A COMPARATIVE STUDY OF THE ECOLOGICAL STATUS OF THE PERUMKULAM AND THAMRAPARANI RIVER IN KANYAKUMARI DISTRICT

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Abstract: Water quality plays an important role in the growth, distribution and abundance of aquatic organisms. Interest in water analysis is due to the enormous importance of water to all categories of living organisms. The present investigation was carried out during November 2013 to August 2014 in order to determine the species richness of microalgae in the Pond and River. Water samples were collected from two stations of Pond and River for the analysis of physicochemical parameters such as pH, temperature, dissolved oxygen, biological oxygen demand, alkalinity, acidity, calcium, chloride, total hardness and magnesium. Microalgae samples were also collected at monthly intervals (Net size No 25) and it was identified using the taxonomic keys and manuals. A total of 98 species belonging to four classes (Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae) were identified. Of these, Chlorophyceae were dominated in terms of species richness (36 species), followed by Bacillariophyceae (28 species), Cyanophyceae (25 species) and Euglenophyceae (9 species). Algal species such as *Chlorella*, *Scenedesmus*, *Ankistrodesmus*, *Closterium*, *Navicula*, *Nitzchia*, *Synedra*, *Gamphonema*, *Merismopedia*, *Chroococcus*, *Microcystis*, *Anabaena*, *Euglena* and *Phacus* were collected from the Pond.

Index Terms: River, Pond, Ecological Status. Microalgae

I. Introduction

Life is dependent on water and in this context, freshwater ecosystems gain fundamental importance. Freshwater ecosystems are conveniently divided into two groups - lentic (standing or still water habitats) and lotic (running water habitats). Both the groups act as specific environmental gradients. In the last few decades, climate change and human socio-economic development have greatly changed the global hydrological cycle, threatening water security, the health of aquatic ecosystems and freshwater diversity (Vorosmarty *et al*., 2010; Jacobsen *et al*., 2012; Vanvliet *et al*., 2013). Lotic aquatic systems are those systems is in a state of perpetual motion like streams and rivers. An important ecosystem service of these lotic water bodies is to carry the excess rain water back to the sea. The most distinctive features of lotic ecosystems are the rate of flow and stream velocity. Another major factor affecting the biotic community of these water bodies is the turbulence or irregularity of the motion of the particular water (Nimisha and Sheeba, 2013).

Wetlands are standing water bodies or slow flowing waters, where the water level is very shallow, which enables sunlight to reach till the bottom, thereby creating a favourable environment for aquatic and semi-aquatic organisms. A pond is a slanting freshwater body that is either natural or man-made and is usually smaller than a lake. Ponds may have been natural water sources that were exploited by mankind from time to time or may be artificial water bodies created to meet the different requirements (Rajagopal *et al*., 2010).

Microalgae form an important component of the food chain as primary producers by serving as a direct source of food for other aquatic plants and animals. They provide information on the productivity of the environment. They are of great importance as a major source of organic carbon stored at the base (Gaikwad *et al*., 2004). Eutrophication of water bodies happens due to rapid increase in the quality and quantity of the discharged sewage which in turn, enhances the algal proliferation. Eutrophication leads to increased algal growth and potential deoxygenation of the lower cooler layers of the water body during summer. Occurrence of water blooms, i.e., the dense growths of microscopic organisms may be induced suddenly due to heavy rainfall or rise in oxygenation that lead to the release of nutrients, leading to the formation of an algal bloom (Kumar, 2002). Despite the importance of freshwater microalgae community, analysis and its relation with water nutrients are still unclear and require further attention. Exploring the biodiversity of microalgae in various aquatic and terrestrial habitats at different periods is the need of the hour. In the present study, an attempt was made to understand of microalgal community in the freshwater pond and a river to the impact of various prevailing environmental factors, with special emphasis on bio-indicator species on lentic ecosystem.

