Eksakta : Berkala Ilmiah Bidang MIPA
VOLUME 25 NO 03 2024, pp 372-381
ISSN : Print 1411-3724 — Online 2549-7464
DOI : https://doi.org/10.24036/eksakta/vol25-iss03/341

Eksakta
Berkala Ilmiah Bidang MIPA
http://www.eksakta.ppj.unp.ac.id/index.php/eksakta

Estimation of Phytoplankton Density in Waters Kampar River Kampar District

Article Info

Article history :

Received September 21, 2022
Revised September 23, 2024
Accepted September 28,2024
Published September 30, 2024

Keywords :
Estimation,
phytoplankton density,
Kampar river

Marta Dinata[1*], Al Khudri Sembiring[1], Rahmat Ramadansur[1]

[1]Department of Biology Education, Faculty of Education and Vocation, Universitas Lancang Kuning, Pekanbaru, Indonesia

Abstract. The Kampar River is one of the rivers in the upper reaches that has caused pollution due to local communities such as excessive activity and gravel and sand mining. The purpose of this study was to determine the density of phytoplankton in the Kampar River in Koto Kampar Hulu Subdistrict, Kampar Regency. Purposive sampling was used to determine observation stations, which took into account habitat types and biological parameters observed such as species composition, abundance, and diversity index. The findings revealed that five classes of algae were discovered in Kampar Chlorophyceae, Cyanophyceae, Zygnematophyceae, Bacillariophyceae, and Xanthophyceae. The abundance of phytoplankton in the Kampar River's waters is classified as moderate fertility, ranging from 2,419.96 cells/liter to 3,629.96 cells/liter.

This is an open-access article under the CC-BY license.

This is an open-access article distributed under the Creative Commons 4.0 Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. ©2024 by author.

Corresponding Author :
Marta Dinata
Department of Biology Education, Faculty of Education and Vocation (FADIKSI),
Universitas Lancang Kuning, Pekanbaru,Riau, Indonesia
Email : martadinata@unilak.ac.id

1. Introduction

A river is a part of the earth's surface that is lower than the surrounding land and serves as a conduit for fresh water to flow into the sea, lake, swamp, or another river [1-2]. There is an ecosystem in the river ecosystem where biotic and abiotic factors interact. Water ecosystems, as part of natural resources, are inextricably linked to all aspects that arise. Excessive human use of rivers is very harmful to water, so the water ecosystem as a habitat for various types of water bodies changes dramatically [3-4]. Plankton is one of the organisms that have a habitat in rivers and can be classified based on their life forms or habits of life [5-6].

Planktons are animal or plant microorganisms that live floating or floating in water. Plankton diversity must be considered because the fertility level of the waters can be determined by the diversity of plankton owned by an aquatic ecosystem [7]. The presence of plankton in river water ecosystems is important for both the food chain and the flow of energy in ecosystems, such as phytoplankton, which is very influential on the life of aquatic organisms because their presence is very supportive of other aquatic organisms [8].

Phytoplankton are microscopic plant organisms that live floating, float in water, and have limited mobility, so their movements are influenced by the movement of water or currents, and have chlorophyll, which plays a role in photosynthesis to produce organic matter and oxygen in the water, which is used as the foundation for the chain in the food cycle in the waters [9-10].

Changes in water conditions can cause changes in the structure and density of phytoplankton, and these changes can be caused by natural and human factors in utilizing aquatic natural resources such as toilets, fisheries, and are also frequently used as transportation routes [11]. One of the villages in the Kampar Regency's Koto Kampar Hulu District is Koto Kampar Hulu. The Kampar River is a vital resource for the people who live in its vicinity.

This causes contamination of river water, which reduces water quality and damages the river ecosystem, resulting in a decrease in biological and animal resources as well as a decrease in organisms in the Kampar river. According to statement [12], human activities, nutrients, assimilation level, and oceanography are all factors that affect phytoplankton abundance and diversity [13]. The existence of phytoplankton is highly dependent on the aquatic environment's suitability for their existence [14]. Freshwater browning has less of an effect on planktonic invertebrate abundances than would be expected based on current knowledge of the biochemical activity of dissolved organic matter [15].

