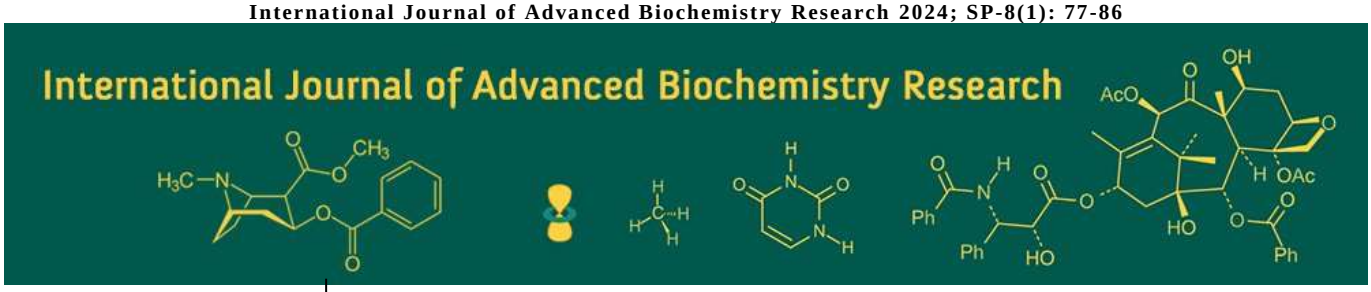

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; SP-8(1): 77-86
www.biochemjournal.com
Received: 09-09-2023
Accepted: 12-10-2023

Suneel Verma
Department of Fisheries Resource Management, COFS, CCSHAU, Hisar, Haryana, India

Gajender Singh
Department of Fisheries Resource Management, COFS, CCSHAU, Hisar, Haryana, India

Ambrish Singh
Department of Fisheries Resource Management, COFS, CCSHAU, Hisar, Haryana, India

Ravikant
(1) Department of Fisheries Resource Management, COFS, CCSHAU, Hisar, Haryana, India
(2) Department of Aquatic Animal Health Management, COFS, CCSHAU, Hisar, Haryana, India

Pragya Mehta
Department of Fisheries Resource Management, COFS, CCSHAU, Hisar, Haryana, India

Mitrasen Maurya
(1) Department of Fisheries Resource Management, COFS, CCSHAU, Hisar, Haryana, India
(2) Department of Aquaculture, COFS, CCSHAU, Hisar, Haryana, India

Shivam Pandey
(1) Department of Fisheries Resource Management, COFS, CCSHAU, Hisar, Haryana, India
(2) Department of Aquatic Animal Health Management, COFS, CCSHAU, Hisar, Haryana, India

Corresponding Author:
Shivam Pandey
(1) Department of Fisheries Resource Management, COFS, CCSHAU, Hisar, Haryana, India
(2) Department of Aquatic Animal Health Management, COFS, CCSHAU, Hisar, Haryana, India

Assessment of plankton diversity of blue bird lake at Hisar Haryana, India

Suneel Verma, Gajender Singh, Ambrish Singh, Ravikant, Pragya Mehta, Mitrasen Maurya and Shivam Pandey

DOI: https://doi.org/10.33545/26174693.2024.v8.i1Sb.288

Abstract
The study was conducted in Blue Bird Lake, which is close to Hisar Airport on National Highway 10 in the town of Hisar, in the Hisar district of Haryana State, India. Plankton evaluation and quantification at Blue Bird Lake were monitored from September 2022 to February 2023. The study revealed that the presence of 46 different genera of plankton, comprising 33 genera of phytoplankton and 13 genera of zooplankton. The phytoplankton was classified into eight main groups: Bacillariophyceae (6 genera), Chlorophyceae (12 genera), Cyanophyceae (4 genera), Dinophyceae (3 genera), Hymenomonadaceae (1 genus), Zygnematophyceae (2 genera), Trebouxiophyceae (2 genera), and Euglenophyceae (3 genera). The zooplankton was classified into six major groups: Copepod (4 genera), Cladocera (2 genera), Rotifers (4 genera), Ascarididae (1 genus), Protozoa (1 genus), and Tubulinea (1 genus). Analysis of the distribution of phytoplankton across various months indicated that sites 1, 2, and 3 had the highest number of species of phytoplankton (84 species). Chlorophyceae was the dominant group in these sites, while Cyanophyceae was the dominant group in Site 4. Among zooplankton, Rotifers were the dominant group, and the most prevalent species were found in sites 1, 2, 3 and 4. Quantitative analysis revealed that the maximum quantity of phytoplankton was observed in October (66800 plankton per litre) in sites 1, 2, 3, and 4, while the minimum quantity was observed in November (28400 plankton per litre). Similarly, the maximum quantity of zooplankton was observed in September (53000 zooplankton per litre), and the minimum quantity was followed in February (22400 zooplankton per litre). The study also calculated the Shannon and Weaver diversity index to assess the diversity of zooplankton and phytoplankton. The highest diversity index for zooplankton was found in site 3 (1.74), while the lowest was in site 1 (1.37). In the case of phytoplankton, the highest diversity index was observed at site 4 (2.47), while the lowest was at site 2 (1.47). The overall diversity index for plankton was highest in sites 3 and 1 (2.28) and lowest in site 2 (2.23).

Keywords: Phytoplankton, zooplankton, Shannon – weaver diversity index

Introduction
Water is an essential component of the environment and supports life on earth. The state of Haryana, located in north-eastern India, has vast water resources, providing an excellent opportunity to increase fish production (Bhatnagar and Singh, 2010) [5]. Blue Bird Lake is situated in the Hisar district of Haryana, with coordinates between 29.10`46''N latitude and 75.43`7''E longitude. The lake is around 20 acres in size, with an average depth of 4-5 meters. Phytoplankton, a vital component of the aquatic ecosystem, plays a crucial role in energy transfer to higher trophic levels. These microscopic plant communities exist in both freshwater and marine environments and contribute to 95% of total marine plant production (Yadav, 2015) [30]. Most of them are autotrophic, and they use chlorophyll-based photosynthesis to harness solar energy, much like terrestrial plants (Findlay and Kling, 2001) [7]. Phytoplankton is ubiquitous in various aquatic settings and plays a significant role in sustaining aquatic food webs. It also serves as an excellent barometer of environmental and ecological shifts (Manickam *et al*., 2012) [14]. This group encompasses diatoms, dinoflagellates, cocolithoides (prymenophyceae), cyanophytes, and chlorophytes (Gireesh *et al*., 2015) [9]. Many fish and shellfish larvae rely on small phytoplanktonic and zooplanktonic organisms as their primary food source (Das *et al*., 2012) [6]. Zooplankton, another microscopic component of aquatic ecosystems, plays a crucial role in the transfer of energy from lower to higher trophic levels.

