Eco. Env. & Cons. 30 (August Suppl. Issue) : 2024; pp. (S248-S256)

ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2024.v30i05s.039

Limnological studies in correlation with microflora of Okhla Bird Sanctuary, New Delhi, India

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(Received 14 February, 2024; Accepted 19 April, 2024)

ABSTRACT

This study delves into the correlation between physico-chemical parameters and phytoplankton density and abundance at three locations (S-I, S-2, and S-3) in the Okhla Bird Sanctuary after the monsoon season. The pH remained steady at an optimal level of 7 across all three sites, while the temperature ranged from 24 ^{0}C to 31^{0}C. TDS and EC values fluctuated between 535 mg/l to 796 mg/l and 822 µs/cm to 1318 µs/cm, respectively. Hardness, on the other hand, ranged from 230 mg/l to 426 mg/l. The highest levels of sodium (Na), potassium (K), calcium (Ca), and nitrate (NO_3) were recorded as 136 mg/l, 85 mg/l, 27 mg/l, and 5mg/l, respectively. The study revealed that 17 algal genera from three groups, namely Cyanophyceae, Chlorophyceae, and Bacillariophyceae, represented the phytoplankton in the three sampling locations. The cyanophyceae group dominated during the pre-monsoon study, followed by Chlorophyceae. The highest phytoplankton diversity was recorded at sampling location S-2, followed by S-3, while the lowest diversity was at S-1. The study used the Shannon-Wiener diversity index (SWI) to estimate the phytoplankton diversity, and the Palmer pollution index revealed that the waters of the given sampling locations of wetland, Okhla Bird Sanctuary and Yamuna River, were not organically polluted. The physico-chemical analysis was done using IS methods for nine parameters. The study found that the concentration of nutrients in the water body directly or indirectly affected phytoplankton growth. This study sheds light on the Okhla Bird Sanctuary's microflora, which remained unexplored until this research. The findings of this study may aid in the management of sustainable ecological conservation.

Key words: *Phytoplankton, Okhla Bird Sanctuary, Wetland, Harmful algae*

Introduction

Wetlands, whether natural or artificial, permanent or temporary, with static or flowing water, fresh, brackish, or salt, are highly diverse and unique communities that involve diverse plants and animals adapted to shallow and dynamic water regimes (Bassi *et al.,* 2014). They are considered biodiversity hotspots and provide important bird habitats for nesting, breeding, roosting, feeding, and social interaction. However, wetlands are under heavy pressure and threats due to human activities such as encroachment, resource harvesting, industrial pollution, poisoning, agricultural runoff, siltation, and the introduction of exotic and invasive species (Newton *et al*., 2020). India has diverse and unique wetland habitats, including 67,429 wetlands covering 4.1 million hectares, of which 2,175 are natural and the rest are artificial, and an additional 6,740 sq km area covered by mangroves. Freshwater wetlands alone support 20% of India's known biodiversity range (Cantonati *et al.,* 2020). For example, the Okhla Bird Sanctuary (OBS) in Noida provides an excellent example of conservation management of wetlands amidst densely populated cities, with 302 bird species and 14,000-20,000 water birds recorded from the sanctuary and surrounding areas. On a daily basis, a substantial quantity of avian excrement is accumulated in a limited observation zone spanning more hectares(Dehgany-Asl *et al.*, 2022). This leads to turbid water transforming into a liquid manifestation of guano. As a result, the guano water enriches the water and soil with high levels of phosphates and nitrates (Schnug *et al.*, 2018). The relationship between nutrients and phytoplankton growth in aquatic ecosystems is multifaceted and diverse. Guano, a mixture of accumulated excrement and remains of birds, bats, and seals, is a valuable fertilizer that supplies nutrients to phytoplankton, thereby boosting their productivity and enhancing the primary productivity of the entire ecosystem (Sun *et al.,* 2022). However, excessive nutrient input can lead to harmful algal blooms and water quality problems, such as oxygen depletion. Water bird colonies are the primary source of bird guano. These water birds frequently use the water, and some species can dive from the air or surface to catch prey in the water. Additionally, aquatic birds indirectly impact phytoplankton growth by consuming zooplankton, which are phytoplankton eaters. By reducing the zooplankton population, aquatic birds indirectly contribute to the growth of phytoplankton. The impact of aquatic birds on nutrient dynamics and phytoplankton growth in aquatic ecosystems depends on the bird species, population size, and overall ecosystem conditions (Petkuviene *et al.,* 2019). Therefore, it is imperative to carefully assess the effects of water bird colonies on aquatic ecosystems to maintain a healthy and sustainable environment. The relationship between water quality and phytoplankton organisms at the OBS area was closely connected and interdependent However, it still faces threats from rapid urbanization and pollution.

