International Journal of Fisheries and Aquatic Studies

E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2021; 9(5): 39-44

www.fisheriesjournal.com
Received: 14-07-2021
Accepted: 21-08-2021

Rizka Aurelia
Department of Fisheries, Faculty of Fisheries and Marine Sciences, Padjadjaran University, Bandung-Sumedang KM 21, Jatinangor, Indonesia

Zahidah Hasan
Department of Fisheries, Faculty of Fisheries and Marine Sciences, Padjadjaran University, Bandung-Sumedang KM 21, Jatinangor, Indonesia

Iwang Gumilar dan Heti Herawati
Department of Fisheries, Faculty of Fisheries and Marine Sciences, Padjadjaran University, Bandung-Sumedang KM 21, Jatinangor, Indonesia

Corresponding Author:
Rizka Aurelia
Department of Fisheries, Faculty of Fisheries and Marine Sciences, Padjadjaran University, Bandung-Sumedang KM 21, Jatinangor, Indonesia

Composition and distribution of phytoplankton in Jatigede reservoir

Rizka Aurelia, Zahidah Hasan, Iwang Gumilar dan Heti Herawati

Abstract
The purpose of this study is to describe the distribution of phytoplankton in the form of maps both vertically and horizontally in Jatigede Reservoir. The study was conducted from August 2020 to March 2021. The method used in research is a survey method with a purposive sampling sampling technique. The highest abundance is in station 1 (reservoir inlet) and the lowest abundance is in station 6 (reservoir outlet), each on the surface, depth of half compensation and compensation. Phylum Pyrrophyta and class Dinophyceae make up the composition of the highest abundance of phytoplankton. Based on the order, Stephanodiscales with the genus Cyclotella became the highest constituents of the composition of abundance. The distribution of phytoplankton is evenly distributed at every station, except the phylum Chrysophyta which is only found at station 3.

Keywords: Jatigede reservoir, phytoplankton, distribution, composition, water quality

1. Introduction
Plankton are organisms that float or float in water. Its ability to move even if there is very limited until the organism is always carried away by the current. Plankton consist of phytoplankton and zooplankton. Zooplankton in aquatic ecosystems have an important role because zooplankton is the first consumer of phytoplankton that has a role to move energy from the primary producer of phytoplankton to even higher levels of consumers such as fish larvae, and small fish.
Phytoplankton is a primary producer that produces organic matter and oxygen that is beneficial to aquatic life (Nugroho 2006) [15]. Phytoplankton are generally dominant as primary producers in inundated aquatic ecosystems, including reservoirs (Zahidah 2020) [32]. Phytoplankton have a very rapid response to environmental changes, both physical and chemical changes in water so that environmental changes can affect the composition and distribution of phytoplankton both vertically and horizontally in the waters.
Factors that affect the spread of phytoplankton include current, nutrient content, temperature, light, brightness, pH, turbidity, and diurnal migration of plankton themselves (Sediadi 2004) [25]. The distribution of phytoplankton is heavily influenced by factors that affect its productivity, such as light, DO, nutrients, temperature, and other factors. While the horizontal distribution of phytoplankton is more influenced by physical factors such as the movement of water masses and water currents.
Phytoplankton in reservoir waters tend to be dominated by the types of Chlorophyceae, Cyanophyceae and Bacillariophyceae (Seller and Markland 1987 in Nurruhwati *et al*. 2017) [16]. The dominance of a type of phytoplankton in a body of water is determined by the comparison of the types of nutrients dissolved in a body of water. This is because each type of phytoplankton has a different response to the comparison of nutrient types (Mujiyanto 2008) [11].
Jatigede Reservoir is located in West Java province, Sumedang Regency, with a water capacity of 980,000,000m3 (Purnama 2015) [19]. Jatigede Reservoir is built as a multifunctional reservoir, among others as irrigation, clean water providers, flood controllers, tourism objects, and is planned as a place for hydroelectric power plants (PLTA) (Djuwendah *et al*. 2017) [2]. The existence of phytoplankton in Jatigede Reservoir needs to be known as a supporter of the management of Jatigede Reservoir, so that the utilization of reservoirs can be done in the long term.

Materials and Methods

The research was conducted from August 2020 to March 2021. The method used in research is the survey method. The sample determination technique used in this study is purposive sampling, which is a sample determination technique used with certain considerations (Siyoto and Sodik 2015) [28]. Water and phytoplankton sampling is conducted at 3 depths (surface, half compensation and compensation) from 6 stations based on input water from major streams and tributaries and represents each zone in Jatigede Reservoir (Figure 1), so as to describe the spread of phytoplankton vertically and horizontally. An explanation of the characteristics of each sampling station is described in Table 1.

Measurement of the physical, chemical and biological parameters of the waters is carried out directly (insitu), including measurement of temperature, transparency, current, pH, Dissolved Oxygen (DO) and carbondioxide (CO_2).

