Rec. zool. Surv. India : **100** (Part 3–4) : 1–19, 2002

STUDIES ON THE PHYSICOCHEMICAL AND BIOLOGICAL PROPERTIES OF TWO MAN MADE LAKES OF CALCUTTA

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INTRODUCTION

Lakes, both natural as well as man made, constitute an important component of fresh water resources, because of their diverse uses. The aquatic environment of such lakes support a variety of flora and fauna which include the biotic community of phytoplankton, macrophytes, zooplankton, benthos, necton etc. Together with the prevailing physico-chemical condition of water and soil, these biotic communities form an interdependent and balanced ecological system. Generally, lakes situated in urban areas are mainly used for recreational purposes like swimming, bathing and other water sports. However, many a times, these water bodies are subjected to undesirable uses such as discharge of industrial and domestic effluents or excessive use by surrounding dense human population for a variety of purposes and thereby degrading the water quality considerably.

In Calcutta metropolitan, there are two medium sized man made lakes viz. Rabindra Sarovar and Subhas Sarovar. Subhas Sarovar, situated in north eastern part of city covers an area of 39.5 acre. Rabindra Saravor situated in Southern part of city is larger than Subhas Sarovar and covers an area of nearly 72 acres. No organised fishing activity is being carried out in these lakes, except sport angling in Subhas Sarovar. Recently these two lakes have been included in National Lake conservation plan by Ministry of Environment and Forests and Rabindra Sarovar has been declared as National Lake.

Several earlier studies on the urban recreational ponds of the country (Michael, 1962, Sreenivasan, 1964, 1965, 1976; George, 1966; Ganapati and Sreenivasan,1970; Jana,1979; Zutsi and Vaas, 1982; Zafar, 1966 Kulshrestha, 1988,) also pointed out their altered ecological condition due to excessive undesirable uses. Inspite of their importance in Calcutta Metropolitan, these lakes have yet not been properly investigated. Excepting few earlier studies of specific nature on primary productivity and zooplankton by Khan (1979, 1981, 1985) in Rabindra Sarovar practically no information is available on general limnological condition of these two lakes. Therefore, the present studies were undertaken for two consecutive annual cycles, 1996-97 and 1997-98. with a view point to work out the physico-chemical characteristics of water, phytoplankton, rate of primary production and diversity and abundance of zooplankton of the two lakes.

DESCRIPTION OF STUDY AREA

Rabindra Sarovar lake is almost elongated in shape and covers an area of nearly 72 acres. Its maximum length is around 1770 m and width at broadest point is approximately 206 m. The mean depth varied between 9 and 10 m at different sampling stations. The main source of water supply is surface run off during rainy season. There is practically no out let. The lake is characterized by dense macrophyte growth in its entire littoral zone.

Subhas Sarovar is comparatively smaller with an area of 39 acres. Its length from east to west is 533.3 m and width at broadest point, south to north, is about 366 m. The littoral zone is almost devoid of macrophyte during major part of years. This lake is also fed mainly by rain water.

MATERIALS AND METHOD

The studies were carried out between the period of February 1995 to January 1997. Sampling were done fortnightly at three different station of both lakes. Water samples were collected from 15-20 cm below the surface. Air and water temperature, pH and conductivity were recorded in the field by electronic meters. Dissolved oxygen was determined by modified Winkler's method. Titrametric method was used to measure the alkalinity of water. For other parameters, water samples collected in clean glass stopper bottles of 500ml capacity were carried to laboratory and analysed immediately. Chloride, phosphate, nitrate, nitrite and ammonium contents were analysed by Spectroquant SQ118 electronic spectrophotometer (EMerck, Germany). Phytoplankton primary production and respiration were determined by classical light and dark bottle technique (Gaarder and Gran 1927) following Vollenweider (1974). Qualitative and quantitative samples of zooplankton were collected from littoral zone with the help of a plankton net made of bolting nylon cloth (no 21). Qualitative sampling for taxonomic and relative abundance studies were done by sweeping the net several times in different directions. Samples were preserved in 4% formalin. Detail taxonomic identification was carried out following Edmondson (1959), Pennak (1978), Michael and Sharma (1987), Sehgal (1983), Battish (1984) and Sharma (1998).

For quantitative analysis of relative abundance and density, identification and enumeration were done simultaneously in a Sedgwick Rafter counter by taking 1 ml sub sample and then raised to total volume of water filtered. All data collected from there stations were pooled together so as to obtain single values for each sampling day. These were further pooled month-wise and season-wise. Seasons have been defined as premonsoon (Feb-May), monsoon (June-Sep) and post monsoon (Oct-Jan).

RESULTS

A. Physico-chemical factor :

Physicochemical characteristics of water of both Rabindra Sarovar and Subhas Sarovar fluctuated moderaely during different seasons (Tables 1 and 2). In Rabindra Sarovar, water temperature

Table 1. Physico-chemical Analysis of water of Rabindra Sarovar in two Annual Cycle (1995–1996 and 1996–1997).

