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PHYTOPLANKTONIC STUDIES OF VILLAGE POND WITH REFERENCE TO WATER QUALITY

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Abstract: Ichchhapore village pond situated in the Surat district of Gujarat state was selected to study the diversity of phytoplankton with reference to physico-chemical properties of pond water. Water samples were collected every month from December 2011 to November 2012 for phytoplankton (qualitative and quantitative) and water analysis for temperature, pH, total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), total hardness (TH), calcium hardness, magnesium hardness, total alkalinity, dissolved oxygen (DO), biological oxygen demand (BOD), chloride, phosphate, silicate, nitrate, nitrite and ammonium nitrogen. Total of forty six species of phytoplankton were identified belonging to Euglenophycae, Chlorophyceae, Bacillariophyceae and Cyanoophyceae. Maximum genera belonged to group of Chlorophyceae followed by Bacillariophyceae and Euglenophycae.

Keywords: Water quality, Chlorophyceae, Bacillariophyceae, Cyanophyceae.

I. INTRODUCTION

Ponds are generally small, shallow, confined bodies of standing water, habitats of great importance providing water for domestic, industrial and agricultural uses. Knowledge regarding the ecology of pond water is important tool for their systematic study. The planktonic study is a very useful tool for the assessment of water quality and productivity of any type of water body and also contributes to understanding of lentic water bodies [1]. The maintenance of healthy aquatic ecosystem is dependent on the biological diversity of the ecosystem and the abiotic properties of water [2]. Distribution of phytoplankton and their variation at different zones of a water body is known to be influenced by physico-chemical parameters of water. Algal flora constitutes a vital link in food chain and its productivity depends on water quality at a given time [3]. The interactions of both the physical and chemical properties of water play an important role in composition, distribution and abundance of aquatic organisms including phytoplankton [4, 5]. Under favorable environmental conditions, nutrient concentration, warm temperature, shallow and slow moving water, the algal growth is encouraged in the water bodies that finally results in the formation of algal blooms [6].Phytoplankton are free floating microscopic plants containing chlorophyll-a, that swim on the upper surfaces of water or are suspended in the water column. In aquatic system phytoplankton are important biological characteristics. Phytoplankton which includes blue-green algae, green algae, diatoms, euglenoids etc. are important among aquatic flora. They form the basic link in the food chain of all aquatic animals [7]. Phytoplanktons are primary producers of aquatic food chain and dependent on sunlight for photosynthesis. In addition to light and oxygen they require basic inorganic nutrients such as phosphates, nitrates and silicates [8]. The present study is an attempt to investigate the phytoplanktonic diversity with reference to water quality from the village pond.

II. STUDY SITE

Ichchhapore village pond lies between latitude 21° 11’ 29. 02’’ N and longitude 72° 44’ 07.83’’ E and falls under the Surat district of Gujarat State Fig. 1. The pond area was 1.5 ha with about 6 feet depth having luxuriant growth of aquatic weeds (Fig. 2).

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Fig 1, Map of Study area

Fig 2, Ichchhapore village pond

III. MATERIALS AND METHODS

Surface water samples were collected from the pond every month from December 2011 to November 2012 and analyzed in the laboratory for important physico-chemical parameters such as temperature, pH, total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), total hardness (TH), calcium hardness, magnesium hardness, total alkalinity, dissolved oxygen (DO), biological oxygen demand (BOD), chloride, phosphate, silicate, nitrate, nitrite and ammonium nitrogen following the standard methods of [9, 10, 11].

Plankton samples were collected by filtering water through plankton net with 60µ mesh size. The filtrate was immediately preserved in 4% formaldehyde for the identification of phytoplankton up to genera according to keys prescribed by Edmondson [12, 13, 14, 15, 16].

IV. RESULT AND DISCUSSION

The physico-chemical parameters including quantitative analysis of plankton of Village pond has been depicted in Table 1 and statistical analysis is shown in Tables 2 & 3.