While the calculation of nitrate, ammonia, phosphate and phytoplankton identification is carried out exclusively at the Laboratory of Water Resources Management, Faculty of Fisheries and Marine Sciences, Universitas Padjadjaran.

2.1 Plankton Abundance

Calculation of phytoplankton abundance is done using counting chambers and observed with binocular microscopes. The abundance of phytoplankton was analyzed using the formula Sachlan (1982) in (Hidayat *et al*. 2015) [6].

$$N = n \times \frac{Vr}{Vo} \times \frac{1}{Vs}$$

Information

N = Abundance of phytoplankton (ind/L)
n = Number of phytoplankton Unidentified
Vr =Filtered phytoplankton volume (50ml)
Vo = Observed volume of plankton (1ml)
Vs = Volume of filtered water (L) (10L)

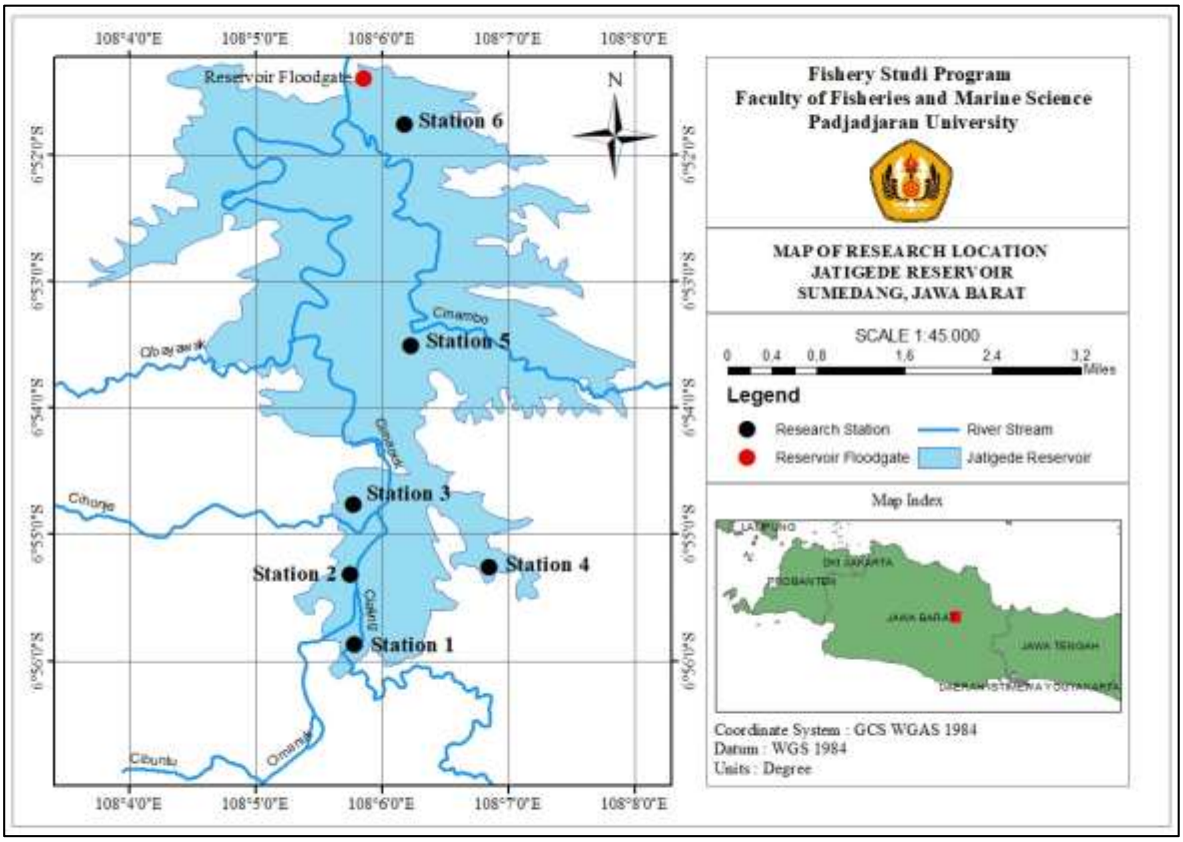

Fig 1: Station Map

Table 1: Description of Sampling Station

Location	Description
Station 1	The main inlet, which is sourced from the Cimanuk River, Cialing River and Cibuntu River, is a riverine zone.
Station 2	The location of the water comes from two small rivers, namely the Cimuja River and the Cijajaway River.
Station 3	The transition zone with water input comes from the Cihonje River, Cimuja River and Cacaban River. Many found floating nets (KJA).
Station 4	The estuary of the Cacaban River and the beginning entered the flooded zone. At this location was found Keramba Jaring Buung (KJA) and close to the settlement of residents.
Station 5	Representing the inundated zone (lacustrine)
Station 6	It is a reservoir outlet

