



Algal flora of Rajarani Lake, Dhankuta and their seasonal distribution

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Abstract

In this paper, a total 46 algae belonging to 34 genera and 3 classes (Chlorophyceae 54%, Bacillariophyceae 28%, Cyanophyceae 18%) have been reported from Rajarani Lake, Dhankuta, Nepal. Among these, 13 algae were reported as new to the country. Genera *Ankistrodesmus*, *Closterium*, and *Desmodesmus* had maximum number of species whereas 25 genera were represented by single species. Seasonal variation of algae showed that there was changing number and type of algae with physicochemical parameters in different seasons. Cyanophycean algae *Microcystis flos-aquae* was dominant and observed in all sites in every collection of winter, summer and rainy seasons, and followed by bacillariophycean algae i.e., *Aulacoseira granulata* var. *angustissima*. The maximum number of algae was found in summer (59%) followed by winter (50%) and rainy (31%) seasons. There were 6 common algae found in all season's viz. *Ankistrodesmus falcatus*, *Aulacoseira granulata* var. *angustissima*, *Flagilaria tenera*, *Microcystis flos-aquae*, *Navicula radiosa* and *Oedogonium* sp. Algae viz., *Anabaena affinis*, *Cyclotella meneghiana*, *Pinnularia divergens*, *Pinnularia interrupta*, *Tetrastrum heteracanthum*, and *Ulothrix subtilissima* were found only in winter season whereas, *Aulacoseira granulata* var. *muzzanensis*, *Bolbochaete* sp., *Closterium striolatum*, *Cylindrospermum muscicola*, *Desmodesmus abundans*, *Desmodesmus quadricauda* var. *bicaudatus*, *Eunotia bilunaris*, *Gomphonema lacustrankaloides* and *Gomphonema pseudoaugur* were observed only in summer. Similarly, *Aphanocapsa pulchra*, *Oscillatoria sancta* and *Pediastrum duplex* var. *gracillimum* were reported only in rainy season.

Key words: Freshwater algae, Chlorophyceae, *Microcystis*, Water parameters, Nepal

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Introduction

Algae are simple thalloid, green, photosynthetic organisms commonly inhabited in water, but they occur also in all kinds of moist habitats, ranging from marine and freshwater to desert sands and from hot boiling springs to snow and ice. They are considered as the base of aquatic food chain as a primary producer and also

provide oxygen for other aquatic life consuming excess amount of carbondioxide from nature. Algae may contribute to mass mortality of other organisms, in cases of algal blooms, but they also contribute to economic well-being in the form of food, medicine, fertilizer and other important industrial products.

Rajarani (Rani) Lake (Lat. 26^o52'50.90" to

26°53'03.80"N, long. 87°26'04.20" to 87°26'12.20"E; elevation 1574m msl) is situated in Rajarani Gau Palika of Dhankuta District in Koshi Zone (Fig. 1). Vedetar to Dandabazaar is the main entry point to Rajarani. There are two lakes viz., Raj and Rani. Raja lake is situated to south west of Rani lake and is larger than Rani in area with about 15-20 hectare but now is under construction and not exist at all. Thus, this study is confined only of Rani Lake. The lake covers about 8 hectare surface area with total circumference 1.5 km and maximum depth ranges from 6-9 m. Its shape is elongated as length from north to south and breadth from east to west. The average air temperature is about

20°C. The surrounding vegetations are *Alnus nepalensis*, *Schima wallichii*, *Castanopsis* sp, *Rhododendron* sp, etc.

Algae of Nepal has been studied by Hirano (1984), Bando *et al.* (1989), Watanabe (1995), Watanabe and Komarek (1988), Komarek and Watanabe (1998), Jüttner *et al.* (2003), Rai *et al.* (2010), Rai and Misra (2010, 2012), Jha and Kargupta (2012), Rai (2013, 2014), Necchi *et al.* (2016) etc. Algal flora of Rajarani lake, Dhankuta has not been studied yet and it is the preliminary work for this area. Thus, an attempt has been made to explore the algae of Rajarani lake with their seasonal variation in distribution.

