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PHYTOPLANKTON SPECIES-DIVERSITY OF JAGATPUR WETLAND, BHAGALPUR, BIHAR (INDIA)

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Jagatpur wetland in the Middle Ganga flood plain in Bihar supports higher phytoplankton density and diversity. Chlorophyceae were dominant and had numerical superiority over the others with regard to density and diversity. Shannon and Weaver (1963) diversity index was calculated from the phytoplankton data recorded during the survey (August, 2003 - July, 2005), and was found to be in the range of 2.8 - 4.7. Species diversity values when compared to the scales of Wilhm and Dorris (1968), and of Staub *et al.* (1970) suggested the wetland to be slightly or moderately polluted. The higher values of the species diversity in most of the months indicate the absence of the stress factors in those months. The relatively low values during monsoon months may be due to more stressful environment of the wetland.

Key words: Jagatpur wetland, Phytoplankton, Species diversity.

The composition of phytoplankton community depends on biotic and abiotic factors, and the nutrient level has a big influence on the species composition. The species composition reflects the biogeography of respective region. The important feature of fresh water algal flora is its cosmopolitanism. Many species are known practically from all the parts of the world, extending from tropics to polar region and growing in a variety of habitats. Algal flora varies from season to season in different types of water bodies. Algae are sensitive to their environment condition (Palmer 1969). Different groups and species of algae respond to different chemical or organic pollution. The quality and quantity of phytoplankton and their seasonal succession pattern have been successfully utilized to assess the water abstraction, changes in natural flood regime, land reclamation, pollution, over-utilization of natural resources and poaching. The algal forms have always been looked upon by the biologists as the important 'marker' in elucidating the changes in natural habitat (Prasad and Singh 1980). The assessment of degree of pollution has also been made on the basis of sensitivity and tolerance of various algal forms to various pollutants. Normally the first stress in aquatic bodies due to pollution is very much narrow showing marginal shift in the species structure, but continuous stress usually involves disappearance and decline in number of species. Concurrently, there is an increase in abundance of a few species, thus the range of individual species widens. The diversity indices are shown to be useful in describing species diversity pattern within different algal community (Pieterse 1987).

MATERIALS AND METHODS

The phytoplankton samples were collected at monthly intervals during the period August, 2003 to July, 2005. Standard methods were adopted as suggested by APHA (1998). Identification of phytoplankton was done with the help of camera lucida diagram and relevant literature and monographs of Turner (1892), West and West (1907), Gandhi (1958, 1961, 1967), Desikachary (1959), Randhawa (1959), Ramanathan (1964),

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Table 1: Density and percent composition of phytoplankton population (Unit/L) of Jagatpur Wetland (August, 2003 - July, 2004)

Months	Total phytoplankton Density (U/L)	Bacillariophyceae		Chlorophyceae		Cyanophyeae		Euglenophyceae		Dinophyceae	
		Density (U/L)	% Comp	Density (U/L)	% Comp	Density (U/L)	% Comp	Density (U/L)	% Comp	Density (U/L)	% Comp
Aug. 2003	24168	10308	42.65	8948	37.02	4254	17.6	658	2.72	-	-
Sept.	14262	1762	12.35	8535	59.84	3965	27.8	-	-	-	-
Oct.	17142	3069	17.9	10040	58.56	4033	23.52	-	-	-	-
Nov.	20234	-	-	12597	62.25	7637	37.74	-	-	-	-
Dec.	19531	5310	27.18	8471	43.37	5750	29.44	-	-	-	-
Jan. 2004	20479	2149	10.49	14778	72.16	3552	17.34	-	-	-	-
Feb.	24519	2500	10.19	16185	66.01		22.36	-	-	351	1.43
March	25029	3293	13.15	14095	56.31	7509	30.0	44	0.175	88	0.351
April	17423	220	1.26	7084	40.65	10119	58.07	-	-	-	-
May.	18161	806	4.43	12376	68.14	4979	27.41	-	-	-	-
June	20989	5196	24.75	10495	50.0	5298	25.24	-	-	-	-
July	12576	3024	24.04	7142	56.79	2410	19.16	-	-	-	-
Total	**234513**	**37637**	**15.7**	**130746**	**56.0**	**64989**	**28.0**	**702**	**0.2**	**439**	**0.1**

