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Impact Of Physico-Chemical Parameters On Distribution And Diversity Of Euglenophyceae In Saroornagar Lake, Hyderabad

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Abstract:- Saroornagar Lake is one of the major fresh water-bodies of Hyderabad. The study deals with the influence of physico-chemical parameters on the distribution and diversityof Euglenophyceae. Samples were collected from four sampling stations for a period of two years and comprehensive physico-chemical analysis was carried out.Linear multiple regression analysis (MRA) has been carried out with SPSS software to evaluate the importance of various physico-chemical variables on the growth and development of Euglenophyceae. The physico-chemical parameters played an important role in distribution and diversity of algae. The growth of Euglenophyceae was positively influenced by sulphates, Free CO2, calcium, total hardness, COD and bicarbonates. Negative influence on euglenoids was exerted by temperature, organic matter, total solids, total dissolved solids, magnesium and chlorides. Euglenoid flagellates exhibited higher peaks in winter and found very low in summer. Diversified species of Euglena, Lipocinclis, Phacus and Trachelomonas were reported. Euglena acus, E. gracillis, E. oxyuris, Lipocinclis ovum and Trachelomonasvolvocina represent high organic pollution of the lake and indicate high degree of organic pollution.

Key words: Euglenophyceae, diversity, physico-chemical parameters, pollution.

Introduction: Fresh water lakes are vital resources for any country.They are linked to human welfare and have greater prominence. Lakes have environmental significance as sources of surfacewith watersheds and air sheds.Lakes are highly polluted by anthropogenic sources such as urbanization, industrialization, various human developmental activities and improper management of water resources and to a lesser extent by natural sources.Sewage discharge, inappropriate agricultural practices and urban run offs disrupt aquatic ecosystems (Suresh, 2015) and lead to eutrophication of the inland water bodies. The deterioration and undesirable changes in physico-chemical characteristics of water body causes water pollution and show the considerable effect on planktonic flora (Mishra, 1992). Chlorophyceaea , Cyanophyceaea , Euglenophyceae, diatoms and desmids are the basic link in the entire aquatic flora with ecological significance (Airsang, 2013). The present study involves assessment of varipos factors influencing the distribution and diversity of Euglenoid flagellates in Saroornagar Lake, which is one of the bigger lakes of Hyderabad and lies in the coordinates of 17.35584° N latitude and 78.52714° E longitudes.

Materials and Methods

The water samples were collected at monthly intervals for a period of two years (September 2019 to August 2021) at four sampling stations in the lake. Priyadarshini Park, Pochamma temple, Singareni colony and Green park colony represent station I, II, III and IV respectively. The samples were analyzed as per the standard procedures of APHA (1995). The samples were analyzed for pH, temperature, carbonates, Free CO2, bicarbonates (HCO_3^-), chlorides (Cl^-), DO, BOD, organic matter (OM), chemical oxygen demand (COD), total hardness, calcium, magnesium, phosphates, silicates, sulphates, nitrates, nitrites, total solids (TS) and total dissolved solids (TDS) as per the standard procedures of APHA (1995).

For Planktonic study one litre of surface water samples were collected from four different stations of the lake and were kept in the sedimentation column after adding 2-3 ml of 4% formaldehyde solution. The samples were kept undisturbed for complete settling of the organisms for about a period of one month. The samples were concentrated to 100 ml. In the final step, the concentrated material was used for identification of species and frequency measurements. For planktonic study the drop method of Pearsal (1946) was followed.

Linear MRA was employed to establish the interaction of physico-chemical parameters and Euglenophyceae. The proposed models contain the minimum number of variables, required to explain the variation of algal number to maximum extent in a statistically significant way. Percentage of variability is evaluated following the F-test to determine the good fit model. The regression equation is constructed with beta values and variables are excluded with backward regression. The most significant predictors will be elevated by forward step ward regression.

Results and Discussion

The average analytic results of each parameter during the period of investigation are summarized in Table 1.