It is also highly sensitive to external disturbances and serves as an indicator of environmental changes such as global warming or increased atmospheric carbon dioxide levels. Zooplankton is also used to gauge water quality, trophic status, and pollution levels, contributing significantly to the secondary production within aquatic ecosystems (Singh and Bhatnagar, 2010 and Singh *et al*., 2016) [24, 25]. These organisms occupy an intermediary position in the food web, facilitating the transfer of energy from lower to higher trophic levels (Ansari and Khan, 2014) [3].

Material and Methods

The monthly plankton samples were taken from Blue Bird Lake from September 2022 to February 2023 for the factors governing water quality. Plankton samples were collected by filtering 50L of water through plankton net of mesh size 50µm with a demarcating collecting tube. These samples were collected in 100 ml plastic bottles, and concentrated samples were then made up to a standard volume of 50 ml with distilled water. Samples were preserved with 4% buffered formalin. The organisms per liter unit used to express plankton abundance in a cell with Sedgwick rafter organisms were counted. The cell cavity received 1.0 ml of the concentrated sample. The number of plankton to genus levels was studied and identified using the keys from Ward and Whipple (1959) [27], Needham and Needham, (1962) [17], and APHA, (1998) [4].

Total no. of planktons.
L-1 =

Where
P = Number of plankton counted in ten fields
C = Volume of final concentrate of the sample (ml)
L = Volume of water sample filtered

Total phytoplankton
L-1 =

Where,
Pp = The number of phytoplankton counted in ten field
C = Volume of final concentrate of sample (ml)
L = The volume of water sample filtered

Total no. of zooplanktons.
L-1 =

Where,
Pz = The number of Zooplankton counted in ten fields
C = Volume of final concentrate of the sample (ml)
L = The volume of water sample filtered
Species diversity index (d)

Species diversity of phytoplankton and zooplankton was determined using the
Shannon and Weaver Diversity Index method (Shannon and Weaver, 1963; [21] Washington, 1984) [28].

$d = - \sum (ni/N) \log 2\ ni/N$

Where
d = Species diversity
ni = Number of individuals of ith species.
N = Total number of individuals in the sample

Results and Discussion

Phytoplankton is significantly responsible for producing oxygen in the atmosphere. Cyanobacteria, diatoms, and green algae are phytoplankton. During the study period, planktons were collected from four distinct places (S1, S2, S3, S4) in Haryana's Blue Bird Lake Hisar district. The qualitative analysis of these is 33 genera of phytoplankton in total belonging to eight major groups: Bacillariophyceae (consisting of 6 genera), Chlorophyceae (consisting of 12 genera), Cyanophyceae (consisting of 4 genera), Dinophyceae (consisting of 3 genera), Hymenomonadaceae (consisting of 1 genus), Zygnematophyceae (consisting of 2 genera), Trebouxiophyceae (consisting of 2 genera and Euglenophyceae (consisting of 3 genera). Kumar and Khare (2015) [11] in the district of Jalaun, Uttar Pradesh, researchers examined the variety of plankton and its seasonal fluctuation in density. 25 taxa were found to include 35 different species of phytoplankton, including the Bacillariophyceae (5 species), Euglenophyceae (7 species), Chlorophyceae (15 species), and Euglenophyceae (12 species). Sarwade and Kamble (2014) [20] reported plankton in numerous areas along the river Krishna in the Sangli region and reported 53 phytoplankton species in five groups (Cyanophyceae, Bacillariophyceae, Chlorophyceae, Hydrocharitaceae, and Desmidiceae). The Chlorophyceae subfamily was the most numerous, accounting for 22 species. The current study followed a similar pattern: Chlorophyceae predominated across all species. Kumar *et al.*, (2020) [12], thirty-one genera in the five groups Bacillariophyceae, Chlorophyceae, Myxophyceae, Euglenophyceae, and Xanthophyceae, as well as a total of 21 phytoplankton species in the three essential categories Bacillariophyceae, Chlorophyceae, and Cyanophyceae, were seen and compiled. Chlorophyceae was the most prevalent phytoplankton group found during the current investigation in the Ottu reservoir, followed by Euglenophyceae (17.54%), Bacilliriophyceae (15.41%), and Cyanophyceae (1.20%), and a similar dominant group of Chlorophyceae found by (Ahmed *et al*., 2003; Shyam *et al*., 2020) [1, 22] with 95.0% and 50%, respectively. Negi *et al*., (2015) [32] also discovered consistent with those made in Nainital Lake between 2007 and 2009 when 25 genera of phytoplankton from three classes Bacillariphyceae (13 genera), Chlorophyceae (8 genera), and Cyanophyceae (4 genera) were identified. Singh *et al*., 2023 [31] similar type of study conducted at Okhla Barrage reported a total of 31 genera, which can be categorized into four major groups Bacillariophyceae (9 genera), Chlorophyceae (15 genera), Cyanophyceae (6 genera) and Euglena, representing Euglenophyceae, has only a single genus. The qualitative analysis of these four different samples exposed that, among the total zooplankton, 13 zooplanktons in total belonging to six major groups belong to the classes Copepod (consisting of 4 genera), Cladocera (consisting of 2 genera), Rotifers (consisting of 4 genera), Ascarididae (consisting of 1 genus), Protozoa (consisting of 1 genus) and Tubulinea (consisting of 1 genus). A Similar study found a similar group on zooplankton diversity of Julur Nalgonda district revealed 26 genera of zooplankton, out of which 8 genera were represented by Rotifers, 5 by Copepods, 12 by Cladocera and 1 by Ostracods Ankathi and Piska, (2009) [2]. Another study on the variety of zooplankton in a tropical wetland system found that there were 36 genera of zooplankton, which were divided into 6 groups: Rhizopoda,

Cladocera, Rotifera, Ciliophora, Copepoda, and others, such as Zooflagellates, Ostracoda, Callanoids, and Herpacticoids Nirmal Kumar *et al*., (2011) [18]. A Similar study on 13 zooplankton species was found in Jal Ghar Bhiwani, Haryana, India, and they belonged to 13 genera, 9 families, 5 orders, and 4 classes. Rotifers were the primary group Kumar and Kumari, (2017) [13]. The current study is also in line with previous research, which classified the zooplankton diversity of the holy Lake Prashar in Himachal Pradesh, India, into five groups: Rotifera (38%), followed by Cladocera (26%), Protozoa (25%), Copepoda (6%), and Ostrocoda (5%); among these, Rotifera and Cladocera were the dominant groups throughout the study period (Sharma and Kumari, 2018 & Singh *et al*., 2021) [22, 26]. In another study, 29 zooplankton species were identified in the Bhimtal Lake in Uttarakhand, India, comprising 16 Rotifera species, 8 Cladocera species, and 5 Copepoda species. Among the three groups, the Rotifera group is dominated Panwar and Malik, (2016) [19].

