International Journal of Scholarly
Research and Reviews
Journal homepage: https://srrjournals.com/ijsrr/
ISSN: 2961-3299 (Online)

(Research Article)

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The physical factor influencing blooming of phytoplankton in Menjer Lake Wonosobo Indonesia

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International Journal of Scholarly Research and Reviews, 2023, 02(02), 073–083

Publication history: Received on 08 April 2023; revised on 23 May 2023; accepted on 25 May 2023

Article DOI: https://doi.org/10.56781/ijsrr.2023.2.2.0037

Abstract

Phytoplankton are organisms that are sensitive to environmental changes and their presence can be used as an indicator of aquatic productivity. Physical factors in the waters can affect the abundance of phytoplankton. The purpose of this study is to determine the relationship between physical factors (temperature, brightness, TDS and TSS) and the abundance of phytoplankton. Phytoplankton sampling was carried out at 7 stations by purposive random sampling in Menjer Lake including 7 sites of the tourism areas, floating net cages, near agricultural areas, the middle of the lake, spring sources, inlets of the Serayu River and outlet areas. The variables measured were temperature, light penetration, TSS and TDS concentration as well as the composition and abundance of phytoplankton. The results of this study obtained 6 species of phytoplankton, namely *Ceratium* sp., *Dictyosphaerium pulchellum*, *Microcystis aeruginosa*, *Microspora* sp., *Nitzschia* sp., and *Pediastrum* sp. The highest abundance of phytoplankton is *Microcystis aeruginosa* and temperature in related to season has a strong effect on the abundance of phytoplankton.

Keywords: Temperature; TDS; TSS; Brightness; Blooming; Phytoplankton; Menjer Lake

1. Introduction

Telaga Menjer is located in the Dieng mountains of Maron Village, Garung District 12 km in the northern part of Wonosobo City. The Basin zone of Telaga Menjer covers an area of 70 hectares and the average depth of water is 45 m. The formation of Telaga Menjer is from a volcanic eruption of Mount Pakuwaja. Since 1982 until now Telaga Menjer has been used for hydropower (PLTA) and fish farming using floating net cages. Currently Telaga Menjer is also used as a tourist spot. Various types of activities can affect the physical condition that can lead to ecological changes in the waters. These conditions will also have an impact on the abundance and composition of biota living in the waters of Telaga Menjer. Aquatic environmental conditions in the form of physical factors can affect the life of phytoplankton (Widiana, 2012). Phytoplankton are plankton capable of photosynthesis. Phytoplankton in water is a producer that can produce food from inorganic compounds. Phytoplankton are a source of food for organisms of higher trophic levels (Persada *et al*., 2019). The existence of phytoplankton can be an indicator of aquatic fertility, because phytoplankton is an organism that is sensitive to environmental changes, so phytoplankton is often used to predict the ecological conditions of water bodies (Kumalasari *et al*., 2015).

Physical factors that limit phytoplankton production in waters can affect phytoplankton abundance (Purnamaningtyas *et al*., 2019). The abundance of phytoplankton in a body of water is also influenced by physiological characteristics. The abundance and composition of phytoplankton can change at various levels in response to changing physical, chemical and biological environmental conditions. Aquatic physical factors including light intensity and temperature stratification are contributing factors to phytoplankton growth (Nirmalasari, 2018). Physical factors such as water temperature, brightness, TDS and TSS concentration will affect phytoplankton in photosynthesis. The relationship

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between the content of PO, No_4, SO_3 and Fe_4 with chlorophyll has been done by Piranti *et al*. (2021). The results showed that Cu, No2, Si, and Na are significant determinants that affect the development of algae in Lake Menjer Wonosobo.

Community structure is the composition and composition of species and their abundance within a community (Fauziah *et al*., 2018). Research on the composition and abundance of phytoplankton in Telaga Menjer Wonosobo has been conducted by Kumalasari *et al*. (2015), that the composition of phytoplankton there are 40 types of species consisting of 6 divisions. The most common species are 71% of Bacillariophyta division and 19% of Chlorophyta which is always found at each station. The type of phytoplankton found at each station is dominated by the Class Bacillariophya. The highest abundance of phytoplankton is at the cage station of 11,884 ind/ml, while the lowest abundance is at the outlet station of 8,476 ind/ml. So far, research on the relationship between physical factors and phytoplankton community structure analyzed temporally and spatially in Telaga Menjer has not been done. Temporal (time) and spatial (station) analysis was conducted to determine the differences in community structure between time and between sampling locations.