	Ist annual cycle (1995-1996)			2nd annual cycle (1995-1996)		
Physico-chemical factors	Pre-monsoon	Monsoon	Post-monsoon	Pre-monsoon	Monsoon	Post-monsoon
Water temp (°C)	32.83	31.62	26.56	30.94	30.61	25.91
pH	8.86	8.64	7.98	8.74	8.64	8.18
Turbidity (NTU)	12.0	31.5	13.1	10.88	21.0	10.04
Conductivity (mmhos)/cm	657.33	613.59	487.08	719.92	655.42	405.35
Dissolved O_2 (ppm)	4.7	4.14	5.63	4.34	5.44	6.53
Total Alkalinity (mg/l)	366.75	323.75	334.50	337.50	328.75	330.75
Chloride (mg/l)	61.00	67.34	54.63	66.75	60.38	33.65
Phosphate (mg/l)	0.43	0.20	0.10	0.43	0.39	0.10
Nitrate (mg/l)	1.00	0.73	0.39	0.73	0.46	0.15
Nitrite (mg/l)	0.08	0.16	0.23	0.11	0.14	0.19
Ammonium (mg/l)	0.18	0.17	0.09	0.16	0.12	0.10

varied between 25.9°C and 32.8°C, highest during premonsoon and lowest in postmonsoon. Conductivity varied from 487.08 to 657.33 mmhos/cm and 405.35 to 719.92 mmhos/cm during first and second annual cycle. Highest turbidity value was recorded in monsoon and the water remained comparatively clear during rest of the year. Dissolved oxygen content was always moderate during the study period. Its values were slightly higher in late postmonsoon of both years and remained more or less similar in premonsoon and monsoon. The pH fluctuated narrowly between different seasons from 7.98 to 8.86 and 8.18 to 8.74 in first and second annual cycle. The contribution of chloride, phosphate, nitrate, nitrite and ammonia were lowest during postmonsoon and highest in premonsoon excepting alkalinity value which was lowest during monsoon.

Table 2. Physico-chemical Analysis of water of Subhas Sarovar in two Annual Cycle (1995–1996 and 1996–1997).

	Ist annual cycle (1995-1996)			2nd annual cycle (1995-1996)		
Physico-chemical factors	Pre-monsoon	Monsoon	Post-monsoon	Pre-monsoon	Monsoon	Post-monsoon
Water temp (°C)	33.13	32.46	25.46	32.26	31.95	26.17
pH	8.40	8.18	7.85	8.60	8.41	8.04
Turbidity (NTU)	12.0	31.5	13.1	10.88	21.0	10.04
Conductivity (mmhos)/cm	471.25	419.00	328.25	458.25	427.25	400.25
Dissolved O_2 (ppm)	4.69	4.71	6.75	5.98	5.08	6.96
Total Alkalinity (mg/l)	246.58	186.08	192.08	229.6	212.93	231.58
Chloride (mg/l)	44.71	46.54	40.75	50.71	45.79	28.42
Phosphate (mg/l)	0.03	0.02	0.10	0.07	0.01	0.03
Nitrate (mg/l)	0.68	0.31	0.12	0.20	0.27	0.20
Nitrite (mg/l)	0.08	0.31	0.12	0.09	0.11	0.04
Ammonium (mg/l)	0.27	0.27	0.14	0.25	0.22	0.06

The physico-chemical characteristics of Subhas Sarovar was more or less similar to that of Rabindra Sarovar including the concentration of nutrients and seasonal variation pattern also followed closely to Rabindra Sarovar. However, noticeable variations were recorded in the values of alkalinity, chloride and conductivity which were somewhat lower than Rabindra Sarovar.

B. Primary productivity :

The Gross Primary Productivity in Rabindra Sarovar varied between 1443.75 and 3662.5 mgC/m^3/day with an annual mean of 2397.42 mgC/m^3/day, while Net primary productivity fluctuated widely and varied from 412.5 to 2237.5 mgC/m^3/day.

Maximum net gross ratio was observed in monsoon (0.71) and minimum in post-monsoon (0.44). Percentage of respiration to GPP fluctuated between 28.87-56.1%

The Gross Primary Productivity values in Subhas Sarovar ranged between 2171.25–3512.00 mgC/m^3/day (Table 3) with annual mean of 2397.42 mgC/m^3/day. Values of net primary productivity ranged between 1375.00-2250.25 mgC/m^3/day with a mean of 1683.54 mgC/m^3/day. The range of fluctuation in community respiration value was between 718.62 and 1261.00 mgC/m^3/day with annual mean of 986.95 mgC/m^3/day.

Net gross ratio varied from 0.59–0.62. Respiration as a percent of gross production varied from 37.91-50.29%.

Table 3. Gross and Net Primary Productivity in Rabindra Sarovar and Subhas Sarovar (mgC/m^3/day).

	Rabindra Sarovar				Subhas Sarovar			
	Pre-monsoon	Monsoon	Post-monsoon	Mean	Pre-monsoon	Monsoon	Post-monsoon	Mean
Gross Primary Productivity (mgC/m^3/day)	3662.50	1443.75	2086.00	397.42	512.00	2171.25	2356.25	2679.83
Community Respiration (mgC/m^3/day)	1425.0	412.50	1144.06	993.85	1261.00	718.62	981.25	986.95
Net primary Priduction (mgC/m^3/day)	2237.00	1031.25	412.50	1226.83	2250.00	1425.63	1375.00	1683.54
Respiration as % of gross	38.30	28.87	56.10	41.09	41.00	50.29	37.91	430.06
Net gross ratio	0.62	0.71	0.44	0.59	0.59	0.62	0.62	0.61

C. Phytoplankton :

Phytoplankton flora were constituted mainly by diatoms (Bacillariophyceae), green algae (Chlorophyceae), blue green algae (Myxophyceae) and phytoflagellates (Euglenophyceae) in these two lakes. A total of 28 species of phytoplankton were recorded from these water bodies.

