Rec. zool. Surv. India : **107**(Part–2) : 51-59, 2007

PHYSICO-CHEMICAL CHARACTERISTICS AND ZOOPLANKTON OF HUSSAIN SAGAR LAKE, HYDERABAD, ANDHRA PRADESH

S.V.A. CHANDRASEKHAR

Freshwater Biological Station, Zoological Survey of India,
1-1-300/B, Ashok Nagar, Hyderabad-500 020

INTRODUCTION

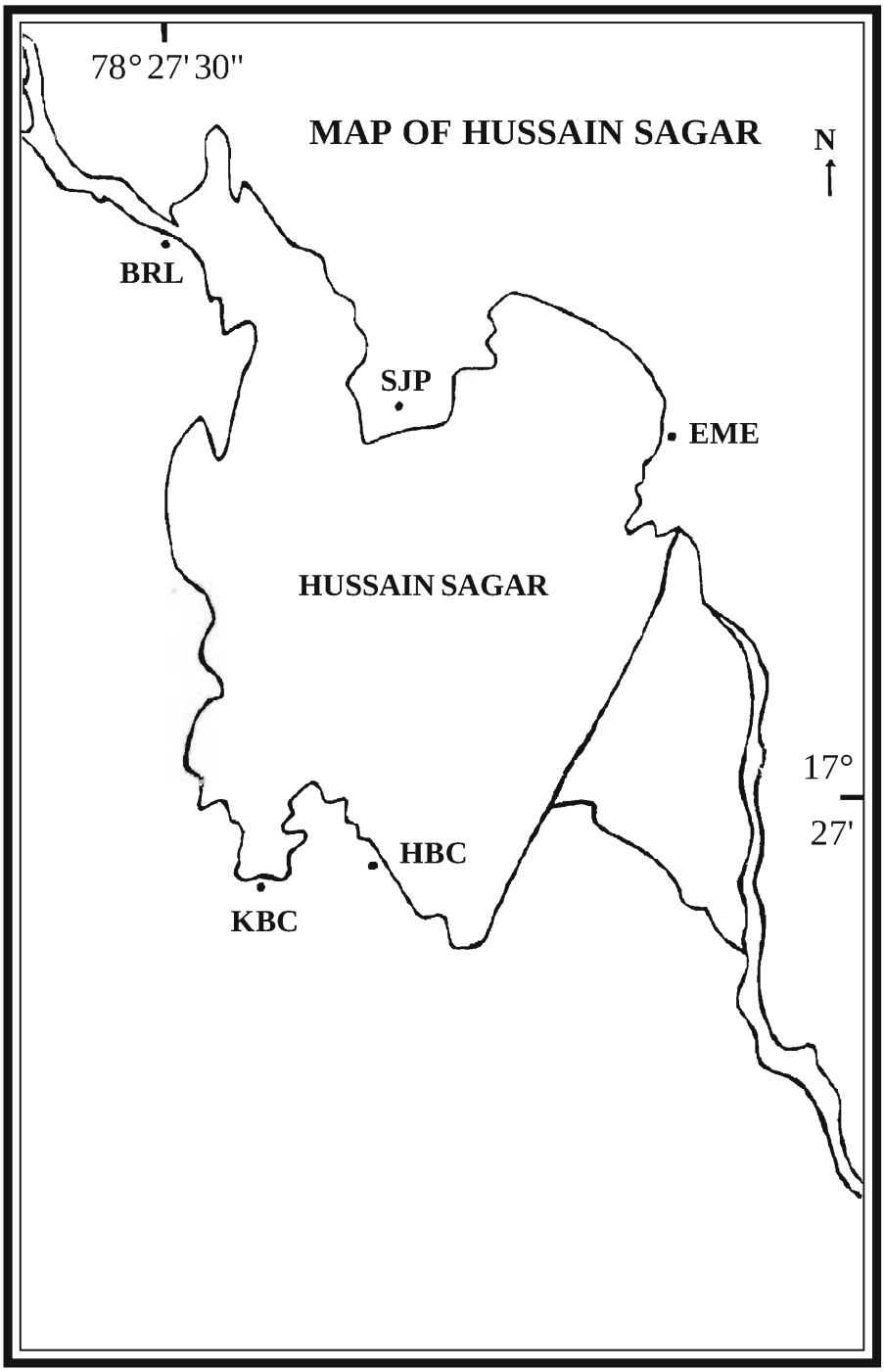
Hussain Sagar with an area of 450 hectares is one of the principal lakes located (78°30' E, 17°30' N) between the twin cities of Hyderabad and Secunderabad, Andhra Pradesh (Map 1). With passage of time, the lake is undergoing a steady degradation in its ecology due to urbanization and industrialization with consequent influx of domestic sewage and industrial effluents. Some important limnological and ecological studies on the Hussain Sagar Lake are by Zafar (1966), Khan and Hussain (1976) and Babu Rao *et al.* (1981). The studies made then indicated possible pollution from domestic and industrial origin. Later on, there has been considerable increase in the population as well as in the developmental activities in the capital in general and around the lake in particular and hence the present study.

