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Diversity and Spacio-temporal Abundance of Phytoplankton in Vanivilas Sagar Reservoir, Chitradurga, Karnataka

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Abstract: The diversity and sectoral abundance of four selected phytoplankton groups have been studied in Vanivilas Sagar Reservoir. Altogether 46 species of phytoplankton were recorded during the study period. The Cyanophyceae are represented by 8 genera, Chlorophyceae by 17 genera, Bacillariophyceae by 11 genera, and Euglenophyceae by 2 genera. The sectoral distribution of total phytoplankton indicated their highest distribution at sector I (35.57%) followed by sector II (34.52%) and sector III (29.90%). Spacio-temporal abundance indicates all the four groups of phytoplankton recorded their peak abundance during the pre-monsoon period in all three sectors.

Keywords: Vanivilas Sagar Reservoir, Phytoplankton, Diversity, Abundance

I. INTRODUCTION

Phytoplankton is floating microscopic autotrophs whose movements are more or less dependent on water currents. They are the primary producers in an aquatic system and vital link in the aquatic food chains. They play a phenomenal role in the biosynthesis of organic material. The spatial-temporal variation in phytoplankton provides information necessary for the proper understanding of the reservoir fishery resources. Their estimates provide good indices of water quality and the capacity of water to sustain heterotrophic communities. They are considered as an index of fertility. With solar energy, the phytoplankton works as factories of life. They fix and transform the sun's energy into the living substance, the protoplasm. Hence, for any scientific utilization of water resources phytoplankton study is of primary interest. In India, the studies of phytoplankton in reservoirs were conducted by many workers [1][2][3][4]. In the present study diversity and Spatio-temporal abundance at three zones in the reservoir were investigated and discussed.

II. MATERIALS AND METHODS

Study Area and Zonal demarcation: The VV Sagar Dam is constructed across the Vedavathi river near Marikanive village in Hiriyur Taluk of Chitradurga district during the year 1897 to 1907. The Vedavathi river is a tributary to the Krishna river. The main object of the VV Sagar Project is to provide irrigation facilities in the drought-prone areas of the Chitradurga district. For sampling, the reservoir was arbitrarily divided into three sectors. Sector I corresponds to the dam area characterized by deeper and stagnant water conditions. Sector III is the confluence point of the reservoir with shallow and flowing waters. The zone in between sectors I and II was marked as sector II. In each sector, two sampling centers were identified opposite each other one on either bank (Fig.1).

Population density: The phytoplankton samples were collected from the three zones of the reservoir at monthly intervals from February 2000 to January 2002. About 50 liters of water was filtered through a nylon bolt with a mesh size of 55 km (No. 25). The estimation of population density was carried out for four groups of phytoplankton viz., Blue greens (Cyanophyceae), Green algae (Chlorophyceae), Diatoms (Bacillariophyceae), and Euglenoids (Euglenophyceae) using the Sedgewick rafter cell method [5][6]. Using a good number of replicates, the average count per milliliter was determined, which was converted to their number per liter (organisms/l) and expressed as percentage abundance.

Qualitative analysis: The identification of phytoplankton was carried out up to a generic level with the help of monographs and other published literature [7][8][9].