II. Materials and Methods

I selected a river (Thamraparani) and one pond namely (Perumkulam) for my research work. Water samples were collected from each sites at monthly intervals at November 2013 to August 2014. The water quality parameters such as pH, water temperature, dissolved oxygen, biological oxygen demand, total alkalinity, chloride, calcium, magnesium and total hardness (APHA 1998) were analysed. Water samples were taken for the analysis of phytoplankton using No. 25 plankton net and the water is concentrated to 25ml. The samples were fixed in 4% formaldehyde and 1ml of Lugol's iodine. Cell counts were made by counting the number of cells/ml -Desikacharry (1959), Philipose (1967), Prescott (1978) and Anand (1998). The microalgae collected from the study area are classified on the basis of Frisch (1935).

III. Result and Discussion

Water temperature fluctuated both daily and seasonally which is an important physical parameter that is directly related to the chemical reactions in the aquatic ecosystem. In the present investigation, temperature of the water ranges between 21ºC to 24ºC. In river, the maximum temperature of 24ºC was recorded during March. In river, the minimum temperature of 21ºC was recorded during December. Mithani *et al*., 2012 reported that the maximum water temperature was recorded during summer and minimum during winter season. Similar observations were also recorded by Sawane (2002) and Khinchi *et al*., 2011.

pH is an important parameter which evaluates the acid and base balance of water. The pH of the water ranges between 6.9 -7.7. In pond, maximum pH of 7.7 was recorded during March. In river, minimum pH of 6.9 was recorded during May. Nimisha and Sheeba (2013) reported that pH variations in the riverine environment ranged from 6.6 to 7 and the values obtained in the present study fall within this range. Mithani *et al*., 2012 reported that maximum pH was recorded during summer and minimum during monsoon season. Narain and Chauhan (2000) also observed maximum pH in summer and minimum pH in monsoon. Similar observations were also reported by Bandela *et al*., (1998) and Khalique (1995).

Alkalinity of water is primarily a function of carbonate, hydroxide content and also the contribution of borates, phosphates, silicates and other bases (Shinde *et al*., 2011). The alkalinity of the water ranges between 33 and 138 ppm. In pond, the maximum alkalinity of 138 ppm was recorded during April. In river, the minimum alkalinity of 33 ppm was recorded during November. Similar variations were reported by Rathore *et al*.(2006). Increase in the breakdown leads to increase in the levels of alkalinity as evidenced from the findings of Rao *et al*.(1993).

Dissolved oxygen ranged from 4.2mg/l to 6.43mg/l. In river, maximum dissolved oxygen of 6.43mg/l was recorded during August. In pond, minimum dissolved oxygen of 4.2 mg/l was recorded during February. Thakur *et al*., (2013) noticed the minimum value of dissolved oxygen of 3.05 mg/l at Rewalsar during summer. The overall decrease in the dissolved oxygen indicates an increase in eutrophic conditions (Sheela *et al*., 2011).

Biological Oxygen Demand is regarded to be a more sensitive test for organic pollution. Increased temperature and sedimentation levels reduce BOD. The BOD of the water ranges between 1 and 2.5mg/l. In river, maximum BOD of 2.5mg/l was recorded during August. In pond, a minimum BOD of 1mg/l was recorded during February. The reason of high BOD in summer may be because in summer, several microbes present in the water bodies accelerate their metabolic activities with concentrated amount of organic matter in the form of municipal and domestic wastes that are discharged into water bodies and hence, they require more oxygen resulting in oxygen demand (Kumar and Sharma, 2005).

The chloride of the water ranges between 15 and 37.3mg/l. In river, maximum Cl 37.3mg/l was recorded during July. In pond, minimum Cl 15mg/l was recorded during June. Thakur *et al*.(2013) recorded an average value of chloride as 38.88 mg/l from Rewalsar lake followed by Kuntbhyoglake (12.57 mg/l) and minimum at Prashar lake (6.096 mg/l). A high concentration of chloride is always regarded as an indicator of eutrophication (Hynes, 1963) and is usually taken as an index of pollution (Hasalam, 1991; Verma *et al*., 2012).Calcium is one of the natural elements found in most of the freshwater ecosystems in the form of calcium carbonate which is a prime factor for hardness (Kamaraj *et al*., 2008). Calcium is found in greater abundance in all natural water bodies. The Ca of the water ranges between 16.03 and 69.7 mg\l. In river, maximum Ca of 69.7 mg/l was recorded during January. In pond, minimum Ca of 16.03 mg/l was recorded during August. Higher concentration of calcium may be due to the inflowing of sewage from surrounding areas. Magnesium is often associated with calcium in all kinds of water, but its concentration remains lower than calcium (Venkatasubramani *et al*., 2007). Magnesium and calcium play an important role in antagonizing the toxic effects of various ions in neutralizing excess acid producer (Munaver, 1970). The mg of the water ranges between 13 and 21.4 mg/l. In river, a maximum of 21.4 mg/l was recorded during January. In pond, a minimum of 13 mg/l was recorded during March. Hardness is the property of water which prevents lather formation with soap and increases the boiling point of water. Hardness of water mainly depends upon the amount of calcium or magnesium salts. The total hardness of the water ranges between 90-166 mg/l. In river a maximum total hardness of 166 mg/l was recorded during January month. In pond, a minimum total hardness of 90 mg/l was recorded during June.

