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Interrelationship between phytoplankton groups and water chemistry variables in two lakes of Mysore using multivariable analysis

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Abstract
Interrelation between plankton groups and water chemistry variables in two lakes of Mysore (Hadhinaru lake and Arasanakere lake).were studied. Multivariable analysis was used for the study; Canonical Correspondence Analysis indicated that in Hadhinaru lake Desmids and Euglenaceae were negatively correlated to physico-chemical parameters and in Arasanakere lake very few plankton showed +ve correlations. Desmids showed high correlation with physico-chemical variables correlation coefficient were significantly high in both water bodies CCA serves as an important tool in freshwater ecological studies.

Keywords: phytoplankton, water chemistry, interrelationship, CCA biplot, PCA

Introduction
Many of the earlier studies on the correlations of the physic-chemical parameters and the phytoplankton counts have discussed based on the mean appearance Sarwar and Wazir (1991), Veeresh Kumar and Hosmani (2006) [17], Hosmani (2006) [17], Noor Alam (2001) [5], Singh R (1990) [14]. these have not yielded significant results. The dependency of certain phytoplankton an important water chemistry variables cannot be traced. Multivariate analysis such as the CCA or the PCA when applied to the ecological data provide an excellent opportunity for a comparative account. Some of the works when have used multivariate analysis in ecological studies are Pandey (1998), Rajendra Nair (1999), Rao (1993), Singh and Mahajana (1987) [15]. Positive and negative relations can be easily detected and this data can be of usefulness in fresh water ecological studies.

2. Materials and Methods
2.1 Description of lakes
The study consists of analysis of physico-chemical and planktons from Hadhinaru and Arasanakere lake of Mysore district. The geographical features of the lakes are as follows.

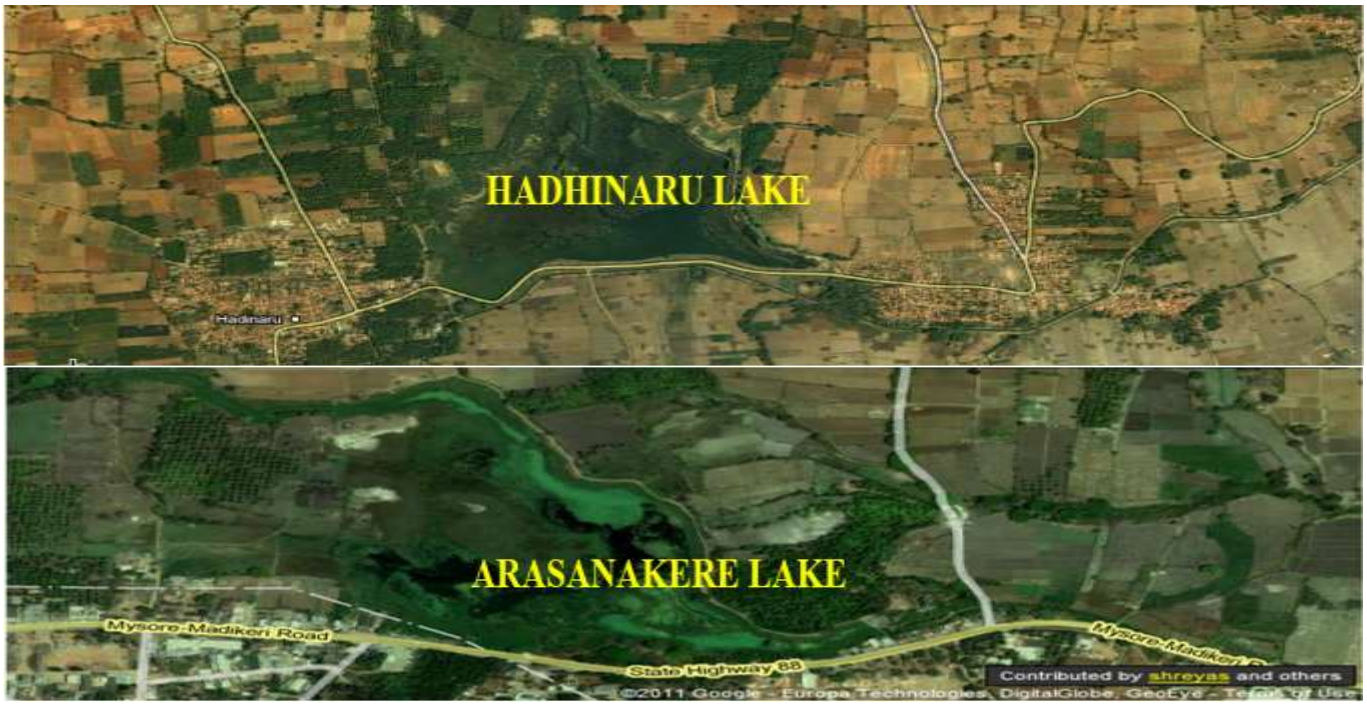


Fig 1: Satellite images of lakes in Mysore District

2.2. Hadhinaru lake (Nanjangudu taluk)

It is located at $12^0$2'02" North latitude and 7 $6^0$41' 38" East longitude at an altitude of 653.35 meters above MSL. It is situated 18 kms away from Mysore city. It has an independent catchment area of 8.59 sq. km with a water spread area of 0.10 hectares having a live capacity of 54.4 Mcft. The maximum depth of the lake when full is 5 meters. The Kabini river feeds the lake through a channel. The water in it is used for irrigation and the villagers surrounding the lake use it for domestic purposes and cattle raring. Abundant aquatic vegetation is present.