Rabindra Sarovar harboured 26 species which included 7 species of Chlorophyceae, 7 of Myxophyceae, 9 of Bacillariophyceae and 2 of Euglenophyceae (Table 4). Green algae were mainly comprised by *Closterium sp, Scenedesmus sp, Oedogonium sp, Spirulina sp, Cosmarium sp, Ankistrodesmus sp, Pediastrum sp* and *Spirogyra sp*. Blue green were chiefly represented of *Anabaena sp, Anacystis sp, Oscillatoria sp, Phormidium sp, Nostoc sp* and, *Cocconinies sp*. Dominant Diatom flora were comprised of *Denticula sp, Cyclotella sp, Nitzchia sp, Caloneis sp,* and *Navicula sp*.

In Subhas Sarovar too, the Bacillariophyceae was found to dominate both qualitatively and quantitatively and were represented by 8 species. Chlorophyceae were represented by 7 species, Myxophyceae by 5 species and Euglenophyceae by 2 species.

Table 4. Phytoplankton abundance in Rabindra Sarovar and Subhas Sarovar.

		Rabindra Sarovar	Subhas Sarovar
I	**Chlorophyceae**		
1.	*Closterium sp.*	•	•
2.	*Scenedesmus sp.*	•	•
3.	*Oedogonium sp.*	•	•
4.	*Spirulina sp*	•	•
5.	*Cosmarium sp.*	•	•
6.	*Ankistrodesmus sp.*	•	•
7.	*Pediastrum sp.*	•	•
8.	*Spirogyra sp.*	•	•
II	**Myxophyceae**		
9.	*Anabaena sp.*	•	•
10.	*Anacystis sp.*	•	
11.	*Oscillatoria sp.*	•	•
12.	*Phormidium sp.*	•	•
13.	*Nostoc sp.*	•	•
14.	*Lyngbya sp.*	•	•
15.	*Cocconies sp.*	•	•

Table 4. *Contd.*

		Rabindra Sarovar	Subhas Sarovar
	III Bacillariophyceae		
16.	*Navicula sp.*	•	•
17.	*Gramatophora sp.*	•	•
18.	*Achananthes sp*	•	•
19.	*Amphiphora sp.*	–	•
20.	*Brachysira sp.*	–	•
21.	*Caloneis sp.*	•	•
22.	*Denticula sp.*	•	•
23.	*Fragillaria sp*	•	•
24.	*Rhopalodia sp.*	•	–
25.	*Cyclotella sp.*	•	•
26.	*Nitzchia sp*	•	•
	IV Euglenophycae		
27.	*Volvox sp.*	•	•
28.	*Euglena sp.*	•	•

• indicates presence
– indicates absence

D. Zooplankton :

Rabindra Sarovar, which is characterised by dense macrophytic littoral vegetation, harbored a total of 45 species with 19 of Cladocera, 5 of Copepoda, 20 of Rotifera and 1 of Ostracoda (Table 5). Cladocerans were represented by 19 genera under 6 family. Highest number of species belonged to family Chydoridae (9 species) followed by Daphnidae (4 species), Sididae (3 species). Macrothricidae, Moinidae and Bosminidae were represented by one species each. Among the Copepoda both Calanoida and Cyclopoida were represented by two genera, each comprising of 5 species altogether. The Rotifer fauna of this lake were composed of 20 species. Alkaline and highly polymorphic cosmopolitan species dominated the faunal composition. Ostracodes were represented by single species, *Cypris subglobosa.*

The zooplankton species richness of Subhas Sarovar was comparatively higher than Rabindra Sarovar as fauna were represented by 48 species (Table 5). Cladoceran were comprised of 20 species belonging to 16 genera under 6 families. Families Daphnidae and Chydoridae (6 species each) were found to be more diverse than other families. The other families viz. Sididae represented by 4 species, Moinidae by 2 species and Macrothricidae and Bosminidae by one species, also

Table 5. Systematic account of zooplankton taxa in. Rabindra Sarovar and Subhas Sarovar.

Species	Rabindra Sarovar	Subhas Sarovar
Class : Rotifera		
Subclass : Eurotaria		
Order : Ploimida		
I. Family : Lecanidae		
1. *Lecane aculata* (Jakubski, 1912)	•	•
2. *Lecane* (Monostyla) *bulla*(Goss, 1851)	•	•
3. *Lecane (Lecane) curvicornis* (Murray 1913)	•	–
4. *Lecane (Lecane) leotina* (Turner, 1892)	•	–
5. *Lecane (Lecane) luna luna* (O. F. Muller, 1776)	•	•
6. *Lecane (Heninostyla) inopinata* (Harring and Myer, 1916)	–	•
7. *Lecane (Monostyla) hamata* (Stokes, 1896)	•	–
8. *Lecane (Monostyla) unguitata* (Fadeev, 1925)		•
II. Family : Brachionidae		
9. *Brachionus angularis* Goose, 1851	•	•
10. *B. calciflorus* Pallas, 1761	•	–
11. *B. caudatus* Barrois & Daday, 1894	•	•
12. *B. fulcatus* Zacharias, 1898	•	•
13. *B. forficula* Wierzeyski, 1891	–	•
14. *B. quadridentatus* Hermann, 1783	•	•
15. *B. patulus* (O. F. Multer, 1786)	•	•
16. *B. rubens* Ehrenberg, 1838	•	•
17. *Keretella tropica* (Apstein, 1907)	•	•
III. Family : Mytilinidae		
18. *Mytilina ventratis* (Ehrenberg, 1832)	•	•
IV. Family : Asplanchnidae		
19. *Asplanchna brightwelli* Gosse, 1850	•	•
20. *Trichocerca (Diurella) weberi* (Jennings, 1903)	–	•
V. Family : Testudinellidae		
21. *Testudinella patina* (Hermann, 1783)	•	•
VI. Family : Synchaetidae		
22. *Polyartha valgaris*	•	•
VII. Family : Filinidae		
23. *Filinia opoliensis* Zacharias, 1898	–	•
24. *Filinia longesita* Ehrenberg, 1834	•	•
VIII. Family - Philodinidae		
25. *Rotatoria neptunia* Ehrenberg, 1832	•	•
Total Rotifera species	20	21