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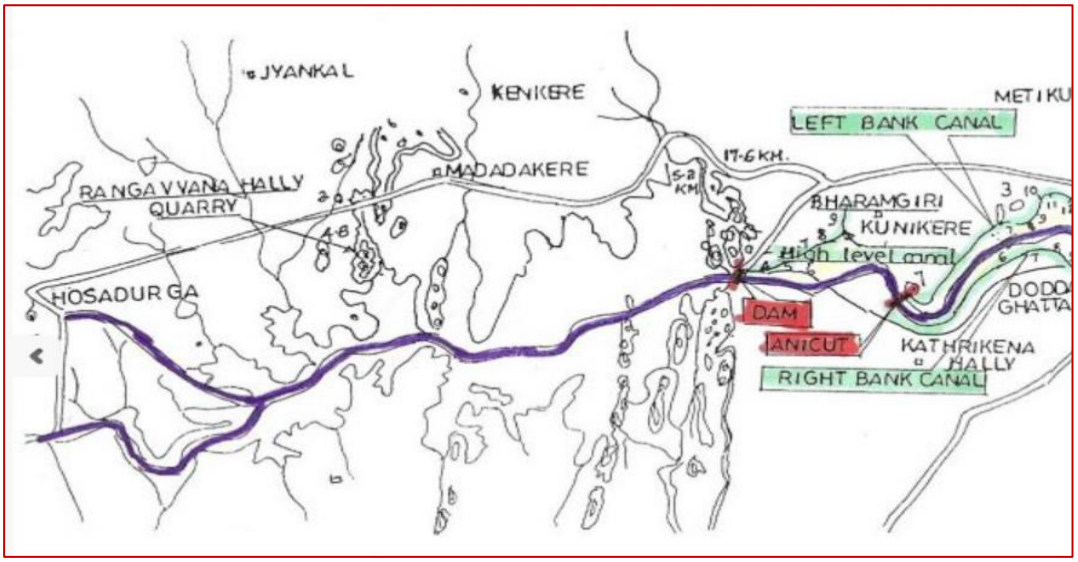

Fig. 1 Vanivilas Sagar Reservoir with sectoral demarcation

III. RESULTS

Diversity: Altogether 46 species of phytoplankton were recorded during the study period from the different sectors of the reservoir. The total phytoplankton was represented by the four groups of algae viz., the blue-green represented by Cyanophyceae, green algae represented by Chlorophyceae, the diatoms represented by Bacillariophyceae, and euglenoids represented Euglenophyceae. The Cyanophyceae were reported by 8 genera, Chlorophyceae by 17 genera, Bacillariophyceae by 11 genera, and Euglenophyceae by 2 genera. Among Cyanophyceae, Microcystis sp., Oscillatoria sp., Lyngbya sp., and Anabaena sp. were present throughout the study period. Whereas Spirulina sp. was found only during the rainy season. Microcystis remained dominant in all the seasons in all the sectors of the reservoirs.

Cyanophyceae: Microcystis aeruginosa, Microcystis incerta, Oscillatoria limosa, Lyngbya sp., Spirulina major, Anabaena sp., Merismopedia sp., Phormidium inudatum, Chroococcus sp.

Chlorophyceae: Chlorella vulgaris, Ankistrodesmus convolutes, Tetracladus sp., Scenedesmus quadricula
Scenedesmus opoliensis, Pediastrum simplex, Pediastrum duplex, Closterium lanceolatu, Closterium ehrenbergii, Eudorina sp., Pandorina sp., Spirogyra punctiformis, Ulothrix sp., Spirogyra rectangularis,
Desmidium greviellei, Cosmarium granatum, Staurastrum gracile, Euastrum pulchellum, Zygnema cylindricum
Oedogonium hians.

Bacillariophyceae: Fragilaria pinnata, Diatoma sp., Synedra capitata, Navicula exigua, Navicula angulatum, Pinnularia divergens, Pinnularia parva, Pinnularia termes, Amphora ovalis, Gomphonema gracile, Melosira granulate, Melosira sp., Nitzrchia acicularis.

Euglenophyceae: Euglena polymorpha, Euglena tuba, Euglena viridis, Phacus sp.
Among Chlorophyceae, Chlorella sp., Ankistrodesmus sp., and Scenedesmus sp. were present throughout the study period. Of which, the previous two species were in higher quantity during the rainy season. Whereas, the last one was in higher quantity during the post-monsoon period. Kirchneriella sp. was observed during monsoon and post-monsoon seasons. Pediastrum sp. was observed only during monsoon season. Whereas, Tetroclodus sp., and Closterium sp., appeared only during the post-monsoon period. Fragillaria sp., Navicula sp., Gomphonema sp., and two unidentified species were the members of Bacillariophyceae observed throughout the study period. Whereas Pinnularia sp. was observed during pre-monsoon and monsoon seasons. Diatom sp. and Amphora sp. were observed during monsoon months only. Among Euglenophyceae, only two genera were observed viz., Euglena sp. and Phacus sp. of which former was dominant and found throughout the study period in all the sectors of the reservoir.