Percentage variation of phytoplankton

In the study conducted at four different sites, various groups of phytoplankton were analyzed. At Site 1, the composition of Bacillariophyceae, Chlorophyceae, Cyanophyceae, Dinophyceae, and Euglenophyceae was 27%, 29%, 26%, 10%, and 8%, respectively.

Chlorophyceae showed the highest composition at 29%, while Euglenophyceae had the lowest at 8%. Site 2 had 28 observed species, with Chlorophyceae at 36% and Teouxiophyceae at 3%. Site 3 had 45 observed species, with Chlorophyceae at 33% and Hymenomonadaceae at 2%. Finally, Site 4 had 29 species, with Cyanophyceae at the highest composition of 41% and Zygnematophyceae at 4%.

Percentage variation of zooplankton

This study examined the composition of zooplankton groups across four different sites. At Site 1, there were 16 observed species, with Rotifers comprising 56%, Copepods 31%, and Cladocera 13% of the composition. Rotifers had the highest percentage at 56%, while Cladocera had the lowest at 13%. Site 2 had 13 observed species, with Rotifers at 46%, Copepods at 23%, Cladocera at 23%, and Tubulinea at 8%. Site 3 had 31 species, with Rotifers at 42%, Copepods at 23%, Cladocera at 26%, Protozoa at 6%, and Ascarididae at 3%. Lastly, Site 4 had 14 species, with Rotifers at 53% and Copepods at 13%, while Cladocera had 27%.

Quantitative analysis of phytoplanktons

A study was conducted on the phytoplankton counts in Blue Bird Lake over a period of six months at four different spots. The findings revealed some interesting patterns. During September, all four spots had relatively high phytoplankton counts, ranging from 29,400 to 37,600, suggesting that the population of phytoplankton in the lake was stable. In October, the counts slightly decreased with sites 1 and 2 experiencing a decline, while sites 3 and 4 showed an increase, ranging from 28,400 to 42,000. In November, there was a significant increase in phytoplankton populations at all spots, ranging from 58,200 to 66,800, indicating a significant rise in the lake's phytoplankton. In December, the patterns varied among the four spots, with sites 1 and 4 experiencing an increase in phytoplankton counts, while sites 2 and 3 experienced a decrease, ranging from 35,800 to 55,600. January maintained relatively constant numbers compared to December, with counts ranging from 33,400 to 42,400, without any specific spot showing a significant maximum or minimum value. In February, there was a significant increase in phytoplankton at site 2, reaching 57,800. While site 3 remained stable, sites 1 and 4 showed slight increases, ranging from 40,800 to 46,600 in phytoplankton counts.

Quantitative analysis of zooplanktons

During the study on zooplankton populations in Blue Bird Lake, four different sites were observed over several months. The study revealed interesting dynamics among the populations. At Site 1, the population started with a minimum of 25,000 individuals in September but steadily increased, reaching its peak in February at 45,400 individuals, indicating significant growth. In contrast, Site 2 began with a minimum population of 28,600 individuals in September, which decreased in October and November. However, it recovered in January and February, reaching a maximum of 43,000 individuals. This shows fluctuations in population during the observation months. Site 3 maintained a relatively stable population, starting at 30,000 individuals in September, declining to 22,800 in December, and then rising to 46,200 in February, but the overall range remained minimal. Site 4 began with a minimum population of 22,400 individuals in September, gradually increasing over the months, and reaching its maximum in February at 53,000 individuals, indicating a steady population growth trend. These findings are illustrated in Figure 4.10, highlighting the varying population dynamics of zooplankton across the different sites and months in Blue Bird Lake.

Shannon and Weaver diversity index for phytoplankton

During the research period at Blur Bird Lake, the Shannon and Weaver diversity index for phytoplankton at several sample sites showed variance in levels. The maximum values recorded in the species diversity index (H) were found at site 4 (2.06), site 1 (1.95), site 2 (1.91), and site 3 (1.89), in descending order. The diversity index (H) ranged from 3.34 to 2.45, as previously found by Ghosh *et al*. (2012) [8]. Post-monsoon, the most excellent value (most heterogeneity) discovered was 2.45, whereas the least (2.344) was seen during the monsoon. Hossain *et al*., (2017) [10] recorded the highest Shannon Index (H) for phytoplankton in Axr (0.6829) and the lowest in CV (0.5387). Nagi and Rajput, (2015) assessed the species richness index for phytoplankton diversity at Lake Nainital and found the highest richness (0.458) among Cynophyceae at site 1, followed by Bacillariophyceae and Chlorophyceae.

Shannon and Weaver diversity index for zooplankton

In the current experiment, differences in the Shannon and Weaver diversity index values for zooplankton were observed at several sample sites. The species diversity index value (H) showed that site 3 (1.74) had the highest value, followed by site 2 (1.55), site 3 (1.39), and site 1 (1.37). During the research period conducted by Sharma and Kumari (2018) [22], zooplankton at Prashar Lake showed Shannon Weaver diversity indices ranging from 2.80 to 3.16 at site 1, 2.84 to 3.17 at site 2, and 2.87 to 3.05 at site 3. Hossain *et al*. (2017) [10] studied the Ananda Bazare, AB (0.450), and Chor Aalexandar (0.693) locations, where the highest and lowest recorded Shannon Index (H) for zooplankton were found, respectively.

