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Research Article

STUDIES ON THE HYDROBIOLOGY OF RIVER CAUVERY AND ITS TRIBUTARIES ARASALAR FROM KUMBAKONAM REGION (TAMILNADU, INDIA) WITH REFERENCE TO PHYTOPLANKTON

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ABSTRACT: The present investigation was an attempt to examine the composition, abundance, frequency of occurrence and diversity of net phytoplankton species inhabiting in river Cauvery and its tributaries river Arasalar at Kumbakonam area (10.110-12.70 E latitude and 78.86-79.85 N longitude), Tamil Nadu, India. From the selected 6 stations of river Cauvery and river Arasalar water samples were collected at monthly intervals. Qualitative and quantitative analyses of phytoplankton were carried out during the year 2010 January to 2011 January. In river Cauvery about 68 species of phytoplankton were found comprising Chlorophyceae 33.82%, Bacilleriophyceae 27.94%, Cyanophyceae 32.35% and Euglenophyceae 5.88%. Similarly in river Arasalar about 63 species of phytoplankton were found comprising Cyanophyceae 34.92%, Bacilleriophyceae 28.57%, Chlorophyceae 31.74% and Euglenophyceae 4.76%. Not all of the identified species were found in all six sites, thus indicating different types of pollution across the sites. There was no significant difference in the quantity of phytoplankton across the sites; however the quality differs as a result of the various stressors. These findings indicate that the effect of anthropogenic stressors, brewery effluent and refuse impact the water body, albeit minimally. This study will aid the baseline data for aqua-culturists in nearby regions.

Key Words: Seasonal variations; Phytoplankton; River Cauvery; River Arasalar

INTRODUCTION

Plankton populations in rivers are not nearly as dense as those of lakes. Time is too short for much multiplication of plankton, since relatively little time is needed for a given quantity of water to flow from its source to the sea. The plankton from head water to outlet varies tremendously (in quantity and quality) and the plankton of rivers at one level varies with that of others. Rivers is constantly moving so it is difficult to obtain a clear analysis of stream plankton. Plankton of rivers varies according to (1) chemistry of the water (including gases and nutrients) (2) temperature (3) amount of suspended matter, all of which are related to elevation gradient, surface wind and current affect the horizontal distribution of plankton.

Phytoplankton and zooplankton dynamics have been studied extensively in lentic fresh waters (lakes and reservoirs), yet comparatively little research has focused on lotic waters (rivers). The investigations in river planktons are scanty due to practical difficulties in the survey and sampling of flowing water. However, phytoplankton of fresh water rivers have been studied extensively in India [10, 21 and 25] various phytoplankton groups prefer to exist in various kinds of water.

The development of a phytoplankton community in a river depends directly upon the physical factors of flow and turbidity, and when either or both of these are too great, no appreciable populations can be formed. Day length and temperature, particularly the former, seem also to be important, and the highest numbers of algae occur during prolonged periods of bright dry weather, when the rate of flow and silt are also at a minimum. In most lowland rivers nitrates and phosphates, derived from agriculture and from sewage, are present in abundance for algal growth. Deficiency of silica, however, may lead to the end of vigorous populations of diatoms in spring, which are then often succeeded by mixed plankton, mainly of green algae, throughout the summer. [2 and3].

Phytoplankton is the most important producer of organic substances in the aquatic environment and the rate at which energy is stored up by these tiny organisms determine the basic primary productivity of the ecosystem. All other living forms at higher trophic levels are directly or indirectly dependant on phytoplankton for energy supply and therefore, performing vital functions. Phytoplankton satisfy conditions to qualify as suitable pollution indicators in that they are simple, capable of quantifying changes in water quality [13 and 27]. They are ecologically significant as they form the basic link in the food chain of all aquatic animals [11]. In fresh water ecosystem primary productivity by phytoplankton involves trapping of radiant energy and its transformation into high potential biochemical energy by photosynthesis, using inorganic materials of low potential energy [12].

This study was therefore designed to determine if various anthropogenic stressors actually impact the water body and if they do, in what way and to determine if there is any significant difference in the abundance and diversity of the phytoplankton population at different stations as a result of these stressors.