Spacio-temporal abundance: The sectoral distribution of total phytoplankton indicated their highest distribution at sector I (35.57%) followed by sector II (34.52%) and sector III (29.90%). The sectoral and seasonal variation of different phytoplankton groups is presented in Table I. All the four groups of phytoplankton recorded their peak abundance during the pre-monsoon period at sectors I, II, and III (42.54%, 38.82%, and 38.00%) of the reservoir. On the other hand, during

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monsoon season-low density was registered i.e., 28.48%, 28.63%, and 29.13% at sectors I, II, and III respectively. During post-monsoon months all the phytoplankton groups were found to be recovered concerning their density to 28.06%, 32.55%, and 32.86% at sectors I, II, and III respectively. The seasonal trend indicated the highest distribution during pre-monsoon followed by post-monsoon and monsoon seasons.

Among the four groups of phytoplankton, the Cyanophyceae (39.50%) formed the total bulk of phytoplankton standing crop followed by Chlorophyceae (30.18%), Bacillariophyceae (27.09%), and Euglenophyceae (32.2%) in the entire stretch of the reservoir (Fig.2).

Cyanophyceae: It constituted the most important group in terms of density and abundance at all the sectors of the reservoir during all three seasons. The percentage contribution of the group to the sectoral total phytoplankton was 40.40%, 38.73%, and 39.16% at first, second, and third sectors respectively. The seasonal abundance of the group at sector I was 15.99%, 11.09%, and 13.32% during pre-monsoon, monsoon, and post-monsoon seasons respectively. Similarly, at sectors II and Ill, the graph contribution was 15.15% and 15.54% during pre-monsoon, 10.62% and 10.58% during monsoon, and 12.98% and 13.04% during post-monsoon seasons.

Chlorophyceae: This group was found to be the second largest in terms of density. The percentage contribution of the group to the sectoral total phytoplankton was 30.04% (sector I), 30.36% (sector II), and 30.22% (sector III). The seasonal abundance of the group at sector I was 13.23%, 8.95%, and 7.86% during pre-monsoon, monsoon, and post-monsoon seasons. A second sector, the contribution of the group was 11.64% (pre-monsoon), 9.35% (monsoon) and 9.37% (post-monsoon). Similarly in the third sector also, the group contribution was 11.88%, 9.06%, and 9.28% during pre-monsoon, monsoon, and post-monsoon months respectively. The periodicity of the group followed the Cyanophycean trend.

Bacillariophyceae: This group was found to be the third one in terms of abundance. The percentage contribution of the group to the sectoral total phytoplankton was 26.63% (sector I), 27.63% (sector II), and 27.08% (sector III). The seasonal abundance of the group at sector I was 12.24%, 7.53%, and 6.86% during pre-monsoon, monsoon, and post-monsoon seasons respectively. At this sector, the density gradually decreased from pre-monsoon to post-monsoon periods taking a deviation from Cyanophycean and Chlorophycean trend, but at sector II and III, the group was represented by 10.73% and 9.31% (pre-monsoon), 7.76%, and 8.44% (monsoon and 9.14% and 9.33% (post-monsoon), indicating Cyanophycean and Chlorophycean trend.

Euglenophyceae: The density and diversity of the group are very low in the reservoir. The percentage contribution to the sectoral total phytoplankton was just 2.91%, 3.26%, and 3.53% at sectors I, II, and III respectively. The seasonal abundance of the group at sector I was 1.08%, 0.91%, and 0.92% during pre-monsoon and post-monsoon seasons. Similarly, at sectors II and III the contribution of the group was 1.30% and 1.27%; 0.90% and 1.05% and 1.06% and 1.21% during pre-monsoon, monsoon and post-monsoon seasons" respectively. As far as periodicity is concerned the group followed the cyanophycean trend.

