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DIVERSITY AND DISTRIBUTION OF EUGLENOPHYCEA MEMBERS IN MIR ALAM LAKE

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ABSTRACT: The present paper is focused on the study of Euglenophyceae in Mir Alam Lake of Hyderabad. Over the course of two years, samples were collected from four sampling locations, and thorough physico-chemical analysis was performed. Significant factors influencing the distribution and diversity of algae were pH, temperature, bicarbonates (HCO_3^-), chlorides, dissolved oxygen (DO), biological oxygen demand (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). There have been reports of diverse species of *Phacus*, *Lepocinclis*, *Euglena*, and *Trachelomonas*. Population size of some euglenoids is significantly correlated to nitrogenous nutrients. *Euglena acus, E. polymorpha, E. ehrenbergii, E. geniculata, E. viridis, Lepocinclis ovum, Phacus tortus, Trachelomonas hispida, and T. volvocina* cells in Mir Alam lake bloomed in winter and spring, when other phytoplanktonic algae greatly decrease.

Key words: Euglenophyceae, physico-chemical parameters, diversity, Mir Alam lake.

I. INTRODUCTION

The majority of taxonomic phyla in existence today are found in aquatic habitats. Phytoplankton is the most common type of microscopic, unicellular creature found in aquatic environments. Euglenoids are members of the Euglenophyceae. These worldwide distributed organisms inhabit most of fresh water habitats, a small number of these taxa is living in brackish or marine biotopes and small number of these organisms could be found edaphon (Leander et al., 2017, Leedale,1967, Wolowski & Hindak, 2005).Cells of euglenoids have characteristic eukaryotic structure with some alterations typical for this group of organisms. They belong to one of the most well-known groups of flagellates that live as photoautotrophs by using pigments that are photosynthetic, and they also live as heterotrophs by encircling and consuming other species. This activity makes euglenoids unique as both plant like algae and animal like protists. All members of this group are unicellular and almost all are motile, either with flagella or by surface-associated gliding movement. Euglenoids numbering around 1500 are commonly found in freshwater especially when it is rich in organic materials. (Leander et al., 2017). A number of countries have carried out research on the Euglenophyceae, including Argentina (Conforti, 1991), Japan (Kato, 1982, 1995), and Korea (Kim et al., 1998). Indian authors Munawar (1972), Kamat (1968, 1975), Gonzalves and Joshi (1946), and Philipose (1982) are among those who studied the Euglenophyceae. The objective of this study is to investigate the range of Euglenophyceae members in the Mir Alam Lake area, the distribution and diversity of Euglenoid flagellates, the effects of physico-chemical factors on Euglenophyceae, and the identification of algae in the lake as bioindicators. Situated on the Hyderabad-Bangalore Highway, the Mir Alam Lake in Hyderabad, India, is close to the Nehru Zoological Park. One of Hyderabad's biggest lakes, Mir Alam Lake is located at 17.34617° or 17° 20' 46" north latitude and 78.44027°, or 78° 26' 25" east longitude. Constructed in 1806, under the reign of Asif Jah-III, the Mir Alam lake spans 465 acres and encompasses a catchment area of 5.90 square kilometers. Hyderabad is 16 kilometers away from Mir Alam Tank. Numerous streams and springs that come down from the surrounding hills feed the tank. The Tank is fed by a canal from the Musi River and is located southwest of Hyderabad.

II. MATERIALS AND METHODS

Water samples from the surface were collected at all the sampling stations in polythene cans at monthly intervals for a period of two years. For this purpose, four sampling stations have been selected. Station-I is situated in the southern of the lake opposite to pratap nagar school. Station –II is situated 100 meters after station-I is provided for the discharge of water to zoo park. Station –III is located 100 meters after station –II and at this location water is polluted because excess water reaching this site by human activities. Station IV is located towards east of Mir Alam lake. To

estimate dissolved oxygen, water samples were collected in separate standard glass bottles (BOD bottles) while taking all necessary safety precautions. Every sample was brought to the laboratory in an icebox. The samples were tested for multiple physico-chemical parameters on the same day using standard laboratory techniques (APHA, 2005). One liter of water sample was 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 not handled for around a month in order to give the organisms time to fully settle. The samples were concentrated to 100 mL. Lastly, species identification and frequency measurements were carried out using the concentrated material. The drop method of Lackey's (1938) was followed for frequency measurement.