Phytoplankton are unicellular microscopic organisms that play a crucial role in supporting aquatic ecosystems. They range from less than 1 µm to 500 µm and can be classified into four main classes: Bacillariophyceae, Chlorophyceae, Cyanophyceae, and Euglenophyceae (Naselli-Flores and Padisák, 2023). They reside in freshwater ponds, lakes, rivers, and marine habitats such as backwaters, mangroves, estuaries, and seas. They are the primary producers of the aquatic ecosystem and play a vital role in nitrogen fixation. Phytoplankton form the basis of the food chain for higher trophic levels and help connect the biotic and abiotic components of the aquatic ecosystem. Additionally, studies of the ecology of freshwater phytoplankton provide insights into the interaction between competition and predation (Lobus and Kulikovskiy, 2023). They are also effective biological indicators of changes in fluid environments due to their short lifespan, which allows them to respond quickly to environmental changes. However, certain phytoplankton species associated with harmful blooms can produce unpleasant flavors and odors and pose hazardous conditions. This study aims to document the phytoplankton species from October to December when thousands of migratory birds visit the Okhla Bird Sanctuary.

Materials and Method

Study area

The Okhla Bird Sanctuary is located on the Yamuna River in India.The sanctuary is located between latitudes 28°32′44" N and 28°34′18" N and longitudes 77°17′41" E and 77°19′12" E, and the floodplains of the Yamuna in Delhi are situated between lateral bunds, with the maximum width of active floodplains observed in and around OBS. The sanctuary is situated at the entrance of Noida in the Gautam Buddh Nagar district of Uttar Pradesh, where the Yamuna River enters the state of UP, leaving the territory of Delhi. The Uttar Pradesh government declared the surrounding floodplains an "Important Bird Area" under India's Wildlife (Protection) Act of 1972. The sanctuary covers an area of 4 km2, with open water covering around 273 ha, reed and sand beds covering 97 ha, and roads and bunds comprising the remaining 30 ha area. The sanctuary comprises a vast alluvial plain with a gentle southeastern slope, surrounded by well-metalled roads and bounded by mesh-wirings and bunds. The reservoir sediment mainly comprises a silt load carried by the river Yamuna, and it is black with a slightly alkaline nature. The sanctuary has three main seasons: summer (April-June, temperature range 40 °C to 29 °C), winter (November-March, temperature range 21 °C to 5 °C), and monsoon (July-September). This sanctuary is valuable for recreation and conservation education in the metropolitan area of the National Capital Region of India.This creates a mosaic of habitats that supports diverse life. Despite heavy pollution and human interventions, several species of birds, reptiles, mammals, and amphibians located in OBS their home. The wintering ducks in Okhla depend on the surrounding areas, particularly the grassy patches, agricultural fields, and marshes around the barrage for food. Field data on the following parameters were collected regularly from October to December 2023 during visits to the sanctuary (Fig. 1).