A total of 98 algal species belonging to four phylum (Chlorophyta, Bacillariophyta, Cyanophyta and Euglenophyta), four classes (Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae), 52 genera and 32 families were recorded in the study area (Table 1). Of these which 9 families, 15 genera and 25 species belonged to cyanobacteria; 12 families, 19 genera and 36 species belonged to chlorophyta; 9 families, 14 genera and 28 species belonged to Bacillariophyta and 2 families, 4 genera and 9 species belonged to Euglenophyta.

In River Chlorophyta (20) found to be dominant followed by Bacillariophyta (18), Cyanobacteria (18) and Euglenophyta (9). In Pond Chlorophyta (36) found to be dominant followed by Bacillariophyta (28), Cyanobacteria (25) and Euglenophyta (4) (Fig.1). Chlorophyceae members were more abundant in summer and maximum during monsoon. During summer, the temperature and light intensity were high resulting in higher biomass of green algae. High pH and higher dissolved oxygen levels during summer may perhaps be responsible for diversity of Chlorophyceae. These results could be compared with the observations of Philipose (1959) and Munawar (1970) who suggested that alkaline waters rich in nitrate and phosphate support volvocales.

Microalgae was represented by four classes of algae viz. Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae. Percentage wise contribution of microalgae groups are shown in Fig.2. Of these 98 species, 36 were from the class of Chlorophyceae (37%), 28 species from Bacillariophyceae (29%), 25 species from Cyanophyceae (25%) and 9 from Euglenophyceae (9%).

Lowest total number of Chlorophyceae was recorded River, (20 Species), the highest number of species were recorded from Pond (36 species). The dominant status of Chlorophyceae was also observed in Bhuiyan & Gupta 2007; Balasingh 2010 and Kumar *et al*., 2012. The lowest total number of Cyanophyceae were recorded at River (18 species) and highest total number of species were recorded in Pond (25 species).The lowest total number of Bacillariophyceae were recorded at River (18 species) and highest total number of species were recorded from Pond (28 species).Euglenophyceae group of phytoplankton such as *Phacus* Sp., and *Euglena* Sp., were dominant species. The lowest total number of Euglenophyceae were recorded at Pond (4 species) and highest total number of species were recorded from River (9 species). Euglenophyceae members show high tolerance to organically polluted water. Palmer (1980) opined them as biological indicators of organic pollution. In the present investigation, *Euglena*, *Phacus* and *Trachelomonas* were found in good numbers with high species diversity. In the present investigation, it has been observed that the water quality of the River has deteriorated and is highly eutrophic and polluted.

IV. Conclusion

From the above study, it is concluded that the River is polluted due to anthropogenic activities such as domestic sewage discharge, agricultural waste, washing and bathing. The organic matter decomposition by microbes are very high. The local people must take an initiative to conserve this perennial pond for their future generation. The unwanted wastes in freshwater bodies leads to loss of biodiversity and ecological imbalance in freshwater ecosystems. So the experimental studies in freshwater ecosystem were dire necessity in present day situations. To overcome serious problem, re-modification of the freshwater body is needed by adding required nutrients which ultimately leads to preserve the biodiversity of microalgae.

