Limnological Studies of Ramgarhlake in Eastern Uttar Pradesh, India

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Abstract: Aspects of physicochemical factors and zooplankton of Ramgarh Lake were studied for a period of twenty four months between May 2010 and April 2012.With the aim of acquiring the necessary knowledge for management of lakes in semi arid areas of Gorakhpur.Using standard methods Ramgarh Lake, which is a natural lake, with an area of about 58,100 hectares and depth of between 1.5m to 7m. Of all the physicochemical parameters studied only temperature, pH and sulphate concentration showed significant seasonal variation ($P<0.001$). However all the physicochemical parameters exhibited highly significant spatial variations ($p<0.001$). The concentration of metals was in the following order Mn> Zn> Fe>Ca> Mg> Cu. Pearson's product moment correlation coefficient between conductivity and other physical properties of the lake indicated a highly positive significant correlation. The zooplankton of Ramgarh Lake was made up of four groups, Cladocera (41%), Copepoda (24%), Rotifera (27%) and Protozoa (18%). There was a total of 16 species with Moina and Keratella dominating the fauna. The zooplankton showed significant seasonal and spatial variation ($P<0.001$).The lake is gradually tending towards eutrophication.

Key words: Limnology · Ramgarh Lake · Variation · Wetlands · Zooplankton

INTRODUCTION

In the last two decades, there has been a growing necessity for conservation of our resources, especially water. At the same time, growing populations, progressive industrialization and intensification of agriculture have led to increased pollution of surface waters. This induces ecological imbalances, deleterious for sustained development of fisheries resources, which has necessitated the suspension of the beneficial uses of these water bodies in some places [1]. Nevertheless, an increasing number of specially created environmental agencies are being assigned the task of conserving water quality for all uses within one river or lake basin. In conserving water quality for multipurpose use, a holistic approach was recommended [2-5] in which allimmediate and potential interests in the water basin are considered simultaneously. Experience has shown that only an ecologically healthy freshwater ecosystem fulfils this goal and the ecology of the flora and fauna of the ecosystem best measure this [6]. Water quality monitoring is of immense importance in the conservation of water resources for fisheries, water supply and other activities; it involves the assessment of physicochemical parameters of water bodies. Impacted changes in the quality of water are reflected in the biotic community structure, with the vulnerable dying, while the most sensitive species act as indicators of water quality [3].Ramgarh Lake being an important internationally recognized ecological site, this study is aimed at providing useful inputs and experience necessary for the management of the environmental aspects of the many multi-purpose lakes and reservoirs in the semi-arid zones of eastern Uttar Pradesh of India for fisheries especially.This study is necessary to update the information and determine the effects of anthropogenic activities on water quality characteristics and nutrient level in relation to zooplankton abundance of the lake.

MATERIALS AND METHODS

Samples for all the physicochemical parameters and zooplankton in five sampling sites using standard methods were collected monthly.

Sampling Sites: Based on the results of the preliminary study, five sampling sites were selected on the lake for the purpose of samples collection.

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Determination of Physicochemical Parameters:
Temperature and pH were determined in the field using pH meter, Model 3150. Other physicochemical parameters were determined in the laboratory with Hach 2010 spectrophotometer using the methods of Karikari *et al.* [7].

Sampling and Identification of Zooplankton: Samples of zooplankton are collected using plankton net of mesh size 100nm. The net is tied to a metal rod and immersed into the water, towed for a fixed distance and hauled out of the water. The water (containing plankton) that is collected in the plastic bottle at the end of the net is emptied into sample bottles and preserved with 4% formation [8]. The zooplankton was indentified using keys Matagi *et al.* [9] in numeration of the plankton was done with the method of Bugenyi and Lutalo-Bosa[10].

Data Analysis: The seasonal data were analyzed by one-way analysis of variance (ANOVA), Duncan's multiple range test (DMRT) was used to compare the means and Pearson's product moment correlation coefficient was used to determine association between the physicochemical properties and the zooplankton.

