Dynamics of Phytoplankton and Their Correlation with Physicochemical Characteristics in Gulur Wetland, Tumakuru District, Karnataka, India

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ABSTRACT

An investigation on quantitative distribution, seasonal dynamics, phytoplankton species composition and physico-chemical characteristics of water was carried out in Gulur wetland from June 2011 to June 2013. It is found that, there is considerable variation in phytoplankton species and distinct seasonal variation. Present study recorded a total of 66 species under 37 genera belonging to five different classes. Algal composition was dominated by Diatoms (41.67%) followed by blue-greens(27.78%), chlorococcales(13.89%), euglenoids(8.33%) and desmids(8.33%). Physico-chemical factors like air and water temperature, pH, potassium, sulphate, silica, nitrate and nitrogen have direct bearing on density, diversity and periodicity of different groups of phytoplanktons and showed significant positive correlation with these groups at 5% level. All the phytoplankton groups recorded their seasonal maxima during pre-monsoon except Chlorococcales as their maximum density is recorded during post-monsoon. Inter-relationship of different physico-chemical parameters and their role with seasonal dynamics of phytoplankton is discussed.

Keywords: Algae, correlation, physico-chemical characters, phytoplanktons, wetland

INTRODUCTION

Wetlands are the most productive water resources in rural area and contribute to the surface and ground water quality. Wetlands provide water regime balance and acts as a host for aquatic flora and fauna. Wetlands considered having functions on hydrologic flux, storage and biological productivity. Planktons are important components of any aquatic ecosystem, obvious from the abundant occurrence of planktonivorous animals in marine ecosystems. Among plankton, phytoplanktons are primary source of food in marine environment, initiating food-chain that can culminate in large mammals (Waniek and Holliday, 2006). Planktonic study is a useful tool for the water quality assessment and contributes to understanding the basic nature and general economy of wetlands. Phytoplanktons acts as producers and occupy lowest trophic level in aquatic ecosystem food chain. Primary productivity has been measured for aquatic ecosystem by several workers (Singh, 1998; Synudeen Sahib, 2002; Mandal et al., 2005; Hujare and Mule, 2007). Patil and Chavan (2010) reported primary productivity of three lakes from Sangli district. Use of phytoplankton density, diversity and their association as biological indicators in water quality assessment and trophic status has studied by Chaturvedi et al., (1999). Seasonal variation of phytoplankton in lakes has been studied by Kaur et al., (2001) and Jarousha, (2002). Even though lot of data is available on occurrence of phytoplankton and primary productivity of lakes (Bhosale et al., 2010a) and physico-chemical parameters, species composition and seasonal variation in phytoplankton community in Indian coastal areas (Vengadesh Perumal et al., 2009), not much of the work has done in regional and local bodies. Present

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investigation has been undertaken to study the seasonal variations of phytoplankton and physico-chemical characteristics in Gulur wetland ecosystem of Tumakuru district.

MATERIAL AND METHODS

Morphometry of Study Area

Gulur wetland is a perennial fresh water body situated towards South, 4 Kms from Tumakuru city at 13º 15' to 13º 20' North latitude and 77º 05' to 77º 10' East longitude. Total area of the wetland is 1.09 km^2. It is constructed by the then Palegar Guli Baachi Deva during 1171 in memory of his wife. Wetland is rectangular in shape with a concave margin towards South (INSAT IRS-1D image: Figure 1). It receives water from Mydala tank and Kallur halla during monsoon and held by raised East West earthen bund. Water is mainly used for agricultural practices. Besides, used for washing clothes, cleaning vehicles, cattle bathing and domestic activities. Immersion of biggest Lord Ganesha idol also takes place every year contributes further addition of different types of chemicals, paints and organic matters.

Water and Phytoplanktons Analysis

Surface water samples were collected in 2 litre plastic cans between 9 to 11AM at monthly intervals for two years (June 2011 to June 2013). Air and water temperature, pH were measured on the spot. Collection, preservation, enumeration of phytoplankton and analysis of physico-chemical characteristics were carried out by Trivedy and Goel (1986) and APHA (1985) methods. One litre of plankton sample was fixed in 10 ml of 1% lugol solution. Identification of phytoplankton up to species level was made with the help of standard references (Biswas, 1980; Prescott, 1982; Sarode and Kamat, 1984). Quantitative enumeration of phytoplankton was made using sedge wick rafter counting chamber.