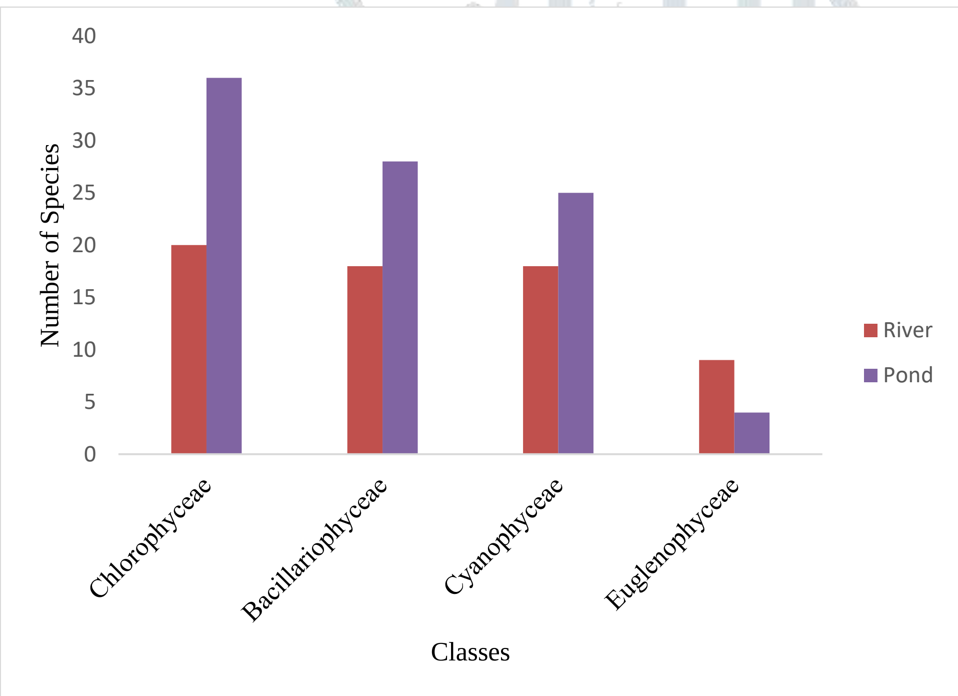

Fig 1 Microalgae recorded from different study sites

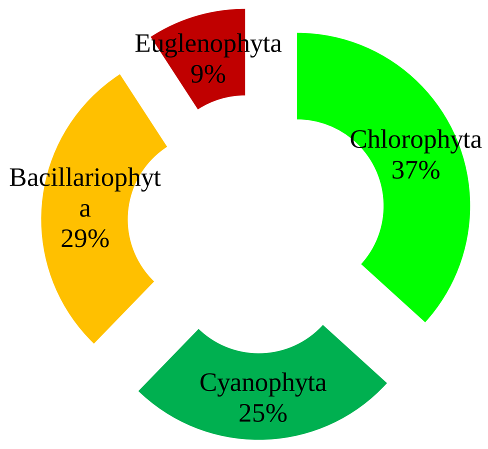

Fig 2. Species richness of microalgae in respective phylum

S.No	Name of the algae	Phylum	Class	Family	River	Pond
1	*Amphora ovalis* (Kutzing) Kutzing	Bacillariophyta	Bacillariophyceae	Catenulaceae	−	−
2	*Anabaena fertilissima* C. B.Rao	Cyanobacteria	Cyanophyceae	Nostocaceae	−	−
3	*Anabaena planctonica* Brunnthaler	Cyanobacteria	Cyanophyceae	Nostocaceae	−	+
4	*Ankistrodesmus falcatus* radiatus Lemmermann	Chlorophyta	Chlorophyceae	Selenastraceae	+	−
5	*Arthrospira platensis* Gomont	Cyanobacteria	Cyanophyceae	Microcoleaceae	+	+
6	*Caloneis bacillaris* (Gregory) Cleve	Bacillariophyta	Bacillariophyceae	Naviculaceae	−	−
7	*Chlorella vulgaris* (Beijerinck)	Chlorophyta	Chlorophyceae	Chlorellaceae	+	+
8	*Chlorococcum humicola* Nageli Rabenhorst	Chlorophyta	Chlorophyceae	Chlorellaceae	+	+
9	*Chroococcus minutus* (Kutz.) Nageli	Cyanobacteria	Cyanophyceae	Chroococcaceae	+	+
10	*Chroococcus tenax* (Kirchn.) Hieron.	Cyanobacteria	Cyanophyceae	Chroococcaceae	−	−
11	*Cladophora glomerata* (Linnaeus) Kutzing	Chlorophyta	Chlorophyceae	Cladophoraceae	+	+
12	*Closterium acutum* var.variable Lammermann Willi Kreiger	Chlorophyta	Chlorophyceae	Desmidiaceae	+	+
13	*Closterium decorum* Brebisson	Chlorophyta	Chlorophyceae	Desmidiaceae	−	+
14	*Closterium ehrenbergii* Menegh. Ex Ralfs. Brit	Chlorophyta	Chlorophyceae	Desmidiaceae	+	−
15	*Closterium incurvum* Brebisson	Chlorophyta	Chlorophyceae	Desmidiaceae	+	−
16	*Closterium lunula* Ehrenberg & Hemprich ex Ralfs	Chlorophyta	Chlorophyceae	Desmidiaceae	+	+
17	*Coelastrum microporum* Nageli	Chlorophyta	Chlorophyceae	Scenedesmaceae	+	+
18	*Cosmarium angulosum* var octagonum (W.B.Turner)Krieger & Gerloff	Chlorophyta	Chlorophyceae	Desmidiaceae	+	+
19	*Cosmarium cucurbitinum* var truncatum wili Krieger	Chlorophyta	Chlorophyceae	Desmidiaceae	+	+
20	*Cosmarium microsphinctum* Nordstedt	Chlorophyta	Chlorophyceae	Desmidiaceae	+	+

21	*Cosmarium quadrum* P.Lundell	Chlorophyta	Chlorophyceae	Desmidiaceae	-	-
22	*Cymbella lanceolata* (C. Agardh) C. Agardh	Bacillariophyta	Bacillariophyceae	Cymbellaceae	+	+
