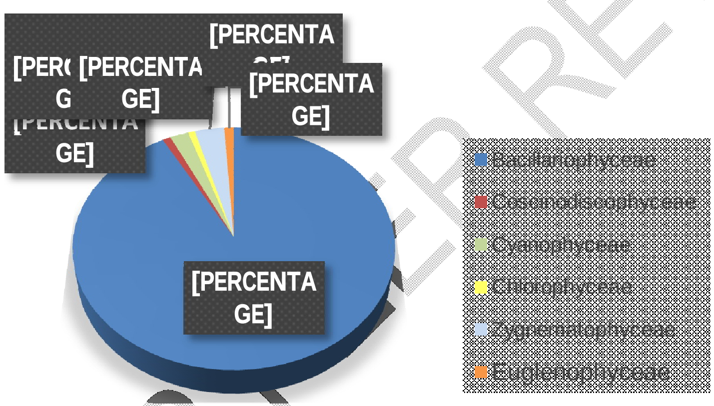

Figure2. Phytoplankton Composition of the Cikidang River

The highest abundance of phytoplankton was found at station 1, as much as 104.6 Ind/L, with the most abundant phytoplankton class, Bacillariophyceae, at 102.3 Ind/L (Figure 3). At station 1, agricultural activities can already contribute input loads, such as nitrate and phosphate, to the waters. Nitrate content in waters can be affected by discharges from agricultural activities (fertilization), industrial activities, and explosives (Effendi, 2003). In water, nitrate and phosphate are needed to meet the nutritional needs of phytoplankton so that phytoplankton can produce energy (Sidaningrat et al., 2018). In addition, other physical and chemical parameters, such as carbon dioxide and the transparency of light entering the waters, are sufficient. To carry out photosynthetic activities so that the growth of phytoplankton is faster than in other stations (Utami, 2020).

The low abundance was at station 3, with an abundance of 17.2 Ind/L. The dominant class is Bacillariophyceae at 14.2 Ind/L. This class can adapt well to the environment, and its breeding is relatively faster (Pambudi et al., 2016). Phytoplankton from the phylum Bacillariophyta is commonly found in waters because they generally have rod-like cells that have a role as the first producer, which is a source of food for zooplankton (Hurtabat & Evans, 1986 in Setyowati, 2017).

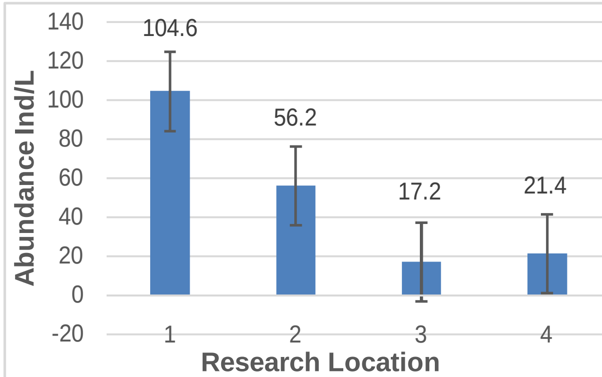

Figure 3. Cikidang River Phytoplankton Abundance Chart

Table 2. Identification of Phytoplankton by Genera

Genera	Station			
	1	2	3	4
Synedra	828	322	71	25
Stauroneis	0	6	1	0
Chaetoceros	0	0	0	125
Bacteriastrum	0	0	0	2
Nitzschia	148	91	35	8
Cyclotella	5	0	8	4
Gyrosigma	15	39	17	1
Navicula	26	54	2	1
Surirella	0	0	6	0
Gomphonema	1	1	2	5
Melosira	0	2	0	16
Oscillatoria	14	1	6	4
Planktothrix	1	2	0	12
Spirulina	0	0	0	1
Pleurotaenium	0	0	1	0
Chlorococcum	0	1	0	0
Pediastrum	0	0	2	0
Scenedesmus	0	0	0	2
Spirogyra	0	1	1	5
Cloesterium	8	21	20	3
Euglena	0	21	0	0
Amount	1046	562	172	214

3.3 Phytoplankton Diversity Index The Phytoplankton

The phytoplankton diversity index in the Cikidang River has an average range of 0.49-0.72, with the highest value at station 3 of 0.72, which indicates high diversity and even distribution of individuals (Figure 16). The low diversity index value is at station 1 of 0.49, which indicates moderate diversity. Simpson's diversity index value ranges from 0-1. Suppose the diversity index value is close to 1. In that case, the distribution of individuals is said to be even, and the stability of the ecosystem is good if it has a Simpson diversity index value between 0.6-0.8 (Odum, 1993).

A community can be said to have high diversity if there are many species with a relatively even number of individuals. Meanwhile, if a community consists of only a few species with an unequal number of individuals, the community has a relatively low diversity index (Barus, 2004).

