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Original Article

An Insight into the Physico-Chemical characteristics of Water and Soil along with Macrophyte Diversity in Kathgola Dighi: A Freshwater Wetland in Jalpaiguri District, West Bengal, India.

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Abstract

In the present communication an attempt has been made to correlate the seasonal change of macrophytes diversity and physico-chemical characteristics of water and soil in Kathgola Dighi, Jalpaiguri, West Bengal. Diversity indices of 48 plant species and the regulatory effects of the four physico-chemical parameters of water and six soil parameters on the plant diversity were assessed. The macrophytes diversity, richness and evenness were high in monsoon but the dominancy was high in the months of mid summer and mid winter. The Euclidean distance of seasonal variation of macrophytes diversity and physico-chemical parameters of soil and water revealed that the wetland plants diversity were changed with the seasonal changes of physico-chemical parameters.

Keywords: *Macrophyte diversity, Physico-Chemical characteristics, Kathgola Dighi, Diversity indices, Eucladian distance.*

INTRODUCTION

The importance of wetland to global carbon cycle, water balance, wildlife biodiversity and human food production is much greater than their proportional surface area on Earth would suggest (Neue *et al.,* 1997). These are geologically very young and ecologically very fragile. They occur in all climates and change perpetually with time season. The wetlands provides refuge for endangered plants and animals, provide foods, fuels and fodders, reduce the impact of flood, purify the water by absorbing the toxic component produced from human society. So, a regular monitoring of limnological status of wetland is very much important for maintaining a healthy and wealthy environment. Several studies have been made on wetland macrophytes Khan & Mahbuba (1987), De Thabrew (1983), Biswas and Calder (1936), Jain and Shastry (1981), Gopal (1990), Cook's (1974, 1980, 1996), Chowdhuri (1998) etc. and limnological profile of wetland Ugale *et al.,* (2005), Kamath *et.al.,* (2006), Sachidanandamur (2006), Sharma (2010), Goswami et.el. (2010) etc. Kathgola Dighi, which was a man-made perennial and private owned wetland; situated in the vicinity of Madari Road, near Falakata, Jalpaiguri, chosen for study. The wetland covers an area of 2.26 Acres, surrounded by agricultural fields and received run-off water from the adjacent high land. The maximum depth of water is 12 ft (August – September) and minimum is 5 ft. (April – may). The average annual depth of water is 8.5 ft. The water of this wetland is mainly used for agriculture and pisciculture. This wetland is abode of different migratory birds particularly during winter season. Hare the present investigation was carried out to explore the seasonal change of macrophytes diversity pattern with physico-chemical properties and nutrient status of water and soil.

MATERIAL & METHODS

In the present investigation 3 hectares area was studied by choosing sites at random in different seasons. For laying 20 quadrates ($1\times1m^2$) specific sites were selected and every individual plants species were counted and identified from different books like Biswas & Calder (1936), Cook (1980, 1996), Jain & Sastri (1981), Khan & Mahbuba (1987). Different diversity indices were

determined on the basis of individual species observed in the quadrats lay.

Water samples were collected in air tight PVC bottles. The pH and conductivity were measured by pH and conductivity meters respectively and the others parameters such as Dissolve Oxygen (DO), Biological Oxygen Demand (BOD) and Dissolve CO_2 were tested by following standard methods (APHA, 1992), Jadav and Jogdan (1993) Central Pollution Control Board (CPCB, 1978); Tribedi and Goel (1992).

Soil samples were collected from surface layers (top 6″) of study sites. 5 samples of soil were collected. After thorough mixing of all the samples (4 X 5 = 20) from each wetland, were preserved in a polythene bag and labeled. The air dried samples were ground into fine powder by gently pressing them with mallet and strained through 2mm sieve and again air dried. Then the analyses of Organic carbon (OC), Nitrate nitrogen (NO_3N) and Phosphate phosphorous (PO_4P) were done with the air-dried samples by following standard methods of APHA (1992), Piper (1950) and Jadav and Jogdan (1993).

The statistical analysis like measurement of Dominance index, Shannon's index, Simpson's index, Evenness index and Margalef's index were done using PAST 2.07 software and single linkage Euclidian distance of different variables by STATISTICAw 5.0 software.