23	*Cymbella turgida* var. obtusa Ottomuller	Bacillariophyta	Bacillariophyceae	Cymbellaceae	+	+
24	*Dactylococcopsis rhaphidioides* Hansgirg	Cyanobacteria	Cyanophyceae	Chroococcaceae	-	-
25	*Denticula elegans* Kuetzing	Bacillariophyta	Bacillariophyceae	Bacillariaceae	+	-
26	*Diatoma vulgaris* Bory	Bacillariophyta	Bacillariophyceae	Tabellariaceae	-	+
27	*Euglena acus* var. rigida E.Hubner	Euglenophyta	Euglenophyceae	Euglenaceae	-	+
28	*Euglena obtusa* caudata I.A. Kisselev	Euglenophyta	Euglenophyceae	Euglenaceae	-	-
29	*Euglena polymorpha* P.A.Dangeard	Euglenophyta	Euglenophyceae	Euglenaceae	-	+
30	*Euglena sanguinea* Ehrenberg	Euglenophyta	Euglenophyceae	Euglenaceae	-	+
31	*Eunotia bilunaris* (Ehrenberg) Schaarschmidt	Bacillariophyta	Bacillariophyceae	Eunotiaceae	-	-
32	*Eunotia camelus* Ehrenberg	Bacillariophyta	Bacillariophyceae	Eunotiaceae	-	-
33	*Fragilaria intermedia* var.continua Mayer	Bacillariophyta	Bacillariophyceae	Fragilariaceae	+	+
34	*Gloeocapsa nigrescens* Nageli	Cyanobacteria	Cyanophyceae	Microcystaceae	-	-
35	*Gloeocystis gigas* var.maxima West	Chlorophyta	Chlorophyceae	Radiococcaceae	+	+
36	*Gomphonema acuminatum* Ehrenberg	Bacillariophyta	Bacillariophyceae	Gomphonemataceae	+	+
37	*Gomphonema lanceolatum* var.turris Hustedt	Bacillariophyta	Bacillariophyceae	Gomphonemataceae	+	-
38	*Gomphonema truncatum* Ehrenberg	Bacillariophyta	Bacillariophyceae	Gomphonemataceae	+	+
39	*Gyrosigma acuminatum* (Kutzing) Rabenhorst	Bacillariophyta	Bacillariophyceae	Naviculaceae	-	-
40	*Hydrodictyon reticulatum* (Linnaeus) Bory	Chlorophyta	Chlorophyceae	Hydrodictyaceae	+	+
41	*Lepocinclis salina* F.E.Fritsch	Euglenophyta	Euglenophyceae	Phacaceae	+	+
42	*Lyngbya connectens* Bruhl & Biswas	Cyanobacteria	Cyanophyceae	Nostocaceae	+	+
43	*Lyngbya diguetii* Gomont	Cyanobacteria	Cyanophyceae	Nostocaceae	+	+
44	*Merismopedia elegans* A. Braun ex Kutzing	Cyanobacteria	Cyanophyceae	Merismopediaceae	-	-
45	*Merismopedia glauca* (Ehrenberg) Kutzing	Cyanobacteria	Cyanophyceae	Merismopediaceae	-	-
46	*Micrasterias radians* Turner	Chlorophyta	Chlorophyceae	Desmidiaceae	-	-
47	*Microcystis aeruginosa* (Kutz.) Kutz.	Cyanobacteria	Cyanophyceae	Microcystaceae	-	-

