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Algal Flora of Barju (Chimdi) Taal, Sunsari District, Province 1, Nepal

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Abstract

The algal flora of Barju Taal (Lake) has been studied in 2017-18 AD. The lake is situated in Barju Rural Municipality, Sunsari District, Eastern Nepal about 12 km west of Biratnagar covering an area of 101.6 hectares. Algae were collected by squeezing submerged aquatic plants. A total of 105 algae under 51 genera have been reported. The largest phylum was chlorophyta (76 species) followed by bacillariophyta (16 species), cyanobacteria (11 species) and euglenozoa (2 species). Similarly, the largest genus was *Cosmarium* (22.85%) followed by *Staurastrum* (8.57%) and *Euastrum* (4.76%). Algae common to Barju Taal were *Dictyosphaerium pulchellum*, *Ankistrodesmus falcatus, Closterium dianae, Euastrum elegans, Actinotaenium subglobosum, Cosmarium quadrum, C. ralfsii, Staurodesmus unicornis, Staurastrum sonthalianu* and *S. striolatum*. Old Barju Taal was rich in algae than the newly constructed one. Further study of algae in different seasons compared with water parameters is recommended.

Keywords: Blue-green algae, Chlorophyceae, Desmids, Diatoms, Freshwater algae

Introduction

Algae are a group of simple plants mostly inhabited in water usually having photosynthetic pigments and simple reproductive structures. They lack true roots, stems, leaves and multicellular gametangia and usually produce water-dispersed spores. They are distributed in all sorts of aquatic habitats from freshwater to marine throughout the world. They are the major primary producers regulating the entire aquatic ecosystem. Algae are widely used for food, industry, medicine, biofuel, forensics, nanotechnology and pollution indicator throughout.

Nepal is small but rich in algal flora because of its diverse geographical and climatic conditions. Algal flora of Nepal has been studied by various workers (Bando et al., 1989; Baral, 1999; Habib & Chaturvedi, 1997; Hayashi & Tanimura, 2015; Hickel, 1973; Hirano, 1955, 1984; Jha & Kargupta, 2001; Joshi, 1979; Jüttner et al., 2003; Kristic et al., 2012; Misra et al., 2009; Necchi et al. (2016); Prasad, 2011; Rai & Misra, 2010; Suxena & Venkateswarlu, 1968; Watanabe, 1995). Similarly, numerous algae have been reported from Koshi Tappu, Biratnagar, Itahari and Betana surrounding this lake. However, only six algae were reported from Barju Taal in previous work (Rai & Rai, 2012). So, in this study, an endeavor is made to explore more algae from Barju Taal.

Materials and Methods

Study site

Barju Taal (also called Chimdi Lake) is located between latitude 26°29'00.75"N to 26°29'32.62"N and longitude 87°10'18.29"E to 87°10'55.75"E, elevation 73 m above sea level in Barju Rural Municipality (RM), Sunsari District, Province 1, Nepal. This RM lies at the southeast corner of the district and joins with the India border to the south. It is surrounded by Biratnagar Metropolitan City in the east, Sinwari Harinagar of Dewanganj RM in the west and Gadhi RM and Duhabi Municipality in the north. Barju Taal is about 15 km west of Biratnagar Metropolitan City. Its total coverage area is about 101.6 ha. The area consists of an old lake in the east, a newly constructed middle lake and bare land in the west (Figure 1). The middle lake is larger than the old lake, north-south elongated and covers a total area of 45.6 ha.

The climate of this area is tropical monsoon type. The monthly average minimum temperature ranges from 8.34°C in January to 25.9°C in August and the maximum temperature from 22.2°C in January to 32.9°C in June. The average annual rainfall is 1828.8 mm and 79% of the total rainfall occurs the in the rainy season from June to September (Mandal et al., 2010).

The main source of water for this lake is precipitation that occurs during the monsoon period and other sources are groundwater springs, small streams and surface water flows from surrounding watershed areas. The physiochemical parameters of this lake range as water temperature from 18.8°C in January to 30.5°C in September, transparency from 2.13 cm in July to 27.83 cm in September, pH from 6.05 in April to 8 in May, dissolved oxygen from 4.82 mg/l in June to 19.92 mg/l in September and total alkalinity from 32 mg/l in July to 86 mg/l in March (Surana et al., 2010). The lake is a rich habitat for aquatic macrophytes viz., *Eichhornia crassipes*, *Pistia stratiotes*, *Ipomoea cornea*, *Hydrilla verticillata*, *Ottelia alismoides*, *Potamogeton crispus*, *Nymphaea pubescens*, *Sagittaria guyanensis*, *Echinochloa* sp. etc. and is well known for migratory birds.

