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A Study on Phytoplankton Community Structure of Nethravati River (Mangaluru), South-west Coast of India

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ABSTRACT: Present investigation was carried out by collecting surface water and phytoplankton (mesoplankton) samples at monthly intervals from Nethravathi River for a period of 16 months to analyse selected physico-chemical parameters of water and community structure of Phytoplankton. Plankton community structure was represented by Chrysophyta (18 genera), Cyanophyta (16 genera), Chlorophyta (31 genera) and Rhodophyta (1 genera). Cyanophytes and Chlophytes seems to be the dominant plankters of the river. Seasonal impact was observed on the community structure, being dominated by cyanophytes during monsoon and post-monsoon seasons, whereas, by chlorophytes during pre-monsoon season. The study infers that the phytoplankton diversity and distribution are subject to changes in the ecosystem. Therefore a frequent monitoring of these ecosystems is required by assessing biological diversity which is crucial to know the health of such globally threatened ecosystem.

Keywords: Phytoplankton, Nethravathi River, Mesoplankton.

INTRODUCTION

Limnological study of a water body is a pre-requisite in any aquatic ecosystem for the assessment of its potentialities and to understand the realities between its different trophic levels and food webs. Study of physico-chemical parameters are of utmost importance, as it is having a lot of influence on the composition, density and relative abundance of planktonic communities which are finally going to decide the fate of productivity of a water body.

They are very important from the ecological and biological points of view. These ecosystems show high levels of productivity which is due to the input of nutrients by rivers and the effective mixing between sediment and surface waters. Hence estuaries act as an important natural source for studying the interactions and adaptations of organisms to wide range of environmental changes including climatic and man-induced changes. Understanding the productivity of these ecosystems will help to reduce the constraints imposed on their threatened biological resources (Badsi *et al.*, 2012).

Phytoplankton, the primary producers, form the base of the food chain and can serve as biological indicators of environmental health, water quality, and degree of eutrophication (Paerl, 2009). Their growth and community structure, diversity, biovolume, and importantly the magnitude of primary production is influenced by different physicochemical and biological factors (Godhe *et al.*, 2015) and also exhibit a seasonal variation (Hillebrand *et al*., 1999; Harrison *et al*., 2015). Due to their sensitivity and fast response to environmental changes, the species composition, abundance and spatio-temporal distribution of these aquatic organisms can be used as indicators of the environmental health or biological integrity of an aquatic system (Paerl *et al*., 2003). The increased nutrient loading in coastal environments due to alteration in the distribution and movement of major nutrient elements by human activities (Shruthi *et al*., 2011) can also alter the species composition of primary producers (Domingues *et al.*, 2005), thus influencing the entire food web (Figueredo and Giani 2001). Therefore, it is important to monitor the relation between the primary producers and coastal water quality

Phytoplankton are major primary producers in the aquatic realm, from which the energy is transferred to higher organisms through food chain and are responsible for almost half of the global 'net primary production'. The density and diversity of phytoplankton are biological indicators for evaluating water quality and the degree of eutrophication. Phytoplankton serve as the base of pelagic food webs and play a major role in the global cycling of carbon, nitrogen, phosphorus and other elements and in the regulation of earth's climate. Their abundance and community structure in an ecosystem directly impact higher trophic levels and key biogeochemical cycles.

Variations in the Phytoplankton abundance from selected estuaries of Karnataka Coast were reported by Karolina *et al.,* (2009); Andrade *et al.,* (2011); Kaladharan *et al*., (2011). The qualitative and quantitative studies have been used in the assessment of phytoplanktonic diversity and quality of the ecosystem (Adoni *et al.*, 1985; Chaturvedi *et al*., 1999).

Rivers are one of the most productive ecosystems in the biosphere and play a significant role in the ecological sustainability of a region. Rivers bring large quantity of terrestrial materials, such as organic matter and nutrients, through estuaries to oceans, supporting an important part of new/export production in the oceans. River Nethravathi originates in the Western Ghats near "Kudremukh" and flows through thick wooded forest over a rocky bed after forming rapids in Bengadi valley up to Belthangadi, which is further flowing through Uppinangadi, where it is joined by a stream- Kumardhara and finally reaches Mangalore. It has an intrusion length of 19 Km, catchment area of 1232 sq.miles with an average depth of 3m and maximum depth of 8m. this river will be in flooding state during monsoon season, while in summer its discharge decreases.