MATERIALS AND METHODS

A. **Study area**

Kumbakonam in Tanjore district is located at 10º 59' north latitude and 79º 23' longitudes. India, along the certain holy river-edge settlements have grown into religious centers or holy cities. Kumbakonam is one such city in Tamilnadu, along the Cauvery River; located in the delta between the Cauvery and its tributary Arasalar. The city has developed in the delta between the Cauvery River to the north and the Arasalar River, to the south and has a gentle slope from north-west to south-east. In the present context, there are vast agricultural wetlands to the north and south of planning area; with the rivers Cauvery and Arasalar as the main source of irrigation. Cauvery originates in Karnataka at Talakaveri, in Kodagu and flows down through Kushal Nagar, Srirangapatna, and Shivanasamudram before reaching Hogennikal and Srirangam in Tamilnadu. In Erode in Tamilnadu two more tributaries join it – Noyyal and Amaravathi. In Trichirapalli, it branches out in to Coleroon and Cauvery. Cauvery again divides in to Arasalar and Cauvery at Papanasam, near Kumbakonam. The mighty Cauvery River in Tamil Nadu is reduced to a number of unused channels and falls into the Bay of Bengal at the historical place of Poompuhar or Kaveripoompatinam about 13kms north of Tharangampadi.

B. Sampling and analysis of phytoplankton:

Each river (Cauvery and Arasalar) three sampling station designated as station1 (upstream of the river) station2 (midstream of the river) and station3 (downstream of the river) were established for sampling purpose. Water samples were collected from six locations on monthly basis for a period of one year (Jan 2010 to Dec 2010). Sampling was done in the mornings before 8.00 am. Water was collected from the surface with minimal disturbance and filtered in a No. 25 bolting silk cloth net of mesh size 63 mm and 30 cm diameter. The final volume of the filtered sample was 125ml. The sample was transferred to another 125ml plastic bottle and labeled mentioning the time, date and place of sampling. The samples collected in 125ml plastic bottles were preserved by adding 5ml of 4% formalin. The preserved samples were kept for 24 hours undisturbed to allow the sedimentation of plankton suspended in the water. After 24 hours, the supernatant was discarded carefully without disturbing the sediments and the final volume of concentrated sample was 50ml. The preserved samples were brought to the laboratory for quantitative and qualitative analysis. Counting of the planktons was done by using a Sedgwick-rafter cell method [26]. The abundance and diversity of phytoplankton at the six stations were determined by counting and identifying using standard identification keys.

RESULTS

The phytoplankton in the six stations of both the river showed variations because of the diverse physico-chemical conditions. The algal (phytoplankton) component of Cauvery River and Arasalar River consisted of the members of Cyanophyceae, Chlorophyceae, Bacillariophyceae and Euglenophyceae. The total number of phytoplankton and monthly average phytoplankton number per ml were shown in the Table 1and 2 while seasonal variation and percentage composition of plankton components has been shown in Table 2 and 3. It was noted that the total number of phytoplankton in the river Cauvery recorded was 3050-5813 number/ml, 3155-6055 number/ml and 3224-5858 number/ml for S1, S2 and S3 respectively. Similarly in the river Arasalar recorded were 3050-5813 number/ml, 3155-6055 number/ml and 3224- 5858 number/ml for S1, S2 and S3 respectively.

River Cauvery

The percentage of total annual phytoplankton of the river Cauvery consisted of 33.82% Chlorophyceae (Green algae), 27.94% Bacillariophyceae (Diatoms), 32.35% Cyanophyceae (Blue green algae), and 5.88% of Euglenophyceae (Fig.1.a). Annual average of Chlorophyceae was 1448.19number/ml, Bacillariophyceae was 1196.52number/ml Cyanophyceae was 1385.44number/ml and Euglenophyceae was 251.44number/ml (Table.5). Annual averages revealed that Chlorophyceae were the dominant group. Monthly fluctuation of phytoplankton showed four peaks in April (9.66%), May (11.44%), June (10.73%) and August (8.57%) (Table1). Four peaks of Chlorophyceae (Green algae) were observed in January (40.52% - 1636 number/ml), March (35.25% - 1334 number/ml), April (42.09% - 2447 number/ml) and November (45.73% - 1544 number/ml). The Bacillariophyceae (diatoms) showed two peaks, one in September (37.37% - 1320 number/ml) and another in October (34.55% -1054 number/ml). Four peaks of Cyanophyceae (Blue Green algae) were observed in February (40.74% - 1675 number/ml), March (36.62% -1386 number/ml), June (37.49% - 2056 number/ml) and August (40.72% - 1786 number/ml) (Fig.2). During the twelve months of collection the Chlorophyceae were the dominant forms. Cyanophyceae and Bacillariophyceae were seen throughout the year.