III. RESULTS AND DISCUSSION

The samples were analyzed from the four sampling stations within the Mir Alam Lake on monthly intervals for a period of two years from September 2021 to August 2023. The average, maximum and minimum analytic results of each parameter during the period of investigation are summarized in Table 1.

TABLE 1: Range and average values of Physico-chemical parameters.

All values are expressed in mg/L except pH and Temp (o C)

S.NO	Parameters	Station-I			Station- II			Station –III			Station – IV		
		Average	Range		Average	Range		Average	Range		Average	Range	
			Min	Max		Min	Max		Min	Max		Min	Max
1.	Temperature	24.85	21.20	28.50	24.80	21.40	28.20	24.15	20.80	27.50	23.55	20.90	26.20
2.	pH	8.68	8.06	9.31	8.86	8.39	9.34	8.74	8.20	9.29	8.84	8.35	9.33
3.	Alkalinity	761	545	922	757	574	890	815	577	935	877	636	883
4.	Carbonates	51.28	18.00	120.01	58.12	12.00	108.02	56.42	24.00	120.02	50.81	24.00	150.03
5.	Bicarbonates	584.77	250.17	1037.31	422.19	408.82	1098.32	564.41	536.96	1159.34	562.36	457.64	1281.38
6.	Chlorides	638.21	332.50	710.00	431.76	401.50	674.50	452.24	411.50	674.50	458.22	397.00	639.00
7.	DO	0.62	0.2	2.40	0.56	1.00	2.30	0.33	0.20	2.00	0.52	0.20	2.00
8.	BOD	228.2	140.00	360.00	182.0	38.00	349.00	216.7	34.00	350.00	221.0	34.00	350.00
9.	OM	63.62	32.00	118.00	85.25	31.00	218.00	85.44	71.00	116.00	106.92	21.00	212.00
10.	COD	125	86.0	218.0	144	143.2	184.0	212	208.0	348.20	182	148.28	287.0
11.	Total Hardness	452.22	120.0	580.0	476.06	110.0	550.0	441.72	140.0	530.0	492.12	110.00	540.0
12.	Calcium	101.64	36.00	176.00	182.71	36.80	160.00	184.22	36.00	176.00	86.44	44.00	172.00
13.	Magnesium	36.77	12.17	68.13	36.17	9.73	77.86	38.66	9.73	80.29	33.22	9.73	70.56
14.	Phosphate	19.11	12.60	25.00	19.06	13.00	25.00	19.32	13.60	25.60	19.12	13.20	25.20
15.	Silicates	1.42	1.35	1.45	1.20	1.18	1.22	1.88	1.86	1.89	1.99	1.95	2.1
16.	Sulphates	214.18	212.00	240.00	223.31	217.00	252.00	221.57	213.00	234.00	221.97	212.00	242.00
17.	Nitrates	16.5	14.8	19.07	19.80	18.8	20.97	19.05	18.09	20.98	17.4	15.89	20.98
18.	Nitrites	1.26	1.20	1.28	1.59	1.40	27.00	1.75	1.20	35.00	1.04	1.02	32.20
19.	Total Solids(TS)	2655.21	2537.54	2683.34	2735.00	2678.70	2784.90	2767.4	2778.00	2781.60	2714.35	2675.00	2788.00
20.	TDS	2402.6	2286.21	2456.22	2424.62	2401.58	2465.02	2422.01	2362.25	2496.21	2423.21	2365.02	2447.00

In the present investigation temperature ranged from 21.0°C – 28.2°C. The pH of the lake is 8.84.The observed minimum and maximum values of total alkalinity at station II and station III are 574.5 mg/L and 935.6 mg/L respectively (Table 1).The values represent alkaline nature of the lake. Alkaline nature of lakes in India was reported by Amin Hossaini (2013) and John Mohammad (2015). Bicarbonates were recorded high at all stations, ranged from 564.6 - 874.7 mg/L. This can be attributed 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 and indicate the presence of high organic matter. Chlorides were recorded in the range of 638.5 - 850.0 mg /L. Higher chloride concentration represents high degree of pollution (Ravish verma 2012, Ameetha Sinha 2014). Very low DO values were recorded in the lake. The minimum and maximum DO values observed were 0.2 mg/L at station IV and 2.40 mg/L at station I. Very high values of BOD were recorded at all stations. 228.2 mg/L, 182 mg/L,216.7 mg/L,221 mg/L were BOD values recorded at station I,II,III and IV respectively. Higher BOD

