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LIMNOLOGICAL STATUS OF TRIMOHINI BEEL OF RAJSHAHI, BANGLADESH

MD. AZIZUL ISLAM AND ABDULLAH HARUN CHOWDHURY[1]

Limnology Laboratory, Department of Botany, Rajshahi University, Rajshahi
[1]*Environmental Science Discipline, Khulna University, Khulna*

Abstract

A total of 38 zooplankton genera and 26 physico-chemical variables were recorded in Trimohini *Beel*. This *beel* marked as a medium level of polluted wetland based on the values of the redox characteristics i.e. pH, DO, BOD, COD, Eh and rH_2, chlorides, nitrites, ammonium, phosphate values etc. and on the presence of some zooplankton as indicator of pollution. A large number of inland fresh water non-culturable fishes and other aquatic biota of the Trimohini *Beel* may be eliminated in future due to mixing of continuous chemicals from agriculture fields. It is necessary to conserve the ecosystem of Trimohini *Beel* for the fresh water non-culturable fishes and other aquatic biota.

Key words*:* Wetland, Agro-chemicals, Zooplankton, Fish disease, Catchment area, Eutrophic nature

Introduction

The wetland ecosystem of Bangladesh is composed of more than 700 rivers, streams, numerous haors, baors, beels, seasonal and perennial floodplain etc. (BBS 1997). During the recent years captive or ponds fishery and beel fishery have become popular in the country. The total number ponds in the country are 12888222 covering an area of 150000 ha. A total of 2832792 ha seasonal floodplain and 1031563 ha is permanent riverine and estuary water body (Nuruzzaman 1990, SPARRSO 1984 and FIB 1986). Through proper culture based fishery and efficient management, an increased fish production of about 16 million m.t./year is possible in inland waters in Bangladesh (Islam 1992).

The agro-chemicals from terrestrial runoff of agricultural fields enter into surface water. This has resulted in the total elimination of a large number of inland fresh water non-cultureable fishes and other biota. Ammonia is produced in surface water by decomposition of organic matters and hydrolysis of urea. Acidification and pollution of the surface water are created by PO_4, SO_4, chlorides etc. along with insecticides and herbicides, and this acidic polluted water is responsible for fish epizootic ulcerative syndrome (Conway and Pretty 1991, Swarup *et al.*1992, Bhatt *et al.* 1999, Bandela *et al.*1999, Cudchodkar and D'souza 1996 and Islam 2004). Limnological knowledge and their proper applications for better fish yield and management of the ecosystems are prerequisites to sustainable fish sectoral development and maintenance of the eutrophic nature of the wetland ecosystem (Wetzel 1983). Fish health and management of other

[1] Corresponding author: Email: aharunc_ku@yahoo.com

biodiversity are practical applications of limnology and aquacultural environment (Khan and Chowdhury 1974 and Toetz 1971). It is most important to study the interrelationship between the physico-chemical aspects and between phyto-zooplankton and the effect of agricultural effluent on the biota. Bhatt *et al*. (1999), Das *et al*. (2002), Mishra and Trivedy (1993), Moyle (1946), Rai (1974) studied the limnology and biology of rivers, lakes and wetlands in India. Islam and Khatun (1966), Islam and Nahar (1967), Islam and Shaha (1975) studied the limnology of the polluted waters in Bangladesh. In the recent years environmental scientists of the country are interested to study the limnological status of surface water bodies to assess the water quality and biodiversity for conservation planning of the wetlands. A natural perennial wetland known as Trimohini *Beel* is situated under Mohonpur *upazila* of Rajshahi, Bangladesh. Intensive cultivation is being practiced in the catchment area of this wetland and organic, inorganic manures, insecticides, herbicides and fungicides are used at heavy doses, as a result water quality changed (Islam 2004). The available scientific documents in Bangladesh reveal that Tromohini *Beel* has not been studied up to date. So it is necessary to know the limnological conditions of this wetland for sustainable conservation of aquatic ecosystem. Thus the present investigation has been carried out to find out the physico-chemical and zooplankton conditions of Trimohini *Beel* of Rajshahi for evaluating the pollution level of water of this wetland.