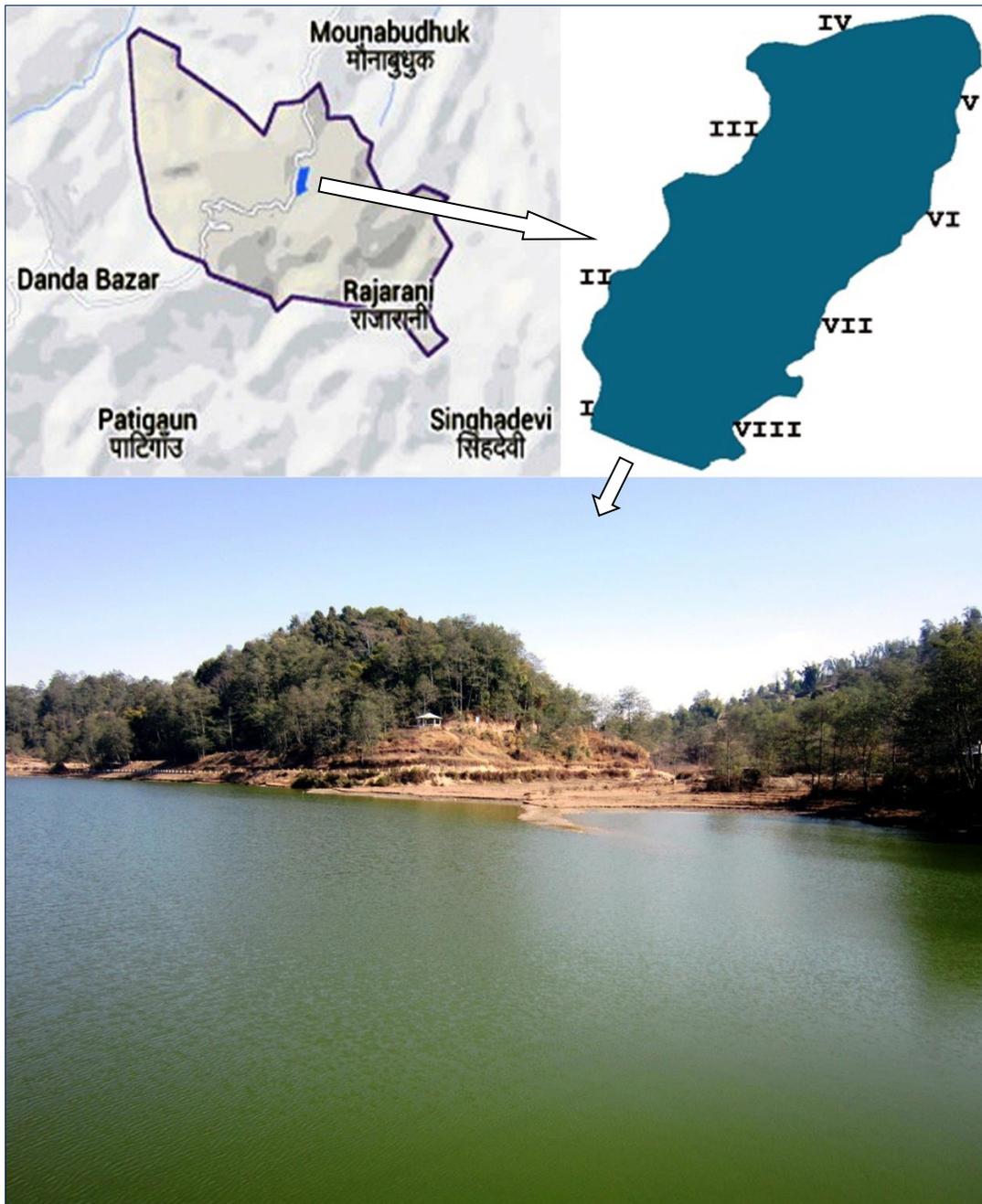


Figure 1. Rajarani Lake showing algae collection sites.

Materials and methods

Total 48 algae samples were collected from eight different sites (Fig. 1) more or less at equal distance from the peripheral littoral zone of the lake in three different season *viz.* winter, summer and rainy, 2015. Planktonic algae were collected using plankton net (mesh size 0.5 mm), epiphytic algae by squeezing the leaves and roots of macrophytes and benthic forms by scrubbing the substratum like stone, pebbles etc. Collection was made between 10 am to 2 pm in the day. Algal samples were then preserved in air tight plastic bottles using alcohol and FAA solution with proper tagging and labeling.

Water parameters *viz.* water temperature, pH and Dissolve Oxygen (DO) of each collection sites were measured by using portable Hanna multiparameter probes. The geographical position *viz.* latitude, longitude and altitude of each site were noted with the help of Garmin e-trex GPS. Field note was also maintained for algal habitats and surrounding vegetation. Finally, photograph of collection sites were also taken with the help of Canon Digital camera.

Algal samples were brought to the Phycology Research Lab, Biratnagar for further investigation. Glycerine mount temporary slides of each sample were prepared and observed under light microscope. Ocular micrometer was used to measure the dimension of algae and Sedgewick Rafter Cell was used for counting their number. Taxonomic identification of algae was made by consulting literature and monographs *viz.* Geitler (1932), Prescott (1951), Tiffany and Britton (1952), Desikachary (1959), Randhawa (1959), Scott and Prescott (1961), Philipose (1967), Croasdale *et al.* (1994), Bey and Ector (2013), Karthick *et al.* (2013), etc. Photomicrography was taken by the help of Olympus CH20i microscope with attached camera. All the samples have been deposited in the repository of the laboratory.

Results and discussion

In the present study a total of 46 algae belonging to 3 classes (Chlorophyceae 54%, Bacillariophyceae 28%, Cyanophyceae 18%), 17 orders, 24 families and 34 genera were recorded from eight different sites of Rajarani Lake. Identified algae were listed alphabetically under three classes as follows.

Chlorophyceae

1. *Acutodesmus acuminatus* (Lagerheim) Tsarenko (Pl. 1, fig. 1) [Prescott 1951, p. 275, pl. 62, fig. 16]
Cells 12-45 μm long between apices, 2-7 μm broad.
2. *Ankistrodesmus convolutus* Corda (Pl. 1, fig. 2) [Prescott 1951, p. 770, pl. 55, fig. 3]
Cells 15-25 μm long, 3-4.5 μm broad.
3. *Ankistrodesmus falcatus* (Corda) Ralfs (Pl. 1, fig. 3) [Prescott 1951, p. 771, pl. 56, figs. 5-6]
Cells 25-100 μm long, 2-6 μm broad.
4. *Ankistrodesmus spiralis* (Turn.) Lemm. (Pl. 1, fig.4) [Philipose 1967, p. 210, fig. 119a]
Cells 45 μm long, 2 μm broad.
5. *Bulbochaete intermedia* De Bary (Pl. 1, fig. 5) [Prescott 1951, p. 151, pl. 26, fig. 9]
Cells 31-70 μm long, 17-19.5 μm broad.
6. *Closterium acerosum* (Schr.) Her.ex Ralfs (Pl. 1, fig. 6) [Scott and Prescott 1961, p. 9, pl. 3, fig. 1]
Cells 146-568 μm long, 30-44 μm broad; apices 4.5-6 μm broad.
7. *Closterium setaceum* Ehr. ex Ralfs (Pl. 1, fig. 7) [Kouwets 1987, p. 207, pl. 5, figs. 2-3]
Cells 150- 610 μm long, 6-16 μm broad.
8. *Closterium striolatum* Ehr.ex Ralfs (Pl. 1, fig. 8) [Croasdale *et al.* 1986, p. 69, pl. 10, figs. 1-2]
Cells 160-500 μm long, 20-45 μm broad.
9. *Cosmarium nitidulum* De Notaris (Pl. 1, fig. 9) [Croasdale *et al.* 1988, p. 79, pl. 35, figs. 5-7]
Cells 35 μm long, 25 μm broad; isthmus 8.5 μm thick.
10. *Desmodesmus abundans* (Krichner) Hegewald (Pl. 1, fig. 10) [Philipose 1967, p. 278, figs. 184 a-d]
Cells 6-15 μm broad; spines 3.5-8 μm long.
11. *Desmodesmus opoliensis* (Richter) Hegewald (Pl. 1, fig. 11) [Philipose 1967, p. 276, figs. 181 c-d]
Cells 10-31 μm long, 3-10 μm broad; spines of terminal cells 10-27 μm long.
12. *Desmedesmus quadricauda* var. *bicaudatus* (Pl. 1, fig. 12) [Philipose 1967, p. 283, fig. 187a]
Cells 8.5-11 μm long, 2.75-4 μm broad.

