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Research Article

STUDIES ON WATER QUALITY AND MACROPHYTE COMPOSITION IN WETLANDS OF BANKURA DISTRICT, WEST BENGAL, INDIA

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ABSTRACT
The physicochemical characteristics of water and aquatic macrophyte from 12 wetlands of Bankuradistrict, West Bengal, India, were studied for a period of two years. 25 species of aquatic Macrophyte belonging to 21 families have been recorded. The physico-chemical characteristics of water and macrophyte diversity were studied for a period of 2 years. The aquatic macrophytes in wetlands of all the subdivisions studied during the present investigation include Hydrocharitaceae-1, Acanthaceae-1, Alismataceae-1, Apiaceae-1, Araceae-2, Asteraceae-1, Convolvulaceae-1, Cyperaceae-1, Hydrocharitaceae-1, Lemnaceae-1, Lentibutariaceae-1, Marsileaceae-1, Menyanthaceae-1, Nymphaceae-3, Poaceae-2, Polygonaceae-1, Pontederiaceae-1, Potamogetonaceae-1, Salviniaceae-1, Trapaceae-1 and Typhaceae-1). We also observed the different plant groups which comprises 13 species of floating, 10 species of emergent and only 2 species of submerged aquatic macrophytes.According to our study it was revealed that wetland in Bankura District possesses a higher diversity of Macrophytes. In the present investigation for the first time we tried to get a glimpse on Macrophyte Community and concurrent limnological environment prevailing in the wetlands of Bankuradisrict, West Bengal-A drought prone province of Eastern India.

Key Words: *Water quality, Macrophyte, Wetland, Bankura District*

INRODUCTION
Water quality monitoring has one of the highest priorities in environmental protection policy. The main objective is to control and minimize the incidence of pollutant oriented problems, and to provide water of appropriate quality to serve various purposes such as drinking water supply, irrigation water. The quality of water is identified in terms of its physical, chemical and biological parameters. Wetlands are diverse ecosystems that link people, wildlife and environment in special and interdependent ways through the essential life-support functions of water (Maltby and Barker, 2009).Wetlands are perhaps the most interesting landscapes in the world to have earned global importance during the last few decades. They are being discussed all round the world in matters of environmental protection, pollution control, eco-restoration, biodiversity conservation etc. Wetland support very large numbers, and a rich diversity, of animal and plant species (Maltby, 2009).Wetlands are important for the provision of environmental and ecological services (MA2005) that result from functioning. Wetlands have been drawing considerable attention of agriculturists, natural and social scientists, urban planners, land managers, landscape designers and many others (Williams, 1990). Worldwide, wetlands have been degraded either by their direct alteration or through the consequences of changes to the unnecessary environmental and especially hydrological inputs (Gosselink and Maltby, 1990).
Macrophytes form the bulk of the wetland flora. They include floating plants as well as those rooted with free floating leaves, the submerged, and amphibious and hygrophilous plants. Researches on wetland macrophyte have started gaining importance not only because systematic stock taking of biodiversity is presently given top most priority but also because these plants have implications with functional values of wetlands. The distribution, abundance, structure and diversity of macrophytes are affected by several environmentalfactors and biological interactions. The relative importance of macrophytes varies according to spatial andtemporal scales (Lacoul and Freedman, 2006). Some important environmental factors are associated with light requirements of plants (Tremp, 2007) sediment characteristics (Schneider

and Melzer 2004 and Paal *et al.*, 2007) trophic status (Schorer *et al.*, 2000 and Kocic *et al.*, 2008), and hydrology (Tremolieres *et al.,* 1994 and Madsen *et al.*, 2001). Generally, ecological factors influencing species composition in water form a set of various physical and chemical properties which can be different in particular countries or regions (Riis *et al.*, 2000 and Baattrup- Pedersen *et al.*, 2006). Moreover, anthropogenic influences modify many of the above mentioned characteristics (Pedersen et al 2006), including macrophytes distribution patterns. Most of the studies between macrophytes and environmental factors have been studied primarily in lotic ecosystems (Ferreira and Moreira 1999; Bernez *et al.*, 2004; Hrivnak *et al.*, 2006 and Hrivnak 2010), but in case of lentic ecosystems such as wetlands these are rare.

