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SEASONAL PHYTOPLANKTON DIVERSITY AND DENSITY IN TWO LENTIC WATER BODIES OF SAGARA, KARNATAKA, INDIA

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ABSTRACT

In the present investigation, the population and density study of 5 classes of Phytoplankton viz., chlorococcales, diatoms, desmids, blue greens and euglenoids in two selected tanks was carried out in relation to 21 physico-chemical water quality parameters. The results obtained were correlated to conclude about nutrients and mesotrophic conditions of the selected water bodies.

Key words: Basavanahole tank, Hirekere tank, Physico-chemical parameters, Phytoplankton, Mesotrophic condition

INTRODUCTION

Phytoplankton community comprises of a heterogeneous group of tiny plants adapted to various aquatic environments. Their nature and distribution varies considerably with respect to seasons and water quality. Their dominance also leads to qualitative changes of aquatic systems. In an aqueous ecosystem, phytoplankton the floating inconspicuous plant life plays a significant role in the food chain and acts as the primary producers on which other life forms depend. Over 90 percent of atmospheric oxygen is produced by phytoplankton by the process of photosynthesis. It is a fact that these phytoplanktons play a major bulk of food material for all aquatic organisms directly and to human beings indirectly.

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Some forms of phytoplankton also act as biological indicators of water quality[1]. As result of rapid multiplication of phytoplankton, water gets polluted, which may not have direct impact on fish yield, but affects biological productivity[2]. Phytoplankton population is good indicator of water quality and sustenance of heterotrophic communities in water. Phytoplankton plays an important role in the biosynthesis of organic matter in aquatic ecosystem, which directly serves all the living organisms of a water body as food. The planktonic study is a very useful tool for the assessment of water quality in any type of waterbody and also contributes to understanding of the basic nature and general economy of the lake.

The present investigation has been carried out to estimate the diversity and density of phytoplankton in two lentic waterbodies of Sagara taluk of Shivamogga district.

Study areas

For the present study, Hirekere tank of Keladi village and Basavanahole tank of Sagara of Shivamogga district were selected. Morphometry of selected lentic waterbodies is given in Table 1.

Table 1: Morphometry of selected lentic waterbodies

Name of the lentic water body	Village	Latitude	Longitude	River basin	Catchment area (sq. km)	Water spread area (Hectare)
Hirekere tank (Keladikere)	Keladi	14^0 13'	75^0 1'	Krishna Varada	1.38	27.2
Basavanahole tank	Sagara	14^0 5'	75^0 15'	Krishna	1.20	44.90

Name of the lentic water body	Command area (Hectare)	Source of water	Type of soil	Avg. depth (Meters)	Purpose
Hirekere tank (Keladikere)	95.00	Rain	Gravelley, clayey on lateritic plateau	5 -7	Irrigation, domestic activities & aquaculture
Basavanahole tank	48.30	Rain	Gravelley, clayey on lateritic plateau	7- 8	Drinking purpose

EXPERIMENTAL

Surface water samples were collected seasonally (Monsoon, Postmonsoon, Premonsoon) from January 2004 to December 2005 from all the four sampling stations for physico-chemical analysis. Water samples were collected in black colored carboys of 2 liter capacity. The water analysis was carried by standard prescribed methods followed for the physico-chemical analysis of the water samples[3].

For the qualitative and quantitative analysis of phytoplankton, two liters of composite water samples at the surface level were collected in 3 seasons. One litre of sample of each tank was fixed with 20 mL of 1% lugol solution. After sedimentation, 100 mL of sample is subjected to centrifugation at 1500 rpm for 20 min and used for further microscopic investigation. Quantitative estimation of phytoplankton counting was done by a Sedgewick rafter counting slide.

RESULTS AND DISCUSSION

Chlorococcales

During the present investigation, phytoplankton communities, composed of five major groups viz., chlorococcales, diatoms, euglenoids, desmids and blue greens in selected tanks were studied.

In Basavanahole tank, 8 genera and 14 species of chlorococcales have been encountered. If species diversity is considered, genus *Scenedesmus* is represented by three species, followed by *Pediastrum*, *Selenastrum*, *Ankistrodesmus* and *Tetraedron* represented by two species each. The genus *Crucigenia*, *Oocystis* and *Kirchneriella* represented by single species each (Table 2).

