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DIATOMS AS PROXY FOR PALEO STUDIES : A CASE STUDY FROM KRP

R. RAMANIBAI[a1] AND S. RAVICHANDRAN[b]

[a]Department of Zoology, University of Madras, Guindy Campus, Chennai, India
[b]Centre For Water Resources, Anna University, Chennai, India

ABSTRACT

Benthic algae play a significant role in food webs and also used for observing long term trends in community changes that can occur because of nonpoint source of pollution. Diatoms which occur in large numbers and are well preserved due to the presence of frustules Their distinctive characteristic feature is the possession of siliceous cell walls, used to define and classify species conformity. Since silica resists against degradation, diatoms are well preserved in fresh water as well as marine sediments. The persistence of diatom frustules in the reservoir environment enables prehistoric conditions to be constructed based on the narrow ecological preferences of most species. The present study reveals the distribution and abundance of diatom community of Krishnagiri reservoir utilize for agricultural purposes along with domestic needs. Surface water and sediment samples were collected through PVC pipe and the sediment samples were sliced into 3 sections with the 5 cm intervals. Each section was sieved into 2 fractions using 50 µm and 120 µm sieve. Water quality parameters were also analyzed using standard methods. Sediment diatom samples were preserved in 4 % formalin. Specimens were identified with the help of authentic literature. Totally 24 diatom species were identified. Morphometric measurements were taken. Abundance and distribution of sediment diatoms at different locations of Krishnagiri reservoir were estimated. Our data provide valuable information about the distribution and abundance of diatoms present in KRP dam. The regulation of the inflow and outflow of this dam influences various physicochemical variables in turn shaping the diatom community structure.

KEYWORDS : Diatoms, Paleo Studies, Benthic

Reservoirs are the important freshwater sources for mankind. It provides a suitable habitat for a large and diverse community adapted to this dynamic habitat, involving close interaction between organisms and the physical and chemical characteristics of the system. Increasing population growth , industrialization, urbanization and modernization of agriculture practices together contributed towards the deterioration of freshwater resources. Subsequently, the quality of reservoir is affected mainly by the depletion of oxygen level and the enormous growth of nuisance of algal bloom finally resulted in the loss of biodiversity of a reservoir. Irrigation has always been motive force behind the construction of dam. Recently concern over the role of environmental impacts on surface water of a variety of water bodies has increased drastically (Stevenson and Pan, 1999; Sukumaran et al., 2008).

Depth analysis of the benthic organisms in terms of diversity, relation with environmental conditions can be used to understand the drastic changes occurred in the environment (Ahmad and Singh, 1993; Ajiar et al., 2009). Benthic diatoms play an important ecological role in carbon dioxide reduction from the atmosphere and oxygen production, which help in controlling global warming. These organisms act as producers in aquatic ecosystems, especially of food for heterotrophic benthic organisms (Lee, 1999). Benthic diatoms are useful in the biodiversity study because they can be found in many substrates in the water and could tolerate different environments.

Diatom valves or skeletons are made up of silica, which preserves well over time with minute disturbance (Eloranta and Soininen, 2002). Diatoms are quite detailed in structure and can be identified upto genus and in most cases upto species level. Diatoms are single-celled microscopic organisms of the class Bacillariophyceae. In ecological studies of diatom communities, the valves are used as a taxonomic tool. Systematically there are two groups of diatoms, the radially symmetrical centric diatoms and the bilaterally symmetrical pennate diatoms. Diatoms serve as an important tool in the study of reconstruction of the paleo limnology and paleo climate conditions of large lakes , because they are highly sensitive to climate induced changes in lake ecosystem. In this paper, we present the observations done on the diversity of benthic diatoms and the physico-chemical properties of water and the sediments of Krishnagiri reservoir. The indicative species like *Cyclotella meneghiniana, Gyrosigma* spp., *Nitzschia* spp., *Cymbella* spp. *Navicula* spp. were present in all locations and in upper and bottom sediment fractions. Their presence indicated the eutrophic condition of the dam water.

