Seasonal Planktonic Diversity of Govind Sagar Dam, Lalitpur, Uttar Pradesh

Kapil Kumar[1], Vijay Kumar Yadav[2], Anuradha[3]

[1]Department of Zoology, Meerut College, Meerut, Uttar Pradesh, India
Corresponding Author Email: *prof07a[at]gmail.com*

[2]Department of Zoology, Bipin Bihari College, Jhansi, Uttar Pradesh, India

[3]Department of Zoology, Raghuveer Singh Government P.G. College, Lalitpur, Uttar Pradesh, India

Abstract: ***The Govind Sagar Dam, constructed across the Shahzad River in Lalitpur district, Uttar Pradesh (24°40′27″ N, 78°25′25″ E), serves as a key freshwater resource supporting local agricultural, recreational, and fisheries activities. This study evaluates the seasonal diversity and community structure of phytoplankton and zooplankton in the reservoir from March 2023 to February 2024. Sampling was conducted during peak operational hours in both summer (06:00--10:00 AM and 16:30--18:30 PM) and winter (07:00--11:00 AM and 15:00--17:30 PM) seasons. Among the identified phytoplankton, Cyanophyceae was the most dominant group (39%), followed by Chlorophyceae (34%), Bacillariophyceae (23%), and Euglenophyceae (4%). The zooplankton community comprised 20 genera across four major taxonomic groups, exhibiting a dominance hierarchy of Rotifera (40%) > Cladocera (35%) > Copepoda (15%) > Ostracoda (10%). Rotifera emerged as the predominant group in terms of both species richness and population density, indicating the trophic status and biological dynamics of the reservoir ecosystem.***

Keywords: Planktonic diversity, Phytoplankton, Zooplankton, Govind Sagar Dam, Aquatic ecosystem, Limnology

1. Introduction

The term "plankton" is derived from ancient Greek and means "drifting" or "wandering." Plankton have very limited mobility and rely on water currents and the physical environment to determine their location. Phytoplankton form the foundation of biogeochemical cycles in aquatic ecosystems[1,2]. They include some of the smallest organisms found on Earth, such as microscopic algae and bacteria, as well as very large organisms like jellyfish which, despite their size, fall into the plankton category because they cannot effectively propel themselves against ocean currents[3–5]. Plankton represent an astonishing diversity of organisms. Scientists generally classify them into four broad functional categories, each playing a vital role in the food web and global biogeochemical cycles[6–8]. Plankton can also be classified by size- ranging from femtoplankton (<0.2 μm) up to megaplankton (>20 cm)- or by life cycle, such as holoplankton which spend their entire lives as plankton versus meroplankton which are only planktonic during larval stages.

It looks like you shared a passage about the two main types of plankton: phytoplankton and zooplankton[9]. Phytoplankton are tiny, plant-like organisms that inhabit the upper layers of lakes and oceans[10-12]. Like plants, they use sunlight energy to convert carbon dioxide into sugars[13]. Because they depend on sunlight[14], they cannot survive in deep waters where light is insufficient. Their population fluctuations directly influence the marine food web[15-18]. Zooplankton feed on phytoplankton or smaller zooplankton and include species such as copepods, krill, jellyfish, and fish larvae[19]. Their populations also fluctuate with environmental changes, impacting the food chain. They facilitate energy transfer and cycle nutrients throughout the ecosystem through their feeding and waste[20].

Although there are giant forms of plankton, most are microscopic. Without these tiny organisms, our world would be a very different place. Plankton can be found in almost any body of water, which is significant given that water covers approximately 71% of our planet. Because they are so tiny, plankton exist in vast numbers- you can find thousands of them in just a single drop of water[21]. Remarkably, half of the oxygen in our atmosphere is produced by phytoplankton, meaning that 50% of every breath you take was generated by these microscopic organisms. Phytoplankton form the primary foundation of the marine food web, as virtually all oceanic life ultimately relies on them for food. By converting solar energy into sugars, algae serve as a vital food source for zooplankton[22]. These zooplankton are then consumed by larger zooplankton, shellfish, fish, and baleen whales. As small fish are eaten by sea birds and larger predators, the entire food web relies on this baseline energy transfer. Apex predators and marine species- including penguins, sharks, killer whales, and dolphins- depend on plankton for survival[23,24].