Results and Discussion

Based on the results of measurements, the average water temperature of Jatigede Reservoir ranges from 26.6°C - 29.7°C and is suitable for phytoplankton life. Photosynthetic processes can occur at intervals between 25°C to 40°C and the good temperature range for phytoplankton life is between 20-30°C (Fogg 1965 in Faiqoh 2009) [4]. The temperature value at all stations decreases as the depth increases. Laevastu and Hayes (1981) in Wilhelmina & Arumingkeng (2007) [31] explained that calm water conditions cause heat energy from solar radiation to enter continuously and result in water temperatures near the surface higher and will form temperature stratification.

The highest transparency value is at station 6 (reservoir outlet) of 106 ± 23.46 cm. Laili *et al*. (2020) [9] states that the higher the turbidity of the waters caused by suspended solids, the lower the transparency because it causes less penetration of light that penetrates the water column. While station 2 has a murier water color because of the water input from two small rivers, namely the Cimuja River and the Cijajaway River. The water input brings suspended solids thus lowering the average value of transparency to 70.5 ± 19.35 cm. Asmawi (1995) in Sofarini *et al*. (2012) [29] which stated that the minimum transparency value for the life of aquatic organisms is more than 45 cm.

The value of the current speed range in Jatigede Reservoir is ranging from 0.08 m/s to 0.83 m/s which affects the distribution of phytoplankton. The average highest current speed is at station 1 which is 0.5 ± 0.365 m/s and the lowest current speed is at station 2 which has a value of 0.11 ± 0.014 m/s. Both stations are included in the riverine zone, which is affected by the main river current, the Cimanuk River. However, due to the distance of the station that is not adjacent and station 2 will enter the transition zone causes the current to slow down. The wind that blows at station 2 is also not too strong because it is surrounded by lush trees, while wind gusts are blocked and do not have a big impact on the movement of water currents.

Measurements of Dissolved Oxygen (DO) in Jatigede Reservoir have values ranging from 3.0 to 6.7 mg/L. Stations 1 to 6 have a higher concentration of DO on surface and decrease in depth. Siagian & Simarmata (2015) [26] explains that on the surface, do concentrations are higher due to air diffusion and photosynthetic processes. According to Puspitaningrum *et al*. (2012) [21], the process of respiration of aquatic plants and animals and decomposition of organic matter can cause reduced oxygen in a water. This statement is evidenced by the phenomenon of DO decrease that occurs at station 3 which contains floating net cultivation activities (KJA) causing more respiration processes to occur, either by aquatic organisms or microorganisms in the process of decomposition of organic matter from the rest of the feed and fish feces.

Based on observations at six stations, the average value of the CO_2 range is 13.22 ± 3.15 mg/L to 7.64 ± 4.9 mg/L. According to Zonneveld (1991) in Prasetyaningtyas (2012) [17], in waters containing dissolved carbon dioxide of more than 2 mg/L can provide optimal phytoplankton life. The ongoing activity of photosynthesis by phytoplankton and plants in the waters is a major factor in the decline in the value of CO_2, especially on the surface. The increase in CO_2 can be due to the process of respiration carried out by aquatic organisms and the decomposition process by microbes at each station and every depth. According to Andriany *et al*. (2018) [1], microbial activity in the process of decomposition or decomposition of organic matter will produce CO2.

Overall, the value of the pH range of Jatigede Reservoir ranges from 6.96-7.45 which means jatigede reservoir has a pH suitable for phytoplankton life. According to Effendi (2003) [3], phytoplankton will photosynthesize well at a neutral pH of about pH 6 – 8. Decreased pH values can occur due to high photosynthetic processes, especially on the surface, thereby decreasing co2 concentrations. While the decrease in pH can be caused by increased microbial activity to decompose organic matter, so O2 decreases and CO2 increases. Frasewi *et al*. (2013) explain that the presence of carbon dioxide affects pH fluctuations in the waters, the higher the carbon dioxide, the lower the pH.

Nitrate measurement values during the study ranged from 0.007 mg/L to 0.044 mg/L. These values have not been able to provide optimal phytoplankton growth support according to Macketum (1969) in Marlian (2016) [10], for optimal growth phytoplankton requires nitrate content in the range of 0.9 – 3.5 mg / L. Nitrates in water come from various sources, including organic waste, domestic waste, industrial waste, livestock waste, and fertilizers, so as to affect nitrate fluctuations (Hendrawati *et al*. 2008) [5]. In addition, nitrate consumption by photosynthesize organisms such as phytoplankton and aquatic plants is also a factor in nitrate fluctuations. Nitrate is needed in the process of photosynthesis phytoplankton because it can serve to accelerate growth and development, because basically nitrogen is used by organisms for the process of protein synthesis (Mustofa 2015) [12].

