EFFECT OF DIFFERENT SEASONAL CONDITIONS ON PHYTOPLANKTON: A SYSTEMATIC APPROACH

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ABSTRACT

Phytoplanktons are a vital part of the plant life in water. Phytoplanktons play a crucial role in aquatic ecosystems as the primary producers upon which the productivity of aquatic ecosystems depends. The abundance and variety of phytoplankton is a good indicator of the health of an aquatic environment. The variety of phytoplankton in Patna Sanjay Gandhi Zoological Garden Pond was the focus of this study. Phytoplankton in Sanjay Gandhi Zoological Garden Pond were studied for their seasonal shifts, correlation coefficients, and biodiversity indicators from January to December of 2014. Changes in the composition and organisation of phytoplankton communities reflect shifts in water quality, particularly in regards to water temperature and other chemical parameters, as shown by monitoring of phytoplankton assemblages in the Pond.

Keywords: - Water, Aquatic, Phytoplanktons, Plant, Diversity.

I. INTRODUCTION

All over the world, water supplies are not shared equally. The seas contain the vast majority of the world's water, whereas the continents contain just 30%. About three-quarters of this 30% is located in glaciers and icebergs. As a result, fewer than one percent of the water in lakes, streams, and the ground is drinkable. Thus, we should appreciate water for what it is and work to keep water supplies unpolluted. Untreated municipal and industrial waste, as well as agricultural run-off containing pesticides, has a negative impact on water quality and the ecosystems that depend on it. Understanding the ebb and flow of plankton populations requires accounting for a wide range of physicochemical, biological, and environmental factors functioning in concert.

There is a wide variety of tiny autotrophs that make up the Phytoplankton found in open water ponds, lakes, and major streams. Microorganisms like algae that float in the water and produce chlorophyll are called phytoplanktons. Phytoplanktons are the foundation of the aquatic food web; as their numbers fluctuate, so does the quality of the water they live in. Phytoplankton abundance and diversity are key indicators of water quality. Cyanophyceae, Chlorophyceae, Bacillariophyceae, Euglenophyceae, etc. are all examples of phytoplankton, which play an essential role among aquatic flora. Water quality and other biotic groups in a body of water regulate the variety and density of phytoplankton. Since phytoplankton are the major producers in aquatic biotopes, their population size and health have a significant impact on the productive capacity of these environments.

Plankton may be found in both natural and manmade waterways, including reservoirs, ponds, irrigation canals, and the like. Phytoplankton are planktons that are composed of plant material. Phytoplanktons are tiny, photoautotrophic organisms having chlorophyll in their cells that may be found in the top, sunny layer of virtually all bodies of water. Phytoplankton derives energy through the process of photosynthesis and must thus dwell in the euphotic zone of water body. Phytoplanktons are the principal producer. They synthesise organic molecules and oxygen from carbon dioxide and water which maintain the aquatic food chain. Many of the oxygen molecules in the air come from phytoplanktons. Phytoplanktons are very variable from photosynthesizing bacteria (Cyanobacteria) to diatoms and green algae. Chlorophyceae, Bacillariophyceae, Cyanophyceae, and Euglenophyceae make up the largest family of phytoplankton.

II. REVIEW OF RELATED STUDIES

Nasser, Mohamed & S., Sureshkumar. (2014) The world's lakes, rivers, and reservoirs are among the most vital natural and human resources. Located in the Palghat district of Kerala, the Parambikulam Dam is an embankment dam on the Parambikulam River, which flows through the Western Ghats. The dam has a reservoir area of 21.22 km 2 with a capacity of 69,1651000 cu. mt. This investigation of Parambikulam reservoir phytoplankton focuses on its seasonal change, hydrobiology, and biodiversity from 2009-2011. During the course of the research, 89 distinct phytoplankton taxa were identified. Chlorophyceae, Desmidiaceae, Bacillariophyceae, Cyanophyceae, and Euglenophyceae are the five families to which they properly belong. The Bacillariophyceae has the most representatives (42), followed by the Desmidiaceae (26). During the monsoons, records of the family Euglenophyceae are absent. Bacillariophyceae's Pinnularia and Navicula and Desmidiaceae's Closterium and Cosmarium were the most common. Average taxonomic distinctness was slightly higher in pre-monsoon (+=69.30) than post-monsoon (+=69.10) and lowest during monsoon (+=65.00), while Shannon diversity index and Margalef's Species richness were highest during the post-monsoon season (H'=6.09; d=11.41) and lowest during the monsoon seasons (H'=3.8; d=3.4). The post-monsoon period had the greatest variation in taxonomic uniqueness (+=417), whereas the pre-monsoon period saw the least (+ =347). Hydrological variables were also monitored for changes, including pH, DO, nitrate, phosphate, silicate, calcium, and chloride levels. The findings give first-hand evidence of the reservoir's microalgae and a fundamental comprehension of its trophic condition. Phytoplankton are valued for their contributions to the rich biodiversity seen in lakes and reservoirs, and as a result are often considered essential components of these water bodies. Because it affects how efficiently carbon and energy are transferred across trophic levels, its community structure is crucial to higher trophic levels.

