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Seasonal Variations of Phytoplankton Diversity in Bethur Pond Near Davangere, Karnataka

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Abstract

Study was carried out in Bethur pond near Davangere city, Karnataka on phytoplankton diversity, density and distribution in different seasons and their correlations with physico-chemical properties of water. Total of 56 phytoplankton were represented. Relative abundance of phytoplankton in pond showed maximum of Chlorococcales (46.65%), followed by blue-greens (43.30%) followed by diatoms (9.60%), euglenoids (0.27%) and desmids (0.18%). The highest density of phytoplankton was recorded during summer season. Chlorococcales varied with peak density (16,267 org/liter) during summer and lowest in rainy season (11,778 org/liter). Blue-greens recorded 16,351 org/liter and least during winter with 14,289 org/liter. Diatoms varied (4,622org/liter) during summer and minimum with (1,822 org/liter) during rainy season. Desmids varied from 92 org/liter during rainy season and lowest during rainy season with 28 org/liter. Euglenoids recorded 132 org/liter during summer and least in winter with 67 org/liter. Our study revealed that the growth of phytoplankton is governed by BOD, carbon dioxide, COD, sulfate, total alkalinity and temperature. Among these parameters COD is positively correlated with chlorococcales. Carbon dioxide and potassium positively correlated with blue-green algae ; sulfate was negatively correlated with desmids. Total alkalinity was positively correlated with desmids. Air temperature, sodium, total hardness, chloride and BOD showed no correlations. Presence of high density of chlorococcalean group and blue-greens indicates eutrophication in the pond. Pollution tolerant species such as *Scenedesmus quadricauda, Coelastrum* sp., *Euglena* sp. *Phacus* sp. *Trachelomonas* sp. and *Microcrocystic aeruginosa* were observed.

Key words : Bethur pond, Phytoplankton diversity, Chlorococcales, Blue-greens, Desmids.

Phytoplankton plays an important role in the biosynthesis of organic matter (primary production) in aquatic systems, which directly or indirectly serve all the living organisms of a water body as food (1). The planktonic study is a useful tool for the assessment of water quality in any type of water body and also contributes to understanding of the basic nature and general economy of the lake (2). Unplanned urbanization, rapid industrialization and indiscriminate use of chemicals in agriculture caused heavy and varied pollution in aquatic environment leading deterioration of water quality and depletion of aquatic biota (3). Due to certain reasons some planktonic population flair-up to dominate water body and ultimately blooms form. Unlike other algae all the common bloom forming blue-green algae contain gas vacuoles which can impart positive buoyancy to the algae under certain conditions. Some species of blue-green algae aggregate and make a colony floating over the surface forming the bloom. Water bloom besides imparting color to the water also gives a disagreeable smell and taste to it. Phytoplankton species distribution show wide spatio-temporal variations due to the differential effect of hydrographical factors on individual species and they serve as good indicators of water pollution (4). Pond ecosystems were studied (5—10) and several studies on phytoplankton diversity were made in India and abroad on the ponds, lakes and reservoirs (11—14). In this paper an attempt was made to study the seasonal changes and correlation of phytoplankton diversity in relation with physico-chemical parameters in Bethur pond. The pond is situated 3 km away in north east direction of Davangere. It lies between $14^0 28'$ N latitude and $75^0 58'$ E longitudes. Water spread area of this water body is 172 Hectares. Rain water is the main source of water and Bhadra right bank channel at Lakkavalli, Chickmagalore district is the other source. water is

Table 1. Monthly occurrence of different groups of phytoplankton density in Bethur pond (org/liter), September 2003 to August 2005.