In addition to nitrates, ammonia is one form of inorganic nitrogen in waters that is very easy to find. Ammonia measurement results in Jatigede Reservoir have an average range value from 0.0019 mg / L to 0.0029 mg / L. The increase in ammonia value in Jatigede Reservoir can be caused by the decomposition process of organic matter and the rest of the metabolism of aquatic organisms (ammonification) that will release ammonia into the waters (Purwata 2010) [20]. While the decrease in ammonia value is due to the nitrification process that takes place aerobically and the utilization of ammonia by phytoplankton for photosynthesis. Although it has been explained that nitrate is an important nutrient needed for photosynthesis, according to Rasit (2016), ammonia is preferred over nitrate as a source of N for phytoplankton, this is because the utilization of ammonia requires less energy than nitrate.

Phosphate measurements in Jatigede Reservoir have an average value range of 0.090 mg/L to 0.106 mg/L. Phosphates in the waters are utilized by phytoplankton and play a role in energy transfer in cells. According to Sidaningrat *et al*. (2018) [27], the optimum phosphate concentration for phytoplankton growth is 0.09-1.80 mg/L. Most phosphate sources in the waters are waste, both industrial, agricultural in the form of fertilizers and domestic waste, namely detergent (Indaryanto 2015) [7]. In addition, KJA activities in Jatigede Reservoir are also a contributor to phosphate concentrations. According to Nugroho *et al*. (2014) [14], feed is given in cultivation activities in the form of pellet feed containing phosphate. The feed given jugs is not all consumed by fish, but 10-15% will fall towards the bottom of the water, it will dissolve or settle so that it releases phosphate elements into the waters of the lake.

Phytoplankton Abundance

The abundance of phytoplankton in Jatigede Reservoir can be seen in Figure 2. The highest abundance is found at station 1 (reservoir inlet) each on the surface, the depth of half compensation and the depth of compensation which is consecutive as much as 59817 ind/L; 46202 ind/L; and 33795 ind/L. While the lowest abundance is at station 6 (reservoir outlet) at each depth, which is as much as 20134 ind/L on the surface, 20576 ind/L at half-compensation depth and 13739 ind/L in compensation depth. This can be due to differences in nutrient concentration. Nutrients in reservoir outlets tend to be lower because they have been used and segmented at previous stations (Nurruhwati *et al*. 2017) [16].

Station 1 in particular the surface has an ammonia concentration of 0.0022 ± 0.001 mg/L, a nitrate concentration of 0.023 ± 0.004 mg/L, and has the highest phosphate concentration compared to other stations of 0.095 ±.020 mg/L. High abundances can occur because the ratio of phosphates to biomass is much more variable than the comparison of ammonia-like nitrogen and nitrate to aquatic organism biomass, including phytoplankton (Horne and Goldman 1994 in Indrayani *et al*. 2015) [8]. The increase and decrease in abundance that occurs in the inlet and outlet of Jatigede Reservoir is also affected by the current. In addition to bringing nutrients into the reservoir, the cimanuk river also carries phytoplankton into station 1. While station 6 as an outlet is a place for water outflow from inside the reservoir, so phytoplankton allows it to be carried outflow and decrease the abundance of phytoplankton (Priambodo 2015) [18].

Other factors that affect the distribution of phytoplankton abundance are the chemical physical condition of water, including CO_2, temperature, light intensity, and dissolved oxygen (Nirmalasari 2018) [13]. Most phytoplankton distributions have the same dispersal pattern, with the highest abundance on the surface decreasing in line with depth due to reduced intensity of light, temperature and dissolved oxygen. Carbon dioxide on the surface in Jatigede Reservoir shows a decrease which means that the process of photosynthesis is happening by utilizing carbondioxide.

According to Zahidah (2020) [32], the relationship of sunlight intensity is not always linear with primary productivity including phytoplankton. If the intensity of light is too high, it causes inhibition of photosynthesis, as well as what happens to phytoplankton at station 6 surfaces. Thus, the depth of half the compensation of station 6 is the best and most supportive environment for phytoplankton life to photosynthesize compared to the surface.