The purpose of this study is to determine the condition of the physical factors of water (temperature, brightness, TDS and TSS), composition, abundance and dominance of phytoplankton spatially and temporally, as well as to determine the relationship between the physical factors of water to the abundance of phytoplankton and the factors that most affect its abundance. The results of this study can provide information about the relationship between the physical factors of the waters with the structure of phytoplankton communities in Telaga Menjer so that it can be used as a reference in the management of water quality in stagnant waters.

2. Material and methods

The tools used in this study were 80 ml phytoplankton sample bottles, 1 liter jerry cans, ice boxes, plankton net 40 µm, milliopore paper, analytical scales, water pump, Secchi disk, GPS, depth sounder, thermometer, pH paper, tissue, bucket, camera, microscope, optilab, dropper drops, object glass, refrigerator, identification book based on Sachlan 1982 and algaebase website (algaebase.org).

The materials used in this study include water samples from Telaga Menjer, ice cubes, alcohol, aquades, formalin, and lugol.

Water sampling and phytoplankton samples were conducted in Telaga Menjer, Wonosobo, Central Java. Analysis and identification of phytoplankton species was carried out in the aquatic Laboratory of the Faculty of Biology Unsoed.

This research method used a survey method in the waters of Telaga Menjer Wonosobo. Phytoplankton sampling was conducted at 7 stations in purposive random sampling, namely in tourism areas, floating net cages, near agricultural areas, the middle of the lake, spring sources, inlet of the Serayu River and outlet areas. Water and phytoplankton samples are taken once a month, namely June, August and September 2021 at noon around 10.00-14.00 WIB.

The variables measured were water temperature, light penetration, TSS and TDS concentration as well as the number of types and the number of individuals of each type of phytoplankton. The parameters observed are the physical factors of water that affect the composition, abundance, and dominance of phytoplankton in Lake Menjer.

2.1 Sampling

Water samples were taken using a 1 liter bottles that has been labeled. Sampling is done by inserting water samples from each station into bottles can as much as 1 liter then the bottles closed. The sample is then stored in an ice box and then taken to the Laboratory of Aquatic Biology Faculty of Biology, University of Jenderal Sudirman to measure levels of TDS and TSS.

Phytoplankton samples were carried out using a water pump which was then filtered using plankton net. The results of the filtration are contained in a container bottle measuring 80 ml. Samples in container bottles are poured into plankton sample bottles. Furthermore, the sample was preserved using lugol and formalin as much as 0.1 ml. The sample is then stored in an ice box and then taken to the Laboratory of Aquatic Biology Faculty of Biology, University of Jenderal Sudirman for identification.

2.2 Identification of Phytoplankton

Phytoplankton samples were identified based on their shape and color characteristics. Phytoplankton samples were observed under a microscope using a magnification of 4X10, then documented and matched with Sachlan identification book (1982) and algabase website (algabase.org).

2.3 Abundance of Phytoplankton

Phytoplankton abundance is calculated using a formula as used by Sachlan (1982) as follows:

$$\mathbf{N = n\ x\ \frac{(Vr)}{(Vo)}\ x\ \frac{(1)}{(Vs)}}$$

Description:

N : Number of cells per liter
n : Number of identified phytoplankton
Vr : Volume of sample or concentrated water (mL)
Vo : Observed volume of water (mL)
Vs : Filtered water Volume (L)

2.4 Phytoplankton Dominance Indeks

Dominance is calculated using the Simpson dominance index formula (Rahmatullah *et al.*, 2016).

$$\mathrm{D} = \sum \left[\frac{ni}{N}\right]$$

Description:

D : Dominance index
ni : Number of individuals of the i-th species (ind)
N : Total number of individuals

2.5 Data Analysis

The condition of the physical factors in Telaga Menjer is known from the data from the measurement of the physical factors of the waters, then tabulated and analyzed descriptively. The abundance of phytoplankton in Telaga Menjer is known by calculating the abundance of the number of individuals of each type based on the Sachlan formula (1982), to determine the dominance index is calculated using the Simpson formula. Data composition, abundance, and dominance made tables and then analyzed spatially and temporally. To determine the relationship between the physical factors of water to the abundance of phytoplankton and determine the factors that most affect the abundance of phytoplankton in Telaga Menjer then conducted correlation analysis using PCA method with XLSTAT software. To determine the strength of the relationship between physical factors with the abundance and diversity of phytoplankton determined by Sugiyono (2005).

