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Diversity of phytoplankton and its relationship with physicochemical parameters of three ponds in Chittagong University campus, Bangladesh

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Abstract: *This study was conducted for two years, from January 2017 to December 2018 to find out the phytoplankton diversity and its relationship with the physicochemical parameters of three ponds at Chittagong University Campus. Species compositions of phytoplankton was 42.86% blue-green algae, 14.29% green algae, 28.57% desmids and 14.29% diatoms in Pond 1, 33.33% blue-green algae, 33.33% green algae and 33.33% desmids in Pond 2 and 33.33% blue-green algae, 50% green algae and 16.67% desmids in pond 3. The total species of phytoplankton classes were recorded as 4, which included 7 species under 7 genera, 9 species under 9 genera and 6 species under 6 genera in the ponds 1, 2 and 3 respectively. The more number of species of phytoplankton was observed in Pond 2 than the other two ponds. Phytoplankton showed direct relationship with DO (Pond 1, r= 0.73, P<0.01), water temperature (Pond 1, r= 0.51, P<0.1), (Pond 3, r= 0.52, P<0.1), air temperature (Pond 1, r = 0.58, P<0.1) and an inverse relationship with transparency (Pond 1, r = -0.56, P<0.1).*

Keywords: *Phytoplankton diversity, physicochemical parameters, ponds, correlation*

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I. Introduction

Plankton is part of aquatic life, which composes tiny organisms living and drifting in the direction of water current. It acts as the main source of food for most faunal both in lotic and lentic water ecosystems. In aquatic food chain, phytoplankton is the most important microscopic algal communities in a water body. In an aquatic ecosystem the productivity is directly related to phytoplankton diversity (Ansari *et al.*, 2015). The zooplankton and fish production depend to large degree on the phytoplankton (Boney, 1975). Plankton is a good indicator of changes in water quality because it is strongly affected by environmental conditions and responds quickly to changes in environmental quality.

Historically the ponds are excavated by human being mainly for the storage of water for drinking purposes and other domestic uses like cooking, washing clothes, utensils and bathing. But recently, the ponds are excavated for the culture of fishes like the major Indian carps, Cat fishes, Tilapia and some species of exotic carps. On the other hand, the ponds are also made for different recreational purposes like swimming, boating and angling. The Chittagong University (CU) campus covering an area of 1754 acres is situated in an urban hilly area of Hathazari Upazilla, Chittagong, where some manmade lentic and natural lotic water bodies including lakes and ponds are present. Some water reservoirs like ponds were constructed in the CU campus in different times for fulfilling the necessity of campus residents and are used by the some campus resident employees and students for different purposes like water polo, swimming, bathing and fish culture.

Despite the high economic value of ponds, limnological works on the ponds are very few. Some mentionable ones in Bangladesh and India are as follows: Sayeswara *et al.* (2011), Bhatnagar and Devi (2013), Ansari *et al.* (2015), Nair *et al.* (2015), Elayaraj *et al.* (2016), Joseph (2017), Rahaman *et al.* (2017), Dhanasekaran *et al.* (2017) and Ansari and Singh (2017). So far, in this respect no detailed works were found on the three selected ponds at CU campus. So, the present study was undertaken to find out the phytoplankton diversity and its relationship with the physicochemical parameters of the three ponds at CU campus.

II. Materials And Methods

Study area:

Location and information of three ponds at Chittagong University campus (Fig.1):

Pond-1 is known as Shova colony pond (Latitude 22° 483778′ and Longitude 91° 79082′) (Fig.1). This pond was excavated for general use and is now extensively used by CU employees residing around the pond, for their household washing, bathing and also for dumping their wastes mainly during rainy season. **Pond-2** is known as

Gol pond (Latitude 22° 466205´ and Longitude 91° 792128´) (Fig. 1). The pond is not used for any household washing purposes except sometimes for swimming, bathing and water polo by the CU students. **Pond-3** is known as Biological Science Faculty (CU-BSF) pond (Latitude 22° 466197´and Longitude 91° 781166´) (Fig. 1). After the construction work of CU-BSF, the pond is sometimes used for swimming and bathing by the students and some local inhabitants and local farmers for washing their locally produced vegetables and to some extent for fish culture.