Seasonwise, chlorococcales were found to be more during pre monsoon season with 9580 O/l and less during monsoon season with 8458 O/l (Table 7). Significant positive correlation of chlorococcales with the some physico-chemical parameters like, air temperature, electrical conductivity and total solids (Table 11) showed negative correlation with carbon dioxide in Basavana hole tank (Table 11).

Chlorococcales in Hirekere tank comprising *Ankistrodesmus falcatus*, *Arthrodesmus* sp., *Ankistrodesmus gracillis, Ankistrodesmus spiralis, Closteriopsis longissima, Crucigenia crucifera Coelstrum microporum, Korshikoviella limnetica, Pedistrum duplex, Pediastrum simplex, Pediastrum tetras, Scendesmus carinatus* and *Selenastrum gracile* are appeared

dominant forms. *Kirchneriella lunaris, Tetraedron minimum* and *Tetraedron muticum* were found absent (Table 2).

Table 2: Occurrence of chlorococcales in selected lentic waterbodies of Sagar taluk, Jan. 2004 to Dec. 2005

Organisms	Basavana hole	Hirekere (Keladi)
Ankistrodesmus falcatus (Corda) Ralfs.	+	+
Ankistrodesmus gracillis	-	+
Ankistrodesmus spiralis (Turner) Lemm. V fasciculatus	+	+
Arthrodesmus sp.	-	+
Closteriopsis longissima Lemm.	-	+
Coelastrum microporum	+	+
Crucigenia crucifera	-	+
Crucigenia quadricauda	-	+
Korshikoviella limnetica	-	+
Krichneriella lunaris (Kirchner) Moeb	+	-
Oocystis gigas	+	+
Pediastrum duplex Var. reticulatum	-	+
Pediastrum simplex Var. Duodenarium (Bailey)	+	+
Pediastrum tetras Var. tetraedon	+	+
Scendesmus protuberans	+	-
Scenedesmus bijugatus Var. bicellularis	+	-
Scenedesmus carinatus Lemm.	-	+

Cont…

Organisms	Basavana hole	Hirekere (Keladi)
Scenedesmus quadricauda Var. Maxima	+	+
Selenastrum gracile	+	+
Selenastrum westlii	+	-
Tetraedron minimum	+	-
Tetraedron muticun	+	-

– = Absent, + = Present

Table 3: Occurrence of Diatoms in selected lentic waterbodies of Sagar taluk, Jan. 2004 to Dec. 2005

Organisms	Basavana hole	Hirekere (Keladi)
Amphora sp.	-	+
Anomoeoneis sphacrophora (Kutz). Pu.	-	+
Cocconeis placentula (ehr).v.	+	-
Cyclotella kuetzingiana	+	+
Cymbella cuspidate Kutzing.	-	+
Cymbella cymbiformis	-	+
Cymbella lanceolata Kutz.	-	+
Cymbella muller Hustedt.	+	+
Cymbella tumida	+	+
Cymbella turgidula	+	-
Diatoma sp.	--	+
Fragillaria crotonensis	+	-
Fragillaria pinnata	+	+
Fragillaria virescens	+	+

Cont…

Organisms	Basavana hole	Hirekere (Keladi)
Gomphonema constrictum	+	+
Gomphonema gracile Ehr.	-	+
Gomphonema intrictum Kutz.	-	-
Gyrosigma accuminatum	+	+
Gyrosigma attenuatum	-	-
Gyrosigma kutzingii	+	+
Melosira granulata	+	+
Navicula angulatum	+	+
Navicula gracilis Ehr.	+	+
Navicula pupila	+	+
Navicula radiosa Kutz.	-	-
Navicula reinhardtii	+	+
Nitzchia acicularis	+	+
Nitzchia acuta Hantz	-	-
Pinnularia biceps	-	+
Pinnularia major	+	-
Pinnularia nobilis	-	+
Pinnularia viridis Smith	+	+
Stauroneis anceps	+	+
Suriella robusta Ehr. *V. splendida* (ehr)	-	--
Synedra acus Kutz	-	+
Synedra tabulate	-	+
Synedra ulna (Nitzsch) Her	+	-
Tabellaria flocculosa	+	+

– = Absent, + = Present

Table 4: Occurrence of Desmids in selected lentic waterbodies of Sagar taluk during January 2004 to December 2005

Organisms	Basavana hole	Hirekere (Keladi)
Closterium gracile	+	-
Closterium lunula (Mullu.) Nitzch	-	+
Closterium parvulum	-	+
Cosmarium constactum	-	+
Cosmarium depresium Nag. F. minor.f. nov.	+	+
Cosmarium portianum	+	+
Cosmarium protuberans	+	+
Cosmarium retusiformae	+	+
Cosmarium tumidum	+	+
Euastrum cuneatum	+	-
Euastrum serratum	+	-
Micrasterius sp.	+	-
Stauastrum gracile	-	+
Stauastrum sebaldi	-	+
Staurastrum cuspidatum Breb.	+	+

– = Absent, + = Present

Seasonally, chlorococcales reached their maximum during pre monsoon with 9906 O/l and their number was reduced to 9713 O/l during monsoon season (Table 8).