RESULTS AND DISCUSSIONS

Monthly and seasonal variations of physico-chemical parameters are recorded (Table 1 and 2). Water temperature varied from 22°C to 34°C is influenced by ambient temperature. As temperature has no direct effect upon aquatic organisms up to 40°C, there is no direct effect on fauna and flora as pointed out by Verma and Shukla (1968). Kaur et al., (2001) reported that, temperature is the major factor influencing species richness and diversity and it is true in the present experiment. Seasonal variation in productivity is related to variation in temperature. Similar findings were reported by Sondergaard and Sand-Jensen (1979); Spencer and King (1989). Temperature is an important factor regulates biogeochemical activities in the aquatic environment. Variation in water temperature in the present study may be due to sampling time and season (Jayaraman et al., 2003; Tiwari et al., 2004). Water temperature influences aquatic weed, algal blooms (Zafer, 1968) and surrounding air temperature (Gupta and Sharma, 1993). All metabolic and physiological activity and life processes such as feeding, reproduction, movements and distribution of aquatic organisms are influenced by water temperature. Water temperature showed significant positive correlation with biological oxygen demand, sulphate, nitrate and silica. pH varied from 6.91 to 7.17 and fall in between slightly acidic to neutral condition and is positively correlated to nitrate. Turbidity varied from 17.84 to 33.81 NTU. Higher values of turbidity attributed to inflow of water during monsoon that in turn reduces photosynthetic activity of algae leading to carbon dioxide accumulation. Statistically, turbidity showed significant positive correlation with conductivity and phosphate. Electrical conductivity varied from 76.81 to 133.87 μ mhos/cm was generally higher (Habib et al., 1977) may be due to precipitation. Conductivity established significant positive correlation with phosphate. Dissolved oxygen is a useful parameter in assessing water quality and providing a check in pollution. Higher concentration of dissolved oxygen during October, November and February may be due to active photosynthesis by algae. Reduction in dissolved oxygen is observed during pre-monsoon and monsoon seasons. Statistically, dissolved oxygen remained as an independent variable. Biological oxygen demand indicates low level of biodegradable substances. Patil and Gouder (1985) arrived at the same conclusion while working on water quality of lentic water bodies. Biological oxygen demand is positively correlated to sulphate, phosphate and silica. Water hardness is due to carbonates, bicarbonates, chloride and sulphate of calcium and magnesium. Total hardness of water depends upon soil characteristics in wetlands. In the present investigation, total hardness of water varied from 26 to 110 mg/l, maximum recorded during monsoon and minimum in pre-monsoon. Total hardness showed significant positive correlation with calcium and magnesium. Total alkalinity of water ranged from 60 to 115 mg/l. It was low during post-monsoon and high in pre-monsoon and monsoon seasons. Total alkalinity showed significant positive correlation with chloride and nitrate. Calcium content of water varied from 7.21 to 28.85 mg/l. Saksena et al., (2006) recorded high calcium during summer. Presently high calcium recorded during monsoon is due to dilution. Magnesium is the main constituent of chlorophyll and its concentration remains lower than calcium (Jutshi and Khan, 1988) is true in the present study. Magnesium concentration ranged between 1.95 to 14.13 mg/l, recorded high during post-monsoon and low in monsoon. Calcium and magnesium showed significant positive correlation with chloride and nitrate respectively (Table 3).