TABLE 1: Average values of Physico-chemical parameters All values are xpressed in mg/L except pH and Temp (OC)

S. No	Physico - chemical Factors	Station - I	Station - II	Station - III	Station - IV
1.	Temperature	25.6	25.3	25.6	25.7
2.	pH	8.37	8.37	8.37	8.36
3.	Carbonates	22.3	20.8	23.2	18.3
4.	Free CO_2	0.86	0.91	0.91	1.46
5.	Bicarbonates	738.9	736.7	792.4	758.8
6.	Chlorides	781.1	759.5	756.3	759.8
7.	Dissolved Oxygen	0.6	0.5	0.5	0.3
8.	Biological Oxygen Demand	238.7	192.0	218.3	226.6

9.	Organic Matter	63.7	80.8	88.3	101.6
10.	Chemical Oxygen Demand	141.0	153.8	288.3	343.9
11.	Total Hardness	648.0	602.4	605.5	615.8
12.	Calcium	145.2	154.3	136.9	133.6
13.	Magnesium	51.7	53.2	57.8	60.8
14.	Phosphates	16.9	20.3	20.1	17.8
15.	Silicates	1.37	1.22	1.88	1.99
16.	Sulphates	247.7	257.7	255.7	252.9
17.	Nitrates	16.5	19.8	19.6	17.4
18.	Nitrites	1.07	1.54	1.09	1.43
19.	Total Solids	2814	2715	2755	2804
20.	Total Dissolved Solids	2615	2521	2556	2606

Temperature is considered as one of the most important factors in the aquatic ecosystem and also in survival and existence of biological life. In the present investigation the average temperature ranged from 25.3 °C-25.7°C. The pH influence survival and nourishment of biological life and is an important factor for plankton growth (Chisty, 2002). The pH of the lake is 8.37. The value represents alkaline nature of the lake.Alkaline nature of lakes in India was reported by Amin Hossaini (2013) and John Mohammad (2015).High values of bicarbonates (HCO_3^-) were recorded at all stations, average values ranged from 736.7mg/L and 792.4mg/L and can be due to increase in organic decomposition during which CO2 is released which reacts to form bicarbonates.Similar observation was made by Mahadev and Hosamani (2010) and Airsang (2013).

Chlorides play a very important role to determine the quality of water. The average values of chlorides were 781.1 mg/L at station I, 759.5 mg/L at station II, 756.3 mg/L at station III and 759.8 mg/L at station IV respectively, representing very high concentration of chlorides.Higher chloride concentration represents high degree of pollution (Ameetha Sinha 2014,John Mohammad, 2015).Very low DO values were recorded in the lake. The minimum and maximum DO values observed were 0.3 mg/L at station IV and 0.6 mg/L at station I. Very high BOD values were recorded at all stations withaverage values ranged from192 mg/L at station II to 238.7 mg/L at station I. Higher BOD values indicate organic contamination, high nutrient loading, decomposition and mineralization of organic matter (Siraj, 2010, Suresh, 2015). Chemical oxygen demand (COD) is a reliable parameter for judging the extent of pollution in water (Amirkolaie, 2008).Chemical Oxygen Demand ranged between 80.0 - 216.0 mg/L with minimum value of 141.0 mg/L at station I and 343.9 mg/L at station IV.

The total hardness of the lake was very high compared to their permissible limit of BIS (1998). It may be due to addition of detergents or sewage contamination. A high value of phosphates and sulphates confirms the lake receiving sewage influx(Amin Hossaini Motlagh et al, 2013) and eutrophication of lakes (Bishnu Kanth Shukla,2020). This was in accordance to Total dissolved solids were higher than BIS permissible limits of 2000 mg/L. The major sources of total solids in the water body are detergents, domestic sewage, runoff, leaching of substances from rocks in surrounding area and may also be attributed to the catchment watershed.

The diversified species of Euglenophyceae were observed in good numbers at all stations. Euglenophyceae was represented by diversified species of Euglena, Lipocinclis, Phacus and Trachelomonas. Euglena acus, E. polymorpha, E. Viridis, E. elastica, E. oxyuris, Lipocinclis fusiformis, L. ovum, Trachelomonashispida, T. volvocina, Phacuscurvicauda, P. caudatus, P. longicauda, P. accuminatus, P. orbicularis, were the dominant species recorded in the present observation. Euglena, Phacus and Trachelomonas were used as bio indicators of eutrophic lakes and are commonly encountered in waters with rich oxidizable organic matter.This is in conformity with Suresh, 2015.The high pollution in the lake is confirmed by the presence of Euglena oxyuris and E. gracillis. Euglena and Trachelomonas are the good bio indicators of eutrophic lake.The highest peaks of Euglenophyceae were reported in the winter and low during summer and monsoon. Accumulation of organic loads from surface run-off, autochthonous and allocthonous organic load, sewage, increasing temperature and clear sun-shine may be the reasons for the dominance of Euglenophyceae in winter. Similar observation was made by Ansari Ekhalak (2013) and Altaf H. Ganai (2014).