MATERIAL AND METHODS

With a view to assess the condition of the lake, a study of the lake was undertaken for a period of 19 months from June 1990 to December 1991. For the study, five sampling stations in the lake were selected nearby five important landmarks around the lake on the basis of the topography, inflow of pollutants and human activities (Map 1).

(a) **HYDERABAD BOAT CLUB (HBC) :** This station is situated in the eastern pocket at the southern end of the lake. Here the Budha statue was installed on the rock of Gibralter. Annually Ganesh idols are being immersed at this site.

(b) **KHAIRATABAD COLONY (KBC) :** This area is situated in the western pocket at the southern end, west of Hyderabad Boat Club and receives domestic sewage from the surrounding colonies. Here also, a lot of silt is added through immersion of Ganesh idols every year.



Map 1. : Map of Hussain Sagar.

(c) **BEGUMPET RAILWAY LINE (BRL) :** Situated in the northwestern pocket of the lake, this station receives the waste water from Kukatpally stream. Domestic sewage and industrial effluents from Kukatpally and Balanagar industrial areas are released into the lake at this point.

(d) **SANJIVAYYA PARK (SJP) :** This zone is situated between the northwestern and northeastern pockets of the lake. Laundry wastes from several *Dhobi Ghats* enter the lake at this point.

(e) **EME SAILING CLUB (EME) :** This station is situated north of the *Tank bund* skirting the eastern border of the lake. The area is mainly utilised for sports activities such as boating, sailing *etc.*

Surface water samples were collected at approximately monthly intervals from the above mentioned five stations for physico-chemical parameters. At each station, a separate sample was collected for estimation of Dissolved Oxygen with usual precautions. Temperature was measured using a centigrade thermometer and pH by 'dip pH' meter in the field. Standard Methods of APHA (Anon, 1989) were applied to measure the chemical parameters. Plankton samples were collected using plankton net of mesh size no. 25 and preserved in 4% formalin in plastic containers. Identification of zooplankton was done with the help of Pennak (1989), Edmondson (1969) and Michael and Sharma (1988).

RESULTS AND DISCUSSION

The ranges of different physico-chemical parameters of the water at five sampling points are pooled and given in Table 1. In general, the water of the lake is turbid, and the colour is brown to pond green with frequent emission of foul smell.

Physico-chemical parameters :

Temperature : Variation in air and surface water temperatures are due to changing seasons in general and variations at different stations on the same day are due to time lag in the collection of samples, which are spatially separated. The maximum atmospheric temperature was attained in all the spots during peak summer month of May which ranged from 36°C to 38°C. Minimum was noticed in winter season, which ranged between 25°C and 26°C at all the stations.

The surface water temperature varied from 24°C to 35°C. Highest was found in summer (35°C) followed by a low of 28°C during the monsoon and 24°C during winter. In general the water temperature closely followed the atmospheric temperature at the time of sampling with slight differences.

pH : The pH of the lake waters was generally alkaline (range–7.3 to 10) throughout the period of study. Highest values were recorded during summer months of March-May with a maximum of 10. During the rest of the period it was around 8 with a minimum of 7.3 during October 1991.

Table 1. : Ranges of Physico-Chemical Parameters of Hussain sagar lake.

