THE EFFECT OF ENVIRONMENTAL PARAMETERS ON PLANKTON ABUNDANCE IN JATIGEDE RESERVOIR, WEST JAVA

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ABSTRACT

The water flowing to Jatigede Reservoir can affect the condition of the waters both physically, chemically and biologically. The correlation between physical-chemical parameters of water affects the life of the organisms below. The purpose of this research was to determine the physical-chemical parameters of the waters that more affect the distribution of plankton in the waters. The research was conducted from August 2019 to October 2019 at the Laboratory of Aquatic Resources, Faculty of Fisheries and Marine Sciences, Padjadjaran University. This study used a survey method. Sampling was carried out at 4 stations on the surface, half compensation and compensation depth. The parameters analyzed were the physical and chemical parameters of the waters, the abundance and composition of plankton, and the multivariate analysis of CCA. Metering of physical-chemical parameters of water includes nine parameters, such as transparency, temperature, current velocity, pH, CO_2, BOD_5, DO, Nitrate and Phosphate. The results showed that the average phytoplankton abundance in the Jatigede reservoir during the research ranged from 6,978-15,069 ind/L and the range of 100-312 ind/L for zooplankton. A total of 49 genera from 22 orders and five phytoplankton phylum as well as 17 genera from 9 orders and 5 zooplankton phylum have been identified. Temperature and nutrients are the parameters that most affect the distribution of phytoplankton, while for zooplankton are temperature and depth.

Keywords: *Abundance, CCA, Distribution, Physical-Chemical Parameters of Waters, Phytoplankton*

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1. INTRODUCTION

Plankton in aquatic ecosystems have an important role as a producers and primary consumers. The distribution of plankton in a waters is affected by the presence of growth supporting factors. Growth supporting factor of the phytoplankton is very complex and interacting between factors of waters physical-chemical parameters such as light intensity, dissolved oxygen, temperature stratification, and the availability of nutrients nitrogen and phosphorus, while the biological aspect is the activity of predation by animals, natural mortality, and decomposition [3]. Just like phytoplankton, Zahidah (2017) states that the existence and abundance of zooplankton is affected by several factors such as abundance of food, presence of predators, and the physical-chemical characteristics of the waters.

Jatigede Reservoir is a reservoir that has water input from various sources. The water flowing into the reservoir can affect the condition of the water physically, chemically and biologically. The correlation between physical-chemical parameters of water affects the life of the organisms below. A typical distribution pattern of a biota, according to the habitat where the biota is located [4]. Therefore, it is important to know the physical-chemical parameters of the waters that more affect the distribution of plankton in the waters as a consideration for sustainable management through the CCA (*Canonical Correspondence Analysis).* This analysis is a multivariate analysis that can explain the correlation between biological communities and environmental parameters in the form of ordination [8].

2. MATERIALS AND METHOD

This research was carried out in Jatigede Reservoir, Sumedang, West Java. The method that used in this research is the method of survey with four locations and five time retrieval of samples, carried out in August until October 2019. The determination of the station making the data observation is based on consideration of input water, the activities of anthropogenic and value of BOD_5 that illustrates the difference characteristics of each station. Determination of the sampling station listed on (Figure 1):