Many hypotheses have been proposed regarding the role of diversity in maintaining ecosystem processes, but current attention focuses primarily on four broad principles. In many ways, these principles relate to Darwin's proposition that a higher number of species provides a greater level of functional stability compared to a lower number[25]. Thus, the loss of species inevitably affects the functional integrity of the ecosystem. The "redundant species hypothesis" challenges this view; since species are not represented equally, some contribute far more to ecosystem functions than others. Indeed, certain "keystone species" drive key functions and are far more influential than "passenger" species[26,27]. Consequently, the argument holds that while a minimum level of diversity is essential for adequate ecosystem functioning, most species are essentially redundant in their roles. Standing in stark contrast to this perspective is the "rivet hypothesis," which assigns an essential, contributory role to every species; the loss of any species from the overall system- akin to rivets popping out of an aircraft's structure- leads to severe functional impairment and system failure[28-30].

2. Materials and Methods

Study Area

The Govind Sagar Dam is the primary attraction of Lalitpur city. Constructed on the Shahzad River between 1947 and 1953, the dam is situated in the Lalitpur district of southern Uttar Pradesh at coordinates 24°40'27" N latitude and 78°25'25" E longitude. Given its significance for agriculture, recreation, and fisheries, it serves as a vital pillar of the local economy.

Sampling Stations

For this research work, five sampling stations were selected to conduct a limnological study of the Govind Sagar Dam in Lalitpur. Samples were collected biweekly over the course of a one-year study period, spanning from March 2023 to February 2024. A variety of fishing gear with varying mesh sizes- including gill nets, hook and line, trawl nets, and purse seines- was utilized for sample collection, complemented by extensive photography for data gathering.

3. Results and Discussion

Phytoplankton Population

The plankton population across the study areas exhibited an abundance of phytoplankton, primarily composed of Cyanophyceae, Bacillariophyceae (diatoms), Chlorophyceae (green algae), Euglenophyceae, and Desmidaceae. The dominant genera recorded were *Volvox*, *Chlamydomonas*, *Euglena*, *Anabaena*, *Navicula*, and *Spirogyra*. The high prevalence of *Anabaena*, *Microcystis*, *Nitzschia*, and various *Navicula* species characterizes the overall phytoplankton composition in the Govind Sagar Dam.

Overall plankton density varied seasonally across summer, monsoon, and winter, with phytoplankton constituting the vast majority of the total population. Phytoplankton numbers peaked during the winter season and reached their minimum during the rainy (monsoon) season. Bacillariophyceae was the primary representative phytoplankton group, followed by zooplankton. Additionally, indicator species such as *Ankistrodesmus* sp., *Coelastrum* sp., *Pediastrum* sp., *Scenedesmus* sp., *Actinastrum* sp., *Cymbella* sp., *Cyclotella* sp., *Fragilaria* sp., *Anabaena* sp., *Lyngbya* sp., *Merismopedia* sp., and *Spirulina* sp. were recorded in smaller numbers within the lotic waters of the dam.

Table 1: Mean monthly variation in phytoplankton density (org · L^{-1}) in Govind Sagar Dam, Lalitpur (March 2023 – February 2024).