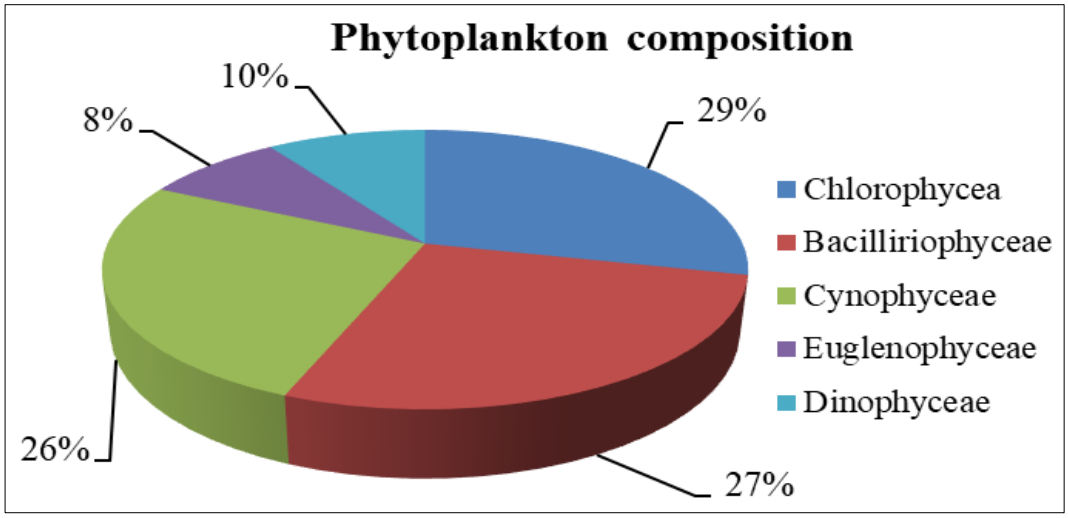

Fig 1: Percent composition of different phytoplankton groups at site 1

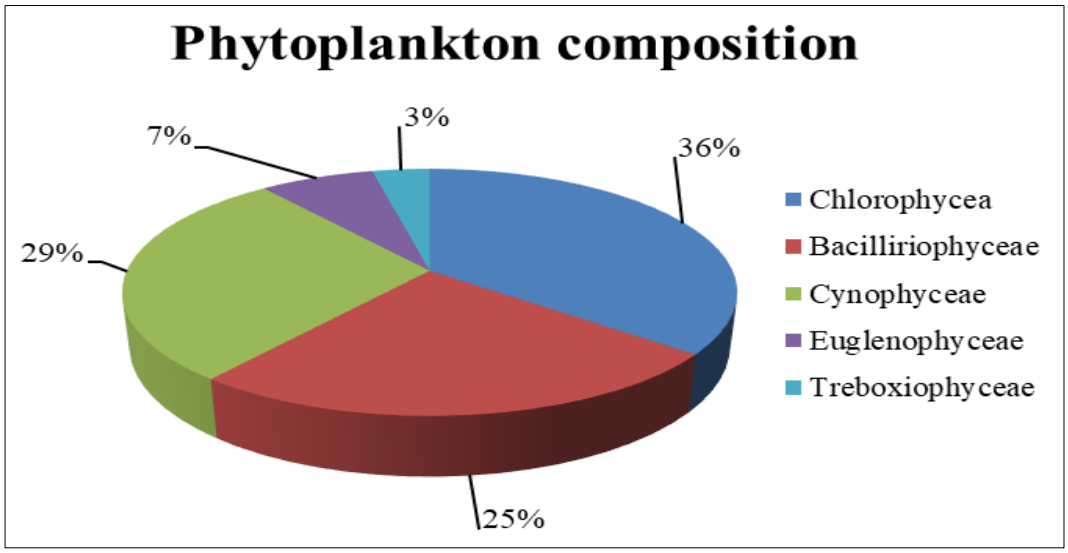

Fig 2: Percent composition of different phytoplankton groups at site 2

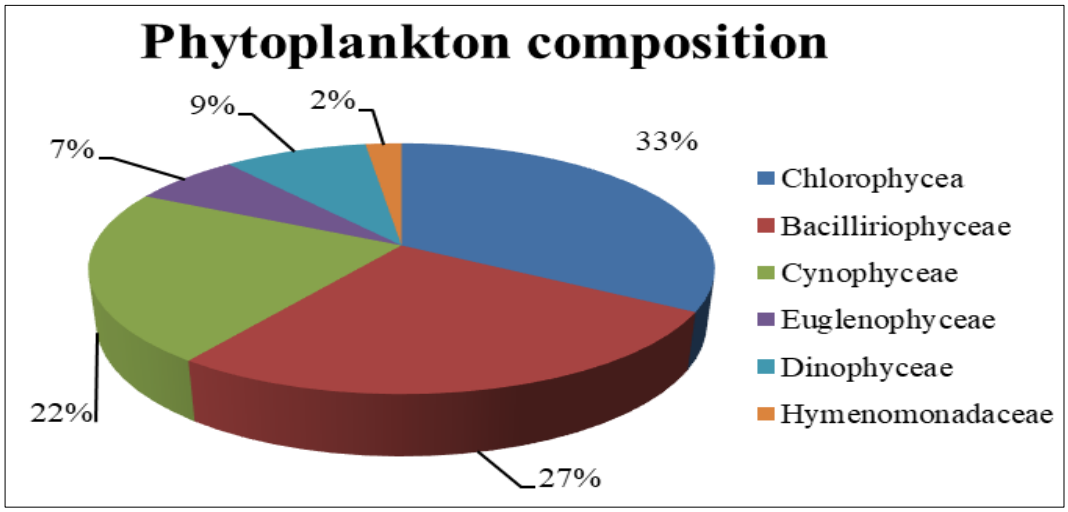

Fig 3: Percent composition of different phytoplankton group at site 3

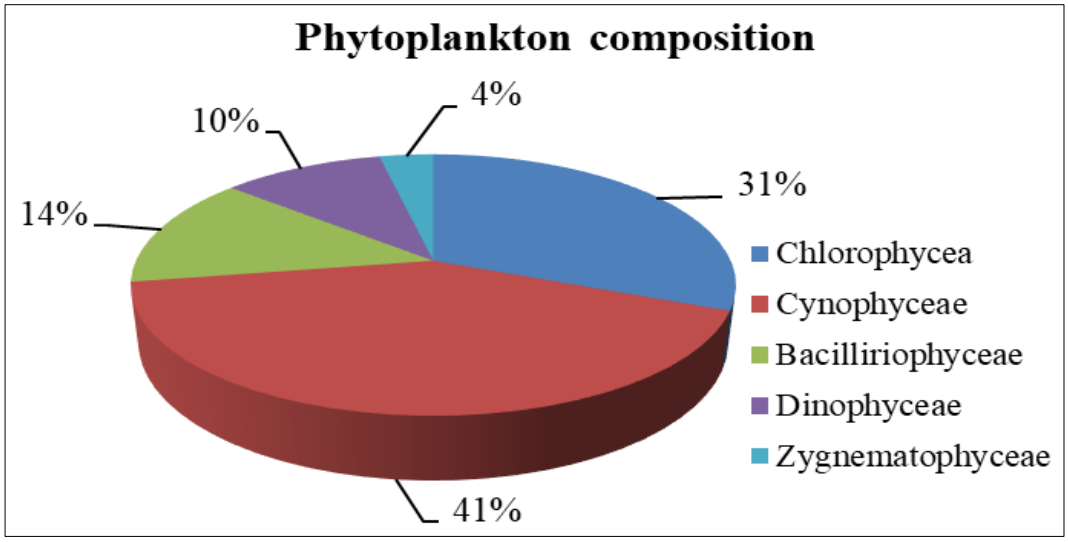

Fig 4: Percent composition of different phytoplankton groups at site 4

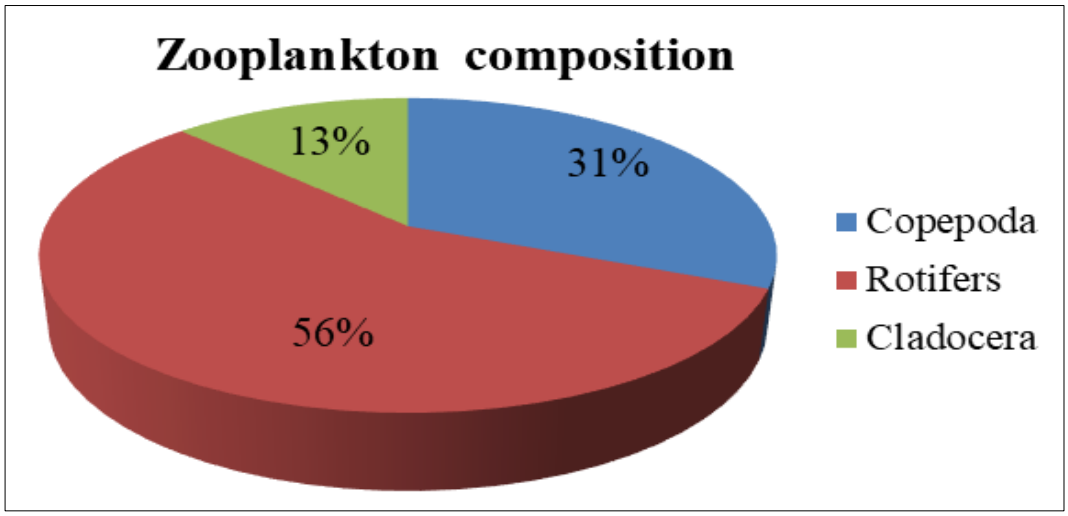