RESULT AND DISCUSSION

The Kathgola Dighi is in possession of important wetland characteristics as laid down by United States Fish and Wild Life Services through their circular 39. This water body also fulfils the demand of Cook's consideration (1996) where inundation must occur for about 14 days and saturation for at least 60 consecutive days.

In this present work, as many as 41 species of macrophytes (pteridophytes and angiosperms) belonging to 25 families, that are associated with this wetland and also the occurrence of different plant species has been presented in Table 1. A different diversity index which gives an idea about the seasonal preference of those macrophyte plant species were also presented (Table-1)

In the month wise seasonal diversity of macrophytes **(**Table 2**)** the plant species richness index was more or less same throughout the year. The highest richness of wetland macrophytes were shown in July followed by May and June that means in the intermediate time of premonsoon and monsoon the species richness was highest and lowest in October and November at the time of winter. The Simpson's dominance index was highest in January followed by March, February and November that is in mid winter only few species were dominated in this wetland. On the other hand the Shannon's general diversity index was high mainly in monsoon season (June to September) followed by pre monsoon (February to May).Similarly the Pielou's evenness index shows that at the mid monsoon time (June to September) the macrophytes were high evenly distributed**.**

Table 1: Enumeration of Macrophytes and their different Diversity Indices

Sl. No.	Name of the Macrophytes	Family	Dominance_D	Shannon_H	Simpson_1D	Evenness_e^H/S	Margalef
1.	*Alternanthera philoxeroides* Grisbach.	Amaranthaceae	0.08814	2.456	0.9119	0.9719	1.834
2.	*Alternanthera sessilis* (L.) R.Brown	Amaranthaceae	0.08485	2.476	0.9151	0.9907	1.621
3.	*Alternanthera pungens* Kunth	Amaranthaceae	0.0948	2.418	0.9052	0.9352	1.903
4.	*Bacopa monnieri* (L.) Pennell	Scrophulariaceae	0.08438	2.479	0.9156	0.994	1.758
5.	*Canna indica* L.	Cannaceae	0.09231	2.428	0.9077	0.945	2.13
6.	*Commelina diffusa* N.L.Burman	Commelinaceae	0.1005	2.374	0.8995	0.8949	2.249