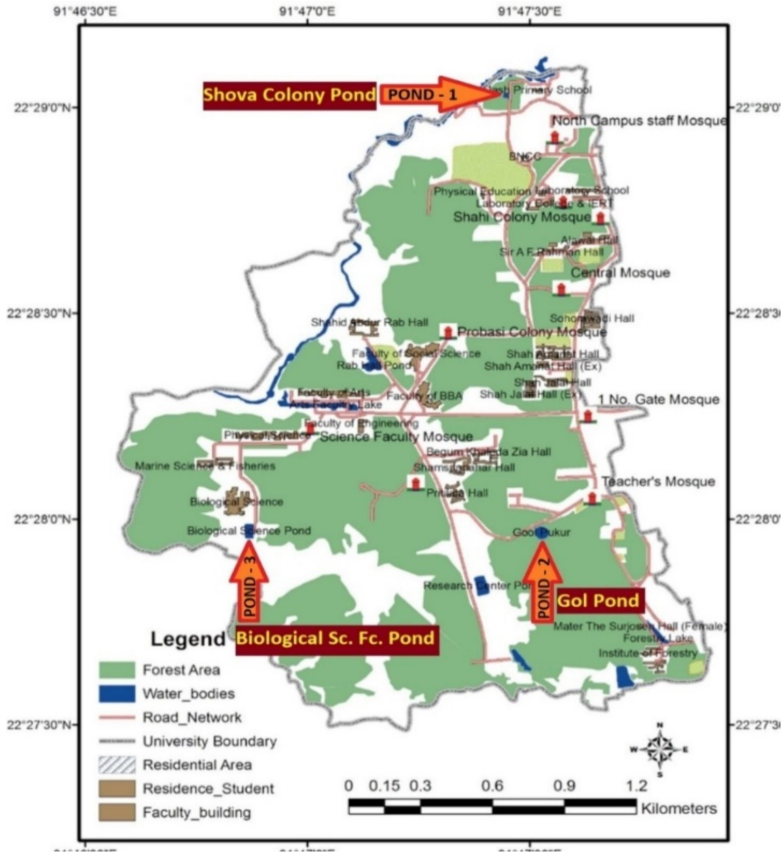

Fig. 1. Map showing location of three experimental ponds (Pond 1: Shova colony pond, Pond 2: Gol pond and Pond 3: Biological Science Faculty pond) in the Chittagong University campus.

Sampling and sample processing

Monthly water samples from subsurface layers of three experimental ponds (Pond-1, Pond-2, and Pond-3) were collected by brown color 250 ml reagent bottles between 9.00 - 11.30 am for two years period during January 2017 to December 2018. Some collected samples were tested in the field and some were taken to the departmental laboratory for further analysis following the standard methods of APHA (2012). The plankton samples were collected from each pond by plankton net made of bolting silk of 55 mesh size (Hydro-bio, Germany). The collected concentrated plankton samples were preserved by adding 5% commercial formaldehyde for identification. Identification of Phytoplankton was done following Ward and Whipple (1959), Needham and Needham (1962) and APHA (2012).

III. Results And Discussion

During the study period, phytoplankton was represented by four classes in Pond 1 and three classes in Pond 2 and Pond 3. From the percentage point of view, phytoplankton species compositions of the Pond 1 was 42.86% blue-green algae, 14.29% green algae, 28.57% desmids and 14.29% diatoms (Fig. 2). This result agreed with the findings of Kumar *et al.* (2012) for two high altitude Himalayan ponds, Badirnath, Uttarakhand, India where they found blue green algae or cyanophyceae as the most dominant among the four classes. Similar result was also found by Singh (2015) for Open pond in Town Deeg (Bhratpur) Rajsthan, India and Joseph (2017) for an artificial pond. In Pond 2 phytoplankton consisted of 33.33% blue-green algae, 33.33% green algae and 33.33% desmids (Fig. 3) and in Pond 3, there was 33.33% blue-green algae, 50% green algae and 16.67% desmids (Fig. 4). During the study period, it was found that the green algae or chlorophyceae was dominant class among the three classes in ponds 2 and 3. This result showed similarities with the findings of Rahaman *et* *al.* (2017) for two ponds at BAU campus, Mymensingh; Ansari *et al.* (2015) for Oil and Natural Gas Company (ONGC) pond, Hazira, India; Chukwu and Afolabi (2017) for ponds in Lagos, Nigeria; Koricho and Alemayehu (2014) for aquaculture pond, Jimma Town, Jimma Zone, South West Ethiopia and Sayeswara *et al.* (2011) for Hosahali Pond, Shivamogga, Karnataka, India.