U/L- Unit of phytoplankton per liter

Table 2: Density and percent composition of phytoplankton population (Unit/L) of Jagatpur Wetland (August, 2004 July, 2005)

Months	Total phytoplankton Density (U/L)	Bacillariophyceae		Chlorophyceae		Cyanophyeae		Euglenophyceae		Dinophyceae	
		Density (U/L)	% Comp	Density (U/L)	% Comp	Density (U/L)	% Comp	Density (U/L)	% Comp	Density (U/L)	% Comp
Aug. 2004	23376	4304	18.41	10514	44.97	8509	36.4	-	-	49	0.2
Sept.	21533	4193	19.47	6421	29.81	10919	50.7	-	-	-	-
Oct.	25046	5439	21.71	12062	48.15	7545	30.12	-	-	-	-
Nov.	38395	6801	17.71	19439	50.62	12023	31.31	132	0.34	-	-
Dec.	36533	13464	36.85	17762	48.61	5307	14.52	-	-	-	-
Jan. 2005	23623	10362	43.86	10055	42.56	3030	12.82	176	0.74	-	-
Feb.	20550	8826	42.94	2152	10.47	9177	44.65	395	1.92	-	-
March	27505	11581	42.10	11713	42.58	3948	14.35	263	0.95	-	-
April	27575	4691	17.01	20138	73.02	2632	9.54	114	0.41	-	-
May.	10573	5068	47.93	2155	20.38	2828	26.74	522	4.93	-	-
June	12997	2703	20.79	57	0.43	5866	45.13	4371	33.63	-	-
July	16686	4625	27.71	5211	31.22	6616	39.65	234	1.40	-	-
Total	**284392**	**82057**	**29.8**	**117679**	**36.9**	**78400**	**29.66**	**6207**	**3.63**	49	0.01

U/L- Unit of phytoplankton per liter

Philipose (1967), Sarode and Kamat (1984), and Saha (1986).

RESULTS AND DISCUSSION

81 species of Chlorophyceae were identified from the wetland and they contributed 56% and 36.9% of the total density in the first and second year of the investigations respectively. In the first year (August, 2003 - July, 2004), the density of Chlorophyceae ranged from 7142 U/L to

Table 3: Species diversity (H), Evenness (J') and Richness (d) of Phytoplankton of Jagatpur wetland (August, 2003-July 2005)

Months	Species diversity (H)	Evenness (J')	Richness (d)
Aug. 2003	3.881	0.816	2.885
Sep.	4.004	0.926	2.277
Oct.	4.525	0.975	3.600
Nov.	4.283	0.856	3.503
Dec.	4.425	0.941	2.841
Jan. 2004	3.985	0.829	3.044
Feb.	4.094	0.764	4.382
Mar.	4.753	0.870	4.696
April	4.197	0.839	3.592
May	4.135	0.819	3.680
June	4.307	0.915	3.252
July	4.448	0.883	3.796
Aug.	2.985	0.654	3.012
Sep.	4.159	0.856	3.141
Oct.	4.368	0.820	4.260
Nov.	4.176	0.756	4.604
Dec.	3.789	0.712	4.019
Jan. 2005	4.429	0.801	4.960
Feb.	3.959	0.712	5.185
Mar.	4.341	0.713	6.134
April	4.155	0.838	3.791
May	4.063	0.768	4.088
June	2.888	0.749	1.662
July	3.129	0.750	2.084

16185 U/L and in the second year (August, 2004 - July, 2005) from 57 U/L to 20138 U/L. Out of 81 species, 3 species belonged to Volvocales, 3 species to Ulotrichales, 2 species to Oedogoniales, 16 species to Chlorococcales and 57 species to Zygnematales. Thus, it is evident that the members of Chlorococcales and Zygnematales contributed greatly to Chlorophycean composition. From Table 1 and 2, it is evident that winter months recorded the highest density of Chlorophyceae followed by summer and rainy months. *Pediastrum*, *Chlorella*, *Ankistrodesmus*, *Scenedesmus*, *Closterium*, *Coelastrum*, *Ulothrix*, *Oocystis* and *Cosmarium* species were pronounced in the wetland during the study period. The dominance of these genera