7.	*Cassia sophera* L.	Caesalpiniaceae	0.08428	2.479	0.9157	0.9942	1.773
8.	*Hydrocotyle asiatica* (L.) Urb.	Apiaceae	0.08911	2.448	0.9109	0.9633	1.694
9.	*Ceratophyllum demersum* L.	Cerotophyllaceae	0.0893	2.449	0.9107	0.9644	1.909
10.	*Commelina bengalensis* L.	Commelinaceae	0.08463	2.477	0.9154	0.9922	1.51
11.	*Cynodon dactylon* (L.) Pers.	Poaceae	0.08412	2.48	0.9159	0.9953	1.483
12.	*Cyperus rotundus* L.	Cyperaceae	0.08368	2.483	0.9163	0.9979	1.461
13.	*Eclipta alba* (L.) Hassk.	Asteraceae	0.08488	2.475	0.9151	0.9906	2.052
14.	*Eichhornia crassipes* (Mart.) Solms	Pontederiaceae	0.09232	2.425	0.9077	0.9416	1.755
15.	*Enydra fluctuans* Lour.	Asteraceae	0.1067	2.341	0.8933	0.8656	2.282
16.	*Eragrostis coarctata* Stapf.	Poaceae	0.08466	2.477	0.9153	0.9918	1.665
17.	*Euphorbia dracanculoides* Lam.	Euphorbiaceae	0.09003	2.444	0.91	0.96	2.29
18.	*Grangea maderaspatana* (L.) Poir	Asteraceae	0.0858	2.47	0.9142	0.9854	1.743
19.	*Heliotropium indicum* L.	Boraginaceae	0.08876	2.454	0.9112	0.9691	2.302
20.	*Hydrilla verticillata* (L.f.) Royle	Hydrocharitaceae	0.09346	2.424	0.9065	0.9409	1.807
21.	*Hygrophila schulli (*Buch. Ham) M.R. and S.M. Almeida	Acanthaceae	0.08749	2.459	0.9125	0.9745	1.838
22.	*Ipomoea aquatica* Forrsk.	Convolvulaceae	0.08378	2.482	0.9162	0.9973	1.646
23.	*Ipomoea carnea* Jacq. ssp. *fistulosa* (Mart. ex choisy) D. Austin	Convolvulaceae	0.08939	2.448	0.9106	0.9638	1.914
24.	*Leptochloa chinensis* (L.) Nees	Lemnaceae	0.09813	2.376	0.9019	0.8971	2.327
25.	*Lemna perpusilla Torrey*	Araceae	0.08351	2.484	0.9165	0.999	1.331
26.	*Marsilea minuta* L.	Poaceae	0.08359	2.483	0.9164	0.9985	1.397
27.	*Mimosa rubicaulis* Lam.	Marsileaceae	0.09066	2.441	0.9093	0.9567	2.476
28.	*Neptunea oleracea* Lour.	Mimosaceae	0.08467	2.477	0.9153	0.9921	1.981
29.	*Nymphaea nouchali* Burm.f.	Mimosaceae	0.08501	2.475	0.915	0.9902	1.734
30.	*Nymphoides indica* (L.) O.Kuntze	Nymphaeaceae	0.09	2.445	0.91	0.9608	2.51
31.	*Panicum repens* L.	Menyanthaceae	0.0865	2.467	0.9135	0.9819	2.082
32.	*Phyllanthus fraternus* Webster	Poaceae	0.09799	2.392	0.902	0.9112	2.54
33.	*Pistia stratiotes* L.	Euphorbiaceae	0.09029	2.441	0.9097	0.9573	1.702
34.	*Polygonum barbatum* L.	Araceae	0.09065	2.437	0.9093	0.9534	2.635

35.	*Polygonum hydropiper* L.	Polygonaceae	0.08813	2.455	0.9119	0.9708	1.97
36.	*Salvinia molesta Mitchell*	Salviniaceae	0.08761	2.458	0.9124	0.9739	1.676
37.	*Schoenoplectus articulatus* (L.) Palla	Polygonaceae	0.095	2.416	0.905	0.9334	2.51
38.	*Sida cordata* (Burm.f.) Borssum	Cyperaceae	0.08459	2.477	0.9154	0.9926	2.006
39.	*Sagittaria montevidensis* Cham.& Schlecht	Alismataceae	0.09372	2.421	0.9063	0.9379	1.922
40.	*Sagittaria sagitifolia* L.	Alismataceae	0.09416	2.421	0.9058	0.9384	1.909
41.	*Wolffia globosa* (Roxburgh) den Hartog	Araceae	0.08554	2.472	0.9145	0.987	1.692

Table 2: Seasonal variations of different diversity indices of plant species:

Month	Dominance_D	Shannon_ H	Simpson_1D	Evenness_e^H/S	Margalef
January	0.07755	3.032	0.9225	0.506	5.37
February	0.07398	3.063	0.926	0.5218	5.342
March	0.07006	3.089	0.9299	0.5353	5.334
April	0.06829	3.114	0.9317	0.5493	5.33
May	0.06032	3.208	0.9397	0.6031	5.253
June	0.0572	3.25	0.9428	0.6291	5.21
July	0.05472	3.282	0.9453	0.6495	5.173
August	0.05354	3.294	0.9465	0.6575	5.159
September	0.0566	3.263	0.9434	0.6374	5.191
October	0.05915	3.23	0.9408	0.6167	5.208
November	0.06335	3.174	0.9367	0.5831	5.23
December	0.06754	3.137	0.9325	0.5618	5.256

Table 3: Seasonal variation of Physico-chemical characteristics of water and soil