Seasonal averages of summer season showed that Chlrophyceae was 1816.33 number/ml, Bacillariophyceae was 1354.83number/ml, Cyanophyceae was 1697.83 number/ml and Euglenophyceae was 305.58number/ml. Seasonal averages of winter season showed that Chlrophyceae was 1354.83number/ml, Bacillariophyceae was 1123.66 number/ml, Cyanophyceae was 1327.83number/ml, and Euglenophyceae was 232.50 number/ml. Seasonal averages of rainy season showed that Chlrophyceae was 1170.83 number/ml, Bacillariophyceae was 1111.08 number/ml, Cyanophyceae was 1135.66 number/ml and Euglenophyceae was 217.75 number/ml (Table.7 and Fig.4). In dry season Chlorophyceae and Cyanophyceae were the dominating group. Phytoplankton was remarkably abundant during dry season

River Arasalar

The percentage of total annual phytoplankton of the river Arasalar consisted of 33.82% Cyanophyceae (Blue green algae), 27.94% Bacillariophyceae (Diatoms) 32.35%, Chlorophyceae (Green algae), and 5.88% of Euglenophyceae (Fig.1.b). Annual averages of Cyanophyceae were 1204.30number/ml, Bacillariophyceae was 985.36number/ml, Chlorophyceae was 1094.72number/ml and Euglenophyceae was 163.80number/ml (Table.6). Annual averages revealed that Cyanophyceae were the most dominant group in this river. Monthly fluctuation of phytoplankton showed three peaks, in February (8.73%), April (9.66%) and May (11.44%) (Table1). Four peaks of Cyanophyceae (Blue green algae) were observed in January (38.36% - 1303 number/ml), February (38.32% - 1390 number/ml), March (38.70% - 1059 number/ml) and November (36.24% - 1199 number/ml).
The Bacillariophyceae (diatoms) showed two peaks, one in September (37.37% - 1120 number/ml) and another in December (34.55% - 1098 number/ml).

Three peaks of Chlorophyceae (Green algae) were observed in August (34.13% - 1069 number/ml), October (34.12% - 959 number/ml) and November (36.27% - 1200 number/ml) (Fig.3). During the twelve months of collection the Cyanophyceae were the dominant forms. Chlorophyceae and Bacillariophyceae were seen throughout the year.

Seasonal averages of summer season showed that Cyanophyceae was 1350.83 number/ml, Bacillariophyceae was 1088 number/ml, Chlorophyceae was 1226.33 number/ml and Euglenophyceae was 213.25 number/ml Seasonal averages of winter season showed that Cyanophyceae was 1222.25 number/ml, Bacillariophyceae was 943.5no/ml, Chlorophyceae was 1038.41 number/ml and Euglenophyceae was 154.41 number/ml. Seasonal averages of rainy season showed that Cyanophyceae was 1040.58 number/ml, Bacillariophyceae was 922.91 number/ml, Chlorophyceae was 1021.08 number/ml and Euglenophyceae was 124.16 number/ml (Table.7 and Fig.5). In dry season Cyanophyceae and Chlorophyceae were the dominating group. Phytoplankton was remarkably abundant during dry season.

Table.1 Monthly variations in phytoplankton count number/ml in River Cauvery (2010).