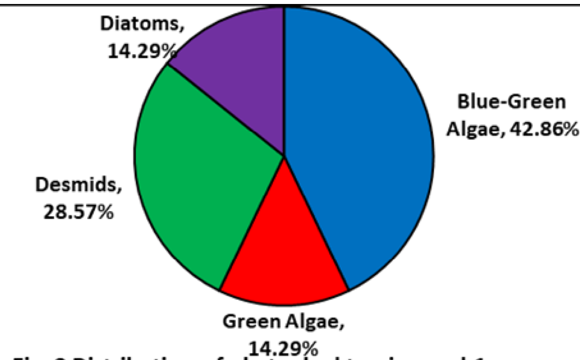

Fig. 2 Distribution of phytoplankton in pond 1

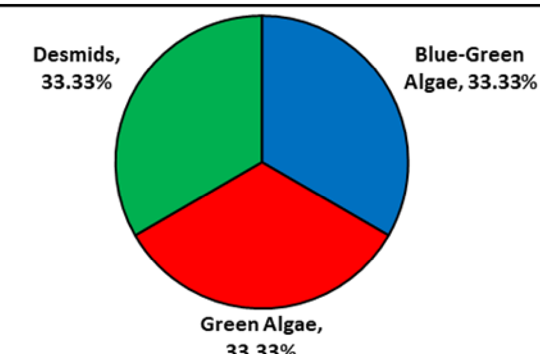

Fig. 3 Distribution of phytoplankton in pond 2

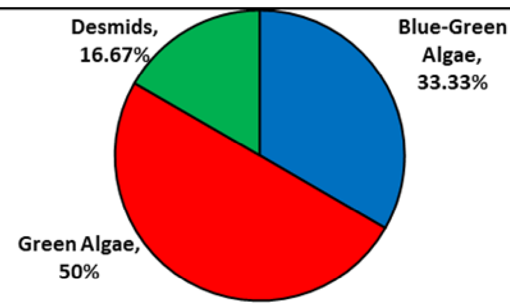

Fig. 4 Distribution of phytoplankton in pond 3

The mean values (with±SD) of physicochemical parameters recorded in Pond 1, Pond 2 and Pond 3 has been depicted in Figure 5. Almost similar air temperature (28.17±3.61^{0}C in Pond 1, 28.75±3^{0}C in Pond 2 and 28.67±3.14^{0}C in Pond 3) was recorded in all the three ponds. The water temperature was 26.94±3.89^{0}C, 27.94±3.64^{0}C and 28.08±3.34^{0}C in ponds 1, 2 and 3 respectively. Transparency of water was 46.69±13.79 cm, 64.98±14.65 cm and 39.96±12.01 cm in ponds 1, 2 and 3 respectively. Conductivity was recorded as 278.90±69.40 µS/cm, 43.83±14.51 µS/cm and 108.80±34.11 µS/cm in ponds 1, 2 and 3 respectively. Total dissolved solids (TDS) were 131±49.19 mg/l, 9.58±5.5 mg/l and 43.80±17.4 mg/l in ponds 1, 2 and 3 respectively. Almost similar pH was recorded in Pond 1(7.25±0.29), Pond 2 (7.48±0.55) and Pond 3 (7.23±0.32). Dissolved oxygen (DO) was recorded as 4.06±1.99 mg/l, 9.39±3.2 mg/l and 7.73±2.76 mg/l in ponds 1, 2 and 3 respectively. BOD was found to be 6.73±2 mg/l, 1.98±0.65 mg/l and 4.69±1.94 mg/l in ponds 1, 2 and 3 respectively. Free-CO_2 was recorded as 15.02±5.53 mg/l, 9.66±4.73 mg/l and 10.20±4.12 mg/l in ponds 1, 2 and 3 respectively. Calcium was found to be 17.85±4.77 mg/l, 7.17±3.47 mg/l and 11.57±6.81 mg/l in ponds 1, 2 and 3 respectively. Total hardness was recorded as 55.63±15.97 mg/l, 22.04±17.41 mg/l and

39.04±11.65 mg/l in ponds 1, 2 and 3 respectively. Alkalinity was 63.92±16.64 mg/l, 53.83±11.43 mg/l and 58.13±13.41 mg/l in ponds 1, 2 and 3 respectively.