Sulphate is a naturally occurring anion. Discharge of sewage and domestic activities tend to increase its concentration. Sulphate recorded high during pre-monsoon. Zutshi and Khan (1988) stated that, polluted water is comparatively rich in sulphate and in the present results it varied between 15.34 to 135.57 mg/l, falls within BIS permissible limit. Most important source of chloride in water is domestic sewage discharge. Man and animals excrete high quantities of chloride along with nitrogenous compounds. In the study, chloride content varied between 21.3 to 45.44 mg/l. With reference to seasonal variation, chloride recorded high during pre-monsoon and lower in post-monsoon. Sulphate and chloride exhibit positive correlation with phosphate, silicate, nitrate respectively. Phosphate is the nutrient element in primary productivity of fresh waters. It is present in lesser quantities than it is required by biotic communities. In the study, phosphate ranges from 0.68 to 0.94 mg/l. Phosphate recorded higher during monsoon season due to influx of agricultural runoff. Significant positive correlation is established between phosphate and silica. Nitrate concentration varied between 6.1 to 7.1 mg/l. Saravanakumar et al., (2008) observed higher nitrate during monsoon is attributed to drainage and it is true in this study. Nitrate showed significant positive correlations with silica and total solids (Table 3). Silica plays an important role in diversity and abundance of diatoms in fresh water bodies. Silica ranges from 32.7 to 40.3 mg/l. Silica found high during pre-monsoon. Hegde (1986) observed that, rise in temperature during summer coupled with evaporation increases silica content in natural waters is true in the present study. Total solids are high in wetlands receiving sewage (Vengadesh Perumal et al., 2009). In the experiment, wetland investigated receives no such sewage yet fluctuated between 80 to 400 mg/l. Seasonally, total solids recorded maximum during pre-monsoon.

Phytoplanktons

Totally 66 species under 37 genera belonging to 5 different classes are identified (Table 4). Seasonal abundance of phytoplanktons (org/l) is recorded (Table 5). Algal composition was dominated by diatoms (41.67%) followed by blue-greens (27.78%), chlorococcales (13.89%), euglenoids (8.33%) and desmids (8.33%) (Figure 2).

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Diatoms

Diatoms are ubiquitous, unicellular microorganisms form the basic bulk of planktonic population in freshwaters characterised by siliceous cell wall (Round et al., 1990). Sabata and Nayar (1987) recorded highest number of diatoms during summer coupled with silica. In the present investigation, diatoms reached their peaks during pre-monsoon coupled with higher temperature. Density and diversity of diatoms is positively correlated with air and water temperature, sulphate, nitrate and silica.

Blue-Greens

Blue-greens are photosynthetic prokaryotes derive electrons during assimilation of carbon di-oxide by simple red-ox process. They present in almost all fresh water forms and chiefly form dense water blooms. Tripathi and Pandey (1995) observed maximum number of blue-greens during summer and minimum in winter. Similar results observed in the present investigation. Seasonal dynamics of Blue-greens is positively correlated with air and water temperature, sulphate nitrate and silica.

Chlorococcales

Chlorococcales occur as greenish scum on the surface of stagnant water. Factors like high temperature and bright sunlight are favourable for the growth of chlorococcales. In the present investigation, temperature has no bearing on chlorococcales growth. Seasonally maximum density is recorded during post-monsoon and low during monsoon. Factors like turbidity, conductivity, total hardness and chloride are positively correlated with chlorococcales dynamics.

Euglenoids

Euglenoids occur in greater number in polluted water bodies. Tripathi and Pandey (1995) have recorded maximum euglenoids during monsoon and low during post-monsoon. Similar findings have been made in the present study. Density and diversity of euglenoids is positively correlated with air and water temperature, sulphate, nitrates and silica.

Desmids

Desmids are sensitive organisms; act as indicators of water pollution. In the present investigation, desmids recorded maximum during pre-monsoon and minimum during monsoon months. Desmids population showed significant positive correlation with air and water temperature, pH, sulphate and nitrate.

CONCLUSION

From the present results, it can be concluded that, phytoplankton population of the selected wetland is closely related with the seasonal variations in hydrography. Phytoplankton diversity, distribution and richness are almost similar to that of other major Indian wetland systems. Present data on physico-chemical parameters in relation to phytoplankton distribution and abundance forms a useful tool for further ecological assessment and monitoring of wetland ecosystems.