Sample collection and identification

Two field trips were made on 2017-11-22 and 2018-01-30 to collect algae from 10 different peripheral sites (8 from the new middle lake and 2 from the old lake) of Barju Taal (Figure 1). Generally, epiphytic algae were collected by squeezing submerged parts of aquatic plants like *Hydrilla verticillata*, *Pistia stratiotes* and *Eichhornia crassipes* in plastic bottles (250 ml). Diatoms were collected by brushing the surface of submerged stones (Jüttner et al., 2003). Algae were preserved in a 4% formaldehyde solution and tagging and labeling were done. Information about the locality was also noted in the field diary.

Algae were studied by preparing temporary slides for each sample and microphotography was done using an Olympus Ch20i microscope in 40X and 100X objectives. Algae were identified following Prescott (1951), Tiffany & Britton (1952), Deshikachary (1959), Scott & Prescott (1961), Philipose (1967), Komárek (1983), Croasdale & Flint (1986, 1988),

Figure 1: Barju Taal showing algae collection sites (1 to 10)

Prasad & Srivastava (1992), Lange-Bertalot (1996), Rai & Misra (2010), Karthick et al. (2013), McGregor (2013), Guiry & Guiry (2018) etc.

Results and Discussion

In this study, a total of 105 algae belonging to four phylum, seven classes, 20 orders, 34 families and 51 genera were reported from 10 different sites of Barju Taal. The largest phylum was chlorophyta (72%) followed by bacillariophyta (15%), cyanobacteria (11%) and euglenozoa (2%) (Tables 1-4). Among the classes, conjugatophyceae was the largest one (54%) followed by bacillariophyceae (14%), chlorophyceae (13%), cyanophyceae (11%), trebouxiophyceae (5%), euglenophyceae (2%) and coscinodiscophyceae (1%). Similarly, the largest genus was *Cosmarium* (22.85%) followed by *Staurastrum* (8.57%), *Euastrum* (4.76%) and *Scenedesmus*, *Closterium*, *Micrasterias*, *Actinotaenium*, *Spondylosium*, *Gomphonema* (each with 3%).

The classification of algae is based on Guiry & Guiry (2018). Each alga is described with source/s of identification, dimension and site/s and date/s of collection. Abbreviations used are as: CPr = with process, SPr = without process; CSp = with spines, SSp = without spines; S = Collection site/s, D = Date of collection.

Phylum: **Cyanobacteria** (Blue-green algae)

Genus: ***Microcystis*** Lemmermann (1907)

1. ***Microcystis aeruginosa*** (Kützing) Kützing (Pl. 1, Fig. 1). Desikachary 1959, P. 93, Pl. 17, Figs. 1, 2, 6; McGregor 2013, P. 59, Pl. 20, Fig. A; Pl. 39, Figs. I, J, K. Mucilage around the colony usually 5-10 µm wide; cells 4-7 µm in diameter. S: 7, 8; D: 2018-01-30.

Genus: ***Aphanothece*** Nägeli (1849)

2. ***Aphanothece granulosa*** (Gardner) Komárek et Komákova-Legnerová (Pl. 1, Figs. 2-3). McGregor 2013, P. 13, Pl. 1, Fig. B; Pl. 23, Figs. B, C. Colonies 60-200 µm in diameter; cells 8.0-10.5 µm long, 5.1-6.5 µm broad. S: 8; D: 2018-01-30.

Genus: ***Gomphosphaeria*** Kützing (1836)

3. ***Gomphosphaeria aponina*** Kützing (Pl. 1, Fig. 4). Prescott 1951, P. 472, Pl. 106, Fig. 5; Desikachary 1959, P. 150, Pl. 28, Figs 1-3; McGregor et al. 2007, P. 313, Fig. 31; McGregor 2013, P. 36, Pl. 9C. Cells 8-12 µm long, 4-6.5 µm broad. S: 1; D: 2017-11-22 & S: 3; D: 2018-01-30.

Genus: ***Merismopedia*** Meyen (1839)

4. ***Merismopedia elegans*** Braun ex Kützing (Pl. 1, Fig. 5). McGregor et al. 2007, P. 313, Figs. 32, 71; McGregor 2013, P. 45, Pl. 14B, 34G. Cells 5-8 µm in diameter. S: 3, 5; D: 2017-11-22.