Components	**Jan** 2010	**Feb** 2010	**Mar** 2010	**Apr** 2010	**May** 2010	**June** 2010	**Jul** 2010	**Aug** 2010	**Sept** 2010	**Oct** 2010	**Nov** 2010	**Dec** 2010	**Total**
Station I Chlorophyceae	1636	1026	1334	2447	1808	1805	1210	1274	1018	775	1544	1403	17280
Bacillariophyceae	1096	1194	876	1386	1708	1200	1124	1074	1320	1054	945	1298	14275
Cyanophyceae	1165	1675	1386	1864	1478	2056	1364	1786	1046	874	781	1056	16531
Euglenophyceae	140	216	188	116	578	426	114	248	148	347	106	376	3003
Total	**4037**	**4111**	**3784**	**5813**	**5572**	**5484**	**3812**	**4382**	**3532**	**3050**	**3376**	**4133**	**51089**
Station II Chlorophyceae	1680	1020	1328	2438	1802	1799	1204	1268	1012	869	1538	1397	17355
Bacillariophyceae	1107	1199	881	1320	1713	1205	1129	1079	955	1059	1390	1303	14340
Cyanophyceae	1171	1681	1392	1870	1484	2062	1370	1790	1052	879	792	1062	16605
Euglenophyceae	142	217	189	427	499	188	117	249	149	348	118	377	3020
Total	**4100**	**4117**	**3790**	**6055**	**5498**	**5254**	**3820**	**4386**	**3168**	**3155**	**3838**	**4134**	**51315**
Station III Chlorophyceae	1690	1030	1338	2448	1812	1809	1214	1278	1022	904	1548	1407	17500
Bacillariophyceae	1117	1209	891	1400	1723	1215	1135	1089	1300	1063	1005	1313	14460
Cyanophyceae	1181	1691	1402	1880	1494	2072	1380	1780	1062	904	822	1072	16740
Euglenophyceae	144	219	201	130	502	141	429	251	167	353	129	379	3045
Total	**4132**	**4149**	**3832**	**5858**	**5531**	**5237**	**4158**	**4398**	**3551**	**3224**	**3504**	**4171**	**51745**

Table.2 Monthly variations in phytoplankton count number/ml in River Arasalar (2010).

Components	**Jan** 2010	**Feb** 2010	**Mar** 2010	**Apr** 2010	**May** 2010	**June** 2010	**Jul** 2010	**Aug** 2010	**Sept** 2010	**Oct** 2010	**Nov** 2010	**Dec** 2010	**Total**
Station I Cyanophyceae	1303	1390	1059	1320	1713	1129	1205	1079	965	881	1199	1107	14350
Bacillariophyceae	946	994	708	1186	1244	1000	924	874	1120	854	795	1098	11743
Chlorophyceae	1007	1099	781	1220	1518	1105	1029	1069	855	959	1200	1203	13045
Euglenophyceae	140	106	188	247	227	154	226	110	148	116	114	176	1952
Total	**3396**	**3589**	**2736**	**3973**	**4702**	**3388**	**3384**	**3132**	**3088**	**2810**	**3308**	**3584**	**41090**
Station II Cyanophyceae	1308	1395	1064	1325	1718	1134	1210	1084	970	901	1204	1112	14425
Bacillariophyceae	951	999	713	1191	1249	1005	929	879	1125	859	800	1100	11800
Chlorophyceae	1012	1104	793	1225	1523	1110	1034	1074	860	964	1205	1208	13112
Euglenophyceae	141	107	189	248	228	155	221	117	149	117	115	176	1963
Total	**3412**	**3605**	**2759**	**3989**	**4718**	**3404**	**3394**	**3154**	**3105**	**2841**	**3324**	**3596**	**41300**
Station III Cyanophyceae	1323	1410	1079	1340	1733	1149	1225	1099	985	901	1219	1117	14580
Bacillariophyceae	965	1009	726	1135	1259	1015	939	889	800	869	1201	1113	11930
Chlorophyceae	1027	1119	1001	1240	1538	1125	1049	1089	875	979	1104	1107	13253
Euglenophyceae	143	109	191	250	226	157	220	117	151	119	117	182	1982
Total	**3458**	**3647**	**2997**	**3965**	**4756**	**3446**	**3433**	**3194**	**2811**	**2868**	**3641**	**3519**	**41745**

Table.3 Seasonal variations of phytoplankton groups of river Cauvery

Seasons	Chlorophyceae	Bacillariophyceae	Cyanophyceae	Euglenophyceae	Total
Summer	21796	16258	20374	3667	62095
Winter	16289	13484	15934	2796	48503
Rainy	14050	13333	13628	2613	43624

Table.4 Seasonal variations of phytoplankton groups of river Arasalar.

