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A study on phytoplankton diversity of Lake Pichhola of Udaipur Rajasthan

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Abstract
The historic lake Pichhola of Udaipur Rajasthan is facing influence of anthropogenic activities leading to nutrient loading at different sites in the lake. To assess the phytoplankton diversity, four stations were predetermined in the lake for collection of plankton samples. A total of 35 genus of phytoplankton were found in the lake during the study. Out of these, 11 genera of Cyanophyceae 9 genera of Bacillariophyceae, 12 genera of Chlorophyceae and 3 genera belonging to Desmidiaceae were recorded at all four stations of the lake. The study explains a rich biodiversity of phytoplankton, in Lake Pichhola with dominance of Cyanophyceae which assigned eutrophic status of the lake. The study also revealed 12 pollution indicating algal species in Pichhola Lake.

Keywords: Phytoplankton, palmer's index, Pichhola Lake

1. Introduction
The qualitative and quantitative variations of natural food materials in a water body are influenced by several abiotic and biotic factors. Several comparative studies on water quality, productivity and plankton population of certain Udaipur waters in comparison to selected waters of Rajasthan have been carried out [9]. Plankton plays a crucial role in aquatic food web because they are important food for other invertebrates and fishes which graze heavily on micro algae and other invertebrates. Plankton communities are highly sensitive to environmental changes. The consequent alteration in their density and species diversity can give important indications of environmental changes. Freshwater constitutes one of the important aquatic biomes for these potential groups of which phytoplankton forms the major source of primary production, while zooplankton serves as an important principal link between primary producers and higher forms. Further, as plankton forms an important component of fish food, the knowledge in its abundance, composition and seasonal variations is considered to be an essential prerequisite for successful fishery management. The estimation of plankton analysis helps in explaining the cause of color, turbidity, presence of odour, taste and visible particles in water. The organisms occurring in the aquatic ecosystem are under great influence of its physico-chemical properties. Thus, the qualitative and quantitative studies of plankton are an important factor to access the water quality [14]. The food chain in Lake Ecosystem is often very simple comprising phytoplankton and aquatic vegetation as primary producers, zooplankton as primary consumers, small fishes as secondary consumers and large fishes as tertiary consumers. Plankton is the most sensitive floating community which is being the first target of water pollution, thus any undesirable change in aquatic ecosystem affects diversity as well as biomass of this community. The measurement of plankton's productivity helps to understand conservation ratio at various trophic level and resources as an essential input for proper management of lake. The historic lake Pichhola has its ethnic and scenic importance for the tourism industry of Udaipur city. However, the lake is facing anthropogenic pressure due to heavy human population and hotels around it. This also leads in nutrient loading at different sites in the lake. The present study has been carried out to study the phytoplankton characteristics of Lake Pichhola of Udaipur, Rajasthan.

2. Materials and Methods
For the proposed study, four sampling stations were selected as shown in Figure 1, in Lake Pichhola for collection of water samples. Station A was located on the South Eastern shore,

this station in relatively shallow isolated site. Whereas, station B was located near the North Eastern shore and is surrounded by maximum human habitation. Sampling station C was at the Northern end, this station site was relatively shallow also surrounded by human habitation and posing threat of entrophication due to solid and liquid waste disposal. Station D was selected near the Western end of lake, this station is on the tail end of lake with major water inlet through Sisarma river which brings silt and agricultural runoff along with rain water. This station is also affected by cattle grazing (Fig 1).

The plankton samples were collected from the surface in littoral region of lake. Plankton net having bolting silk cloth (mesh size 55 µ) was used for collection of samples. Appropriate quantity of water (50 liters for water) was measured in a graduated bucket and filtered through the net. Planktons thus obtained were preserved in 4% neutralized formalin for further quantitative and qualitative analysis. Sedgwick Rafter plankton counting cell was used for qualitative and quantitative analysis of plankton. Concentrated samples of planktons were transferred on the counting sell by using 1 ml plankton pipette. Plankton were identified and counted by moving the Sedgwick Rafter cell under the microscope. The total number of phytoplankton counted in each sample was multiplied with dilution factor and results were expressed in cell ml^{-1} for phytoplankton [1]. The qualitative analysis of phytoplankton was done following the standard methods of Edmondson, Needham and Needham and Adoni [2, 3, 7]. The identification of phytoplankton was restricted only up to major Groups *viz*. Cyanophyceae, Chlorophyceae, Bacillariophyceae and Desmidiaceae. To assess the trophic status of sampling station the palmer's algal pollution Index was calculated following Trivedi [13].