The multi-stressors that drive phytoplankton development in estuaries show that differences in salinity tolerances and physical processes (freshwater and particle transport, tidal amplitude, mixing processes, and upward/downward boundaries) feature in phytoplankton successions and magnitudes that are unique to each estuary [16]. However, the density of phytoplankton used as a bioindicator to detect changes in the aquatic environment is currently unclear and remains a major challenge.

According to [17], the extinction of a dominant species will result in significant changes not only in its biotic community but also in its physical environment. The dominance of a type of plankton can indicate that the waters are polluted or unfavorable, allowing only certain species to adapt to these conditions. According to [18], phytoplankton is one of the parameters of aquatic fertility. The goal of this study was to determine the density of phytoplankton in the waters of the Kampar River, Koto Kampar Hulu District, Kampar Regency, and whether it can be used as a bioindicator to detect changes in the aquatic environment.

2. Experimental Section

2.1. Sample and Population

Data collections were carried out at three points of Kampar River in Riau Province (Figure 1). This research was conducted for three months from November 2021 to May 2022.

Figure 1. Location of sampling for Phytoplankton in Kampar River, Yellow point Station 1, Green Point Station 2, and Black point Station 3. (photo taken from the site https://www.google.com/maps/place)

The survey method with purposive sampling was used in this study. This study was carried out in both the field and the laboratory. Planktonnet, plastic buckets, and glass bottles are used to collect phytoplankton samples. Water samples taken directly from the field are used. Physicochemical parameters are among the water parameters observed.

2.2 Data Collection Technique

2.2.1 Sampling Point

Determine the specified sample point, in addition to the DO value, based on the results of the research, but also on characteristics. Station 1 is Sibiruang Kampar Hulu (yellow point) (representing a sparsely populated area with a good air conditioner), and stations 2 and 3 are Kampar river (a representative of a crowded area and poor air conditions).

2.2.2 Environmental Parameter Measurement

Several physical and chemical parameters of water were calculated as supporting data and were carried out at each station concurrently with phytoplankton sampling. Current velocity (pumice stone and rope), temperature (thermometer), pH (pH meter), brightness (Secchi Disk), DO (DO meter), BOD (Lab), COD (Lab), phosphate and nitrate are among the parameters measured (Lab)

2.2.3 Phytoplankton Sampling

The Kampar Hulu River was sampled between 8 a.m. and 12 a.m. WIB. Surface water sampling is done. Methods Phytoplankton sampling is done using a horizontal sampling method called Plankton Net, which is drawn according to the distance we determined. The plankton net is thrown 5 meters, then the rope is slowly pulled. The reservoir bottle's filtered water sample was transferred to a storage bottle, and 250 ml of sample water was preserved with 1 ml of formalin. Each bottle is labeled with the station it belongs to. Each station is repeated three times.

2.2.4 Identification of Phytoplankton Samples

The phytoplankton sample was first homogenized, and then 1 ml was taken and placed in the SRCC, which was then sealed with a cover glass. The samples were examined under a 10x magnification microscope. The phytoplankton discovered were counted and documented and books are used for phytoplankton identification [19-21].

2.2.5 Laboratory Analysis

Phytoplankton samples were chopped in a Sedgwick-Rafter Cell, a rectangular glass preparation [22]. Phytoplankton found in the waters of the Kampar Hulu river was examined under a microscope and identified using books from [16][21]. Phytoplankton samples were identified to the genus level. The identification was completed at Universitas Lancang Kuning's Biology Laboratory.