Wetlands have been extensively investigated for their ecology, management, conservation and restoration (Gopal *et al.*, 1982; Gore, 1983; Sharitzand Gibbons, 1989; Lugo *et al.*, 1990; Mitsch, 1994; McComband Davis, 1999; Westlake *et al.*, 1999; Keddy, 2000; Mitschand Gose link, 2000 and Fraserand Keddy 2005). Earlier studies on Wetlands in Bankura District, West Bengal are very scarce which only includes investigations pioneered by Palit *et al.,* (2012).

In this context, the main objective of this study was to evaluate the physicochemical characteristics of water, aquatic macrophytes and the assessment of relationships between macrophytes assemblage and physicochemical conditions in wetlands of Bankura District, West Bengal, India.

MATERIALS AND METHODS

Physico chemical characteristics of water samples of 12 wetlands (Table 1) from three subdivisions of Bankura district were analysed between December 2010- October 2012 using APHA (2005). Aquatic macrophytes was collected and identified by Cook (1996).

Water samples were collected seasonally from the 12 wetlands for physicochemical analysis. Sampling was done between 9 to 11 AM from limnetic zone at a depth of 5 cm from the surface. Water samples were collected in plastic bottles (volume approx 1 L).Water Temperature (WT), pH and Conductivity (COND) were measured immediately after collection of the samples. Physicochemical analyse for DisolveOxygen(DO), Alkalinity(ALK), Total Hardness(HARD) and Chloride(CHL) were performed in the laboratory on same day or within a week. Analysis of all parameters wee done following the standard methods as outlined in APHA (2005). The seasonal data were pooled together (December –February= winter), (March –Jun=summer) and (July-October=Monsoon) and their annual values are reported.Themacrophytes started growing during April and reached peak in July-August; then gradually diminished after September. During winter the macrophytes were greatly reduced. The XLSTAT (2010) software package was employed for data treatment.

Table 1: List of Study sites in Bankura District, West Bengal, India

Subdivision	Block name	Wetland name	Longitude(N)	Latitude(E)
Bankurasadar	Barjora	Jamunabandh	$23^0\ 28^/\ 18.8^{//}$	$87^0\ 13^/\ 7.7^{//}$
	Mejia	Mejia bill	$23^0\ 33^/\ 54.9^{//}$	$87^0\ 6^/\ 40.5^{//}$
	Gangajalghati	Sali reservoir	$23^0\ 24^/\ 7.7^{//}$	$87^0\ 4^{//}\ 46.2^{//}$
	Onda	Khamar Beria Dighi	23° 7'45.57"N	87°13'15.59"E
Bishnupur	Bishnupur	Jomunabandh	23° 4'17.23"N	87°18'26.34"E
	Sonamukhi	SayerDighi	23°18'28.71"N	87°24'37.54"E
	Patrasayer	Dannardighi	23°11'31.65"N	87°32'23.68"E
	Joypur	Samudrabandh	23° 2'39.81"N	87°26'12.45"E
Khatra	Indpur	Kuturidougdighi	23° 9'26.67"N	86°55'30.09"E
	Taldangra	Chechuriabandh	$23^0\ 3^/\ 0.1^{//}$	$87^0\ 5^/\ 18.1^{//}$
	Simlapal	Sahebbandh	$22^0\ 55^/\ 20^{//}$	$87^0\ 5^/\ 1.2^{//}$
	Khatra	GowlaBandh	22°57'30.00"N	86°52'42.12"E