Fig 5: Percent composition of different zooplankton groups at site 1

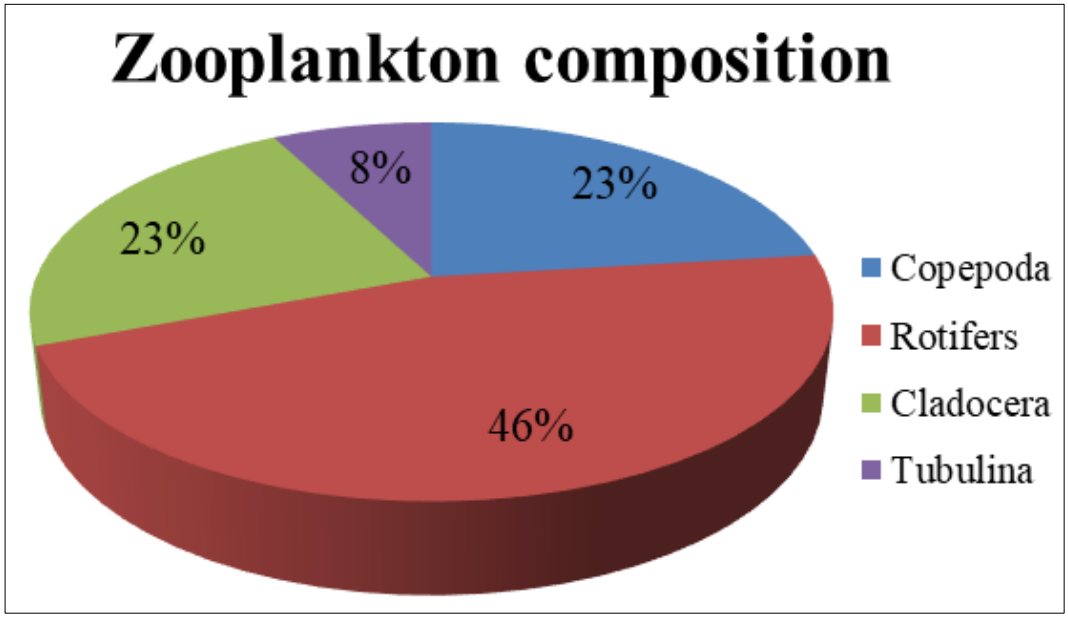

Fig 6: Percent composition in various zooplankton groups at site 2.

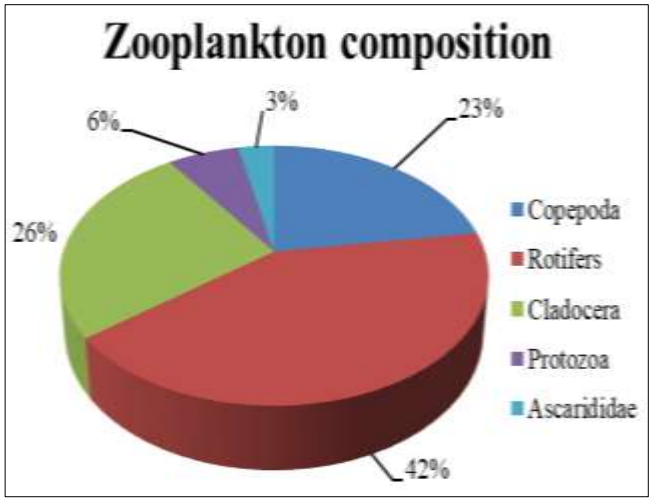

Fig 7: Percent composition of different zooplankton groups at site 3

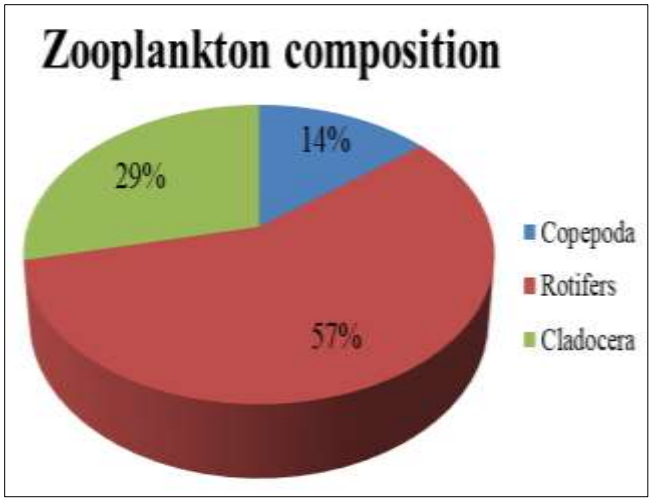

Fig 8: Percent composition of different zooplankton groups at site 4

Table 1: Monthly distribution of different phytoplankton species/ groups at sampling site 1