Fig 1: Geographical Representation of Lake Pichhola, Udaipur (Raj.)

3. Results and Discussion

The algal flora of lake Pichhola was contributed by four categories *viz* Cyanophyceae, Chlorophyceae, Bacillariophyceae, Desmidiaceae. Over 35 genera of phytoplankton were recorded in Lake Pichhola. Out of this 11 were from Cyanophyceae, 9 were from Bacillariophyceae, 12 were Chlorophyceae and 3 were belongs to Desmidiaceae. However Sharma [9] found the phytoplankton community of water body was represented by 6 groups namely Chlorophyceae, Bacillariophyceae, Cyanophyceae, Xanthophyceae, My xophyceae and Dinophyceae. On the basis of water quality parameters in general, Lake Pichhola was found to be eutrophic with a rich number of species and biodiversity of aquatic animals. The authors also reported a high rate of primary production (302.085mgc/m2 /hr) and diversity of phytoplankton (58 forms), zooplankton (104 forms) and fish (15 species) observed during the study period [10]. Range of dominance forms of phytoplankton were Chlorophyceae > Cyanophyceae > Bascillariophyceae > Desmidiaceae at stations A and C of lake Pichhola. Whereas, at station B and D the dominance trend were Cyanophyceae > Bascillariophyceae > Chlorophyceae > Desmidiaceae observed (Fig. 3). Total 36 genera of phytoplankton were recorded in lake Pichhola, Udaipur and scenario of dominance was observed as Chlorophyceae> Cyanophyceae> Bascillariophyceae> Desmidiaceae [6]. The monthly average values of all four stations of overall mean phytoplankton density as more at station A *i.e.* (143.19 Cells ml^{-1}) followed by station D (142.19 Cells ml^{-1}), station C (137.36 Cells ml^{-1}) and station B (126.51 Cells ml^{-1}) (Fig. 4). The trends of seasonal variations of phytoplankton population at four stations are more or less same, both species wise and in abundance. Palmer has prepared a composite rating of algae tolerant of organic pollution, assembled from the 165 authors and developed a pollution- tolerant algal index. The pollution tolerant genera belonging to four groups of algae at all four stations of Pichhola Lake were recorded (Table 2). By using Palmer's index of pollution for rating of water samples as moderate polluted and high organically polluted at four stations of Lake Pichhola were tested. The total score of Algal Pollution Index (API) of station A<D<C<B were calculated to be 13, 19, 27 and 31 respectively (Table 2 and Fig. 2). The total scores of station A showed 13 indicating moderate pollution, station D showed 19 indicating probable organic pollution while station B and C showed 27 and 31 indicating highest organic pollution due to surrounded by maximum human habitation and posing threat of eutrophication due to solid and liquid waste disposal. In the lake Masunda in Thane (Maharashtra) 11 pollution tolerant algal genera were foundg using Palmer's algal genus index. Kotadia and Mulia [4] studied phytoplankton diversity and investigated Palmer pollution index for Ghuma Lake in rural area of Ahmedabad (Gujarat) and found 20 algal genus including 7 pollution indicators genus.

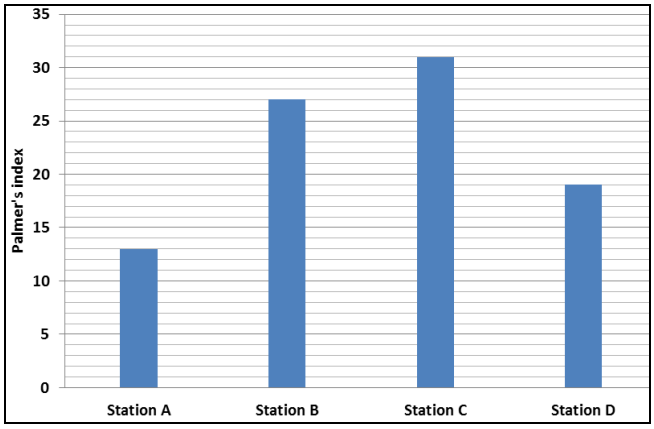

Fig 2: Pollution index score of algal species at selected sampling stations of Lake Pichhola, Udaipur.