Genus: ***Snowella*** Elenkin (1938)

5. ***Snowella lacustris*** (Chodat) Komárek et Hindák (Pl. 1, Fig. 6). McGregor 2013, P. 37, Pl. 10, Fig. B; Pl. 31, Figs. D, E, F. Colonies up to 80 µm in diameter; cells 2.0-4.0 µm long, 1.5-3.5 µm broad. S: 2; D: 2017-11-22 & S: 10; D: 2018-01-30.

Genus: ***Oscillatoria*** Vaucher (1803)

6. ***Oscillatoria tenuis*** Agardh ex Gomont (Pl. 1, Fig. 7). Prescott 1951, P. 491, Pl. 110, Figs. 8, 9, 14; Tiffany & Britton 1952, P. 346, Pl. 93, Fig. 1074; Desikachary 1959, P. 222, Pl. 42, Fig. 15. Cells 2-4 µm long, 5-6.5 µm broad. S: 7, 10; D: 2018-01-30.

Genus: ***Phormidium*** Kützing ex Gomont (1892)

7. ***Phormidium autumnale*** Gomont [***Microcoleus autumnalis*** (Gomont) Strunecky, Komárek et Johansen] (Pl. 1, Fig. 8). Prescott 1951, P. 493, Pl. 107, Fig. 19, 20; Tiffany & Britton 1952, P. 348, Pl. 96, Fig. 1108; Desikachary 1959, P. 276, Pl. 44, Figs. 24, 25. Cells 2-5 µm long, 4-7 µm broad. S: 1; D: 2017-11-22 & S: 7, 8; D: 2018-01-30.

Genus: ***Lyngbya*** Agardh (1824)

8. ***Lyngbya hieronymusii*** Lemmermann [***Limnoraphis hieronymusii*** (Lemmermann) Komárek, Zapomelová, Smarda, Kopecky, Rejmánková, Woodhouse, Neilan et Komárková] (Pl. 1, Figs. 9-10). Desikachary 1959, P. 297, Pl.

48, Fig. 4. Filaments 12-14 µm broad; cells 2.5-4 µm long, 11-13 µm broad. S: 1; D: 2017-11-22 & S: 10; D: 2018-01-30.

Genus: ***Anabaena*** Bory (1822)

9. ***Anabaena affinis*** Lemmermann [***Dolichospermum affine*** (Lemmermann) Wacklin, Hoffmann et Komárek] (Pl. 1, Figs. 11-12). Prescott 1951, P. 513, Pl. 115, Figs. 10, 14-15. Cells 6 µm broad; heterocytes 7 µm broad. S: 1; D: 2017-11-22.

Genus: ***Gloeotrichia*** Agardh (1842)

10. ***Gloeotrichia echinulate*** Richter (Pl. 1, Figs. 13-14). Prescott 1951, P. 557, Pl. 134, Figs. 1, 2; Desikachary 1959, P. 556, Pl. 116, Figs. 9, 10. Thallus 0.5-7 mm in diameter; trichome at the base 8-10 µm broad, with a long hair 1-3 µm broad. S: 3; D: 2018-01-30.

11. ***Gloeotrichia raciborskii*** var. ***kashiensis*** Rao (Pl. 1, Figs. 15-16). Desikachary, T.V. 1959, P. 563, Pl. 117, Figs. 2-6. Trichomes 7-10 µm broad at base, 6-6.5 µm broad higher up; cells 7.5-9 µm long at base, up to 10 µm long higher up; heterocysts 12.5 µm long, 10-11.3 µm broad; akinets 30 µm long, 14.6 µm broad (30-45 µm broad with sheath). S: 1, 3; D: 2017-11-22.

cells 13-32 µm long, 8-22 µm broad. S: 1; D: 2017-11-22 & S: 8; D: 2018-01-30.

Genus: ***Nephrocytium*** Nägeli (1849)

2. ***Nephrocytium agardhianum*** Nägeli (Pl. 2, Fig. 2). Prescott 1951, P. 248, Pl. 54, Figs. 15-16; Tiffany & Britton 1952, P. 116, Pl. 32, Fig. 315; Philipose 1967, P. 189, Fig. 104; Prasad & Misra 1992, P. 23, Pl. 3, Fig. 5. Colonies 33-44 µm in diameter; cells 10-16 µm long, 3-6 µm broad. S: 3, 10; D: 2018-01-30.

Genus: ***Dictyosphaerium*** Nägeli (1849)

3. ***Dictyosphaerium pulchellum*** Wood [***Mucidosphaerium pulchellum*** (Wood) Bock, Proschold et Krienitz] (Pl. 2, Figs. 3-4). Prescott 1951, P. 238, Pl. 51, figs. 5-7; Tiffany & Britton 1952, P. 115, Pl. 31, Fig. 305; Philipose 1967, P. 199, Fig. 110. Cells 3-10 µm in diameter. S: 1, 5; D: 2017-11-22 & S: 10; D: 2018-01-30.