Materials and Methods

Trimohini wetland is near Rajshahi, Bangladesh. The investigated wetland lies between 24º35' to 24º40'N latitudes and between 88º35' to 88º40'E longitudes (Anon 1997). This perennial wetland is 24 km^2 (8 km×3 km) and covers an area of 50 km^2 (10 km×5 km) during monsoon. The catchments area is 150 km^2 (20 km×7.5 km), where intensive cultivation is being practiced by using organic, inorganic manures, insecticides, herbicides and fungicides. Water and plankton samples were collected from January 2010 to December 2011 in four different spots of the wetlands. Fortnightly samplings were done in this wetland and in each sampling date physico-chemical and biological samples were collected three times (8 A.M, 12 Noon and 4 P.M.). An average of these data for each spot was made and average depth of each spot was also determined. Water samples were collected from a depth 10-15 cm below the surface using a 250 ml. BOD bottle. Water colour was detected by following method as stated by Welch (1948). Temperature was noted by a digital thermometer (Model China Empex-range 10-110˚C). Transparency was determined by a Secchi disc. A digital pH meter (Model pH epi HANNA instruments CEEN 50081-1) and portable conductivity meter (Model OSK CM-1K) were used for the measurement of pH and conductivity respectively. DO content of water was measured by DO meter (Model- JENWAY-9015). Free CO_2, CO_3, HCO_3, alkalinity, total hardness, chloride, BOD_5, COD, mobile NH_3 and NH_4-N were determined by following APHA (1989), FAO (1984) and (Welch 1948). Total phosphate, Oxidation-reduction Potential

(Eh) and Oxidation reduction index (rH_2) were measured by following Gautam (1990). Primary productivity was measured by Gaarder and Graan (1927).

Plankton were collected by using a plankton net No. 20 silk bolting cloth of mesh size 76µm. Identification of plankton was done immediately after collection. Plankton abundance was measured by using a Sedgewick-Rafter counting chamber (Welch 1948) and expressed in unit/l whether it is an individual or part thereof.

Results and Discussion

In this study 26 physico-chemical variables were measured and 38 genera of zooplankton were recorded. Average data of 4 spots are presented in Tables 1 and 2 respectively.

During the period of study water colour was found always transparent except monsoon (June to August) in the four study spots. Air temperature was almost similar in all study spots and ranged from 19-33.5º C (yearly mean value 29.00±5.88º C). Water temperature varied from 20-32.5º C (yearly mean value 28.29±4.96º C). Average depth of water was 60-320 cm (yearly mean value 158.8± 94.6 cm). Transparency was 20-110 cm (yearly mean value 72.08± 29.88 cm). TSS varied from 250-380 mg/l (yearly mean value 273.3±49.92 mg/l) in all spots. Electric conductivity ranged from 84.6-110.5 µmho/cm (yearly mean value 93.65±10.15 µmho/cm) in all spots. pH varied from 7.2-7.5 (yearly mean value 7.35±0.10). Free CO_2 ranged from 13-23 mg/l (yearly mean value 17.50±3.23 mg/l). CO_3 alkalinity was nil in all spots and HCO_3 alkalinity varied from 45-72 mg/l (yearly mean value 61.20±11.75 mg/l). Ca-hardness and Mg-hardness ranged from 75.0-85.0 mg/l (yearly mean value 80.28±3.53 mg/l) and 40.0-52.4 mg/l (yearly mean value 48.12±3.96 mg/l) respectively in all spots. Total hardness varied from 120-137 mg/l (yearly mean value 128.40±7.03 mg/l). Chloride ranged from 60-100 mg/l (yearly mean value 78.79±12.62 mg/l). DO values varied from 5.3-5.7 mg/l (yearly mean value 5.57±0.16 mg/l) and percentage of sat. of oxygen ranged from 64.5-78.2 (yearly mean value 71.66±5.14) in all spots. BOD and COD values varied from 5.9-6.4 mg/l (yearly mean value 6.21±0.16 mg/l) and 13.70-14.64 mg/l (yearly mean value 14.28±0.30 mg/l) respectively. Nitrite-nitrogen and NH_4-N ranged from 0.15-0.59 mg/l (yearly mean value 0.39±0.16 mg/l) and 0.15-0.36 mg/l (yearly mean value 0.28±0.08 mg/l) respectively. PO_4 values varied from 0.20-0.45 mg/l (yearly mean value 0.33±0.07 mg/l). Eh and rH_2 values were from 0.28-0.32 mv (yearly mean value 0.30±0.01 mv) and 24.48-25.40 (yearly mean value 25.02±0.31) respectively. Gross primary productivity (GPP) and net primary productivity (NPP) ranged from 0.016-0.020 mgC/h/l (yearly mean value 0.018±0.001 mgC/h/l) and 0.008-0.011 mgC/h/l (yearly mean value 0.009±0.0012 mgC/h/l) respectively in all spots.