Seasons	Cyanophyceae	Bacillariophyceae	Chlorophyceae	Euglenophyceae	Total
Summer	16201	13056	14716	2559	45992
Winter	14667	11322	12461	1848	40298
Rainy	12487	11075	12253	1490	37305

Table.5 Annual average and Percentage of phytoplankton in river Cauvery.

Groups	No. of genera	Annual Average (n/mL)	Annual Percentage
Chlorophyceae	24	1448.19	33.82
Bacillariophyceae	14	1196.52	27.94
Cyanophyceae	26	1385.44	32.35
Euglenophyceae	3	251.88	5.88

Table.6 Annual average and percentage of phytoplankton in river Arasalar.

Groups	No. of genera	Annual Average (n/mL)	Annual Percentage
Cyanophyceae	23	12034.30	34.92
Bacillariophyceae	13	985.36	28.57
Chlorophyceae	25	1094.72	31.74
Euglenophyceae	2	163.8	4.76

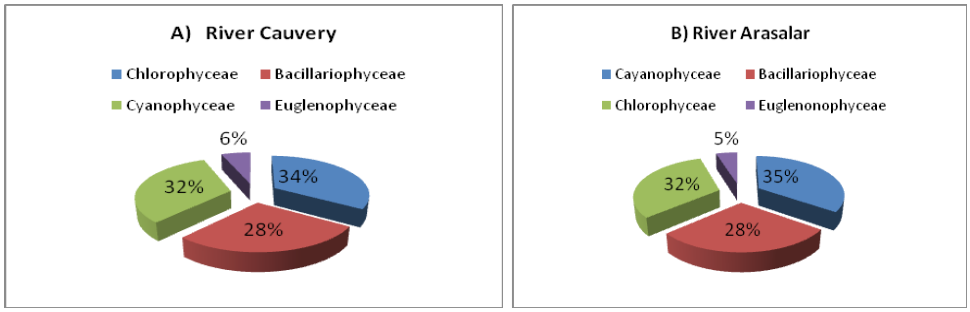

Fig.1 Percentage of total annual phytoplankton in river Cauvery and Arasalar (2010).