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TABLE 1: PHYSICO-CHEMICAL PARAMETERS OF ICHCHHAPORE VILLAGE POND

S.N.	Parameters	December	January	February	March	April	May	June	July	August	September	October	November
1	Color	Colorless	Colorless	Light green	Light green	Light green	Light green	Light green	Light green	Light green	Light green	Light green	Light green
2	Air Temp. (°C)	21	21	20	25	32	29	30	29	30	27	31	27
3	Water Temp. (°C)	22	19	22	22	26	31	29	31	30	28	32	25
4	pH	8.1	8.2	8	8.4	7.8	8.6	8.6	7.8	8.3	8.6	8.5	8.8
5	Turbidity (NTU)	-	-	32.2	23	4	4	4	2	8	16	5	1
6	TS (mg/L)	-	-	280	380	350	300	290	340	350	418	300	270
7	TDS (mg/L)	161	340	250	280	290	280	270	270	270	304	200	210
8	TSS (mg/L)	-	-	30	100	60	20	20	70	80	114	100	60
9	TH (mg/L)	146	166	172	192	192	176	142	158	144	130	118	126
10	Calcium (mg/L)	37.67	41.68	44.088	48.89	47.29	46.49	40.88	41.68	32.86	32.86	29.65	36.07
11	Magnesium(mg/L)	12.66	15.1	15.1	17.05	18.02	14.61	9.74	13.15	15.1	11.69	10.72	8.77
12	TA (mg/L)	162	142	154	152	146	134	126	132	192	164	156	156
13	DO (mg/L)	Nil	Nil	Nil	1.21	2.02	1.62	2.02	2.43	1.62	1.62	0.4	3.64
14	BOD (mg/L)	3.64	3.24	4.05	4.86	4.05	3.65	4.46	2.43	1.21	3.24	4.45	3.25
15	Chloride (mg/L)	49.7	49.7	56.8	63.9	63.9	56.8	63.9	71	56.8	49.7	56.8	35.5
16	Phosphate (mg/L)	1.011	0.181	0.459	0.24	0.275	0.125	0.116	0.268	0.126	0.128	0.107	0.087
17	Silicate (mg/L)	0.373	0.363	0.33	0.181	0.407	0.487	0.377	0.097	0.306	0.317	0.181	0.194
18	Nitrate (mg/L)	2.696	7.751	2.057	0.817	0.456	1.702	0.528	1.303	4.234	4.634	1.69	1.188
19	Nitrite (mg/L)	0.007	0.026	0.007	0.005	0.004	0.007	0.004	0.009	0.03	0.038	0.01	0.009
20	AN (mg/L)	0.118	0.029	0.008	0.195	0.035	Nil	0.032	0.007	0.144	0.001	0.07	0.212
21	Chlorophyll-a (mg/m^3)	1.7	4.132	0.46	0.92	8.96	7.63	37.02	5.95	16.32	0.66	6.438	0.183
22	Plankton sediment (ml/55lit.)	2.4	0.4	0.2	0.2	0.4	0.2	0.2	0.2	0.2	0.2	0.2	0.2

* TS-Total solids, TDS-Total dissolved solids, TSS-Total suspended solids, TH-Total hardness, TA-Total alkalinity, DO-Dissolved oxygen, BOD- Biological oxygen demand, AN-Ammonium nitrogen