2.3. Arasanakere lake (Piriyapatna taluk)

The lake is situated about 60 km away from Mysore on the Mysore – Kodagu highway; south west of Periyapatna taluk. It has a catchment area of almost 210 acres. The maximum depth of the lake when full is about 6 meters and has 3 outlets. The soil type within the lake is black. It is rich in aquatic vegetation. The water in it is used for irrigation and is polluted by sewage. Human disturbances around the lake are in excess. The physico-chemical characterization of water samples collected from lakes has been carried out as per APHA (1995) [1].

2.4 Chemical analysis of water

The collection and analysis of water samples were done as per the methods prescribed by APHA 1995 [1] edition. During the period from July 2013 to June 2014.

2.5 Phytoplankton Analysis

Samples for the estimation of phytoplankton were collected from surface waters at various places of the lakes simultaneously. There were collected at an interval of 30 days. Precaution was taken to avoid filamentous algae and floating debris of angiosperm origin. One liter plastic car buoys were employed for the purpose of collection. An approximate amount of 25 ml, 4% formaldehyde followed by a few drops of Lugol's iodine were added to the sample which was sediment in glass columns as described by Welch (1948). The amount thus sediment was further reduced to 20 ml by centrifugation and on certain occasions when the plankton population was thin it was adjusted to 10 ml or less. These samples were preserved and stored for further analysis. Semi-permanent mounts in 50 % glycerin were prepared for identification and enumeration of plankton. Identification was done by consulting monographs of Desikachary (1959) [2], Philipose (1967) [7], Prescott (1982) [9], Scott and Prescott (1961) [10], Sarode and Kamath (1984) [13]. They were enumerated as per the methods described by Welch (1948) and Hosmani and Bharathi (1980) [3]. Plankton count was done by Lackey's drop method (1938), modified by Suxena (1987) [16]. The algae identified were recorded as organisms per liter and tabulated for further study.

3. Results and Discussions

The water chemistry variables for Hadhinaru lake are presented in Table-1 and the phytoplankton distribution in Table-2. About 30 species of plankton were recorded during the study. Among these 9 species of Bacillariophyceae, 8 species of Chlorophyceae, 4 Species of cyanophyceae, 3 species of Desmidaceae, and 5 species of Euglenophyceae, Diatoms were the dominant species and Desmids were least (Table-2). However occurrence of phytoplankton during the 12 months was not well marked. The pearsons correlation coefficient between these two variables is presented in (Table-3). pH, DO, and Chlorides showed high –ve correlations with Bacilariophyceae, while the other parameters showed +ve correlation.High –ve correlations were recorded between BOD, CO_3, SO_4 were –ve correlated to Cyanophyceae, Desmids showed high –ve correlation with all water chemistry variables. Euglenaceae also showed less –ve correlations, Highest +ve correlations among the variables was observer between Chlorococcales 59%followed by Cyanophyceae 53% and Bacillariophyceae 41% while highest –ve correlations were observed among the members of Euglenophyceae (Fig-1) which is emphasized as a CCA Biplot. In comparison the water chemistry variables and phytoplankton population in Arasanakere Lake varied to a greater extent. About 42specis of plankton were recorded in this lake. As many as 20 species of Bacilariophyceae were recorded in they occurred in meager numbers as compared to Hadhinaru lake. 7 species of chlorococcales, 8 species of cyanophyceae and 7 species of Euglenophyceae are appeared interestingly desmids did not appear in this lake or probably they were below the level of detection. The physic-chemical data nd plankton counts are presented in table 4 and 5 respectively.

The correlation coefficients are presented in table-6 highest positive correlation were observed between cyanophyceae 64%. followed by Chlorococcales 41% and Euglenaceae 35% very low –ve correlations were observed (Fig-2). The overall correlation coefficients of phytoplankton and the 17 physico-chemical variables are presented in Table-7.

Table 1: Physico-chemical characters of Hadhinaru Lake from July 2013- June- 2014

Parameters	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
pH	9	8	7	7	7	7	7.5	7.5	7.5	8	7	8
Temperature	31	28	28	32	26	25	26	29	28	32	31	29
Conductivity	1002	640	600	560	590	580	590	680	690	830	740	700
Turbidity	10.4	1.52	Nil	2	1.8	Nil	1.2	2.4	11.68	2.88	4.25	4.8
DO	7.18	7.32	10.13	7.47	4.8	5.2	6.4	4.9	6.42	4	5.61	8.9
BOD	3.8	4	1.5	3.8	6.2	4.1	3.8	6.4	2.8	5.8	2.6	4.8
Total hardness	172	165.3	137.4	214	148	210	240	186	349.38	172.8	230	260
Calcium	12.02	32.7	25.8	32	38.4	35.2	32.4	13.6	31.11	15.8	64.12	28.04
Magnesium	34.5	20.2	17.7	32.5	9.2	15.5	18.3	36.9	66	32.38	17	46.17
Carbonate	117	100	70	40	20	450	70	70	180	80	120	100
Bicarbonate	596	500	380	220	60	250	360	280	400	390	620	390
Total phosphorus	Nil	8	Nil	0.85	Nil	Nil	Nil	12	35	10	12	19.2
Sulphate	240	80	22.1	100	480	430	400	300	Nil	320	240	230