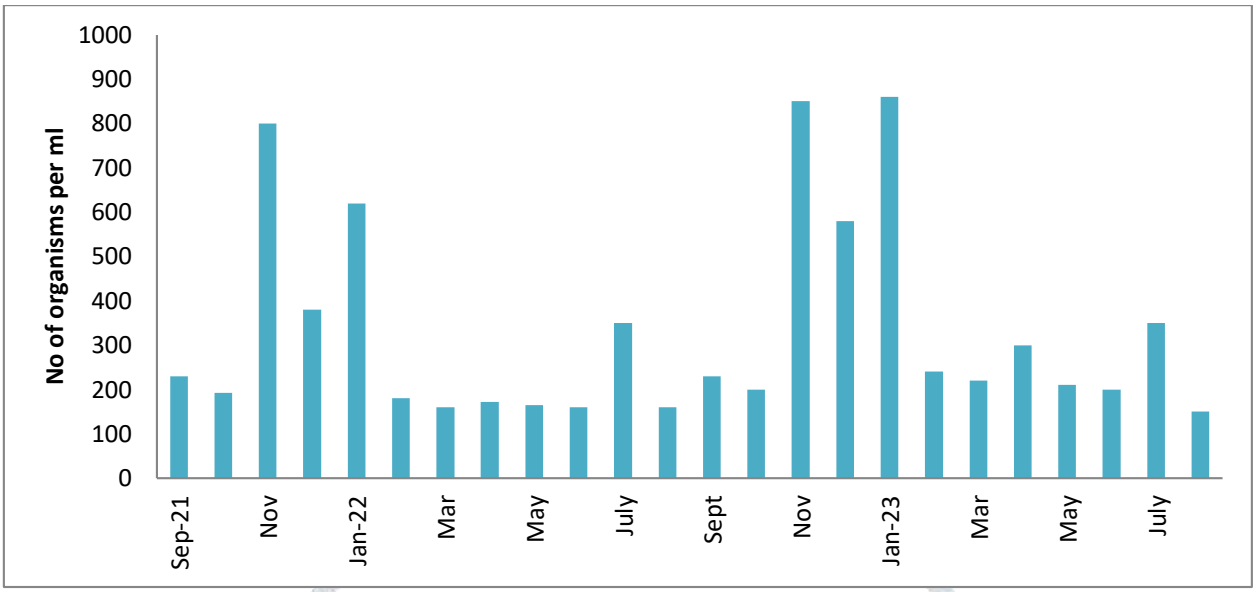
values indicate organic contamination, high nutrient loading, decomposition and mineralization of organic matter (Siraj, 2010, Suresh, 2015). Chemical Oxygen Demand ranged between 144.0 - 212.0 mg/L with minimum value of 86.0 mg/L at station I and 148.9 mg/L at station IV. Total hardness was recorded high in the range of 452.0 - 532.0 mg/L, calcium and magnesium in the range of 101.0 - 184.0 mg/L and 12.12 – 80.29 mg/L. In the present observation the phosphates ranged from 19.06 - 19.32 mg/L, 214 - 223 mg/L was the range of sulphates recorded and confirms the lake receiving sewage influx (Langmuir 1971, Sudha Rani 2004).Silicates, nitrites and nitrates ranged between 1.20 - 1.99 mg/L, 1.04 - 1.75 mg/L and 16.5 - 19.80 mg/L respectively. Sewage, industrial discharges, road runoff, fertilizers, and soil erosion acts as major sources of total solids in the water body. Total solids and total dissolved solids were observed in high concentration and reported in the range of 2655.21 - 2767 mg/L and 2402.6 – 2424.62 mg/L.