13. *Micractinium pusillum* Fresenius (Pl. 1, fig. 13) [Prescott 1951, p.287, pl. 66, fig. 8]
Cells 3-7 μm in diameter without setae; setae 20-35 μm long.
 14. *Mougeotia punctata* Wittrock 1867 (Pl. 1, fig. 14) [Prescott 1951, p. 303, pl. 72, figs. 1-12]
Filaments 115-135 μm long, 8-10 μm broad.
 15. *Oedogonium* sp. (Pl. 1, fig. 15)
Filaments single, unbranched, vegetative cells capitate, with numerous pyrenoids, basal cell with holdfast, terminal cell obtuse.
 16. *Pediastrum duplex* Meyen var. *gracillimum* W. et G.S. West (Pl. 1, fig. 16) [Philipose 1967, p. 124, figs. 43 h-i]
Colonies 50-54 μm in diameter; marginal cells 13-17 μm long, 8-10 μm broad; inner cells 12-14 μm long, 9-14 μm broad.
 17. *Scenedesmus acutiformis* Schroeder (Pl. 2, fig. 1) [Tiffany and Britton 1952, p.123, pl. 35, fig. 356]
Cells 25 μm long, 6.2 μm broad.
 18. *Selanastrum gracile* Reinch (Pl. 2, fig. 2) [Philipose 1967, p. 219, fig. 128]
Cells 13-30 μm long, 3-5 μm broad.
 19. *Spirogyra rhizopus* Jao (Pl. 2, fig. 3) [Randhawa 1959, p. 331, figs. 321 a-c]
Vegetative cells 160-175 μm long, 40 μm broad.
 20. *Staurastrum acanthocephalum* Skuja (Pl. 2, fig. 4) [Scott and Prescott 1961, p. 85; pl. 52; figs. 5-6]
Cells 17.5-22 μm (without process) to 28.5-40 μm (with process) long, 39.5-58 μm (with process) broad; isthmus 4.5-6.5 μm thick.
 21. *Staurastrum pingue* Teil. var. *pingue* (Pl. 2, fig. 5) [Croasdale et al. 1994, p. 122, pl. 97, figs. 1-7]
Cells 27-42 μm long, 10-15 μm broad (with spines); 42-77 μm long, 42-84 μm broad (without spines); isthmus 6-14 μm thick.
 22. *Stigeoclonium fasciculare* Kuetz. (Pl. 2, fig. 6) [Prasad and Misra 1992, p. 60, pl. 9, figs. 4-5]
Cells 30.5-60 μm long, 5.1-10.2 μm broad.
 23. *Tetraedron pentaedricum* West and West (Pl. 2, fig. 7) [Prescott 1951, p. 268, pl. 60, figs. 21-23]
Cells 18-21 μm in diameter.
 24. *Tetrastrum heteracanthum* (Nordstedt) Chodat (Pl. 2, fig. 8) [Philipose 1967, p. 244, fig. 156]
Coenobia about 8.4 μm in diameter.
 25. *Ulothrix subtilissima* Rabenhorst (Pl. 2, fig. 9) [Prescott 1951, p. 95, pl. 6, fig. 3]
Cells 11-14.8 μm long, 4-5 μm broad.
- Cyanophyceae**
26. *Anabaena affines* Lammermann (Pl. 2, fig. 10) [Prescott 1951, p. 890, pl. 115, figs. 14-15]
Cells 5-7 μm in diameter; heterocyst 7.5-10 μm in diameter.
 27. *Aphanocapsa pulchra* (Kuetz) Rebenh (Pl. 2, fig. 11) [Desikachary 1959, p.132, pl. 21, fig. 2]
Cells 3.5-4.5 μm in diameter.
 28. *Cylindrospermum muscicola* Kuetzing ex Born. Et Flah (Pl. 2, fig. 12) [Geitler 1932, p. 822, fig. 520d]
Cells 4-5 μm long, 4-5 μm broad.
 29. *Merismopedia punctata* Meyen (Pl. 2, fig. 13) [Desikachary 1959, p. 155, pl. 23 and 29, figs. 5-6]
Cells 2.5-3 μm in diameter.
 30. *Microcystis flos-aquae* (Wittr.) Kirchner (Pl. 2, fig. 14) [Desikachary 1959, p.94, pl. 17, fig. 11]
Cells 4-7 μm in diameter.
 31. *Oscillatoria princeps* Vaucher (Pl. 2, fig. 15) [Prescott 1951, p. 880, pl. 110, fig. 1]
Cells 4-8.7 μm long, 32-55 μm broad.
 32. *Oscillatoria sancta* Kuetz. ex Gomont (Pl. 2, fig. 16) [Desikachary 1959, p. 203, pl. 42, fig 10]
Cells 2.8 μm long, 18.5 μm broad.
 33. *Tolypothrix distorta* Kuetzing (Pl. 3, fig. 1) [Geitler 1932, p. 719, fig. 460]
Cells 30 μm long, 9-12 μm broad.
- Bacillariophyceae**
34. *Aulacoseira granulata* var. *angustissima* (O. Muller) Simonsen (Pl. 3, fig. 2) [Bey and Ector 2013, p. 12, figs. 1-5]
Frustule 5 μm in diameter; semicell 11-14 μm high; rows of punctae 15 in 10 μm ; number of punctae in a row 15 in 10 μm .
 35. *Aulacoseira granulata* var. *muzzanensis* (Meister) Simonsen (Pl. 3, fig. 3) [Potapova and English (2011) <http://western>

diatoms.colorado.edu/taxa/species/aulacoseira_muzzanensis]