MATERIALS AND METHODS

Surface water samples were collected on monthly basis for a period of 16 months from Nethravati River, covering post-monsoon, pre-monsoon, monsoon and post-monsoon of the subsequent year for analysing selected limnological parameters of water. Rainfall data was obtained from Agricultural Research Station, Kankanadi, Mangalore. Atmospheric and surface water temperatures were measured using standard mercury filled centigrade thermometer. Salinity was analysed in the laboratory following Mohr's method (Strickland and Parsons, 1972). Dissolved Oxygen was estimated by modified Winkler's method (Strickland and Parsons, 1972). pH was measured potentiometrically using digital pH meter (EUTECH instruments, pH/mv/˚C/˚F meter). Total Suspended Solid (TSS) content was measured using Millipore Filtering System. For the analysis of nutrients, water samples were filtered using a Millipore Filtering System (MFS) and analysed for dissolved inorganic phosphate, nitrite-nitrogen, nitrate-nitrogen, ammonium-nitrogen and reactive silicate by adopting the standard methods (Strickland and Parsons, 1972). Standard Plankton net (60µ pore size) was used to collect plankton samples, collected samples were then preserved in 4% formalin for further analysis). Qualitative and quantitative analysis of plankton was carried out using OLMPUS – CX 21 and OLMPUS – CKX41 Microscopes, placing sample on Sedgwick Rafter Cell and plankton abundance was expressed in number/m^3.

RESULTS AND DISCUSSION

Data regarding analysis of water quality parameters was presented in Table 1. Top ten 'net phytoplankton' genera (based on regularity & dominance) found at this station are *Desmidium, Merismopedia, Hydrodictyon, Aphanizomenon, Pediastrum, Spirogyra, Tabellaria, Coscinodiscus, Mougoetia* and *Microcystis spp*. Centrales were represented by the regular/dominant forms like *Campylodiscus* (0 to 20000 cells/m^3), *Coscinodiscus* (0 to 160000 cells/m^3), *Melosira* (0 to 272000 cells/m^3), and rare forms like *Planktoniella spp*. Pennales were represented by the regular/dominant forms like *Gyrosigma* (0-34000 cells/m^3), *Fragilaria* (0 to 100000 cells/m^3), *Pleurosigma* (0 to 10000 cells/m^3), *Navicula* (0 to 6000 cells/m^3), *Nitzschia* (0 to 14,000 cells/m^3), *Surirella* (0 to 10000 cells/m^3), *Tabellaria* (10000 to 520000 cells/m^3), and rare forms like, *Asterionella, Gomphonema, Pinnularia, Thalassionema and Thalassiothrix spp*. Cyanophyta was represented by the regular/dominant forms like *Aphanizomenon* (0 to 1280000 cells/m^3), *Lyngbya* (2000 to 12000 cells/m^3), *Merismopedia* (0 to 5120000 cells/m^3), *Microcystis* (0 to 1300000 cells/m^3), *Oscillatoria* (0 to 10000 cells/m^3), *Phormidium* (0 to 18000 cells/m^3), *Spirulina* (0 to 18000 cells/m^3) and rare forms like *Anabaena, Aphanizomenon, Aphanotheca, Coelosphaerium, Gomphosphaeria, Marssoniella, raphidiopsis, stigonema* spp. Chlorophyta was represented by *Basicladia* (0 to 144000 cells/m^3), *Cladophora* (0 to 24000 cells/m^3), *Closterium* (0 to 54000 cells/m^3), *Desmidium* (0 to 4770000 cells/m^3), *Dichotomosiphon* (0 to 30000 cells/m^3), *Hydrodictyon* (0 to 2500000 cells/m^3), *Microthamnion* (0 to 120000 cells/m^3), *Mougoetia* (0 to 84000 cells/m^3), *Pediastrum* (0 to 600000 cells/m^3), *Spirogyra* (0 to 518000 cells/m^3), *Stigeoclonium* (0 to 60000 cells/m^3), *Ulothrix* (0 to 180000 cells/m^3), and rare forms like *Bulbochaete, Chlorella, Cosmarium, Kirchneriella, Micrasterias, Pandorina, Pithophora, Radiofilum, Scenedesmus, sirogonium, Spitotaenia, Staurastrum, Triploceros and Zygnema spp*. Rhodophyta was represented by single genus *Lemanea* spp. (0 to 16000 cells/m^3).

Phytoplankton community structure (Table 2 & Fig. 1) revealed that, it was dominated by Cyanophyta and Chlorophyta, compared to Chrysophyta. Pennales found to be the dominant chrysophytes. Though, as a whole, pennales dominated centrales, centrales were dominant during pre-monsoon season (Fig. 2). Rhodophyta also contributed to a lesser extent by a single species (Fig. 3).