Nitrite	Nil	Nil	4	Nil	Nil	Nil	Nil	3	Nil	Nil	Nil	3.2
Nitrate	1	0.6	0.5	0.1	0.6	0.4	Nil	2.8	3	1	4.08	2.4
Sodium	80	38.5	35.1	40	37.5	42.3	51.8	31	54.2	59.8	49.5	52.2
Potassium	15	4	2	3	2	1.8	2	2	6.2	8.2	5.8	2.6
Chloride	103.2	81.6	113.9	85.4	55.18	57.6	60.5	71.2	31.3	92.5	65.2	53.4
Chlorophyll a	0.293	0.543	0.305	1.28	1.245	1.425	3.197	0.18	0.5532	1.619	1.551	0.521
Chlorophyll b	0.532	0.985	0.553	2.34	2.268	2.869	5.8	0.332	1	2.943	2.818	0.946
Total Chlorophyll	0.632	1.317	0.708	3.32	3.618	4.125	7.99	0.48	1.385	4.238	3.941	1.382
Sechi'sdisc transparency	18	28	33	43	52	49	46	42	24	18	24	22

All values are expressed as mg/l, except pH, temperature ^{0}C, conductivity as µs/cm turbidity (ntu), Chlorophyll as mg/l fresh weight of tissue, and Secchi's disc in cms.

Table 2: Phytoplankton in Hadhinaru Lake from July 2013- June- 2014

Sl. No	Planktons	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1	Cocconies placentala Her.	0	2240	0	0	0	0	0	0	0	0	0	0
2	Cymbella turgidula Grun	0	0	0	0	0	1120	0	0	0	0	0	0
3	Gomphonema gracile Ehr.	6160	0	0	0	0	5600	0	0	5040	0	0	0
4	Navicula rhomboidica Kutez.	0	0	0	0	0	5600	3920	4480	0	0	0	12320
5	Nitzschia intermedia Hantz	0	0	0	0	0	7000	0	0	0	0	0	0
6	Nitzschia obtusa W. Smith	0	0	0	0	0	0	0	0	10500	0	0	0
7	Pinnularia gibba Ehr.	0	0	0	0	0	0	0	0	0	0	0	3080
8	Synedra ulna (Nitz) Ehr.	0	2240	1120	3360	2240	0	1960	2240	0	1120	1120	24640
9	Actinastrum hantzschi Lagerhaim	1840	1120	5600	0	0	0	0	0	0	0	0	6160
10	Dimorphococus lunatus A Braun	0	0	11200	0	0	0	0	0	0	0	0	0
11	Pediastrum simplex Meyen	0	0	5600	0	0	0	0	0	0	0	0	0
12	Pediastrum tetras (Ehr.) Ralfs	0	0	5600	0	0	0	0	0	0	0	0	0
13	Scenedesmus bijuga (Turpin)	0	0	0	0	0	0	0	0	5040	0	0	6160
14	Scenedesmus obliquis (Turpin) Kuetz	0	2240	0	0	0	0	0	0	0	0	0	6160
15	Scenedesmus qudricandatus Chodat	0	2240	0	0	0	0	0	0	0	0	0	0
16	Selenastrum gracile Reinsch	0	1120	0	0	0	0	0	0	0	0	0	0
17	Tetraedron lobatum (Naeg.)	0	1120	5600	0	0	0	0	0	0	0	0	0
18	Chroococus limeneticus Lemn	0	0	5600	0	0	0	0	0	5040	0	0	0
19	Merismopedia elegans A Br.	6160	2240	11200	0	0	0	0	0	0	0	0	0
20	Merismopedia tenussima Lemermann	0	0	0	0	0	0	0	0	0	0	3920	6160
21	Oscillatoria subbrevis Schmidle	3080	0	0	0	0	0	0	0	0	0	0	0
22	Closterium ehrenbergii Menegh	308	0	5600	0	0	0	0	0	0	0	0	0
23	Cosmarium quadrifarium (Nords).	0	1120	5600	0	0	0	0	0	0	0	0	0
24	Staurastrum javanicum (Nordst.)	0	0	2800	0	0	0	0	0	0	0	0	0
25	Euglena elastica Ehr.	0	1120	5600	0	0	0	0	0	0	0	0	0
26	Euglena limmophyla Lemmermann	0	0	5600	0	0	0	0	0	0	0	0	0
27	Euglena polymorpha Dangeard	0	0	5600	0	0	0	0	0	0	0	0	0
28	Lepocinclis ovum (Ehrenb) Lemn	0	2240	5600	0	0	0	0	0	0	0	0	0
29	Phacus tortos (Lemn) Skuortzov	0	0	2800	0	0	0	0	0	0	0	0	0
30	Trachelomonas charkowensis Swirenko	0	0	5600	0	0	0	0	0	0	0	0	0