Groups	March	April	May	June	July	August	September	October	November	December	January	February
Station A												
Chlorophyceae	72	131	91	30	57	24	17	104	42	22	42	103
Bacillariophyceae	77	68	44	56	35	34	13	43	24	23	73	66
Cyanophyceae	156	145	161	71	84	41	23	97	34	41	51	187
Euglenophyceae	07	17	11	04	12	-	08	04	04	-	04	02
Total	**312**	**361**	**307**	**161**	**188**	**99**	**61**	**248**	**104**	**86**	**170**	**358**
Station B												
Chlorophyceae	33	75	32	32	50	22	35	64	21	32	15	24
Bacillariophyceae	33	46	24	34	10	12	12	50	17	20	25	36
Cyanophyceae	80	125	50	35	46	32	34	80	34	40	22	32
Euglenophyceae	03	10	05	03	-	04	05	04	05	-	04	-
Total	**149**	**256**	**111**	**104**	**106**	**70**	**86**	**198**	**77**	**92**	**66**	**92**
Station C												
Chlorophyceae	30	92	22	14	32	15	50	23	22	30	16	47
Bacillariophyceae	50	37	43	32	15	50	45	40	43	61	20	76
Cyanophyceae	44	104	42	34	44	21	22	33	64	62	16	66
Euglenophyceae	05	04	02	04	04	03	03	06	06	07	05	-
Total	**129**	**237**	**109**	**84**	**95**	**89**	**120**	**102**	**135**	**160**	**57**	**189**
Station D												
Chlorophyceae	50	67	18	22	36	16	22	35	22	24	13	30
Bacillariophyceae	41	35	22	41	23	27	32	23	12	35	34	50
Cyanophyceae	101	112	30	52	66	20	24	44	36	26	17	60
Euglenophyceae	05	05	01	04	05	-	02	-	04	02	-	05
Total	**197**	**219**	**71**	**119**	**130**	**63**	**80**	**102**	**74**	**87**	**64**	**145**
Station E												
Chlorophyceae	62	112	82	36	55	22	15	101	40	24	40	101
Bacillariophyceae	70	64	43	52	31	28	12	42	26	26	68	05
Cyanophyceae	138	142	158	66	83	42	22	88	34	44	50	162
Euglenophyceae	08	15	10	06	14	-	06	03	03	-	03	03
Total	**278**	**333**	**293**	**160**	**183**	**92**	**55**	**234**	**103**	**94**	**161**	**271**

Phytoplankton Group Dynamics Analysis of key phytoplankton groups- specifically Chlorophyceae, Euglenophyceae, Bacillariophyceae, and Cyanophyceae- revealed distinct seasonal patterns, with population densities reaching their minimum during the winter season and peaking at their maximum during the summer season.

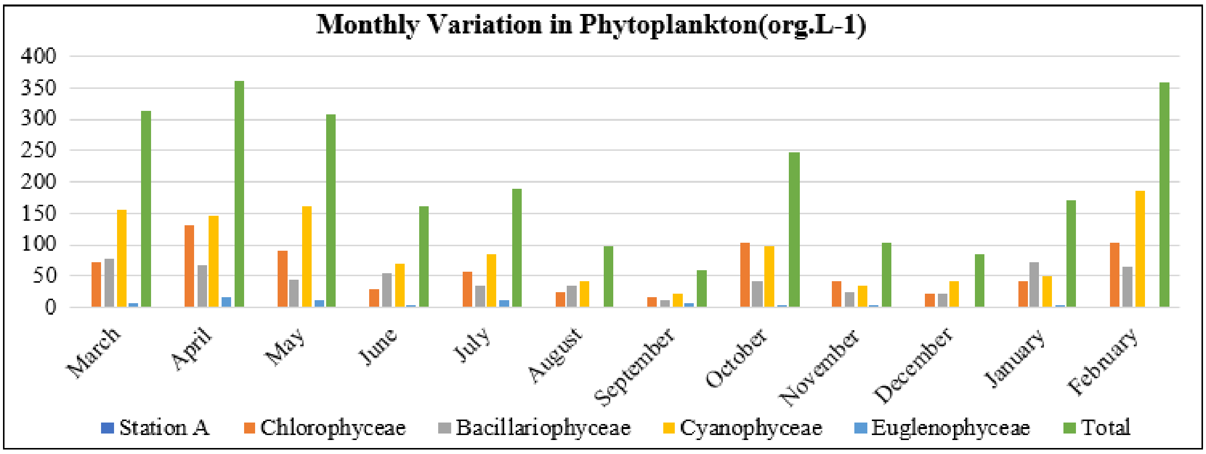

Figure 1: Seasonal variation in phytoplankton species composition at Station A (Govind Sagar Dam, Lalitpur).