RESULTS AND DISCUSSION

The physicochemical characteristics of water samples of 12 wetlands (annual mean values and subdivision wise mean values) are presented in Table 2(a, b). The limnological investigations on the selected wetlands of the three subdivisions of Bankura district revealed significant variations in the parameters studied in relation to the three seasons. Water temperature variation throughout the three subdivisions of Birbhum district ranges from 21 to 25^0c with a mean value 23^0c.Maximum conductivity value was noted in Bishnupur subdivision (0.8mS) and minimum in Khatrasubdivision (0.2mS). There was very little season induced variations in pH, in the wetlands of three subdivisions of the Bankura district. Maximum pH was recorded in Bishnupur subdivision (7.7) and minimum in Bankurasadar (7.2).Dissolved oxygen variation throughout the three subdivisions of Bankura district ranged between 5.2 to 8 mg/lt with a mean value 6.93 mg/lt. Alkalinity was maximum in Bankurasadar subdivision(22.4 mg/lt) and minimum in case of Bishnupur subdivision (13.2 mg/lt) with a mean value 18.5mg/lt. Wetlands in Bankurasadarshowed maximum total hardness (162.8mg/lt) and the minimum inKhatra(12 mg/lt) with a mean value of 73.8mg/lt.The seasonal impact on the chloride is dissimilar. Maximum value was noted in Khatrasubdivision (151mg/lt) and minimum (46.2mg/lt) in Bankurasubdivision with a mean value of 92.4 mg/lt.

The aquatic macrophytes in wetlands of all thee subdivisions studied during the present investigation are listed in Table 3. In all, 25 genera were identified, belonging to 21 families (Hydrocharitaceae-1, Acanthaceae-1, Alismataceae-1, Apiaceae-1, Araceae-2, Asteraceae-1, Convolvulaceae-1, Cyperaceae-1, Hydrocharitaceae-1, Lemnaceae-1, Lentibutariaceae-1, Marsileaceae-1,, Menyanthaceae-1, Nymphaceae-3, Poaceae-2, Polygonaceae-1, Pontederiaceae-1, Potamogetonaceae-1, Salviniaceae-1, Trapaceae-1 and Typhaceae-1). Fig 1 depicted the composition of different plant groups which comprises 13 species of floating, 10 species of emergent and only 2 species of submerged aquatic macrophytes. Figure 2 depicted Macrophyte occurrence pattern in different wetlands of Bankura district during the study period. It was revealed that wetlands in Bankurasadar comprises 84%, Bishnupur 88% and Khatra 80% positive occurrence of macrophytes. Fig 3 depicted the human use potentials of the observed aquatic macrophytes. They were observed to play substantial role in the local socio-economy as edible plants (32%), Medicinal values (28%), feed for livestock (20%), green manure/compost (12%), religious (12%) and thatch-cordage (4%). Figure 4 depicts the Symmetric biplot of observations (Macrophyte Species) and Variables (Occurrence of Macrophytes and Use potential) derived from MCA. It was observed that Most of the specieswith multiple uses chiefly occurred in wetlands of Khatra subdivision.

Macrovegitation in wetlands play important role in determining its Limno-biological environment (Das 2009).According to our study it was revealed that wetlands in Bankura District possesses a higher diversity of Macrophytes. Kaul *et al.*, (1980) have stated that the macrovegitation is useful in maintaining ecological balance by deriving nutrients from the water in benthic zone. Varshney (1981) have pointed out that certain aquatic plants like Lemna sp., *Eichornia* sp. and *Utricularia* sp. Can be used as pollution indicator.Macrophytes in this eco-region of West Bengal was not reported vividly with a few records fromadjoining areas by Palit and Mukherjee (2006), Palit and Mukherjee (2007); Palit and Palit (2008), Palit and Mukherjee (2010); Palit, Mukherjee and Gupta (2012). In the present investigation for the first time we tried to get a glimpse on Macrophyte Community and concurrent Limnological environment prevailing in the wetlands of Bankuradisrict, West Bengal-A drought prone province of Eastern India.