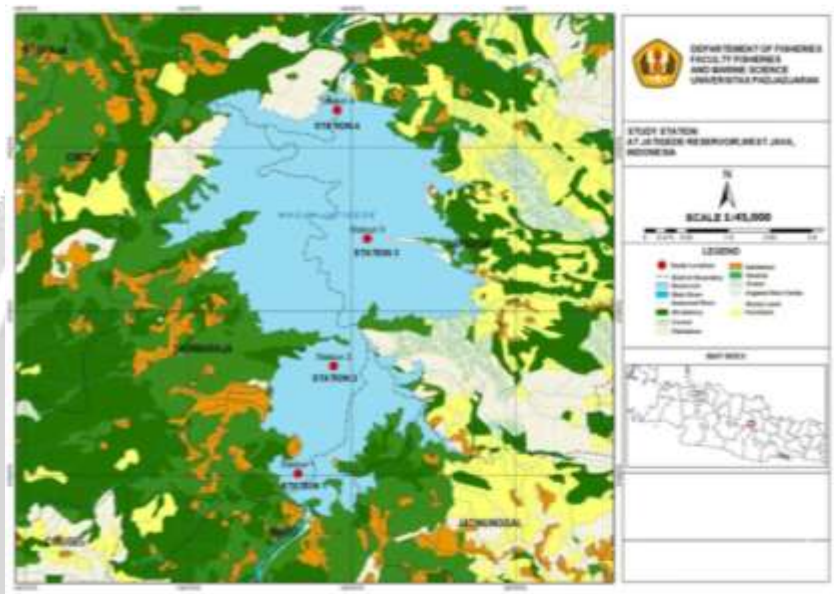


Figure 1. Research locations in Jatigede Reservoir, West Java

Station 1. Located at the *inlet* of Jatigede Reservoir which is located in Sukamenak Village, Darmaraja District or at coordinates 6°55'58.8" S and 108°05'20.3" E. The station is selected for receiving input from the dominant water Cimanuk River and by the value of BOD_5 classified in the category of heavily polluted.

Station 2. Located the middle of Jatigede Reservoir, located in Leuwihideung Village, Darmaraja District coordinates 6°54'40.1" S and 108°05'46.4" E. The station is selected for activity anthropogenic which encountered the activities of aquaculture fish in floating net and based on the value of BOD_5 classified in the category of medium polluted.

Station 3. Located in the middle of Jatigede Reservoir, located in Jemah Village, Jatigede District or at coordinates 6°53'06.8" S and 108°06'11.3" E. This station was chosen because it receives water input apart from the Cimanuk River but also other tributaries such as the Cinambo River, Cibayawak River, Cihonje River, Cicacaban River and Cimuja River. Based on the value of BOD_5 classified in the category of medium polluted.

Station 4. Located at the Jatigede Reservoir *outlet* located in Cijeungjing Village, Jatigede District or at coordinates 6°51'32.6" S and 108°05'49.0" E. This station was chosen because it is an *outlet* of the Jatigede Reservoir so that it is affected by all water input and every activity in the Jatigede Reservoir and is a utilization- free area. Based on the value of BOD_5 classified in the category of heavily polluted.

Data analysis

Research data were analyzed using comparative descriptive methods. Plankton abundance is expressed as the average abundance per species per unit volume (ind/L). The Correlation between water quality parameters and plankton parameters was calculated using *Canonical Correspondence Analysis* (CCA). The discussion is explained by relating plankton abundance to the water quality parameters that influence it.

3. RESULTS

This research was carried out in August - October 2019. Sampling was carried out in the Jatigede Reservoir by time series every seven days as many as five replications for each station. Sampling was carried out at four stations at three different depths including surface, half compensation and compensation depth. Plankton samples were taken using a plankton net with a mesh size of 20 µm. The filtered plankton sample was then put into a sample bottle and given a 1% lugol. Furthermore, the analysis and identification in Laboratorium Aquatic Resources Faculty of Fisheries and Marine Sciences, University of Padjadjaran using a microscope binocular. Metering of the physical-chemical parameters of water includes nine parameters, such as transparency, temperature, current velocity, pH, CO_2, BOD_5, DO, Nitrate and Phosphate.

Abundance and Composition of Phytoplankton and Zooplankton

The abundance and composition of plankton is related to the physical and chemical conditions of the waters. This is because each organism has a tolerance range to certain environmental conditions that will affect the existence, abundance and population of organisms in that area. Here are the results and discussion based on data abundance and composition of the plankton in Figure 2, Figure 3, and Figure 4, as well as water parameters obtained in Table 1 and Table 2.