3. Results and discussion

Phytoplankton growth in Telaga Menjer is influenced by environmental factors, one of which is the physical factor of the waters. Based on the results of the measurement shows the condition of the physical factors of the waters in Telaga Menjer classified as good enough for the growth of phytoplankton, because based on the results of the measurement of the value of physical factors is not less or more than the optimum value (Table 1.). Physical factors measured include temperature, brightness of Total Suspended Solid (TSS), and Total Dissolved Solid (TDS).

Temperature in a body of water is one of the physical factors that can affect the life and growth of phytoplankton. Water temperature also plays an important role in helping the process photosynthetic phytoplankton (Radiarta, 2013). The water temperature measurement results in Telaga Menjer spatially ranged from 22-24°C. This shows that the temperature of the waters in Telaga Menjer is good enough for the growth of phytoplankton. The average value of the highest water temperature is at Station 7 (outlet) of 24°C, because at Station 7 (outlet) there are no trees that block sunlight from penetrating the waters.

Table 1 Data from Measurement of Physical Factors of Water Spatially at the Research Site

No.	Physical Factors Of Water	Station							Average
		1	2	3	4	5	6	7	
1	Water temperature	22	22	23	22	23	23	24	22.5
2	Brightness	165.8	180.75	152.65	106.33	167.91	169.83	158.5	15.4
3	TSS	70	83	91	85	93	106	118	92.29
4	TDS	192	193	181	217	237	202	212	205.14

Measurement of Physical Factors in Temporal Waters at the Research Site was represented in Table 2. Temporally, the average value of the highest water temperature is in the 1st month of 23°C. The high water temperature in the 1st Month is due to the time of measurement in the field the weather is more hot when compared to the 2nd and 3rd month.

Table 2 Data from Measurement of Physical Factors in Temporal Waters at the Research Site

No.	Physical Factors Of Water	Month			Average
		1	2	3	
1	Water temperature	23	22	22	22
2	Brightness	202.78	116.42	153	157.4
3	TSS	89.71	95.43	92.72	92.62
4	TDS	234.71	200.86	179.86	205.14

According to Maresi et al. (2015), the optimum temperature for phytoplankton growth in a body of water ranges from 20-30°C, while according to Lantang & Pakidi (2015), the optimum temperature for phytoplankton growth ranges from 25-32°C. According to Marhana et al. (2019), that the water temperature below 16°C can result in a decrease in phytoplankton growth, while the temperature above 36°C can result in the occurrence of death in certain types of phytoplankton.The brightness measurement results in Telaga Menjer spatially ranged from 158.5 to 180.75 cm. The brightness range in Telaga Menjer is good enough for phytoplankton growth. According to Gurning et al. (2020), that the optimum brightness value is good for phytoplankton growth is > 45 cm. The highest brightness value is at Station 2 (floating net cage) of 180.75 cm. The high value of brightness at Station 2, because at station 2 there is no turbidity, so at this station has a high level of brightness. The higher brightness value can increase the abundance of phytoplankton in a water because more sunlight penetrates into a water so that phytoplankton is active for photosynthesizing (Ramadhan & Yusanti, 2020). Temporarily, the average value of the highest brightness is in the 1st month of 202.78 cm. The high brightness value in the 1st Month is due to having low TSS levels when compared to the 2nd and 3rd months. TSS value in an increasingly low waters can lead to high brightness value (Manurung et al., 2015). Brightness in a water is characterized by the ability of an intensity of sunlight to penetrate a water (Gurning et al., 2020). Brightness in a water is influenced by the number of dissolved particles and suspended particles. Higher numbers of dissolved particles or suspended particles can cause low brightness in a water (Sartimbul et al., 2021).