Mathivanan *et al.* (2007) also reported the dominance of blue-green algae and green algae over diatoms in Cauvery River waters. Annalakshmi and Amsath (2012) reported the dominance of Chlorophyceae among phytoplankton community in River Cauvery, whereas, Cyanophycese in River Arasalar. Panigrahy and Patra (2013) in river waters of Mahanadi, reported the dominance of Chlorophyceae (53.45%) over that of acillariophyceae (25.77%) and Cyanophyceae (20.78%).

Table 1: Temporal variations observed in the Meteorological and Limnological Parameters at of water of Nethravati River.

Observations / Limnological Parameters	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Rainfall (mm)	28.4	0.0	0.0	0.0	190.0	24.9	0.0	200.0	1483.2	889.3	367.5	180.4	146.5	44.2	0.0	0.0
Air temp. (˚C)	27.5	29.6	29.4	29.1	30.1	30.3	32.5	33.7	29.7	25.8	25.4	26.1	26.3	28.9	27.9	27.7
Water temp.(˚C)	28.2	30.2	29.9	30.0	28.6	29.4	31.2	32.5	30.8	26.6	25.5	26.9	26.9	29.6	28.8	28.6
TSS (mg/L)	212.8	24.2	26.8	18.0	18.0	24.2	20.6	28.0	44.0	66.0	82.0	542.0	267.0	34.0	32.0	16.0
pH	6.92	6.96	6.98	7.01	7.19	7.23	7.71	7.57	7.46	6.63	6.26	6.34	6.82	6.94	6.92	6.87
Salinity (ppt)	0.10	0.13	0.17	0.05	0.08	0.06	0.38	0.51	0.18	0.11	0.03	0.04	0.08	0.10	0.05	0.05
DO (mg/L)	7.75	7.31	6.73	7.92	8.39	7.92	7.12	5.10	6.33	8.39	8.62	9.10	8.31	8.57	7.92	7.81
Ammonium-nitrogen (µM)	2.41	2.61	4.67	6.44	5.03	4.00	8.29	9.45	10.91	9.05	7.60	11.05	13.33	8.75	6.87	5.84
Nitrite-nitrogen (µM)	0.23	0.31	0.10	0.10	0.54	0.02	0.02	0.56	0.59	0.59	0.92	0.33	0.36	0.44	0.40	0.42
Nitrate-nitrogen (µM)	3.50	2.32	2.64	2.97	1.76	0.56	0.31	3.39	2.13	1.97	3.37	2.73	4.71	6.79	5.21	6.26
Phosphate-phosphorus (µM)	0.66	0.46	0.72	0.61	0.71	0.25	0.76	1.12	0.61	1.07	0.18	0.25	0.91	0.76	0.55	0.51
Silicate- silicon (µM)	246.83	264.76	239.46	216.94	194.91	222.39	154.23	79.42	98.91	172.99	136.68	227.35	190.43	194.54	184.86	228.92

Observations 1 to 4 represents post-monsoon, 5 to 8 represents pre-monsoon, 9 to 12 represents monsoon and 13 to 16 represents post-monsoon seasons respectively.

Table 2: Phytoplankton Community Structure in terms of abundance (Cells/m^3).

Plankton type / Observation	Centrale	Pennales	Total chrysophytes	Cyanophytes	Chlorophytes	Rhodophytes	Total phytoplankton
1.	6000	64000	70000	1218000	1020000	6000	2314000
2.	8000	112000	120000	1230000	724000	2000	2076000
3.	300000	352000	732000	2056000	904000	4000	3696000
4.	88000	50000	138000	766000	1666000	4000	2574000
5.	206000	82000	308000	4572000	2210000	6000	7096000
6.	114000	98000	232000	3940000	5136000	10000	9318000
7.	128000	64000	212000	3636000	4720000	16000	8584000
8.	78000	46000	204000	4884000	5702000	8000	10798000
9.	46000	194000	260000	3028000	2992000	4000	6284000
10.	60000	82000	282000	5848000	2346000	10000	8486000
11.	40000	90000	154000	2814000	812000	6000	3786000
12.	24000	30000	74000	2042000	1058000	6000	3180000
13.	2000	50000	52000	1410000	3146000	8000	4616000
14.	2000	104000	130000	1746000	894000	4000	2774000
15.	8000	580000	604000	1292000	1394000	--	3290000
16.	232000	126000	358000	332000	662000	--	1352000

Observations 1 to 4 represents post-monsoon, 5 to 8 represents pre-monsoon, 9 to 12 represents monsoon and 13 to 16 represents post-monsoon seasons respectively.