Frustules 9-24 µm long, 5-13 µm broad; striae 7-15 in 10 µm.

36. *Cyclotella meneghiniana* Kuetz. (Pl. 3, fig. 4) [Sinnu and Squires 1985, p. 298, pl. 1, figs. 4-6]
Valves 17 µm in diameter; striae 8 in 10 µm.
37. *Eunotia lunaris* (Ehr.) Grun. [Current accepted name: *Eunotia bilunaris* (Ehr.) Schaarschmidt] (Pl. 3, fig. 5) [Rai 2006, p.79, pl. 6, fig. 14]
Valves 48 µm long, 4.5 µm broad; striae 16 in 10 µm.
38. *Eunotia minor* (Kutzing) Grunow (Pl. 3, fig. 6) [Karthick *et al.*, 2013, pl. 29]
Cells 20-60 µm long, 4.5-8 µm broad; striae 9-15 in 10 µm.
39. *Flagilaria tenera* Lynbye (Pl. 3, fig. 8) [Karthick *et al.* 2013, pl. 78]
Valves 53-55 µm long, 2-2.5 µm broad; striae 17-18 in 10 µm.
40. *Gomphonema lacusrankaloides* (Gandhi) Karthick and Kociolek (Pl. 3, fig. 9) [Karthick *et al.*, 2013, pl. 84] Valves 62-90.5 µm long, 11-15 µm broad.
41. *Gomphonema pseudoaugur* Krammer (Pl. 3, fig. 10) [Karthick *et al.* 2013, pl. 78]
Valves 41-60 µm long, 9.5-12 µm broad.
42. *Navicula radiosa* Kutz. (Pl. 3, fig. 11) [Tiffany and Britton 1952, p. 255, pl. 67, fig. 780]
Valves 65-72 µm long, 10-112 µm broad; striae 10-12 in 10 µm.
43. *Pinnularia divergens* W. Smith (Pl. 3, fig. 12) [Karthick *et al.* 2013, pl. 75]
Valves 48-66 µm long, 9.5-10 µm broad; striae 8-10 in 10 µm.
44. *Pinnularia interrupta* W. Smith (Pl. 3, fig. 13) [Prasad and Srivastava 1992, pl. 30, fig. 7] Valves 30-40 µm long, 7-9 µm broad; striae 10-12 in 10 µm.
45. *Rhopalodia musculus* (Kutz.) Mull. (Pl. 3, fig. 14) [Karthick *et al.* 2013, pl. 78]
Valves 22-32 µm long, 5-8 µm broad; striae 16-18 in 10 µm; fibula 3-4 in 1 µm.
46. *Synedra ulna* (Nitz.) Ehr. [New name: *Ulnaria ulna*] (Pl. 3, figs. 15-16) [Prasad and Srivastava 1992, p. 170, pl. 24, figs. 11]

Valves 92-236 µm long, 7-9.5 µm broad; striae 9-11 in 10 µm.

Among these, 13 algae were reported as new for Nepal. They were *Micractinium pusillum*, *Staurastrum acanthocephalum*, *Tetraedron pentaedricum* and *Tetrastrum heteracanthum* of Chlorophyceae; *Anabaena affinis* and *Cylindrospermum muscicola* of Cyanophyceae; and *Aulacoseira granulata* var. *muzzanensis*, *Eunotia minor*, *Fragilaria tenera*, *Gomphonema lacusrankaloides*, *G. pseudoaugur*, *Pinnularia divergens* and *P. interrupta* of Bacillariophyceae.

The average temperature of water in winter, summer and rainy seasons were recorded as 14.8°C, 23.4°C and 21.1°C, respectively. Similarly, average pH of water in winter, summer and rainy seasons were 6.30, 7.34 and 5.91, respectively. The average dissolve oxygen (DO) of water in three seasons were recorded as 6.40 mg/l, 7.10 mg/l and 6.30 mg/l, respectively. The average temperature, pH and DO of water were found maximum in summer season. Average temperature of water was low in winter but both pH and DO were lowest in rainy season.

Classwise distribution showed that, chlorophyceae has maximum number of species which was followed by diatoms and then least number by blue-green algae, in all three seasons (Fig. 1). In average, more species of chlorophycean algae were observed in both winter and summer than in the rainy season. But, diatoms species were maximum in summer than in the other seasons that may be due to high temperature and pH favourable to them.

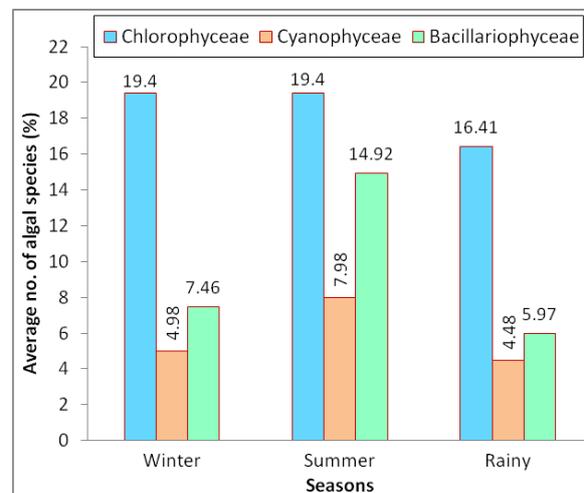


Figure 1. Class-wise distribution of algae in different seasons.