The measurement of total Suspended Solid (TSS) spatially in Telaga Menjer ranged from 70-118 $mg.L^{-1}$. The highest average TSS content is at Station 6 (inlet) 106 $mg.L^{-1}$ and Station 7 (outlet) 118 $mg.L^{-1}$. The high level of TSS at Station 6 is because the station is the inflow of water that gets suspended particles carried from the Serayu River. The high level of TSS at Station 7 is due to the area close to the hydroelectric power plant which causes large water flows so that mud and sand are carried to the outlet area. Temporarily, TSS levels are highest in the 2nd month. The high level of TSS in the 2nd month is due to the measurement of the incoming water flow from the Serayu River is greater when compared to the 1st and 3rd months, so that more get the input of suspended particles carried from the Serayu River. Based on PP number 22 of 2021 Regarding Class III water quality standards, the maximum threshold value of TSS is 100 $mg.L^{-1}$. TSS levels at stations 6 and 7 exceeded the required threshold value, while at other stations TSS levels were below the required quality standard threshold. TSS is a suspended solid that can result in turbidity of water. Mud, fine sand and small bodies are materials from the Total Suspended Solid (TSS) that can potentially inhibit the brightness that goes into the waters. This can interfere with phytoplankton in carrying out photosynthetic activity so that it can result in the condition of a water is declining (Laili et al., 2020).

The measurement results of total Dissolved Solid (TDS) spatially in Telaga Menjer ranged from 181-237 $mg.L^{-1}$. The highest TDS level is at Station 5 (spring source) of 237 $mg.L^{-1}$. The high levels of TDS at Station 5 because the station is close to the agricultural area so that it gets input of organic waste which then settles at Station 5. Temporarily, the highest TDs value is in the 1st month. High levels of TDS come from agricultural waste and livestock waste which then settles so that the levels of TDS in high waters. The value of dissolved solids in Telaga Menjer Waters is still below the required quality standard threshold, thus Telaga Menjer waters are good for phytoplankton growth. Total Dissolved Solid (TDS) is sourced from household waste, industry and agricultural overflow. Based on PP number 22 of 2021 Regarding Class III water quality standards, the maximum threshold value of Total Dissolved Solid (TDS) is 1000 $mg.L^{-1}$. The value of TDS in a water greatly affects the abundance of phytoplankton. The abundance of phytoplankton will increase if the TDS levels are low because sunlight is able to penetrate into the waters so that phytoplankton can perform photosynthesis well (Andriani et al., 2015).

Based on the results of phytoplankton observations in Telaga Menjer were 6 species obtained spatially (Table 3.) and temporarilly (Table 4.).

Table 3 Average Abundance of Phytoplankton Species in Telaga Menjer Wonosobo (Spatial)

No.	Species	Station							Average
		1	2	3	4	5	6	7	
1	*Ceratium* sp.	0	0	0	2.1	0	27.5	0	4.229
2	*Dictyosphaerium pulcellum*	2.133	0	0	0	0	0	4.16	0.899
3	*Microcystis aeruginosa*	291	207.6	308.2	379.9	423	81.1	111.7	256,214
4	*Microspora* sp.	13,81	0	0	0	0	25.7	0	5.644
5	*Nitzschia* sp.	225.7	126.3	564.5	182.8	310	9.87	107.9	218.152
6	*Pediastrum* sp.	0	0	0	1.387	1.39	0	1.387	0.594

The highest abundance of phytoplankton was *Microcystis aeruginosa*. It was found in such a large number of colonies. According to Wijayanti *et al*. (2021), that *M. aeruginosa* consists of small cells and does not have individual membranes, so its cells are arranged into large colonies that can be seen with the naked eye. *M. aeruginosa* is a unicellular phytoplankton that can cause blooming. Blooming *M. aeruginosa* can be caused by environmental factors, one of which is by seasonal temperature changes. Spatially the highest abundance of *M. aeruginosa* is at Station 4 (the middle of the lake) of 379.9 colonies/ml. The abundance at Station 4 is higher because at Station 4 it has low TSS levels so that sunlight can penetrate into the body of water perfectly.