TABLE 2: Station wise distribution of Euglenophyceae

S.No	Eugelenophyceae members	Station I	Station II	Station III	Station IV
1.	*Euglena mangini* Lefevre.	+	+	+	+
2.	*Euglena acus* Ehren.	+	+	+	+
3.	*Euglena viridis* Ehren.	+	+	+	+
4.	*Euglena deses* Ehren.	-	+	+	+
5.	*Euglena adhaerens* Matvienko.	-	-	+	+
6.	*Euglena polymorpha* Dang.	-	-	+	+
7.	*Euglena oblonga* Smith.	-	+	+	+
8.	*Euglena proxima* Dang.	+	+	+	+
9.	*Lepocinclis oxyuris* Schmarda.	+	+	+	+
10.	*Lepocinclis fusiformis* Lemm.	+	+	+	+
11.	*Lepocinclis ovum* Ehren.	+	+	+	-
12.	*Lepocinclis acuta* Prescott.	+	+	+	+
13.	*Phacus longicauda* Ehren.	+	+	+	+
14.	*Phacus caudatus* Hubner.	+	+	+	+
15.	*Phacus curvicauda* Svirenko.	+	+	+	+
16.	*Phacus tortus* Lemm.	+	+	+	+
17.	*Phacus acuminatus* Stokes.	+	+	+	+
18.	*Trachelomonas oblonga* Lemm.	-	+	+	+
19.	*Trachelomonas hispida* Lemm.	+	+	+	+
20.	*Trachelomonas abrupt* Deflandre.	+	-	+	+

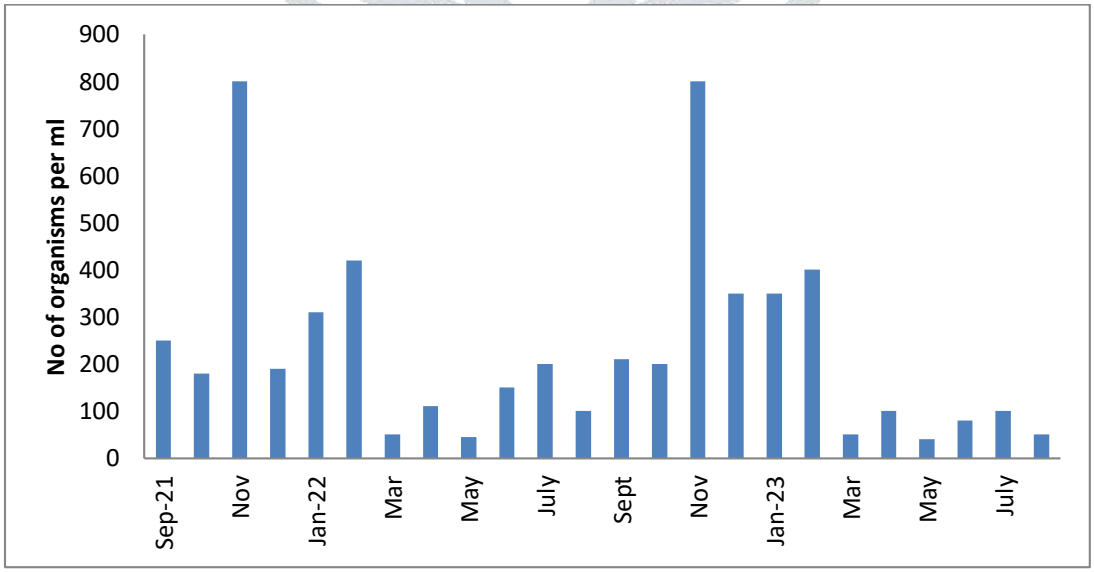
Diversified species of *Euglena, Lepocinclis*, *Phacus* and *Trachelomonas* were present. *Euglena acus, E. polymorpha, E. viridis E. elastica, E. convoluta, E. minimata, E. elongata, E. oxyuris, E. sanguinea, E. gracillis, Lepocinclis globulus, L. ovum, Trachelomonas hispida, T. oblonga, T. volvocina, Phacus curvicauda, P. caudatus, P. longicauda, P. accuminatus, P. orbicularis, P. tortus, P. triquater* were the species recorded in the present observation.