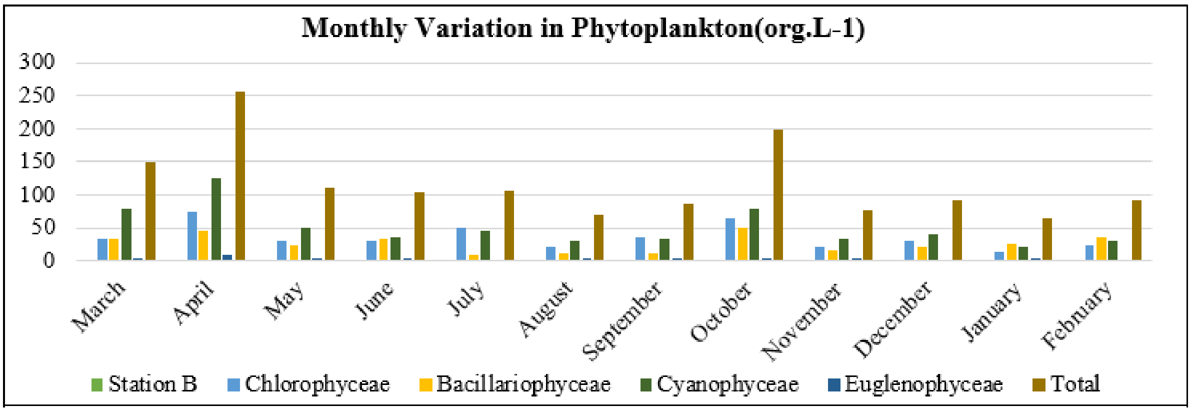

Figure 2: Seasonal variation in phytoplankton species composition at Station B (Govind Sagar Dam, Lalitpur)

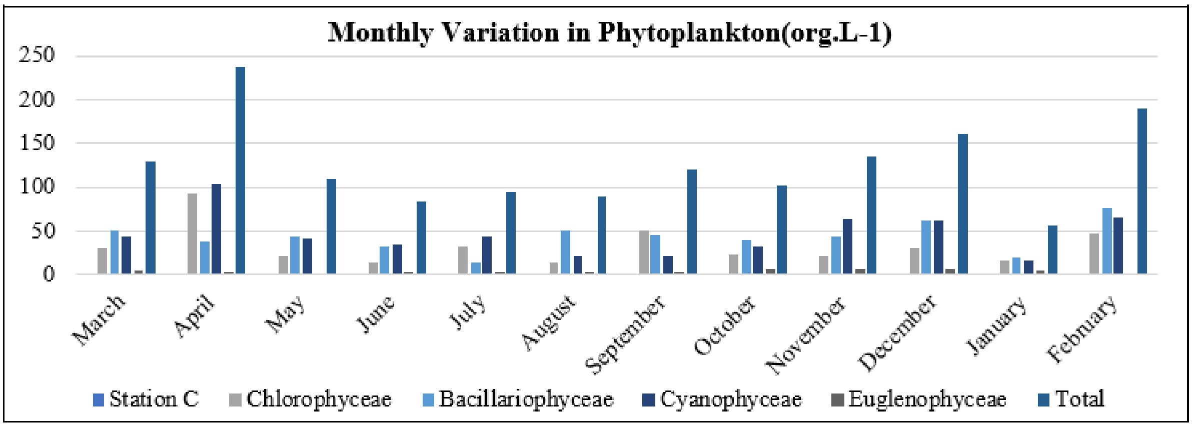

Figure 3: Seasonal variation in phytoplankton species composition at Station C (Govind Sagar Dam, Lalitpur)