The Linear MRA reveals the R^2 value for all the 20 independent factors is 0.997 at station I, 0.958 at station II, 0.909 at station III and 0.947 at station IV respectively. The best regression model obtained by backward elimination method represented the factors accounting algal variance significantly and eliminated insignificant factors. The coefficients in the best model are given in Table 2, 3, 4 and 5 and the best regression model obtained by backward elimination method is given by equation 1, 2, 3 and 4 at Station I, II, III and IV respectively.

At station I, Euglenoid flagellates have attained high peaks during winter and bloom of Trachelomonas sp. was observed. Euglena sp., Lipocinclis sp. and Phacus sp. were also represented during winter. The lowest peaks were observed in August with the representation of Euglena sp. and Phacus sp. The Linear MRA analysis (Table 2) reveals that all the physico-chemical factors together account for 97.4% variation in algal growth.Among them temperature, pH, Free CO_2, calcium, DO, COD, silicates, sulphates, nitrates, nitrites, TS, TDS, HCO_3^-, phosphates and magnesium are the minimum factors that could influence the growth of Euglenophyceae to the maximum extent of 99.2%. pH, Free $CO_2$and nitrites exhibited positive influence on the growth of Euglenoids at 1% level. The direct relation of pH was in accordance with Ashwani Dubey (2012) and Ansari Ekhalak (2013). The positive relation of Free CO_2 was proved by Ashesh Tiwari (2006), Hosmani (2008) and Shankar (2012). Temperature and HCO_3^- negatively influenced the algal growth. Similar observation was made by Sur Altaf H. Ganai (2014) and Suresh (2015). Calcium, silicates, sulphates exhibited direct relationship with Euglenophyceae members at 1% level. The positive influence of sulphates was observed by Ashwani Dubey (2012). DO, COD and nitrates showed the significant positive influence on the growth of algae at 1% level. This is in accordance with Shankar (2012) and Suresh (2015). The positive correlation of COD and Euglenoids was reported by Suresh (2015). The negative influence of TDS, magnesium and phosphates at 1% level was observed in the present investigation (Table 2). Similar observation was made by Suresh (2015) regarding TDS and phosphates. Negative correlation of magnesium was observed by Ananthaiah (2010). Silicates exhibited positive correlation with Euglenophyceae at 1% level influencing 40% of algal variance.Nitrites influenced with 20% algal variance on positive side at 5% level. Similar observation was made by Ananthaiah (2010). TDS and TS at 1% level influenced algal growth on negative side with 43% and 42% algal variance respectively. The higher peaks of Euglenophyceae were associated with high pH and silicates and low TS and TDS.

Table 2: Multiple Regression Analysis of Phisico-Chemical Factors on Euglenophyceae at Station I

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
6	(Constant)	-31177.553	6764.365		-4.609	.002
	Temp	-42.766	11.226	-.192	-3.809	.005
	PH	627.765	46.841	1.404	13.402	.000
	$FreeCO_2$	136.906	10.499	.846	13.040	.000
	HCO_3^-	-2.070	.187	-.632	-11.096	.000
	DO	402.035	33.757	1.230	11.910	.000
	COD	6.052+	.633	.821	9.564	.000
	Ca^{2+}	1.977	.498	.193	3.967	.004
	Mg^{2+}	-3.219	.477	-.323	-6.751	.000
	PO_4^{3-}	-225.428	25.610	-1.820	-8.802	.000
	SiO_2	10172.546	990.354	.835	10.272	.000
	$SO4_2^-$	30.782	4.417	.831	6.969	.000
	$N0_3^-$	208.657	26.478	1.200	7.880	.000
	NO_2^-	983.089	280.993	.316	3.499	.008
	TS	39.550	4.628	3.085	8.545	.000
	TDS	-40.592	3.996	-3.519	-10.158	.000

a. station = STATION Ib. Dependent Variable: Euglenophyceae (CP)

CP=-31177.553-42.766Temp+627.765PH+136.906FreeCO_2-2.070HCO_3^-+402.035DO+6.052 COD+1.977Ca^{2+}-3.219Mg^{2+}-225.428PO_4^{3-}+10172.546SiO_2+30.782$SO4_2^-$+208.657$N0_3^-$+983.089NO_2^-+39.550 TS-40.592 TDS ---------------------(1)