Parameters	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
WpH	7.22	6.3	5.25	5.79	6.5	7.1	6.98	7.08	6.88	5.55	5.62	5.88
DO mg/lt	2.77	1.86	1.99	2.05	2.82	2.65	2.55	2.52	2.96	3.06	3.11	3.16
BOD mg/lt)	7.9	13.7	12.9	10.5	10.2	9.91	9.6	9.32	8.7	7.54	7.12	6.34
CO_2 mg/lt)	30.06	27.94	28.8	28.46	27.06	28.6	27.06	27.06	28.54	33.66	34.28	30.8
SpH	5.38	5.73	5.01	5.23	5.8	6.12	6.02	6.08	5.82	5.08	5.01	5.24
SCO u.mhos.m)	130	145	143	154	165.5	180	188	186	189	128	116	120
SN_2 g/kg	2.12	1.87	2.56	3.12	1.76	1.48	1.98	2.55	2.71	2.38	3.44	2.12

SPO_4 g/kg	1.62	1.32	1.56	1.44	1.1	2.1	2.22	2.7	2.48	1.51	1.54	1.68
SOC (%)	1.47	1.36	1.58	1.48	1.46	1.54	1.42	1.48	1.69	1.76	1.81	1.60
C/N	0.69	0.73	0.62	0.47	0.83	1.04	0.72	0.58	0.62	0.74	0.53	0.75

[Water pH (WpH), Dissolve oxygen (DO), biological oxygen demand (BOD) and dissolve carbon dioxide (CO_2) and six physico-chemical parameters of soil i.e. soil pH (SpH), Specific conductance (SCO), nitrate-nitrogen (SN_2), phosphate (SPO_4), organic carbon (SOC) and carbon-nitrogen ratio (C/N).]

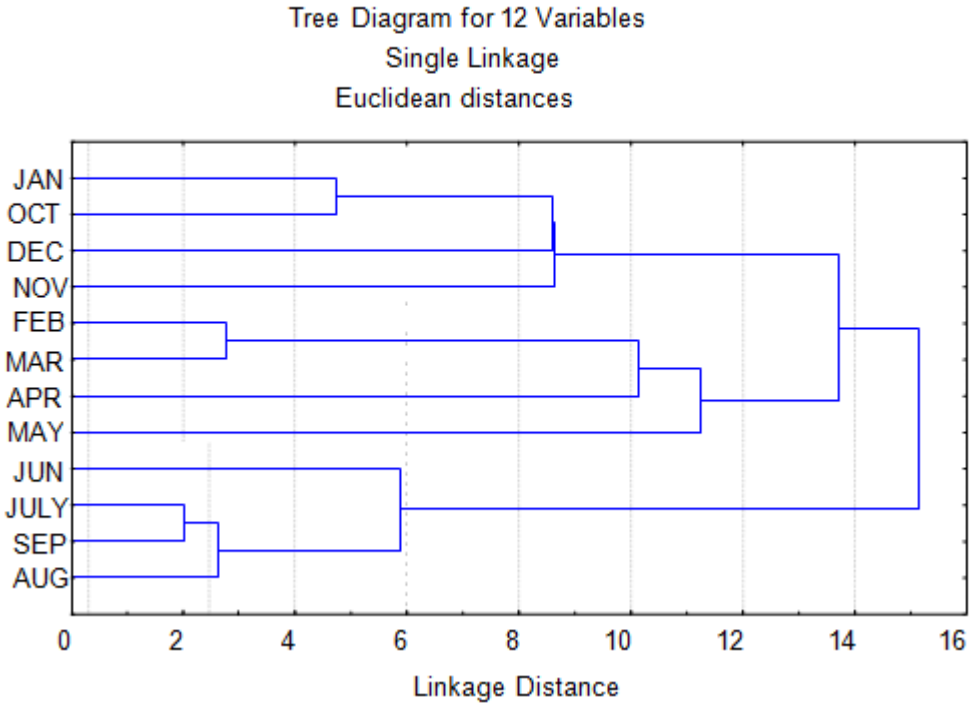

Fig 1: Hierarchical cluster analysis of the months under study of Kathgola Dighi depending on the physico-chemical parameters of water and soils