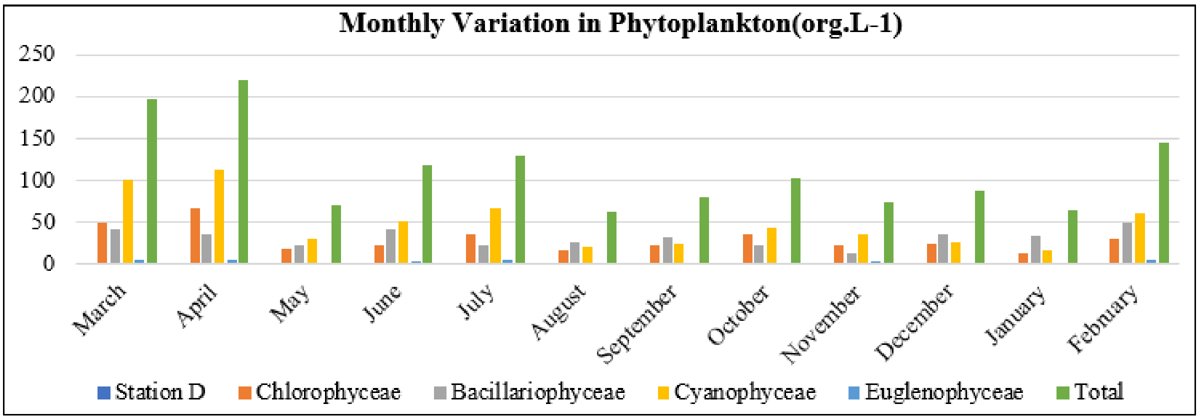

Figure 4: Seasonal variation in phytoplankton species composition at Station D (Govind Sagar Dam, Lalitpur)

International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2025: 7.089

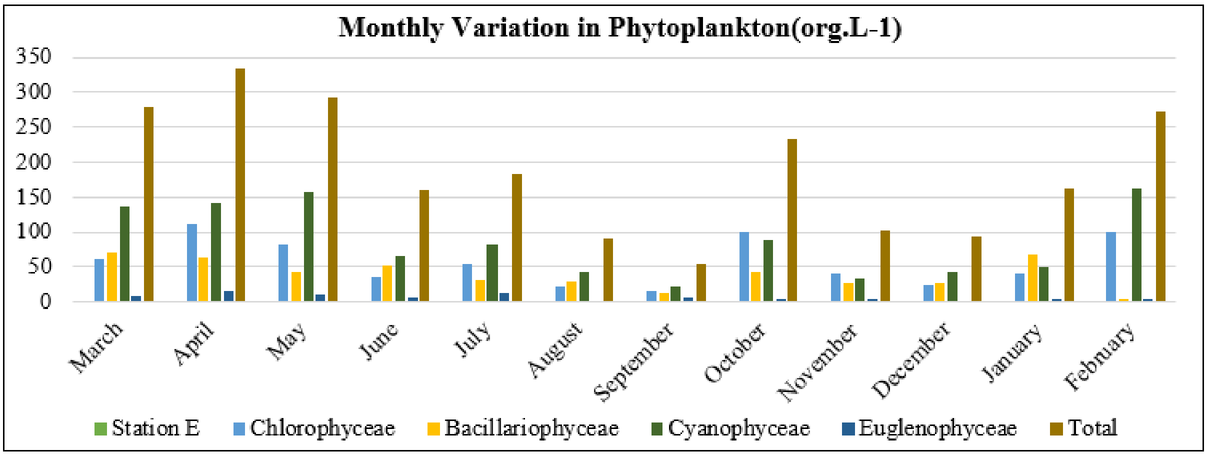

Figure 5: Seasonal variation in phytoplankton species composition at Station E (Govind Sagar Dam, Lalitpur).

The primary factors influencing this seasonal pattern include water temperature, photoperiod duration, salinity, and concentrations of both organic and inorganic nutrients. Higher water clarity facilitates deeper sunlight penetration, which raises water temperature and increases dissolved carbon dioxide, bicarbonate levels, pH, and conductivity. These factors positively correlate with and stimulate phytoplankton populations. Additionally, phosphorus concentrations exhibit a strong positive correlation with overall phytoplankton growth.