Months & year	Chloro-coccales	Diatoms	Desmids	Euglen-oids	Blue greens
Sep 3	14355	2355	38	87	11566
Oct 3	12172	1822	47	78	13155
Nov 3	14089	2178	42	82	11355
Dec 3	12578	2889	58	67	11244
Jan 4	14267	3290	53	78	15688
Feb 4	15644	3467	87	86	13556
Mar 4	14534	4133	92	92	16044
Apr 4	15600	4622	68	88	13867
May 4	16088	3644	72	94	14356
Jun 4	13643	2489	52	72	12711
Jul 4	14045	2044	28	81	13600
Aug 4	14132	2267	32	90	11689
Sep 4	13311	1978	48	83	12667
Oct 4	12267	2133	53	75	11867
Nov 4	13910	1911	46	84	10356
Dec 4	12534	2089	62	71	9689
Jan 5	13956	3378	74	57	11867
Feb 5	14578	3511	81	91	13156
Mar 5	15600	4222	84	106	14356
Apr 5	13956	4533	61	118	12625
May 5	16267	2978	56	132	15867
Jun 5	12756	2400	47	87	13911
Jul 5	11778	2178	32	78	14133
Aug 5	13867	2267	37	88	12756

mainly used for irrigation. Cattle bathing and other domestic activities are observed. The catchment area of the water body is 1.11 sq. km is covered by areca nut, paddy and natural vegetation.

Methods

Water samples were collected using acid washed plastic containers for the physico-chemical parameters from September 2003 to August 2005 for a period of two years. Parameters such as temperature, pH and DO tests were performed in the field.Alkalinity, chlorides, turbidity and hardness were determined. Phosphate, nitrate, nitrite, sulfate and silica were determined using UV-visible spectrophotometer. Standard prescribed methods were followed for the physico-chemical analysis of the water sample (15).

For qualitative and quantitative analysis of phytoplankton one liter of composite water samples at surface level were collected at interval of 30 days for 2 years during the period from September 2003 to August 2005. One liter of sample was fixed with 20 ml of 1% Lugol's Iodine solution and kept 24 hours for sedimentation. 100 ml of sample is subjected to centrifugation at 1500 rpm for 20 minutes and used for further investigation. Identification of plankton up to species level was done by referring standard manuals (16, 17). Quantitative estimation of phytoplankton was done by using Sedgewick rafter counting cell. The Pearson correlation coefficient was used to examine the relationships among the different environmental variables including phytoplankton density. Correlation coefficient (r) was calculated to detect the relationship between the various parameters of the water bodies under study.

Results and Discussion

Table 1 shows the monthly occurrence of different groups of phytoplankton density, Table 2 shows seasonal variations of phytoplankton density, Table 3 shows Pearsons correlation matrix of different physico-chemical variables, and phytoplankton taxa were recorded in Table 4.

A total 56 phytoplankton species were recorded in pond. It constitutes 46.65% of the total phytoplankton population. Chlorococcales represent the first dominated group among the phytoplanktons. The pond comprises of 11 genera and 16 species of Chlorococcales among which *Pediastrum duplex,*

Table 2. Seasonal variations of phytoplankton density in Bethur pond (org/liter).

		Sep 2003 to Aug 2004			Sep 2004 to Aug 2005			Sep 2003 to Aug 2005		
	Phytoplankton	Winter	Summer	Rainy	Winter	Summer	Rainy	Winter	Summer	Rainy
1	Chlorococcales	13277	15467	13783	13167	15100	12800	13222	15284	13292
2	Diatoms	2545	3967	2195	2378	3811	2282	2461	3889	2239
3	Desmids	50	80	40	59	71	39	55	76	40
4	Euglenoides	76	90	82	72	112	84	74	101	83
5	Blue-greens	12861	14456	12667	10945	14001	13600	11903	14229	13134

Table 3. Correlation coefficient among the physico-chemical parameters with the density of the phytoplankton in Bethur pond.Values in the bold letters indicate the significant values.