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TABLE 2: STATISTICAL ANALYSIS OF PHYSICO-CHEMICAL PARAMETERS

Parameters	N	Range	Minimum	Maximum	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Air temperature	12	12.00	20.00	32.00	26.8333	1.20500	4.17424	17.424	-.642	.637	-1.040	1.232
Water temperature	12	13.00	19.00	32.00	26.4167	1.26406	4.37884	19.174	-.306	.637	-1.358	1.232
pH	12	1.00	7.80	8.80	8.3083	.09571	.33155	.110	-.303	.637	-1.084	1.232
Turbidity	10	31.2	1.0	32.2	9.920	3.2995	10.4338	108.864	1.414	.687	1.031	1.334
Total solid	10	148.0	270.0	418.0	327.800	15.1275	47.8372	2.288E3	.635	.687	-.432	1.334
Total dissolved solid	12	179.0	161.0	340.0	260.417	14.1247	48.9294	2.394E3	-.654	.637	.428	1.232
Total suspended solids	10	94.0	20.0	114.0	65.400	10.7623	34.0333	1.158E3	-.109	.687	-1.320	1.334
Total hardness	12	74.00	118.00	192.00	1.5517E2	7.17934	24.86996	618.515	.131	.637	-1.130	1.232
Calcium hardness	12	19.24	29.65	48.89	40.0090	1.79937	6.23321	38.853	-.216	.637	-1.100	1.232
Magnesium hardness	12	9.25	8.77	18.02	13.4758	.82701	2.86485	8.207	-.138	.637	-.839	1.232
Total alkalinity	12	66.00	126.00	192.00	1.5133E2	5.08315	17.60854	310.061	.821	.637	1.580	1.232
Dissolved oxygen	12	3.64	.00	3.64	1.3817	.32456	1.12430	1.264	.335	.637	-.146	1.232
Biological oxygen demand	12	3.65	1.21	4.86	3.5442	.28715	.99472	.989	-1.123	.637	1.722	1.232
Chloride	12	35.50	35.50	71.00	56.2083	2.68778	9.31074	86.690	-.690	.637	1.159	1.232
Phosphate	12	.924	.087	1.011	.26025	.074783	.259056	.067	2.582	.637	7.237	1.232
Silicate	12	.487	.000	.487	.28600	.040557	.140494	.020	-.795	.637	.081	1.232
Nitrate-N	12	7.295	.456	7.751	2.42133	.619386	2.145617	4.604	1.608	.637	2.513	1.232
Nitrite-N	12	.034	.004	.038	.01300	.003323	.011513	.000	1.427	.637	.670	1.232
Ammonium-N	12	.212	.000	.212	.07092	.022256	.077097	.006	.911	.637	-.665	1.232
Chlorophyll-a	12	36.837	.183	37.020	7.53108	3.006377	10.414394	108.460	2.387	.637	6.322	1.232
Plankton sediment	12	2.200	.200	2.400	.41667	.181673	.629333	.396	3.374	.637	11.530	1.232
Valid N (listwise)	10											

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TABLE 3: CORRELATION COEFFICIENT OF VARIOUS PHYSICOCHEMICAL PARAMETERS OF WATER