Agbeti and Smol[4] have recorded chlorococcales at all the water bodies and studied that, the temperate waters with a low range of temperature do not support the chlorococcales. Similar situations have never observed in the present study. Since, in all the water bodies the higher temperature was recorded i.e. above 21^{o}C.

The higher concentration of dissolved oxygen lodged small number of chlorococcales. These observations are in conformity with the findings[5]. Munawar[6] has discussed, magnesium as one of the factors regulating the distribution of chlorococcales. His

opinion was that, the water containing magnesium in the range of 25 mg/L to 60 mg/L supports the abundance of chlorococcales[6].

Table 5: Occurrence of Blue greens in selected lentic waterbodies of Sagar taluk, Jan. 2004 to Dec. 2005

Organisms	Basavana hole	Hirekere (Keladi)
Aphanocapsa banaresensis	+	-
Arthospira tenuis	-	+
Chroococcus turgidus	-	+
Coelosphaerium sp.	-	+
Merismopedia glauca	+	+
Merismopedia punctata	+	+
Nostoc microscopicum	+	+
Oscillatoria acuta	+	-
Spirulina spiroides	+	+

– = Absent, + = Present

Table 6: Occurrence of Euglenoids in selected lentic waterbodies of Sagar taluk, Jan. 2004 to Dec. 2005

Organisms	Basavana hole	Hirekere (Keladi)
Euglena acus	+	+
Euglena elastica	+	-
Euglena minuta	-	+
Phacus undulatus	-	+

– = Absent, + = Present

Diatoms

Diatoms in Basavanahole tank represented by 13 genera and 22 species (Table 2). If the diversity of diatoms is considered, the genus *Navicula* represented by 4 species followed by *Fragellaria* with 3 species, *Cymbella* with 3 species and *Pinnularia* with 2 species, *Coconies, Synedra, Stauronies, Tabellaria, Nitzchia* and *Cyclotella* with single species.

Seasonal variation of diatom population showed maximum density during post monsoon season with 6593 O/l and minimum with 5967 O/l during monsoon season (Table 7). Statistical data reveals that desmids show significant positive correlation with pH in Basavana hole Tank (Table 11).

In Hirekere tank, diatoms showed their maximum development more during post monsoon with 6942 O/l and followed by pre monsoon with 6896 O/l and monsoon season 6800 O/l with least number of organisms (Table 8). Dissolved oxygen is an important factor that influences the growth and development of diatoms. In the present investigation, dissolved oxygen content varies from 1.21 mg/L to 16.62 mg/L.

However, in the present investigation, diatoms were abundant during pre monsoon in two water bodies. This is due to the fact that the diatoms have the ability to withstand relatively high temperature ranges for their maximum development. Nevertheless, in the present investigation, temperature ranged between 21 to 33.5°C.

Desmids

The Basavanahole tank represents 5 genera and 10 species of desmids. If species diversity of desmids is considered, then *Cosmarium protuberans, C. depressum, C. portianum, C. retusiformi and C. tumidum, Euastrum cuneatum, E. serratum, Closterium gracile, Staurastrum cuspidatum and Micrasterias* sp. are recorded. (Table 4).

If density is considered, desmids recorded a minimum in the postmonsoon season and maximum in the months of monsoon. (Table 7)

In Hirekere tank, 3 genera and 11 species of desmids were noticed (Table 4). If species diversity is considered then the genus *Closterium* is represented by 2 species, whereas, *Cosmarium* represents 6 species and the genus *Staurastrum represents* 3 species. Seasonally, desmids recorded maximum of 110 O/l during pre monsoon and minimum of 108 O/l during monsoon season (Table 8).