Zooplankton Population

The zooplankton community in the study area comprises species from five major groups: Protozoa, Rotifera, Cladocera, Ostracopoda, and Copepoda, with Ostracopoda and Rotifera representing the most abundant taxa. Overall zooplankton populations exhibit marked seasonal variations, increasing rapidly as temperatures rise during the summer and declining during the rainy season. These demographic shifts indicate that zooplankton density is strongly regulated by seasonal changes in physicochemical water quality parameters.

Specifically, Protozoa and Ostracopoda populations reached their minimum during the rainy season and peaked during the winter months. This seasonal surge is primarily driven by warmer water temperatures, heightened metabolic activity, nutrient enrichment, and abundant organic matter supplied by decaying aquatic organisms. Additionally, environmental variables such as lower concentrations of dissolved oxygen and carbon dioxide during summer, alongside elevated dissolved oxygen levels during winter, appear to play a key role in modulating these population dynamics.

Table 2: Mean monthly variation in zooplankton density (org · L^{-1}) in Govind Sagar Dam, Lalitpur (March 2023 – February 2024).

Groups	March	April	May	June	July	August	September	October	November	December	January	February
						Station A						
Protozoa	42	25	71	18	45	11	06	25	13	17	13	15
Rotifera	70	72	57	116	68	20	48	40	21	50	34	50
Cladocera	35	56	17	41	13	07	08	28	24	13	11	42
Copepoda	48	35	55	110	22	10	20	20	20	11	12	57
Ostracoda	07	06	12	14	03	01	-	04	05	01	-	04
Total	**202**	**194**	**212**	**299**	**151**	**49**	**82**	**117**	**83**	**92**	**70**	**168**
						Station B						
Protozoa	25	32	17	08	13	07	08	05	08	12	-	10
Rotifera	24	66	73	126	28	28	23	62	35	53	18	100
Cladocera	31	37	12	24	10	17	12	10	20	06	23	17
Copepoda	63	80	83	120	38	16	30	55	41	18	23	73
Ostracoda	18	23	06	16	06	01	07	13	04	10	02	08
Total	**161**	**238**	**191**	**294**	**95**	**69**	**80**	**145**	**108**	**99**	**66**	**208**
						Station C						
Protozoa	28	14	68	23	72	08	06	28	12	05	06	16
Rotifera	121	137	141	155	22	36	47	78	48	36	43	67
Cladocera	25	21	08	38	10	06	08	14	10	08	07	10
Copepoda	131	111	83	173	62	30	40	88	42	27	40	57
Ostracoda	09	15	04	24	07	04	-	04	06	11	03	16
Total	**314**	**298**	**304**	**413**	**173**	**84**	**101**	**212**	**118**	**87**	**99**	**166**
						Station D						
Protozoa	30	75	20	92	20	05	08	23	02	08	10	34
Rotifera	108	135	66	130	41	27	41	95	90	43	23	55
Cladocera	40	28	55	24	12	07	11	38	37	10	12	21
Copepoda	194	120	77	274	21	26	22	109	61	80	51	90
Ostracoda	15	06	22	12	-	06	07	12	08	03	06	05

Total	387	364	240	532	94	71	89	277	198	144	102	205
Station E												
Protozoa	40	28	67	16	42	12	05	23	11	15	12	13
Rotifera	68	69	55	112	64	22	45	38	22	48	32	48
Cladocera	32	54	16	40	14	06	08	26	22	11	10	40
Copepoda	46	32	52	108	20	12	18	18	18	12	13	55
Ostracoda	06	05	10	12	03	02	-	03	04	02	-	03
Total	**192**	**188**	**200**	**288**	**143**	**54**	**76**	**108**	**77**	**88**	**67**	**159**

Zooplankton Dynamics and Community Composition

Zooplankton population dynamics were studied extensively, and the resulting quantitative data were systematically tabulated. The quantitative abundance of zooplankton in aquatic ecosystems is critical for effective aquaculture management, as population densities vary significantly across geographic regions and even among different water bodies within the same ecological zone.