Table 5. *Cont'd.*

Species	Rabindra Sarovar	Subhas Sarovar
Class : Crustacea		
Subclass : Copepoda		
Order : Calanoida		
I. Family : Calanidae		
26. *Heliodiaptomus viduus*	●	●
27. *Heliodiaptomus contortus*	●	●
Order : Cyclopoida		
II. Family : Cyclopidae		
28. *Mesocyclops leuckarti* (Claus)	●	●
29. *Mesocyclops hyalinus* Rehberg)	●	●
30. *Microcyclops varicans* (Sars)	●	●
Total Copepoda species	5	5
Class : Crustacea		
Subclass : Branchipoda		
Order : Cladocera		
I. Family : Sididae		
31. *Sida crystallina* (O. F. Muller, 1776)	●	●
32. *Diaphanosoma sarsi* Richard, 1894	●	●
33. *Diaphanosoma excisum* Sars, 1885	●	●
34. *Pseudosida bidentata* Herrick, 1884	–	●
II. Family : Daphnidae		
35. *Ceriodaphnia cornuta* Sars, 1885	●	●
36. *Daphnia carinata* King, 1853	–	●
37. *Daphnia lumholtzi* Sars, 1885	–	●
38. *Scapholeberis kingi* Sars, 1903	●	●
39. *Simocephalus expinosus* (Koch, 1841)	●	●
40. *Simocephalus vetulus* (O. F. Muller, 1776)	●	●
III. Family : Moinidae		
41. *Monia micrura* Kurz, 1874	●	●
42. *Moinodaphnia macleayi* King, 1841	–	●
IV. Family : Bosminidae		
43. *Bosmina longirostris* (O. F. Muller, 1776)	●	●
44. *Macrothrix triserials* (Brady, 1886)	●	●

Table 5. *Cont'd.*

Species	Rabindra Sarovar	Subhas Sarovar
Family : Chydoridae		
45. *Chydorus barroisi* Richard, 1894	•	•
46. *Chydorus sphaericus* (O. F. Muller, 1776)	•	•
47. *Dunhevedia crassa crassa* King, 1853	•	•
48. *Pleuroxus similis* Vavra, 1900	•	•
49. *Pseudochydorus globosus* (Baird, 1843)	•	–
Sub-Family : Aloninae		
50. *Alona davidi* Richard, 1895	•	•
51. *Alona pulchella* King, 1853	•	•
52. *Oxyurella singalensis* (Daddy, 1898)	•	–
53. *Acropus harpae* (Baird, 1834)	•	–
Total Cladocera species	19	21
Class : Crustacea		
Subclass : Ostracoda		
Family : Cyprinidae		
54. *Cypris subglobosa* Sowerby, 1840	•	•
Total Ostracoda species	1	1
Total Zooplankton species	**45**	**48**

• Indicates presence; – Indicates absence

contributed to the Cladoceran diversity. Like Rabindra Sarovar, Copepod fauna of this wetland was also comprised by three Cyclopoids viz, *Mesocyclops leuckarti, Mesocyclops hyalinus* and *Microcyclops varicans* and two Calanoides, *Heliodiaptomus viduus* and *Heliodiaptomus contortus*. Ostracoda was represented by only species *Cypris subglobosa.* Rotifera fauna of Subhas Sarovar were mainly comprised by 6 species of family Lecenidae, 8 species of Brachionidae, 2 of Trichoceridae and a single species of family Mytilinidae, Testudinellidae, Synchaetidae, Filinidae, and Philodinidae.

In Rabindra Sarovar, the zooplankton density varied between 668- 1134/l and 619–1144 units/l in first and second annual cycle with peak in post-monsoon (Fig. 1). Seasonal fluctuation pattern was almost similar in both lakes. In Subhas Sarovar, total density varied between 608-936 units/l and 673–1238 units/l in the two cycles respectively (Fig. 2).