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	1																				
2	0.83	1																			
3	0.16	0.21	1																		
4	-0.35	-0.25	-0.06	1																	
5	0.64	0.59	0.16	0.42	1																
6	0.07	-0.08	-0.1	0.14	0.22	1															
7	0.47	0.41	0.18	0.31	0.78	0.06	1														
8	-0.16	-0.38	-0.52	0.31	0.04	0.46	-0.22	1													
9	-0.17	-0.37	-0.37	0.24	0.01	0.38	-0.34	0.93	1												
10	-0.12	-0.32	-0.61	0.33	0.06	0.46	-0.02	0.88	0.65	1											
11	-0.07	-0.04	0.07	0.21	0.08	-0.24	0.39	-0.3	-0.56	0.08	1										
12	0.6	0.42	0.3	-0.29	0.52	0.05	0.31	-0.15	0.001	-0.32	-0.14	1									
13	-0.11	-0.25	0.15	0.28	-0.01	-0.14	-0.066	0.246	0.395	-0	-0.49	-0.24	1								
14	0.36	0.34	-0.54	0.16	0.383	0.29	0.14	0.494	0.445	0.456	-0.38	-0.06	0.133	1							
15	-0.59	-0.46	-0.48	0.03	-0.58	-0.54	-0.455	0.142	0.115	0.149	0.127	-0.5	0.102	-0.04	1						
16	0.01	-0.01	0.1	-0.13	-0.28	0.12	-0.545	0.174	0.135	0.182	-0.08	-0.39	0.212	-0.11	0.117	1					
17	-0.45	-0.36	0.003	-0.1	-0.48	0.42	-0.18	-0.15	-0.31	0.098	0.328	-0.45	-0.45	-0.38	-0.02	0.175	1				
18	-0.07	0.03	0.186	0.03	0.046	0.43	0.31	-0.36	-0.55	-0.04	0.55	-0.09	-0.6	-0.33	-0.28	0.007	0.81	1			
19	-0.05	-0.25	0.329	-0.03	-0.03	-0.43	0.235	-0.14	-0.14	-0.11	0.482	0.26	-0.04	-0.39	0.059	-0.42	-0.17	-0.12	1		
20	0.49	0.41	0.157	-0.27	0.126	0.14	-0.205	-0.12	-0.03	-0.23	-0.27	0.21	0.004	0.395	-0.29	0.275	-0.22	-0.13	-0.17	1	
21	-0.45	-0.37	-0.25	-0.29	-0.69	-0.58	-0.469	-0.06	-0.08	-0.03	0.168	-0.41	0.036	-0.22	0.914	0.22	0.09	-0.16	0.16	-0.18	1

1-Air Temperature, 2-Water Temperature, 3-pH, 4-Turbidity, 5-Total solids, 6-Total dissolved solids, 7-Total suspended solids, 8-Total hardness, 9-Calcium hardness, 10-Magnesium hardness, 11-Total alkalinity, 12-Dissolved oxygen, 13-Biological oxygen demand, 14-Chloride, 15-Phosphate, 16-Silicate, 17-Nitrate, 18-Nitrite, 19-Ammonium nitrogen, 20-Chlorophyll-a, 21-Plankton sediment

The water was found colorless to light green. Air temperature and surface water temperature ranged from 20-32°c and 19-31°c respectively. The pH of water fluctuated from 7.8-8.8 and was alkaline throughout the year. Turbidity ranged from 1.0-32.2 NTU. Total solids observed from the pond was 270-418 mg/L, total dissolved solids ranged from 161-340 mg/L and total suspended solids varied from 20-114 mg/L. Total hardness was recorded 118-192 mg/L from the pond. Calcium ranged from 29.65-48.89 mg/L and magnesium content varied from 8.77-18.02 mg/L. Total alkalinity ranged from 126 to 192 mg/L. In the present study, DO was found between 0-3.64 mg/L. BOD value varied from 1.21-4.86 mg/L. The chloride was found between 35.50-71.0 mg/L. Nutrients like phosphate, silicate, nitrate, nitrite, ammonium nitrogen varied from 0.087-1.011 mg/L, 0.0-0.487 mg/L, 0.456-7.751 mg/L, 0.004-0.038 mg/L, 0.212-0.070 mg/L respectively.

Phytoplanktons (qualitative) were represented by four classes of algae viz. Euglenophycae, Chlorophyceae, Bacillariophyceae and Cyanophycae. Percentage contribution of phytoplankton groups are shown in Fig 3.

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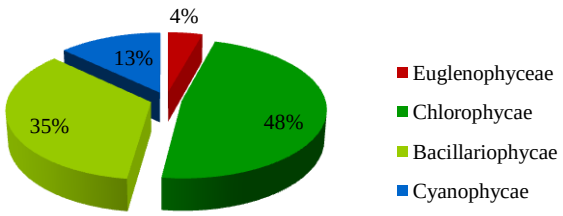

Fig 3, Percentage contribution of phytoplankton groups

Diversity of phytoplankton during different months in the Year 2011-12 has been given in Table 4.