At station II, Euglenoid flagellates have attained peaks in November represented by the bloom of Trachelomonas sp. The species were Trachelomonasvolvocina, T. hispida and T. euchlora. At this station, all the physico-chemical factors together account for 95.8% of algal variance in a statistically significant manner. Carbonates, Free CO_2, HCO_3^-, magnesium, phosphates, sulphates, nitrates, TS and TDS are the minimum factors that could influence the growth of Euglenoid flagellates to the maximum extent of 86.0%. Among these factors nitrates, TDS, sulphates are influencing algal growth on negative manner at 1% level. This was in accordance to Suresh (2015). HCO_3^-, and phosphates are found to be exerting a positive influence on algal growth at 5% level and 1% level respectively. Agale (2013) reported similar relationship and quotedHCO_3^-as one of the important factors regulating

Euglenophycean growth. This was also in accordance with Agale (2013) and Ansari Ekhalak (2013). In the present observation carbonates exerted indirect relation at 1% level. This was in accordance to Ananthaiah (2010). Magnesium and TS exhibited negative relationship with the growth of Euglenoids at 1% level and Free CO_2 at 5%level. Chlorides are negatively correlated with algal growth at 6% level and significantly influencing algal variance to an extent of 16%. Similar negative correlation was reported by Suresh (2015). This is in contrary with Ansari Ekhalak (2013). Nitrates exhibited negative correlation at 8% level, contributing 12% of algal variance (Table 3). Silicates and nitrites at 1% level positively correlated with Euglenophyceae with 31% and 30% of algal variance. Direct relationship of nitrites and algae was in accordance with Ananthaiah (2010). TS and TDS are negatively correlated with the growth of algae at 1% level and 5% level and influencing algal variance significantly to an extent of 37% and 23% respectively. In the present study the higher peaks were associated with high bicarbonate concentration and low sulphates and TS.

Table 3 : Multiple Regression Analysis of Phisico-Chemical Factors on Euglenophyceae at Station II

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
12	(Constant)	39248.055	6169.100		6.362	.000
	CO_3^{2-}	-16.828	3.500	-1.127	-4.808	.000
	FreeCO_2	-70.306	25.308	-.572	-2.778	.015
	HCO_3^-	1.063	.407	.385	2.612	.020
	Mg^{2+}	-9.450	1.439	-1.079	-6.565	.000
	PO_4^{3-}	231.794	45.615	2.113	5.081	.000
	$SO4_2^-$	-30.039	7.809	-.924	-3.847	.002
	$N0_3^-$	-142.924	40.622	-.919	-3.518	.003

	TS	-8.660	2.160	-.766	-4.009	.001
	TDS	-3.754	1.165	-.555	-3.223	.006

a. station = STATION I b. Dependent Variable: Euglenophyceae (CP)

CP=-39248.055-16.8282 CO_3^{2-}-70.306 FreeCO_2+ 1.063 HCO_3^--9.450Mg^{2+}+231.794 PO_4^{3-}--30.039 $SO4_2^-$-142.924

-8.660 TS- 3.754 TDS--------------------- (2)

At station III, MRA revealed all the factors together constitute 90.9% of algal variance significantly. Among them the minimum factors Free CO_2, organic matter, temperature, total hardness, silicates, TS, TDS are the minimum factors that explain the variation in Euglenophyceae to the maximum extent of 82.6%. According to regression analysis temperature at 1% level, carbonates, chlorides, calcium and magnesium at 5% level influenced algal growth on negative side (Table 4). This was in accordance to Vijaya (1999) and Ananthaiah (2010). TH, sulphates and nitrites had a direct relation with Euglenoids significantly at 1% level. Temperature, OM exerted negative influence on the algal growth at 5% level with 23% and 17% of algal variance(Table 4).Free CO2 influenced Euglenoid growth positively at 6% level with 14% of algal variance. TH and silicates showed positive correlation at 8% level and 1% level influencing the growth of Euglenophyceae with 13% and 61% of algal variance. Algal growth is indirectly proportional to TS and TDS, exhibited negative correlation at 1% level. TS influenced to an extent of 43% and TDS with 45% of algal variance. Higher concentration of silicates and nitrites and low levels of TS are associated with the peaks of Euglenoids in the present observation.