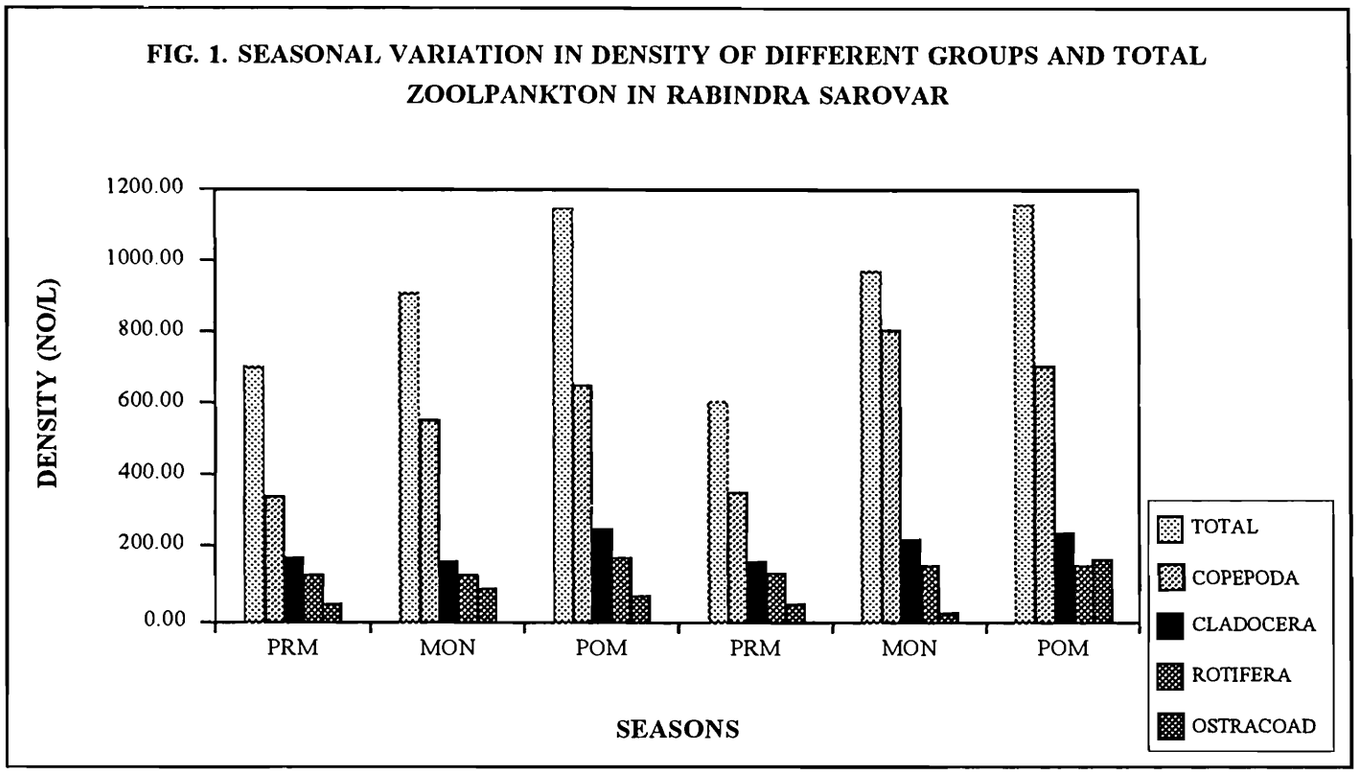

Fig. 1. Seasonal variation in density of different groups and total zoolpankton in Rabindra Sarovar.

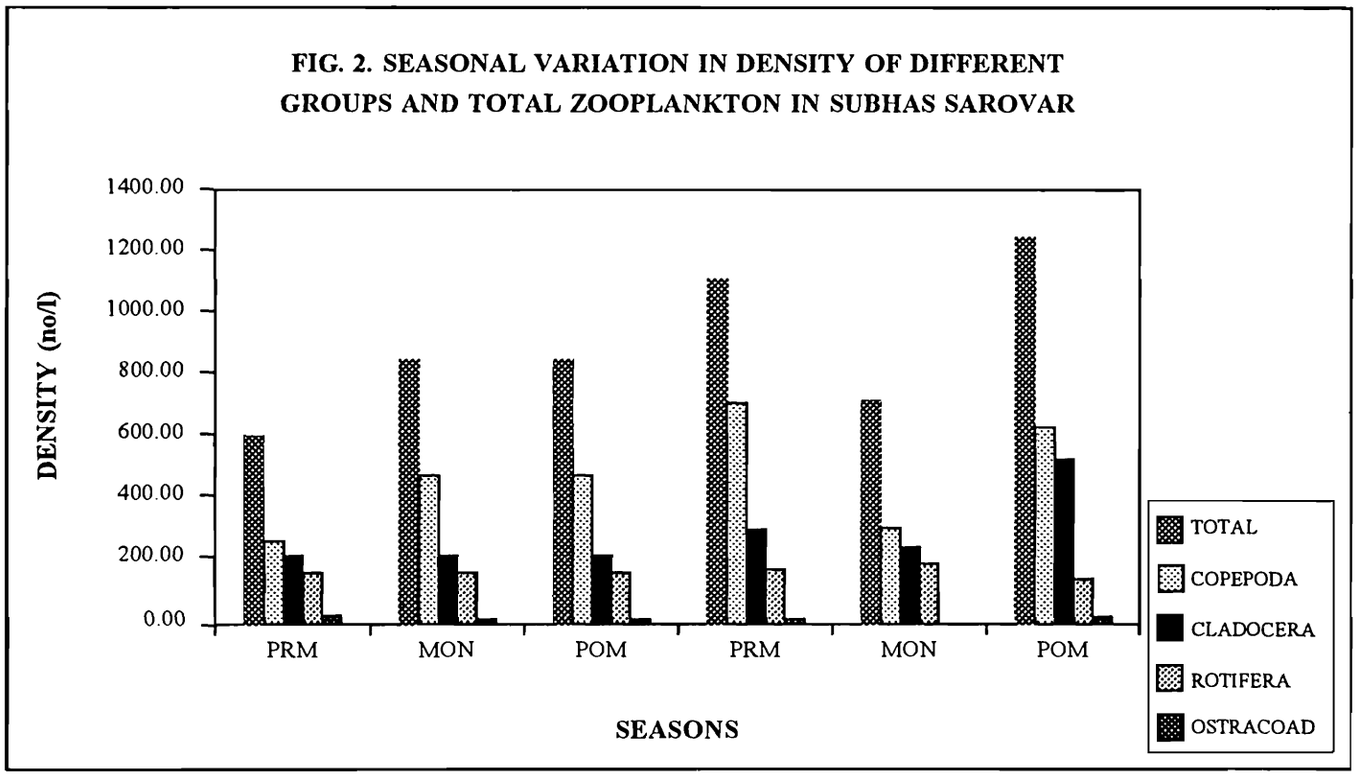

Fig. 2. Seasonal variation in density of different groups and total zoolpankton in Subhas Sarovar.