Phytoplankton

The average phytoplankton abundance in the Jatigede reservoir during the research ranged from 6,978-15,069 ind/L (Figure 2). The highest average abundance of phytoplankton was found at station 2 with a value of 15.069 ind/L. This is because the location of station 2 is a transition zone between the *riverine* and *lacustrine* zones so that it receives a lot of organic material input that was brought in from the previous station. In this zone there has been a decrease in current velocity, indicated by station 2 (Table 1) is the station with the lowest current velocity. Barus (2004) explains that current flow patterns has a role in determining the distribution characteristics of materials such as nutrients and plankton. While the lowest average of phytoplankton abundance was found at station 1 with a value of 6978 ind/L. This is related to the low light transparency at station 1 (Table 1). As an *autotrophic* organism, the presence of light in the waters is a limiting factor for phytoplankton life [6].

In general, the highest of vertical phytoplankton abundance was found in the surface layer with an average abundance value of 12417 ind/L (Figure 3). As *autotrophic* organisms, the presence of light is very important for the life of phytoplankton. Zahidah (2017) explains that water depth affects the vertical distribution of light intensity and the deeper the waters the lower the light intensity. Sulawesty (2007) also adds that the abundance of phytoplankton is high in the surface layer and decreases with increasing depth and decreasing the penetration of sunlight.

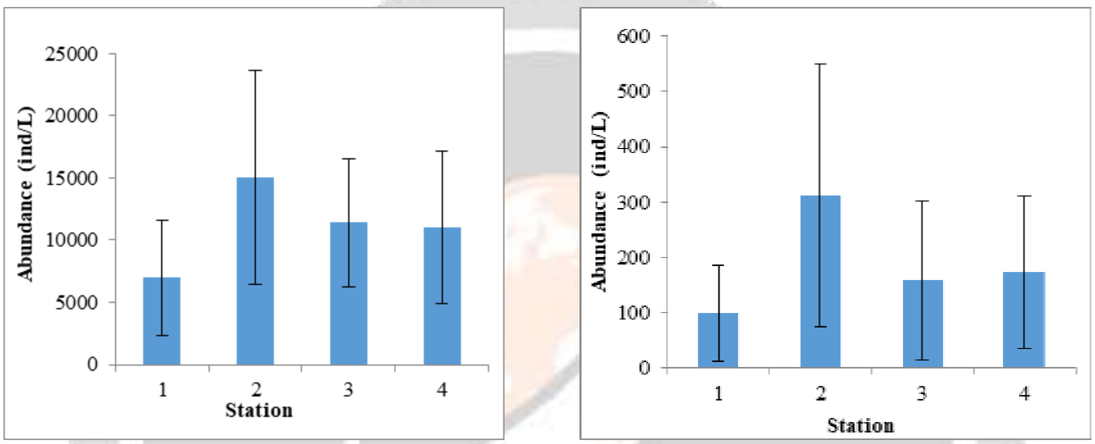
The phytoplankton identified in Jatigede Reservoir during the research consisted of 49 genera from 22 orders and five phylum. The composition of the abundance of phytoplankton in the Jatigede Reservoir was dominated by the Chrysophyta phylum with a value of 60% (Figure 4) with the most common genus being Nitzschia. The high composition of the abundance of chrysophyta phylum, especially the Nitzschia genus, was found because this type of phytoplankton is easily able to adapt to its environment. Nurfadilah et al (2012) explain that the Bacillariophyceae class, including the genus Nitzschia, is the most tolerant type of diatom and is able to adapt well so that it can reproduce quickly and optimally utilized the nutrient.

Zooplankton

The average zooplankton abundance in the jatigede reservoir during the research ranged from 100-312 ind/L (Figure 2). The highest average zooplankton abundance was found at station 2 with a value of 312 ind / L and the lowest was found at station 1 with a value of 100 ind/L (Figure 2). This is related to the existence of phytoplankton which is the food of the zooplankton itself. Zahidah (2017) explains that the existence and abundance of zooplankton is influenced by several factors such as the presence and abundance of food, the presence of predators, and the physical and chemical properties of the waters.