[1]**Corresponding author**

MATERIALS AND METHODS

Study Area

History and Morphometric of Krishnagiri Reservoir

Krishnagiri dam is located in Krishnagiri Dharmapuri district of Tamil Nadu at the latitude of 12°28' North on the longitude of 78º11' East. The Krishnagiri dam was constructed across the Ponnaiyar River (also called as Ponnaiyar) near Periyamuttur village about 10 km from Krishnagiri town. The reservoir has two main canals, one on the left side called Left Main Canal (LMC) and other on the right side Right Main Canal (RMC) running almost parallel to the Ponnaiyar River.

The Ponnaiyar takes its source near Nandi durga in Karnataka of Chennakesava hills. It is known as Dhakshina Pinakini in Karnataka. It enters Tamil Nadu at places near Bagalur village in Hosur taluk. The river is called Ponnaiyar from this point of Tamil Nadu. It is located at latitude of 12º28'N and longitude of 78º11'E. Irrigation projects are constructed across Ponnaiyar Kelavarapalli reservoir project Krishnagiri reservoir project and Sathanur reservoir project. The reservoir is being used for multipurpose utility such as irrigation, fishing and washing. The main sources for nutrients are from rivers, soil erosion etc and enrichment of organic matter from sediments in an important source for the lakes water eutrophication (Gold et al., 2002). (Figure, 1).

Field Work

The field work was carried out from January to December 2010. Four sampling locations were selected in the KRP. The location L1 is the inflow point, location L2 is the mid flow point, L3 is the out flow point and L4 is the area near dam wall of the reservoir. The sediment samples were transferred immediately in to zip lock bags to avoid the oxidation of sediment samples. The samples were stored at 5ºC in an ice box and carefully transferred to the laboratory.

Figure 1 : Satellite Imagery of Krishnagiri Reservoir

Laboratory Analyses

Surface water samples were collected in clean polypropylene containers of 1 litre capacity and transported to the laboratory for the analysis of physico-chemical and biological parameters. Sediment samples were collected by PVC corer to a depth of 20 cm and preserved in 4% formalin for further analysis. All the parameters were measured for all sediment and water samples collected from four locations. All analyses and extractions were done in duplicate.

Preparation of Diatoms

Detailed diatom studies were done following hot HCl and $KMnO_4$ method (recommended technique of acid digestion) by. The benthic diatom samples were identified at a magnification of 400 x and 1000 x. Photographs were taken using Nikkon upright microscope.

RESULTS

An increase in the level of temperature was noticed from the month of January to May and slow decrease in its level started from June to September. The minimum temperature was noticed in the month of November and December. The temperature ranged between 21 -28.5 °C. The pH values showed its neutral condition started from 7.7 to highly alkaline up to 10. 2. The alkaline status remained throughout the study period. The monthly TOC concentration ranged between 3.2 and 5.4 mg/g where the maximum quantity estimated during the month of December. The monthly average phosphate level was found to be fluctuated between 0.287 and 1.369 mg/g. The phosphate level was increased during rainy season this may be due to the runoff from the agricultural fields. The nitrite concentration showed more or less uniform distribution pattern among the locations, concentration was varied between 0.345 and 1.439 mg/g. (Table, 1)

Based on the morphological structures a total

Table 1 : Physico Chemical Parameter of KRP Dam

S.N.	Parameters	Nov	Dec	Jan	Feb	Mar	Apl	May	June	July
1	Temperature	21	21	24	25.7	27.8	28	28.5	24	24.8
2	pH- Sediment	8.1	10.2	9.9	7.7	10	8.7	9	9.5	7.8
3	Phosphate sediment	0.519	1.349	1.298	1.369	0.421	0.287	0.376	0.312	0.342
4	Nitrite sediment	0.35	0.269	0.19	0.446	1.156	0.967	0.732	1.439	1.438
5	TOC %	4.2	5.4	5.9	4	4.5	3.4	3.2	3.9	4

Table 2 : Diatom Species in Sediment Samples From KRP Reservoir During Nov 2010- July 2011 (Upper Fraction)