Figure 1: Distribution of Euglenophyceae at station I



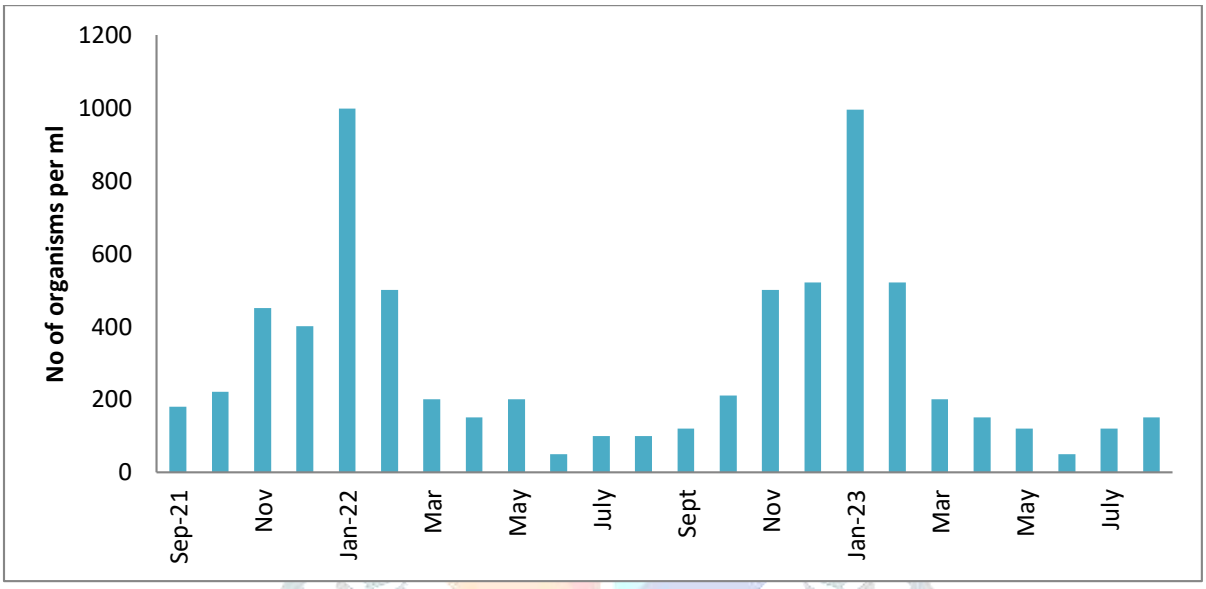
At station I, Euglenoid flagellates have attained high peaks during winter (Fig. 1) and bloom of *Trachelomonas* species was observed. *Euglena*, *Lepocinclis and Phacus* species were also represented during winter. The lowest peaks were observed in August with the representation of *Euglena* and *Lepociclis* species. High pH and Free CO_2 exhibited positive influence on Euglenoid flagellates. This was in accordance to Ashwani K Dubey (2012) and Ansari Ekhalak (2013) with reference to pH and Kiran (2002), Ashesh Tiwari (2006) and Shankar (2012) regarding Free CO_2. Temperature influenced negatively on the growth of algae. Temperature and bicarbonates negatively influenced the algal growth. Similar observations were made by Suresh (2013), Altaf H. Ganai (2014) and Suresh (2015). Calcium, silicates, and sulphates exhibited direct relationship with Euglenophyceae. 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. This is in accordance with Shankar (2012) and Suresh (2015). TDS and phosphates influenced algal growth negatively and high magnesium concentration decreased Euglenoid flagellates. This is in conformity with Suresh (2015) and Ananthaiah (2010). The higher peaks of Euglenophyceae were associated with high pH and silicates and low TS and TDS.

Figure 2: Distribution of Euglenophyceae at station II



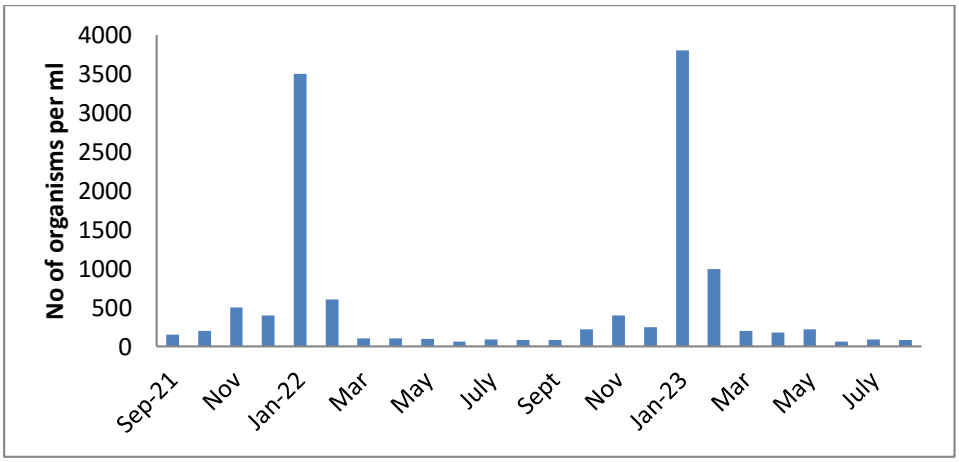
At station II, The winter dominance of Euglenophyceae (Fig. 2) was due to *Trachelomonas, Euglena* and *Lepocinclis* species. The low peaks were reported during May. Euglenoid flagellates have attained peaks in November constituted the bloom of *Trachelomonas* species and the bloom of E*uglena* and *Lepocinclis* was observed in February. The winter dominance of Euglenophyceae was due to *Trachelomonas, Euglena* and *Lepocinclis* sp. The low peaks were reported during May and showed the presence of *Trachelomonas* sp., *Euglena* sp. and *Phacus* sp. The maximum number of *Phacus* was represented in August. Bicarbonates, phosphates, silicates and nitrites exerted positive influence on algae. Similar relationship of bicarbonates and Euglenophyceae was reported by Ananthaiah (2010) and Agale (2013) and was observed as important parameter which regulates Euglenophyceae growth. Total phosphorus favouring the abundance of Euglenophyceae was reported by Munawar (1972), Ananthaiah (2010) and Shankar (2012). Nitrates, magnesium, sulphates, carbonates, Free CO2, chlorides, TS and TDS negatively influenced Euglenoid flagellates. Among these factors nitrates, TDS, sulphates, chlorides, influencing algal growth on negative side was in accordance to Suresh (2015). The higher peaks at this station were associated with high bicarbonate concentration, low sulphates and TS.