48	*Microcystis flos-aquae* (Wittr.) Kirchn.	Cyanobacteria	Cyanophyceae	Microcystaceae	−	−
49	*Navicula cuspidata* var.obtusa Grunow	Bacillariophyta	Bacillariophyceae	Naviculaceae	+	−
50	*Navicula halophila* var.fogedii H.P.Gandhi	Bacillariophyta	Bacillariophyceae	Naviculaceae	−	+
51	*Navicula radiosa* Kutzing	Bacillariophyta	Bacillariophyceae	Naviculaceae	+	−
52	*Navicula rhomboides* Kuetz	Bacillariophyta	Bacillariophyceae	Naviculaceae	−	+
53	*Navicula viridula* (Kutzing) Ehrenberg	Bacillariophyta	Bacillariophyceae	Naviculaceae	−	+
54	*Netrium digitus* (Brebisson ex Ralfs) Itzigsohn & Rothe	Chlorophyta	Chlorophyceae	Mesotaeniaceae	+	+
55	*Nitzschia amphibia* (Grunow)	Bacillariophyta	Bacillariophyceae	Bacillariaceae	−	+
56	*Nitzschia circularis* Smith	Bacillariophyta	Bacillariophyceae	Bacillariaceae	−	+
57	*Nitzschia obtusa* W.Smith	Bacillariophyta	Bacillariophyceae	Bacillariaceae	+	+
58	*Nitzschia palea* (Kutzing) W.Smith	Bacillariophyta	Bacillariophyceae	Bacillariaceae	+	+
59	*Nodularia* Sp	Cyanobacteria	Cyanophyceae	Aphanizomenonaceae	+	+
60	*Nostoc commune* Vaucher ex Bornet & Flahault	Cyanobacteria	Cyanophyceae	Nostocaceae	−	−
61	*Oedogonium hispidum* Nordstedt ex Hirn	Chlorophyta	Chlorophyceae	Oedogoniaceae	+	+
62	*Oedogonium macrodrium* var. hohenackerii (wittr.) Tiffany	Chlorophyta	Chlorophyceae	Oedogoniaceae	+	+
63	*Oscillatoria acula* Bruhl & Biswas	Cyanobacteria	Cyanophyceae	Oscillatoriaceae	−	+
64	*Oscillatoria curviceps* C. Agardh ex Gomont	Cyanobacteria	Cyanophyceae	Oscillatoriaceae	−	+
65	*Oscillatoria limosa* C. Agardh ex Gomont	Cyanobacteria	Cyanophyceae	Oscillatoriaceae	−	−
66	*Oscillatoria princeps* Vaucher ex. Gomont	Cyanobacteria	Cyanophyceae	Oscillatoriaceae	−	−
67	*Oscillatoria subbrevis* Schmidle	Cyanobacteria	Cyanophyceae	Oscillatoriaceae	−	+
68	*Pediastrum biradiatum* var.emarginatum (Ehrenberg)Lagerheim	Chlorophyta	Chlorophyceae	Hydrodictyaceae	+	−
69	*Pediastrum boryanum* var.meneghinii Claassen	Chlorophyta	Chlorophyceae	Hydrodictyaceae	−	−
70	*Pediastrum duplex* Meyen	Chlorophyta	Chlorophyceae	Hydrodictyaceae	+	+
71	*Pediastrum reticulatum* (Lagerh.) Zacharias	Chlorophyta	Chlorophyceae	Hydrodictyaceae	+	+
72	*Pediastrum simplex* var. annulatum Chodat	Chlorophyta	Chlorophyceae	Hydrodictyaceae	+	+