Kaparapu, et al. (2013) Using data collected from April 2011 to March 2012 at the Riwada reservoir in Visakhapatnam, Andhra Pradesh, India, this study examines seasonal shifts in phytoplankton abundance, correlation coefficients, and biodiversity indexes. Five stations were sampled before, during, and after the monsoon. There were 57 different genera, divided evenly between four different families: Chlorophyceae (27), Bacillariophyceae (14), Cyanophyceae (13), and Euglenophyceae (11). (three genera). Station three reported the highest and lowest total phytoplankton population and percentages before to the monsoon, whereas station two recorded the highest and lowest during the monsoon. Maximum species richness (Menhinick index R 2) was recorded at station 1, while the lowest was recorded at station 3. The greatest species diversity was found between stations 4 and 5, and the least diversity was found between stations 2 and 3. Water's total solids, total dissolved solids, total hardness, dissolved oxygen, nitrates, sulfates, and phosphates all had negative correlations, while the water's temperature, pH, transparency, biological oxygen demand, and chlorides all had positive ones, according to the correlation coefficient matrix. The diversity indices demonstrated that the phytoplankton population in the reservoir is stable and diverse.

Ghosh et al., (2012) Water samples were collected from West Bengal's Santragachi Lake between November 2009 and July 2010 to examine phytoplankton diversity and its seasonal change. Canonical Correspondence Analysis was used to determine a relationship between a number of measured physicochemical characteristics and the concentration of phytoplankton. This demonstrated that an increase in temperature and nutrients led to a greater concentration of phytoplankton. Nine samples were collected throughout the research period, and a total of 29 phytoplankton species were identified. These taxa were distributed across the phyla Chlorophyta (10), Cyanobacteria (8), Charophyta (5), Bacillariophyta (4), and Euglenozoa (2). The diversity and proportional representation of Chlorophyta species were significantly higher than those of the Euglenozoa. During the monsoon season, bio-indication indicated a less diversified community with higher water quality compared to the pre- and post-monsoon periods. Phytoplankton diversity was measured by many different indices to determine seasonal shifts. These included the Shannon-Wiener diversity index, the Gleason species richness index, the Pielou evenness index, and the Naughton dominance index. Indicating both the trophic level of the water and the pollution level, the Shannon-Wiener diversity index showed that this lake had a modest amount of pollution.

Kaparapu, Jyothi & Narasimha Rao, Geddada. (2013) Using data collected from April 2011 to March 2012 at the Riwada reservoir in Visakhapatnam, Andhra Pradesh, India, this study examines seasonal shifts in phytoplankton abundance, correlation coefficients, and biodiversity indexes. Five stations were sampled before, during, and after the monsoon. There were 57 different genera, divided evenly between four different families: Chlorophyceae (27), Bacillariophyceae (14), Cyanophyceae (13), and Euglenophyceae (11). (three genera). Station three reported the highest and lowest total phytoplankton population and percentages before to the monsoon, whereas station two recorded the highest and lowest during the monsoon. Maximum species richness (Menhinick index R2) was recorded at station 1, while the lowest was recorded at station 3. Station 4 (3.98), along with Station 2, has the highest species diversity (H1) (3.71). The greatest species diversity was found between stations 4 and 5, and the least diversity was found between stations 2 and 3. Water's total solids, total dissolved solids, total hardness, dissolved oxygen, nitrates, sulfates, and phosphates all had negative correlations, while the water's temperature, pH, transparency, biological oxygen demand, and chlorides all had positive ones, according to the correlation coefficient matrix. The diversity indices demonstrated that the phytoplankton population in the reservoir is stable and diverse.