Table 2a: Physicochemical characteristics of 12 wetlands in Bankura District, West Benagl, India (Annual)

Statistic	WT	COND	pH	DO	ALK	HRD	CHL
Minimum	21	0.20	7.20	5.20	13.20	12.00	46.20
Maximum	25	0.80	7.71	8.00	22.40	162.80	151.80
Mean	23	0.40	7.50	6.93	18.53	73.87	92.40
Standard deviation (n-1)	2	0.39	0.27	1.51	4.77	78.96	54.02

Table 2b: Physicochemical characteristics of 12 wetlands in Bankura District, West Benagl, India (Annual)

		Unit	Bankura Sadar	Subdivision Bishnupur	Khatra
		No. of Wetlands	4	4	4
Water temparature	WT	°C	21	25	23
Conductivity	COND	mS	0.4	0.8	0.2
pH	pH		7.2	7.71	7.6
Dissolve Oxygen	DO	mg/lt	8	5.2	7.6
Alkalinuty	ALK	mg/lt	22.4	13.2	20
Total Hardness	HRD	mg/lt	162.8	46.8	12
Chloride	CHL	mg/lt	46.2	79.2	151.8

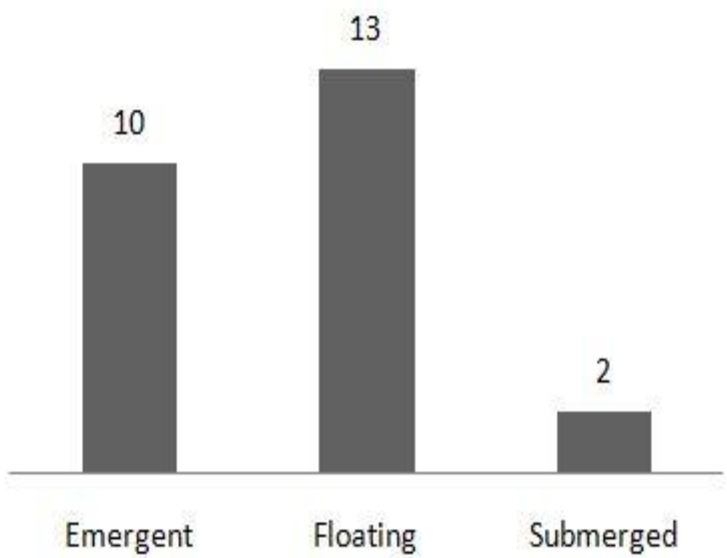

Figure 1: Wetland plant groups observed in the wetlands of Bankura district during the study period

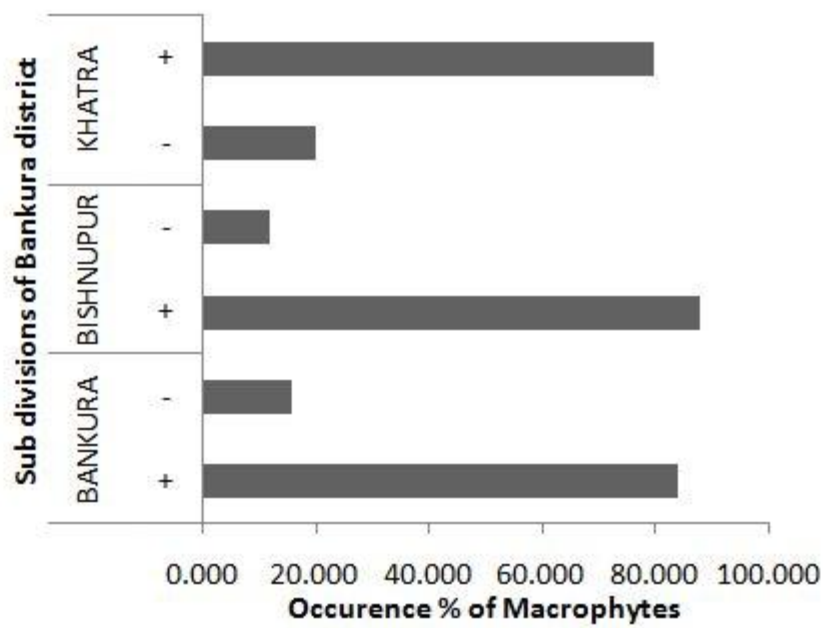

Figure 2: Macrophyte Occurrence pattern in different wetlands of Bankura district during the study period.