Seasonally, maximum algal species were found in summer (59%) followed by winter (50%) and then in rainy (31%) seasons (Fig. 2, Table 1). Occurrence of maximum number of algal species in the summer season was may be due to more temperature, pH and DO in the summer comparison to the winter and rainy seasons. Least occurrence of algal species in rainy season was may be due to more acidic water and low DO caused by flooding (Figs. 1 and 2).

Sampling site VII was rich in algal species followed by sites IV, III, VI, V, VIII, II and I; as site VII was the undisturbed habitat where as site I was the first entry point of the lake and highly disturbed by human activities like boating, swimming, fishing etc. (Fig. 2).

Two algae, *Microcystis flos-aque* and *Aulacoseira granulata* var. *angustissima* were highly dominant in the lake, found in all sites in every collection of winter, summer and rainy seasons. Similarly, *Ankistrodesmus falcatus*, *Flagilaria tenera*, *Navicula radiosa* and *Oedogonium* sp were also reported in all three seasons (Table 1). *Ankistrodesmus falcatus* and *Navicula radiosa* were common and *Flagilaria tenera* was rare species in the study.

Altogether 7 algae commonly seen in both winter and rainy seasons were *Ankistrodesmus spiralis*, *Closterium acerosum*, *Closterium setaceum*, *Desmodesmus opoliensis*, *Merismo-*

pedia punctata, *Selanastrum gracile*, and *Staurastrum acanthocephalum*. The algae viz., *Anabaena affinis*, *Cyclotella meneghiana*, *Pinnularia divergens*, *Pinnularia interrupta*, *Tetrastrum heteracanthum*, and *Ulothrix subtilissima* were reported only in winter. In the other hand, *Acutodesmus acuminatus* was appeared only in summer and rainy seasons but not in winter. Similarly, *Aulacoseira granulata* var. *muzzanensis*, *Bolbochaete* sp, *Closterium striolatum*, *Cylindrospermum muscicola*, *Desmodesmus abundans*, *Desmodesmus quadricauda* var. *bicaudatus*, *Eunotia bilunaris*, *Gomphonema lacustrankaloides* and *Gomphonema pseudoaugur* were observed only in summer. In the other hand, taxa like *Ankistrodesmus spiralis*, *Closterium acerosum*, *Desmodesmus opoliensis*, *Merismopedia punctata*, *Selanastrum gracile* and *Staurastrum acanthocephalum* were seen only in winter and rainy seasons but not in summer. The taxa like *Aphanocapsa pulchra*, *Oscillatoria sancta* and *Pediastrum duplex* var. *gracillimum* were found only in rainy season. In the other hand, taxa like *Mougeotia punctata* and *Oscillatoria princeps* were appear only in summer and winter seasons but not in rainy (Table 1). Seasonal variation of algae showed that there was changing number and type of algae with physicochemical parameters in different seasons.

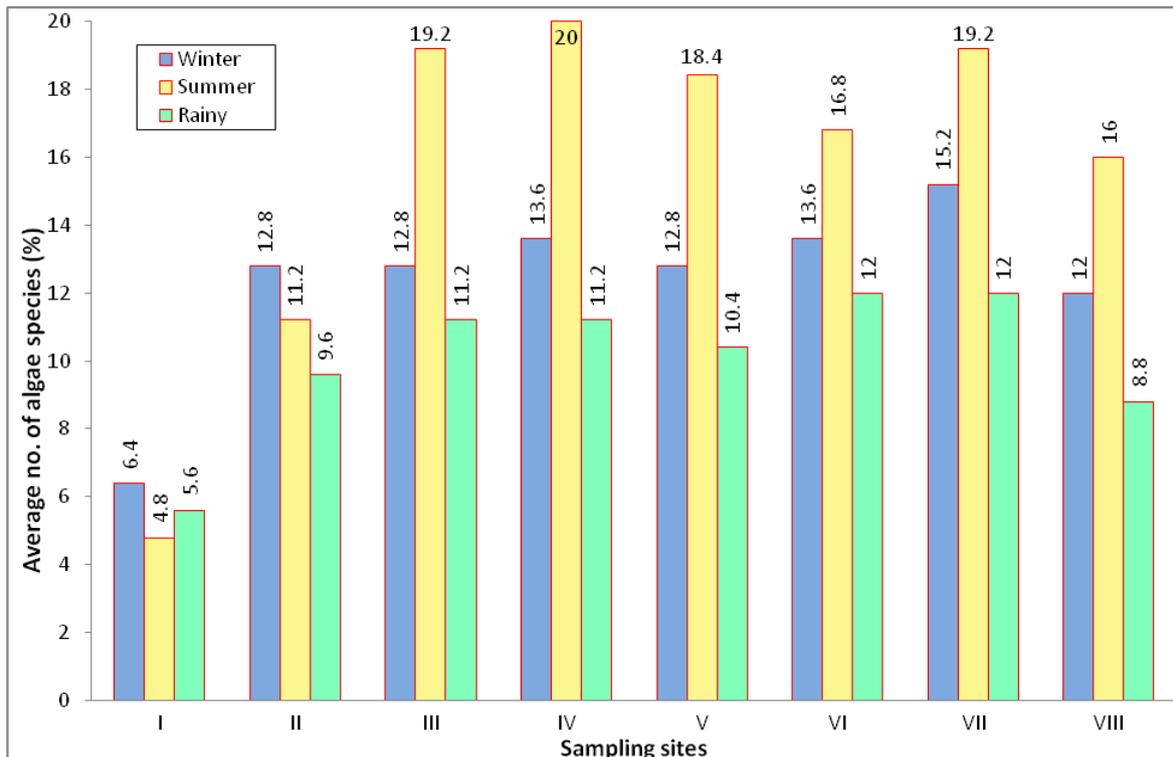


Figure 2. Seasonal distribution of algae in different sites.