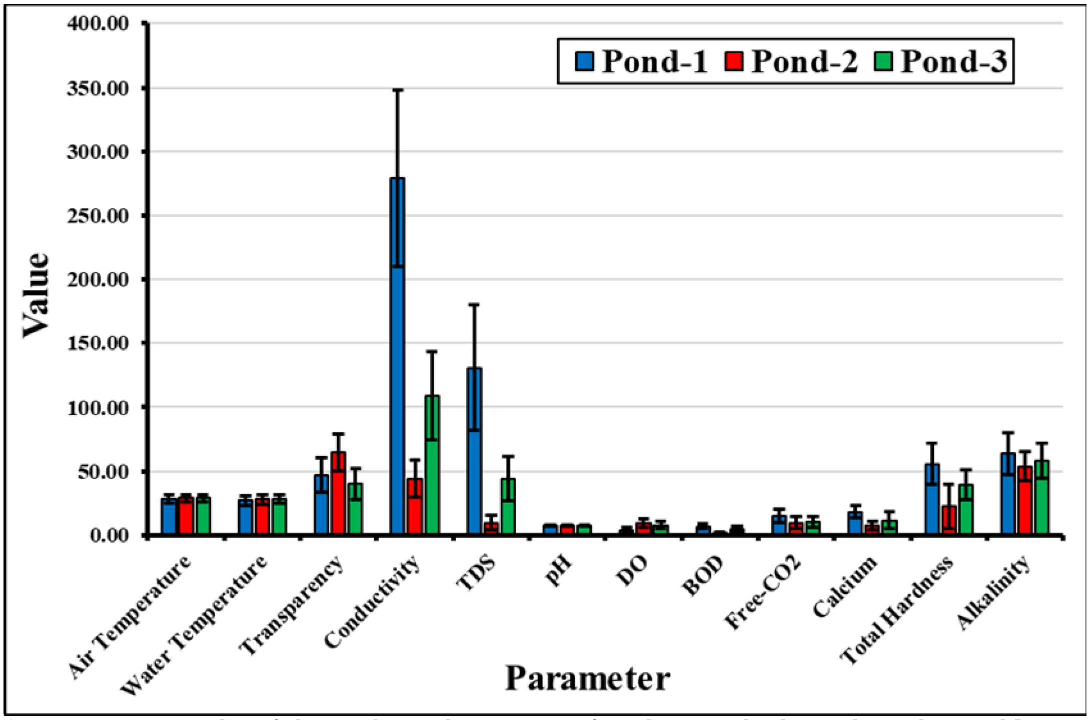

Fig. 5. Mean (±SD) value of physicochemical parameters of ponds 1, 2 and 3 during the study period [Air and water temperature (^{0}C), Transparency (cm), Conductivity (µS/cm), TDS, DO, BOD, Free CO_2, Calcium, Total Hardness, Alkalinity (mg/l)].

Diversity of phytoplankton in ponds 1, 2 and 3 during the study period are given in Tables 1, 2 and 3 respectively and their photographs in Plate-I. In Pond 1, the abundant species of blue-green algae were *Anacystis cyanea, Microcystis flosaquae* and *Phormidium murrayi, g*reen algae were *Ulothrix aequalis,* desmids were *Docidium ehrenbergii* and *Closterium praelongum* and diatoms were *Melosira varians.* In Pond 2, the abundant species of blue-green algae were *Anacystis cyanea, Microcystis flosaquae* and *Oscillatoria princeps,* green algae were *Pediastrum duplex, Scenedesmus opliensis* and *Ulothrix aequalis* and desmids were *Docidium ehrenbergii, Closterium praelongum* and *Desmidium swartzii*. And in Pond 3, the abundant species of blue-green algae were *Anacystis cyanea* and *Spirulina platensis,* green algae were *Pediastrum duplex, Scenedesmus opliensis* and *Ulothrix aequalis* and desmids were *Closterium praelongum* (Tables 1, 2 & 3 and Plate-I). More species was recorded in Pond 2 than the other two ponds which might be due to high amount of DO in Pond 2. DO and Secchi disc transparency was higher in Pond 2 than the other two ponds. On the other hand, ponds 1 and 3 were used by the surrounding people for different purposes including bathing, washing clothes and utensils, fishing, discharging household wastes and surrounding runoff etc. The abundance of green algae or chlorophyceae in ponds 2 and 3 might be due to high dissolved oxygen content. Green algae preferred water with high concentration of dissolved oxygen (Koricho & Alemayehu, 2014).