2.3 Data Analysis Techniques

The obtained data can be used to calculate the density, diversity index, and species composition of phytoplankton [12] using the following formula:

$$F = \frac{T}{L} X \frac{Vo}{Vi} X \frac{1}{P} X \frac{1}{W} X\ N$$

The Shannon Winner formula is used to calculate the Diversity Index (H'):

$$H' = - \sum_{i=1}^{s} pi\ Ln\ pi$$

The Phytoplankton species composition was examined by counting the number of species and the number of individuals in each species, which were then classified.

$$Pi = \frac{ni}{N} \times 100\%$$

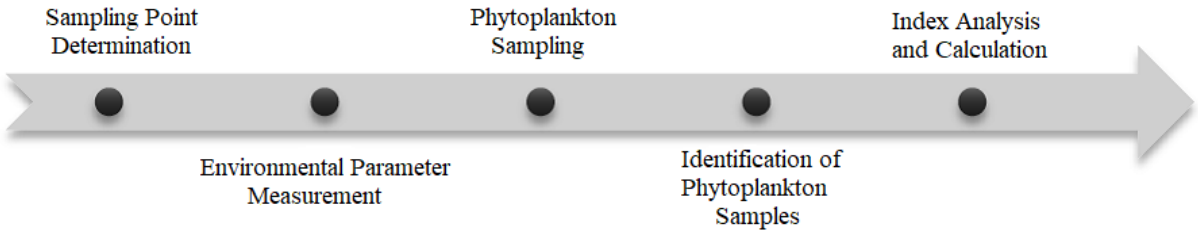

Figure 2. Research stages

3. Results and Discussion

Phytoplankton from five classes were discovered in the Kampar River during the study: Chlorophyceae, Cyanophyceae, Zygnematophyceae, Bacillariophyceae, and Xanthophyceae. The highest to lowest class composition, namely Class Chlorophyceae, was found in as many as two types, namely Oedogonium Sp and Protococcus, with a proportion of 0.42%. With a percentage of 0.24%, there were two types of Zygnematophyceae: Gonatozygon and Closterium.

With a proportion of 0.15%, there were two Cyanophyceae species, Phormidium sp. and *Oscillatoria* sp. with a proportion of 0.09%, the class Xanthophyceae was found in as many as 1 species, *Ophiocytium* sp. Class Bacillariophyceae had one species, *Synedra* sp., with a proportion of 0.06% (Figure 3).

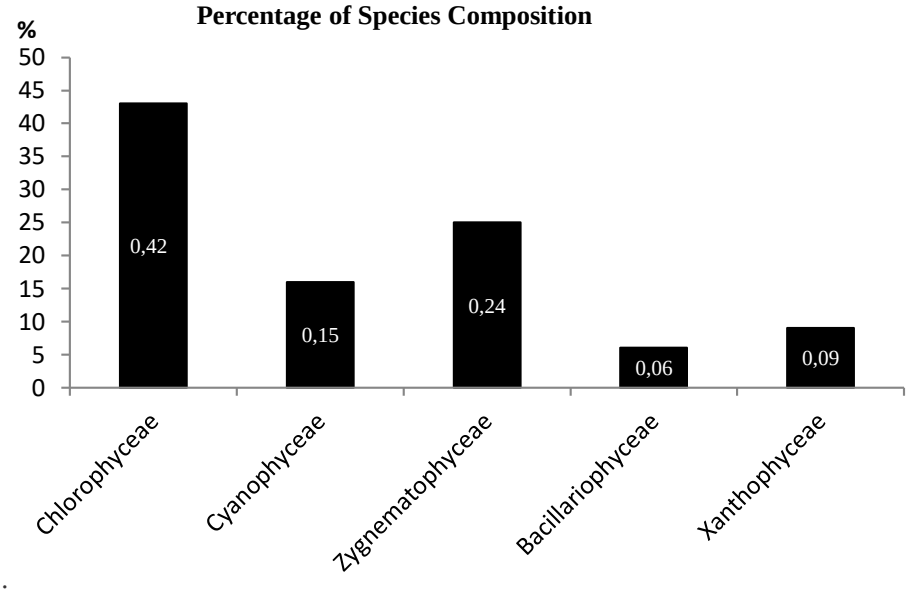

Figure 3. Phytoplankton Class Diversity

The number of species occurrences at station I was lower than at the other stations due to the presence of Physico-chemical factors in the waters that supported the life of Phytoplankton organisms. The high diversity of species at Station III is due to the abundance of vegetation and various types of trees on the river's banks, as well as the physicochemical factors of the water that support the life of phytoplankton organisms. According to [23], the farther away the source of the waste, the less pollution.