Pandey and Pandey[7] have pointed out that the water temperature in the range of 20-30º C is favorable for the growth of the desmids. When these contentions are applied to the present investigation, the water bodies under study, during monsoon season did not experience the influence of bright sunshine because of cloudy weather as these water bodies are located almost near the foothills of Western Ghats. Similarly, the temperature during monsoon months was found to be little low, when compared to pre monsoon and post

monsoon months (Tables 6, 7, 8 and 9). However, opposite to this situation, bright sunshine coupled with high temperature was noticed during pre monsoon season. If the pattern of distribution of desmids considered, then they were found to be more during pre monsoon season and relatively low during monsoon season. The forgoing observations clearly indicate that desmids are favored by bright sunshine coupled with temperature above 25°C. Zafar[8] pointed out that the water bodies rich in calcium and magnesium do not favor the abundance of desmids.

Blue greens

Basavanahole tank supported 4 genera and 6 species, *Chroococcus turgidus, Anabaena spiroides, Arthrospira tenuis, Gleocapsa magma, Coelosphaerium* sp. *Microcystis aeruginosa, M.viridis and Oscillatoria tennuis* were found absent (Table 5). Seasonally they were more during pre monsoon season i.e. 6489 O/l and less during monsoon season 6189 O/l. Nevertheless, in post monsoon season, their number was almost equal to pre monsoon season (Table 7).

The Hirekere tank shows six genera and seven species of blue greens populations. (Table 4). Among blue greens, Arthrospira *tenuis, Chrococcus turgidus, Coelosphaerium* sp. *Merismopedia punctata, Microcystis aeruginosa* and *Nostoc microscopicum* appeared as dominant species.

Seasonally, they were more during post monsoon season of 6760 O/l and less during monsoon season with 6346 O/l (Table 8). Statistical study reveals that Blue greens showed significant positive correlation with phosphate (Table 12). A large number of investigators have considered phosphate, nitrate, free carbon dioxide, dissolved oxygen, pH and temperature as the factors that regulate the distribution of cyanophyceae members in fresh water bodies[9].

Euglenoids

In Basavanahole tank, one genera and two species of euglenoids have been encountered. If species diversity is considered, the Genus *Euglena* is represented by two species, whereas, genus *Phacus* and *Tracheolomonas* were not found in this tank.

Hirekere tank supported two genus of euglenoids represented by 3 species .This tank had poor species diversity. The genus *Euglena* is represented by two species like *Euglena elastica* and *Euglena minuta* followed by *Phacus* represented by single species i.e. *Phacus undulates.*

Table 7: Seasonal variation of phytoplankton density in Basavana hole tank, Sagar Jan. 2004 to Dec. 2005

Phytoplankton	Jan 2004 – Dec 2004			Jan 2005 – Dec 2005			Jan 2004 – Dec 2005		
	Pre Monsoon	Monsoon	Post Monsoon	Pre Monsoon	Monsoon	Post Monsoon	Pre Monsoon	Monsoon	Post Monsoon
Chlorococcales	9987	8801	9382	9174	8116	8872	9580	8458	9127
Diatoms	6503	6004	6623	6345	5930	6563	6424	5967	6593
Desmids	122	115	127	140	120	124	131	117	125
Blue greens	6759	6184	6287	6219	6194	6137	6489	6189	6212
Euglenoids	29	32	28	32	30	32	30	31	30

Table 8: Seasonal variation of phytoplankton density in Hirekere tank, Keladi (O/l)

Phytoplankton	Jan 2004 – Dec 2004			Jan 2005 – Dec 2005			Jan 2004 – Dec 2005		
	Pre Monsoon	Monsoon	Post Monsoon	Pre Monsoon	Monsoon	Post Monsoon	Pre Monsoon	Monsoon	Post Monsoon
Chlorococcales	9911	9773	9884	9901	9654	9911	9906	9713	9897
Diatoms	6884	6719	6885	6909	6882	7000	6896	6800	6942
Desmids	111	102	115	110	115	105	110	108	110
Blue greens	6567	6276	6718	6791	6417	6803	6679	6346	6760
Euglenoids	24	24	26	26	23	28	25	23	27

Table 9: Seasonal variation of physico-chemical parameters of Basavana hole tank, Sagar