Group/Class	Species	September	October	November	December	January	February
Chlorophyceae	*Scenedesmus sp*	+	+	-	+	+	-
	Pediastrum sp	-	-	+	+	+	+
	Ankistrodasmus sp	+	-	-	-	+	+
	Tetrastrum sp.	-	+	-	+	+	-
	Tetraedron sp.	+	-	+	-	-	-
	Tetradesmus	+	+	-	+	+	+
	Acutodesmus sp		+	+	-	-	+
	Ulothrix sp	+	+	-	+	+	+
	Microspora sp	+	+	-	+	-	+
	Monactinus sp	+	+	+	-	+	-
	Coelasrtum sp	-	-	+	+	+	+
	Cocconeis sp	+	+	+	-	+	+
Cyanophyceae	*Spirulina sp*	+	-	-	-	+	+
	Anabaena sp	-	+	-	+	-	-
	Gloeocapsa sp	-	+	+	-	+	+
	Chroococcus sp	+	-	+	+	+	+
Bacillariophyceae	*Navicula sp*	-	-	+	+	+	+
	Nitzschia sp	+	-	+	-	-	-
	Peurosigma sp	-	-	+	-	+	-
	Syndera sp	+	-	+	+	+	
	Aulacoseira sp	+	-	+	-	-	+
	Chaetoceros sp	+	-	+	+	+	+
Dinophyceae	*Pyrodinium sp*	+	+	-	-	-	-
	Cystodinium sp	-	+	-	+	+	+
	Ceratium sp	-	+	+	+	-	-
Zygnematophyceae	*Cosmarium*	-	-	-	-	-	-
	Desmidium sp.	-	-	-	-	-	-
Trebouxiophyceae	*Chliorella sp*	-	-	-	-	-	-
	Botryococcus sp	-	-	-	-	-	-
Euglenophyceae	*Euglena sp*	+	-	+	-	+	+
	Eutreptia sp	+	-	+	-	+	+
	Phacus sp	+	-	+	-	+	-
Hymenomonadaceae	*Ochrosphaera sp*	-	-	-	-	-	-

Table 2: Monthly distribution of different phytoplankton species/ groups at sampling site 2

Groups	Species	September	October	November	December	January	February
Chlorophyceae	*Scenedesmus sp*	+	+	-	+	-	+
	Pediastrum sp	+	+	-	-	+	+
	Ankistrodasmus sp	-	+	+	+	+	+
	Tetrastrum sp.	-	+	-	+	+	-
	Tetraedron sp	-	+	_	+	+	+
	Tetradesmus	+	+	-	-	+	-
	Acutodesmus sp	+	-	+	+	+	-
	Ulothrix sp	+	+	-	+	-	+
	Microspora sp	-	-	+	-	+	-
	Monactinus sp	+	+	+	+	+	+
	Coelasrtum sp	+	-	+	+	+	+
	Cocconeis sp	-	+	+	-	+	-
Cyanophyceae	*Spirulina sp*	+	-	+	+	+	+
	Anabaena sp	+	-	+	+	-	+
	Gloeocapsa sp	+	-	+	-	+	+
	Chroococcus sp	+	-	+	+	+	+
Bacillariophyceae	*Navicula sp*	-	+	+	+	-	+
	Nitzschia sp	+	-	+	-	+	-
	Peurosigma sp	-	+	+	+	+	+
	Syndera sp	+	-	+	+	+	-
	Aulacoseira sp	+	+	+	-	+	+
	Chaetoceros sp	+	-	+	+	-	+
Dinophyceae	*Pyrodinium sp*	-	-	-	-	-	-
	Cystodinium sp	-	-	-	-	-	-
	Ceratium sp	-	-	-	-	-	-
Zygnematophyceae	*Cosmarium*	-	-	-	-	-	-
	Desmidium sp.	-	-	-	-	-	-
Trebouxiophyceae	*Chliorella sp*	-	+	-	+	+	-
	Botryococcus sp	+	-	+	-	+	-
Euglenophyceae	*Euglena sp*	+	-	+	-	+	-
	Phacus sp	-	-	+	-	-	-
	Eutreptia sp	+	-	+	-	+	-
Hymenomonadaceae	*Ochrosphaera sp*	-	-	-	-	-	-

Table 3: Monthly distribution of different phytoplankton species/ groups at sampling site 3

Groups	Species	September	October	November	December	January	February
Chlorophyceae	*Scenedesmus sp*	+	-	+	+	+	+
	Pediastrum sp	+	+	-	-	+	+
	Ankistrodasmus sp	-	+	-	+	-	+
	Tetrastrum sp.	-	+	-	+	+	-
	Tetraedron sp	-	-	-	-	+	+
	Tetradesmus	+	+	+	+	-	-
	Acutodesmus sp	+	+	+	+	-	+
	Ulothrix sp	-	+	+	-	+	+
	Microspora sp	+	-	+	+	+	-
	Monactinus sp	+	+	-	+	-	+
	Coelasrtum sp	-	+	-	+	+	-
	Cocconeis sp	+	-	+	-	-	-
Cyanophyceae	*Spirulina sp*	+	-	+	-	+	+
	Anabaena sp	+	-	+	-	-	-
	Gloeocapsa sp	+	-	-	+	+	+
	Chroococcus sp	-	-	+	-	-	-
Bacillariophyceae	*Navicula sp*	+	-	+	+	+	+
	Nitzschia sp	+	-	+	-	+	+
	Peurosigma sp	+	-	+	-	+	-
	Syndera sp	+	-	+	+	+	-
	Aulacoseira sp	+	-	+	-	+	+
	Chaetoceros sp	+	-	+	+	+	+
Dinophyceae	*Pyrodinium sp*	+	+	+	+	-	+
	Cystodinium sp	+	+	-	+	-	+
	Ceratium sp	-	+	+	+	-	-
Zygnematophyceae	*Cosmarium*	-	-	-	-	-	-
	Desmidium sp.	-	-	-	-	-	-
Trebouxiophyceae	*Chliorella sp*	-	-	-	-	-	-
	Botryococcus sp	-	-	-	-	-	-
Euglenophyceae	*Euglena sp*	-	+	+	-	+	-
	Phacus sp	-	+	-	+	-	-
	Eutreptia sp	-	+	-	+	-	-
Hymenomonadaceae	*Ochrosphaera sp*	+	-	+	-	-	-