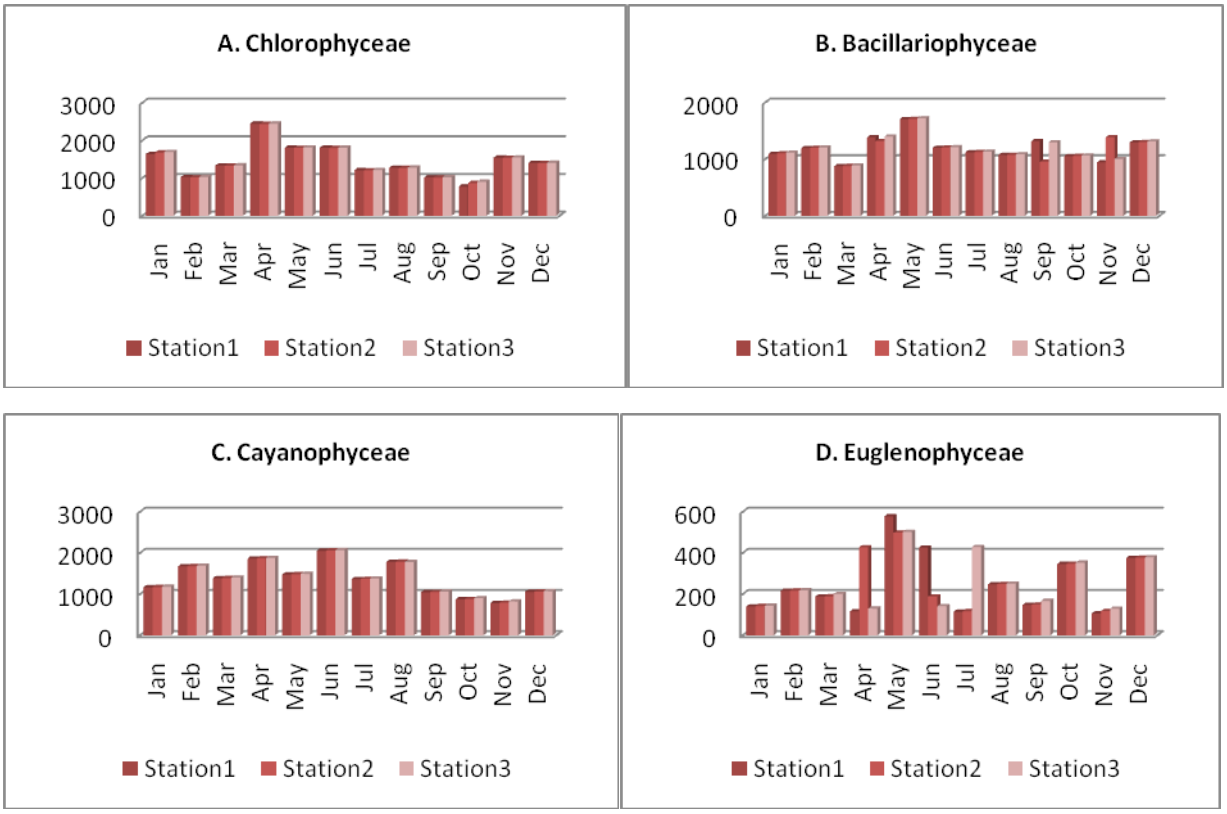

Fig.2 Monthly fluctuations of phytoplankton (n/mL) at 3 stations of Cauvery River - 2010.

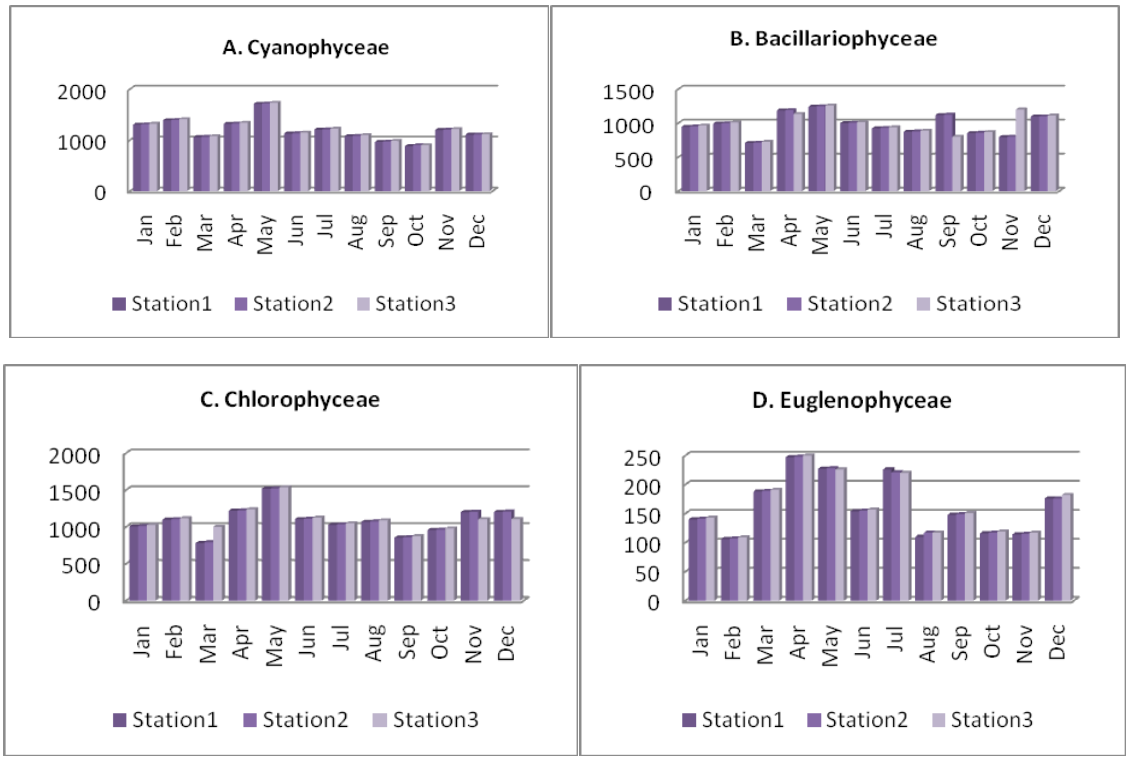

Fig.3 Monthly fluctuations of phytoplankton (n/mL) at 3 stations of Arasalar River - 2010.