Shinde et al., (2012) Phytoplankton at the Harsool-Savangi dam in Aurangabad, India were studied for their seasonal shifts, correlation coefficients, and biodiversity indices from January to December of 2008. Fifteen Chlorophyceae, seven Bacillariophyceae, seven Cyanophyceae, and six Euglenophyceae taxa were found in total. The present study found that Chlorophyceae made up 41.91 percent of the north site, 32.70 percent of the west site, 19.50 percent of the south site, and 11.4 percent of the west site. There is a minimum of 37.80 percent Chlorophyceae at the southern site, 28.15 percent Bacillariophyceae at the eastern site, 17.47 percent Cyanophyceae at the western site, and 10.57 percent Euglenophyceae at the northern site. The values of Margalef's index (R1) and Menhinick index (R2) were determined to be 4.12 and 0.56, respectively, at the south site, and 3.77 and 0.38, respectively, at the north site. The greatest Simpson's index (I) value was found at the north site (0.30), while the lowest was recorded in the south, east, and west sites (0.29). The south, east, and west sites had the greatest values of the Shannon-Weiner index (H'), at 1.26, while the north site had the lowest (H' = 1.24). The species distribution was most even in the southern location and most uneven at the northern one. The highest Chlorophyceae, Bacillariophyceae, Cyanophyceae, and Euglenophyceae population densities (1923, 1173, 889, and 541) were reported at the north site during the summer, whereas the lowest were found during the monsoon at the south site (108,195, 67, and 24 organisms l(-1)).

Shailendra Sharma and Amrita Vyas. (2011) Atrophic phytoplankton are the aquatic environment's principal producers of organic matter; they float on the water's surface and are carried along by the wind or currents. They provide the foundation of many aquatic food webs and are themselves supported by the metabolic processes of other microorganisms that transform organic matter into inorganic nutrients needed by plants. Blue-green algae (Chlorophyta), diatoms (Bacillariophyta), and green algae (Chlorophyceae) made up the bulk of the phytoplankton in the Narmada River. (Myxophyceae). There were 23 different genera in the family Chlorophyceae, including Zygnema and Eudorina. Species of Chlosterium. More common species were Chlorella, Pediastrum, and Spirogyra. Seven genera of diatoms (Bacillariophyceae) and ten genera of myxophytes were found. Chrysophyceae > Cyanophyceae > Bacillariphycease is the observed chronology of phytoplankton groups in the Narmada River.Physicochemical variables in the water body control phytoplankton population characteristics such as species composition, dispersion, and abundance. Plankton numbers change with the seasons and months. of Phytoplankton in the Madhya Pradesh Section of the River Narmada (India).

Jepachandramohan et al., (2010) From January till December, the phytoplankton population in India's Kanyakumari District's Pechiparai Reservoir was evaluated by . Primary output and phytoplankton abundance fluctuated somewhat on average across the time span of our investigation. The phytoplankton diversity appeared to be controlled by the rate of water entering the reservoir during the monsoon, which was identified as the primary factor influencing the entry of the nutrients. Thirteen different types of phytoplankton were identified. Only four of the thirteen species had consistently high population densities; these were Staurastrum longipes, S. fremantii, Navicula sp., and Botryococcus sp. Most phytoplankton species in the reservoir reached their maximum population size when the monsoon season ended.

Saravanakumar et al. (2008) At three locations along the western mangrove of Kachchh, the amount of phytoplankton in the stream waters was evaluated statistically and subjectively. One hundred four distinct species of phytoplankton were discovered. There were two types of green algae, eighty-two types of diatoms (Bacillariophyceae), sixteen types of dinoflagellates (Dinophyceae), three types of blue greens (Cyanophyceae), and so on. There was a range of 94,166.67-2,44,500 cells/l among the three locations. Salinity was between 36 and 44 parts per thousand, temperature was between 17 and 35 degrees Celsius, and pH was between 7 and 8.9. In the monsoon and early winter, these semi-arid zone mangrove stream areas were documented as having exceptionally high populations.