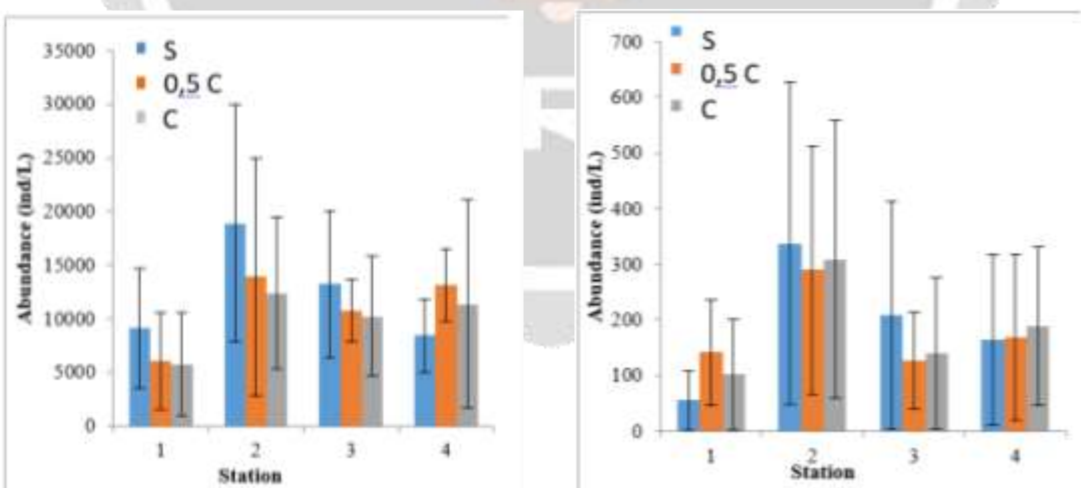
In general, the highest vertical zooplankton abundance was found in the surface layer with an average abundance value of 191 ind/L (Figure 3). This is affected by the presence and abundance of phytoplankton as food. As has been stated before, the existence and abundance of zooplankton is influenced by the presence and abundance of phytoplankton.

Zooplankton identified in Jatigede Reservoir during the research consisted of 17 genera from 9 orders and 5 phylum. The composition of the abundance of zooplankton in the Jatigede Reservoir is dominated by Rotifera phylum with a value of 57% (Figure 4). This is because Rotifers are one of the zooplankton groups that are mostly found in freshwater and rarely found in waters with high salinity [7]. The high dominance of the Rotifera phylum shows that this type of zooplankton is able to adapt to its environment. Effendi (2003) explains that the high number of individuals in an area indicates that the species is able to adapt to its environment, characterized by relatively fast reproduction and growth, so that the abundance of this type of zooplankton is higher than other types.



a. b.

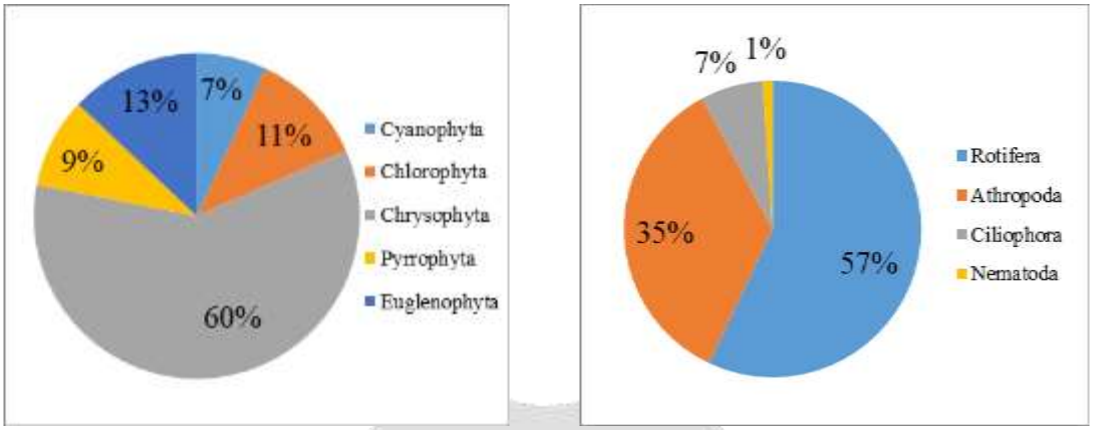
Figure 2 . Abundance of (a.) Phytoplankton and (b.) Average data of Zooplankton in Jatigede Reservoir



a. b.