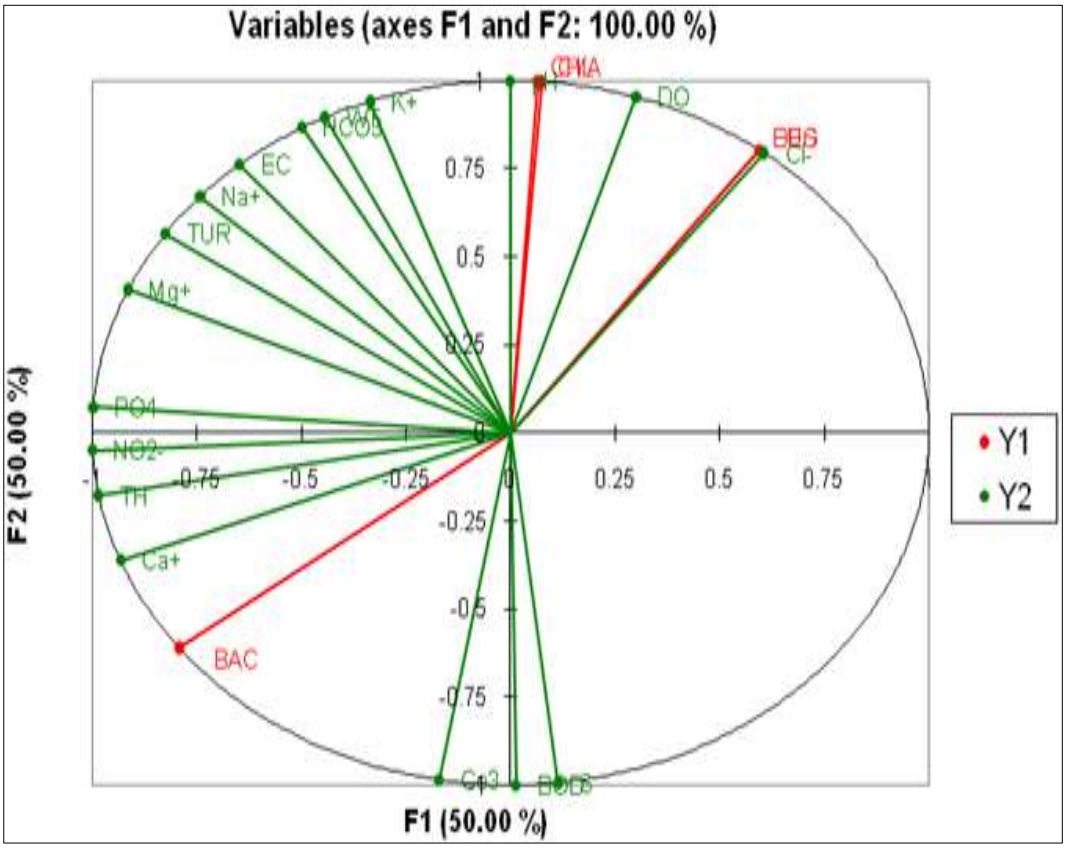
Org/l = Organisms/liter. Note: Observation under microscope 40 X 10x magnification.

Table 3: Pearson's correlation coefficients between Measured water chemistry variables and Phytoplankton counts in Hadhinaru lake

Variables	BAC	CHL	CYA	DES	EUG
pH	-0.611**	0.998**	0.997**	0.803**	0.803**
WT	-0.196	0.866**	0.861**	0.455	0.455
EC	0.048	0.718**	0.711**	0.225	0.225
TUR	0.308	0.510**	0.501**	-0.038	-0.038
DO	-0.820**	0.971**	0.974**	0.945**	0.945**
BOD	0.601**	-0.997**	-0.996**	-0.795**	-0.795**
TH	0.887**	-0.240	-0.250	-0.729**	-0.729**
Ca^{2+}	0.959**	-0.422	-0.431	-0.847**	-0.847**
Mg^{2+}	0.474	0.347	0.338	-0.217	-0.217
CO_3^{2-}	0.737**	-0.994**	-0.995**	-0.893**	-0.893**
HCO^-_3	-0.135	0.833**	0.827**	0.399	0.399
PO^-_4	0.745**	0.008	-0.002	-0.536**	-0.536**
SO_4^{2-}	0.517**	-0.984**	-0.982**	-0.730**	-0.730**
NO_3^-	0.821**	-0.114	-0.124	-0.635**	-0.635**
Na^+	0.178	0.621**	0.613**	0.096	0.096**

K^+	-0.309	0.918**	0.914**	0.556**	0.556**
Cl^-	-0.966**	0.833**	0.839**	1.000**	1.000**

**Significance @0.05%level



CCA biplot Showing relationship between water chemistry variables and Phytoplankton counts in Hadhinaru lake

CCA biplot Showing relationship between water chemistry variables and Phytoplankton counts in Hadhinaru lake, BAC: *Bacillariophycea;* CHL: *Chlorococcales*; CYA: *Cyanophyceae*; DES: *Desmidaceae*; EUG: *Euglenaceae*; WT: Water temperature; EC: Electrical conductivity; TUR: Turbidity; DO: Dissolved Oxygen; BOD: Biological Oxygen Demand; TH: Total hardness; Ca^{2+}: Calcium; Mg^{2+}: Magnesium; CO_3^{2-}: Carbonates; HCO_3: Bicarbonates; PO_4: Total phosphorus; SO_4^{2-}: Sulphate; NO_3^-: Nitrate; K^+: Potassium; Cl^-: Chloride; (Phytoplankton: Organisms/litr; Water temperature ^OC; Turbidity: NTU; Electrical conductivity; µ moles and the remaining as mg/litr).