Table1. Average Physico-chemical conditions of all study spots of Trimohini wetland, Mahonpur of Rajshahi.

Parameters	Jan.	Feb.	Mar.	April.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Mean±SD
Air Temp. ºC	19	20	32.5	33	33	32.5	32.5	33	33.5	32	27	20	29.00±5.88
Water Temp.ºC	20	21	30	32	32	31	31	32	32.5	30	28	20	28.29±4.96
Av. Depth (cm)	110	100	85	75	60	85	300	320	270	230	150	120	158.8±94.6
S.D. Depth (cm)	110	100	85	75	60	50	20	20	70	80	95	100	72.08±29.88
T.S.S (mg/l)	250	250	250	255	250	260	380	380	255	250	250	250	273.3±49.92
E. Con (µmoh/cm)	110.5	108.5	90.6	86.6	86.6	88.6	88.6	86.6	84.6	86.6	95.5	110.5	93.65±10.15
pH	7.2	7.3	7.3	7.4	7.5	7.4	7.4	7.4	7.5	7.3	7.3	7.2	7.35±0.10
Free CO_2 (mg/l)	20	20	15	15	13	13	20	23	15	18	18	20	17.50±3.23
CO_3 (mg/l)	0	0	0	0	0	0	0	0	0	0	0	0	0
HCO_3 (mg/l)	72	72	70	50	45	48	48	49	68.4	70	70	72	61.20±11.75
Ca hard (mg/l)	76	78	81	82	83	83	80	81	84.4	85	75	75	80.28±3.53
Mg hard (mg/l)	44	47	49	50	52	52	40	49	52.4	52	45	45	48.12±3.96
Total hard (mg/l)	120	125	130	132	135	135	120	130	136.8	137	120	120	128.40±7.03
Chloride (mg/l)	75	77	65	63	60	88	95	100	87.5	85	75	75	78.79±12.62
DO (mg/l)	5.7	5.6	5.5	5.4	5.4	5.8	5.7	5.7	5.3	5.4	5.6	5.7	5.57±0.16
% of Sat. of O_2	64.5	64.5	73.04	73.8	73.8	78.2	76.8	77.90	72.90	67.70	72.30	64.50	71.66±5.14
BOD_5 (mg/l)	6.2	6.3	6.2	6.1	6.0	5.9	6.3	6.3	6.4	6.1	6.4	6.3	6.21±0.16
COD (mg/l)	14.26	14.45	14.26	14.07	13.88	13.70	14.45	14.45	14.64	14.07	14.64	14.45	14.28±0.30
Nitrite-nitrogen (mg/l)	0.30	0.30	0.25	0.20	0.15	0.58	0.59	0.58	0.56	0.50	0.40	0.30	0.39±0.16
NH_4-N (mg/l)	0.35	0.30	0.15	0.15	0.20	0.25	0.25	0.30	0.35	0.36	0.36	0.36	0.28±0.08
PO_4 (mg/l)	0.30	0.30	0.25	0.25	0.20	0.35	0.40	0.45	0.40	0.35	0.35	0.30	0.33±0.07
Eh (mv)	0.32	0.32	0.30	0.29	0.28	0.30	0.30	0.30	0.28	0.30	0.31	0.32	0.30±0.01
rH_2	25.4	25.35	25.09	24.48	24.63	25.04	25.05	25.05	24.58	25.05	25.15	25.40	25.02±0.31
GPP (mgC/h/l)	0.018	0.018	0.019	0.020	0.020	0.016	0.017	0.017	0.020	0.020	0.018	0.018	0.018±0.001
NPP (mgC/h/l)	0.009	0.009	0.010	0.011	0.011	0.008	0.008	0.008	0.010	0.011	0.009	0.009	0.009±0.001