Table 1. Presence (+) and absence (-) of algae in different seasons.

| SN | Algae | Occurrence of algal species in different seasons | | |
|-------|---|--|--------|-------|
| | | Winter | Summer | Rainy |
| 1 | <i>Acutodesmus acuminatus</i> | - | + | + |
| 2 | <i>Anabaena affinis</i> | + | - | - |
| 3 | <i>Ankistrodesmus convolutus</i> | + | - | - |
| 4 | <i>Ankistrodesmus falcatus</i> | + | + | + |
| 5 | <i>Ankistrodesmus spiralis</i> | + | - | + |
| 6 | <i>Aphanocapsa pulchra</i> | - | - | + |
| 7 | <i>Aulacoseira granulata</i> var. <i>angustissima</i> | + | + | + |
| 8 | <i>Aulacoseira granulata</i> var. <i>muzzanensis</i> | - | + | - |
| 9 | <i>Bolbochaete intermedia</i> | - | + | - |
| 10 | <i>Closterium acerosum</i> | + | - | + |
| 11 | <i>Closterium setaceum</i> | + | - | + |
| 12 | <i>Closterium striolatum</i> | - | + | - |
| 13 | <i>Cosmarium nitidulum</i> | - | + | - |
| 14 | <i>Cyclotella meneghiana</i> | + | - | - |
| 15 | <i>Cylindrospermum muscicola</i> | - | + | - |
| 16 | <i>Desmodesmus abundans</i> | - | + | - |
| 17 | <i>Desmodesmus opoliensis</i> | + | - | + |
| 18 | <i>Desmodesmus quadricauda</i> var. <i>bicaudatus</i> | - | + | - |
| 19 | <i>Eunotia bilunaris</i> | - | + | - |
| 20 | <i>Eunotia minor</i> | - | + | - |
| 21 | <i>Flagilaria tenera</i> | + | + | + |
| 22 | <i>Gomphonema lacustrale</i> | - | + | - |
| 23 | <i>Gomphonema pseudoaugur</i> | - | + | - |
| 24 | <i>Merismopedia punctata</i> | + | - | + |
| 25 | <i>Micractinium pusillum</i> | + | - | - |
| 26 | <i>Microcystis flos-aquae</i> | + | + | + |
| 27 | <i>Mougeotia punctata</i> | + | + | - |
| 28 | <i>Navicula radiosa</i> | + | + | + |
| 29 | <i>Oedogonium</i> sp. | + | + | + |
| 30 | <i>Oscillatoria princeps</i> | + | + | - |
| 31 | <i>Oscillatoria sancta</i> | - | - | + |
| 32 | <i>Pediastrum duplex</i> var. <i>gracillimum</i> | - | - | + |
| 33 | <i>Pinnularia divergens</i> | + | - | - |
| 34 | <i>Pinnularia interrupta</i> | + | - | - |
| 35 | <i>Rhopalodia musculus</i> | - | + | - |
| 36 | <i>Scenedesmus acutiformis</i> | - | + | - |
| 37 | <i>Selanastrum gracile</i> | + | - | + |
| 38 | <i>Spirogyra rhizopus</i> | - | + | - |
| 39 | <i>Staurastrum acanthocephalum</i> | + | - | + |
| 40 | <i>Staurastrum pingue</i> var. <i>pingue</i> | - | - | + |
| 41 | <i>Stigeoclonium fasciculare</i> | - | + | - |
| 42 | <i>Tetraedron pentaedricum</i> | - | + | - |
| 43 | <i>Tetrastrum heteracanthum</i> | + | - | - |
| 44 | <i>Tolypothrix distorta</i> | - | + | - |
| 45 | <i>Ulnaria ulna</i> | - | + | - |
| 46 | <i>Ulothrix subtilissima</i> | + | - | - |
| Total | | 23 | 27 | 18 |