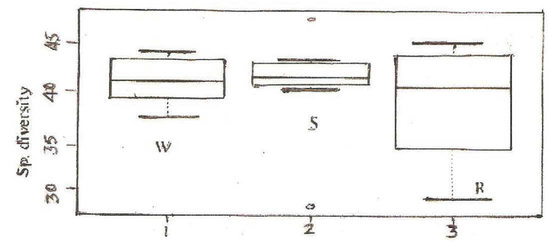

Figure 1: Species diversity in winter, summer and rainy seasons (all taxa)

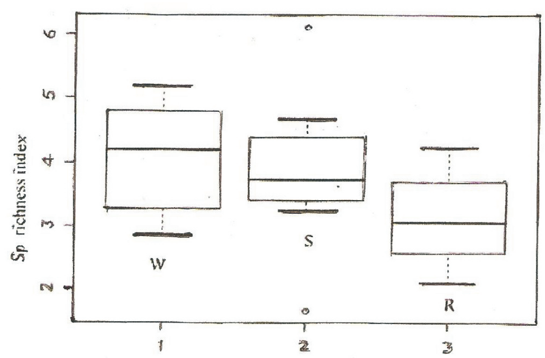

Figure 1: Species richness indices winter, summer and rainy seasons (all taxa)
Seasons: 1 - W (Winter 2 - S (Summer). 3 = R (Rainy)

was probably because of eutrophic nature of the wetland and indicates organic pollution.

Bacillariophyceae were next to Chlorophyceae. All 42 species of diatoms belonged to Pennales. They contributed to 15.7% and 29% of the total algal density in the first and second year of investigation respectively. The density of diatoms varied from 220 to 10308 U/L. Diatoms were dominant in winter months followed by rainy and summer months. Presence of *Synedra*, *Navicula*, *Cymbella*, *Pinnularia* and *Fragillaria* species suggest the water body rich in organic pollution.

Cyanophyceae were next to Bacillariophyceae. All 31 species were from the order Chroococcales (6 forms) and Nostocales (25 forms). They contributed 28% and 29.66% of the total density recorded during first and second year respectively. The density of Cyanophyceae population ranged from 2410 U/L - 10119 U/L in the first year and from 2632 U/L - 12063 U/L in the second year of investigation. Cyanophyceae density was maximum in rainy months followed by winter

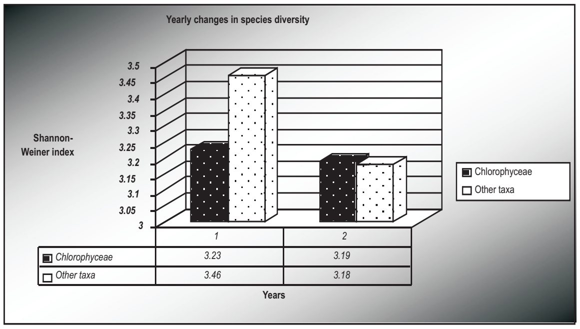

Figure. 3: Yearly changes in species diversity for Chlorophyceae and other taxa

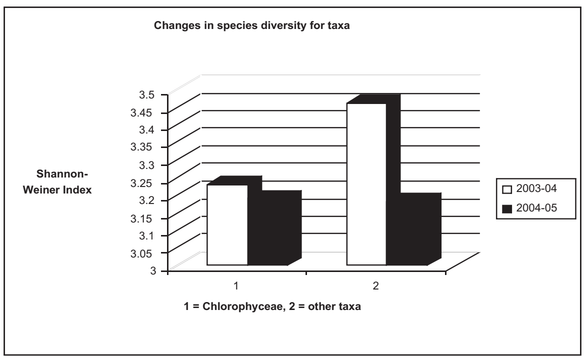

Figure. 4: Changes in species diversity for Chlorophyceae and other taxa from 2003-04 to 2004-05

and summermonths respectively. Cyanophycean members had numerical superiority over Bacillariophyceae in the first year, while in the second year, Bacillariophyceae were slightly more in numbers compared to Cyanophyceae. Chlorophyceae was more pronounced compared to Cyanophyceae. Presence of species of *Oscillatoria*, *Phormidium*, *Anabaena*, *Lyngbya* and *Spirulina* also indicates about organic pollution of the wetland.

Euglenophyceae constituted only 0.2% and 3.63% of the total phytoplankton density in the first and second year of investigation respectively. The group was mainly represented by *Euglena* and *Phacus* species.