According to Retnaningdyah *et al*. (2011), *M. aeruginosa* can grow quickly and bloom in summer conditions and nutrient-rich waters. *M. aeruginosa* is a phytoplankton that is most commonly found in fresh waters with warm temperatures and is cosmopolitan. In addition, *M. aeruginosa* also has mucus that is disliked by other aquatic organisms (Alina *et al*., 2015). According to Almanza *et al*. (2016), when on the surface of the waters formed layer by *M. aeruginosa* in a water, then the abundance of *M. aeruginosa* is more dominant than other types of phytoplankton, there is competition in obtaining light.

The highest average phytoplankton abundance in the waters of Telaga Menjer, Wonosobo is *Microcystis aeruginosa*. The species with the lowest abundance in the 1st Month were *Ceratium* sp. *Dictyosphaerium pulchellum*, and *Pediastrum* sp. with an abundance index value of 0. The lowest abundance index value in the 2nd month is *Ceratium* sp. and *Microspora* sp. with an abundance index value of 0. The lowest abundance index value in September is *Microspora* sp. and *Pediastrum* sp. with a value of 0 (Table 4.). The low abundance of phytoplankton is caused by physical factors of water and human activities, because Telaga Menjer is a tourist location and functioned as a Garung hydropower (PLTA).

The next highest phytoplankton abundance that can be calculated individually is found in the Bacillariophyceae class, *Nitzschia* sp. at station 3, with a value of 564.5 ind.ml^{-1}. The abundance at station 3 is higher because the station is an agricultural area, there are nutrients such as nitrogen and phosphorus that can support the growth of phytoplankton. In addition, at station 3 it has a low TDS value, so that light can penetrate into the waters. High abundance of the Bacillariophyceae class because phytoplankton of the Bacillariophyceae class are highly adaptable to the environment. According to Cahyaningtyas *et al*. (2013), phytoplankton of the Bacillariophyceae class are well adaptable and can grow quickly despite low light and nutrient conditions. Pamrayoga & Soeprobowati (2016), added that phytoplankton from Bacillariophyceae class are cosmopolitan and able to live in extreme aquatic environments and can adapt to environmental changes such as temperature, pH and do levels. Based on the results of research in the same location by Sulawesty *et al*. (2021), the result of abundance in Telaga Menjer is the highest in the Bacillariophyceae class ranging from 88.39-99.08% which indicates that the lake is included in eutrophic lakes.

Temporally, the abundance of phytoplankton tends to increase during the sampling period (Table 4). The lowest phytoplankton abundance is in the 1st month and then increases in the 2nd and 3rd months. The 2nd and 3rd months are the peak of the dry season and in that period the hydropower (PLTA) is not operated, so there is a chance of increasing phytoplankton abundance.

Table 4 Average Abundance of Phytoplankton Species in Lake Menjer Wonosobo (Temporal)

No.	**Spesies**	**Bulan**			**Rata-rata**
		1	2	3	
1	*Ceratium* sp.	0	0	12.68	4.23
2	*Dictyosphaerium pulcellum*	0	1.783	0.9	0.894
3	*Microcystis aeruginosa*	29.6	181.9	210	140.5
4	*Microspora* sp.	16.91	0	0	5.64
5	*Nitzschia* sp.	142.9	268.6	280	230.5
6	*Pediastrum* sp.	0	1.783	0	0.594
	TOTAL	189.4	454.066	503.58	382.354

When compared with research previously by Pamrayoga & Soeprobowati (2016), 12 species are included into 4 divisions in the waters of Lake Menjer Wonosobo. Some species not found in previous studies are *Ceratium* sp., *Dictyosphaerium pulchellum*, *Microspora* sp., and *Pediastrum* sp.. Phytoplankton that were not found in this study but were found in previous studies are *Denticula tenuis, Synedra ulna, Aulacoseira granulata, diatoma vulgaris, Lyngbya, Lyngbya, Calothrix, Stigeoclonium* and *Lingulodinium polyedrum*.