Figure 3: Distribution of Euglenophyceae at station III



At station III, Euglenophyceae showed their peaks in January (Fig. 3) with the bloom of *Trachelomonas* and *Euglena*. The winter dominance of Euglenoid flagellates was represented by the species of *Trachelomonas, Euglena* and *Lepocinclis*. The low peaks were reported in June and the species found were *Euglena* and *Lepocinclis*. The bloom of *Euglena* was reported in January. *Trachelomonas* bloom was found in February and *Lepocinclis* bloom was observed during winter and attained maximum in November. The *Phacus* peaks were reported in April. Temperature, carbonates, organic matter, chlorides, calcium, magnesium, TS and TDS showed negative influence on Euglenoid flagellates and total hardness, sulphates, nitrites, silicates and Free CO2 exerted positive influence. The low levels of TS are associated with the peaks of Euglenoids at this station.

Figure 4: Distribution of Euglenophyceae at station IV



In the present investigation at station IV, highest percentage of Euglenoid flagellates were reported compared to the other stations. High peaks were observed in January (Fig. 4) represented by the bloom of *Lepocinclis*, *Trachelomonas* and *Euglena* and all the species were in the maximum numbers. Euglenophyceae peaks were low in June. *Phacus* was reported in maximum number in April. Significant influence of Free CO_2, COD and silicates was observed on positive side. Calcium and magnesium exhibited positive relationship with algal growth. This was in accordance to Sudha Rani (2004). Temperature, chlorides, phosphates, organic matter, BOD, nitrites, TS and TDS exerted a significant negative influence on the growth of Euglenoid flagellates. The concentration of organic matter and nutrients was very high in the lake at all stations and the presence of *Euglena* and *Phacus* species indicates organic pollution and these species also tolerates high degree of pollution. This was in conformity with Palmer (1980), Nayak and Khare (1993), Ashesh Tiwari (2006), Shankar (2012), Altaf H. Ganai (2014) and Suresh (2015). Rama Swamy (1982) reported that the species of *Euglena*, *Phacus* and *Trachelomonas* are commonly encountered in waters with rich oxidizable organic matter. *Euglena oxyuris* and *E. gracillis* were represented in good numbers at all the stations. According to Amin Hossaini (2015) *Euglena* and *Trachelomonas* are the bio indicators of eutrophic lake and the blooms represent eutrophic condition of the lake.

The present investigation elevated the distribution and diversity of Euglenophyceae in Mir Alam Lake. The evaluated physico-chemical parameters considerably influenced the growth of algae. Euglenoid flagellates were represented by diversified species and presence of *Euglena*, *Phacus* and *Trachelomonas* species which are pollution indicators symbolize eutrophic condition of the lake. High diversity of Euglenophyceae was reported in the lake representing 11 species of *Euglena*, 8 species of *Phacus*, 4 species of *Lepocinclis* and 3 species of *Trachelomonas*. The diversity is very high compared to other lakes. The presence of *Euglena*, *Phacus* and *Lepocinclis* species indicates the eutrophic nature of the lake.

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