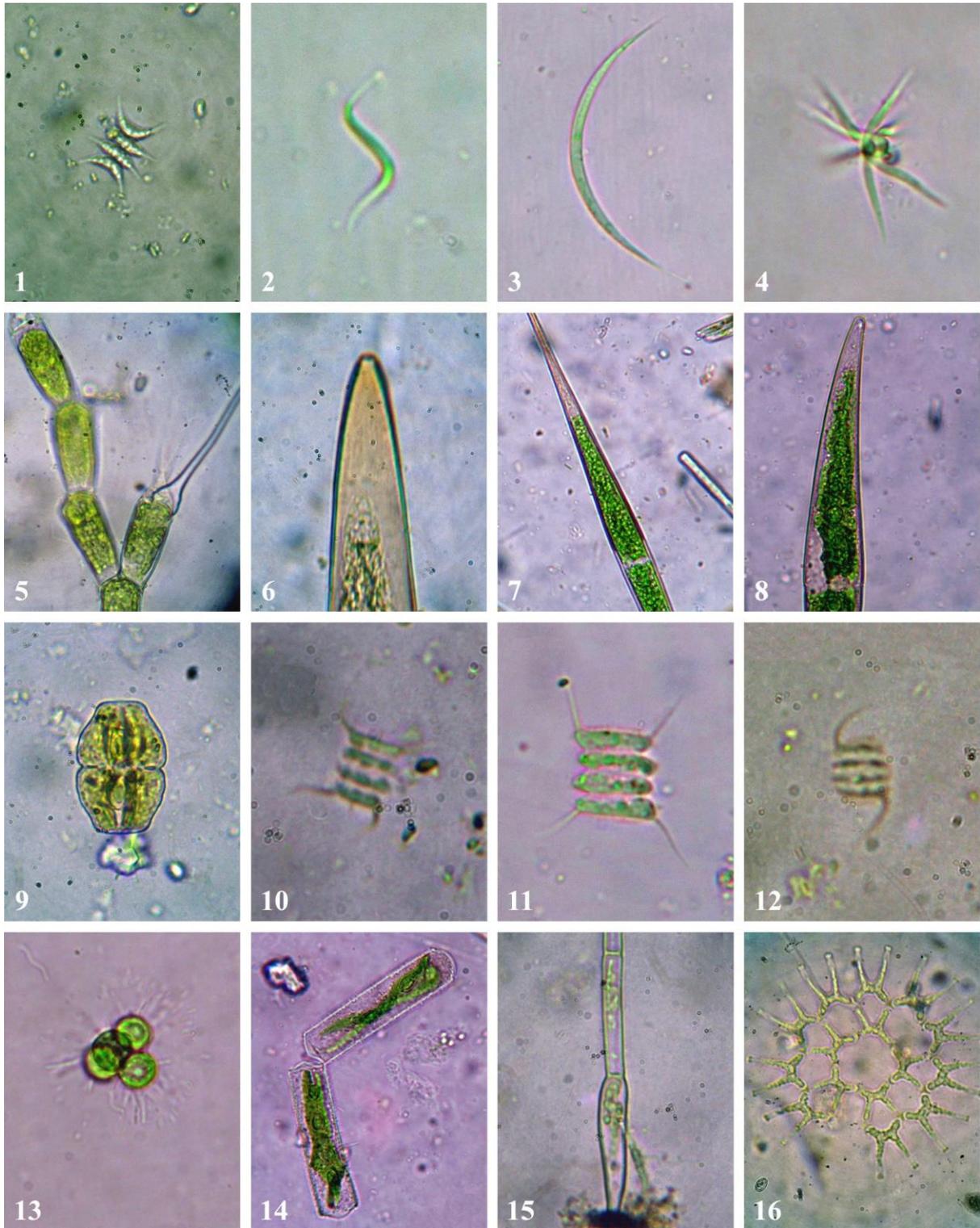


Plate 1. Figures 1. *Acutodesmus acuminatus* 2. *Ankistrodesmus convolutus* 3. *A. falcatus* 4. *A. spiralis* 5. *Bolbochaete intermedia* 6. *Closterium acerosum* 7. *C. setaceum* 8. *C. striolatum* 9. *Cosmarium nitidulum* 10. *Desmodesmus abundans* 11. *Desmodesmus opoliensis* 12. *D. quadricauda* var. *bicaudatus* 13. *Micractinium pusillum* 14. *Mougeotia punctata* 15. *Oedogonium* sp. 16. *Pediastrum duplex* var. *gracillimum*