Nitzschia sp. it is a single-celled phytoplankton and belongs to the Bacillariophyceae class, which is found to be the second largest number of individuals after *Microcystis aeruginosa*. Species *Nitzschia* sp. found as much as 931 ind.ml^{-1}. Spatially, *Nitzschia* sp. found the most number of individuals at Station 3 (agricultural Area) as much as 323 ind.ml^{-1}. *Nitzschia* sp. found most in Station 3 because the station is an agricultural area, there are nutrients such as nitrogen and phosphorus that can support the growth of phytoplankton. In addition, at Station 3 it has a low TDS value, so that light can penetrate into the waters. *Nitzschia* sp. able to live at temperatures below 25°C. The water temperature in the waters of Telaga Menjer is ranging from 22-24°C. This is in accordance with the statement Ilhami et al. (2015), that *Nitzschia* sp. capable of menthol water temperature below 25°C. Awal et al. (2014), stated that *Nitzschia* sp. it is easy to adapt to a water, especially in polluted waters. Tarigas et al. (2020), added that *Nitzschia* sp. it has a very fast growth because it is able to adapt to extreme environmental changes and is often found in every water so that it can be used as a biological indicator of water pollution. *Nitzschia* sp. it acts as a major producer in the waters because it can be consumed directly by various types of organisms from heterotrophic Dinoflagellates and plankton-eating fish. *Nitzschia* sp. it is a diatom that has an elongated cell shape and at each end there is a long setae, has a cell size that ranges from 10-40 μm and the cell wall is thin. *Nitzschia* sp. in its growth is influenced by environmental factors including temperature, light, water pH, osmotic pressure, and salinity (Puspitasari, 2017).

Microcystis aeruginosa is a blue-green alga that belongs to the class of Cyanobacteria found in quite a number of colonies in the waters of Lake Menjer so that it cannot be counted as the number of individuals. Species *M. aeruginosa* found as many as 572 colonies/ml. Spatially, *M. aeruginosa* found the most number of colonies at Station 4 (the middle of the lake) as many as 268 colonies/ml. *M. aeruginosa* is found most in Station 4 because it has low TSS levels so that sunlight can penetrate into the body of water perfectly. *M. aeruginosa* can grow quickly and is a major producer. M. aeruginosa also predominates at the research site, in addition to Nitzschia sp., *M. aeruginosa* can grow quickly or bloom in subtropical areas in summer conditions. *M. aeruginosa* in a blooming state can produce toxins in the form of microcystins that are toxic to animals and plants and can cause death. *M. aeruginosa* in its growth is strongly influenced by the intensity of sunlight and the duration of irradiation. Phytoplankton of the Cyanobacteria class are common in the middle of the dry season and with high light intensity (Retnaningdyah et al., 2011). According to Mohan et al. (2020), *M. aeruginosa* is generally 5-7 mm in size. According to Sulastri et al. (2019), that *M. aeruginosa* can grow optimally at temperatures close to 30°C. According to. Putri & Triajie (2021), phytoplankton from the Cyanophyta division can be used as an indicator of dirty and polluted waters, so it is usually most commonly found in heavily polluted waters where there is waste disposal both household waste and industrial waste so that there is less sunlight.

Pediastrum sp. belonging to the Chlorophyceae class, the least number of individuals found in the waters of Telaga Menjer is as much as 3 ind.ml^{-1}. *Pediastrum* sp. only found at Station 4 (central lake) 1 ind.ml^{-1}, 5 (spring source) 1 ind.ml^{-1}, and 7 (outlet) 1 ind.ml^{-1}. Species *Pediastrum* sp. at station 4 only found 1 ind/ml because at this station is dominated by *M. aeruginosa*, at station 5 only found 1 ind.ml^{-1} because at station 5 has high levels of TDS and at station 7 only found 1 ind.ml^{-1} because at this station has high levels of TSS, so that less optimal light penetrates into the body of water. Harmoko et al. (2017), tates that phytoplankton of the Chlorophyceae class require more light to photosynthesize compared to other classes. According to Muhammad & Yusminah (2012) phytoplankton of the Chlorophyceae class has characteristics that are unicellular, chain, live in colonies, green and hover on the surface so that it is able to photosynthesize.