Figure 3. Abundance of (a.) Phytoplankton and (b.) Vertical Average data of Zooplankton in Jatigede Reservoir

Description: S = Surface; 0.5 C = Half Compensation; C = Compensation



a. b.

Figure 4. Abundance Composition (a.) Phytoplankton and (b.) Zooplankton of Jatigede Reservoir by Phylum

Table 1. Physical Parameter of Water at Jatigede Reservoir

Unit Parameters	**Depth**		**Station**			
			1	**2**	**3**	**4**
Transparency (m)		R	0,20-0,39	0,25-0,79	0,63-1,17	0,72-1,13
		A	0,28±0,08	0,55±0,21	0,89±0,19	0,93±0,18
Temperature (°c)	S	R	26,9-28,3	27-28,1	26,4-28,9	26,4-28,4
		A	27,48±0,54	27,46±0,5	27,02±1,06	27,26±0,73
	0,5 C	R	26,7-28	26,7-27,8	26,4-27,5	26,4-28
		A	27,38±0,53	27,32±0,45	27,02±0,53	27,04±0,59
	C	R	26,4-27,8	26,4-27,6	26,2-27,1	26,3-27,6
		A	26,96±0,59	27,06±0,51	26,58±0,36	26,72±0,6
Current (m/s)		R	0,14-0,16	0,05-0,25	0,06-0,43	0,04-0,20
		A	0,152±0,008	0,136±0,092	0,216±0,148	0,142±0,069

Description: S= Surface; 0,5 C = Half Compensation; C = Compensation; R = Range; A= Average

Table 2. Chemical Parameter of Water at Jatigede Reservoir

Unit Parameters	**Depth**		**Station**			
			1	**2**	**3**	**4**
Acidity	S	R	7,04-8,77	7,94-8,74	7,88-8,57	7,79-8,46
		A	7,96±0,64	8,26±0,3	8,194±0,25	8,30±0,29
	0,5C	R	7,57-8,7	7,73-8,65	7,9-9,38	7,81-8,76
		A	8,15±0,44	8,03±0,38	8,40±0,59	8,40±0,36
	C	R	7,04-8,62	6,5-8,67	8,18-8,44	7,78-8,51
		A	7,84±0,58	7,69±0,78	8,30±0,11	8,17±0,28
Carbondioxide (mg/L)	S	R	4,19-12,57	4,19-4,19	4,19-8,38	4,19-4,19
		A	9,22±3,5	4,19±0	5,03±1,87	4,19±0
	0,5C	R	4,19-12,57	4,19-4,19	4,19-4,19	4,19-4,19
		A	7,54±3,5	4,19±0	4,19±0	4,19±0
	C	R	4,19-12,57	4,19-4,19	4,19-8,38	4,19-4,19
		A	7,54±3,5	4,19±0	5,03±1,87	4,19±0
BOD (mg/L)		R	4,86-21,08	6,48-24,32	6,48-17,84	3,24-17,84
		A	12,65±6,00	12±7,12	12,32±4,95	11,03±6,00
Dissolved Oxygen (DO) (mg/L)	S	R	6,2-7,9	5,4-8	5,8-7,9	6,1-7,3
		A	6,94±0,8	6,78±1,1	7,12±0,8	6,54±0,5
	0,5C	R	6,5-7,9	4,8-7,9	6,2-7,5	6,5-7,7
		A	7±0,6	6,38±1,2	6,76±0,5	7±0,5
	C	R	6-7,9	5,5-8,2	6-7,9	6,1-8