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Table 1. Physico-chemical parameters during 2011-2013

MONTHS	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23
J	27	26	6.81	32.14	122.41	6.89	15.4	5.27	24	64	75	12.83	7.8	81.7	154.54	18.46	5.2	3.2	8.4	0.89	6.2	35.7	130
J	28	26	6.90	34.31	130.86	6.48	11	0.81	80	88	50	25.63	5.84	82.3	37.43	29.82	5.3	3.2	8.5	0.91	6	33.1	150
A	27	25	6.82	33.24	135.92	5.88	19.8	0.82	76	82	40	20.04	7.8	83.1	59.6	19.88	5.3	3.3	8.6	0.87	6.1	32.9	170
S	28	25	7	30.19	118.31	7.30	4.4	0.41	60	52	45	10.42	6.33	84.2	62.5	28.14	4.8	3.6	8.4	0.81	6	36	100
O	30	26	7.12	26.33	98.12	10.13	6.6	1.01	52	96	60	15.23	14.13	85	52.63	22.72	4.8	3.7	8.5	0.79	6.1	35	50
N	29	24	7.13	23.14	83.31	12.16	17.6	1.82	24	68	65	15.23	7.31	85.4	58.97	24.14	4.8	3.8	8.6	0.71	6.3	34.1	100
D	26	23	7.25	21.57	73.16	6.69	15.4	0.41	32	64	80	16.03	5.85	85.9	30.24	22.72	4.8	4	8.8	0.68	6.6	32.8	150
J	29	25	7.27	19.31	78.31	8.11	8.8	0.41	28	66	75	14.43	7.31	86.1	35.4	24.14	4.8	4.2	9	0.61	6.5	32.1	190
F	32	28	7	24.74	94.81	10.94	6.6	2.43	20	64	85	16.03	5.85	85.7	100.2	28.4	6.5	3.3	8.9	0.7	6.9	34.4	200
M	33	29	7.12	26.27	97.54	5.67	11	0.81	16	58	90	18.44	2.92	84.2	107.57	29.82	5.2	3.5	8.7	0.87	7	35.9	290
A	34	30	7.1	28.64	104.32	6.08	11	2.03	32	64	100	20.84	2.92	81	109.72	35.5	5.2	3.3	8.5	0.89	6.9	37.3	150
M	32	30	7.14	30.16	115.81	7.09	8.8	3.04	28	30	85	8.01	2.44	80.3	102.23	29.82	5.3	3.2	8.5	0.91	6.9	39.9	110
J	26	23	7.10	31.46	121.94	6.89	6.6	3.85	24	60	80	12.02	7.31	82.1	119.54	28.4	5.3	3.1	8.4	0.89	6.3	36	100
J	28	26	6.91	33.81	129.72	6.28	11	1.22	32	94	75	27.25	6.33	82.5	42.43	32.66	5.2	3.2	8.4	0.91	6.1	33.9	110
A	27	24	6.92	32.62	133.87	6.28	13.2	1.01	36	110	115	28.85	9.26	83	48.6	36.92	5.2	3.4	8.6	0.89	6.2	33.1	180
S	26	24	6.97	29.31	114.39	8.31	11	0.21	48	54	65	8.82	7.8	83.4	62	22.72	4.8	3.8	8.5	0.84	6.1	35.1	150
O	31	27	7.10	24.18	110.91	10.94	6.6	3.24	48	92	85	16.03	12.67	84.9	15.34	21.3	4.7	3.8	8.5	0.8	6.2	34.8	100
N	28	24	7.12	24.43	96.32	12.36	22	2.63	4	64	75	14.43	6.82	85.1	60.58	25.56	5	3.9	8.9	0.77	6.4	34.3	150
D	25	22	7.15	19.92	84.16	7.09	13.2	0.61	48	66	90	17.64	5.36	85.7	39.14	29.82	4.9	4.2	9.1	0.7	6.8	33.2	200
J	30	24	7.16	17.84	76.81	8.51	6.6	0.4	36	66	80	13.62	7.8	85.9	30.2	28.4	4.7	4.4	9.1	0.68	6.4	32.7	160
F	33	29	7.14	26.17	86.47	10.54	6.6	2.23	24	60	90	19.23	2.92	85.6	98.11	26.98	5.2	3.5	8.7	0.69	6.7	35.7	200
M	33	29	7.10	27.14	92.54	4.86	11	0.4	20	52	90	16.03	2.92	85	135.57	32.66	4.9	3.7	8.6	0.79	7.1	39.2	400
A	35	34	7.17	29.11	100.19	6.28	8.8	2.63	48	80	115	20.84	6.82	84.1	102.72	45.44	5.4	3.1	8.5	0.92	6.9	40.1	100
M	34	31	7.12	29.12	109.27	8.51	11	5.06	32	26	60	7.21	1.95	81.2	107.23	26.98	5.3	3	8.3	0.94	6.8	40.3	80