Fig 2: Hadhinaru lake

Table 4: Physico-chemical characters of Arasanakere Lake from July 2013- June- 2014

Parameters	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
pH	7	7	7	7	7	7	7	7	7	7	7	7
Temperature	28	27	24	25	25	25	26	24	29	31	30	29
Conductivity	720	500	550	540	680	630	730	680	950	930	900	850
Turbidity	1.08	2.64	0.24	7.8	7.4	0.4	0.84	2.56	0.72	Nil	1.8	2.2
DO	5.26	8.68	6.73	7.78	8.5	7.2	6	5.43	8	5.4	7.07	8.2
BOD	2.5	4.2	4.5	3.8	3.1	2.2	3.8	2.6	5.2	2.4	4.2	4.8
Total hardness	190	151.4	113.1	184	196	256	320	204	465.8	187.2	290	320
Calcium	18.43	42.54	23.01	39.2	63.3	52.1	48	37.6	72.6	28.13	56.11	16.3
Magnesium	34.9	10.9	13.53	24.3	9.2	25.3	48.6	26.7	69.17	28.43	36.45	68.04
Carbonate	70.2	75	50	10	Nil	25	40	50	70	60	90	80
Bicarbonate	327.6	250	280	190	200	230	270	210	280	230	280	240
Total phosphorus	Nil	Nil	Nil	0.7	Nil	0.25	0.4	10	15	Nil	13.2	6.8
Sulphate	230	200	256	125	Nil	120	200	435	Nil	60	85	131.2
Nitrite	Nil	Nil	Nil	0.8	0.8	1	0.7	0.35	12.2	Nil	Nil	4.88
Nitrate	Nil	0.6	0.4	0.2	0.65	0.4	Nil	3.2	2	1.5	8.52	3.2

Sodium	50	29.3	28	31	39	32.4	25.8	40.7	46.5	41.9	44.9	41.9
Potassium	4	4	3.8	4	6.5	6.8	7	10	13	12.6	16.2	16.4
Chloride	145.9	103.2	138.8	110.3	99.6	96.2	94.3	160.2	57.1	153	148	119.2
Chlorophyll a	0.308	1.249	0.41	0.659	0.578	0.98	1.57	1.247	0.7559	0.723	1.013	0.329
Chlorophyll b	0.56	2.267	0.744	1.191	1.049	1.826	2.856	2.26	1.374	1.313	1.838	0.599
Total Chlorophyll	0.799	3.002	0.998	1.669	1.372	2.392	4.306	3.09	2.058	1.712	2.449	0.883
Sechi's disc transparency	25	27	28	29	31	27	25	22	18	23	24	23

All values are expressed as mg/l, except pH, temperature ^{0}C, conductivity as µs/cm turbidity (ntu), Chlorophyll as mg/l fresh weight of tissue, and Secchi's disc in cms.