In total 38 zooplankton genera were recorded from four spots during the period of study of which 12 genera belonged to Copepoda (31.58%), 12 to Cladocera (31.58%) and 14 to

Rotifer (36.84%) (Table 2). The average zooplankton abundance of four spots varied from 15015-26000 units/l with mean abundance (21240 units/l).

The abundance of Copepoda, Cladocera and Rotifera varied from 6740-11170 units/l (mean abundance 9138 units/l; 43.02%), 3730-6565 units/l (mean abundance 5418 units/l; 25.51%) and 4545-8265 units/l (mean abundance 6684 units/l; 31.47%) respectively.

The *Copepoda* were *Allodiaptomus* sp., *Cyclops* sp., *Diaptomus* sp., *Eucyclops* sp., *Heliodiaptomus* sp., *Paradiatomus* sp., *Phyllodiaptomus* sp., *Rhinediaptomus* sp., *Macrocyclops* sp., *Mesocyclops* sp.,*Orthocyclops* sp. and *Paracyclops* sp.. *Diaptomus* sp. (22.28%) and *Cyclops* sp. (20.46%) were found to occur in higher abundance followed by *Eucyclops* sp. (12.22%), *Mesocyclops* sp. (9.83%) and others.

The *Cladocerans* were represented by *Alona* sp., *Alonella* sp., *Bosmina* sp., *Bosminopsis* sp. *Ceriodaphnia* sp., *Daphnia* sp., *Diaphanosoma* sp., *Macrothrix* sp., *Moina* sp., *Polyphemus* sp., *Sida* sp. and *Simocephalus* sp.. The *Cladoceran* were dominated by *Diaphanosoma* sp.(10.50%), *Simocephalus* sp. (10.27%), *Daphnia* sp. (9.89%) and others.

The Rotifers were represented by *Brachionus* sp., *Dorystoma* sp., *Filinia* sp., *Gastropus* sp., *Harringia* sp., *Hexarthra* sp., *Keratella* sp., *Monostyla* sp., *Notholca* sp., *Philodina* sp., *Platyias* sp., *Polyarthra* sp., *Scaridium* sp. and *Trichocerca* sp.. The Rotiferans were dominated by *Trichocerca* sp.(11.20%), *Keratella* sp. (10.86%), *Brachionus* sp. (9.91%) and others.

The Rotifers are tolerant to varying degree of physico-chemical and biological conditions. Islam *et al*. (2005), Islam *et al*. (2001) and Arora (1966) observed that the rotifers occur in eutrophic waters in high abundance. Islam *et al*. (2005), Islam *et al*. (2001), Arora (1966) and Bergins (1949) designated a large number of rotifers genera including *Barchionus* sp., *Keratella* sp., *Filinia* sp. *Gastropus* sp., *Hexarthra* sp., *Polyarthra* sp., *Trichocerca* sp. and others as indicators of eutrophic or polluted waters and the findings of the present study appears to be in conformity with their works.