RESULTS AND DISCUSSION

The results of physicochemical parameters are presented in Table 1. Of all the physicochemical parameters studied only temperature, pH, total dissolved solutes, dissolved oxygen and sulphate concentration showed significant seasonal variations ($P < 0.001$). However all the physicochemical parameters exhibited highly significant spatial variations ($p < 0.001$). The concentration of metals was in the following order Mn> Zn> Fe>Ca> Mg> Cu. Pearson's product moment correlation coefficient between conductivity and other physical properties of the lake indicated a highly positive significant correlation (>0.718). Results of zooplankton are presented in Table 2. The zooplankton of Ramgarh Lake was made up of four groups, Cladocera (41%), Copepoda (24%), Rotifera (27%) and Protozoa (18%). There was a total of 16 species with *Moina* and *Keratella* dominating the fauna. The zooplankton showed significant seasonal and spatial variations ($P < 0.001$). Shannon-Weiner index of 5.76, 4.14 and 5.02 for stations 1, 2 and 3 respectively indicate that these stations have relatively high species diversity and therefore theyare not polluted. But stations 4 and 5 with indexes of 2.96 and 1.98 respectively have relatively lower species diversity suggesting possible pollution.

Table 1: Mean spatial distribution of physicochemical parameters of Ramgarh Lake

Parameter	Station 1	Station 2	Station 3	Station 4	Station 5	Mean
Temperature	16.25[b]	20.29[a]	17.63[b]	21.71[a]	20.92[a]	19.36
pH	8.77[a]	8.59[b]	8.16[c]	7.87[d]	8.29[a]	8.33
Transparency	91.46[b]	137.67[a]	42.55[c]	17.67[d]	19.83[d]	103.06
Depth	178.8[a]	188.08[a]	54.29[b]	52.16[b]	49.87[b]	104.64
TDS	74.17[c]	61.75[d]	90.08[b]	97.21[a]	92.25[a]	83.09
Suspended solids	2.04[d]	3.38[c]	3.25[c]	6.00[a]	5.00[b]	3.93
Turbidity	2.50[d]	4.17[c]	6.75[b]	12.63[a]	6.46[b]	6.49
Conductivity	171.25[b]	122.77[c]	180.68[b]	203.38[a]	182.76[b]	172.16
Alkalinity	30.54[b]	35.67[a]	25.75[b]	23.38[a]	18.27[b]	26.72
DO	7.64[a]	7.09[b]	6.39[c]	6.25[c]	6.37[c]	6.74
BOD	2.26[d]	1.98[d]	9.40[a]	4.09[c]	5.44[b]	4.63
COD	6.42[dc]	5.73[d]	7.73[c]	11.48[b]	15.24[a]	9.32
Total Phosphate	5.93[b]	5.12[b]	5.74[b]	5.93[b]	11.56[a]	6.86
Total Nitrogen	5.37[c]	6.03[a]	5.45[a]	6.23[a]	6.32[a]	5.88
Sulphate	3.29[c]	5.01[b]	4.79[b]	6.04[a]	5.84[a]	4.99
Magnesium	0.07[bc]	0.05[c]	0.11[a]	0.09[ba]	0.08[bc]	0.08
Calcium	0.63[d]	0.15[c]	0.19[c]	0.34[a]	0.16[c]	0.29
Iron	0.11[d]	0.15[c]	0.27[b]	0.30[a]	0.31[a]	0.23
Zinc	0.59[b]	0.91[a]	0.78[ba]	0.85[a]	0.56[b]	0.74
Copper	0.01[d]	0.14[a]	0.01[d]	0.07[c]	0.11[b]	0.07
Manganese	2.17[d]	3.06[c]	4.80[b]	5.15[b]	6.54[b]	4.34

Means with the same superscriptletterin the same roware not significantly different using DMRT.