Parameters	Blue-greens	Chlorococcales	Desmids	Diatoms	Euglenoids
Air temp	0.371	0.272	0.298	0.467	0.482
BOD	0.022	0.200	0.097	0.159	-0.122
Calcium	0.120	-0.346	-0.314	-0.342	-0.234
Chloride	0.251	0.326	0.483	0.427	0.146
COD	0.432	**0.572**	0.233	0.302	0.270
Conductivity	0.276	0.249	0.262	0.220	0.430
Dissolved oxygen	0.097	0.098	0.174	0.264	-0.166
Carbon dioxide	**0.646**	0.255	0.127	0.193	0.414
Magnesium	0.172	0.037	0.148	0.214	0.327
Nitrate	0.252	-0.074	-0.355	-0.090	0.226
Nitrite	0.064	-0.284	-0.495	-0.302	0.030
pH	0.302	0.127	0.184	0.143	0.067
Phosphate	0.169	-0.028	-0.455	-0.057	0.327
Potassium	**0.571**	0.267	0.213	0.370	0.287
Silica	-0.349	-0.237	0.046	-0.205	-0.044
Sodium	0.472	0.093	-0.005	0.219	0.223
Sulfate	-0.047	-0.156	**-0.509**	-0.266	0.061
Total alkalinity	0.257	0.368	**0.633**	0.449	0.077
TDS	0.158	0.242	0.430	0.298	0.300
Total hardness	0.417	0.029	0.143	0.140	-0.086
Turbidity	0.289	-0.066	-0.187	-0.051	0.045
Water temp	0.362	0.206	0.277	0.422	0.402

Scenedesmus quadricauda and *Crucigenia crucifera* were appeared in all months of study period whereas *Chlorella vulgaris* and *Ankistrodesmus* sp. appeared as rare forms. Species diversity showed that genus *Scenedesmus* was represented by 4 species and *Pediastrum* with 2 species. Similarly the genus *Tetraedron* and *Crucigenia* was represented with 2 species and *Actinastrum, Ankistrodesmus, Chlorella, Chlamydomonas, Coelastrum, Eudorina* and *Selenastrum* were represented by single species. Some of the pollution tolerant species (18) identified during the present study are *Scenedesmus quadricauda, Coelastrum* sp. *Tetraedon* sp. in water body which indicate eutrophication.

Diatoms represented by 13 genera and 16 species constituting 9.60% of total phytoplankton population. For the diversity of diatoms, the genus *Navicula* represented by four species, *Anamoenies* by two species, *Synedra* by two species and other genera like *Cymbella, Cyclotella, Fragillaria, Gyrosigma, Melositra, Surirella, Pinnularia* and *Closterium* were represented by single species. Density of diatoms recorded a maximum of 4,622 org/liter in April 2004 and a minimum of 1,822 org/liter during October 2003 whereas seasonal variation of diatoms population showed maximum density during summer season with 3,889 org/liter and minimum with 2,239 org/liter during rainy season. Some of the pollution tolerant diatoms (18) were recorded from the pond are *Synedra* sp. *Cyclotella* sp. *Cymbella* sp and *Pinnularia* sp.

Desmids represent five genera and seven species constituting 0.18% of total phytoplankton population. When the diversity of desmids is considered Cosmarium was represented by two species, *Euastrum* with two species, *Staurastrum, Micrasterias* and *Closteriopsis* were represented by single species. The population density reached their peak March 2004 with 92 org/liter, while in July 2004 recorded least number with 28 org/liter. Season wise more during summer (76 org/liter followed by winter season (55 org/l) and least in rainy season (40 org/liter).

The pond recorded three genera and six species of Euglenoids and constituting of 0.27% of total phytoplankton population. If the diversity of Euglenoids is considered a genus Phacus represented by three species, Euglena represented by two species and *Trachelomonas* represented by a single species. When monthly variations are considered pond re-

Table 4. Phytoplankton taxa recorded in Bethur pond during Sep 2003-Aug 2005.