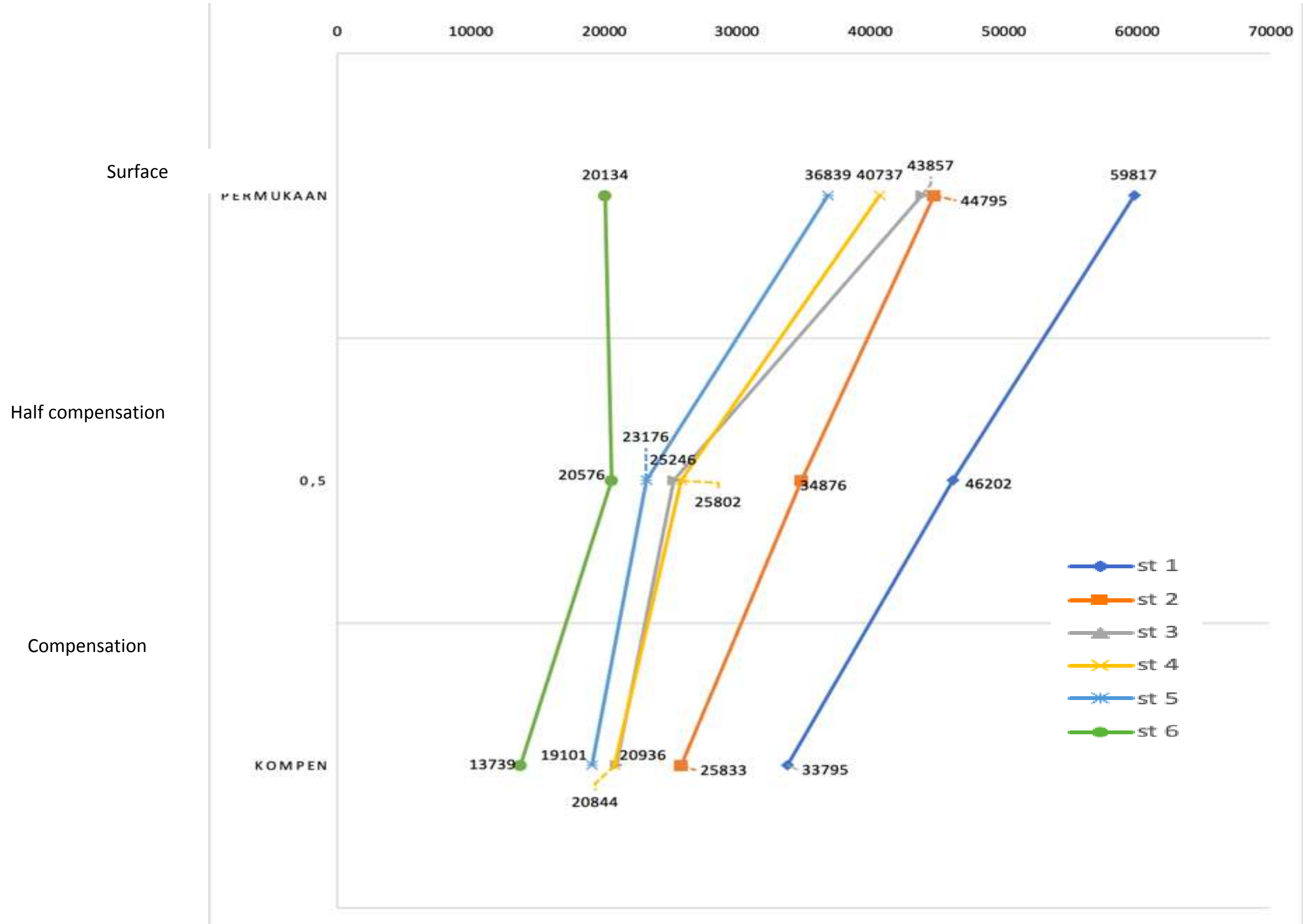

Fig 2: Phytoplankton Abundance in Jatigede Reservoir

Composition and Distribution Map of Phytoplankton

Phytoplankton identification results in Jatigede Reservoir found consisting of 6 phyla with 8 classes of phytoplankton, namely phylum Chlorophyta (2 classes; 6 orders; 18 genera), Chrysophyta (1 class; 1 order; 1 genus), Cyanophyta (1 class; 5 orders; 8 genera), Pyrrophyta (1 class; 2 orders; 2 genera), Bacillariophyta (2 classes; 5 orders; 5 genera), and euglenophyta phylum (1 class; 1 order; 3 genus). Based on the composition of abundance, the Phylum Pyrrophyta became the highest constituent in the composition of phytoplankton abundance as much as 40.74% and the Dinophyceae class also became the highest constituent as much as 40.92% compared to other classes. The high percentage of Pyrrophyta phylum is due to pyrrophyta phylum, especially the Dinophyceae class has a high tolerance to changes in nutrient variation so that it is able to compete with other phytoplankton (Saddam *et al*. 2015) [23]. In addition, Sulawesty (2019) [30] also mentioned that Pyrrophyta can live in nutrient-poor environments though, because of the feeding methods used and the ability to move throughout the water column to get nutrients, thus becoming a more identified phylum.