The class Chlorophyceae has the highest density of phytoplankton, with the most species being Oedogonium. According to each observation station, the highest abundance was found at station III, with the number of individuals at 3,629.96 cells/liter, and the lowest abundance was found at station I, with the number of individuals at 2,419.96 cells/L (Figure 4).

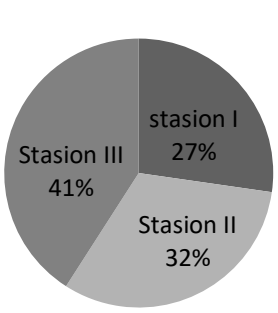

Figure 4. Phytoplankton diversity

Figure 4 shows that station III has the highest density compared to the other stations, which is 3,629.96 cells/L, indicating that the waters at station III can be expressed at a medium density level. Meanwhile, the lowest density was found at station I, with a total of 2,419.96 cells/L, which was also classified as moderate. At station I, the brightness level was lower than in stations II and III, where the low level of brightness in the waters could affect the photosynthesis process, causing phytoplankton organisms to decrease. Overall, the density of phytoplankton in Kampar River waters is moderate. The phytoplankton diversity index at Station I is 1.70, 1.80 at Station II, and 1.90 at Station III.

The waters at each station had a moderate level of diversity according to the Phytoplankton diversity criteria. If H' is 1, diversity is low. If H' - 3, the diversity is described as Medium. The diversity of H' 3 is said to be high [22].

Table 1. Phytoplankton diversity index for each station

Station	Parameter H'	Quality
Stasion I	1.70	Medium
Stasion II	1.80	Medium
Stasion III	1.90	Medium

Note: If H' < 1 then diversity is low, If H' – 3 then the diversity is Medium, and if H' < 3 then the diversity is high [20].

The Kampar River has a medium current velocity. The speed at station I is 11.11 cm/s, 14.28 cm/s at station II, and 10 cm/s at station III. The water temperature at station I is 25 degrees Celsius, 26 degrees Celsius at station II, and 26 degrees Celsius at station III. The water's brightness is 21 cm at station I, 25 cm at station II, and 37.5 cm at station III. The pH of the water is 7.1 at station I, 7.3 at station II, and 7.4 at station III. The pH of Kampar River water is neutral. Meanwhile, the O2 level in Kampar River waters at Station I was 5.1 mg/l, 5.3 mg/l at Station II, and 5.6 mg/l at Station III (Table 2.)

Table 2. Physical and chemical factors contained in the research

No	Physical and Chemical Parameters	Station I	Station II	Station III
1	Current Speed (cm/s)	11.11	14.28	10
2	Water Temperature °C	25	26	26
3	Turbidity (cm)	21	25	37.5
4	pH	7.1	7.3	7.4
5	O_2 Level (mg/l)	5.1	5.3	5.6

Note: Station I: Sand and gravel mining, Station II: Community activities, Station III: Located far from community activities, with a lot of vegetation of various types of trees on the river's banks.

The pH levels obtained during the study were 7.1 to 7.4 based on the physical-chemical parameters of the waters. The pH level is one of the factors that influence aquatic organisms' lives. The pH value at this station, 7.4, supports the life of phytoplankton, according to [24] opinion that the waters are quite good for the life of phytoplankton, pH levels range from 5.0-9.0. The pH of the Kampar River's

waters is neutral. The pH of Kampar River waters at each station is in the neutral pH range, according to the water class II criteria in PP No. 82 of 2001 for good water quality, which is in the range of 6-9.

At station I, the brightness value is 21 cm, at station II, it is 25 cm, and at station III, it is 37.5 cm. This is due to the extremely high volume of water discharge, which has an impact on phytoplankton life [25]. That the brightness of the waters is good for aquatic organism survival is greater than 45 cm [8]. The ideal temperature for phytoplankton growth is 20-30 °C [26].

The Kampar River is located upstream. This study was conducted at three different stations: station I, where the community was excavating gravel, station II, where there was a lot of community activity, and station III, where there was a lot of vegetation of various types of trees. This study was conducted for three days at 9:00 a.m. in sunny weather.