Methods of Sample Collection

To obtain phytoplankton samples, surface water was collected using 250 ml water bottles and filtered immediately with a plankton net made of nylon bolting cloth with a mesh size of 50 µm to prevent contamination. The phytoplankton samples were taken from 3 different sampling locations (Fig. 1) using 100-ml plastic bottles and immediately fixed with Lugols iodine solution. The biomass was preserved in specimen bottles containing 4% neutralized formalin for species identification. Phytoplankton samples were centrifuged using centrifuge tubes of 10 to 30 ml capacity and allowed to settle for 24 hours in formalin. Using an Olympus microscope BX51 (Olympus, Japan), under a magnification of 100X and 400X phytoplankton were observed and counted in at least 10 microscopic fields. Identifications of phytoplankton up to genus level were analysed out using and taxonomic keys while density and percentage of composition of phytoplankton were enumerated using standard method (APHA, 2005).

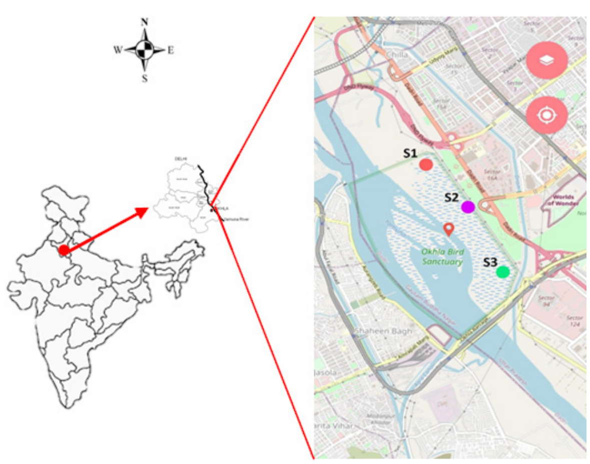

Fig. 1. Map of the Okhla Bird Sanctuary indicating the location of the sampling site (S1-S3)

Diversity of Phytoplankton

The Shannon-Wiener diversity index (SWI) was estimated for phytoplankton diversity using following equation for individual sample

$$H' = -\Sigma(p\_i * \ln(p\_i)) \quad \ldots\ldots\ldots\ldots(1)$$

Where,

H′ is the Shannon Diversity Index; Ó represents the sum; p_i is the proportion of individuals belonging to the ith species; ln(p_i) is the natural logarithm of p_i.

Results and Discussion

The study analysed various factors affecting water quality in the Okhla Bird Sanctuary, particularly after the monsoon season. The research focused on three locations, S-I, S-2, and S-3, considering physico-chemical parameters, phytoplankton density, and abundance. The study found that the pH levels across all three locations remained stable at an optimal level of 7. However, the temperature varied between 24 * C and 31 * C, suggesting that the varying temperature levels could affect the water quality. The total dissolved solids (TDS) and electrical conductivity (EC) values also fluctuated between 535 mg/l and 796 mg/l and 822us/cm to 1318us/cm, respectively, which could significantly impact the water quality. The water hardness levels were also found to vary from 230mg/l to 426mg/l across all three sites. In addition to these factors, the study also found that the highest levels of sodium (Na), potassium (K), calcium (Ca), and nitrate (NO_3) were recorded at different locations. The highest sodium (Na) levels were registered at 136 mg/l, while the highest potassium (K) levels were recorded at 85 mg/l. The highest calcium levels (Ca) were 27 mg/l, and nitrate (NO_3) was recorded at 5 mg/l. These findings suggest that various factors, including the location and sodium, potassium, calcium, and nitrate levels, could influence the Okhla Bird Sanctuary's water quality. Overall, the study provides a comprehensive overview of the water quality and phytoplankton abundance in the Okhla Bird Sanctuary after the monsoon season, highlighting the various factors that could affect the water quality (Table 1).