Table 5: Phytoplankton in Arasanakere Lake from July 2013- June- 2014

Sl. No	Planktons	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1	*Amphora copulata Kutz.*	0	0	0	5600	0	0	0	0	0	0	0	0
2	*Amphora ovalis (Kutz)*	0	0	0	0	0	0	0	0	2800	0	0	0
3	*Colnochinus nippocrepis*	0	0	0	0	0	0	4480	0	0	0	0	0
4	*Encyonema minutum (Hilse) DG Mann*	0	0	0	0	3920	0	0	0	0	0	0	0
5	*Fragilaria pinnata Her (F. Subrotunda) (bloom)*	0	0	0	0	0	0	0	0	0	0	2800	0
6	*Fragilaria ulna (Kutz)*	0	0	0	5600	0	0	0	0	0	0	0	0
7	*Gomphonema gracile Ehrenbarg.*	0	2240	3920	0	0	0	4480	0	2800	0	0	0
8	*Gomphonema parvalum (Kutzing) Kutzing*	0	0	0	0	0	0	0	0	0	0	2800	0
9	*Gomphonema turis Ehrenbarg.*	0	0	0	0	0	1120	0	0	0	0	0	0
10	*Navicula rhomboidica*	0	0	0	5600	0	0	4480	0	0	0	0	2240
11	*Navicula viridula Kutz*	0	0	0	0	0	0	0	0	0	0	2800	0
12	*Nitzchia intermedia Hantzsch*	0	0	0	0	0	0	0	0	0	2800	0	0
13	*Nitzchia obtusa W. Smith.*	0	0	0	0	0	0	0	0	2800	0	0	0
14	*Pinnularia gibba Ehr.*	0	0	0	0	0	0	0	0	5600	0	0	0
15	*Rhopalodia gibba Eherenberg*	0	0	0	11200	0	0	0	0	0	0	0	0
16	*Sclenastrum gracile*	0	0	0	0	0	0	0	0	0	2800	0	0
17	*Stauroniums phoenicenteron Eherenberg*	0	0	0	5600	0	0	0	0	5600	2800	0	0
18	*Synedra ulna (Nitz) Ehr.*	0	0	3920	5600	7840	0	4480	3360	0	0	0	0
19	*Actinastrum hantzschi Lagerhaim*	0	0	0	0	0	0	0	0	0	0	2800	0
20	*Actinastrum sentzschi Lagern*	0	0	0	0	0	0	0	0	0	2800		0
21	*Ankistrodermus falcutis (Corda) Ralfs*	0	0	0	0	0	0	0	0	0	0	2800	0
22	*Coelastrum cambricum Archar*	0	0	0	0	0	0	0	0	0	2800		0
23	*Coelosphaerium naegelianum Unger*	0	0	0	0	0	0	0	0	0	0	2800	0
24	*Scenedesmus bijugatus ver bicellularis Comb*	0	0	0	0	0	0	0	0	0	2800	2800	0
25	*Scenedesmus qudricandatus (Chodat)*	0	0	0	5600	0	0	0	0	0	2800		0
26	*Tetradron duospinum Ackley*	0	0	0	0	0	0	0	0	0	0	2800	0
27	*Tetradron trilobatum (Reinsch) Hansgirg*	0	0	0	0	0	0	0	0	0	0	5600	0
28	*Anabena constriseta (Szafar) giteler*	0	0	0	0	0	0	0	0	0	2800	0	0
29	*Aphanocapsa delicatissima West & West*	0	0	0	0	0	0	0	0	0	0	2800	0
30	*Arthrospira jenneri (Kuetz) Stizenberger*	0	0	0	0	0	0	0	0	0	0	2800	0
31	*Chroococus dispersus (Keissl) Lem*	0	0	0	0	0	0	0	0	0	2800	0	0
32	*Merismopedia tenussima Lemermanin*	0	0	0	0	0	0	0	0	0	0	2800	0
33	*Oscillotoria curviceps Schmidle*	0	0	0	0	0	0	0	0	0	5600	0	0
34	*Phormedium ambiguum Gom*	0	0	0	0	0	0	0	0	0	28000	0	0
35	*Spirulina nordestedti Gomont*	0	0	0	0	0	0	0	2800	0	0	0	0
36	*Euglena minuta Prescott*	0	0	0	0	0	0	4480	0	0	0	0	0
37	*Euglena oxyuris Scharmarda*	2520	0	0	0	0	0	0	0	0	0	0	0
38	*Lepocinclis ovum (Ehrenb) Lemn*	0	0	0	0	0	0	0	0	2800	2800	5600	0
39	*Phacus caudata Drezepolski*	0	0	0	0	0	0	0	0	0	0	2800	0
40	*Phacus longicauda (Ehrenb) Dujardin*	0	0	0	0	0	0	4480	3360	0	0	0	0
41	*Phacus orbicularis Huebner*	0	0	0	0	0	0	0	3360	0	0	0	0
42	*Phacus tortos (Lemn) Skuortzov*	0	0	0	0	0	0	0	3360	0	0	0	2240

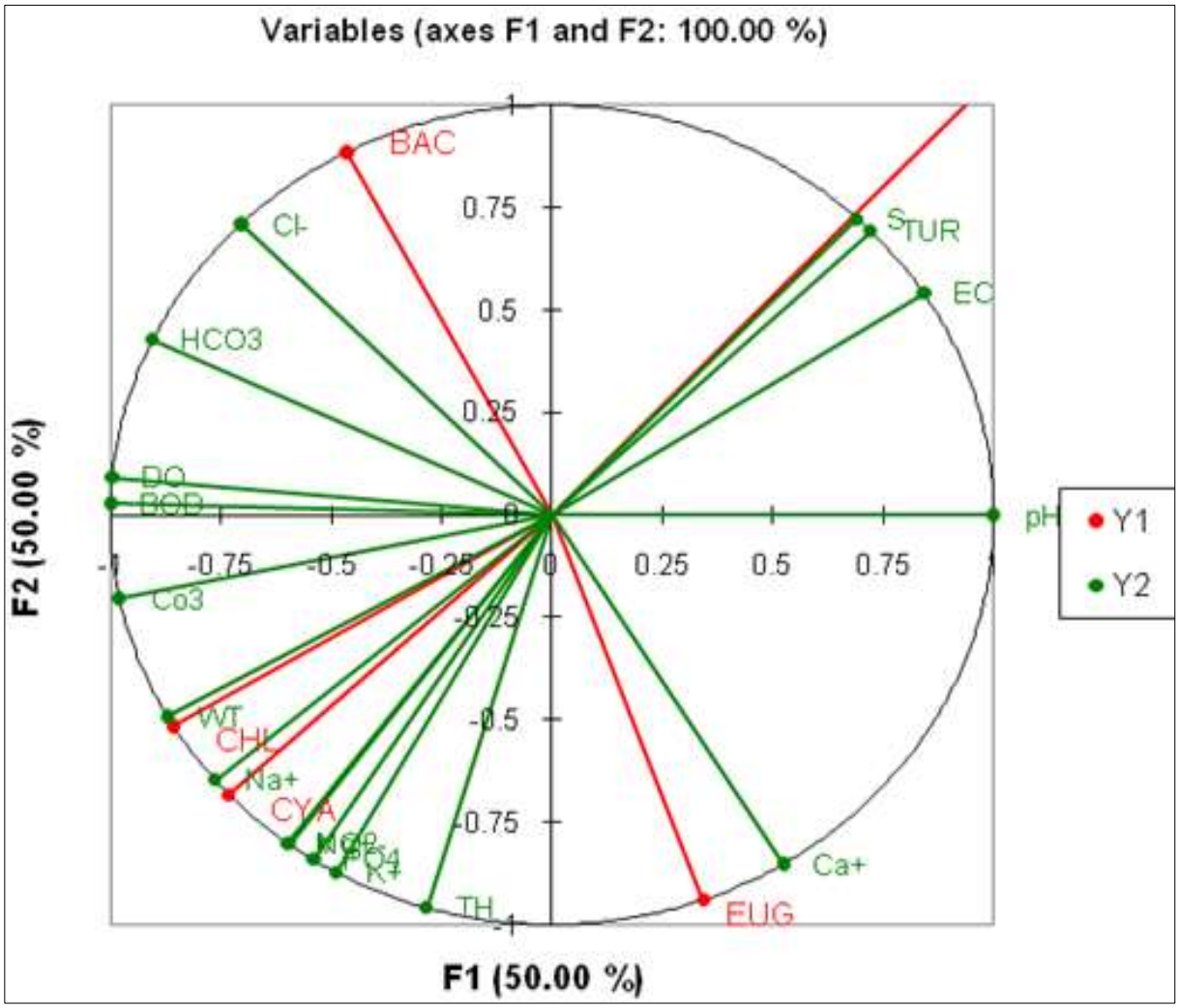
Org/l = Organisms/liter. Note: Observation under microscope 40 X 10x magnification.

