

Studies on Diatom Variations With Reference to Physico-Chemical Properties of Water of Hussain Sagar Lake of Hyderabad in Telangana State

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Abstract

Selected aspects of limnology and Diatom diversity of Hussain Sagar Lake were investigated during December, 2020 to December, 2021 to assess the water quality status with respect to management and conservation needs of this manmade lake. Three sampling stations (HSL-I, HSL-II and HSL-III) were chosen in the Lake. Some physical and chemical parameters (water temperature, total hardness, nitrate, nitrite, phosphate and pH) of water samples were measured. Total alkalinity in Hussain Sagar Lake of Hyderabad Metro city in Telangana State ranged between 3.0 to 3.4 mg/l total Calcium Hardness varied, Sulphate varied between 4.3 to 4.5 mg/l and Nitrate–nitrogen ranged between 0.3 to 0.5 mg/l. The Diatom community of Hussain Sagar Lake was diverse as evident from presence of fifty species representing Seventeen Genera including centric forms and pennate types. Among the notable diatoms recorded from this wetland were *Melosira granulata*, *Cocconeis placentula*, *Diatoma elongatum*, *Fragilaria crotonensis*, *Ghomphonema olivaceum*, *Ghomphoneis herculeanum*, *Nitzschia* sp. *Navicula radios* and *Synedra ulna* which appeared as the most dominant species and considered flourished well under poor water quality conditions. Mainly the present study had been made to know the diversity and distribution of diatoms. These Bacillariophyceae algae were identified based on their internal and external morphological characters. Almost all species were first new records for Hussain Sagar Lake, the present study could provide evaluating the impacts of diatomic algae resources caused by infrastructures in the future.

Keywords: Investigation, Morphological characters, Hussain Sagar Lake, New record, and Bacillariophyceae algae.

Introduction:

Algae that forms source of food and oxygen for heterotroph organisms in aquatic habitats affect directly primary productivity by forming first circle

of food chain. And also it's reported that the algae have a role in determining water pollution and cleaning waste water (Çolak and Kaya, 1988). In recent years algal indicators are effective in checking and observing tools. If the chemical monitoring is limited, the use of diatoms in monitoring would be valuable in remote locations subject to the pronounced change (Jüttner *et. al.*, 1996)

Algae are a large and diverse group of simple, typically autotrophic organisms, ranging from unicellular to multicellular forms. In aquatic ecosystems phytoplankton play an important role in the ecology of rivers through primary production. Studies on planktonic composition and physicochemical characteristics of water are necessary to acquire basic knowledge on the biodiversity status of a water body. Algal flora varies from season to season and an important feature of freshwater algal flora is cosmopolitanism. The phytoplanktonic study is a very useful tool for the assessment of water quality in any type of water body and also contributes to understanding of the basic nature of lake (Pawar *et. al.* 2006). The necessity of using phytoplankton as effective and appropriate method of bio monitoring for evaluation of river water quality has been emphasized (Annalakshmi and Amsath 2012).

Hussain Sagar Lake is the largest man-made lake in Asia, built on a tributary of the Musi River by Hussain Shah Wahi, under ruling of Ibrahim Quli Qutub Shah in the year 1562. The excessive inputs of nutrient load such as phosphates and nitrates received through sewerage, which lead to the growth of cyanobacterial algal blooms and aquatic weeds made Hussain Sagar water body a eutrophic lake. Eutrophication of the lake causes

decomposition of the aquatic weeds and algae, depletion of dissolved oxygen leading to massive fish kill (Kodarkar, 2004; Ranjan and Reddy, 2008; Suneela *et al.*, 2008; Unnisa and Narasimha Rao, 2007). In addition to sewage and effluents, twenty to thirty thousand idols made up of plaster of paris along with flowers and leaves are immersed every year during festivals, especially during September into the water of Hussain Sagar lake; thereby increasing the chemical and organic content of the

water and also leading to siltation (Ranjan and Reddy, 2008; Suneela *et al.*, 2008; Unnisa and Narasimha Rao, 2007). The lake has been classified as an urban wetland and listed in the wetland inventory of India by the Ministry of Environment and Forests, Government of India. Some part of the lake has been designated as wetland eco-conservation zone (ISRO, 2011, 2013; Javed *et al.*, 2008; Unnisa and Narasimha Rao, 2007)