Correlation: Relationship of phytoplankton composition with the mean values of physicochemical parameters of three ponds for two years period are calculated and shown in Table 4.The mean value of phytoplankton in pond 1 showed more positive significant relationship with DO ($r = 0.73$, $P<0.01$) which agreed with Nair *et al.* (2015) for some selected ponds in Nedumanaged block Pnachayet, Kerala, India. Phytoplankton showed positive significant relationship with water temperature in Pond 1 ($r = 0.51$, $P<0.1$) and in Pond 3 ($r = 0.52$, $P<0.1$). This result showed similarities with the findings of Elayaraj *et al.* (2016) for a shallow pond water body at Chidambara taluk of Tamil Nadu, India. Phytoplankton in Pond 1 also showed positive significant relationship with air temperature ($r = 0.58$, $P<0.1$) and an inverse relationship with transparency ($r = -0.56$, $P<0.1$) (Table 4).

IV. Conclusion

This study showed that Pond 2 had more number of species which might be due to high level of oxygen than the other two ponds. The ponds 1 and 3 were used by the surrounding people for different purposes including bathing, washing clothes and utensils, fishing, discharging household wastes and surrounding runoff etc. So, for most of the time DO level was low and BOD, free CO_2, total hardness, conductivity, alkalinity and TDS levels were high in Pond 1 indicating high contamination which occurred due to human interference.

Table 1: Total groups/classes and genus with species of phytoplankton in Pond 1 during the study period.

Serial	Groups/Classes	Genus	Species
1	Blue-green algae	*Anacystis*	*Anacystis cyanea*
		Microcystis	*Microcystis flosaquae*
		Phormidium	*Phormidium murrayi*
2	Green algae	*Ulothrix*	*Ulothrix aequalis*
3	Desmids	*Docidium*	*Docidium ehrenbergii*
		Closterium	*Closterium praelongum*
4	Diatoms	*Melosira*	*Melosira varians*

Table 2: Total groups/classes and genus with species of phytoplankton in Pond 2 during the study period.

Serial	Groups/Classes	Genus	Species
1	Blue-green algae	*Anacystis*	*Anacystis cyanea*
		Microcystis	*Microcystis flosaquae*
		Oscillatoria	*Oscillatoria princeps*
2	Green algae	*Pediastrum*	*Pediastrum duplex*
		Scenedesmus	*Scenedesmus opliensis*
		Ulothrix	*Ulothrix aequalis*
3	Desmids	*Docidium*	*Docidium ehrenbergii*
		Closterium	*Closterium praelongum*
		Desmidium	*Desmidium swartzii*

Table 3: Total groups/classes and genus with species of phytoplankton in Pond 3 during the study period.

Serial	Groups/Classes	Genus	Species
1	Blue-green algae	*Anacystis*	*Anacystis cyanea*
		Spirulina	*Spirulina platensis*
2	Green algae	*Pediastrum*	*Pediastrum duplex*
		Scenedesmus	*Scenedesmus opliensis*
		Ulothrix	*Ulothrix aequalis*
3	Desmids	*Closterium*	*Closterium praelongum*

Table 4: Correlation amongst the mean values of phytoplankton with different physicochemical factors of ponds 1, 2 and 3.

Factors	Pond 1	Pond 2	Pond 3
Phytoplankton with air temperature (^{0}C)	0.58 *	0.13	0.37
Phytoplankton with water temperature (^{0}C)	0.51 *	0.20	0.52 *
Phytoplankton with transparency	-0.56 *	0.08	0.15
Phytoplankton with conductivity	0.19	0.18	-0.31
Phytoplankton with pH	0.31	0.41	0.36
Phytoplankton with DO	0.73 ***	0.47	0.04
Phytoplankton with BOD	0.37	0.19	0.13
Phytoplankton with fCO_2	0.42	-0.08	-0.21
Phytoplankton with Ca^{++}	0.19	-0.30	-0.28
Phytoplankton with TDS	0.15	-0.01	-0.18
Phytoplankton with total hardness	-0.15	-0.26	-0.05
Phytoplankton with alkalinity	0.21	0.19	-0.36