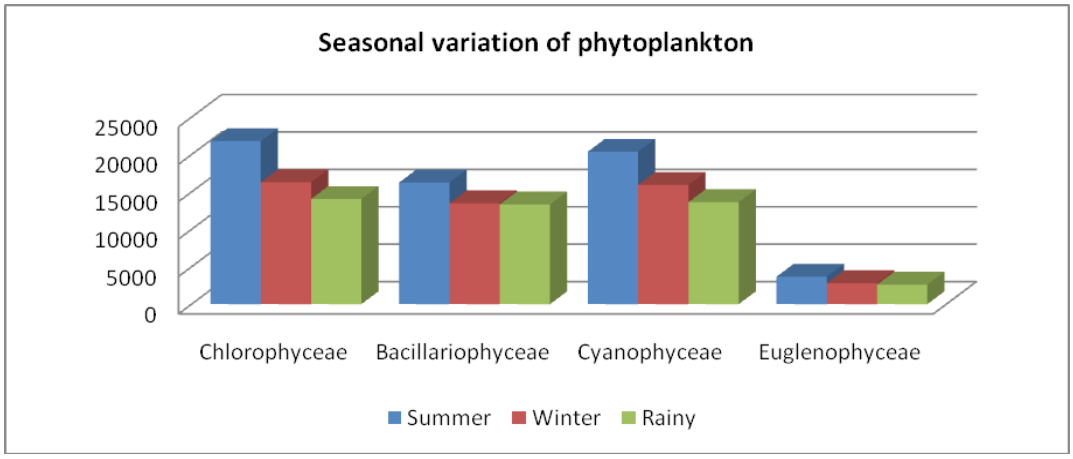

Fig 4. Seasonal variations of phytoplankton in River Cauvery during the study period.

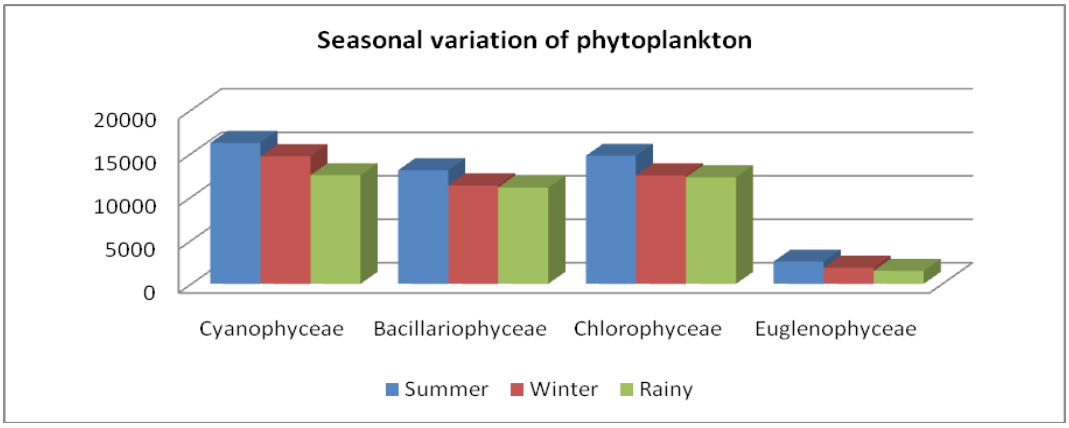

Fig 5. Seasonal variations of phytoplankton in River Arasalar during the study period.

Table 7. Seasonal Averages of phytoplankton (number/ml) in River Cauvery and River Arasalar during the study period.