Table 6: Pearson's correlation coefficients between Measured water chemistry variables and Phytoplankton counts in Arasanakere lake

Variables	BAC	CHL	CYA	DES	EUG
pH	-0.464	-0.857**	-0.731**	0.000	0.342
WT	-0.032	1.000**	0.972**	0.000	0.165
EC	0.089	-1.000**	-0.984**	0.000	-0.221
TUR	0.280	-0.975**	-1.000**	0.000	-0.405

DO	0.543**	0.806**	0.666**	0.000	-0.426
BOD	0.489	0.842**	0.712**	0.000	-0.369
TH	-0.717**	0.739**	0.862**	0.000	0.803**
Ca^{2+}	-0.998**	-0.010	0.197**	0.000	0.979**
Mg^{2+}	-0.430	0.927**	0.984**	0.000	0.547**
CO_3^{2-}	0.274	0.944**	0.855**	0.000	-0.144
HCO^-_3	0.798**	0.554**	0.370	0.000	-0.711
PO^-_4	-0.495	0.897**	0.969**	0.000	0.606**
SO_4^{2-}	0.321	-0.965**	-0.998**	0.000	-0.444
NO_3^-	-0.436	0.924**	0.983**	0.000	0.552**
Na^+	-0.220	0.987**	0.999**	0.000	0.348
K^+	-0.547**	0.868**	0.952**	0.000	0.653**
Cl^-	0.956**	0.236	0.031	0.000	-0.908**

**Significance @0.05%level



CCA biplot Showing relationship between water chemistry variables and Phytoplankton counts in Arasanakere lake

CCA biplot Showing relationship between water chemistry variables and Phytoplankton counts in Arasanakere lake, BAC: *Bacillariophycea;* CHL: *Chlorococcales*; CYA: *Cyanophyceae*; DES: *Desmidaceae*; EUG: *Euglenaceae*; WT: Water temperature; EC: Electrical conductivity; TUR: Turbidity; DO: Dissolved Oxygen; BOD: Biological Oxygen Demand; TH: Total hardness; Ca^{2+}: Calcium; Mg^{2+}: Magnesium; CO_3^{2-}: Carbonates; HCO_3: Bicarbonates; PO_4: Total phosphorus; SO_4^{2-}: Sulphate; NO_3^-: Nitrate; K^+: Potassium; Cl^-: Chloride; (Phytoplankton: Organisms/litr; Water temperature ^OC ; Turbidity: NTU; Electrical conductivity; µ moles and the remaining as mg/litr).