Parameters	Jan. 2004 to Dec. 2004			Jan. 2005 to Dec. 2005		
	Pre Monsoon	Monsoon	Post Monsoon	Pre Monsoon	Monsoon	Post Monsoon
Atmospheric temp.	33.25	27.12	28.87	34.87	27.75	28.0
Water temp.	30.25	24.5	26.25	30.87	26.12	26.12
pH	7.82	7.47	7.62	7.85	7.57	7.47
Electrical conductivity	115.54	81.25	84	113.75	71.75	104.0
Total dissolved solids	73.92	51.98	53.76	72.8	45.92	47.68
Total solids	155	98.12	109.97	139.3	84.23	89.56
Turbidity	15.72	15.67	20.27	11.12	66.25	12.30
Dissolved oxygen	6.65	4.51	9.52	6.88	6.38	7.54
Biological oxygen demand	2.05	2.92	1.50	2.8	2.33	1.34
Free carbon dioxide	77	8.8	7.7	9.13	10.23	8.8
Chloride	14.53	12.98	10.64	16.41	18.51	15.95
Calcium	7.78	5.46	6.79	7.01	5.25	6.09
Magnesium	3.62	3.09	3.57	4.12	4.15	3.31
Total hardness	34	26.33	32	35.3	31.5	27.33
Total alkalinity	44	42.5	37.5	52.5	52.5	45.0
Total acidity	5.20	6.87	5.37	15	15	6.25
Phosphate	0.020	0.08	0.003	0.010	0.055	0.038
Nitrate	0.13	0.19	0.13	0.15	0.15	0.17
Sulphate	18.26	10.12	25.26	27.83	25.92	20.28
Sodium	3.02	3.1	2.38	1.15	1.15	1.92
Potassium	2.55	2.75	2.25	1.0	0.72	2.63

All the parameters are in mg/L except pH, Electrical conductivity (μmhos/cm) and temp. (°C).

Table 10: Seasonal variation of physico-chemical parameters of Hirekere tank, Keladi

Parameters	Jan. 2004 to Dec. 2004			Jan. 2005 to Dec. 2005		
	Pre monsoon	Monsoon	Post monsoon	Pre monsoon	Monsoon	Post monsoon
Atmospheric temp.	31.62	29.37	30.5	33.87	27.25	28.12
Water temp.	28.62	26.78	27.25	30.87	25.87	26.5
pH	8.07	7.2	7.67	6.92	7.45	7.47
Electrical conductivity	123.5	65.75	7.8	85.75	61.6	77.75
Total dissolved solids	79.7	42.08	49.12	54.97	39.04	49.76
Total solids	169.3	84.42	100.25	101.37	77.13	104.75
Turbidity	18.35	18.85	21.72	9.5	53.25	22.15
Dissolved oxygen	6.74	4.35	10.86	8.37	5.26	8.20
Biological oxygen demand	3.71	2.99	4.22	7.27	1.77	4.35
Free carbon dioxide	8.8	6.6	7.7	11	9.13	8.8
Chloride	18.43	14.17	12.75	20.54	17.72	11.34
Calcium	10.78	5.23	6.52	6.85	4.2	6.69
Magnesium	3.67	2.36	2.77	1.98	3.27	3.33
Total hardness	42	22.83	29.15	26	26.5	30.5
Total alkalinity	47.5	30	32.5	48.25	35	37.5
Total acidity	8.75	6.25	7.5	10	13.75	10.0
Phosphate	0.13	0.047	0.0032	0.005	0.045	0.005
Nitrate	0.12	0.19	0.18	0.12	0.13	0.20
Sulphate	23.61	8.95	25.40	14.46	22.55	24.29
Sodium	3.02	2.77	2.45	1.45	1.02	2.55
Potassium	1.92	1.65	1.45	0.57	0.72	1.12

All the parameters are in mg/L except pH, Electrical conductivity (μmhos/cm) and temp. (°C)

Seasonally, euglenoids recorded maximum of 27 O/l during post monsoon season and less density during monsoon season (Table 7 and 8). Seasonal variation of phytoplankton density in Basavanahole tank is depicted in Figs. 1-2 and Seasonal variation of phytoplankton density in Hirekere tank is depicted Figs. 3-4.