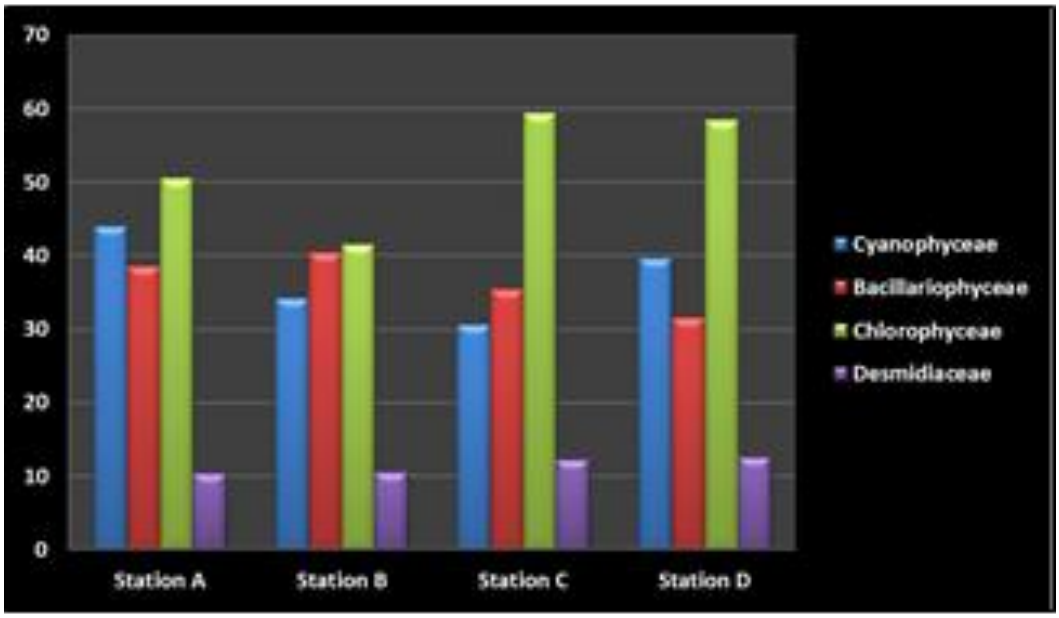

Fig 3: Group wise variation of phytoplanktons at station A, B, C and D of lake Pichhola, Udaipur (Raj.)

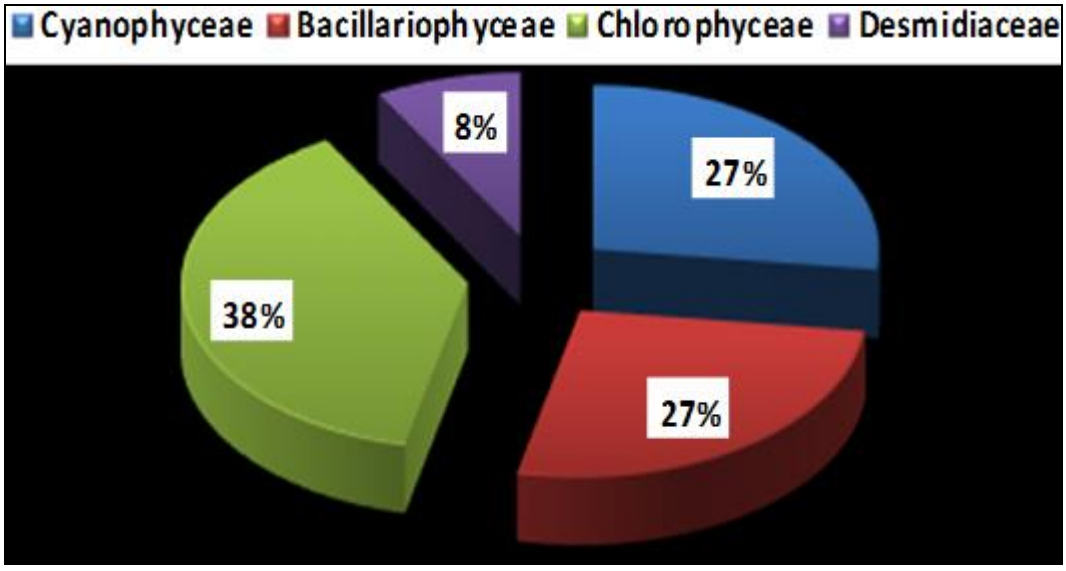

Fig 4: Percentage contribution of phytoplankton groups in lake Pichhola, Udaipur (Raj.)

Table 1: Annual average values of phytoplankton (cells ml^{-1}) at four stations of lake Pichhola.