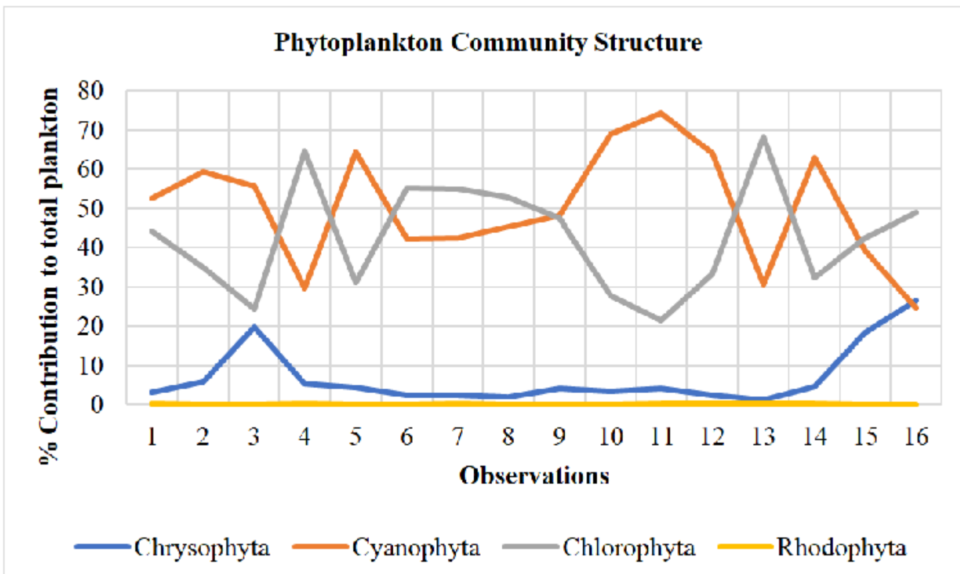

Fig. 1. Phytoplankton Community Structure of Nethravati River during present study.

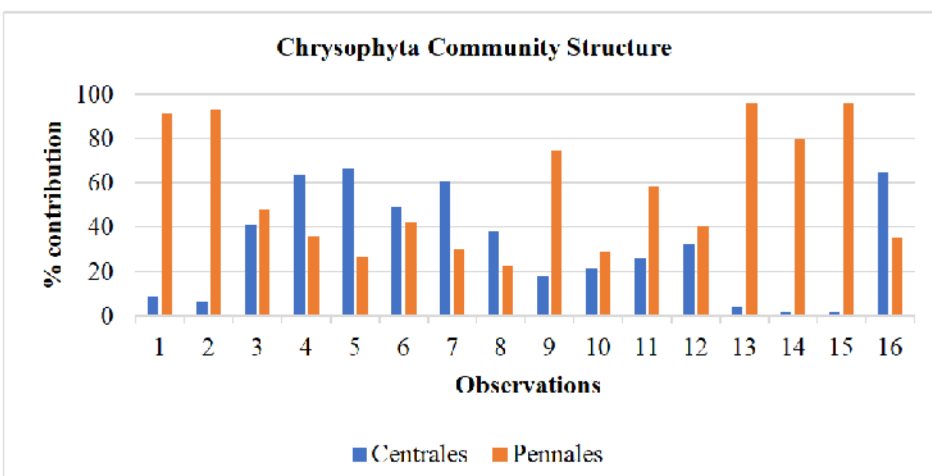

Fig. 2. Percentage contribution of Centrale and Pennate diatoms to total Chrysophytes.

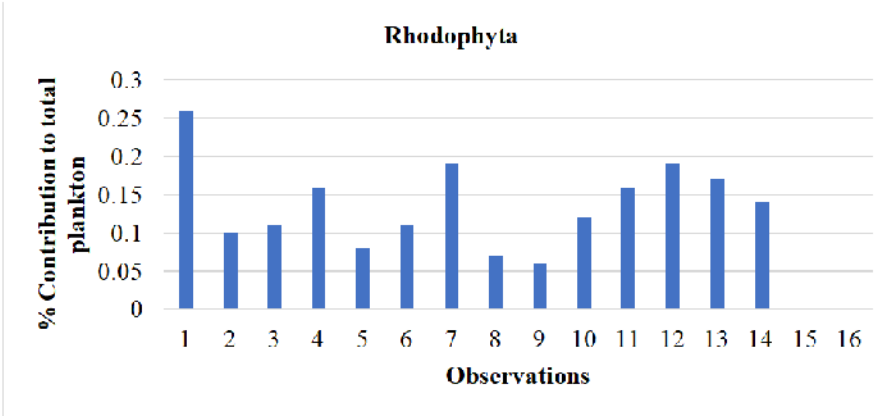

Fig. 3. Percentage contribution of Rhodophyta to total Phytoplankton.

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Conflict of Interest. None.

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