The study recorded 17 algal genera from three groups of phytoplankton, namely Cyanophyceae, Chlorophyceae, and Bacillariophyceae. Cyanophyceae was the dominant group followed by Chlorophyceae in terms of generic density. The phytoplankton density ranged from 809 to 2432 cells ml^{-1} and was found to be highest in October at location S-2. The phytoplankton diversity was highest at S-2 and S-3 in October, but lowest at S-1. In November, 21 algal genera were identified from four groups of phytoplankton, namely Cyanophyceae, Chlorophyceae, Bacillariophyceae, and Euglenophyceae. Cyanophyceae was the dominant group followed by Chlorophyceae in terms of generic density. The phytoplankton density varied from 975 to 2184 cells ml^{-1} and was highest at locations S-2 and S-3. The phytoplankton diversity was highest at S-2 and S-3 in November, but lowest at S-1. In December, 13 algal genera were identified from three groups of phytoplankton, namely Cyanophyceae, Chlorophyceae, and Bacillariophyceae. Cyanophyceae was the dominant group followed by Chlorophyceae in terms of generic density. The phytoplankton density ranged from 774 to 3674 cells mL^{-1}, and was highest at locations S-1 and S-2. The phytoplankton diversity was highest at S-2 and S-1 in December, but lowest at S-3.In October, there were 9 genera of Chlorophyceae, 7 genera of Cyanophyceae, and a single genus of Bacillariophyceae. The maximum phytoplankton density was recorded at sampling location S2 (2432 cells/ml^{-1}), followed by location S3 (1597 cells/ml^{-1}), while the minimum was recorded at sampling location S-1 (809 cells/ ml^{-1}). In November, there were 10 genera of Chlorophyceae, 7 genera of Cyanophyceae, 2 genera of Bacillariophyceae, and a single genus of Euglenophyceae. The maximum phytoplankton density was recorded at sampling location S3 (2184 cells/ml), followed by location S2 (1134 cells/ ml^{-1}), while the minimum was recorded at sampling location S-1 (975 cells/ml). In December, there were 6 genera of Chlorophyceae, 5 genera of Cyanophyceae, and a single genus of Bacillariophyceae. The maximum phytoplankton density was recorded at sampling location S3 (773 cells/ml^{-1}), followed by location S2 (3674 cells/ml^{-1}), while the minimum was recorded at sampling location S-1 (998 cells/ml^{-1}) (Table 2).

The study results indicated that Chlorophyceae, *Ulothrix*sp., *Chlorella*sp., and *Oscillatoria*sp.were the dominant groups, while *Microspora*sp. was abundant. *Chlamydomonas*sp., *Stigeoclonium*sp., *Tetraedron*sp., *Polyedriopsis*sp., and *Oocystis*sp.were less common. Among the blue-green algae, Cyanophyceae, *Anabaena*sp., *Oscillatoria*sp., and

Table 1. Physicochemical variables measured at OBS sampling station covering the period deployments.

Sampling Site	Site-1			Site-2			Site-3		
PARAMETERS	**Oct**	**Nov**	**Dec**	**Oct**	**Nov**	**Dec**	**Oct**	**Nov**	**Dec**
pH	7.36	7.69	6.98	7.36	7.96	7.14	7.14	7.97	7.09
Temperature	27	21	23	29	23	19	29	24	21
Total dissolved solids	657	587	555	679	796	535	684	737	540
Total Hardness	284	426	278	296	432	23	286	354	272
Electric conductance	1010	1318	854	1048	1226	822	1055	1134	831
Chemical oxygen demand	42	48	25	62	52	50	50	68	29
Dissolved oxygen	7.6	6.9	7.1	7.1	6.7	6.9	7.2	5.9	7.2
Biochemical Oxygen demand	12	16	4	14	15	7	11	18	5
Calcium	65.6	84.8	55.6	66.4	82.4	52.6	64	70.4	54.4
Magnesium (Mg)	29.1	52	33.7	31.6	52.4	32.5	30.6	43.2	33
Ammonia	4.5	5.2	6.4	4.2	5.3	6.1	4.1	5.1	6.3
Sodium	58	64	101.4	64	68	135.6	54	58	129.9
Potassium	8	9	20.2	12	14	27	10	10	25.9
Phosphorus	0.46	0.41	0.52	0.52	0.44	0.49	0.58	0.39	0.5
Total Kjeldhi Nitrogen	14	13.7	11.5	15.8	14.2	11	16.6	13.5	10.9
Nitrate (NO3)	4.72	4.68	5.2	4.84	4.72	4.8	4.88	4.37	5
Nitrite	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sulphate (SO4)	48	59	46	52	56	44	42	52	45
Boron	0.32	0.37	0.12	0.45	0.39	0.12	0.41	0.32	0.12
Turbidity	3.6	4.2	4.8	3.4	4	5	5.6	4.7	4.7
Bicarbonate	264	306	198190	272	284	190	266	264	192