The pH measurements at each station ranged from 7.1 to 7.4, which is neutral. The ideal pH range for aquatic organisms is generally 6-8. Temperature measurements at each station range from 25°C to 26°C, indicating a relatively high temperature suitable for adapting to most types of phytoplankton. The current velocity at each station is 10cm/s - 14.28 cm/s, and as a result, phytoplankton is carried away by river water flow. The brightness of the waters at each station is classified as high, ranging from 21 cm to 37.5 cm, which hinders the penetration of the intensity of sunlight entering the waters. This inhibits the growth of phytoplankton, which requires sunlight for photosynthesis [27].

The number of occurrences of Phytoplankton species varies from station to station. It is suspected that there is an excessive community activity factor as well as the influence of water physicochemical factors. Station III has a higher number of species than the other stations because it is located away from community activities and is more natural than Stations I and II. That the further away the source of the waste, the less pollution. Furthermore, there is the influence of physical and chemical factors in the waters that support the life of phytoplankton, such as pH, water brightness, and dissolved O_2 [28].

The pH levels obtained during the study were 7.1 to 7.4, according to Table 2. The pH level is one of the factors that influence the life of aquatic organisms. Following [29] opinion that the waters are quite good for the life of Phytoplankton, pH levels range from 5.0-9.0. The pH of the upstream Kampar River is neutral. According to the water class II criteria in PP No. 82 of 2001, good water quality is in the range of 6-9, and the pH of the upstream Kampar River waters at each station is in the neutral pH range.

Figure 4 also shows that station I had the lowest number of occurrences of Phytoplankton species. Station I is a location where locals excavate gravel and sand, causing phytoplankton to decline. The photosynthesis of phytoplankton can be hampered by low water brightness. The brightness value at each station can be classified as low at station I, 21 cm, 25 cm, and 37.5 cm. This is due to the extremely high volume of water discharge, which has an impact on phytoplankton life. That the water's brightness is beneficial to aquatic organism survival is greater than 45 cm [30]. Furthermore, the dissolved O_2 level is 5.6 mg/l, which supports the life of phytoplankton [31]. According to the water class II criteria established by the government in PP No. 82 of 2001, the level of O_2 in water must be no less than 4 mg/l.

Station III has the highest Phytoplankton density of the other stations, with 3,629.96 cells/liter. So the waters at Station III can be described as medium density, while the lowest Phytoplankton density is found at Station I, which is 2,419.96 cells/liter, which is also classified as moderate. Overall, the fertility level of the Kampar Hulu River in terms of phytoplankton density is moderate. Waters with low fertility levels have phytoplankton densities of less than 102 cells/liter, waters with moderate fertility levels have densities of 102-104 cells/liter, and waters with high fertility levels have phytoplankton densities of more than 104 - 107 cells/liter. The community's gravel and sand mining at station I results in cloudy river water, which allows river pollution to cause a decrease in water quality and ecosystem changes.

Table 1 shows that the diversity of phytoplankton ranges from 1.70 to 1.90. H = 1.90 when compared to other stations based on the Phytoplankton diversity index value at station III, which has the highest diversity index value. Station I had the least diversity, with H = 1.70. According to the diversity criteria, the waters at this station have a medium level of diversity. According to the Phytoplankton diversity index value, the Kampar Hulu River's waters are classified as moderate. If the diversity index ranges from 1 to 3, diversity is considered moderate [32].

4. Conclusion

Phytoplankton density in the waters of the Kampar River, Koto Kampar Hulu District, Kampar Regency, is at a moderate fertility level. The study found that there are five classes of phytoplankton, namely Chlorophyceae, Cyanophyceae, Zygnematophyceae, Bacillariophyceae, and Xanthophyceae, with the highest density at station III of 3629.96 cells/liter and the lowest density at station I of 2419.96 cells/liter. This study shows that physicochemical factors of waters such as pH, current speed, air temperature, and brightness have a significant effect on the distribution and density of phytoplankton. The results of the study also stated that community activities such as sand and gravel mining have caused a decrease in air quality at several stations, especially at station I. Overall, the waters of the Kampar River have a moderate diversity index, with Shannon-Wiener index values ranging from 1.70 to 1.90, which indicates water conditions with a moderate level of diversity.