The zooplankton community as a whole was dominated by Copepods (56.69% in Rabindra Sarovar and 53.17% in Subhas Sarovar) followed by Cladocera (22.11% in Rabindra Sarovar and 30.53% in Subhas Sarovar). Rotifers contributed only 14.26% in Rabindra Sarovar and 15.91% in Subhas Sarovar. Ostracodes constituted only a small proposition in Subhas Sarovar (0.86%) but their share in Rabindra Sarovar was comparatively higher (6.94%) (Figs. 3 and 4).

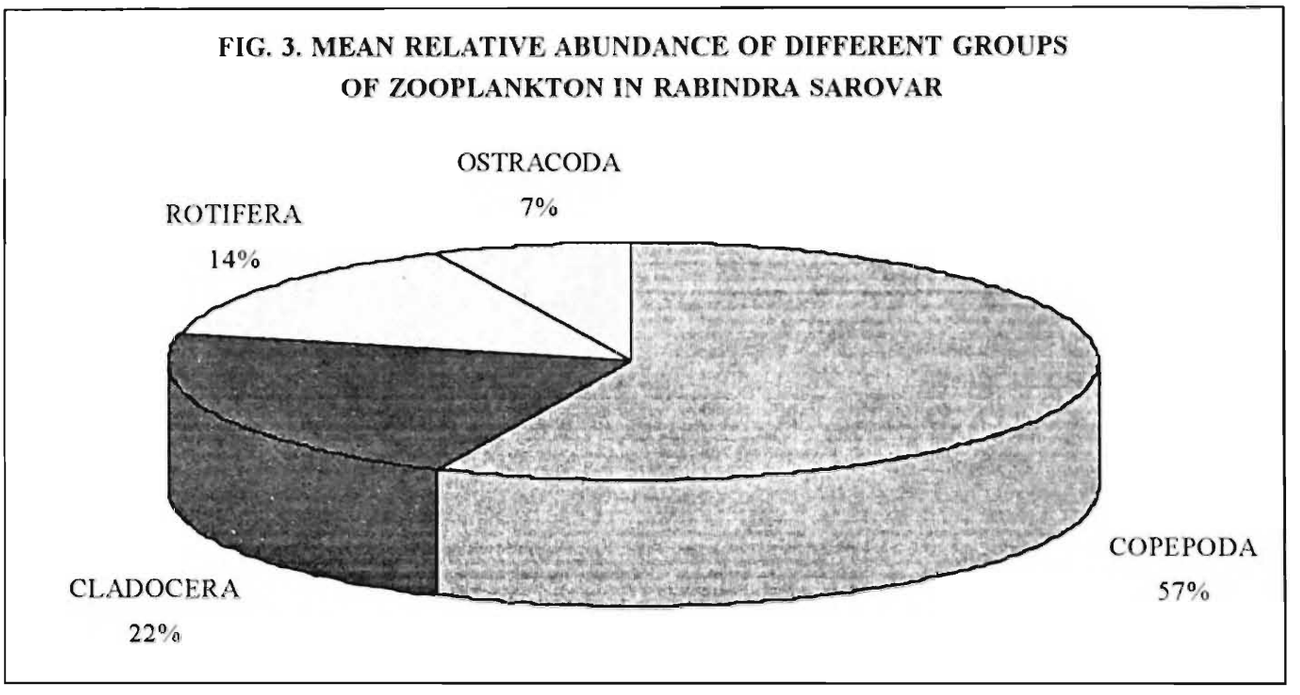

Fig. 3. Mean relative abundance of different groups of zooplankton in Rabindra Sarovar.