Table 3: Aquatic macrophytes composition of 12 wetlands inBankura District, West Benagl, India

S.No.	Species	Family	Group	Occurrence			Uses
				BANKURA	BISHNUPUR	KHATRA	
1	*Hydrilla verticillata*	Hydrocharitaceae	Floating	+	+	-	FO
2	*Ipomea aquatica*	Convolvulaceae	Floating	+	+	+	F/M
3	*Nelumbo nucifera*	Nymphaceae	Emergent	+	+	+	F/R
4	*Marsilea minuta*	Marsileaceae	Emergent	+	+	-	M/F
5	*Trapa bispinosa*	Trapaceae	Floating	+	+	+	F
6	*Utricularia gibbosa*	Lentibutariaceae	Floating	-	-	+	M
7	*Salvinia sp.*	Salviniaceae	Floating	+	+	+	GM/C
8	*Potamogeton nodosus*	Potamogetonaceae	Submerged	-	+	-	FO
9	*Sagittaria sagitifolia*	Alismataceae	Floating	+	+	+	M
10	*Eichhornia crassipes*	Pontederiaceae	Floating	+	+	+	GM/C
11	*Nymphaea pubescens*	Nympheaceae	Floating	+	+	+	F/R
12	*Centella asiatica*	Apiaceae	Emergent	-	-	+	M
13	*Nymphaea nouchali*	Nympheaceae	Floating	+	+	+	F/R
14	*Typha angustifolia*	Typhaceae	Emergent	+	+	+	HC/TC
15	*Colocasia esculanta*	Araceae	Emergent	+	+	+	FO/F
16	*Oryza sativa*	Poaceae	Emergent	+	+	+	FO/F
17	*Saccharum sp.*	Poaceae	Emergent	+	-	-	FO/TC
18	*Vallisnaria spiralis*	Hydrocharitaceae	Submerged	+	+	+	M
19	*Pistia sp.*	Araceae	Floating	+	+	+	M/GM/C
20	*Lemna minor*	Lemnaceae	Floating	+	+	+	FO
21	*Cyperus sp.*	Cyperaceae	Emergent	+	+	+	FO
22	*Enydra sp.*	Asteraceae	Floating	+	+	+	FO/F
23	*Hygrophyla sp.*	Acanthaceae	Emergent	-	+	-	M
24	*Polygonum berbatum*	Polygonaceae	Emergent	+	+	+	M
25	*Nymphoides indica*	Menyanthaceae	Floating	+	+	+	M

+ denotes presence of macrophytes; -denotes absence of macrophytes
F=Food, FO=Fodder, GM/C-Green Manure-Compost, HC=Handicraft, M=Medicinal, R=Religious, TC=Thatching Material

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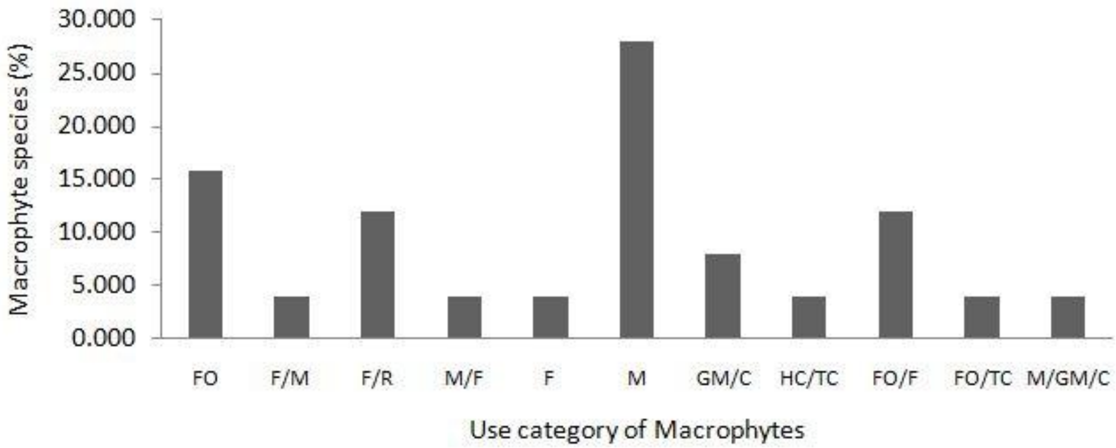