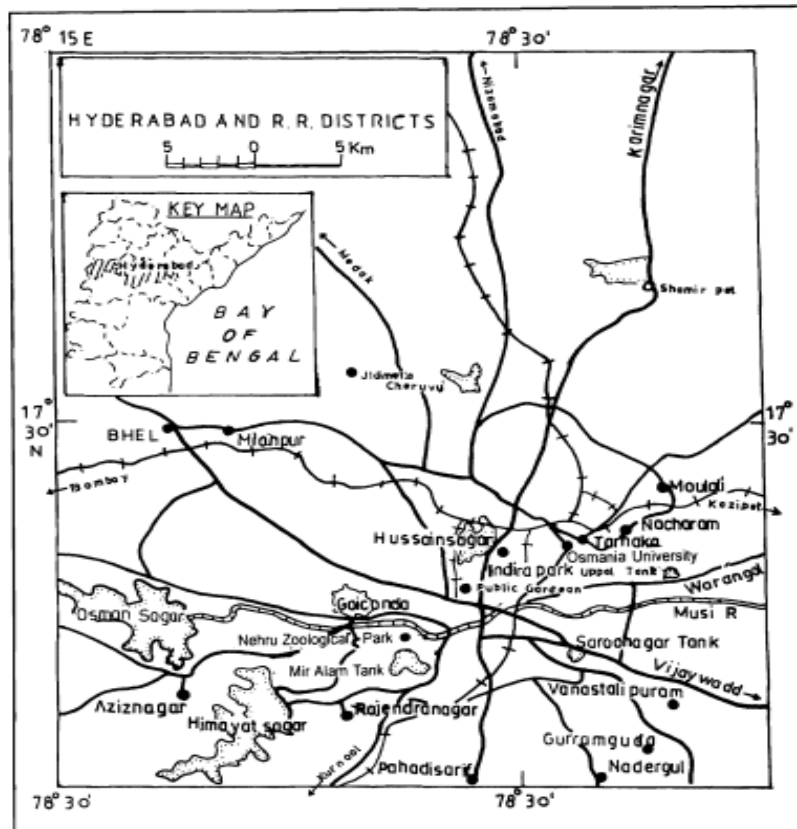


Figure 1: Map of Hyderabad and adjoining Ranga Reddy Districts showing location of different lakes and tanks in the region. Inset. Location of Hyderabad district in the state of Telangana

Our research attempted to investigate the Bacillariophyceae algae of the Hussain Sagar Lake ecosystem in order to develop a database of Hussain Sagar Lake algae as a potential bio resource, along with their respective habitat and taxonomic data. The

investigation was largely focused on the collection, preservation, identification, and strain maintenance of the algal flora obtained from various locations across Hussain Sagar Lake, as well as the preservation of germplasm.

Materials and Methods

Sampling sites

Hussain Sagar lake is located at 17.45°N 78.5°E, 510 m above the sea level. The lake connects the twin cities of Hyderabad and Secunderabad and it was originally used as a source of drinking and irrigation water during 1894–1930. The maximum surface area of the lake is 5.7 km², the present water spread area is 4.81 km², basin area is 240 km², shoreline length is 14 km, storage volume at spill level is 28.6 × 10⁶ m³, average depth at full capacity is 5.2 m and the road bund level is 5.18 m.

Collection of algal samples:

Materials and methods

For the collection of water and diatom samples one location was fixed in the lake (Fig. 1). Only surface water samples were collected for analysis of selected physicochemical parameters using one liter capacity plastic bottles during a period of thirteen months from December, 2020 to December 2021. The collected samples were immediately processed for measuring temperature, pH, alkalinity, free CO₂ and dissolved oxygen in the field whereas other parameters like EC, hardness, dissolved silicates, sulphate, orthophosphate and nitrate nitrogen were analyzed in the laboratory as per methodology for the assessment of physicochemical parameters given in APHA (1985) and Sharma and Saini (2003). For the study of diatom diversity of the lake, a known volume of water sample was filtered through plankton net of bolting silk no. 25 and preserved in Lugol's solution. Quantitative analyses of diatom samples were carried out in the laboratory using Sedgewick Rafter Cell. The diatoms were identified with the help of Edmondson (1959) and Weber (1971).