TABLE 4: LIST OF PHYTOPLANKTON

Sr. No.	Plankton	Dec	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov
Phytoplankton													
Euglenophycae													
1.	*Euglena* sp.	-	+	+	-	-	+	-	+	-	+	-	-
2.	*Phacus* sp.	-	-	+	-	+	-	-	-	+	+	-	+
Chlorophyceae													
3.	*Actinastrum* sp.	-	-	-	-	+	-	-	+	+	+	-	-
4.	*Arthrodesmus* sp.	-	-	-	-	-	+	-	-	-	-	-	-
5.	*Centritractus* sp.	-	-	-	-	+	+	+	+	-	-	-	-
6.	*Characium* sp.	+	-	-	-	-	-	-	-	-	-	-	-
7.	*Chlorococcum* sp.	-	-	-	-	-	-	-	-	-	+	+	+
8.	*Chlorosarcina* sp.	-	-	-	-	+	+	-	-	-	-	-	-
9.	*Closterium* sp.	-	-	-	-	-	+	-	+	-	-	-	-
10.	*Closteriopsis* sp.	-	-	-	-	-	-	-	-	-	+	-	-
11.	*Coelastrum* sp.	-	-	-	-	+	+	-	-	+	-	-	+
12.	*Cosmarium* sp.	-	-	+	-	-	+	-	-	-	-	-	-
13.	*Crucigenia* sp.	-	-	-	-	+	+	-	+	+	+	-	-
14.	*Dictyospharium* sp.	-	-	-	-	+	-	-	-	-	-	-	-

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15.	*Hydrodictyon* sp.	+	+	-	-	-	-	-	-	-	-	-	-
16.	*Staurastrum* sp.	-	-	-	-	-	+	-	-	-	-	-	-
17.	*Kirchneriella* sp.	-	-	-	-	-	-	-	-	+	-	-	-
18.	*Pediastrum* sp.	-	-	-	-	+	+	-	+	+	+	-	+
19.	*Pleurotaenium* sp.	-	-	+	-	+	+	-	-	-	+	-	-
20.	*Rhizoclonium* sp.	+	-	-	-	+	-	-	-	+	+	-	+
21.	*Scendesmus* sp.	-	-	-		+	+	-	+	+	+	+	-
22.	*Spirogyra* sp.	-	-	-	-	-	-	-	+	+	-	-	-
23.	*Tetraedron* sp.	-	-	+	-	+	+	-	+	-	+	-	-
24.	*Volvox* sp.	-	-	-	-	-	-	-	-	-	+	-	-
	Bacillariophyceae												
25.	*Achananthes* sp.	-	+	-	-	-	-	-	+	-	-	-	-
26.	*Caloneis* sp.	+	-	-	-	-	-	-	-	-	-	+	+
27.	*Cyclotella* sp.	+	-	-	-	-	+	+	+	-	-	-	-
28.	*Cymbella* sp.	-	-	-	+	-	-	-	-	+	-	-	-
29.	*Diatoma* sp.	+	+	+	-	+	+	-	+	+	-	+	+
30.	*Fragillaria* sp.	+	+	-	+	+	+	-	+	+	-	-	-
31.	*Frustulia* sp.	+	-	-	-	-	-	-	-	-	-	-	-
32.	*Gomphoneis* sp.	+	+	-	-	-	-	-	-	-	-	-	-
33.	*Gomphonema* sp.	+	+	-	-	+	-	+	-	+	-	+	+
34.	*Melosira* sp.	-	-	-	-	+	+	+	+	+	-	+	
35.	*Navicula* sp.	+	+	-	-	+	+	-	+	+	-	+	+
36.	*Nitzschia* sp.	-	-	-	+	-	+	+	-	+	-	+	+
37.	*Pinnularia* sp.	+	+	-	-	+	+	-	-	+	-	-	-
38.	*Rhopalodia sp.*	-	+	-	-	+	+	-	-	-	-	-	-
39.	*Stauroneis* sp.	-	+	-	-	-	-	-	-	-	-	-	-
40.	*Synedra* sp.	+	-	-	+	-	+	+	+	+	+	-	+
	Cyanophyceae												
41.	*Gomphosphaeria* sp.	-	+	-	-	-	-	-	-	-	-	-	-
42.	*Lyngbya* sp.	-	+	-	+	-	-	-	-	-	-	-	+
43.	*Microcystis* sp.	+	+	+	-	-	+	-	-	+	-	-	-