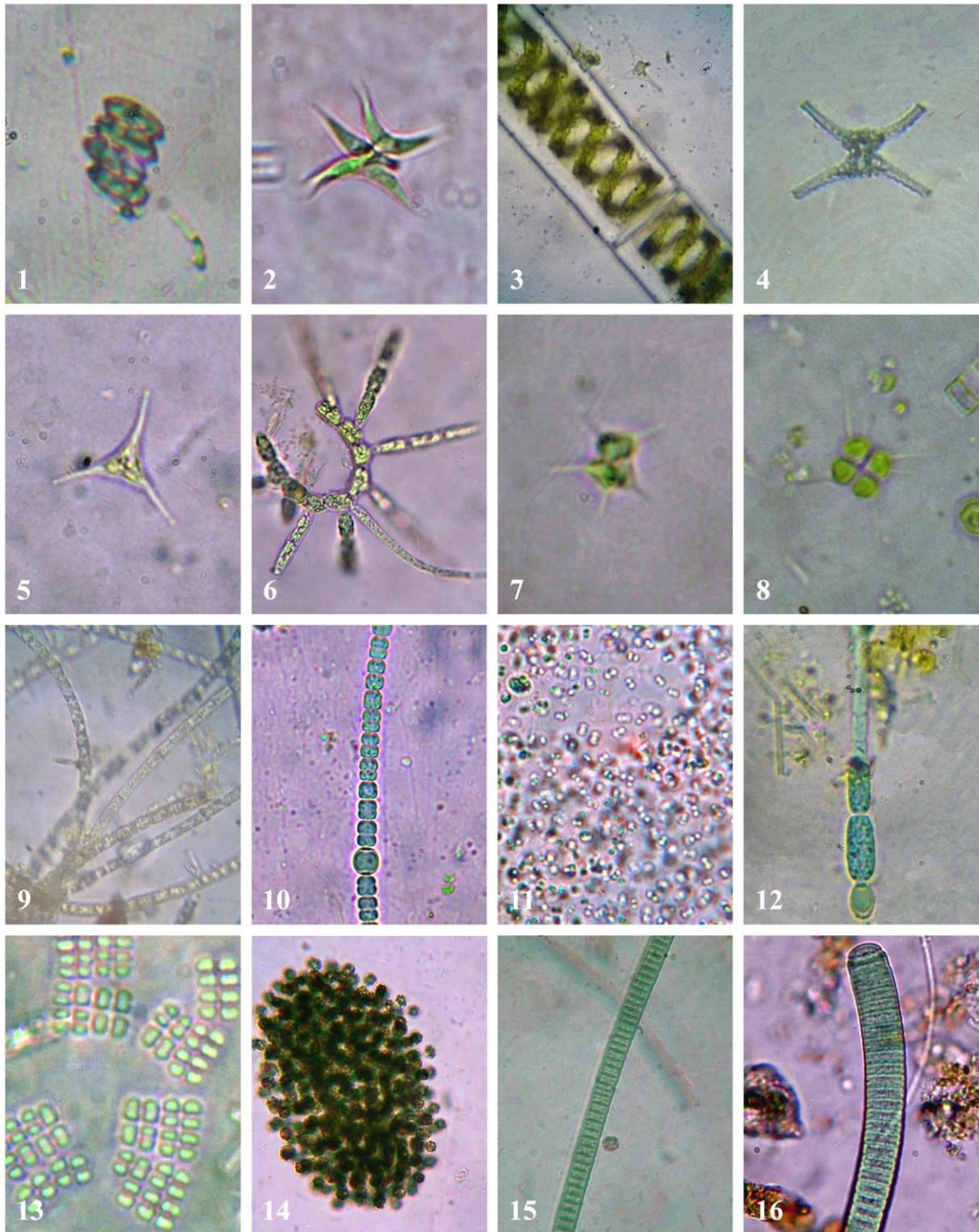


Plate 2. Figures 1. *Scenedesmus acutiformis* **2.** *Selenastrum gracile* **3.** *Spirogyra rhizopus* **4.** *Staurastrum acanthocephalum* **5.** *S. pingue* var. *pingue* **6.** *Stigeoclonium fasciculare* **7.** *Tetraedron pentaedricum* **8.** *Tetrastrum heteracanthum* **9.** *Ulothrix subtilissima* **10.** *Anabaena affinis* **11.** *Aphanocapsa pulchra* **12.** *Cylindrospermum muscicola* **13.** *Merismopedia punctata* **14.** *Microcystis flos-aquae* **15.** *Oscillatoria princeps* **16.** *O. sancta*

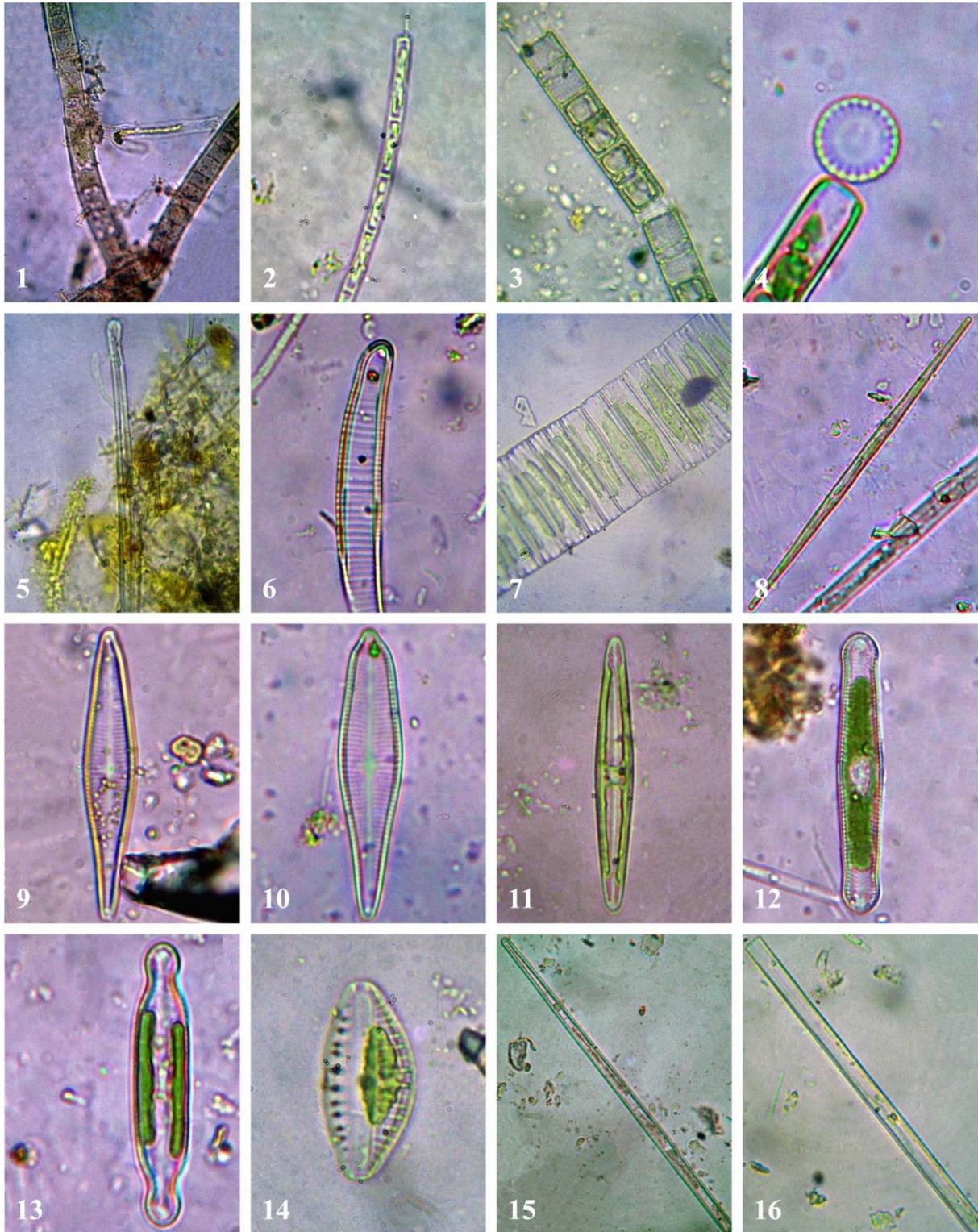


Plate 3. Figures 1. *Tolypothrix distorta* **2.** *Aulacoseira granulata* var. *angustissima* **3.** *A. granulata* var. *muzzanensis* **4.** *Cyclotella meneghiniana* **5.** *Eunotia bilunaris* **6.** *E. minor* **7.** *Fragilaria* sp **8.** *Fragilaria tenera* **9.** *Gomphonema lacustrankaloides* **10.** *G. pseudoaugur* **11.** *Navicula radiosa* **12.** *Pinnularia divergens* **13.** *P. interrupta* **14.** *Rhopalodia musculus* **15-16.** *Ulnaria ulna*

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