Genus: ***Botryococcus*** Kützing (1849)

4. ***Botryococcus protuberans*** West et West (Pl. 2, Figs. 5-6). Prescott 1951, P. 232, Pl. 52, Figs. 4-5; Philipose 1967, P. 197, Fig. 109; Prasad & Srivastava 1992, P. 25, Pl. 4, Fig. 2. Colonies 100-120 µm in diameter; cells 16.5-20 µm long,

Table 1: Blue-green algae reported from Barju Taal

Class	Order	Family	Algae
Cyanophyceae	Chroococcales	Microcystaceae	1. *Microcystis aeruginosa*
		Aphanothecaceae	2. *Aphanothece granulosa*
		Gomphosphaeriaceae	3. *Gomphosphaeria aponina*
	Synecho-coccales	Merismopediaceae	4. *Merismopedia elegans*
		Coelosphaeriaceae	5. *Snowella lacustris*
	Oscillatoriales	Oscillatoriaceae	6. *Oscillatoria tenuis*
			7. *Phormidium autumnale*
			8. *Lyngbya hieronymusii*
	Nostocales	Nostocaceae	9. *Anabaena affinis*
		Gloeotrichiaceae	10. *Gloeotrichia echinulata* 11. *G. raciborskii* var. *kashiensis*

Phylum: **Chlorophyta** (Green algae)

Genus: ***Oocystis*** Nägeli ex Braun (1855)

1. ***Oocystis lacustris*** Chodat (Pl. 2, Fig. 1). Philipose 1967, P. 181, Fig. 90. Eight celled colonies 30-75 µm long, 26-43 µmbroad, four-celled colonies 32-37 µm long, 26 µm broad; 9.5-11.5 µm broad. S: 1, 7; D: 2017-11-22 & S: 1, 10; D: 2018-01-30.

Genus: ***Crucigenia*** Morren (1830)

5. ***Crucigenia crucifera*** (Wolle) Kuntze (Pl. 2, Fig. 7). Philipose 1967, P. 240, Fig. 149. Four-celled colonies 14-16 µm long, 9-11 µm broad; cells 5-7

μm long, 3.5-5.3 μm broad. S: 1; D: 2017-11-22 & S: 3; D: 2018-01-30.

Genus: ***Pandorina*** Bory (1826)

6. ***Pandorina morum*** (Müller) Bory (Pl. 2, Fig. 8). Prescott 1951, P. 75, Pl. 1, Fig 23; Tiffany & Britton 1952, P. 16, Pl. 1, Fig 13; Prasad & Misra 1992, P. 4, Pl. 1, Fig. 3. Colonies 88 μm long, 62 μm broad; cells 14-18 μm long, 9-14 μm broad. S: 1; D: 2017-11-30.

Genus: ***Eudorina*** Ehrenberg (1832)

7. ***Eudorina elegans*** Ehrenberg (Pl. 2, Fig. 9). Prescott 1951, P. 76, Pl. 1, Figs. 24-26; Tiffany & Britton 1952, P. 17, P l. 2, Fig. 14; Prasad & Misra 1992, P. 5, Pl. 1, Fig. 1. Colonies up to 200 μm in diameter; cells 10-20 μm in diameter. S: 1, 2; D: 2017-11-22.

Genus: ***Bulbochaete*** Agardh (1817)

8. ***Bulbochaete varians*** Wittrock ex Hirn (Pl. 2, Figs. 10-11). Prescott 1951, P. 155, Pl. 28, Figs. 7-9. Cells 22-33 μm long, 17-19.5 μm broad. S: 1; D: 2017-11-22 & S: 4; D: 2018-01-30.

Genus: ***Stigeoclonium*** Kützing (1843)

9. ***Stigeoclonium fasciculare*** Kützing (Pl. 2, Fig. 12). Prasad & Misra 1992, P. 60, Pl. 9, Fig. 4-5 (as var. *glomeratum*). Cell 30.5-60 μm long, 5.1-10.2 μm broad. S: 2; D: 2017-11-22.

Genus: ***Pediastrum*** Meyen (1829)

10. ***Pediastrum duplex*** var. ***subgranulatum*** Raciborski (Pl. 2, Fig. 13). Philipose 1967, P. 125, Figs. 43 c, j; Komárek 1983, P. 82, Figs. 7 a-d. Colonies 100-180 μm in diameter; cells 10-25 μm broad. S: 10; D: 2018-01-30.