In the studied water body, overall zooplankton abundance reached its peak during the rainy season and dropped to its minimum during the winter months, with a secondary peak observed between February and March. Among the identified taxa, Protozoa (notably *Monas*) were present throughout the entire study period. Cladocerans were primarily represented by *Daphnia* sp., *Moina* sp., *Bosmina* sp., and *Chydorus* sp., with maximum numbers observed in June and minimum densities recorded during December and January. The copepod community was dominated by *Cyclops* sp., *Diaptomus* sp., and *Nauplius* larvae, reaching their peak abundance during May and June. Rotifers were represented mainly by *Asplanchna* sp., *Filinia* sp., and *Rotaria* sp., which were most prevalent in June.

4. Conclusion

The limnological analysis conducted at Govind Sagar Dam reveals a rich and diverse plankton community (both phytoplankton and zooplankton) within the reservoir's aquatic ecosystem. Algal flora and rotifers constitute the dominant planktonic groups in this water body. Zooplankton- particularly rotifers- serve as a crucial primary food source for fish larvae, highlighting their importance for aquaculture management. Within the phytoplankton community, members of Cyanophyceae were predominant, followed by Chlorophyceae, Bacillariophyceae, and Euglenophyceae. Ultimately, this study provides valuable insights into freshwater plankton diversity and seasonal community dynamics, offering essential baseline data to support sustainable fisheries management and aquaculture development in the region.

Acknowledgement

The author expresses heartfelt gratitude to Meerut College, Meerut, and BBC, Jhansi, for their valuable assistance in the identification of the reported plankton specimens.

References

[1] Anand, N. (1998). *Indian Freshwater Microalgae*. Bishen Singh Mahendra Pal Singh, Dehradun, pp. 5–88.

[2] Ansari, E., Gadhia, M., & Ujjania, N. C. (2015). Phytoplankton diversity and water quality assessment of ONGC pond, Hazira. *International Journal of Research in Environmental Science*, 1(1), 1–15.

[3] APHA. (2005). *Standard Methods for the Examination of Water and Wastewater* (21st ed.). American Public Health Association, Water Environment Federation, AWWA, New York.

[4] Ashok, A. J., Reshma, J. K., Mathew, A., & Raghunath, R. (2015). Effect of water quality on phytoplankton abundance in selected ponds of Athiyannoor Block Panchayat, Kerala. *Journal of Science Research in Applied Sciences*, 1(2), 91–100.

[5] Bais, V. S., & Agarwal, N. C. (1990). Seasonal variations of nitrogen contents in the sediment and water of the Sagar Lake. *Bulletin of Environmental Sciences*, 8, 21–24.

[6] Desikachary, T. V. (1959). *Cyanophyta*. Indian Council of Agricultural Research, New Delhi.

[7] Devi, U. A., & Singara Charya, M. A. (2007). Phytoplankton in Lower Manair Dam and Kakatiya Canal, Karimnagar. *Nature Environment and Pollution Technology*, 6(4), 643–648.

[8] Devika, R., Rajendran, A., & Selvapathy, P. (2006). Variation studies on the physicochemical and biological characteristics at different depths in model waste stabilization tank. *Pollution Research*, 24, 771–774.

[9] Fritsch, F. E. (1935). *The Structure and Reproduction of the Algae* (Vol. 1). Cambridge University Press, London.

[10] Ganai, A. H., Parveen, S., Khan, A. A., & Maryam, H. (2010). Phytoplankton diversity at Watlab Ghat in Wular Lake, Kashmir. *Journal of Ecology and the Natural Environment*, 2(8), 140–146.

[11] Gopinath, P. T., & Ajit Kumar, K. G. (2014). A study on the physico-chemical parameters and diversity of phytoplankton in Vellayani Lake, Thiruvananthapuram, Kerala, India. *Journal of Aquatic Biology & Fisheries*, 2, 489–492.

[12] Harikrishnan, K., Sabu, G., Sanil, M., Paul, M., Satish, M., & Das, M. R. (1999). A study on the distribution and ecology of phytoplankton in the Kuttanad wetland ecosystem, Kerala. *Pollution Research*, 18, 261–269.