*Spirulina*sp. were the dominant genera, while *Microcystis*sp., *Aphanothece*sp., and *Aphanocapsa* sp. were abundant, and *Coelosparium* sp. was rarely observed. In the Bacillariophyceae group, represented by the single genus *Navicul*a sp., only a few specimens were found at the S-1 sampling site. During November, the study showed that blue-green algae, i.e., Cyanophyceaesp., *Microcystis* sp., *Aphanocapsa* sp. and *Oscillatoria* sp., were the dominant genera, while *Gloeocapsa* sp. and *Aphanothece* sp. were abundant, and *Spirulina* sp. and *Anabaena*sp. were less common. Cyanophyceae was the most abundant group during the study. *Chlorella*sp. was the dominant genus among Chlorophyceae, while *Chlamydomonas* sp. and *Tetraedron* sp. were abundant. *Scenedesmus*sp., *Oocystis*sp., *Triceratium*sp., and *Cosmarium* sp. were less common, and *Tetrastrum* sp., *Crucigenia* sp., and *Clostridium* sp. were rarely observed. In the Bacillariophyceae group, represented by the two genera *Synedra* sp. and Diatoms, specimens were abundantly found at the S-2 and S-3 sampling sites. Among Euglenoids, represented by the single genus *Euglena* sp., specimens were recorded abundantly only at the S-3 sampling site. In December, the study showed that blue-green algae, i.e., Cyanophyceae, *Aphanothece* sp., *Microcystis* sp., and *Oscillatoria* sp., were the dominant genera, while *Gloeocapsa*sp. was less common. Cyanophyceae was the most abundant group during the study. Chlorophyceae, *Chlorell*asp., and *Triceratium* sp.were the dominant genera, Chlamydomonas were abundant, and *Chloromonas* sp.and *Tetradesmus* sp. were less common. In the Bacillariophyceae group, represented by the single genus *Synedra* sp., only a few specimens were found at the S-1 sampling site (Fig. 1).

OBS predominantly contain blue green algae (Cyanophyceae), which is consistent with Palmer's (1980) observations that blue green algae thrives in freshwater systems with high organic matter (Paerl et *al.*, 2001). Studies suggest that zooplankton assimilates blue green algae with low efficiency, and excretory products from blue green algae can impede the growth of other algal species (Moustaka-

Table 2. Density, diversity and percent composition of Phytoplankton in given sampling locations of wetland, Okhla Bird Sanctuary Yamuna River

Sampling Locations	Density cells (mL^{-1})	Composition of algal groups (%)				SWI*	PPI+
		Cyanophyceae	Chlorophyceae	Bacillariophyceae	Euglenophyceae		
October							
S-1	809	43	56	1	0	2.335	15
S-2	2432	66	44	0	0	2.99	15
S-3	1597	79	21	0	0	2.592	11
Min.	809	43	21	0	0	2.335	11
Max.	2432	79	56	1	0	2.99	15
Average	1612	63	40	0.33	0	2.639	13.6
SD	662.67	14.88	14.52	0.471	0	0.269	1.885
November							
S-1	975	89	11	00	00	2.154	09
S-2	1134	43	44	13	00	3.378	19
S-3	2184	57	30	06	07	2.156	19
Min.	975	43	11	00	00	2.154	09
Max.	2184	89	44	13	07	3.378	19
Average	1431	63	28.33	6.33	2.33	2.561	15.6
SD	656.9	23.57	16.56	6.5	4.04	0.706	5.77
December							
S-1	998	50	46	4	0	3.733	11
S-2	3674	64	36	0	0	2.681	17
S-3	773	53	47	0	0	2.425	13
Min.	773	64	47	0	0	2.425	11
Max.	3674	53	46	4	0	3.733	17
Average	1815	56	43	1	0	2.95	14
SD	1613	7	6	2	0	0.693	2.5