Parameter	1990							1991											
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Temp. (Atm.)	31–34	28	30–32	28–29	29–30	28–29	28–29	25–26	24–30	35–37	36–37	36–38	27–28	28–29	25–27	29–34	27–28	25–26	27
Temp. (Water)	29–30	26–28	29–32	26–28	27–28	26–27	27–28	22–25	26–27	29–35	30–31	31–34	26–27	26–27	24–25	28–30	25–26	24–25	25–27
pH	7.9–9.4	7.8–8.0	7.6–8.5	7.6–8.1	7.6–8.2	7.8–8.2	8.0–8.3	8.1–8.5	8.4–8.5	8.9–10.0	8.6–9.5	8.2–9.5	7.9–8.2	7.8–8.0	7.8–8.1	7.4–8.3	7.3–7.6	7.6–8.1	8.2–8.6
Sp. Cond.	1470–1710	1435–1465	1495–1565	1480–1600	1425–1522	1500–1650	1550–1600	1725–1797	1715–1782	1782–1949	1810–2050	2109–2170	1808–1928	1500–1705	1259–1648	1658–1887	1380–1620	1628–1735	1684–1774
Dis. Oxygen	5.4–17.0	3.4–5.2	0–10.6	1.2–6.2	1.2–7.8	1.6–6.0	2.0–5.8	2.0–7.2	2.6–5.6	4.0–8.2	3.2–6.2	2.2–5.6	0.6–3.4	1.0–3.6	0–8.4	0–4.0	0–5.2	0–4.0	2.6–8.0
Carbonates	0–120	0	0–24	0	0	0	0	0–6	12–24	24–54	0–25	0–60	0	0	0	0	0	0	0–18
Bicarbonates	165–378	311–323	262–305	280–320	286–336	275–325	275–318	311–360	317–360	281–311	290–360	275–427	397–427	350–385	305–384	299–366	329–366	311–366	229–360
Free Co2	0–4.6	4.0–6.0	0–8.4	4.6–7.0	4.0–4.8	4.0–4.6	4.0–4.4	0–4.2	0	0	0–3.6	0–7.8	4.2–6.0	4.2–7.0	3.6–5.6	6.2–9.2	6.0–9.6	4.0–7.0	3.8–7.2
Chloride	262–920	273–284	269–280	230–275	230–245	240–260	250–265	273–291	280–294	319–337	300–340	347–372	319–337	298–332	225–337	300–370	250–312	227–290	270–287
Total Hard.	250–475	295–315	280–305	275–295	275–335	235–330	224–300	185–210	195–210	220–235	215–242	220–245	245–285	200–280	210–255	215–270	215–320	250–320	220–310
Calcium	56–76	76–80	74–92	74–87	70–80	58–90	42–84	44–50	46–58	42–50	43–55	40–52	58–62	36–58	40–54	50–72	50–84	34–58	20–36
Magnesium	24–74	23–29	13–29	18–28	21–39	25–32	23–30	15–24	11–21	23–32	26–31	19–34	22–33	26–30	24–30	21–23	22–47	27–46	38–63

The pH pattern was closely related to the carbonates, bicarbonates and free CO_2. High pH in summer correlated with high carbonate and bicarbonate values and low pH with presence of free CO_2. The same pattern was found in all the five stations.

Specific conductance : The range of conductivity during the study was 1259–3660 micro mho's/cm. Lowest values were observed during monsoon. The values gradually increased through winter to reach the maximum in summer.

High Specific Conductance indicates richness of ions necessary for organic production and the converse is also true. The high Specific Conductivity in summer could be due to concentration of domestic effluents containing nutrients, resulting from evaporation and no inflow of freshwater. This leads to variations in DO, nil under anaerobic conditions and high values under eutrophic conditions.

Dissolved Oxygen (DO) : During the course of study, the range of DO observed is 0 to 17 mg/1. The general range however is from around 2 to about 6 or 8 mg/1. High values of 10.6 mg/1, 12.2 mg/1 and 17 mg/1 were encountered which are exceptional. The station-wise ranges of DO values noticed are 1.4–12.2 at HBC, 1.8–17 at KBC, 0–5.4 at BRL, 0–5.8 at SJP and 3.0–8.2 at EME. Low values indicate organic enrichment resulting sometimes in anaerobic conditions. The same high content of nutrients also leads to eutrophication under suitable conditions of dilution and light penetration, resulting in extremely high DO. The high values of DO are due to high productivity during clear weather seasons. Exceptionally high values were the effect of eutrophication. Low values during monsoon are probably due to low sunshine coupled with poor penetration light resulting from high turbidity.

Carbonates, Bicarbonates and Free CO_2 : The maximum values of carbonate during the present study were 24 mg/1 at HBC and KBC, 48 mg/1 at EME and 54 mg/1 at BRL, 60 mg/1 at SJP, all in the month of March, excepting at SJP where it was in May. During the rest of the year the values were nil for the most part or only low. The value was exceptionally high, 120 mg/1 at KBC during June 1990. Zafar (1966) also found higher quantities of Carbonates during hot months. Highest values of about 400 mg/1 were observed at all stations during May-July period. During the rest of the period the values were around 300 mg/1 or more at all stations excepting at KBC where the minimum was 165 mg/1 during June 1990. Munawar (1970) noted higher bicarbonate contents in eutrophic waters and sewage pond respectively. Phillipose (1960) reported higher values of total alkalinity in polluted waters. As is well known, presence of free Carbon-dioxide indicates the absence of carbonates. Whenever it was present, the values ranged between 3.6 and 9.6 with maximum during late monsoon.