The phylum Chrysophyta was identified at least 0.41%, with the only class being Coscinodiscophyceae making up only 0.43% of phytoplankton abundance composition by class. The decrease in abundance can be due to changes in aquatic conditions over time, thus affecting fluctuations in the physical and chemical factors of the waters as well as the pressures exerted by the phylum Pyrrophyta, a class of Dinophyceae, specifically the genus Peridinium. Because, explained by Rengefors and Legrand (2001) [22] that Peridinium has the ability to prevent other phytoplankton to grow with high biomass, so it is found abundant phytoplankton in tropical lakes. Such events can occur because peridinium can produce toxic allelophatic chemicals that can prevent the growth and even turn off other phytoplankton.

By order, the constituent composition of phytoplankton in the highest Jatigede Reservoir is the order Stephanodiscales at 25.08% with the genus Cyclotella. While the lowest composition of phytoplankton is the order Xanthophyceae incertae sedis by 0.02% with the genus Polyedrium. The high percentage of phytoplankton constituent composition in Jatigede Reservoir can occur due to the different ability of each order of phytoplankton to utilize available nutrients and the ability to tolerate the conditions of a water.

The spread of phytoplankton in Jatigede Reservoir is mapped based on the phylum identified in Figure 3. The presence of Pyrrophyta at each station indicates that its spread is evenly distributed. In addition to the phylum Pyrrophyta, the spread of phytoplankton phylum Bacillariophyta, Chlorophyta, Cyanophyta and Euglenophyta is also evenly distributed although it is not always the phytoplankton with the highest abundance at each station. Fluctuations in the abundance and spread of different phytoplankton at each station can be due to different aquatic environmental conditions, competition or competition in the utilization of nutrient resources and the presence of predation events in a water. Similarly, the phylum Chrysophyta, depicted with the fewest identified and uneven orange graphs. That is, in competition or competition for the utilization of nutrient resources in the waters, the phylum Chrysophyta cannot rival other phyla. This is supported by the statement Sarniati *et al*. (2017) [24], that the type found in a widely found in a water is the type of organism that is most capable of competition with other types in utilizing limited resources, such as nutrients.