Ceratium sp. including the type of Dinoflagellata found in quite a small number of individuals in the waters of Telaga Menjer that is as much as 14 ind.ml^{-1}. *Ceratium* sp. found the most number of individuals at station 6 (inlet) as much as 13 ind.ml^{-1}, because at station 6 more water input from the Serayu River and there are nutrients carried from the Serayu River. *Ceratium* sp. it is a phytoplankton that has a single cell and belongs to heterotrophic organisms. Genus *Ceratium* does not produce toxins, but in the event of blooming can cause mass death in other organisms to occur red tide if the aquatic environment is favorable for its growth (Gurnning et al., 2020).

Table 5 Dominance index of Phytoplankton (spatial)

Station	Dominance Index
1	0.6818
2	0.6510
3	0.7683
4	0.8562
5	0.9751
6	0.7275
7	0.6086

Dictyosphaerium pulchellum is a phytoplankton belonging to the Class of Chlorophyceae which found a small number of individuals in the waters of Telaga Menjer that is as much as 4 ind.ml^{-1}. *Dictyosphaerium pulchellum* found the most number of individuals at Station 7 (outlet) as much as 3 ind.ml^{-1}. *Dictyosphaerium pulchellum* was found in small quantities because the temperature at the study site was insufficient for the growth of *Dictyosphaerium pulchellum*. The temperature in the waters of Telaga Menjer ranges from 22-24°C. According to Sulastri (2018), *Dictyosphaerium pulchellum* lives at a temperature of 29.07°C and its habitat is in meso-eutrophic deep lake waters. The *Dictyosphaerium pulchellum* is 1-10 μm in size and has cells that form colonies, rounded or irregular. *Microspora* sp. it is a phytoplankton that belongs to the Chlorophyceae class. *Microspora* sp. found as much as 20 ind.ml^{-1}. *Microspora* sp. only found at station 1 (tourism area) 7 ind.ml^{-1} and station 6 (inlet) 13 ind.ml^{-1}, because station 1 has low TSS levels and station 6 has an optimal water temperature. *Microspora* sp. the filamentous form is unbranched and has cylindrical cells, the length is 15-20 μm and the width is 17 μm (Harmoko & Sepriyaningsih, 2020).

Dominance index value obtained from the results of research in Telaga Menjer, Wonosobo shows a value that varies at each station and month (Table 5.). The average value of the highest dominance index is in the 2nd month with a value of 0.8672, while the lowest dominance index is in September of 0.6708.

Table 6 Dominance index of Phytoplankton (Temporal)

Month	Dominance Index
1	0.7199
2	0.8672
3	0.6708

Spatially dominance index values ranged from 0.6086 to 0.9751. The highest dominance index is at station 5 (spring source) of 0.9751 which indicates that at the station there is a type of phytoplankton that dominates. Temporarily the value of the dominance index in the 1st, 2nd, and 3rd months were 0.7199, 0.8672, and 0.6708 respectively. The three dominance index values indicate the type of phytoplankton that dominates because the dominance index value is close to 1.

It can be concluded that in Telaga Menjer Wonosobo dominance occurred. According to Munandar et al. (2016), dominance index value that is close to 0 ($C < 0.5$) indicates the absence of the type of phytoplankton that dominates. Dominance index value that is close to 1 ($C > 0.5$) indicates that the presence of the type of phytoplankton that dominates.

Based on the results of analysis using PCA (Principal Component Analysis) in XLSTAT software spatially and temporally shows the relationship between physical factors with the abundance of phytoplankton in Telaga Menjer, Wonosobo, obtained a graph that produces two axes constituent of the main component with a total contribution of 66.96%, it can be interpreted that the environmental characteristics of physical factors have an influence on all observation stations by 66.96% (figure 1.). Physical factors that are taken into account are temperature, brightness, TDS and TSS.