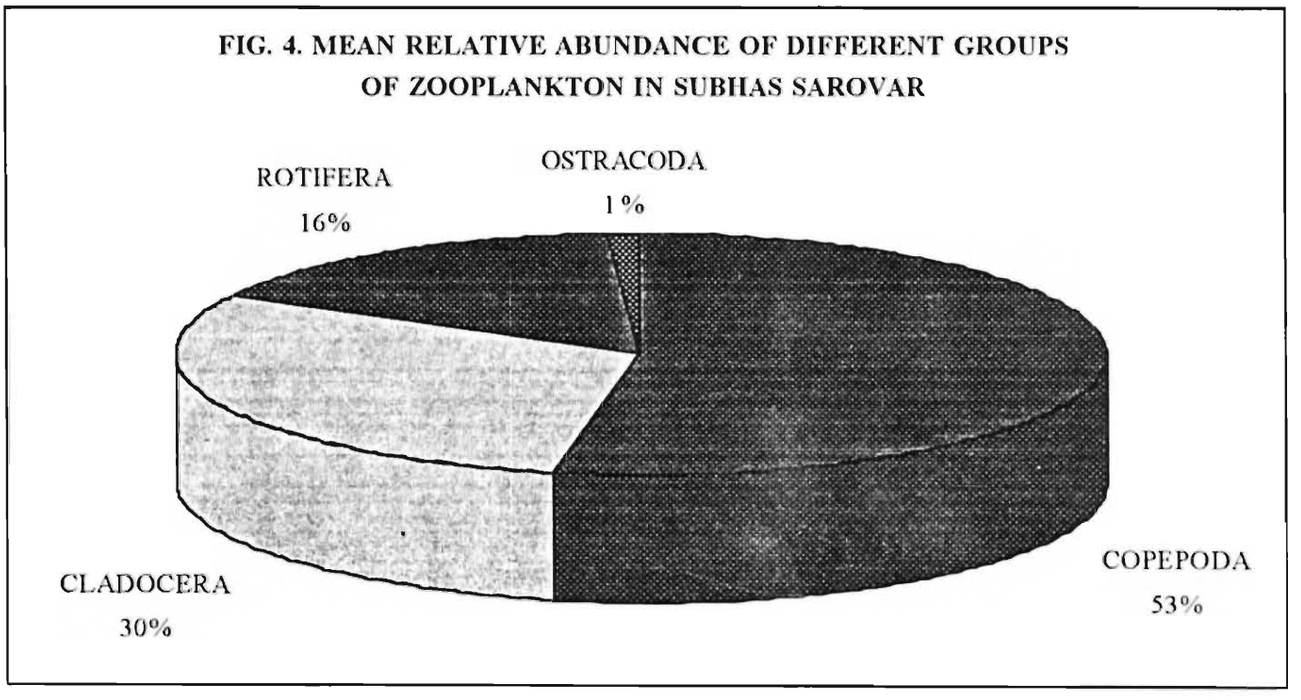

Fig. 4. Mean relative abundance of different groups of zooplankton in Subhas Sarovar.

DISCUSSION

The present investigations revealed that general physico-chemical nature of the water of both lakes was comparatively good and almost similar to other water bodies of this region (Michael 1966, Banerjee 1967, Khan 1979). The water temperature fluctuated narrowly, except during a brief period of late post-monsoon (Dec-Jan), which corresponds to a moderate winter season of the region and did not affect significantly the seasonal dynamics of zooplankton of two lakes. Unlike northern or high altitude region of the country (Sarwar and Wazir, 1991; Hazarika and Dutta, 1997), where temperature drops drastically during winter affecting considerably the dynamics of aquatic fauna, the impact of temperature drop on aquatic organisms in this region in general is not very significant. Similarly pH of both lakes also fluctuated narrowly. Banerjee (1967) too reported a narrow variation in pH of a number of ponds of Howrah and 24 Parganas which ranged between 7.2 and 8.2. However, Khan (1979) reported a slightly higher range of pH in Rabindra Sarovar. The dissolved oxygen content of both the lakes were moderate throughout the year and at no time it decreased substantially. The two lakes differed considerably in respect to their chloride, alkalinity and nutrient contents, which were always higher in Rabindra Sarovar than Subhas Sarovar. The higher nutrient content, specially phosphates, in Rabindra Sarovar was mainly due to increased human activities.

The higher rate of primary productivity in both lakes exhibited eutrophic nature of these water bodies. High primary productivity of Rabindra Sarovar was also observed by Khan (1979) who reported the annual means as 3733 mgc/m^3/day of Gross Primary Productivity, 1558 mgc/m^3/day of Community Respiration and 2175 mgc/m^3/day of Net Primary Productivity. High primary productivity and consequent accumulation of biomass are probably due to improper utilization as no proper exploitation of fishery resources are being done in these wetlands.

The freshwater zooplankton fauna of the wetlands studied comprised of 3 major groups, viz. Rotifera, Cladocera : Crustacea and Copepoda : Crustacea. Besides these, another Crustacean group, Ostracoda was also represented constantly but by a single species. Altogether 54 species of zooplankton were recorded from these wetlands over the entire period of the study. This include 25 species of Rotifera, 23 of Cladocera, 5 of Copepoda and one of Ostracoda. Regarding the diversity of zooplankton fauna in tropical waters, there are divergent views. An earlier concept was that the diversity of zooplankton, particularly of Cladocera, is very much restricted in tropical water bodies. (Green 1976, 1990, Fernando and Kanduru 1984,Fernando et. al., 1987, Dussart *et al.* 1984, Kerfoot and Lynch, 1987. Ravera 1996). However, recently this view point has been questioned by Dumont (1994). He reported that, contrary to earlier concept, the diversity of zooplankton fauna in tropical water bodies is no way lesser than those reported from temperate water bodies. Considering the existence of 54 species in two wetlands, it can be very safely said

that the diversity of zooplankton of this region is considerably rich. This is also evident from some earlier works carried out on the zooplankton fauna of the region. Venkatraman and Das (1993) and Sharma (1998) recorded 148 species of Rotifera and 56 of Cladocera respectively from a few districts of West Bengal surrounding Calcutta. Khan and Sinha (1999) reported the existence of 90 species from few wetlands of Calcutta and surrounding districts situated in southern West Bengal. This rich zooplankton faunal diversity of the wetlands of the country has also been substantiated by several workers who have paid proper attention to taxonomic aspects (George 1966, Zutsi and Vaas 1982, Yousuf *et.al.* 1983). However, due to lack of proper taxonomic treatment, the number of zooplankton species reported from majority of wetlands of the country were extremely under represented (Sinha *et. al.* 1987; Ahmed and Singh, 1991; Singh and Pandey, 1991; Khatri, 1992; Sinha *et. al.* 1992; Baruah *et. al.* 1993; Bose and Gorai 1993, Pushpendra 1994, Kumar 1995). This is due to the fact that majority of studies dealt with general limnological condition and variation in total zooplankton density and identification of individual species was given only a passing reference. It is strongly viewed that when these waterbodies will be explored thoroughly for the zooplankton fauna and proper taxonomic studies are carried out, the diversity will increase several folds.