P1-Air temperature
P2-Water temperature
P3-pH
P4-Turbidity
P5-Conductivity
P6-Dissolved oxygen
P7-Free carbon dioxide
P8-Biological oxygen demand
P9-Chemical oxygen demand
P10-Total hardness
P11-Total alkalinity
P12-Calcium
P13-Magnesium
P14-Potassium
P15-Sulphate
P16- Chloride
P17- Organic nitrogen
P18- Ammonical nitrogen
P19- Total kjeldahl nitrogen
P20- Phosphate
P21- Nitrate nitrogen
P22- Silica
P23- Total solids

All parameters are expressed in terms of mg/l except temperature (^{0}C), pH, turbidity (NTU) and conductivity µ mho

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Table 2. Seasonal variations in physico-chemical parameters

Physico-Chemical Parameters	2011-2012			2012-2013		
	Rainy	Winter	Summer	Rainy	Winter	Summer
Air temperature	27.5	28.5	32.25	26.75	28.5	34
Water temperature	25.5	24.5	29.5	24.25	24.25	31
pH	6.88	7.19	7.09	6.98	7.13	7.1
Turbidity	32.47	22.59	27.45	31.8	21.59	28
Conductivity	126.88	83.23	103.12	124.98	92.05	97
Dissolved oxygen	6.64	9.27	7.45	6.94	9.73	7.5
Free carbon dioxide	12.65	12.1	9.35	10.45	12.0	9.4
Biological oxygen demand	1.83	0.91	2.08	1.57	1.72	2.6
Chemical oxygen demand	60	34	24	35	34	31
Total hardness	71.5	73.5	54	79.5	72	55
Total alkalinity	52.5	70	90	83.75	82.5	88.75
Calcium	17.23	15.23	15.83	19.24	15.43	16
Magnesium	6.94	8.65	3.53	7.68	8.16	3.7
Potassium	82.83	85.6	82.8	82.75	85.4	84
Sulphate	78.52	44.31	104.93	68.14	36.32	1.11
Chloride	24.08	23.43	30.88	30.18	26.27	33
Organic nitrogen	5.15	4.8	5.55	5.13	4.83	5.2
Ammonical nitrogen	3.33	3.93	3.33	3.35	4.08	3.3
Total kjeldahl nitrogen	8.84	8.73	8.65	8.48	8.9	8.5
Phosphate	0.87	0.70	0.84	0.88	0.74	0.8
Nitrate nitrogen	6.08	6.38	6.93	6.18	6.45	6.9
Silica	34.43	33.5	36.88	34.53	33.75	38.82
Total solids	137.5	122.5	187.5	135	152.5	195

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Table 3. Correlation matrix of Physico-chemical parameters v/s physico-chemical parameters during 2011-2013