5. Acknowledgement

Hibah Penelitian Utama Fakultas Perguruan Tinggi (APBF-UNILAK) 2021 Number: 1025/FKIP/Pn/2021 funded this research. Universitas Lancang Kuning

References

[1] Adamczuk, M. (2021). Demographic consequences of mitigating strategies in planktonic invertebrates facing global browning of freshwater ecosystem. *Aquatic Sciences*, *83*(2), 31.
[2] Wohl, E. (2020). *Rivers in the Landscape*. John Wiley & Sons.
[3] Engel, F. (2020). *The role of freshwater phytoplankton in the global carbon cycle* (Doctoral dissertation, Acta Universitatis Upsaliensis).
[4] Malmqvist, B., & Rundle, S. (2002). Threats to the running water ecosystems of the world. *Environmental conservation*, *29*(2), 134-153.
[5] FItriadi, R., Pratiwi, N. T. M., & Kurnia, R. (2021). Komunitas fitoplankton dan konsentrasi nutrien di Waduk Jatigede. *Jurnal Ilmu Pertanian Indonesia*, *26*(1), 143-150.
[6] Reynolds, C. S. (2006). *The ecology of phytoplankton*. Cambridge University Press.
[7] Gómez-Ocampo, E., Gaxiola-Castro, G., Durazo, R., & Beier, E. (2018). Effects of the 2013-2016 warm anomalies on the California Current phytoplankton. *Deep Sea Research Part II: Topical Studies in Oceanography*, *151*, 64-76.
[8] Smith, J., Connell, P., Evans, R. H., Gellene, A. G., Howard, M. D., Jones, B. H., ... & Caron, D. A. (2018). A decade and a half of Pseudo-nitzschia spp. and domoic acid along the coast of southern California. *Harmful algae*, *79*, 87-104.
[9] Spilling, K., Olli, K., Lehtoranta, J., Kremp, A., Tedesco, L., Tamelander, T., ... & Tamminen, T. (2018). Shifting diatom—dinoflagellate dominance during spring bloom in the Baltic Sea and its potential effects on biogeochemical cycling. *Frontiers in Marine Science*, *5*, 327.
[10] Dalu, T., Mwedzi, T., & Wasserman, R. J. (2022). Phytoplankton dynamics. In *Fundamentals of Tropical Freshwater Wetlands* (pp. 189-219). Elsevier.
[11] Hendrajat, E. A., & Sahrijanna, A. (2019). Kondisi Plankton pada Tambak Udang Windu (Penaeus monodon Fabricius) dengan Substrat berbeda. BERITA BIOLOGI, 18(1), 47-57.