Air and water temperature was always found with low values. Indiscriminately uses of agro-chemicals like urea, TSP, chloride in catchment area of the wetland caused the water of the wetland acidic (Islam 2004). In unpolluted rivers the values of chloride are usually low (between 2 to 10 mg/l). The desirable level of chloride in water should be below 200 mg/l for human consumption (Koshy and Nayar 1999). In the studied wetland the chloride content showed higher values. The higher amounts of nitrite nitrogen (NO_2-N) and ammonium nitrogen (NH_4-N) indicated the higher loads of organic matters and excessive use of inorganic fertilizers which was washed into natural water by the rain and flood water (Islam 2004 and Swarup *et al*. 1992). Low pH, Eh, DO and high rH_2, BOD, COD are the indication of presence of both organic and inorganic load in study water coupled with NH_4-N, NO_2-N and PO_4 values and the whole physical-chemical variable together formed a complex of nutrient status of biological importance imparting an eutrophic nature to study water (Morris and Stumm 1967, Morrissette and Mavinic 1978, Lakshminarayana 1965 and Jayangaudar 1964).

Table 2. Monthly average of abundance (units/l) of zooplankton of Trimohini wetland.

Zooplankton	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Mean	%
Copepoda														
Allodiaptomus 2sps.	275	270	265	275	280	290	285	250	195	175	200	230	249	2.73
Cyclops 3sps.	1800	2000	1890	2050	2100	2150	2100	2000	1650	1500	1590	1600	1869	20.46
Diaptomus 2sps.	1900	2050	2200	2250	2300	2400	2350	1800	1775	1650	1750	2000	2035	22.28
Eucyclops 2sps.	1000	1120	1200	1250	1300	1400	1300	1200	1100	800	825	900	1116	12.2
Heliodiaptomus sp.	450	475	500	550	575	600	575	500	450	350	375	400	483	5.29
Paradiaptomus sp.	295	300	320	350	375	400	350	300	250	195	200	260	300	3.28
Phyllodiaptomus sp.	300	250	350	370	380	400	385	300	270	200	230	270	309	3.38
Rhinediaptomus sp.	290	320	340	350	380	430	350	325	275	230	240	250	315	3.45
Macrocyclops sp.	900	940	960	980	1000	1050	950	900	600	500	540	870	849	9.29
Mesocyclps sp.	100	1020	1050	1090	1120	1150	1000	950	900	700	750	950	898	9.83
Orthocyclops sp.	290	300	310	350	350	320	300	250	195	160	200	250	273	2.99
Paracyclops sp.	400	470	500	550	570	580	490	400	350	280	295	400	440	4.82
Total	8000	9515	9885	10415	10730	11170	10435	9175	8010	6740	7195	8380	9138	100
Cladocera														
Alona 2sps.	360	355	370	380	390	340	300	290	270	210	290	350	325	6.01
Alonella 2sps.	390	385	395	430	450	470	450	430	340	290	330	400	397	7.32
Bosmina 2sps.	410	420	450	470	490	500	495	445	395	300	390	440	434	8.01
Bosminopsis 2sps.	390	380	400	430	450	470	490	400	350	320	350	345	398	7.34
Ceriodaphnia sp.	400	430	450	470	490	520	490	410	370	330	370	400	428	7.89
Daphnia 2sps.	500	540	580	600	620	670	620	600	400	340	460	490	535	9.87
Diaphanosoma 2sps.	550	590	620	640	670	690	640	610	420	370	495	530	569	10.50
Macrothrix 2sps.	540	570	600	620	640	680	610	500	400	350	410	450	531	9.80
Moina 3sps.	380	390	420	450	480	500	440	400	360	300	340	345	400	7.39

(Contd.)