Cleber Figueredo and Alessandra Giani. (2001) A tropical eutrophic reservoir was studied for a year. (Pampulha Reservoir, Brazil). Two-week intervals at a single collection site were used to calculate species richness and diversity (Shannon-Wiener, H"). Individuals, cells, and biomass levels were used to determine indices. Biomass-based estimations provided the most accurate descriptions of the study environment due to the disproportionate weight given to colonial species. As a putative perturbing factor and an enhancer of variety, climatic variations, and particularly rainfall, were crucial in explaining the observed seasonal fluctuation. Diversity index calculations indicated high H" values, demonstrating the system's instability and proving that no single species can dominate for long periods of time.

III. MATERIALS AND METHODS

This study collected plankton samples from four locations (south, north, east, and west) throughout the course of a year (January–December, 2014), spanning the summer (February–March, April–May), monsoon (June–July, August–September), and winter (October–November, December–January) seasons.

Examination of plankton: The surface water (the Secchi disc's transparency zone) was swept using a plankton net (mesh size 25 m), and the plankton caught were placed in individual plastic bottles or containers. Surface water (100 l) was sieved via plankton net to extract planktons.

The 4% formalin used to preserve these planktons ensured their stability. Plankton samples were fixed in formalin and centrifuged at 1500–2000 rpm for 10–12 minutes. Sedgwick Rafter cells were used to estimate the concentration of phytoplanktons at the bottom of the sample, and the dilution factors were calculated such that the phytoplanktons could be counted individually using a compound binocular microscope.

Ludwick and Reynolds' methods for calculating biodiversity, species richness, and species evenness were used. (1988). The diversity indexes developed by Shannon and Weaver (1949) and by Simpson (1949) were also computed.

IV. RESULTS OF THE STUDY

Phytoplankton diversity: Examination of phytoplankton under the microscope revealed that there are four families, totaling 35 genera: Chlorophyceae (15 genera), Bacillariophyceae (7 genera), Cyanophyceae (7 genera), and Euglenophyceae (7 genera). The following species were observed: Microalgae like Chlorella and Hydrodicton and Chlamydomonas. Chara sp., Cladophora sp., Closterium sp., Cosmarium sp., Oedogonium patulum, Oedogonium sp., Pediastrum duplex, Pediastrum simplex, Pediastrum sp., Spirogyra sp., Ulothrix zonata and Volvox sp. (Chlorophyceae); Diatom sp., Navicula subtilis, Navicula accomda, Navicula sp., Nitzschia denticulate, Nitzschia sp., and Pinnularia sp. (Bacillariophyceae); Anabaena sp., Anabaena beckii, Microcystic sp., Nostoc sp., Oscillatoria chlorina, Oscillatoria cortiam and Spirulina sp. (Cyanophyceae); Euglena acus, Euglena granulate, Euglena sp., Euglena elongate, Phacus sp. and Trachelomons sp. (Euglenophyceae).

Summer at the north site had the highest average and total seasonal variation for Chlorophyceae (32.05 and 1923 org l-1), whereas the south site had the lowest (1.8 and 108 org l-1). Summer at the north site had the highest concentration of Bacillariophyceae (41.89 and 1173 org l-1), whereas the south site saw the lowest concentration during the monsoon. (6.96 and 195 org l-1). Average and total seasonal variation for Cyanophyceae was highest during summer at north site (31.75 and 889 org l-1) and min during monsoon at sourth site (2.39 and 67 org l-1). Similarly, the highest concentrations of Euglenophyceae were found during the summer at the north site (22.54 and 541 org l-1) and the monsoon at the south site (1.1 and 24 org l-1). (Table 1).

Table - 1: Orderwise average and total seasonal variations of phytoplankton's (organisms)

Site	Order	Average			Total			Grand total	Total percentage
		Summer	Monsoon	Winter	Summer	Monsoon	Winter		
South	Chlorophyceae	16.41±12.85	1.8±3.01	5.88±6.69	664	108	527	1446	37.80
	Bacillariophyceae	24.64±21.43	6.96±8.59	11.92±10.57	690	195	334	1219	31.86
	Cyanophyceae	17.10±9.63	2.39±4.12	7.14±6.10	479	67	200	746	19.50
	Euglenophyceae	12.45±7.36	1.1±1.56	3.79±3.40	299	24	73	414	10.82
	Total				2132	394	1134	3825	
North	Chlorophyceae	32.05±20.19	7.05±8.93	17.91±12.47	1923	423	1075	3421	41.91