*SWI Shannon–Wiener Diversity Index, PPI Palmer's Pollution Index, SD standard deviation

Gouni and Sommer, 2020). Furthermore, nitrogen and phosphate enrichment can lead to silica depletion, which favors blue green algae over diatoms. The phosphate and nitrate levels in OBS may have increased due to bird droppings, resulting in a limited phytoplankton population (Xiao *et al*., 2019). Dilution of water by rain during August, September may have caused a decline in the phytoplankton concentration (Jargal and An, 2023). The rapid grazing behaviour of Cladocerans and copepods could be responsible for lower phytoplankton concentration in OBS.Phytoplankton, a vital component in the nutrient cycling of ecosystems, is globally diverse and widespread. As the foundation of the aquatic food web, phytoplankton plays a significant ecological role. However, some species can become toxic and render water unsuitable for human consumption (Naselli-Flores and Padisák, 2023). The taxo-

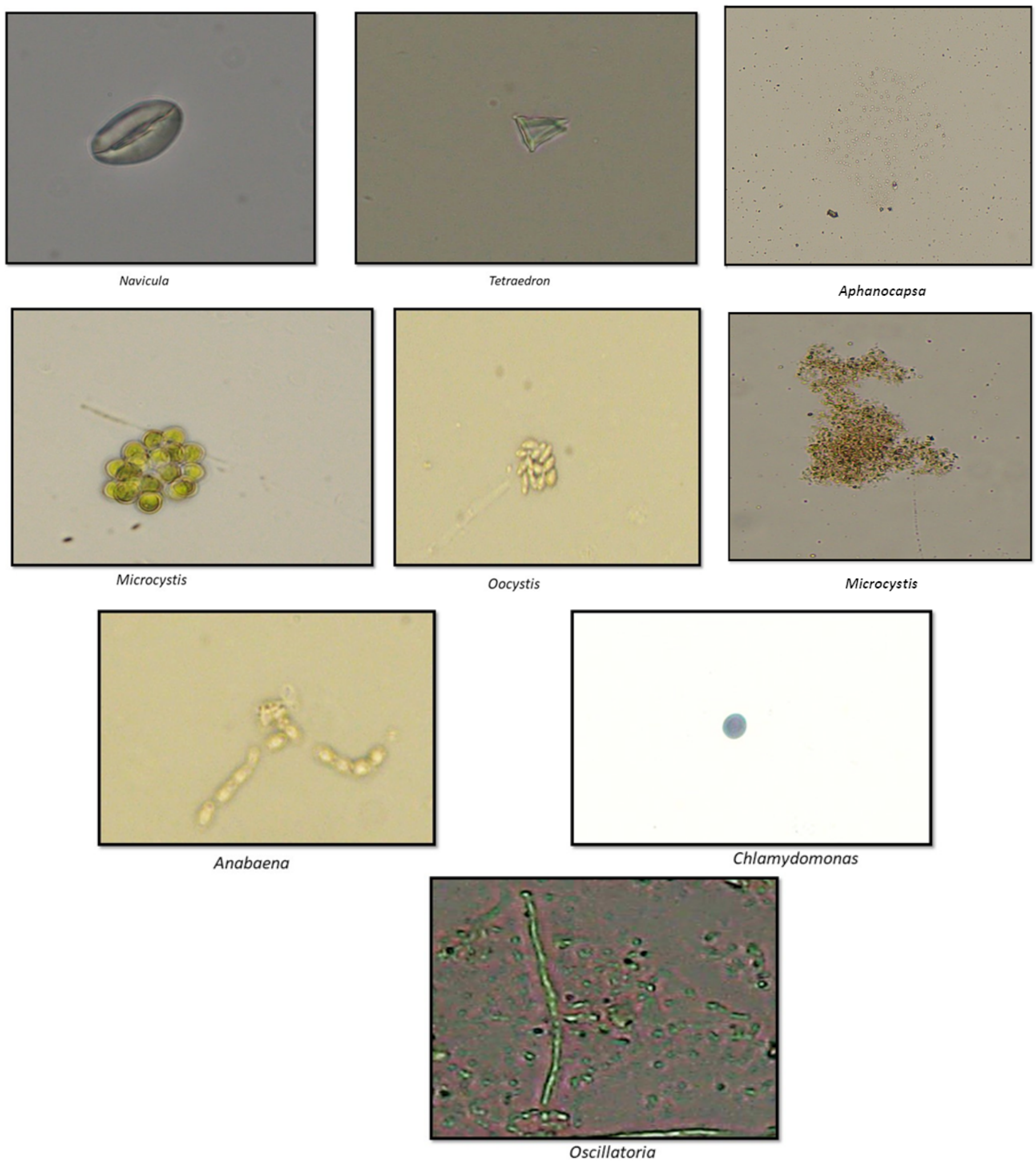

Fig. 1. Photos of some dominant species of phytoplankton in the water of OBS.

nomical composition, structure, and seasonal dynamics of phytoplankton can be altered by climate change caused by population growth, deforestation, and pollution from industrialization and urbanization (Henson *et al.*, 2021). OBS, with its high potential for aquatic organisms and migratory birds, is under threat from climate change. The sanctuary is home to diverse aquatic life, including fishes, reptiles, migratory birds, which benefit agriculture and humans. Therefore, it is crucial to conserve and gain deeper insights into the diversity, conservation, and production