Preparation of Semi-permanent Slides

For Bacillariophyceae Algae a drop of glycerin formalin mountant (6 ml glycerin 10 ml of 40% formaldehyde + 84 ml of distilled water) was taken on slide, to which a drop of concentrated preserved sample was added and was covered by a cover slip of suitable size. MRA reveals that pH, temperature, carbonates, bicarbonates, Dissolved oxygen, Organic matter, Total hardness, Ca, Mg,

SO₄, SiO₂, NO, NO₂, and total solids together account for 66% of variance in diatoms. In the step down regression analysis a minimum of six factors viz. NO), Mg, pH, SO₄, and CO₂

Results:

Physicochemical characteristics

The observed physicochemical features of the lake showed notable variations as shown in (Table -1). Temperature The annual average surface water temperature of the lake was observed 17.0°C. Based on thermal classification of lakes (Das, 1989).

Hydrogen ion concentration

The pH value of the investigated water body was found to be on the alkaline side with an annual average of 7.8 units. The higher value of pH may be due to increased photosynthetic activities of phytoplankton and macrophytes triggered by the decomposition of excessive organic matter and inputs of sewage (Singh and Mahajan, 1987). This also coincided with the results of Pearsall (1930) and Zafar (1966) who concluded that the pH of water is dependent upon the relative quantities of calcium, carbonates and bicarbonates. The water tends to be more alkaline if it possesses carbonates and it is much less alkaline when it possesses large quantity of bicarbonates, carbon dioxide and calcium. A similar situation was noticed in the investigated water body.

Nitrate-nitrogen:

Nitrate generally occurs in trace quantities which is essential for many photosynthetic autotrophs and in some has also been identified as growth limiting nutrient (Prakash, 1994). Sharma *et al.* (1984) reported nitrate-N for unpolluted water (0.008 mg/l) and polluted water (0.165 mg/l) of Pichhola and Rang Sagar, respectively. In Hussain Sagar Lake, NO₃⁻N values varied between 0.0 to 0.106 mg/l with an annual average of 0.018 mg/l, thus affirming moderate level of pollution.

Calcium hardness Ohle (1934) categorized water body as 'rich' having calcium values >25 mg/l. Calcium hardness in Hussain Sagar lake varied between 3.0 to 3.4 mg/l with an annual average of 12.0 mg/l. The higher content of calcium in comparison to magnesium may be due to the fact that

CO₂ reacts more rapidly with calcium salts converting large quantities of calcium into soluble bicarbonates. This is further supported from the observed high values of bicarbonates in Hussain Sagar Lake. Carbonate alkalinity In Hussain Sagar Lake Carbonate alkalinity was altogether absent during study period as this absence of carbonate alkalinity coincides with presence of free CO₂ and bicarbonates

A total of fifty species representing Seventeen Genera including centric and pennate types was found in the three stations of Hussain Sagar Lake only the study period. September 2020 to January 2021 especially reported Bacillariophyta algal were the richest taxonomic group with 17 Genera 55 species taxa List of algae present in the phytoplankton and their occurrence at the three stations were given in (Table-2) Total organism numbers have almost show similar seasonal variations at HSL-1, HSL-II and HSL-III.

Carbonate alkalinity

In Hussain Sagar Lake carbonate alkalinity was altogether absent during study period as this absence

of carbonate alkalinity coincides with presence of free CO₂ and bicarbonates. Total alkalinity Phillipose (1960) suggested that a water body with alkalinity values >100 mg/l is nutritionally rich. High total alkalinity values of Hussain Sagar Lake indicate its high trophic status as in the present study the annual average value of total Calcium alkalinity was 3.4 mg/l.

Diatom diversity:

The diatom community of Hussain Sagar Lake was diverse and comprised of fifty species representing Seventeen Genera including centric forms and pennate types. The species composition and frequency of diatom community are shown in (Table-2). The predominant diatom species recorded from the investigated site were *Synedra ulna*, *Navicula* spp., *Gomphonema olivaceum*, *Diatoma elongatum*, *Nitzschia* spp., *Cocconies placentula* and *Fragilaria crotonensis*. The presence of these species is indicative of the enriched status of the water-body. According to Williams (1969) presence of *Fragilaria* sp. indicates the sewage pollution.