	Bacillariophyceae	41.89±25.44	16.14±13.29	26.75±17.72	1173	452	749	2374	29.08
	Cyanophyceae	31.75±17.80	8.03±10.54	13.92±15.16	889	225	390	1504	18.42
	Euglenophyceae	22.54±17.59	3.45±5.03	9.95±11.36	541	83	239	863	10.57
	Total				4526	1183	2453	8162	
East	Chlorophyceae	25.25±14.76	4.91±5.81	11.81±9.63	1515	295	709	2519	41.20
	Bacillariophyceae	31.78±22.69	10.46±11.17	19.21±14.89	890	293	538	1721	28.15
	Cyanophyceae	24.03±14.50	5.25±7.93	11.9±11.62	673	147	357	1177	19.25
	Euglenophyceae	19.83±11.18	1.79±2.66	7.37±6.81	476	43	177	696	11.38
	Total				3554	778	1781	6113	
West	Chlorophyceae	20.68±14.21	3.03±6.03	8.46±8.79	1241	182	508	1931	38.34
	Bacillariophyceae	30.67±22.70	10.39±10.76	17.75±14.58	859	291	497	1647	32.70
	Cyanophyceae	18.75±12.71	3.53±5.46	9.14±7.80	525	99	256	880	17.47
	Euglenophyceae	16.95±10.89	1.16±1.55	5.95±4.38	407	28	143	578	11.47
	Total				3032	600	1404	5036	

Chlorophyceae were most abundant in the north (41.91%), while they were least abundant in the south (37.80%). The highest recorded proportion of Bacillariophyceae was found in the west site (32.70%), while the lowest was found in the east site (28.15%). The south site had the highest proportion of Cyanophyceae (19.50%), while the west site had the lowest (17.47%). The west site also had the highest percentage of Euglenophyceae (11.47%), while the north site had the lowest (10.57%). Phytoplankton predominated throughout the summer, followed by the winter and monsoon.

In the summer, there is an abundance of food available in the form of photosynthesis, and the nutritional concentration increases as a result of concentration and evaporation because of the higher temperatures. Density of phytoplankton is lowest during the monsoon season due to significant flood and fresh water input, and highest during the summer due to steady hydrological variables and low water level. Due to the high water level and diluting effects of the monsoon, they were restarted. t

Margalef's index (R 1=4.12) and the Menhinick index (R 2=0.56) found the greatest diversity of species at the south site, while they found the least diversity at the north site (R 1=3.77 and R 2=0.38). Similarly, Simpson's index values of 0.30 and Shannon's-Weiner indices of 1.26 were observed in the southern, eastern, and western locations, while values of 0.29 and 1.24 were recorded at the northern site. The species evenness was highest in the south and lowest in the north. (Table 2).

Table - 2: Annual variations of phytoplankton's biodiversity indices at Tehri dam during January - December, 2014

Indices	Index	South site	North site	East site	West site
Species richness	(N0)	35	35	35	35
	(R1)	4.12	3.77	3.89	3.98
	(R2)	0.56	0.38	0.44	0.49
Species diversity	(l)	0.29	0.30	0.29	0.29
	(H')	1.26	1.24	1.26	1.26
Species evenness	(E1)	0.36	0.34	0.33	0.33
	(E2)	0.11	0.09	0.11	0.11
	(E3)	0.07	0.07	0.07	0.07
	(E4)	0.97	0.98	0.97	0.97
	(E5)	0.98	0.95	0.98	0.98

R1 = Margalef's index, N0 = No. of all species, H' = Shannon-Weiner index, l = Simpson's index, R2 = Menhinick index, E1-E5 = Evenness index

Both the phytoplankton species diversity index (PSDI) and Simpson's index (l), which can range from 0 to 1, measure the likelihood that two randomly selected members of a population are of the same species. Simply put, if the likelihood was high both individuals belonged to the same species, then the diversity of the community sample was low. As a more comprehensive measure of variety, Shannon's index (H') takes into account both the abundance and distribution of different types of species. Phytoplankton had a greater PSDI in the southern location. When H' was larger, it meant that there was a wider variety of species. When there are more species in a community, there is a higher probability of negative feedback regulation, which dampens oscillations and makes the community more stable.