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17
P1	1.000																
P2	0.881	1.000															
	0.000*																
P3	0.322	0.134	1.000														
	0.125	0.534															
P4	-0.067	0.241	-0.755	1.000													
	0.755	0.256	0.000*														
P5	-0.240	0.045	-0.821	0.920	1.000												
	0.258	0.834	0.000*	0.000*													
P6	0.053	-0.161	0.247	-0.440	-0.365	1.000											
	0.806	0.452	0.245	0.031	0.079												
P7	0.246	0.379	-0.102	0.266	0.237	0.230	1.000										
	0.246	0.068*	0.635	0.210	0.264	0.280											
P8	-0.231	-0.289	-0.335	0.158	0.273	0.003	-0.291	1.000									
	0.277	0.170	0.110	0.461	0.197	0.990	0.168										
P9	0.361	0.340	0.337	-0.180	-0.244	-0.159	0.108	0.134	1.000								
	0.083	0.104	0.107	0.399	0.250	0.458	0.615	0.532									
P10	0.002	-0.018	-0.321	0.283	0.263	-0.293	-0.322	0.783	0.328	1.000							
	0.993	0.932	0.126	0.180	0.215	0.165	0.125	0.000*	0.118								
P11	-0.372	-0.442	-0.167	-0.072	0.135	0.340	-0.096	0.701	-0.161	0.106	1.000						
	0.074	0.031	0.435	0.738	0.529	0.104	0.655	0.000*	0.452	0.623							
P12	0.427	0.546	-0.136	0.360	0.132	-0.261	0.555	-0.504	0.236	-0.259	-0.509	1.000					
	0.038*	0.006*	0.526	0.084	0.540	0.218	0.005*	0.012*	0.267	0.222	0.011*						
P13	0.388	0.436	0.287	0.077	-0.063	-0.453	-0.177	0.112	0.666	0.453	-0.339	0.099	1.000				
	0.061*	0.033	0.173	0.719	0.772	0.026*	0.408	0.601	0.000*	0.026*	0.105	0.646					
P14	0.133	0.428	-0.528	0.860	0.811	-0.481	0.409	0.024	0.001	0.151	-0.134	0.403	0.214	1.000			
	0.537	0.037	0.008*	0.000*	0.000*	0.017*	0.047*	0.911	0.996	0.482	0.531	0.051*	0.316				
P15	0.639	0.599	0.539	-0.331	-0.502	-0.165	0.128	-0.517	0.588	-0.126	0.682	0.502	0.457	-0.103	1.000		
	0.001*	0.002*	0.007*	0.114	0.012	0.441	0.552	0.010*	0.003*	0.556	0.000*	0.012	0.025*	0.633			
P16	0.644	0.811	0.161	0.300	0.101	-0.198	0.501	-0.558	0.248	-0.367	-0.472	0.706	0.331	0.530	0.549	1.000	
	0.001*	0.000*	0.452	0.154	0.639	0.353	0.013*	0.005*	0.242	0.078	0.020*	0.000*	0.114	0.008*	0.005*		
P17	0.190	0.063	0.053	-0.184	-0.260	-0.348	-0.400	-0.137	0.296	0.193	-0.440	0.262	0.174	-0.245	0.520	-0.005	1.000
	0.375	0.769	0.806	0.391	0.220	0.095	0.053*	0.523	0.160	0.367	0.032	0.215	0.416	0.248	0.009*	0.980	

+ = Positive Correlation, - = Negative Correlation, * = Significant at 5% level

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Table 4. Phytoplankton species recorded during 2011-2013

Diatoms	***Blue-Greens***
Amphora ovalis	*Anabaena spiroides*
Cocconeis placentula	*Chroococcus turgidus*
Cyclotella meninghiniana	*Coelosphaerium kuetzingianum*
Cymbella cymbiformis	*Gloeocapsamagma*
Cymbella lanceolata kutz	*Gloeocapsa puncatata*
Cymbella turgidula	*Merismopedia glauca*
Fragillaria virescens	*Merismopedia punctate*
Gomphonema gracile Her	*Microcystis aeruginosa*
Gomphonema truncatum	*Microcystis marginata*
Gyrosigma attenuatum	*Mycrocystis viridis*
Melosira granulate	*Nostoc linckia*
Navicula cuspidate	*Oscillatoria earlei*
Navicula pupila	*Oscillatoria tenuis*
Navicula radiosa	*Scytonema hofmannii*
Navicula tuscula	*Spirulina princeps*
Navicula reinharditii	*Spirulina spiroides*
Navicula salinarum	
Navicula crucicula	***Euglenoids***
Nitzchia recta	*Euglena minuta*
Pinnularia acrosphaeria	*Euglena polymorpha*
Pinnularia major	*Euglena proxima*
Rhopalodia gibberula Her	*Phacus accuminatus*
Tabellaria flocculosa	*Phacus ankylonoton*
Surirella robusta	*Phacus undulates*
Synedra ulna	*Trachelomonas armata*
Synedra tabulate	
Chlorococcales	***Desmids***
Ankistrodesmus falcatus	*Closterium gracile*
Ankistrodesmus gracilis	*Cosmarium melanosporum*
Crucigenia tetrapedia	*Staurastrum gracile*
Pediastrum duplex var. reticulatum	
Pediastrum tetras	
Pediastrum simplex	
Scenedesmus bijugatus	
Scenedesmus quadricauda	
Tetraedon muticon	

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Table 5. Seasonal variations in phytoplanktons groups (Org/L)