[12] Walter, R. K., Armenta, K. J., Shearer, B., Robbins, I., & Steinbeck, J. (2018). Coastal upwelling seasonality and variability of temperature and chlorophyll in a small coastal embayment. *Continental Shelf Research*, *154*, 9-18.
[13] Abonyi, A., Kiss, K. T., Hidas, A., Borics, G., Várbíró, G., & Acs, E. (2020). Cell size decrease and altered size structure of phytoplankton constrain ecosystem functioning in the middle Danube River over multiple decades. *Ecosystems*, *23*, 1254-1264.
[14] Zhu, W., Wan, L., & Zhao, L. (2010). Effect of nutrient level on phytoplankton community structure in different water bodies. *Journal of Environmental Sciences*, *22*(1), 32-39.
[15] Adamczuk, M. (2021). Demographic consequences of mitigating strategies in planktonic invertebrates facing global browning of freshwater ecosystem. *Aquatic Sciences*, *83*(2), 31.
[16] Brereton, A., Siddons, J., & Lewis, D. M. (2018). Large-eddy simulation of subsurface phytoplankton dynamics: an optimum condition for chlorophyll patchiness induced by Langmuir circulations. *Marine Ecology Progress Series*, *593*, 15-27.
[17] Dwirastina, M., & Riani, E. (2019). Komposisi, Kelimpahan dan Keanekaragaman Fitoplankton di Pulau Salah Nama Sungai Musi Sumatera Selatan. *Sainmatika: Jurnal Ilmiah Matematika dan Ilmu Pengetahuan Alam*, *16*(1), 74-80.
[18] Ma, C., Li, Z., Mwagona, P. C., Rabbany, A., & Bhadha, J. H. (2022). Spatial and seasonal dynamics of phytoplankton groups and its relationship with environmental variables in Lake Okeechobee, USA. *Journal of Freshwater Ecology*, *37*(1), 173-187.
[19] Cencini, M., Boffetta, G., Borgnino, M., & De Lillo, F. (2019). Gyrotactic phytoplankton in laminar and turbulent flows: a dynamical systems approach. *The European Physical Journal E*, *42*, 1-15.
[20] Clifton, W., Bearon, R. N., & Bees, M. A. (2018). Enhanced sedimentation of elongated plankton in simple flows. *IMA Journal of Applied Mathematics*, *83*(4), 743-766.
[21] Dodds, W. K., Whiles, M. R., Dodds, W. K., & Whiles, M. R. (2020). Nutrient use and remineralization. *Freshwater Ecology. Concepts and Environmental Applications of Limnology, 3rd ed. Academic Press, Cambridge*, 503-535.
[22] Lu, X., Sui, F., Liu, Y., & Fan, Y. (2022). Comparison of three functional classification approaches to characterize phytoplankton response to environmental heterogeneity: A case study in NE China wetlands. *Journal of Freshwater Ecology*, *37*(1), 103-116.
[23] Sen, B., Alp, M. T., Sonmez, F., Kocer, M. A. T., & Canpolat, O. (2013). Relationship of algae to water pollution and waste water treatment. *Water treatment*, *14*, 335-354.
[24] Li, Y., Yu, Z., Ji, S., Meng, J., Kong, Q., Wang, R., & Liu, J. (2021). Diverse drivers of phytoplankton dynamics in different phyla across the annual cycle in a freshwater lake. *Journal of Freshwater Ecology*, *36*(1), 13-29.
[25] Amorim, C. A., & do Nascimento Moura, A. (2021). Ecological impacts of freshwater algal blooms on water quality, plankton biodiversity, structure, and ecosystem functioning. *Science of the Total Environment*, *758*, 143605.
[26] Trommer, G., Poxleitner, M., & Stibor, H. (2020). Responses of lake phytoplankton communities to changing inorganic nitrogen supply forms. *Aquatic Sciences*, *82*, 1-13.
[27] Durante, G., Basset, A., Stanca, E., & Roselli, L. (2019). Allometric scaling and morphological variation in sinking rate of phytoplankton. *Journal of phycology*, *55*(6), 1386-1393.
[28] Yang, X., Liu, Q., Luo, X., & Zheng, Z. (2017). Spatial regression and prediction of water quality in a watershed with complex pollution sources. *Scientific Reports*, *7*(1), 8318.
[29] Naselli-Flores, L., Zohary, T., & Padisák, J. (2021). Life in suspension and its impact on phytoplankton morphology: an homage to Colin S. Reynolds. *Hydrobiologia*, *848*(1), 7-30.

[30] Cook, K. V., Li, C., Cai, H., Krumholz, L. R., Hambright, K. D., Paerl, H. W., ... & Zhu, G. (2020). The global Microcystis interactome. *Limnology and Oceanography*, *65*, S194-S207.

[31] Jin, L., Chen, H., Xue, Y., Soininen, J., & Yang, J. (2022). The scale-dependence of spatial distribution of reservoir plankton communities in subtropical and tropical China. *Science of the Total Environment*, *845*, 157179.

[32] Effendi, H., Kawaroe, M., Lestari, D. F., & Permadi, T. (2016). Distribution of phytoplankton diversity and abundance in Mahakam Delta, East Kalimantan. *Procedia Environmental Sciences*, *33*, 496-504.