IV. DISCUSSIONS

The phytoplankton constitutes a vital link in the aquatic food chains. They play a phenomenal role in the biosynthesis of organic material. The spatial-temporal variation in phytoplankton provides information necessary for the proper understanding of the reservoir fishery resources. However, it is well established that, composition and abundance of phytoplankton are greatly regulated by Physico-chemical and biological factors (Gulati, 1984). The diversity and abundance of phytoplankton in Indian reservoirs have been well studied by Sugunan, (1989); Devaraj et al., (1988); Govind et al., (1990); Adholia and Vyas, (1992); Sharma and Gupta, In Peppara, maximum abundance was noticed coinciding with minimal mean depth, inflow, and outflow. Sabu and Abdul (1988) working on the phytoplankton of Mettur reservoir, Sreenivasan, (1969) observed a similar trend. Sugunan (1980) while working on Nagarjun Sagar reservoir, made it clear that the annual water renewal plays an important role in the seasonal succession of phytoplankton. The phytoplankton cycle more or less conforms to a general pattern of aestival (pre-monsoon) and autumnal (post-monsoon) seres, punctuated by the hiemal (monsoon) minima. This observation holds well in the present study also. A similar trend of distribution was reported from other Indian reservoirs. Govind (1963) demarcates three seasons based on plankton abundance in the Tungabhadra reservoir. They are the productive period (pre-monsoon), retardation period (monsoon), and recovery period (post-monsoon).

Group dominance: Numerically Cyanophyceae represented by Microcystis aeruginosa dominated the phytoplankton population in the reservoir under study throughout the year. However, the diversity of the group is very poor with a negligible sectoral variation. The second dominant group was found to be Chlorophyceae, which was rich in diversity.

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Cyanophyceae and Bacillariophyceae as the dominant groups in the Badua reservoir [11]. The Microcystis aeruginosa constituted the bulk of the Cyanophyceae. The other members of the group are Merismopedia sp., Anabaena sp., and Gloeocapsa sp. The phytoplankton in Konar is characterized by poor species diversity and the overwhelming dominance of Microcystis aeruginosa [12]. Similarly, Cyanophyceae are represented by Microcystis sp. dominating the phytoplankton in Rihand reservoir and recorded occasional appearance of Chlorophyceae and Bacillariophycean members [13]. The Phytoplankton community of Amaravathy reservoir affected the indigenous fish population due to Microcystis dominated plankton and almost all indigenous species of commercial value disappeared [14]. In Idukki reservoir, a poor crop of Phytoplankton and the Cyanophyceaean members are found to be scanty [15]. Phytoplankton community of Mettur reservoir predominantly with diatoms with the occasional presence of blue-greens. Chlorophyceae and Cyanophyceae form the major bulk of phytoplankton contributing 24.4 and 18.6% to the total plankton respectively [16]. However, no such trend was noticed in the reservoir under study.

Seasonal abundance: The examination of seasonal trend indicated the highest abundance in pre-monsoon followed by post-monsoon and monsoon periods. The studies made by ClFRl in the Aliyar reservoir reveal that the abundance of phytoplankton is related to the water level, the low mean depth favors high density and when the depth was high, there were no blooms [17]. In the reservoir under study, the seasons having higher mean depth matched with low density of phytoplankton. During monsoon season with more inflow, a low density of phytoplankton was noticed. Maximum phytoplankton abundance during the pre-monsoon season in the Bhavanisagar reservoir [18].

Sectoral distribution: The analysis of the sectoral distribution of phytoplankton indicates the undisturbed bays at the lentic sector with a rich bloom of Microcystis aeroginosa. The deep lentic sector has diatom blooms in summer. The sectoral variation in diversity and composition is discernible. The fluviatile sector exhibited a rich variety of algae but numerically was poor. The lentic waters especially in bays have blue-green algae in blooms with low diversity [1]. The peak abundance in phytoplankton was recorded in the intermediate sector of the Konar reservoir [12]. Higher phytoplankton density in the lentic sector of the Getaslud reservoir, suggesting a subdued production process at the main reservoir due to lack of autochthonous enrichment [19]. In Peppara reservoir, phytoplankton abundance was maximum in the lotic zone followed by intermediate and lentic zones [3]. However, in the present investigation, a reverse trend was observed.