of phytoplankton, one of the primary producers of the sanctuary.Eutrophication, a result of excessive nutrient loading, is a growing concern due to its potential to cause harmful algal blooms, mainly caused by cyanobacteria, particularly during summer (Devlin and Brodie, 2023). Nutrient loading primarily occurs from human activities, agriculture, and natural sources; however, studies on bird poop's impact on nutrient loading are limited. Research has shown that algal blooms exacerbate phosphorus release from freshwater sediments, leading to further bloom development. Despite the challenging task of managing responses to climate change and other nutrient reinforcements, it is critical to address eutrophication's root causes (Nwankwegu *et al.*, 2019). The mechanisms causing eutrophication are poorly understood, although empirical modelling has shown that phosphorus and nitrogen are significant drivers of cyanobacteria abundance and dominance. Aquatic organisms depend on phosphorus as a primary source of nutrients, mainly in the form of inorganic phosphate (IP) and dissolved organic phosphorus (DOP). In some lakes, the phosphorus cycle requires DOP, constituting 12-60% of total phosphorus (TP) (Balaji Prasath *et al.*, 2021). Microalgae play an essential role in the phosphorus cycle by using alkaline phosphatase excretion to decompose and absorb DOP, releasing inorganic phosphate into the water. Recent studies have shown that microalgae selectively use DOP, and their response to it varies depending on the species. The optimal nitrogen/phosphorus ratio for algal growth ranges from 16:1, but it differs based on specific species' unique N and P requirements.