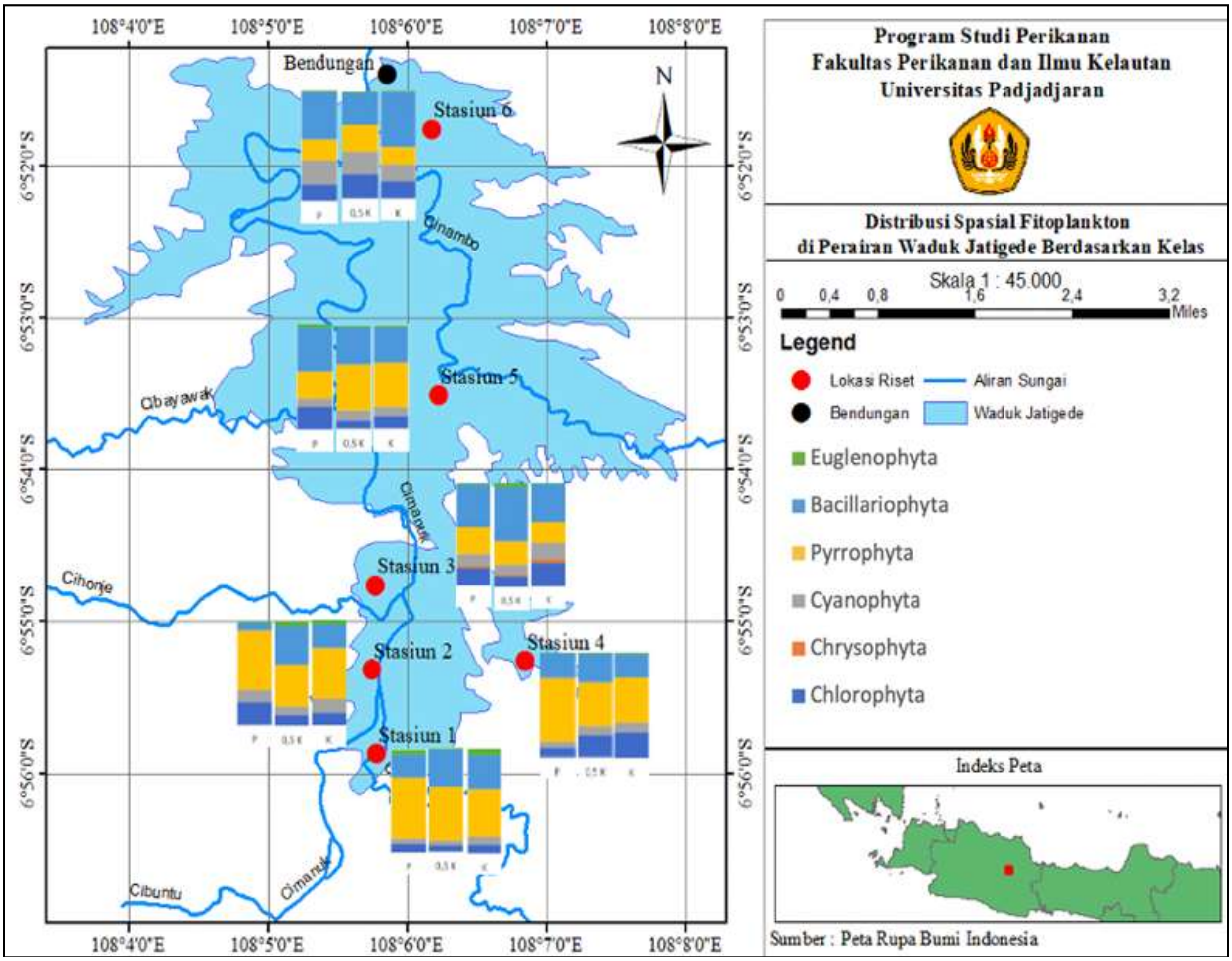

Fig 3: Map of Phytoplankton Distribution in Jatigede Reservoir

Conclusion

Based on the results of identification, phytoplankton in Jatigede Reservoir found 6 phyla with 8 classes and 20 orders. The composition of phytoplankton abundance by phylum, class and order is composed by the Phylum Pyrrophyta (40.74%), Class Dinophyceae (40.92%) and order Stephanodiscales with the genus Cyclotella (25.08%). In general, the condition of Jatigede Reservoir can still be tolerated by all phytoplankton phyla with an even distribution at each station.

References

1. Andriany A, Fahruddin F, Abdullah A. Pengaruh Jenis Bioaktivator Terhadap Laju Dekomposisi Seresah Daun Jati Tectona Grandis L.F., Di Wilayah Kampus Unhas Tamalanrea. Bioma : Jurnal Biologi Makassar 2018;3(2):31-42. Https://Doi.Org/10.20956/Bioma.V3i2.5820
2. Djuwendah E, Hapsari H, Deliana Y. Potential Ecotourism Based On Local Resources In The Jatigede Reservoir At Sumedang Regency. Paspalum 2017;5(2):51-59.
3. Effendi H. Telaah Kualitas Air Bagi Pengelolaan Sumber Daya Dan Lingkungan Perairan, Edisi 5, Penerbit Kanisius, Yogyakarta. In Kanisius 2003.
4. Faiqoh E. Kelimpahan Dan Distribusi Fitoplankton Serta