Trophic status: With the work of many authors on reservoir ecology, it was well established that some species of phytoplankton act as indicators of eutrophy. Initially, the Bhavanisagar reservoir had very high plankton diversity, later blooms of Microcystis have become a common feature accompanied by a substantial reduction in diversity [20]. The fall in diversity and increase in the dominance of lentic species, apart from indicating organic enrichment, suggested a transient eutrophication stage through which the reservoir is passing. Therefore, it is inferred that due to the dominance of Microcystis aeruginosa in all the sectors during all the seasons and the reservoir has already reached eutrophic status. The presence of Microcystis sp., Anabaena sp., Melosira sp., and Ceratium sp. among the plankton is an indication that the reservoir is on its road to eutrophication [21]. Whereas, studies on Hemavathy reservoir suggest that the density and composition of the plankton do not reflect any eutrophic tendencies in the reservoir ecosystem [22]. However, the present investigation contradicts this report.

TABLE I. SEASONAL ABUNDANCE (%) OF PHYTOPLANKTON GROUPS

Season	Cyanophyceae	Chlorophyceae	Bacillariophyceae	Euglenophyceae
Sector-I				
Pre-monsoon	15.99	13.23	12.24	1.08
Monsoon	11.09	8.95	7.53	0.91
Post-monsoon	13.32	7.86	6.86	0.92
Sector-II				
Pre-monsoon	15.15	11.64	10.73	1.30
Monsoon	10.62	9.35	7.76	0.90
Post-monsoon	12.98	9.37	9.14	1.06
Sector-III				
Pre-monsoon	15.54	11.88	9.31	1.27
Monsoon	10.58	9.06	8.44	1.05
Post-monsoon	13.04	9.28	9.33	1.21

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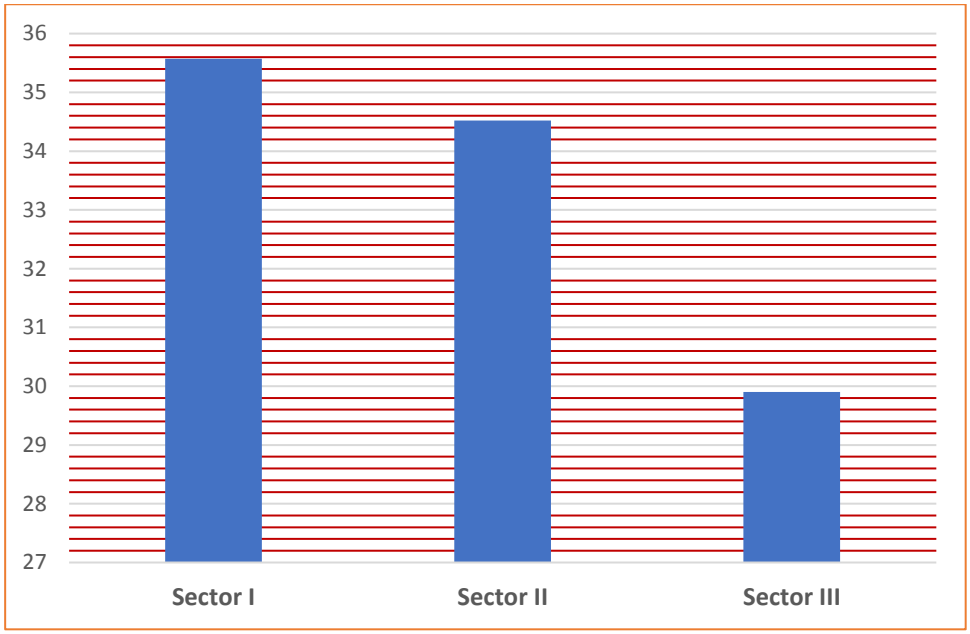