Unit Parameters	Depth		Station			
			1	2	3	4
		A	7±0,8	6,46±1	6,84±0,8	7±0,8
Nitrate (NO_3-) (mg/L)	S	R	0,209-0,279	0,16-0,314	0,133-0,222	0,121-0,2
		A	0,238±0,028	0,232±0,066	0,187±0,034	0,168±0,037
	0,5C	R	0,148-0,357	0,126-0,286	0,116-0,259	0,13-0,237
		A	0,244±0,082	0,222±0,061	0,199±0,051	0,188±0,046
	C	R	0,15-0,37	0,162-0,321	0,159-0,251	0,152-0,221
		A	0,256±0,103	0,236±0,064	0,191±0,036	0,183±0,029
Ammonia (NH_3) (mg/L)	S	R	0,007-0,101	0,0047-0,042	0,004-0,02	0,003-0,016
		A	0,039±0,04	0,0139±0,016	0,011±0,006	0,0098±0,005
	0,5C	R	0,009-0,09	0,005-0,053	0,002-0,023	0,004-0,021
		A	0,04±0,031	0,0184±0,02	0,0132±0,009	0,0103±0,008
	C	R	0,002-0,067	0,003-0,049	0,002-0,019	0,0023-0,013
		A	0,027±0,026	0,0136±0,02	0,0113±0,008	0,0065±0,005
Phosphate (PO_4^{3-}) (mg/L)	S	R	0,128-0,211	0,114-0,169	0,127-0,182	0,115-0,183
		A	0,161±0,031	0,148±0,02	0,156±0,023	0,148±0,027
	0,5C	R	0,146-0,215	0,104-0,214	0,123-0,17	0,131-0,16
		A	0,174±0,026	0,152±0,04	0,139±0,019	0,141±0,012
	C	R	0,14-0,267	0,134-0,183	0,113-0,219	0,111-0,193
		A	0,185±0,049	0,152±0,019	0,15±0,041	0,142±0,033

Description: S= Surface; 0,5 C = Half Compensation; C = Compensation; R = Range; A= Average

Correlation of Plankton order distribution with Physical-Chemical Parameters of Waters

The existence of phytoplankton in the waters is influenced by the physical and chemical parameters of the environment arround. *Canonical Correspondence Analysis* (CCA) was conducted to determine the correlation between phytoplankton abundance and abiotic parameters. The parameters analyzed were transparency, depth, temperature, DO, pH, carbon dioxide, nitrate, ammonia, and phosphate.

Phytoplankton

The CCA triplot ordination diagram in Figure 4 shows that different environmental parameters affect each identified order of phytoplankton. The correlation between the phytoplankton orders and the respective results of the CCA analysis in Figure 25 is simplified in Table 3.