Zooplankton	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Mean	%
Polyphemus 2sps.	500	490	520	540	580	600	550	520	440	320	480	500	503	9.29
Sida 2sps.	300	330	350	380	400	430	400	350	300	250	295	320	342	6.31
Simocephalus 2sps.	520	540	580	600	640	695	640	600	500	350	495	515	556	10.27
Total	5240	5420	5735	6010	6300	6565	6125	5555	4545	3730	4705	5085	5418	100
Rotifera														
Brachionus 3sps.	640	650	690	720	750	800	760	700	600	420	590	630	663	9.91
Dorystoma 2sps.	400	420	450	490	520	580	500	470	400	370	400	430	453	6.77
Filinia 2sps.	390	400	430	460	500	580	500	450	400	300	370	400	432	6.46
Gastropus 2sps.	460	480	500	530	560	600	550	500	450	390	450	475	495	7.41
Harringia 2sps.	450	425	440	460	495	620	490	400	370	300	430	440	443	6.63
Hexarthra 2sps.	330	360	390	400	430	470	400	320	295	240	320	330	357	5.34
Keratella 3sps.	700	730	760	790	820	850	790	720	650	440	740	720	726	10.86
Monostyla sp.	250	270	290	310	330	370	370	300	250	230	225	260	288	4.31
Notholca 2sps.	220	240	270	300	360	400	330	300	200	195	210	220	270	4.05
Philodina 2sps.	320	350	370	390	420	450	400	370	295	250	300	340	355	5.30
Platyias 3sps.	450	590	600	630	670	695	650	550	450	350	420	450	542	8.11
Polyarthra 2sps.	345	320	360	390	450	480	400	390	290	240	500	530	391	5.85
Scaridium 2sps.	500	530	580	600	640	680	520	420	390	320	520	550	521	7.79
Trichocerca 3sps.	750	725	750	800	840	690	920	840	750	500	700	720	749	11.20
Total	6205	6490	6880	7270	7785	8265	7580	6730	5790	4545	6175	6495	6684	100
Grand Total	19445	21425	22500	23695	24815	26000	24140	21460	18345	15015	18075	19960	21240	

The GPP and NPP values, higher amounts of CO_2 and absence of CO_3 throughout the study period indicate the low rate of photosynthesis and high rate of respiration by the aquatic biota in Trimihini *Beel*. Similar findings were recorded by Islam (2004), Bhatt *et al.* (1999) and Das *et al.* (2002) in their studies. Islam (2004) also observed that low air and water temperature, low pH etc. are the causes of epizootic ulcerative syndrome of fin fishes in natural wetlands. Higher amounts of nitrite nitrogen (NO_2-N) and ammonium nitrogen (NH_4-N) were recorded in this wetland, which are the causes of death of more than hundred species of fish (Cudchodkar and D’souza 1996, Islam *et al.* 2001 and Islam 2004). Islam (2004) mentioned that toxic chemicals including fungicides, insecticides, herbicides, urea, chlorides, sulphates and phosphates were used at heavy doses in agricultural crops fields around the studied wetland; as a result residual effluent of used chemicals or as direct solution of chemicals entered into the water of wetland.

According to Gautam (1990), Chowdhury *et al*. (1996), Islam and Nahar (1967), Lakshiminarayana (1965), Jayangauder (1964), Zafar (1964), George (1968), Moyle (1946), Montgomery *et al.* (1964), Mortimer (1956), Islam *et al.* (1998), Zaman *et al.* (1993), Mishra *et al.* (1992) and Ameen *et al.* (1986) the studied wetland marked as a medium level polluted wetland on the basis of values of the redox characteristics i.e. pH, DO, BOD, COD, Eh, and rH_2 chlorides, nitrites, ammonium, phosphate values etc. and on the presence of some zooplankton as pollution indicator. The findings of the present study indicate that a large number of inland fresh water non-culturable fishes and other aquatic biota of the Trimohini *Beel* may be eliminated in future due to mixing of continuous chemicals from agriculture fields. Toxic chemicals have a deleterious effect on the wetlands ecosystem as a whole (Cudchodkar and D'souza 1996, Chowdhury *et al.* 1996 and Gautam 1990). So, it is necessary to conserve the ecosystem of Trimohini *Beel* for the fresh water non-culturable fishes and other aquatic biota. A sustainable management plan as well as area demarcation is necessary for the agriculture to protect the further degradation of water quality and biodiversity of the study area. Findings of this study will be helpful for further study and sustainable management plan of the fresh water wetlands.

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