Fig. 2 Sectoral abundance of phytoplankton

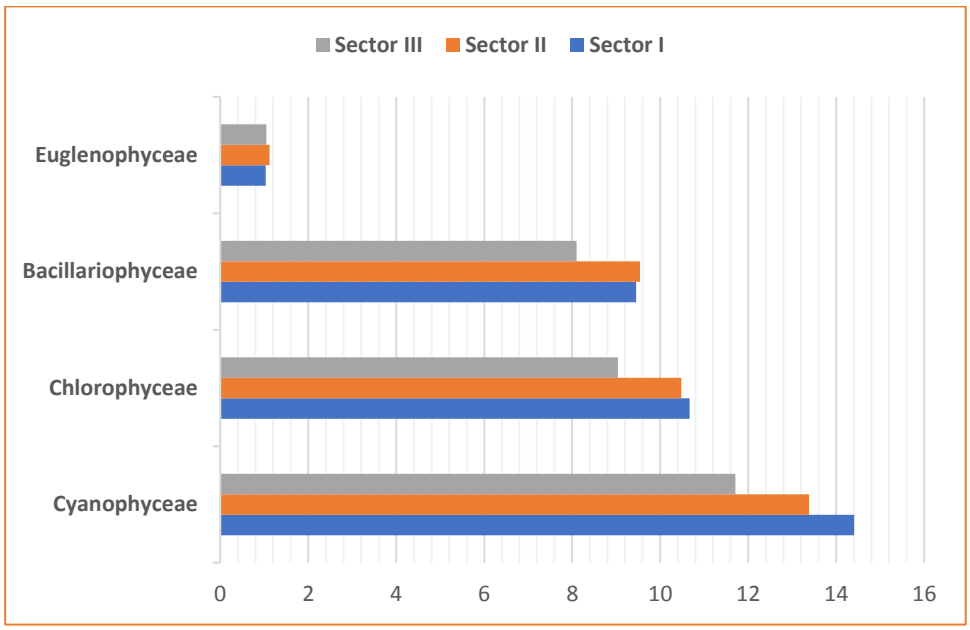

Fig.3 Sectoral distribution (%) phytoplankton

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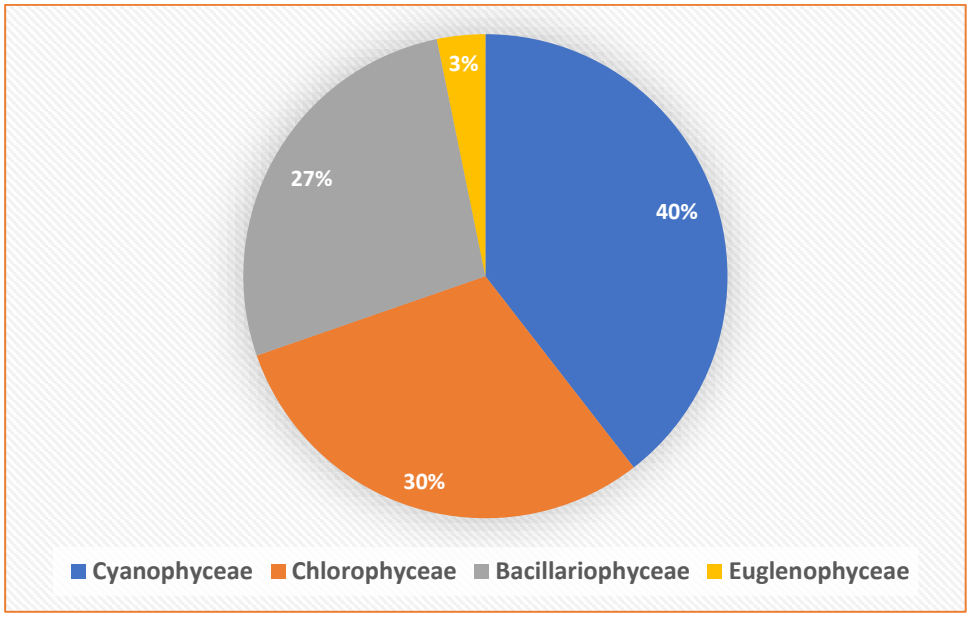

Fig.4 Group contribution to total phytoplankton

CONCLUSION

Generally, in harmony with the other products, warm water reservoirs of the country, in the Vanivilas Sagar reservoir, there was one phytoplankton pulse each during pre-monsoon and post-monsoon seasons. The planktonic organisms reach their highest density during pre-monsoon months due to low water levels with exposure to sunlight. The lentic sector represented the highest density, whereas fluviatile sectors represented rich diversity. Blue-green algae form the mainstay of the phytoplankton community in all the sectors of this man-made reservoir. The overwhelming presence of Microcystis aeruginosa is remarkable. The high density of the community is probably due to the low flushing rate noticed in the reservoir together with the physicochemical profile of the water.

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