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44.	*Oscillatoria* sp.	+	+	+	+	-	+	+	+	+	+	+	+
45.	*Phormidium* sp.	+	-	+	-	-	-	+	-	-	+	-	+
46.	*Synechococcus* sp.	-	+	+	-	+	+	-	+	+	-	-	+

(+) Present, (-) Absent

Only two species of Euglenophyceae viz: *Euglena* sp. and *Phacus* sp. were identified from the village pond. Both the species were common in February and September (Table 4) where as only *Euglena* sp. was observed in the months of January, February, May, July and September while *Phacus* sp. was noted in the months of February, April, August, September and November. The high pH, temperature, chloride, TDS, and BOD might have played an important role in the development of euglenophyceae. Results of these parameters in the present study show the favorable impact on the growth of euglenophyceae. Temperature above 25°C was favorable for the growth of euglenophyceae [17]. High pH was favorable for the growth of euglenophyceae [18]. Present study was also supported by [19, 20].

Chlorophyceae was the most important group having a contribution of 48 % (Fig. 3) from the total phytoplankton population. Diversity of this group was highest in April, May and lower in June. This class was represented by *Actinastrum* sp., *Arthrodesmus* sp., *Centritractus* sp., *Characium* sp., *Chlorococcum* sp., *Chlorosarcina* sp., *Closterium* sp., *Closteriopsis* sp., *Coelastrum* sp., *Cosmarium* sp., *Crucigenia* sp., *Dictyospharium* sp., *Hydrodictyon* sp., *Staurastrum* sp., *Kirchneriella* sp., *Pediastrum* sp., *Pleurotaenium* sp., *Rhizoclonium* sp., *Scendesmus* sp., *Spirogyra* sp., *Tetraedron* sp., and *Volvox* sp., Table 4. Chlorophyceae members grow well in water that is rich in nutrients such as nitrate and phosphate [21].

In village pond the high diversity of Diatoms was recorded in the month of December whereas less variety was recorded in the month of February and September. It appeared that the presence of pH, Phosphate, Nitrate, Silicate and Calcium favored the growth of diatoms. This group was represented by sixteen species. Calcium rich water bodies have high number of diatoms [22]. High pH favored the high number of diatoms [23]. Chloride is one of the important factor for controlling the growth of diatoms [24]. Regular supply of nitrate encouraged the augmentation and periodicity of diatoms [25]. Bacillariophyceae generally occurs in all types of waters [26].

The study revealed that the blue-green algal population was higher in January and reduced in April and October. Identified species were *Gomphosphaeria* sp., *Lyngbya* sp., *Microcystis* sp., *Oscillatoria* sp., *Phormidium* sp. and *Synechococcus* sp. This may be due to the high value of pH, Dissolved oxygen, TDS, Phosphate, Nitrate and BOD. High nutrients favored the luxuriant growth of cyanophyceae [27, 22].

V. CONCLUSION

The study revealed that the pond had a diversified algal flora dominated by Chlorophyceae members followed by Bacillariophyceae, Cyanophyceae, and Eugleanophyceae. The present investigation ensures that variation in the diversity of plankton may be explained with water quality. Thus it may be concluded that the diversity of phytoplankton is dependent on different abiotic factors directly or indirectly. The basic information of the phytoplankton distribution and abundance would form a useful tool for further ecological assessment and monitoring of village pond.

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