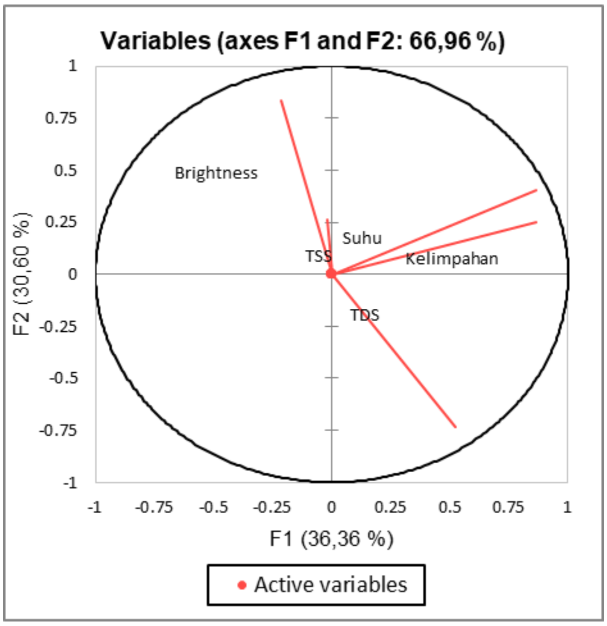

Figure 1 Results of analysis of the relationship of Aquatic physical factors with phytoplankton abundance (PCA)

The presence of phytoplankton abundance is positively correlated with temperature and TDS. This shows that temperature and TDS affect the abundance of phytoplankton. The higher the water temperature and TDS levels, the higher the phytoplankton abundance. The correlation of brightness and TSS to phytoplankton abundance showed a negative correlation. This shows that TSS levels and brightness are inversely proportional to phytoplankton abundance. TSS levels and increased brightness can decrease phytoplankton abundance. Conversely, low levels of TSS and brightness can increase the abundance of phytoplankton. The correlation coefficient between the physical factors of waters and abundance can be seen in (Table 4.5.).

Table 5 Correlation coefficient of Principal Component Analysis (PCA) in Telaga Menjer Wonosobo

Physical Factors Of Waters	Correlation Coefficient	Interpretation
water temperature	0.728	Strong
Brightness	-0.096	Uncorrelated
TDS	0.123	Very weak
TSS	-0.052	Uncorrelated

The relationship between temperature and phytoplankton abundance showed a strong correlation of 0.728. Temperature is a physical factor with a high correlation value. This shows that the abundance of phytoplankton in the waters of Telaga Menjer, Wonosobo is more influenced by the temperature of the waters. Samudera *et al.* (2021), states that if the temperature concentration increases, the abundance of phytoplankton will also increase. The relationship between TDS with phytoplankton abundance is positive with a correlation value of 0.123 which indicates that the correlation level is very weak. According to Novia *et al.* (2016), the increasing TDS value can reduce the abundance of plankton in water. High levels of TDS can also inhibit the brightness into the waters and can lead to disruption of the process of photosynthesis. The correlation between brightness and abundance of phytoplankton is negative with a value of -0.096. According to Novia *et al.* (2016), if the brightness increases, the abundance of phytoplankton will increase. The correlation between TSS and phytoplankton abundance is negative with a value of -0.052. High TSS levels can affect the process of photosynthesis and can reduce the abundance of phytoplankton, conversely low TSS levels can increase the abundance of phytoplankton (Mayagitha & Rudiyanti, 2014).

4. Conclusion

Based on the results of research conducted, it can be concluded that: the condition of physical factors in the waters of Telaga Menjer, Wonosobo is quite good because it does not exceed the optimum value standards for phytoplankton growth. Phytoplankton species found in Telaga menjer numbered 6 species. The highest abundance of phytoplankton and dominated in Telaga Menjer Lake was *M. aeruginosa*. Physical factors of water most influential on the abundance of phytoplankton in the waters of Telaga Menjer is the temperature with a correlation value of 0.728 which has a very strong correlation level. The suggestion of this study is, the presence of phytoplankton species that dominate in the waters of Telaga Menjer, namely *M. aeruginosa* feared to cause blooming, it is necessary to prevent blooming of this types of phytoplankton in these waters.

Compliance with ethical standards

Acknowledgments

This reseach was funded by Unsoed BLU with a contract No, T/524/UN23.16/PT.01.03/2022. A Great thanks to Dr. Dwi Nugroho Wibowo, M.S. as dean of the Faculty of Biology, University of Jenderal Sudirman on supporting everything so this research could be done smoothly.

Disclosure of conflict of interest

All authors of the manuscript have no conflict of interests to declare.

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