Chloride : The chloride content at all the five stations of the lake varied from a minimum of 225 mg/1 at BRL in August to a maximum of 372 mg/1 at SJP in May and 370 mg/1 at BRL in September. Exceptionally the value was 922 mg/1 at HBC in June 1990. The general range is

however from 270 mg/1 to 300 mg/1. Only at KBC the chloride content varied slightly around 260 mg/1 for a greater part of the year. High value in September immediately after the minimum in August suggest complicated processes in Hussain Sagar Lake and high variation in the discharges particularly of industrial origin.

Total Hardness (TH) and Calcium and Magnesium ions : The TH of the Hussain Sagar waters ranged from a minimum of 185 mg/1 in January 1991 at EME to a maximum of 475/1 in June 1990 at HBC during the study period. Generally the values were around 200–250 for the most period at all the places during 1991, while higher values around 300 were recorded during June to November-December period of 1990. The main source of calcium is rocks from which the rainwaters leach it. The values of Calcium ranged from 20–50 mg/1 (winter and summer) to 80–90 mg/1 (monsoon). The Magnesium values were generally between 20 mg/1 and 30 mg/1, sometimes around 10–15, with occasional high values of 40–50 mg/1 in Nov-Dec 1991 and an exceptional value of 74 mg/1 in June 1990. The TH is influenced by the Calcium and Magnesium ions in the water-body. These, though significant, showed only a little relationship with TH, indicating influence of variation in the inflow and content of other ions like iron, manganese, strontium *etc.* of freshwater as well as other discharges into the lake. The variation, thus, seems to depend on he varying contents and degree of different ions in the inflow.

Total Hardness is an indicator of water quality. Generally the desirable limit of this factor is 300 mg/1 with permissible limit up to 600 mg/1 as per Indian Standards (Anon, 1991). Thus the TH is within the desirable limit.

Zooplankton :

The composition of zooplankton in the lake shows the high species diversity of cladocerans (10 spp.) followed by that of rotifers (7 spp.) while ostracods were represented by three species and copepods by only two species. Following is the list of species encountered during the present study and those reported by Babu Rao *et al.* (1981).

Groups	Present Study	Babu Rao *et al.* (1981)
ROTIFERA	*Brachionus calycifloms* (Gosse, 1851)	*B. calycifloms*
	B. forficula Wierzeiski, 1891	*B. caudatus*
		B. quadridentata
		B. urceoloris
	Keratella tropica (Apstein, 1907)	*K. tropica*
	Filinia longiseta (Ehrb., 1834)	
	Mytilina sp.	
	Platiyas quadricornis Ehrb., 1882	*P. quadricornis*
	Lecane sp.	

Groups	Present Study	Babu Rao *et al.* (1981)
CLADOCERA	*Pseudosida bidentata* Herrick, 1884 *Diaphanosoma sarsi* Richard, 1984 *D. excism* Sars, 1885 *Ceriodaphnia cornuta Sars,* 1885 *Daphnia lumholtzi* Sars, 1885 *Simocephalus vetulus* (O.F. Müller, 1776) *Moina brachiata* (Jurine, 1820) *Moinadaphnia macleayi* (King, 1853) *Macrothrix spinosa* King, 1853 *Leydigia* sp.	*Diaphanosoma sarsi* *Ceriodaphnia cornuta* *Ceriodaphnia* sp. *Daphnia lumholtzi*
COPEPODA	*Heliodiaptomus* sp. *Mesocyclops* sp.	*Heliodiaptomus* sp. *Mesocyclops leucartii*
OSTRACODA	*Cypris* sp. *Cyprinotus* sp. *Stenocypris* sp.	

A few studies on the zooplankton of Hussain Sagar were earlier made, chiefly by Babu Rao *et al.* (1981). Dhanapathi (1974) has reported 4 species of Rotifera *viz.*, *Brachionus falcatus*, *B. durgae*, *B. calyciflorus* var. *dorcas*, *Platiyas quadricornis* of which the first two are not encountered during the present study.