Table 4 : Multiple Regression Analysis of Phisico-Chemical Factors on Euglenophyceae at Station III

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
13	(Constant)	-15600.297	3057.223		-5.103	.000
	Temp	-100.643	24.571	-.449	-4.096	.001
	CO_3^{2-}	-5.055	2.300	-.286	-2.198	.044
	Cl^-	-2.533	.899	-.445	-2.819	.013
	TH	3.641	1.185	1.013	3.073	.008
	Ca^{2+}	-5.310	2.068	-.681	-2.567	.021
	Mg^{2+}	-10.783	4.071	-.910	-2.649	.018

	SO_4^{2-}	42.831	7.867	1.015	5.444	.000
	NO_2^-	8031.221	1376.692	1.088	5.834	.000

a. station = STATION I b. Dependent Variable: Euglenophyceae (CP)

$CP=-15600.297-100.643-5.055\ CO_3^{2}-2.533\ Cl^{-}+3.641\ TH\ -5.310\ Ca^{2+}-10.783\ Mg^{2+}$
$+42.831\ SO4_2^{-}+8031.221NO_2$--------------------- (3)

At this station IV, all the physico-chemical factors together account for 94.7% of algal variance in a statistically significant manner. Free CO_2, COD, calcium, magnesium, silicates, chlorides, BOD, phosphates, nitrites; TDS are the factors which statistically influence the algal variance significantly a up to 85.9% according to linear MRA. Significant influence of Free CO_2, COD and silicates was observed at 1% level on positive side. Calcium and magnesium exhibited positive relationship with algal growth at 5% level (Table 5). This was in accordance with Sudha Rani (2004), who observed a positive influence of calcium and magnesium on the growth of Euglenophyceae. Chlorides, BOD, nitrites and TDS exerted a significant negative influence on the Euglenoid growth at 1% level. Phosphates influenced at 5% level on negative side. According to Pearson Correlation Matrix, temperature and organic matter influenced indirectly and exhibited negative correlation with algae at 1% and 6% level respectively with an algal variance of 29% and 15% (Table 5). Silicates showed positive correlation with algal growth at 1% level and influenced algal variance to an extent of 35%. TS and TDS strongly influenced the growth of Euglenophyceae with 19% and 20% of algal variance on negative side at 5% level. Higher peaks of Euglenoids were associated with low TDS and silicates at this station.

Table 5 : Multiple Regression Analysis of Phisico-Chemical Factors on Euglenophyceae at Station IV

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
11	(Constant)	118366.368	40954.589		2.890	.013
	FreeCO₂	590.270	135.981	1.387	4.341	.001
	Cl^-	-6.772	2.100	-.495	-3.224	.007
	BOD	-23.835	4.760	-1.505	-5.007	.000
	COD	79.535	15.046	2.460	5.286	.000
	Ca^{2+}	8.560	3.598	.311	2.379	.033
	Mg^{2+}	19.960	8.69	.453	2.297	.03

			0			9
	PO_4^{3-}	-235.483	103.493	-.473	-2.275	.040
	SiO_2	17080.152	4245.363	.660	4.023	.001
	NO_2^-	-16173.653	4815.522	-.813	-3.359	.005
	TDS	-55.375	12.835	-1.033	-4.314	.001

a. station = STATION I b. Dependent Variable: Euglenophyceae (CP)

CP=-118366.368+590.270 FreeCO_2-6.772 Cl^---23.835 BOD+79.535 COD+8.560 Ca^{2+}+19.960 Mg^{2+} -235.483 PO_4^{3-}+17080.152 SiO_2-16173.653NO_2^--55.375TDS --------------------- (4)

Conclusions

The present investigation elevated the impacts of physico-chemical Parameters on distribution and diversity of Euglenophyceae in Saroornagar Lake. The water of Saroornagar Lake is highly polluted as the physico-chemical parameters such as chlorides, total hardness, phosphates, sulphates, BOD, total solids and total dissolved solids were higher than permissible limits and dissolved oxygen is in very low concentration when compared with the standards stipulated by WHO (1971), ISI (1982), and BIS (1998). The evaluated physico-chemical parameters considerably influenced the distribution and diversity of algae. Euglenoid flagellates were represented by diversified species and presence of Euglena, Phacus and Trachelomonas species which are tolerant to pollution and serve very good bio indicators of eutrophic pollution. All these species indicates polysaprobic condition of the lake and high degree of organic pollution.

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