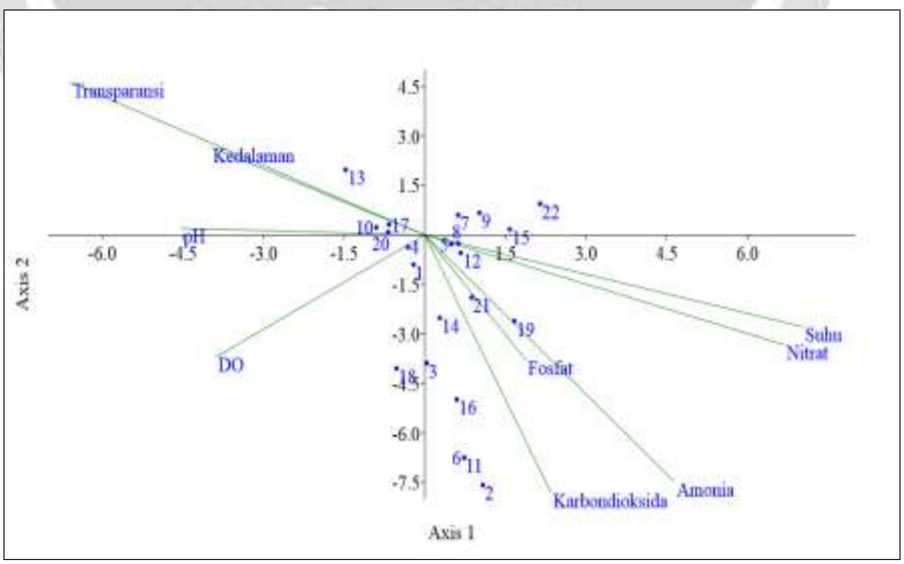


Figure 5. *Canonical Correspondence Analysis* (CCA) Diagram of Phytoplankton Orders with Water Quality Parameters

1= Synechococcales, 2 = Chroococcales, 3 = Oscillatoriales, 4 = Nostocales, 5 = Chlorellales, 6 = Trebouxiales, 7 = Trebouxiophyceae ordo incertae sedis, 8 = Sphaeropleales, 9 = Chlamydomonadales, 10 = Desmidiales, 11 = Zygnematales, 12 = Tribonematales, 13 = Eustigmatales, 14 = Stephanodiscales, 15 = Naviculales, 16 = Cymbellales, 17 = Bacillariales, 18 = Fragilariales, 19 = Surirellales, 20 = Gonyaulacales, 21 = Peridiniales, 22 = Euglenida

Based on Table 3, the four orders are in the same ordinate, thus indicating that the four orders are correlated with parameters of transparency, depth, and pH. Order Gonyaulacales strongly correlated with pH parameters, Bacillariales strongly correlated with depth. It is shown in Figure 5 that these orders are closest to the triplot line. Three orders are correlated with the DO parameter in the same ordinate. The order of Nostocales is the order that is most strongly correlated with DO compared to other orders in the same ordinate. It is indicated by the point of the order closest to the triplot DO line.

Furthermore, 11 phytoplankton orders identified in the same ordinate showed that the eleven orders were correlated with temperature, nitrate, ammonia, and phosphate. Order of Chlorellales has strong correlation with nitrate, order of Sphaeropleales has strong correlation with temperature, order of Surirellales has strong correlation with ammonia, and order of Peridiniales has strong correlation with phosphate. This is shown in each order point that coincides with each of these parameters compared to other orders in the same ordinate. Meanwhile, the Trebouxiophyceae, incertae sedis, Chlamydomonadales, Naviculales, and Euglenida orders did not have a strong correlation with certain parameters, although they were still close to the ordinate axis. The correlation of a parameter with an identified order indicates that the phytoplankton of an order is influenced by its presence with certain water quality parameters.

Table 3. Correlation of Phytoplankton Order with Enviromental Parameters

Ordo Fitoplankton	**Parameter**
Desmidiales Eustigmatales Bacillariales Gonyaulacales	Transparency, Depth, pH
Synechococcales Nostocales Fragilariales	DO
Chroococcales Oscillatoriales Chlorellales Trebouxiales Sphaeropleales Zygnematales Tribonematales Stephanodiscales Cymbellales Surirellales Peridiniales	Temperature, Carbondioxide, Ammonia, Phosphate, Nitrate
Trebouxiophyceae ordo incertae sedis Chlamydomonadales Naviculales Euglenida	Not strongly correlated with certain parameters

Table 3 also shows that most of the orders identified during the study were more influenced by temperature and nutrients (carbon dioxide, ammonia, phosphate, and nitrate). Meanwhile, several orders that do not have a strong correlation with certain parameters show that the phytoplankton in these orders are phytoplankton that are tolerant of various water conditions.

Zooplankton

The CCA triplot oration diagram in Figure 6 shows that different environmental parameters affect each identified order of zooplankton. The correlation between the zooplankton orders and the respective CCA analysis results in Figure 6 is simplified in Table 4.