Fig 3: Arasanakere lake

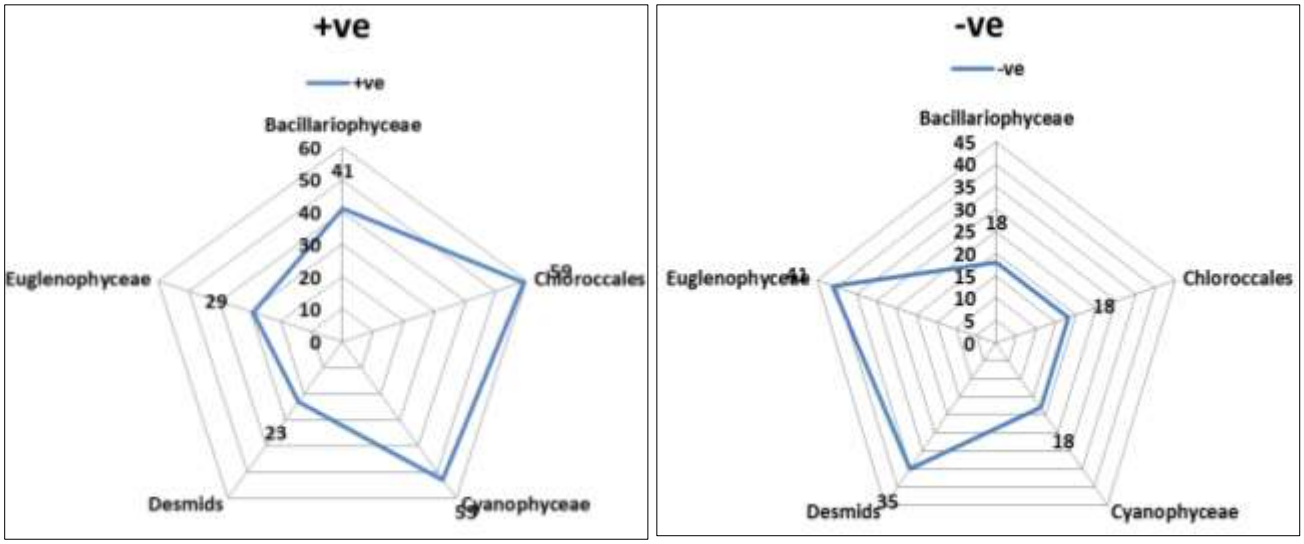


Fig 3: Hadhinaru Lake

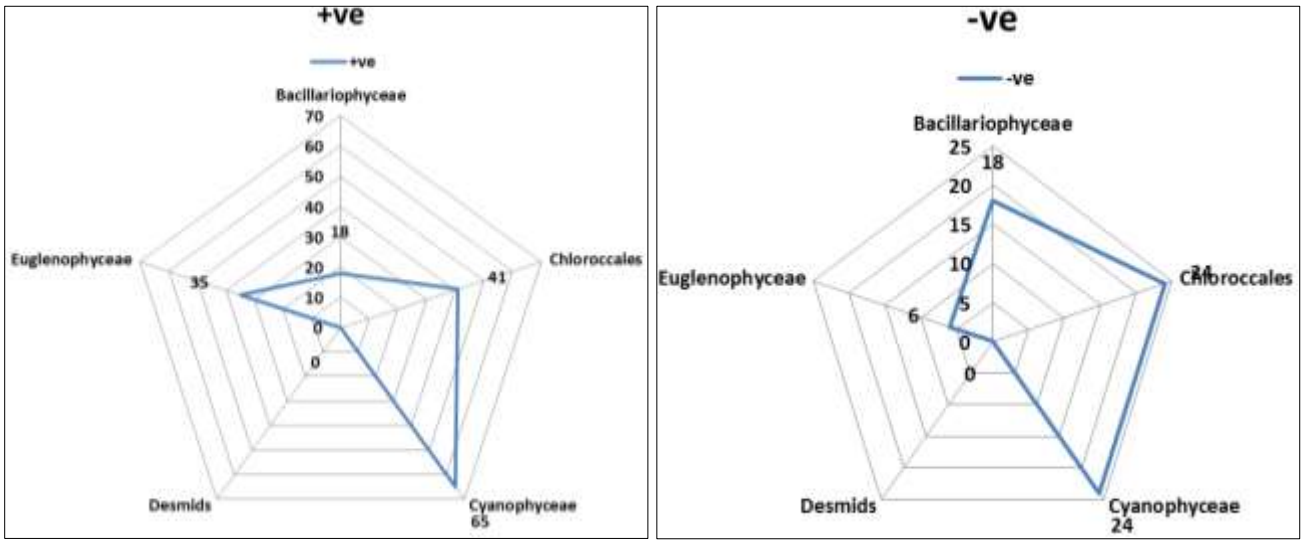


Fig 4: Arasanakere lake

Table 7: Interrelation between phytoplankton population and water chemistry variables (%) Hadhinaru lake

	Bacillariophyceae	Chloroccales	Cyanophyceae	Desmids	Euglenophyceae
+ve	41	59	53	23	29
-ve	18	18	18	35	41
Nil	41	25	29	42	30

Table 8: Arasanakere lake

+ve	18	41	65	0	35
-ve	18	24	24	0	6
Nil	64	35	11	0	59

4. Conclusion

The most dominant species in Hadhinaru lake and Arsanakere lake were those of Bacillariophyceae fallowed by Cyanophyceae; Desmids were poorly represented with no appearance in Arsanakere lake +ve correlation with water chemistry variables were high 91% indicating a direct correlation, while –ve correlation were very low. Cyanophyceae have highest correlation. Parameters with no correlations were recorded high in Hadhinaru lake and were low in Arasanakere lake.

Mutivariate analysis provides a handy proof in understanding the interrelation between phytoplankton and water chemistry variables. It gives an understanding absent. The total monthly load of nutrients and the abundance of microorganisms in a particular water body.

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