S. N.	Upper fraction
1	*Aulocoseria* sp
2	*Cyclotella meneghiniana*
3	*Cyclotella glomerulata*
4	*Melodira granulate*
5	*Melosira distans*
6	*Gyrosigma accuminatum*
7	*Stauroneis phonicenteron*
8	*Staurosirella leptostauron*
9	*Stauroneis* sp
10	*Navicula protracta*
11	*Navicula cuspidate*
12	*Navicula cari*
13	*Nitzschim amphiba*
14	*Cyclotella glomerulata*
15	*Gymphonema vastum*
16	*Synedra rumpens*
17	*Fragilaria intermedea*
18	*Fragilaria cuspidata*
19	*Cymbella tumida*
20	*Cocconeis placentula*
21	*Achnanthes* sp
22	*Actinella* sp
23	*phonecenteron* sp
24	*Cocconeis placentula*

Table 3 : Diatom Species in Sediment Samples From KRP Reservoir During Nov 2010- July 2011 (Bottom Fraction)

S. N.	Bottom fraction
1	*Frustulia vulagris*
2	*Cymbella tumida*
3	*Gomphonema subtile*
4	*Gomphonema vastum*
5	*Fragilaria brevistriata*
6	*Aulocoseira* sp
7	*Frailaria intermedia*
8	*Nitzschia ignorta*
9	*Nitzschia amphibia*
10	*Pinnularia viridis*
11	*Pinnularia gibba*
12	*Pinnularia interrupta*
13	*gomphenema lanceolatum*
14	*Synedra ulna*
15	*Cocconeis placentula*
16	*Cyclotella glomeculata*
17	*Staurosirella leptostauron*
18	*Navicula dicephala*
19	*Navicuala cocconeiformis*
20	*Navicula cuspidata*
21	*Stauroneis phoenicenteron*
22	*Gyrosigma distortum*
23	*Melosira granulata*
24	*Fragilaria capucina*
25	*Cyclotella menaghiniana*
26	*Actinella* sp
27	*Eunotia* sp
28	*Melosira granulata*
29	*Cyclotella kutzingiina*

number of 53 species were identified from the sediment core sample (Table, 2 and 3). They belong to the orders of Aulacoseirales, Thalassiosirales, Fragilariales, Achnanthales, Cymbellales, Mastogloiales, Naviculales, Bacillariales, Rhopalodiales, and Eunotiales. Two species of centric diatoms were observed in the upper fraction namely *Cyclotella glomerulata* and *Cyclotella meneghiniana*, the rest of other species are belonging to Pennate. In the bottom fraction 26 pennate diatoms along with three centric diatom (*Cyclotella glomerulata, Cyclotella kutzingiana and Cyclotella meneghiniana*) were recorded .Species like *Achnathes bory*, *Cymbella cistula*, *Navicula fulva, Pleurosigma salinarum* and *Tahellaria* spp were rarely found at upper fraction and these diatoms were

totally absent in bottom fraction. In the bottom fraction *Cymbella ventricosa*, *Fragilaria brevistriata, Gomphonema subtile, Nitzschia sigma, Pinnularia interrrupta* and *Rhopalodia musculus* were occasionally present, but these were not recorded in the upper fraction. Species like *Aulocoseira* sp, *Navicula cuspidata*, *Cyclotella glomerulata* and *Fragilaria intermedia* were evenly distributed in all the location's upper fraction but this trend was not found in bottom fraction.

Percentage Composition of Diatom Species in Upper Fraction

The species like *Navicula caspidata*, *Gomphonema* spp., *Aulocoseira* spp., *Nitszchia amphibian* and *Frustulia vulgaris* were frequently present in location one throughout the study period and their percentage composition were calculated as 33% of *Navicula cupsidata, Gomphonema* spp. recorded as 21%, 16% of *Aulocoseira spp*. were observed at loc 1, *Nitzchia amphibia* and *Frustulia vulgaris* were recorded as 15%. At Location 2, 24% of Eunotia spp were recorded. In case of *Pleurosigma sp* and *Gyrosigma spp*. there was no such differences were observed, they were recorded as *Pleurosigma* spp. - 21% and Gyrosigma spp. - 20%. *Fragilaria spp*. and *Navicula fulva* as 18%. In location 3, *Aulocoseira* spp. and *Nitzchia ignorta* contributed 27%, and *Fragilaria capucina* as 12.2% and *Navicula cuspidata* contributed up to 22%. At location 4, *Pinnularia viridis* as 29%, *Gyrosigma kutzingii* and *Staurosirella leptostauron* as 24% and *Cyclotella glomerulata* were recorded as 22%.