[13] Hudder, B. D. (1995). *Hydrobiological studies in lentic freshwater bodies of Hubli* (Doctoral dissertation). Karnatak University, Dharwad, pp. 267.

[14] Hujare, M. S. (2008). Seasonal variation of phytoplankton in the freshwater tank of Talsande, Maharashtra. *Nature Environment and Pollution Technology*, 7(1), 147–150.

[15] Jasprica, N., Dubravka, H., Marina, C., & Rimac, A. (2006). A preliminary investigation of phytoplankton of karstic pond (Dugi Otok Island, Croatia). *Acta Botanica Croatica*, 65(2), 181–190.

[16] Jayabhaye, U. M. (2010). Studies on phytoplankton diversity in Sawana Dam, Maharashtra, India. *Samiksha Aur Mulyankan*, 11(11-12), 40–42.

[17] Joseph, J. (2012). *Studies on the cyanobacterial diversity from selected freshwater environment and its application in biotechnology* (Doctoral dissertation). Manonmaniam Sundaranar University, Tirunelveli.

[18] Álvarez-Cobelas, M., Rojo, C., & Angeler, D. G. (2005). Mediterranean limnology: Current status, gaps and the future. *Journal of Limnology*, 64(1), 13–29.

[19] Angeler, D. G., & Rodrigo, M. A. (2004). Ramp-disturbance-ramp response: A simple model for wetland disturbance ecology. *Marine and Freshwater Research*, 55(1), 33–37.

[20] Pithart, D., Pichlová, R., Bílý, M., Hrbáček, J., Novotná, K., & Pechar, L. (2007). Spatial and temporal diversity of small shallow waters in river Lužnice floodplain. *Hydrobiologia*, 584, 265–275.

[21] Reynolds, C. S. (1997). *Vegetation Processes in the Pelagic: A Model for Ecosystem Theory*. Ecology Institute, Oldendorf-Luhe.

[22] Reynolds, C. S., Huszar, V. L. M., Kruk, C., Naselli-Flores, L., & Melo, S. (2002). Towards a functional classification of the freshwater phytoplankton. *Journal of Plankton Research*, 24(5), 417–428.

[23] Rodrigo, M. A., Rojo, C., & Armengol, X. (2002). Plankton biodiversity in a landscape of shallow water bodies (Mediterranean coast, Spain). *Hydrobiologia*, 506, 317–326.

[24] Rodrigo, M. A., Rojo, C., & Álvarez-Cobelas, M. (2003). Autotrophic and heterotrophic picoplankton in wetlands: Differences with lake patterns. *International Review of Hydrobiology*, 88(5), 464–481.

[25] Scheffer, M., & van Nes, E. H. (2007). Shallow lakes theory revisited: Various alternative regimes driven by climate, nutrients, depth and lake size. *Hydrobiologia*, 584, 455–466.

[26] Vörös, L., Callieri, C., Balogh, K. V., & Bertoni, R. (1998). Freshwater picocyanobacteria along a trophic gradient and light quality. *Hydrobiologia*, 369/370, 117–125.

[27] Wagner, C., & Adrian, R. (2009). Exploring lake ecosystems: Hierarchy responses to long-term change? *Global Change Biology*, 15(5), 1104–1115.

[28] Ward, J. V., & Tockner, K. (2001). Biodiversity: Towards a unifying theme for river ecology. *Freshwater Biology*, 46(6), 807–819.

[29] Zwart, G., Crump, B. C., Agterveld, M. P. K., Hagen, F., & Han, S. K. (2002). Typical freshwater bacteria: An analysis of available 16S rRNA gene sequences from plankton of lakes and rivers. *Aquatic Microbial Ecology*, 28(2), 141–155.

[30] Beckerman, A. P., Petchey, O. L., & Warren, P. H. (2006). Foraging biology predicts food web complexity. *Proceedings of the National Academy of Sciences USA*, 103(37), 13745–13749.