Major groups of Phytoplankton	Pollution Index score (Palmer1969)	Station A	Station B	Station C	Station D	Overall Avg.
Cyanophyceae						
Agmenellum	-	7.20	7.25	0.00	6.80	5.31
Arthrospira	2	6.80	5.50	12.20	8.71	8.30
Anabaena	-	5.90	6.88	7.10	6.60	6.62
Coelospharium	-	5.00	6.00	0.00	6.75	4.44
Merismopedia	-	6.86	6.67	0.00	8.75	5.57
Microcystis	1	0.00	7.00	5.77	0.00	3.19
Nostoc	-	8.75	5.86	8.33	8.56	7.87
Oscillatoria	4	0.00	2.00	2.00	0.00	1.00
Polycystis	-	8.09	8.30	8.08	7.69	8.04
Synechocystis	-	7.29	0.00	0.00	3.78	2.77
Sprirulina	-	10.00	0.00	9.25	9.75	7.25
Total		**44.00**	**34.08**	**30.50**	**39.64**	**37.06**
Bacillariophyceae						
Asterionella	-	7.38	9.57	9.57	7.38	8.47
Cyclotella	1	6.17	9.10	5.40	9.30	7.49
Diatom	-	6.43	7.46	6.38	7.31	6.90
Fragilaria	-	7.36	9.80	7.90	6.90	7.99
Navicula	3	6.33	6.50	8.25	0.00	5.27

Nitzschia	3	0.00	6.00	6.40	0.00	3.10
Pinnularia	-	4.75	8.17	0.00	10.14	5.76
Synedra	2	8.40	5.44	5.78	4.70	6.08
Tabellaria	-	6.44	7.00	6.18	4.75	6.09
Total		**38.43**	**40.43**	**35.36**	**31.50**	**36.43**
Chlorophyceae						
Ankistrodesmus	2	8.00	8.50	8.50	8.33	8.33
Chlamydomonas	4	0.00	0.00	7.78	9.22	4.25
Chlorella	3	10.00	10.00	10.00	0.00	7.50
Colostrum	1	7.89	8.44	8.44	8.89	8.42
Hydrodictyon	-	6.70	5.30	5.30	5.40	5.68
Ultrix	-	7.50	0.00	7.50	8.00	5.75
Pedi strum	-	7.44	12.44	12.44	11.67	11.00
Protococcus	-	7.82	0.00	6.82	7.45	5.52
Tetraspora	-	6.20	0.00	3.80	6.30	4.08
Spirogyra	-	8.89	12.44	12.44	12.33	11.53
Volvox	-	7.33	11.33	11.33	10.33	10.08
Zygnema	-	8.71	9.00	9.00	7.00	8.43
Total		**50.50**	**41.50**	**59.36**	**58.50**	**52.46**
Desmidiaceae						
Cosmarium	-	5.55	4.22	4.78	4.82	4.84
Gonatozygon	-	4.71	0.00	0.00	2.50	1.80
Closterium	3	0.00	6.27	7.36	5.23	4.72
Total		**10.26**	**10.49**	**12.14**	**12.55**	**11.36**
Grand total		**143.19**	**126.51**	**137.36**	**142.19**	**137.31**

Table 2: Algal pollution index score (Palmer, 1969) at station A, B, C, D of lake Pichhola.

S. No.	Algal genera considered for pollution Index with respective score	Scores at stations			
		A	B	C	D
1	*Ankistrodesmus* (2)	2	2	2	2
2	*Arthrospira* (2)	2	2	2	2
3	*Chlamydomonas* (4)	-	-	4	4
4	*Chlorella*(3)	3	3	3	3
5	*Colostrum* (3)	3	3	3	3
6	Closterium(3)	-	3	3	3
7	Cyclotella (1)	1	1	1	-
8	Microcystis (1)	-	1	1	-
9	Navicula (3)	-	3	3	-
10	Nitzschia (3)	-	3	3	-
11	Oscillatoria (4)	-	4	4	-
12	Synedra (2)	2	2	2	2
	Total	13	27	31	19

4. Conclusion

Palmer [8] suggested that algal flora of a lake ecosystem is a reliable indicator of water pollution as it is justified in present study. The study explains that lake Pichhola as a rich biodiversity of plankton, with a dominance of Chlorophyceae, assigning eutrophic status of lake. The study it is recommends that a sustainable management plan should be formulated and implemented in order to conserve diverse ecosystem of Lake Pichhola.

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