Hubungannya Fitoplankton Serta Hubungannya Dengan Kelimpahan Dan Distribusi Zooplankton Bulan Januari – Maret 2009 Di Teluk Hurun, Lampung Selatan. Universitas Indonesia 2009.
5. Hendrawati H, Prihadi TH, Rohmah NN. Analisis Kadar Phosfat Dan N-Nitrogen (Amonia, Nitrat, Nitrit) Pada Tambak Air Payau Akibat Rembesan Lumpur Lapindo Di Sidoarjo, Jawa Timur. Jurnal Kimia Valensi 2008. Https://Doi.Org/10.15408/Jkv.V1i3.223
6. Hidayat D, Elvyra R, Dan F. Keanekaragaman Plankton Di Danau Simbad Desa Pulau Birandang Kecamatan Kampar Timur Kabupaten Kamr Provinsi Riau. Jom Fmipa 2015;2(1).
7. Indaryanto F, Dan S. *Limnologi : Ilmu Tentang Perairan Darat.* Untirta Press 2015.
8. Indrayani E, Nitimulyo KH, Hadisusanto S, Rustadi R. Analisis Kandungan Nitrogen, Fosfor, Dan Karbon Organik Di Danau Sentani - Papua. Jurnal Manusia Dan Lingkungan 2015;22(2):217.
9. Laili S, Cahyono BE, Nugroho AT, Tegalboto K, Timur J, Solid TS. Analisis Kualitas Air Di Danau Batur Menggunakan Citra Landsat-8 Oli/Tirs Multitemporal. Jurnal Geodesi Dan Geodinamika 2020;3(1):71-79.
10. Marlian N. Analisis Variasi Konsentrasi Unsur Hara Nitrogen, Fosfat Dan Silikat (N, P Dan Si) Di Perairan Teluk Meulaboh Aceh Barat. Acta Aquatica: Aquatic Sciences Journal 2016. Https://Doi.Org/10.29103/Aa.V3i1.329
11. Mujiyanto. Beberapa jenis fitoplankton dominan di waduk Jatiluhur. Seminar Nasional Tahunan V. UGM 2008.
12. Mustofa A. Kandungan Nitrat Dan Pospat Sebagai Faktor Tingkat Kesuburan Perairan Pantai. Disprotek 2015;6(1):13-19.
13. Nirmalasari R. Analisis Kualitas Air Sungai Sebangau Pelabuhan Kereng Bengkiray Berdasarkan Keanekaragaman Dan Komposisi Fitoplankton. Jurnal Ilmu Alam Dan Lingkungan 2018;9(17):48-58.
14. Nugroho A, Tanjung D, Hendrarto B. Distribusi Serta Kandungan Nitrat Dan Fosfat Di Perairan Danau Rawa Pening. Bioma 2014;3(1):27-41.
15. Nugroho A. Bioindikator Kualitas Air. Universitas Trisakti 2006.
16. Nurruhwati I, Sahidin A. Kelimpahan Plankton Di Waduk Cirata Provinsi Jawa Barat Plankton Abundance At Cirata Reservoir West Java Province. Jurnal Akuatika Indonesia 2017;2(2):102-108. Https://Media.Neliti.Com/Media/Publications/243807-Kelimpahan-Plankton-Di-Waduk-Cirata-Prov-Ebf1d6c6.Pdf
17. Prasetyaningtyas T. Keanekaragaman Plankton Di Perairan Tambak Ikan 2012.
18. Priambodo AB. Kelimpahan Jenis Fitoplankton Di Inlet Dan Outlet Waduk Bening Sebagai Bahan Penyusun Media Pembelajaran Berbentuk Poster. Florea : Jurnal Biologi Dan Pembelajarannya 2015. Https://Doi.Org/10.25273/Florea.V2i1.404
19. Purnama Y. Dampak Pembangunan Waduk Jatigede Terhadap Kehidupan Sosial Budidaya Masyarakatnya. Patanjala : Jurnal Penelitian Sejarah Dan Budaya 2015;7(1), 131.Https://Doi.Org/10.30959/Patanjala.V7i1.89
20. Purwata J. Kajian Kualitas Air Kolam Ikan Bawal Pada Kelompok Pembudidaya Ikan (Kpi) Mina Mulya Tempelsari, Maguwoharjo, Depok, Sleman, D.I. Yogyakarta 2010, 1-10.
21. Puspitaningrum M, Izzati M, Haryanti S. Produksi Dan Konsumsi Oksigen Terlarut Oleh Beberapa Tumbuhan Air. Anatomi Dan Fisiologi 2012. Https://Doi.Org/10.14710/Baf.V12i1.4765
22. Rengefors K, Legrand C. Toxicity In Peridinium Aciculiferum - An Adaptive Strategy To Outcompete Other Winter Phytoplankton? Limnology And Oceanography 2001;46(8):1990-1997. Https://Doi.Org/10.4319/Lo.2001.46.8.1990
23. Saddam M, Ario D, Yusli W. Distribusi Spasial Dinoflagellata Plantonik Di Perairan Makassar, Sulawesi Selatan. Ilmu Dan Teknologi Kelautan Tropis 2015;7(2).
24. Sarniati Effendy IJ, Balubi AM, Kurnia A. Identifikasi Dan Kultur Jenis Diatom Epifit Dari Waring Keramba Budidaya Abalon. Media Akuatika 2017;2(2):377-389.
25. Sediadi A. Dominasi Cyanobacteria Pada Musim Peralihan Di Perairan Laut Banda Dan Sekitarnya. Makara of Science Series 2004;8(1). Https://Doi.Org/10.7454/Mss.V8i1.381
26. Siagian M, Simarmata A. Profil Vertikal Oksigen Terlarut Di Danau Oxbow Pinang Dalam, Desa Buluh Cina-Siak Hulu, Kabupaten Kampar, Provinsi Riau. Jurnal Akuatika Indonesia 2015;6(1):244-207.
27. Sidaningrat IGA, Arthana IW, Suryaningtyas EW. Tingkat Kesuburan Perairan Berdasarkan Kelimpahan Fitoplankton Di Danau Batur, Kintamani, Bali. Jurnal Metamorfosa 2018.
28. Siyoto S, Dan Sodik M. Dasar Metodologi Penelitian. Literasi Media Publishing 2015.
29. Sofarini D, Rahman A, Ridwan I. Permodelan Uji Logam Berat Pada Badan Air, Biota Dan Sedimen Di Perairan Muara Das Barito. Bumi Lestari 2012.
30. Sulawesty F. Phytoplankton Characteristics In Lake Matano, Indonesia. Iop Conference Series: Earth And Environmental Science 2019. Https://Doi.Org/10.1088/1755-1315/308/1/012072
31. Wilhelmina P, Arumingkeng A. Variasi Temporal Dari Penyebaran Suhu Di Muara Sungai Sario. Ilmu Kelautan: Indonesian Journal of Marine Sciences 2007. Https://Doi.Org/10.14710/Ik.Ijms.12.2.73-78
32. Zahidah. (2020). Produktivitas Perairan. Unpad Press