Table 2: Mean distribution of Zooplankton in RamgarhLake and the diversity indices of the stations

Cladocera	Station 1	Station 2	Station 3	Station 4	Station 5	Total
MoinamicruraKutz	111	212	31	41	12	407
CeriodaphniacornutaSars	91	230	52	81	22	476
SimocephalusserrulatusKoch	82	171	-	41	-	294
GurnayellamondiSars	72	111	-	-	-	183
MonellaexcisaKutz	-	81	-	-	-	81
AlonamonacanthaSars	-	72	21	-	-	93
Copepoda						
Tropodiaptomus incognitos D&G	-	51	12	-	-	63
ThermocyclopsneglectusSars	112	101	-	-	-	213
MacrocyclopsalbidusImhof	131	-	-	-	-	131
AfrocyclopsgibsoniKutz	72	101	-	73	-	246
Rotifera						
BrachionuspatulusMuller	91	172	71	82	33	449
KeratellaquadrataHauer.	141	192	42	103	31	509
KellicottialongispinaKellicott	22	41	-	-	-	63
Protozoa						
Paramecium sp.	-	-	32	11	10	53
ColpidiumcampylumSars	-	-	-	51	22	73
Mean No. of individuals(N)	911	1362	253	561	20	6214
No. of species (S)	10	12	7	8	6	43
Shannon-Weiner index(D)	5.76	4.14	5.02	2.96	1.98	3.97
Evenness index(E)	0.96	0.906	0.944	0.66	0.50	0.794

The extreme ecological conditions of the Sahel savanna especially climatic variation could have a resultant effect in modifying lake ecosystems. The water regime in this lake was mainly influenced by rainfall pattern and duration, in addition to discharge from its tributaries. So it is expected that any variation, whether seasonal or spatial in physicochemical properties of RamgarhLake may be influenced by climatic regime and catchments characteristics i.e. extent of human activitiesand water volume fluctuations. This could have resulted in the significant seasonal and spatial variations in temperature, dissolved oxygen, pH and sulphate during the study period. Studies by Sarnelle [11] showed that temperature variation in lakes might be caused by the influence of environmental factors and human activities in or around the lake. Dissolved oxygen(DO) provides a broad indicator of water quality and that DO concentrations in unpolluted waters are normally about 8-10mgL^{-1} (at 25°C). This result indicates that the lake is tending towards eutrophication. The concentration of nutrients in a water body is strongly influenced by the nature of the sediment.Jeppessenger *et al.* [12] states that the rate of phosphorus release into the water can double, when sediments are frequently disturbed. The phosphate level in Ramgarh Lake may be a result of release from disturbed sediment and anoxic conditions as a result of decaying macrophytes. Sixteen species of zooplankton were recorded during the study period, of which members of the *Cladocera* dominated with seven species, constituting 38% of the total population observed. The richness of *Cladocera* in Ramgarh Lake was relatively high; this may be attributed to the abundance of aquatic macrophytes, particularly *Typha* in the water, which hampers the rate of predation by fish. As Sarnelle [11] suggested that fish prefer open waters to feed on zooplankton. This was further collaborated byKemdirim,Jeppessen *et al.* and Havens [12-14] who observed that the absence of Cladocera and the low numbers of Copepoda could be due to the effects of fish predation, which was found to be the major factor structuring zooplankton assemblages in several studies. Work on some lakes byHakanson and Boulion [15] indicates that the degree of vegetation affects zooplankton distribution with the greatest number of zooplanktonic organisms in waters with sparse vegetation.The Cladocera was the dominant zooplankton in Ramgarh Lake, both in terms of species diversity and in terms of biomass. However, what was remarkable was that the Rotifera with only two species was the second highest in terms of biomass [16]. This may most likely be due to the increasing importance of Cyanophyta in Ramgarh Lake. It is clear from the study that the rotifers are abundant in water bodies with a wide range of physicochemical conditions and that they are able to use bacteria, cyanophytes and suspended detritus as food resources.

CONCLUSION

From the obtained results, one can safely conclude that,different levels of anthropogenicinputs have caused wide variations in physicochemical parameters in variousparts of Ramgarh Lake. There was significant seasonal and spatial variations in physicochemical parameters. Human activities and other biotic factors were implicated as the reasons for the observed spatial variations in the distribution of zooplankton of the lake.

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