Table- 1 Range of physicochemical parameters recorded in the three stations; average of air temperatures (Av. A. Temp, average of air temperature (Av. A. temp.), average of water temperature (Av. W. temp.), pH, total hardness (German degree d°) (T. H.), nitrate(NO₃) and nitrite (NO₂)

Stations	Av. A. Temp.	pH	NO ₂ mg/l	NO ₃ mg/l	Ca,	Mg,	SO ₄ ,	Sio ₂ ,
HSL-1,	17.0	7.5-8	2	0.5	2.3	3.4	4.5	5.0
HSL-II	17.5	7.5-8	2.5	0.2	2.5	3.2	4.0	5.3
HSL-III	17.6	7.5-8	2.3	0.3	2.0	3.0	4.3	5.3

Discussion:

Bacillariophyta dominated in the plankton of the Hussain Sagar Lake and also in the plankton only Bacillariophyta division always recorded at all stations. The diatom community of Hussain Sagar Lake was diverse and comprised of fifty species representing Seventeen Genera including centric forms and pennate types. The species composition

and frequency of diatom community are shown in (Table-2). The predominant diatom species recorded from the investigated site were *Synedra ulna*, *Navicula* spp., *Gomphonema olivaceum*, *Diatoma elongatum*, *Nitzschia* spp., *Cocconies placentula* and *Fragilaria crotonensis*. The presence of these species is indicative of the enriched status of the water-body.

Table- 2 Bacillariophyceae algal species diversity recorded in the three stations of Hussain Sagar Lake, Hyderabad Metro City in Telangana State

Sl. No	Name of the Genera	Name of the Species	Number of Species
1	Amphora	ovalis	01
2	Caloneis	amphisbaena	01
3	Cocconeis	Placentula and pediculus	02
4	Cyclotella	atomtus, glomerata and bodanica	03
5	Cymbella	affinis, turgida, tumida, aspera, cymbiformis and rigida	06
6	Diatoma	Vulgare, anceps and elongatum	03
7	Fragilaria	crotoneinsis	01
8	Fragilaria	capucina	01
9	Ghomphonema	Olivaceum, montanum lanceolatum, Intricatum angustatum, constricticum and herculeanum	07
10	Melosira	Granulate and herozogii	02
11	Navicula	radiosa, viridula, cryptocephala cuspidate, canalis, bacillum, pupula and hungarica	08
12	Neidium	dubium	01
13	Pennate	forms	01
14	Nitzschia	Apiculata, acicularis, holsatica, elliptica, dissipata, angustata, denticulate and paradoxa	08
15	Rhopalodia	gibba.	01
16	Synedra	ulna, acusm and palchella	03
17	Surirella	angustata	01
	Total		50

Fig-I Investigation on aquatic diatoms of Hussain Sagar Lake Bacillariophyceae algal species diversity recorded in the view of Three Stations (a, b and c).

According to Williams (1969) presence of *Fragilaria* sp. indicates the sewage pollution while Benson (1967) and Vollenweider (1968) consider *Fragilaria crotoneinsis* to indicate eutrophy. Lowe (1972) considers *Synedra ulna* as eutrophic species. According to Dickman (1975) *Cymbella*, *Fragilaria capucina*, *Diatoma elongatum*, *Gomphonema olivaceum* and *Cocconies placentula* are commonly

found in organically polluted waters. Richardson (1968) considers *Nitzschia* spp. to be characteristics of organically rich waters and Sommerfeld *et. al.*, (1975) consider it to be a typical eutrophic species. Lowe (1974) reported that *Melosira granulata* is favoured by sewage effluents. Further, considering the observed numbers of Centric and Pinnate diatoms Nygaard's trophic State Index was found to be 0.235 which is approaching the upper limit of oligotrophy. However, apparently Hussain Sagar Lake is eutrophic as evident from water quality and recorded species of diatoms.

The taxonomic composition of freshwater algae collected from different stations is presented in (Table- 1 and 2). Out of fifty species representing Seventeen Genera including centric forms and pennate types identified species, (especially in First station) is greatly influenced by water conditions and physico-chemical parameters. Resulted the decline of algal density and physico-chemical parameters. (Rajagopal, 2010; Pundhir and Rana, 2002). According to several previous studies (Wu and Chou, 1999; Richardson *et al.*, 2000; Ersanli and Gönülol, 2003; Tyor and Chawla, 2012) the seasonal variations of phytoplankton are related to different environmental factors especially temperature (water and air temperatures) that regulate the growth and distribution of these organisms (Thebault and Rabouille, 2003).

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