Dinophyceae contributed insignificantly (only 0.1% in the first year and 0.01% in the second year) towards total phytoplankton density. The group was mainly represented by *Ceratium* species.

The Species diversity, Evenness and Richness values for phytoplanktonic algal forms recorded from the wetland were

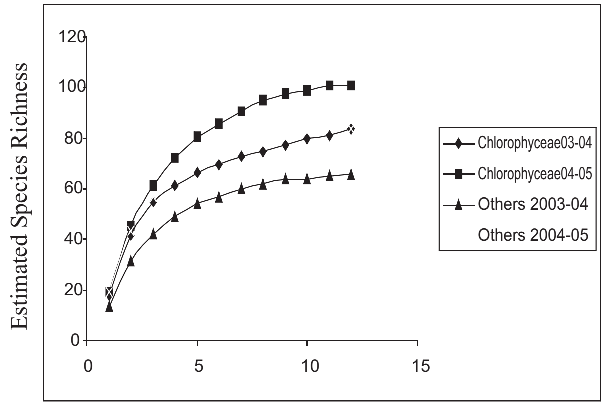

Figure. 5: Jack-knife estimates of actual species richness for Chlorophyceae and other taxa

calculated and have been presented in the Table-3. Species diversity values ranged from 3.88 - 4.75 in the first year (2003-04) and from 2.88 - 4.42 in the second year (2004-05) of the study. The diversity was maximum in summer and monsoon months in 2003-04, while in 2004-05, the maximum diversity was recorded in winter and summer months. The minimum diversity was recorded in winter months during 2003-04 and in monsoon during 2004-05. The species richness was maximum in summer and minimum in monsoon in 2003-04, while in 2004-05, the maximum was in winter and minimum in monsoon. The Evenness index was generally low in study period ranging from 0.654 to 0.975.

Oedogonium oblongum (145), *Navicula cuspidata* (118), *Synedra ulna* (100) were the dominant species in 2003-04. Their relative abundance were 25.93, 21.41 and 18.14 respectively, while in 2004-05, *Mougeotia spherocarpa* (190), *Navicula minuta* (174), *Synedra ulna* (162) were the dominant species and their relative abundance were 22.81, 34.87 and 25.84 respectively.

The values of species diversity obtained from the wetland may be compared to some of the scales proposed by Wilhm and Dorris (1968) and Staub *et al*. (1970) based on extensive studies of various aquatic bodies. From the perusal of data (Table-3), it is evident that the wetland under study falls under clear water category except some months (i.e. June and August, 2004-05), when it was moderately polluted according to the scale of Wilhm and Dorris (1968), and from slightly to lightly polluted according to the scale of Staub *et al*. (1970). The narrow range of the species diversity of phytoplankton may possibly be attributed partly to organic influx into wetland. The scale of species diversity may not be totally full proof but they certainly give an idea about the general quality of water in polluted and non-polluted zone. Our observations support Silluvan (1978) who opined that the higher values of species diversity indicate the absence of stress factor. The low values during monsoon are due to more stressful environment which has also been supported by Pieterse (1987).

Diversity indices for the three seasons (summer, rainy and winter) were then compared using box plot (box and whishkess plot) which gives the distribution of data on both sides of the median value (Magurran 1988). The same was done for comparing Margalef's (1958) richness indices too (Fig. 1 & 2). No significant variation between seasons was obtained. However, notable in both cases is the presence of an outlier in the summer season, possibly indicating June. Certain ecological conditions and physical variables may be considered as indicating a kind of season transition.

Shannon-Weaver's Diversity index was estimated by the above program for the taxonomic groups for 2003-04 and 2004-05. The bar graph indicates comparison (Fig. 3 & 4). Diversity among other taxa reduced sharply in the next year, but Chlorophytic diversity showed an overall similar value.

Using the program Estimates 4.0 (http:// Viceroy), Jack-Knife indices (Palmer 1990) were calculated by splitting the taxonomic groups into Chlorophyceae and other taxa (i.e.Bacillariophyceae, Cyanophyceae, Euglenophyceae and Dinophyceae) for the year 2003-04 and 2004-05 (Fig. 5). It is clear that sampling has been adequate due to saturated asymptote seen in the curve. Also, any missed species are added by this estimater to estimate true species richness for the samples data.

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