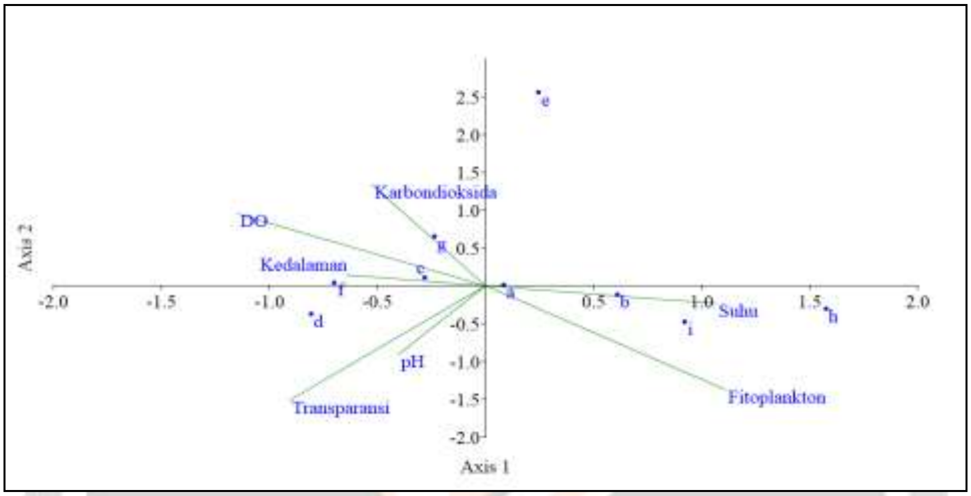


Figure 6. *Canonical Correspondence Analysis* (CCA) Diagram of Zooplankton Orders with Water Quality Parameters
a= Ploima, b= Polyarthra, c= Copepoda, d= Cladocera, e= Myzostomida, f= Dileptida, g= Hypotrichida, h= Mobilida, i= Rhabditida

The transparency and pH parameters have a correlation with the Cladocera order (Figure 6, Table 4). This can be seen from the proximity of this order point to the environmental parameter triplot line. So it can be said that changes in these parameters will affect the abundance of this type of zooplankton. Copepoda, Dileptide, Hypotrichide are three orders, whose have a correlation with the parameters of depth, carbon dioxide, and dissolved oxygen. Hypotrichide order has strong correlation with carbon dioxide parameter, Copepoda order has strong correlation with depth parameter. This can be seen from the proximity of this order point to the environmental parameter triplot line.

Table 4. Correlation between Zooplankton Orders with Enviromental Parameters

Affected Orders	**Enviromental Parameters**
Cladocera	Transparency, Ph,
Copepoda, Dileptida, Hypotrichida	Dissolved Oxygen, Carbondioxide , Depth
Ploima, Mobilida, Polyarthra, Rhabditida	Temperature, Kelimpahan Phytoplankton Abundance
Myzostomida	Not strongly correlated with certain parameters

There are four orders contained in the same ordinate with parameters of temperature and abundance of phytoplankton, the order Ploima, Mobilida, Polyarthra, and Rhabditida. It is shows that the four orders are correlated with temperature parameters. The orders Ploima and Polyarthra are the orders that are most strongly correlated with temperature compared to the other three orders, seen from the order point closest to the temperature triplot line. Meanwhile, the Myzostomide order does not have a strong correlation with certain parameters, which is indicated by the location of the order points that are not adjacent to any environmental parameter triplot lines. The correlation between a parameter and the order identified indicates that the existence of the order is influenced by certain environmental parameters. Therefore, the uncorrelation of the Myzostomide order with any parameters shows that the existence of this order is not influenced by the existing environmental parameters.

4. CONCLUSION

The plankton identified in Jatigede Reservoir consisted of 49 genera from 22 orders and five phytoplankton phylum with an average abundance of 11,110 ind/L while zooplankton consisted of 17 genera from 9 orders and 5 phylum with an abundance of 186 ind/L. Temperature and nutrients are the parameters that most influence the presence of most of the identified phytoplankton orders. Meanwhile, the parameters that most influence the abundance of zooplankton in the Jatigede Reservoir are temperature and depth parameters.

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