Phytoplanktons	*2011-2012*			*2012-2013*		
	Rainy	*Winter*	*Summer*	*Rainy*	*Winter*	*Summer*
Diatoms	6051	5976	6979	6560	6761	6967
Blue-Greens	11298	11485	12297	11151	11129	12075
Chlorococcales	11630	12454	12981	11880	12747	11915
Euglenoids	99	71	110	106	78	108
Desmids	31	53	70	33	49	68

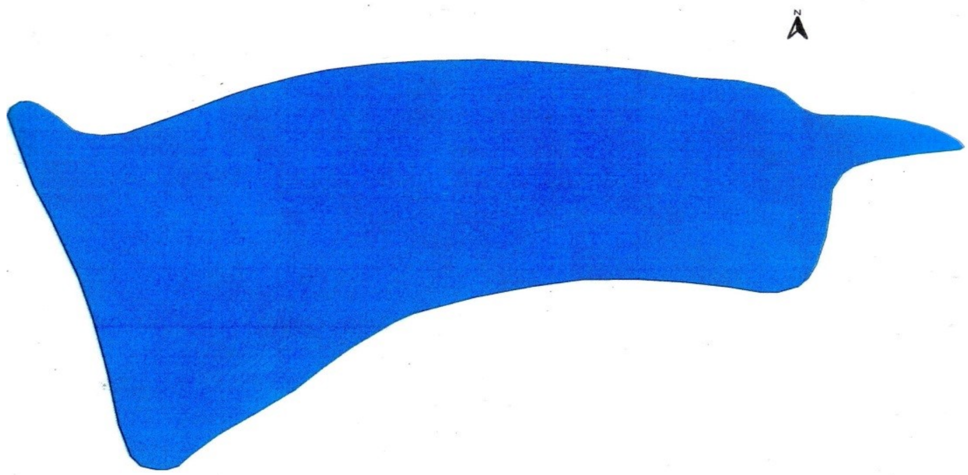

Figure 1. View of Gulur wetland as recorded by IRS-1D

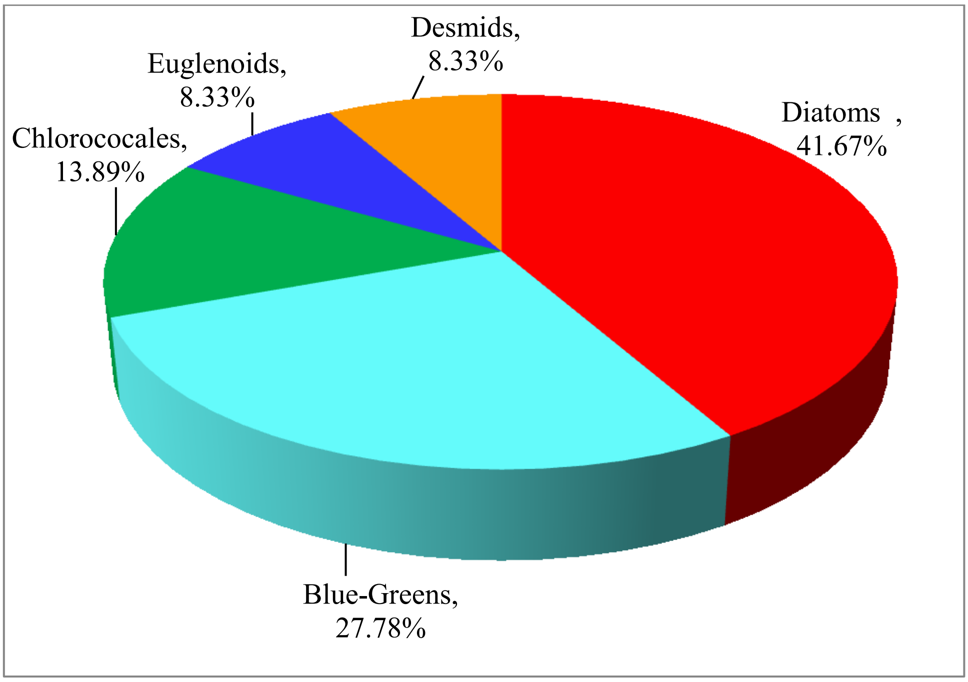

Figure 2. Relative abundance of phytoplanktons in Gulur wetland

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