Significant level: *** = P<0.01, * = P<0.1

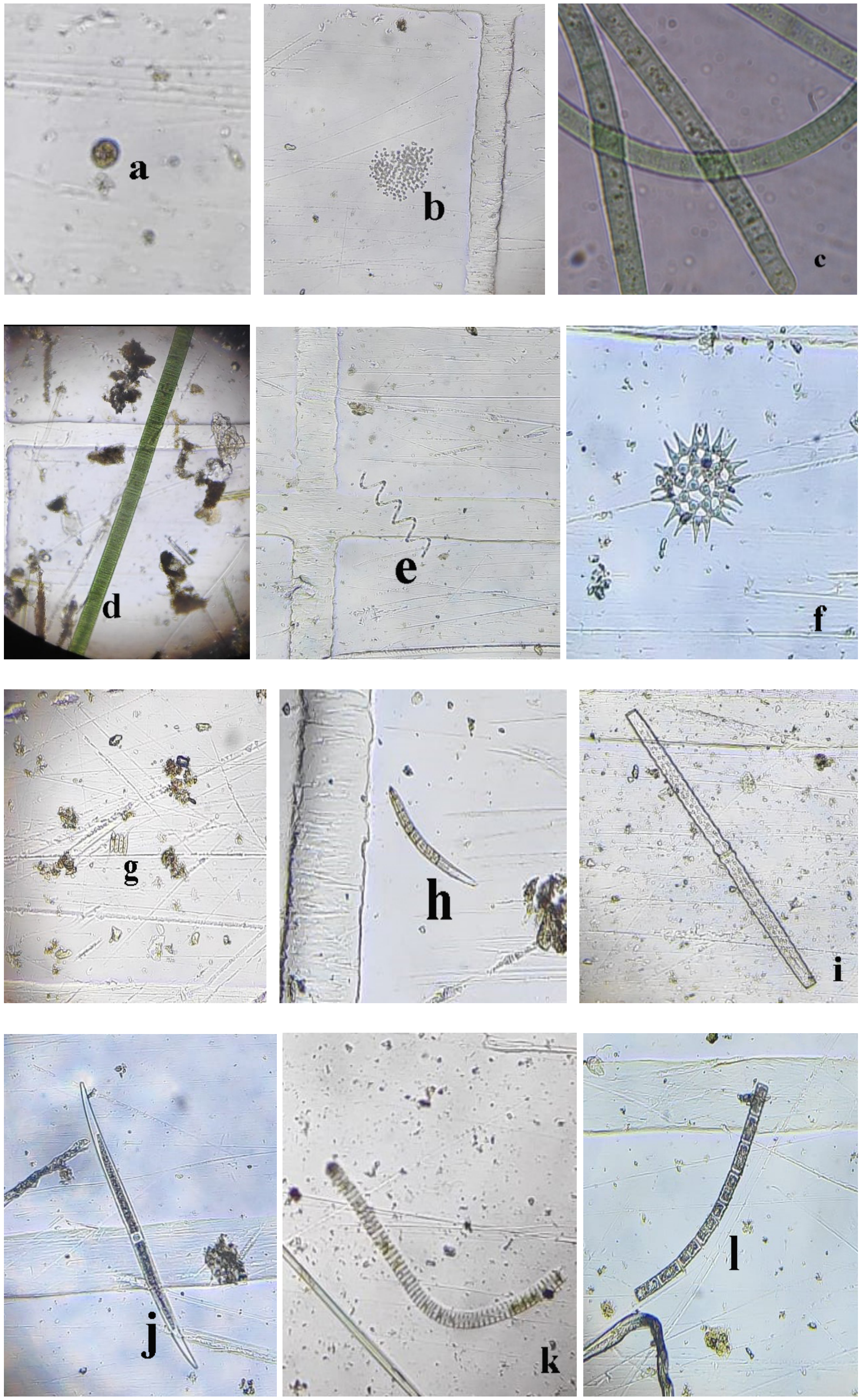

PLATE-I: (a) *Anacystis cyanea*, (b) *Microcystis flosaquae*, (c) *Phormidium murrayi*, (d) *Oscillatoria princeps*, (e) *Spirulina platensis*, (f) *Pediastrum duplex* (g) *Scenedesmus opliensis*, (h) *Ulothrix aequalis*, (i) *Docidium ehrenbergii*, (j) *Closterium praelongum*, (k) *Desmidium swartzii* and (l) *Melosira varicans*

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