73	*Pediastrum tetras* var. tetraodon (Corda) Hansgirg	Chlorophyta	Chlorophyceae	Hydrodictyaceae	+	+
74	*Phacus curvicauda* Svirenko	Euglenophyta	Euglenophyceae	Phacaceae	+	+
75	*Phacus cylindrus* Pochmann	Euglenophyta	Euglenophyceae	Phacaceae	−	+
76	*Phacus longicauda* (Ehrenberg) Dujardin	Euglenophyta	Euglenophyceae	Phacaceae	+	+
77	*Phormidium inundatum* Kutzing ex Gomont	Cyanobacteria	Cyanophyceae	Oscillatoriaceae	+	+
78	*Pinnularia simplex* Ake Berg	Bacillariophyta	Bacillariophyceae	Pinnulariaceae	+	−
79	*Pinnularia viridis* (Nitzsch) Ehrenberg	Bacillariophyta	Bacillariophyceae	Pinnulariaceae	+	+
80	*Scenedesmus bijugatus* var. seriatus Chodat	Chlorophyta	Chlorophyceae	Scenedesmaceae	+	+
81	*Scenedesmus denticulatus* var. minor Shen	Chlorophyta	Chlorophyceae	Scenedesmaceae	+	−
82	*Scenedesmus dimorphus* f. minor Chadha & D.C.Pandey	Chlorophyta	Chlorophyceae	Scenedesmaceae	+	+
83	*Scenedesmus obliquus* f. tetradesmoides Dedusenko-Shchegoleva	Chlorophyta	Chlorophyceae	Scenedesmaceae	+	−
84	*Selenastrum gracile* var. minutum Playfair	Chlorophyta	Chlorophyceae	Selenastraceae	−	−
85	*Senedesmus quadricauda* (Turbin) Brebisson	Chlorophyta	Chlorophyceae	Scenedesmaceae	+	+
86	*Spirogyra crassa* (Kutzing) Kutzing	Chlorophyta	Chlorophyceae	Zygnemataceae	+	−
87	*Spirulina gigantea* Schmidle	Cyanobacteria	Cyanophyceae	Spirulinaceae	−	−
88	*Spirulina major* Kutzing ex Gomont	Cyanobacteria	Cyanophyceae	Spirulinaceae	+	+
89	*Synechocystis pevalekii* Ercegovic	Cyanobacteria	Cyanophyceae	Merismopediaceae	+	+
90	*Synedra delicatissima* var.mesoleia Grunow	Bacillariophyta	Bacillariophyceae	Fragilariaceae	−	+
91	*Synedra ulna* var.impressa Hustedt	Bacillariophyta	Bacillariophyceae	Fragilariaceae	−	+
92	*Tabellaria fenestrata* (Lyngbye)Kutzing	Bacillariophyta	Bacillariophyceae	Tabellariaceae	+	−
93	*Tabellaria flocculosa* (Roth) Kutzing	Bacillariophyta	Bacillariophyceae	Tabellariaceae	−	−
94	*Trachelomonas volvocina* (Ehrenberg) Ehrenberg	Euglenophyta	Euglenophyceae	Euglenaceae	−	+
95	*Ulothrix zonata* var. rigidula (Kutzing) Hansgirg	Chlorophyta	Chlorophyceae	Ulotricaceae	+	+
96	*Volvox aureus* Ehrenberg	Chlorophyta	Chlorophyceae	Volvocaceae	+	−

97	*Westiellopsis prolifica* Janet	Cyanobacteria	Cyanophyceae	Hapalosiphonaceae	-	-
98	*Zygnema carinatum* Taft	Chlorophyta	Chlorophyceae	Zygnemataceae	+	+

Table 1. List of microalgae species found in the study area

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