Aquatic birds, found in large colonies in estuarine systems, can be a significant source of nutrients to the water column through direct and indirect mechanisms. They ingest food and produce faeces, making nutrients available to primary producers (Petkuviene *et al.* 2019). Stepping on sediment and its resuspension and macrophyte grazing prevent nutrient uptake or sediment stabilization with roots. The more birds present at a particular roosting site, the higher the likelihood of affecting the quality of nearby water sources, especially during heavy rain events. Over time, bird faeces can accumulate at the bottom of lakes, ponds, and shores, affecting many local water bodies (Morkûnë *et al.*, 2020). Bird faeces are rich in phosphorus and nitrogen, adding nutrients to the water. Although it is impossible to blame aquatic birds for algal blooms entirely, their faeces may have some influence, as demonstrated in microcosm experiments. Researchers aim to continue researching how many birds a water body can support before becoming seriously polluted. Colonial water birds can significantly impact the environment due to their large numbers and concentrated nesting sites. The accumulation of bird droppings, or excretion, in these colonies, can contribute to nutrient enrichment in water bodies, affecting water quality and aquatic ecosystems (Bartoli *et al.*, 2018). This can lead to issues like algal blooms and changes in the composition of aquatic communities. Management and monitoring of colonial water bird colonies are often necessary to mitigate these environmental impacts. The excretion of colonial water birds can have positive and negative implications for conservation efforts. Bird guano (excrement) can be rich in nutrients like nitrogen and phosphorus, stimulating primary production and benefiting some species of plants and aquatic organisms. However, excessive nutrient input from bird droppings can lead to eutrophication, the overgrowth of algae and aquatic plants, depleting oxygen levels in the water, and harming fish and other aquatic life (Han *et al.*, 2017).

In some cases, colonial water birds' physical presence and trampling can damage fragile nesting habitats like coastal marshes or islands. Conservationists often monitor water bird colonies to assess their impact on local ecosystems and identify potential conservation issues. Protecting critical nesting habitats for colonial water birds by establishing reserves or protected areas is essential for their conservation (Matuszak *et al.*, 2014). Some conservation efforts involve managing the size and location of water bird colonies to minimize their impact on sensitive ecosystems. Raising public awareness about the importance of colonial water birds and the need for their conservation can help garner support for protective measures. Balancing the conservation of colonial water birds with the potential environmental impacts of their excretion is crucial.

Future Outlook

Our research indicates that the formation of cyanobacterial blooms in the OBS is a complex process that involves multiple factors. The prevalence of cyanobacteria is typically observed during hot weather conditions when nutrient levels are optimal, water temperature is high, internal recycling is imbalanced, and grazing pressure is low. Cyanobacteria thrive in stagnant areas with limited water circulation and stratification, providing a competitive advantage. These areas serve as initiation points for blooms that are then spread by wind. However, we have limited knowledge of how birds interact with each other and respond to climate changes and species invasions, which may affect the formation of blooms. To better understand this process, we have employed a combination of satellite remote sensing, traditional environmental monitoring process analysis, and ecological network models. Our ultimate objective is to enhance our ability to forecast the severity and occurrence of algal blooms and recommend preventive measures.

Conclusion

The relationship between biodiversity and ecosystem is intricate, as the structure of an ecosystem is closely linked to the diversity and distribution of its species. Any alterations to the ecosystem's structure can significantly impact a species' ability to function effectively and provide services to the ecosystem, ultimately disrupting the ecological balance. With the ongoing environmental changes and global warming, phytoplankton - the foundation of primary production - is at risk of losing its diversity, leading to taxonomical composition and seasonal dynamics variations. Conducting a long-term study of phytoplankton diversity in freshwater ecosystems can help us understand the health and quality of aquatic ecosystems. It is crucial to continuously monitor the water OBS region for potentially harmful algae species, even in low counts. This is because, during favorable conditions, these species can cause severe effects. The primary objective is safeguarding the water OBS from unfavorable changes resulting from increasing land activities. Therefore, it is essential to keep track of the probable bloom of these species and predict any adverse effects. This study provides baseline information on the phytoplankton diversity in OBS, highlighting Cyanophyceaeas the dominant class, followed by Chlorophyceae, Bacillariophyceae, and Euglenophyceae. Further research is needed to understand the relationship between ecological structure and producer diversity. The sanctuary's climatic factors should be further studied to inform conservation measures for these classes. The study also emphasizes the importance of continuously monitoring phytoplankton diversity and influential hydrological factors to achieve sustainable management of the sanctuary's water and related ecosystem.

Acknowledgements

They also appreciate the constructive comments and suggestions provided by anonymous reviewers to improve the manuscript.
Data Availability Statement: Data are available from the authors on request.
Ethics Approval: Not applicable.
Conflict of interest: The author declares no conflict of interest.

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