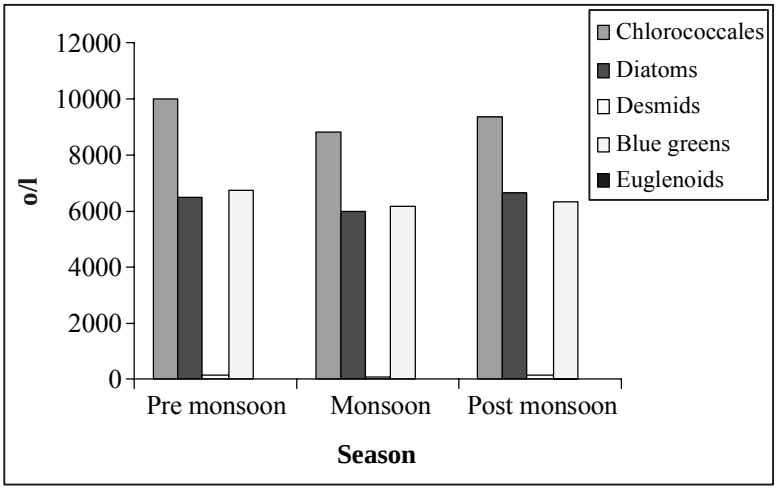

Fig 1: Seasonal variation of phytoplankton density in Basavana hole tank, 2004

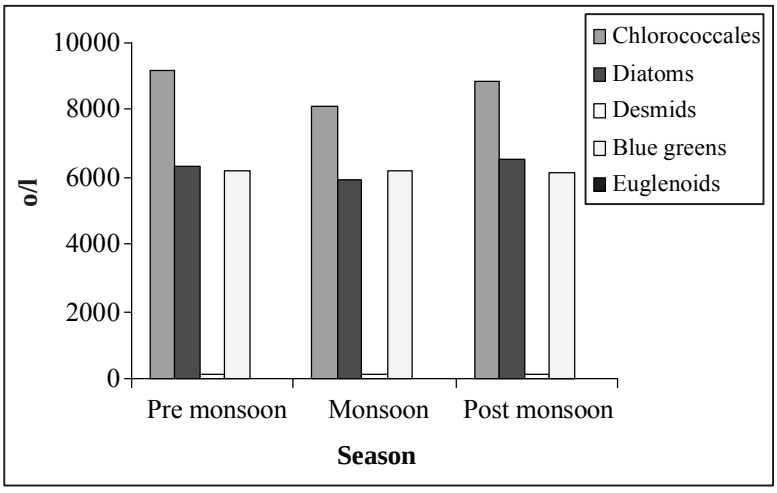

Fig 2: Seasonal variation of phytoplankton density in Basavana hole tank, 2005

Table 11: Correlation matrix (Pooled) of physico-chemical parameters v/s different groups of phytoplankton in Basavanahole tank.

Parameters	Chlorococcales	Diatoms	Desmids	B. greens	Euglenoids
Atmospheric temp.	**0.55**	0.21	0.19	0.30	0.27
Water temp.	0.37	0.20	0.09	0.35	0.17
pH	0.40	0.03	**0.54**	0.14	-0.33
Electrical conductivity	**0.75**	0.00	0.24	0.42	0.12
Total dissolved solids	**0.75**	0.00	0.24	0.42	0.12
Total solids	**0.82**	0.07	0.22	**0.49**	0.07
Turbidity	-0.34	-0.42	-0.10	-0.14	0.00
Dissolved oxygen	-0.20	0.05	-0.17	-0.11	-0.08
Biological oxygen demand	-0.08	-0.20	-0.34	-0.08	0.24
CO_2	**-0.53**	-0.53	-0.03	-0.31	-0.06
Chloride	-0.14	0.04	-0.01	-0.06	0.03
Calcium	0.37	-0.03	0.11	0.34	0.02
Magnesium	0.13	0.07	-0.02	0.13	-0.34
Total hardness	0.35	-0.09	0.10	0.32	-0.24
Alkalinity	0.28	0.00	0.30	0.08	0.00
Acidity	-0.31	-0.35	0.40	-0.23	0.04
Phosphate	-0.27	-0.44	-0.41	-0.19	**0.41**
Nitrate	0.13	-0.08	-0.02	-0.09	0.22
Sulphate	0.08	0.17	0.33	-0.17	-0.38
Sodium	0.42	0.20	-0.31	0.30	0.12
Pottassium	0.08	0.14	-0.18	0.13	0.00

Note: Positive - negative correlation, Bold values = significant at 5%

Table 12: Correlation matrix (Pooled) of Physico-chemical parameters v/s different groups of Phytoplankton in Hirekere tank