The dominance of 3 major groups of zooplankton in freshwater lentic ecosystem differed widely and like present study Copepods were found to dominate in many other lakes/ponds/ reservoirs of the country (Chacko and Krishnamurthi 1954, Ganapati 1943, Das and Srivastava 1959, Khatri 1992, Baruah *et. al.* 1993, Dash *et al.* 1993). However, dominance of Cladocera (Kaul and Hando 1993) or Rotifera (George 1966, Joshi and Adoni 1993, Pandit 1993, Kumar 1995) in the freshwaters of the country has also been widely reported. In the light of markedly varying dominance, no generalisation seems possible, and it can be concluded that the dominance of any group solely depends upon local factors. Sehgal (1983) found the occurrence and abundance of Cyclopoid Copepods in turbid as well as in clear waters infested with aquatic plants. He also gave ranges of some physico-chemical parameters for abundance of Copepods (water temperature 25.7°C–31.5°C, pH-7.2–8.8, dissolved oxygen 6.6–7.8 ppm and total alkalinity 160–220 ppm). During present investigation, similar type of physico-chemical environment was found in these two wetlands.

On the basis of above observations it can be said that non exploitation of fishery resources from Rabindra Sarovar is chiefly responsible for increased organic decay, hence, increased nutrients load and high primary production resulting in high eutrophication. It is suggested that for the proper management and conservation of Rabindra Sarovar, a rational policy should be evolved and due emphasis should be given to commercial exploitation of the aquatic resources. Biomanupulation of the lake by introduction of suitable species of fish and other organisms are urgently needed, particularly for the control of macrophytes.

SUMMARY

Generally, lakes situated in urban areas are mainly used for recreational purposes like swimming, bathing and other water sports. However, many a times, these water bodies are subjected to undesirable uses such as discharge of industrial and domestic effluents or excessive use by surrounding dense human population for a variety of purposes and thereby degrading the water quality considerably. In Calcutta metropolitan area there are two such man made lakes, situated in the heart of the city, namely Rabindra Sarovar and Subhas Sarovar. Studies were undertaken for two consecutive annual cycles, 1996-97 and 1997-98. with a view point to work out the physico-chemical characteristics of water, phytoplankton, rate of primary production and diversity and abundance of zooplankton of the two lakes.

Physicochemical characteristics of water of both Rabindra Sarovar and Subhas Sarovar fluctuated moderately during different seasons. In Rabindra Sarovar, water temperature varied between 25.9°C and 32.8°C, highest during premonsoon and lowest in postmonsoon. Conductivity fluctuated between 405.35 to 719.92 mmhos/cm. Highest turbidity value was recorded in monsoon and the water remained comparatively clear during rest of the year. Dissolved oxygen content was always moderate during the study period. The pH fluctuated narrowly (7.98-8.86) between different seasons. The contribution of chloride, phosphate, nitrate, nitrite and ammonia were lowest during postmonsoon and highest in premonsoon excepting alkalinity value which was lowest during monsoon. The physico-chemical characteristics of Subhas Sarovar was more or less similar to that of Rabindra Sarovar excepting noticeable variations were in alkalinity, chloride and conductivity. The Gross and Net Primary Productivity values in Rabindra Sarovar varied between 1443.75 and 3662.5 mgC/m^3/day and 412.5 to 2237.5 mgC/m^3/day respectively. In Subhas Sarovar the values for gross and net productivity varied from 2171.25–3512.00 mgC/m^3/day and from 1375.00–2250.25 mgC/m^3/day.Maximum net : gross ratio was observed in monsoon and minimum in post-monsoon.

Rabindra Sarovar, which is characterised by dense macrophytic littoral vegetation, harbored a total of 45 species of zooplankton with 19 of Cladocera, 5 of Copepoda, 20 of Rotifera and 1 of Ostracoda (Table 5). Among Cladocera highest number of species belonged to family Chydoridae (9 species),followed by Daphnidae (4 species). Copepods were represented by 5 species, 2 of Calanoida and 3 of Cyclopoida. The Rotifer fauna of the lake were composed of 20 species. Alkaline and highly polymorphic cosmopolitan species dominated the faunal composition. Ostracods were represented by single species, *Cypris subglobosa*. The zooplankton, species richness of Subhas Sarovar was comparatively higher than Rabindra Sarovar from where 48 species were recorded. This was due to higher number of species of Cladocera (20) and Rotifera (22). The zooplankton density varied between 619–1144 units/l in Rabindra Sarovar and between 608–1238

units/l in Subhas Sarovar with peak in post-monsoon. Seasonal fluctuation pattern was almost similar in both lakes. The zooplankton community as a whole was numerically dominated by Copepods followed by Cladocera. Rotifers contributed only 14- 16% in both lakes.

ACKNOWLEDGEMENTS

The authors are thankful to Director, Zoological Survey of India for providing necessary facilities and his keen interest in the work. One of the authors (CS) is also grateful to the Zoological Survey of India and the Ministry of Environment and Forests, Govt. of India for kindly providing research fellowship.

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