Among the rotifers collected from Hussain Sagar and listed above, occurrence of *Brachionus calyciflorus* and *Filinia longiseta* indicates eutrophic conditions of the lake. *Keratella tropica* prefers the polluted waters and *Brachionus forficula* prefers clean water. Presence of the genera, *Diaphanosoma*, *Ceriodaphnia* and *Simocephalus* is also indicative of eutrophic nature of the water body (Mahajan, 1981).

Based on the DO and species abundance ratios, Babu Rao *et al.* (1981) found the western and northwestern parts of the lake to be polluted and the fauna having the environmental stress. The DO was low at Station 2 (Western region) and nil at Station 3 (NW part) located on the western flank. During the present study the DO values in general are low, around 3 mg/1 at all the stations for most part of the year and occasionally nil or very low indicating organic load. High alkalinity, low Dissolved Oxygen with occasionally nil or very high values and presence in the zooplankton, *viz.*, rotifers, *Brachionus calyciflorus*, *Filinia longiseta* and *Keratella tropica*, and the cladocerans, *Diaphanosoma*, *Ceriodaphnia* and *Simocephalus* are some of the characteristics of the lake indicating of organic pollution and eutrophic nature of the water body. Thus during the decade from the studies of Babu Rao *et al.* (1981) the degradation has spread almost to the entire lake. Based on

different biotic and abiotic parameters, Siddiqi and Khan (2002) also classified the Hussain Sagar, as a highly eutrophic lake. It is possible, considering the rate at which the resident and floating population of the twin cities is growing and the rate of developmental activities that took place and are continuing, the condition of the lake further deteriorated needing a fresh look into the condition and control over the factors responsible for the deterioration.

SUMMARY

A limnological study on Hussainsagar, a highly eutrophic lake in Hyderabad, was undertaken during 1990-91. Twelve parameters were analysed and discussed with a brief note on its zooplankton composition.

ACKNOWLEDGEMENTS

The author is grateful to the Director, Zoological Survey of India, Calcutta and the Officer-in-Charge, Freshwater Biological station, ZSI, Hyderabad for excellent facilities and encouragement. Thanks are also due to Dr. D.R.K. Sastry, Joint Director, Zoological Survey of India, Hyderabad, whose suggestions and help greatly improved the manuscript.

REFERENCES

Anon. 1989. *Standard Methods for the Examination of Water and waste water.* 17th Ed. APHA, AWWA & WPCF.

Anon. 1991. *Indian Standard Drinking Water-Specification.* IS 10500 : 1991 Table 1.

Babu Rao, M., Mukhopadhyay, S.K., Muley, E.V. and Siddiqui, S.Z. 1981. Diversity in zooplankton community as indicator for organic and industrial pollution in Hussainsagar, Hyderabad. *Bull. zool. Surv. India*, **4**(10) : 61-66.

Dhanapati, M.V.S.S. 1974. Rotifers from Andhra Pradesh, India-I. *Hydrobiologia*, **45**(4) : 357-372.

Edmondson, W.T. 1959. *Freshwater biology* 2nd Ed. John Willey & Sons. Inc., New York. 1248 pp.

Khan, M.A. and Aziz Hussain, M. 1976. Preliminary observations on pollution of the lake Hussainsagar caused by industrial effluents *Indian J. Env. Hlth.*, **18**(3) : 227-232.

Mahajan, C.L. 1981. Zooplankton as indicators for assessment of water pollution. WHO Workshop on Biological Indicators and Indices of Environmental Pollution. *Cent. Bd. Prev. Cont. Poll.* 35-148.

Michael, R.G. and Sharma, B.K. 1988. *Fauna of India : Indian Cladocera (Crustacea : Brachiopoda : Cladocera).* Zoological Survey of India, Calcutta. 262 pp.

Munawar, M. 1970. Limnological studies of freshwater ponds of Hyderabad, India-I. The Biotype. *Hydrobiologia*, **35** : 127-162.

Pennak, R.W. 1989. *Freshwater invertebrates of the United States.* 3rd Ed. John Wiley & Sons. Inc. N.Y. 628 pp.

Phillipose, M.T. 1960. Freshwater phytoplankton of Inland Fisheries. *Proc. Symp. Algae*, p. 272-291. ICAR, New Delhi.

Siddiqi, S.Z. and Khan, R.A. 2002. Comparative Limnology of few man-made lakes in and around Hyderabad, India. *Rec. zool, Surv. India*, Occ. Pap. No. **203** : 1-64.

Zafar, A.R. 1966. Limnology of Hussainsagar lake, Hyderabad. *Phykos*, **5** : 115-126.