Percentage Composition of Diatom Species in Bottom Fraction

The percentage composition of Diatom species at location 1 were recorded as 34% in case of *Nitzchia paleo, Frustulia vulgaris* as 23%, *Cymbella tumida* as 22% and *Aulocoseira granulata* as 21%. At Location 2 *Cocconeis placentula* contributed 29%, *Cyclotella kutzingiana* as 25%, *Gyrosigma acuminatum* as 22% and *Fragilaria brevistriata* as 24%. At Location 3 *Aulocoseira spp* observed as 28%, *Cyclotella kutzingaiana* as 28%, *Stauroneis phonicentreron* recorded 22% and *Navicula cari* contributed as 22%. *Cyclotella kutzingaiana* (26%), *Stauroneis phonicentreron* (26%) and *Navicula cari* (22%) were noted at location 4 during the study period.

The indicative species like *Cyclotella meneghiniana*, *Gyrosigma spp.*, *Nitzschia spp.*, *Cymbella spp. Navicula spp.* were present in all locations and present both in upper and bottom fractions. These species indicates that the lake was eutrophicated.

DISCUSSION

The alkaline nature of the Dam water prevailed throughout the study period was similar to the observations made by (Pandey et al, 1998; Patrick, 1973). They reported that the pH values above 8 in natural waters influenced through photosynthetic activity which demands more CO_2 than quantities furnished by respiration and decomposition. The pH of the water also depends on the relative quantities of calcium, carbonates and bicarbonates. The main source for alkalinity is obtained from soaps and detergents, used by the local residents for bathing and washing purposes at Krishnagiri Reservoir.

Low input of nitrogen and phosphorous appears to limit the phytoplankton productivity. The data showed that phosphate concentration decreased quickly with an increase in phytoplankton abundance, and in most cases phosphate concentration was lower than the level where phytoplankton is limited (Round, 1991a & b). High plankton count and high phosphate content were noticed in KRP dam. The highest concentration of phosphate showed the eutrophication nature of KRP dam. Temperature is an important factor which regulates the biogeochemical activities in the environment. The variation in water temperature in present investigation may be due to the difference in sampling time and the effect of season (Schoeman and Haworth, 1986; Wetzel, 1983). Low dissolved oxygen content and high amount of organic nitrogen present in the Krishnagiri reservoir was interesting to note and when compared to the present conditions, the reservoir appear highly eutrophicated. The presence of suspended organic matter in this reservoir may also serve as a causative factor for the depletion of oxygen.

The study of sediment samples of KRP shows the presence of few centric diatoms in some location to total absence in some locations. Thus, it indicated stressful environments of the Krishnagiri Reservoir. Therefore, it can be summarized that the Krishnagiri reservoir may be less

productive some decades ago, with less supply of nutrients. However, due to urbanization and human-induced pollutants, the reservoir now became more productive. The same situation was observed by (Ahmad and Singh, 1993) and (Ajair et al., 2009). There is a high abundance of *Gomphonema parvulum*. *G. parvulum* is known to be tolerant to several forms of pollution and indicates disturbed conditions.

From the present investigation it could be noted that phytobenthos population of the reservoir is closely related with seasonal variation in hydrography. The variability of water, sediment, quality and benthic diatom diversity are not controlled by a set of environmental factors which are very much interrelated. These are of catchment land use factors. The study of fresh water ecosystem should be carried out on a regular and continual basis in order to assess the trends and influential parameters correctly and needs to be taken up as long duration study.

CONCLUSION

At present, the lake has eutrophic status and is at the verge of degradation. Further studies are needed for micro-level identification of age and the palaeotrophic status based on diatom transfer function and radiometric dating (210Pb and 137Cs).

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