Figure 3: Human use potential of observed macrophytes in wetlands of Bankura District

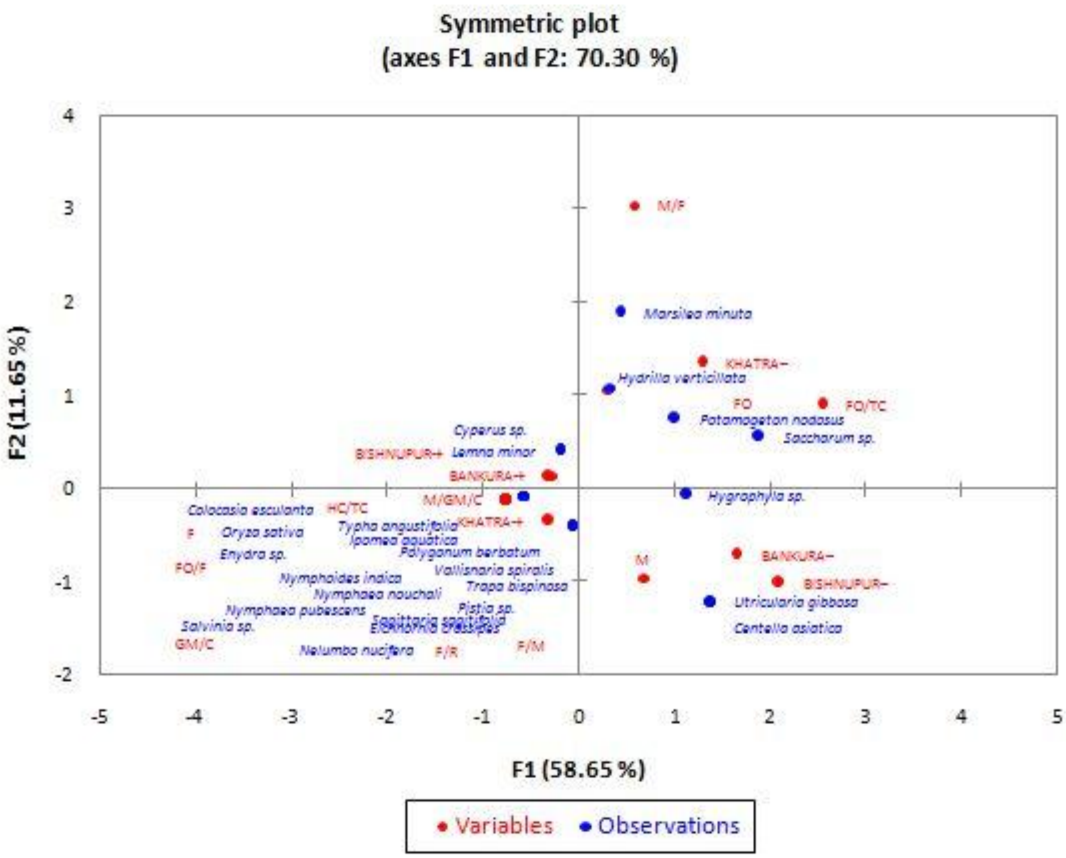

Figure 4: Symmetric graphical display in two dimensions resultingfrom the MCA of Table 2b. The percentage of inertia accounted for by the two dimensions is 70.3%

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