A high diversity index value is usually indicated by the formation of a stable environmental ecosystem. An environment under pressure or disturbance is usually marked with a moderate diversity index value. A low diversity index indicates that the environment has experienced disturbances that impact the organism's structure (Shabrina *et al*., 2021).

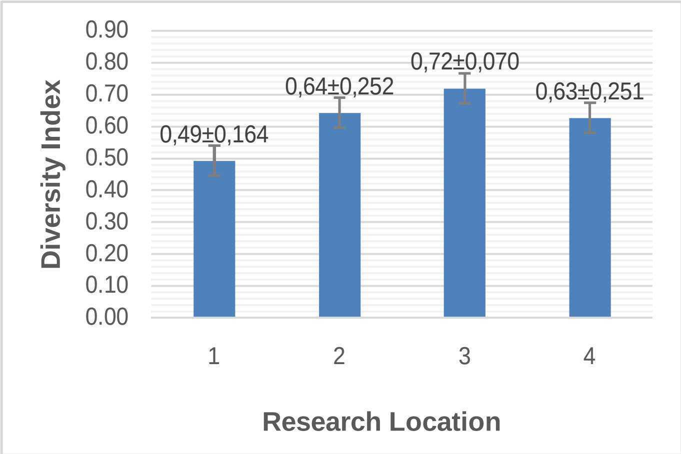

Figure 4. Phytoplankton Diversity Index of Cikidang River

3.4 Phytoplankton Dominance

Index Simpson's dominance index ranges from 0-1, as shown in Figure 5). Phytoplankton dominance index values ranged from 0.28 to 0.51. At Station 1 location, the dominance index value is in the moderate category 0.5 < C < 1, with the dominance of *Synedra* (Odum, 1998). Phytoplankton of the *Synedra* genus is known to adapt well to unfavorable environmental conditions. This adaptability occurs because *Synedra* has a characteristic diatom shape, equipped with layered wrapping cells (Conradie 2008 in Huda and Laily 2015).

According to Sulastri (2018), *Synedra* is tolerant of extensive water quality conditions, occupying oligotrophic (low in nutrients), mesotrophic, and eutrophic (rich in nutrients) waters with low nitrogen and phosphate concentrations. Because *Synedra* can accumulate nutrients (nutrients) and store them as food reserves in insoluble polymers (Venter 2003 in Huda and Laily 2015).

At stations 2, 3, and 4, the phytoplankton dominance index value in the low category 0 < C < 0.5 indicates that there are no dominant phytoplankton species at that location. The dominance index value close to 0 indicates that in the phytoplankton community structure, there are no species that extremely dominate other species. All types of phytoplankton have the same ability and opportunity to utilize resources in their environment, and the community structure condition is stable (Shabrina et al., 2021).

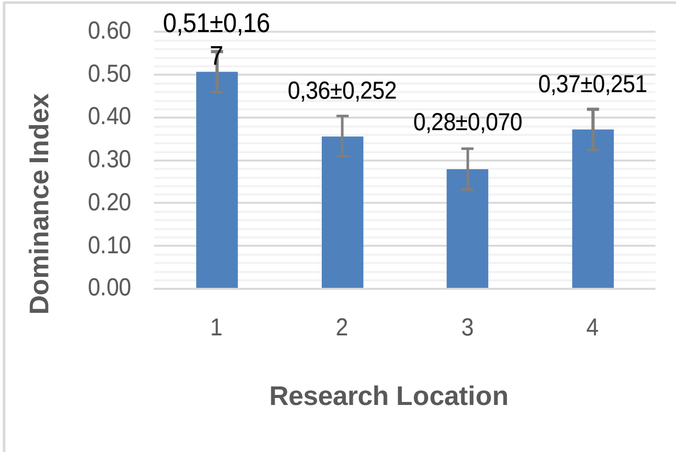

Figure 5.Phytoplankton Dominance Index Of Cikidang River

4. CONCLUSION

Phytoplankton consists those in the Cikidang River consist of 21 genera from 6 classes such as Bacillariophyceae, Coscinodiscophyceae, Cyanophyceae, Chlorophyceae, Zygnematophyceae, Euglenophyceae, and 4 phyla such as Chrysophyta, Cyanophyta, Chlorophyta, and Euglenophyta. Abundances index ranging from 17.2-104.6 Ind/L. The phytoplankton diversity index ranged from 0.49 to 0.72. Meanwhile, the phytoplankton dominance index ranged from 0.28 to 0.51, including low to moderate dominance. The dominant genus is Synedra. The water quality in the Cikidang River generally meets the requirements of class II and class III standards, according to Government Regulation 22 of 2021 concerning Water Quality Management and Water Pollution Control.

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