V. CONCLUSION

As the first link in the food chain for all other aquatic organisms, phytoplanktons play an important ecological role. When there are a lot of them, the water becomes green. In summary, chlorophyceae were the most common kind of phytoplankton over the time span of our research at Tehri dam. A species' ability to survive in its habitat will determine whether or not it exists, but the resources it has access to will determine how many of it there are. There will be more of the species if we take steps to lessen the impact of competition and predators, enhance the availability of food and adequate habitat, or both. To better analyse and monitor ecosystems at Tehri dam, this study provides fundamental data on the distribution and quantity of phytoplanktons. Phytoplanktons showed irregular patterns of yearly change, characterised by more variety, lower dominance, and greater evenness. The south site's high species richness values indicate a more extensive food web than at other sites. Higher Simpson index values for the north location indicate a more stable ecosystem compared to the other sites. The Shannon index values indicate that the north site is extremely polluted (0>1), whereas the south, east, and west locations are not highly contaminated (1 < 3).

REFERENCES: -

[1] Bhattacharya, T, Pahari, P.R. and Dutta, T.K., 2002. Temporal variation in density of major planktonic groups with special reference to Cyclopodia (Copepoda) in ientic habitat. In: Kumar, A. (Ed.), Ecology and Conservation of Lakes, Resen/oirs and Rivers, APH Publishing Corp.j New Delhi, pp. 350-386.

[2] Chellapa N.T., Borda J.M. and Rocha O.(2008). Phytoplankton community and physical-chemical characteristics of water in the public

reservoir of Cruzeta, RN, Brazil, Braz. J. Biol., 68, 477-494.

[3] Chowdhury M.M.R., Mondol M.R.K. and Sarker C., (2007). Seasonal variation in plankton population of Borobila beel in Rangpur district, Univ. J. Zoo. Rajshahi University, 26,49 -54

[4] Ghosh, Subhabrata & Barinova, Sophia & Keshri, Jai. (2012). Diversity And seasonal variation of phytoplankton community in the Santragachi Lake,West Bengal,India,. qscience connect. 2012. 10.5339/connect.2012.3.

[5] Jepachandramohan, P & Wesley, S. & Subramanian, Ramya & Alaguchamy, N & Kalayanasundaram, M & Ramaraj, Jayakumararaj. (2010). Seasonal Variation in the Phytoplankton Diversity and Primary Productivity in Pechiparai Reservoir, KK District, TN, India. Journal of Ecobiology 26(4):319-322. 26. 319-322.

[6] Kaparapu, Jyothi & Narasimha Rao, Geddada & Geddada, Rao. (2013). Seasonal Distribution of Phytoplankton in Riwada Reservoir, Visakhapatnam, Andhra Pradesh, India. Notulae Scientia Biologicae. 5. 290-295. 10.15835/nsb.5.3.9082.

[7] Kaparapu, Jyothi & Narasimha Rao, Geddada. (2013). Seasonal Distribution of Phytoplankton in Riwada Reservoir, Visakhapatnam, Andhra Pradesh, India. Notulae Scientia Biologicae. 5. 290. 10.15835/nsb539082.

[8] Nasser, Mohamed & S., Sureshkumar. (2014). Seasonal Variation and Biodiversity of Phytoplankton in Parambikulam Reservoir, Western Ghats, Kerala. International Journal of Pure and Applied Biosciences. 2. 272-280.

[9] Saravanakumar, Ayyappan & Mayalagu, Rajkumar & Thivakaran, Alagiri & Serebiah, Sesh. (2008). Abundance and seasonal variations of phytoplankton in the creek waters of western mangrove of Kachchh-Gujarat. Journal of environmental biology / Academy of Environmental Biology, India. 29. 271-4.

[10] Sharma, Shailendra & Vyas, Amrita. (2011). Diversity And Seasonal Abundance Of Phytoplankton Of River Narmada Madhya Pradesh (India). World Rural Observations. 2011.
Figueredo, Cleber & Giani, Alessandra. (2001). Seasonal variation in the diversity and species richness of phytoplankton in a tropical eutrophic reservoir. Hydrobiologia. 445. 165-174. 10.1023/A:1017513731393.

[11] Shinde, Sunil & Pathan, Taslim & Sonawane, D. (2012). Seasonal variations and biodiversity of zooplankton in Harsool-Savangi dam, Aurangabad, India. Journal of environmental biology / Academy of Environmental Biology, India. 33. 643-7.

[12] Tiwari A.and Chauhan S.V.(2006).Seasonal phytoplanktonic diversity of Kitham lake, Agra, J. Enviro. Biol., 27, 35- 38.