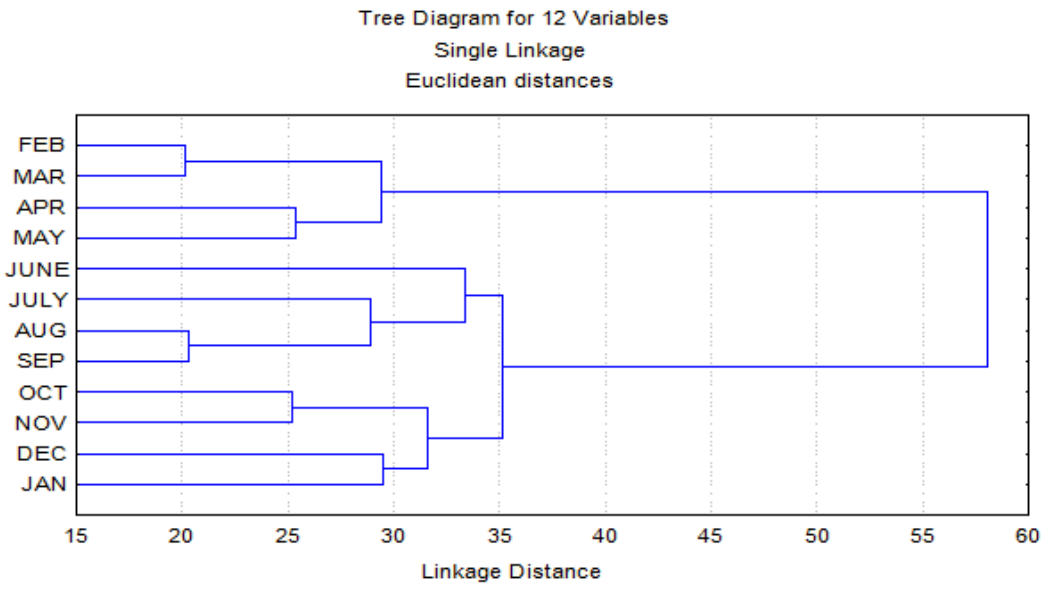

Fig: 2 Hierarchical cluster analysis of the months under study of Kathgola Dighi depending on the total number of plant species present in quadrat study.

In the present investigation physico-chemical parameters of soil like soil pH (SpH), Specific conductance (SCON), nitrate-nitrogen (SN_2), phosphate (SPO_4), organic carbon (SOC) and carbon-nitrogen ratio (C/N) and four physico-chemical parameters of water i.e. water pH (WpH), Dissolve oxygen (DO), Biological Oxygen Demand (BOD) and Dissolve Carbon Dioxide (CO_2) were taken into consideration and their values were determined **(**Table: 3). The values of water pH was high during monsoon. It might be due to fertilizer and detergent mixed agricultural and domestic run off that are mixed into this wetland and the values being lowest in post monsoon season. As the solar radiation high in summer, the photosynthesis rate enhanced primary productivity, which increased total respiration and the dissolve oxygen was decreased. On the other hand increased of solar radiation increased the decomposition rate of organic matter and that increased the BOD value (Wetzel, 2001) and it was high in pre monsoon season (February to May). As in summer the photosynthesis rate increased may be for this reason the dissolve carbon dioxide value was less in summer and high in winter months. The soil pH change along with the change of water pH. Specific conduction was high in June to September and low in October to January. The soil phosphate, nitrate-nitrogen and organic carbon mainly varied with the loading rate from municipal sewage, domestic water, monsoon runoff, agricultural runoff and adding of food for pisciculture. (Gopal, 1990). The nitrate-nitrogen was high in pre winter- august to November and the phosphate concentration was high in monsoon- June to September due to mixing of runoff water. The organic carbon load not too much differs throughout the year. The carbon-nitrogen ratio was highest during late monsoon i.e. August- September.

The single linkage Euclidean distance graph **(Fig:1)** significantly shown that physico-chemical parameter of water and soil are similar in February – May that is pre-monsoon season and this type of relation also observed in June-September that is Monsoon season and October – January that is post-monsoon seasons and the single linkage Euclidean distance graph **(Fig:2)** obtained from macrophyte diversity shows more of less same pattern of similarity with physico-chemical parameter of water and soil graph. So, it was concluded that with the changes of physico-chemical parameters of water and soil of that freshwater wetland the macrophyte diversity was changed.

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