	Chlorococcales		**Diatoms**
1	*Actinastrum* sp.	1	*Anomoeonies sphaeophora*
2	*Ankistrodesmus falcatus*	2	*Anmoeonies phybrachysira*
3	*Arthrodesmus* sp.	3	*Cymbella cistula*
4	*Chlorella vulgaris*	4	*Cyclotella stelligera*
5	*Coelastrum* sp.	5	*Fragillaria* sp.
6	*Crucigenia crucifera*	6	*Gyrosigma accuminatum*
7	*Chlamydomonas* sp.	7	*Melosira granulata*
8	*Eudorina elegans*	8	*Navicula pupula*
9	*Pediastrum simplex*	9	*Navicula cuspidate*
10	*Pediastrum duplex*	10	*Navicula cryptocephala*
11	*Scenedesmus bijugatus*	11	*Navicula radiosa*
12	*Scenedesmus quadeicauda*	12	*Nitzchia amphibia*
13	*Scenedesmus dimorphous*	13	*Pinnularia microstauron*
14	*Scenedesmus bicaudatus*	14	*Surirella capronii*
15	*Selenastrum gracile*	15	*Synedra ulna*
16	*Tetradaedron longispinum*	16	*Synedra tabulata*
	Desmids		**Euglenoids**
1	*Cosmarium granatum*	1	*Euglena oxyalis*
2	*Cosmarium constractum*	2	*Euglena acus*
3	*Closteriopsis* sp.	3	*Phacus longicauda*
4	*Euastrum sublobatum*	4	*Phacus circumflexes*
5	*Euastrum flommeum*	5	*Phacus pleuronectes*
6	*Micrasterias* sp.	6	*Trachelomonas robasta*
7	*Staurastrum gracile*		
	Blue-greens		
1	*Agmenellum* sp.	7	*Nostoc microscopium*
2	*Anacystis* sp.	8	*Nostoc microscopium*
3	*Aphanocapsa* sp.	9	*Oscillatoria* sp.
4	*Gloecapsa* sp.	10	*Phormidium* sp.
5	*Merismopediz* sp.	11	*Spirulina major*
6	*Microcystis aeruginosa*		

corded a minimum of 67 org/liter during December 2003 and a maximum of 132 org/liter during May 2005. Seasonal variations showed maximum density with 101 org/liter during summer followed by 83 org/liter during rainy season and least in winter with 74 org/liter. Some of the pollution tolerant species (18) recorded from the study area are *Euglena* sp., *Phacus* sp., and *Trachelomonas* sp.

Bethur pond supported 11 genera represented by single species of blue-greens constituting 43.30% of the total plankton population. With regard to their diversity the genus *Anacystis, Anabaenopsis, Aphanocapsa, Agmenellum, Anabaena, Merismopedia, Microcystis, Nostoc, Oscillatoria, Spirulina* and *Gloeocapsa* were represented by single species. Some of the pollution tolerant blue-greens were recorded from the study area such as *Oscillatoris* sp. *Microcystis* sp. and *Anabaena* sp. *Microcystis* sp. is used as the best indicator of pollution and associated with highest degree of civic pollution. In the present study *Microcystis aeruginosa* was recorded.

Monthly density of blue-greens recorded minimum of 9,689 org/liter during December 2004 and maximum of 16,044 org/liter during March 2004. Seasonally, summer season recorded more number of blue-greens with 14,229 org/liter followed during rainy season with 13,134 org/liter and minimum number during winter season with 11,903 org/liter.

The data representing correlation coefficient of various parameters (Table 3) indicates that among

these parameters COD showed positive correlation with chlorococcales. Carbon dioxide showed positive correlation with blue green algae. Potassium was positively correlated with blue green algae. Sulfate showed negative correlation with desmids. Total alkalinity showed positive correlation with desmids. Air temperature, BOD, conductivity and TDS did not show any correlations with any of the phytoplankton group. Investigators considered that DO as pre-requisite for the better growth of chlorococcales (19). Researchers showed that DO and blue-greens exhibit a positive correlation with each other. But our studies showed no such correlations (20). High free carbon dioxide favors appreciable number of blue-greens (21, 22). In our findings carbon dioxide showed positive correlation with blue green algae.

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