Parameters	Chlorococcales	Diatoms	Desmids	B. greens	Euglenoids
Atmospheric temp.	0.07	0.07	-0.20	0.06	-0.26
Water temp.	-0.02	0.08	-0.14	0.11	0.03
pH	0.20	0.32	0.17	0.18	-0.36
Electrical conductivity	0.27	0.07	-0.15	0.09	-0.19
Total dissolved solids	0.26	0.07	-0.15	0.08	0.19
Total solids	0.26	0.09	-0.13	0.11	-0.14
Turbidity	-0.45	0.04	-0.06	-0.20	-0.33
Dissolved oxygen	0.28	0.15	0.15	0.45	0.27
Biological oxygen demand	0.20	-0.07	-0.17	0,35	0.24
CO_2	0.20	0.12	-0.16	0.22	0.26
Chloride	-0.13	-0.19	0.30	-0.01	0.00
Calcium	0.34	0.07	-0.06	0.23	-0.05
Magnesium	-0.16	-0.18	0.05	0.06	-0.06
Total hardness	0.19	-0.02	0.00	0.23	-0.08
Alkalinity	0.10	0.31	0.00	0.24	-0.20
Acidity	-0.09	0.21	0.36	0.08	0.10
Phosphate	-0.22	**-0.51**	-0.08	-0.60	0.11
Nitrate	0.22	-0.11	-0.44	-0.03	0.35
Sulphate	0.21	0.27	0.30	0.42	0.05
Sodium	0.33	-0.02	-0.28	0.05	0.05
Pottassium	0.21	-0.05	-0.17	-0.03	**-0.32**

Note: Positive – negative correlation, Bold values = significant at 5%

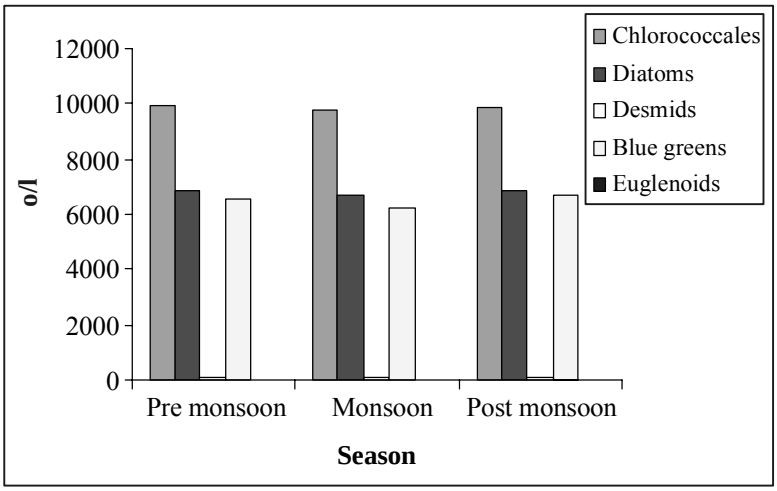

Fig 3: Seasonal variation of phytoplankton density in Hirekere tank, 2004

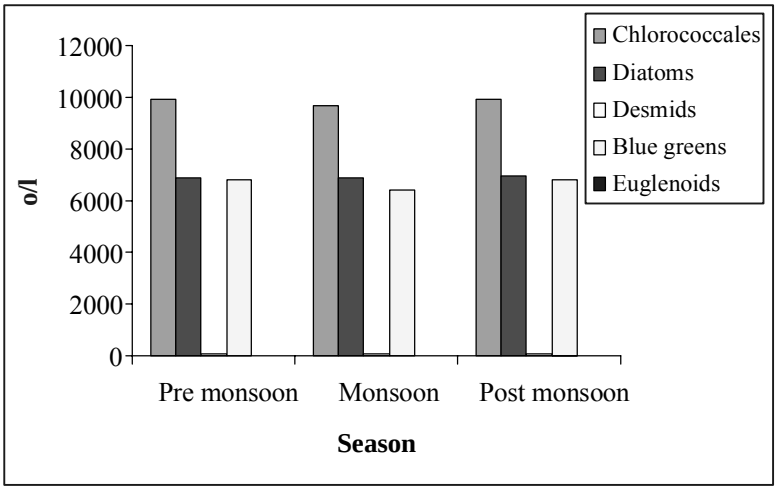

Fig 4: Seasonal variation of phytoplankton density in Hirekere tank, 2005

CONCLUSION

The present investigation confirms that the physico-chemical parameters show lesser nutrients and the biological parameters indicate the mesotrophic condition of Hirekere tank and Basavana hole tank.

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