Table 4: Monthly distribution of different phytoplankton species/ groups at sampling site 4

Groups	Species	September	October	November	December	January	February
Chlorophyceae	*Scenedesmus sp*	+	+	+	+	-	+
	Pediastrum sp	+	+	+	+	-	+
	Ankistrodasmus	+	+	+	+	-	+
	Tetrastrum sp.	-	-	-	+	-	-
	Tetraedron sp	-	+	+	+	+	+
	Tetradesmus	+	+	-	-	-	-
	Acutodesmus sp	+	+	+	+	-	+
	Ulothrix sp	+	+	+	+	-	+
	Microspora sp	+	+	+	+	-	+
	Monactinus sp	+	+	+	+	-	+
	Coelasrtum sp	+	+	+	+	-	+
	Cocconeis sp	+	+	+	+	-	+
Cyanophyceae	*Spirulina sp*	+	+	+	+	-	+
	Anabaena sp	+	+	+	+	-	+
	Gloeocapsa sp	+	+	+	+	-	+
	Chroococcus sp	+	+	+	+	-	+
Bacillariophyceae	*Navicula sp*	+	-	+	+	-	+
	Nitzschia sp	+	-	+	+	-	+
	Peurosigma sp	+	-	+	+	-	+
	Syndera sp	+	-	+	+	-	+
	Aulacoseira sp	+	-	+	+	-	+
	Chaetoceros sp	+	-	+	+	-	+
Dinophyceae	*Pyrodinium sp*	+	+	+	+	+	+
	Cystodinium sp	+	+	+	+	+	+
	Ceratium sp	+	+	+	+	+	+
Zygnematophyeae	*Cosmarium*	+	+	+	+	+	+
	Desmidium sp.	-	+	+	+	+	-
Trebouxiophyceae	*Chliorella sp*	-	-	+	-	+	+
	Botryococcus sp	-	-	+	-	+	+
Euglenophyceae	*Euglena sp*	-	+	+	+	+	-
	Phacus sp	-	+	+	+	+	-
	Eutreptia sp	-	+	+	+	+	-
Hymenomonadaceae	*Ochrosphaera*	-	+	+	-	+	+

Table 5: Monthly distribution of different zooplankton species/ groups at sampling site 1

Groups	Species	September	October	November	December	January	February
Copepoda	*Cyclops sp*	-	+	+	-	+	+
	Calanus sp	+	-	+	+	-	+
	Leptodiaptomus sp	-	+	-	+	+	-
	Naupilus larve	-	-	+	-	-	+
Cladocera	*Moina sp*	+	-	+	-	+	-
	Daphinia sp	+	+	-	+	-	+
Rotifers	*Brachinous sp*	-	+	+	-	+	+
	Asplanchna sp	+	-	+	+	+	+
	Lecane sp	+	+	-	+	+	+
	Diaphanosoma sp	+	+	+	+	+	+
Protozoa	*Paramisium sp*	-	-	-	-	-	-
Tubulinea	*Diffugia sp*	-	-	-	-	-	-
Ascarididae	*Ascaris sp*	-	-	-	-	-	-

Table 6: Monthly distribution of different zooplankton species/ groups at sampling site 2

Groups	Species	September	October	November	December	January	February
Copepoda	*Cyclops sp*	+	-	+	+	-	+
	Calanus sp	-	+	-	+	-	+
	Leptodiaptomus sp	+	-	+	-	+	-
	Naupilus larve	+	+	+	-	+	+
Cladocera	*Moina sp*	+	-	+	-	+	-
	Daphinia sp	+	-	+	+	-	-
Rotifers	*Brachinous sp*	+	+	+	-	+	+
	Asplanchna sp	+	-	+	+	+	-
	Lecane sp	+	+	-	-	+	+
	Diaphanosoma sp	+	-	-	+	-	+
Protozoa	*Paramisium sp*	-	-	-	-	-	-
Tubulinea	*Diffugia sp*	-	-	-	-	-	-
Ascarididae	*Ascaris sp*	-	-	-	-	-	-

Table 7: Monthly distribution of different zooplankton species /groups at sampling site 3

Groups	Species	September	October	November	December	January	February
Copepoda	*Cyclops sp*	-	+	+	+	+	+
	Calanus sp	-	-	+	-	-	-
	Leptodiaptoms sp	-	+	-	+	-	+
	Naupilus larve	-	-	+	-	+	+
Cladocera	*Moina sp*	-	-	-	+	-	+
	Daphinia sp	+	-	-	+	+	+
Rotifers	*Brachinous sp*	+	+	-	+	+	-
	Asplanchna sp	-	+	+	-	+	+
	Lecane sp	+	-	+	+	+	+
	Diaphanosoa sp	+	+	+	+	+	+
Protozoa	*Paramisium sp*	+	-	-	-	+	-
Tubulinea	*Diffugia sp*	-	-	-	-	-	-
Ascarididae	*Ascaris sp*	-	-	+		-	-

Table 8: Monthly distribution of different zooplankton species/ groups at sampling site 4

Groups	Species	September	October	November	December	January	February
Copepoda	*Cyclops sp*	-	-	-	-	-	+
	Calanus sp	-	-	-	-	+	+
	Leptodiaptomus sp	+	+	+	-	-	-
	Naupilus larve	+	+	-	-	+	+
Cladocera	*Moina sp*	+	-	+	-	-	-
	Daphinia sp	+	-	+	+	+	+
Rotifers	*Brachinous sp*	-	+	+	+	+	+
	Asplanchna sp	-	+	+	-	+	+
	Lecane sp	-	+	-	-	+	+
	Diaphanosoma sp	-	+	-	+	-	+
Protozoa	*Paramisium sp*	-	-	-	-	-	-
Tubulinea	*Diffugia sp*	-	-	-	-	-	-
Ascarididae	*Ascaris sp*	-	-	-	-	-	-

Conclusion

A six-month study was conducted on the populations of phytoplankton and zooplankton in Blue Bird Lake at four different locations. The study revealed interesting patterns and variations in these aquatic creatures. The overall findings of the study demonstrate how dynamic the phytoplankton and zooplankton populations are in Blue Bird Lake. These populations fluctuate between sites and months based on different environmental conditions. Understanding these patterns is crucial to evaluate the ecological dynamics and overall health of aquatic ecosystems such as Blue Bird Lake. Additional study and observation may help us learn more about the underlying reasons for these population changes.