River name	Seasonal Average of river Cauvery			Seasonal Average of river Arasalar		
Groups	Summer	Winter	Rainy	Summer	Winter	Rainy
Chlorophyceae	1816.33	1357.41	1170.83	1226.83	1038.41	1021.08
Bacillariophyceae	1354.83	1123.66	1111.08	1088	943.5	922.91
Cyanophyceae	1697.83	1327.83	1135.66	1350.83	1222.25	1040.58
Euglenophyceae	305.58	232.50	217.75	213.25	154	124.16

DISCUSSION

The seasonal dynamics of the phytoplankton is influenced by the climatic conditions as well as the physico-chemical characteristics of the river. Maximum number of total phytoplankton during summer and winter indicates good physicochemical conditions [5]. A marked difference in the composition and in the relative abundance of various algal groups was observed in both the rivers.

The settled volume and the individual numbers of phytoplankton were very weak during the wet season while many fold increase in phytoplankton populations was noted during the dry season. The turbidity and the heavy water current will prevent the growth of phytoplankton during the wet season. During dry season, the river water turns to more lacustrine and the addition of nutrients will favor the growth of planktons. Hydrological factors such as discharge or water residence time are thought to be of greater importance to planktonic development in rivers.

In the present investigation, Chlorophyceae population was the most abundant group in the river Cauvery followed by Cyanophyceae, Bacillariophyceae and Euglenophyceae (Table 3). Similar finding was also reported by [24] in Tungabhadra River. Whereas, in the river Arasalar Cyanophyceae were most dominant followed by Chlorophyceae, Bacillariophyceae, and Euglenophyceae (Table 3). [18] have observed that high turbidity, pH, bicarbonate, orthophosphate, alkalinity, chloride may be responsible for the Cyanophycean growth and bloom. [4] have reported that higher diversity of the blue-green algae may be attributed to high nitrate values during the rainy season.

In the present study Bacillariophyceae were more in summer than in winters and least in rainy season. [6] have recorded minimum population of diatoms during moderate temperature. As compared to other classes of algae, the members of Euglenophyceae were recorded least in number. Its percentage was very less as compared to other groups.

In water body, there usually occur seasonal qualitative and quantitative fluctuations in the planktonic population in temperate and tropical climate. The reports of some workers suggest that the maximum development of phytoplankton occur during summer and minimum in winter [1, 16]. While Kumar estimated that the density of phytoplankton is greater during summer, post monsoon and winter and is lowest in monsoon. In the present investigation also peak of the phytoplankton was observed during summer followed by winter (Fig 4 and 5) [17].

Phytoplankton count also registered higher value during non-rainy months. This result gains support from the similar observations of [5] and [20]. It is reported that excessive growth of certain algal genera, viz., *Scenedesmus, Anabaena, Oscillatoria and Melosira* indicate nutrient enrichment of aquatic bodies [7, 27]. Although these plankters were present in both the rivers but their density varied. [14] has showed the algal genera, *Euglena, Oscillatoria, Scenedesmus, Navicula, Nitzschia and Microcystis* which are the species found in organically polluted waters. Similar genera were also recorded in the present study.

In this study, the peak of phytoplankton was observed during April, May, and June while lowest peak was found in September followed October and November in 3 stations of river Cauvery (Table.1 and Fig.2). Similarly, the peak of phytoplankton was observed during February, April, and May while lowest peak was found in March followed September and October in 3 stations of river Arasalar (Table.2 and Fig.3). [22] have observed that the peaks of phytoplankton occurred at different period in different years. Margalef (1968) suggested that phytoplankton population in fertile water is more diverse than those in infertile water.

In the present investigation, the phytoplankton fluctuates monthly and its productivity was high during summer and low during rainy seasons as evidenced earlier by Sadguru et al. (2002). The low productivity of phytoplankton might be due to the grazing effect by zooplankton and fishes as evidenced earlier by [9]. Low density phytoplankton recorded during rainy season may be possibility is due to dilution by the rainy water coupled with other unfavorable environmental conditions (Fig 4 and 5).

CONCLUSION

Based on our results, it can be concluded that the river Cauvery which is one of the most productive riverine system of Tamilnadu. In kumbakonam area, the river Cauvery and its tributaries Arasalar were polluted at downstream stations. The present findings show that there are certain members of species in the Chlorophyceae and Cyanophyceae which are tolerant to organic pollution and resist the stress caused by pollutants. Abundance of such taxa in the polluted habitats suggests their possible use an “indicator organism”. The study emphasizes the necessity of using phytoplankton as effective and appropriate method of biomonitoring for evaluation of river water quality.

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