References

1. Ahmed KKU, Ahamed SU, Hossain MRA, Ahmed T, Barman S. Quantitative and qualitative assessment of plankton: some ecological aspects and water quality parameters of the river Meghna, Bangladesh. Bangladesh Journal of Fisheries Research. 2003;7(2):131-140.
2. Ankathi MR, Piska RS. Studies on zooplankton diversity in a Tilapia dominated perennial tank, Julur Nalgonda, district. Aquaculture. 2009;10(1):11-16.
3. Ansari S, Khan AA. Diversity and distribution of zooplankton in a freshwater body of Aligarh region. Indian Journal of Scientific Research and Technology. 2014;2(1):73-82.
4. APHA, AWWA, WPCF. Standard methods for the examination of water and wastewater. 20th edition. American Public Health Association, New York; c1998.
5. Bhatnagar A, Singh G. Culture fisheries in village ponds: A multi-location study in Haryana, India. Agriculture and Biology Journal of North America. 2010;1(5):961-968.
6. Das P, Mandal SC, Bhagabati SK, Akhtar MS, Singh SK. Important live food organisms and their role in aquaculture. Frontiers in Aquaculture. 2012;5(4):69-86.
7. Findlay DL, Kling HJ. Protocols for measuring biodiversity: phytoplankton in freshwater. Winnipeg: Department of Fisheries and Oceans; c2001. p. 1-10.
8. Ghosh S, Barinova S, Keshri JP. Diversity and seasonal variation of phytoplankton community in the Santragachi Lake, West Bengal, India. Q Science Connect. 2012;3(1):1-19.
9. Gireesh R, Varghese M, Thomas VJ. Phytoplankton-collection, estimation, classification and diversity, Teaching Resource. Marine Biology Central Marine Fisheries Research Institute. 2015;24-28.
10. Hossain MRA, Pramanik MMH, Hasan MM. Diversity indices of plankton communities in the River Meghna of Bangladesh. International Journal of Fisheries and Aquatic Studies. 2017;5(3):330-334.
11. Kumar M, Khare PK. Diversity of plankton and their seasonal variation of density in the Yamuna River at Kalpi, District Jalaun (UP) India. Journal of Global Biosciences. 2015;4(7):2720-2729.
12. Kumar R, Kumari R, Prasad C, Tiwari V, Singh N, Mohapatra S, *et al*. Phytoplankton diversity in relation to physicochemical attributes and water quality of Mandakini River, Garhwal Himalaya. Environmental Monitoring and Assessment. 2020;192(12):1-23.
13. Kumar U, Kumari S. An assessment of diversity status of zooplankton in Jal Ghar Bhiwani, Haryana India.

International Journal of Biotechnology Research. 2017;7(2):13-16.
14. Manickam N, Bhavan PS, Vijayan P, Sumathi G. Phytoplankton species diversity in the Parambikulam-Aliyar irrigational canals (Tamil Nadu, India). International Journal of Pharma and Bio Sciences. 2012;3(3):289-300.
15. Mehta P, Singh G, Dahiya T, Inwanti L. Aquatic weeds community of Ottu reservoir in Haryana state. Environment and Ecology. 2023;41(2B):1157-1161.
16. Nagi RK, Rajput V. Assessment of Phytoplankton Diversity in Relation to Abiotic Factors of Nainital Lake of Kumaon Himalayas of Uttarakhand State, India. Asian Journal of Scientific Information. 2015;8(2):157-164.
17. Needham G, Needham R. Guide to Study Freshwater Biology. Holden Day, San Francisco. Nagpur; c1962. p. 34.
18. Nirmal Kumar JI, Das M, Mukherji R, Kumar RN. Assessment of zooplankton diversity of a tropical wetland system. International Journal of Pharmacy and Life Sciences. 2011;2(8):983-990.
19. Panwar S, Malik DS. Zooplankton diversity, species richness and their distribution pattern in Bhimtal Lake of Kumaun region, Uttarakhand. Hydrology Current Research. 2016;7(1):219.
20. Sarwade AB, Kamble NA. Plankton diversity in Krishna River, Sangli, Maharashtra. Journal of Ecology and the Natural Environment. 2014;6(4):174-181.
21. Shannon EE, Weaver W. The mathematical theory of communication. Univ. of Illinois Press, Urbana; c1963. p. 117.
22. Sharma RC, Kumari R. Seasonal variation in zooplankton community and environmental variables of sacred Lake Prashar, Himachal Pradesh, India. International Journal of Fisheries and Aquatic Studies. 2018;6(2):207-213.
23. Shyam R, Kumar P, Badola S. Seasonal variation in the planktonic diversity of Tumaria reservoir of Kashipur, Uttarakhand, India. Environment Conservation Journal. 2020;21(3):119-125.
24. Singh G, Bhatnagar A. Water Quality Characteristics and Yields in Small-Scale Fish Culture Ponds in Yamunanagar, Haryana. Environment & Ecology. 2010;28(3):1615-1619.
25. Singh G, Bhatnagar A, Kalla A, Singh A. Fish yields in relation to water quality and plankton production in managed and unmanaged freshwater ponds. Journal of Experimental Agriculture International. 2016;4(6):1-10.
26. Singh G, Dahiya T, Ravikant, Bhatnagar A, Sridevi T. Physicochemical characteristics and fish food organisms in the pond ecosystem - A review. Journal of Research SKUAST. 2021;23(2):116-126.
27. Ward HB, Whipple GC. Freshwater Biology. John Wiley and Sons; c1959. p. 1248.
28. Washington HG. Diversity, biotic, and similarity indices: a review with special relevance to aquatic ecosystems. Water Research. 1984;18(6):653-694.
29. Yadav SR, Ravikant, Jatav SK, Yadav MK, Singh G, Dahiya T. Assessment of fish species biodiversity in Yamuna river (Haryana): a post-covid 19 analysis. Journal of Experimental Zoology India. 2023;26(1):817-824.
30. Yadav P. Studies on biodiversity of zooplankton in Kass Lake during rainy and winter seasons. International Journal of Researches In Biosciences, Agriculture and Technology. 2015;3(2):399-402.
31. Singh I, Blukis V, Mousavian A, Goyal A, Xu D, Tremblay J, Fox D, Thomason J, Garg A. Progprompt: Generating situated robot task plans using large language models. In 2023 IEEE International Conference on Robotics and Automation (ICRA) 2023 May 29 (pp. 11523-11530). IEEE.
32. Negi V, Pal S, Juyal D, Sharma MK, Sharma N. Bacteriological profile of surgical site infections and their antibiogram: A study from resource constrained rural setting of Uttarakhand state, India. Journal of clinical and diagnostic research: JCDR. 2015 Oct;9(10):DC17.