11. ***Pediastrum tetras*** var. ***tetraodon*** (Corda) Hansgirg (Pl. 2, Figs. 14-15). Tiffany & Britton 1952, P. 112, Pl. 30, Fig. 294; Philipose 1967, P. 129, Fig. 45 e, g; Prasad & Misra 1992, P. 12, Pl. 1, Figs. 7, 10. Colonies 30 μm in diameter; marginal cells 10 μm long, 9-10 μm broad; inner cells 8.5 μm long, 9.5 μm broad. S: 1, 3; D: 2017-11-22 & S: 10; D: 2018-01-30.

Genus: ***Tetraëdron*** Kützing (1845)

12. ***Tetraëdron minimum*** (Braun) Hansgirg (Pl. 2, Fig. 16). Prescott 1951, P. 267, Pl. 60, Figs. 12-15; Philipose 1967, P. 138, Fig. 53 a, c. Cells 6-20 μm in diameter. S: 4, 5; D: 2018-01-30.

Genus: ***Ankistrodesmus*** Corda (1838)

13. ***Ankistrodesmus falcatus*** (Corda) Ralfs (Pl. 3, Figs. 1-6). Tiffany & Britton 1952, P. 114, Pl. 31, Fig. 307; Philipose 1967, P. 211, Fig. 121 a, e; Komárek 1983, P. 138, Pl. 25, Fig. 64b. Cells 20-165 μmlong, 1.5-7.0μmbroad. S: 3, 7, 8; D: 2018-01-30.

Genus: ***Kirchneriella*** Schmidle (1893)

14. ***Kirchneriella contorta*** (Schmidle) Bohlin [***Raphidocelis danubiana*** (Hindák) Marvan, Komárek et Comas] (Pl. 3, Fig. 7). Prescott 1951, P. 258, Pl. 57, Figs. 7-8; Philipose 1967, P. 224, Fig. 133. Cells 8-14 μm long, 0.7-2 μm broad. S: 1; 2017-01-22 & S: 3, 4; D: 2018-01-30.

15. ***Kirchneriella lunaris*** (Kirchner) Möbius (Pl. 3, Figs. 8-10). Tiffany & Britton 1952, P. 116, Pl. 31, Fig. 308; Philipose 1967, P. 222, Fig. 131; Prasad & Misra 1992, P. 28, Pl. 4, Fig. 3. Colonies up to 250μm in diameter; cells 6-15 μm long, 3-8 μmbroad. S: 4; D: 2017-11-22 & S: 10; D: 2018-01-30.

Genus: ***Coelastrum*** Nägeli (1849)

16. ***Coelastrum cambricum*** Archer (Pl. 3, Figs. 11-13). Prescott 1951, P. 229, Pl. 53, Fig. 2; Tiffany & Britton 1952, P. 113, Pl. 31, Fig. 310; Philipose 1967, P. 230, Fig. 138a. Colonies usually up to 70 μm in diameter; cells 6-12 μmin diameter. S: 1, 2; D: 2017-11-22 & S: 8, 9; D: 2018-01-30.

Genus: ***Scenedesmus*** Meyen (1829)

17. ***Scenedesmus acutiformis*** Schröder [***Acutodesmus acutiformis*** (Schröder) Tsarenko et John] (Pl. 3, Fig. 14). Philipose 1967, P. 260, Figs. 169 a-b; Nakano & Watanabe 1988, P. 61, Figs. 38-40; Prasad & Misra 1992, P. 33, Pl. 5, Fig. 11. Cells 12-22.4 μm long, 3.8-8 μm broad. S: 1, 4; D: 2018-01-30.

18. ***Scenedesmus incrassatulus*** Bohlin [***Tetradesmus incrassatulus*** (Bohlin) Wynne] (Pl. 3, Fig. 15).

Prescott 1951, P. 278, Pl. 63, Fig. 14; Philipose 1967, P. 252, Fig. 163. Cells 12-28 µm long, 5-10 µm broad. S: 2; D: 2017-11-22 & S: 1; 2017-11-30.

19. ***Scenedesmus tropicus*** Crow [***Desmodesmus tropicus*** (Crow) Hegewald] (Pl. 3, Fig. 16). Philipose 1967, P. 279, Fig. 185. Colonies 28-38.7 µm long,26-33 µm broad; cells 26-33 µm long, 7-9.6 µm broad; spines 17.6-24.6 µm long. S: 1; D: 2017-11-22 & S: 4; D: 2018-01-30.

Genus: ***Gonatozygon*** Bary (1858)

20. ***Gonatozygon monotaenium*** Bary (Pl. 4, Figs. 1-2). Croasdale & Flint 1986, P. 41, Pl. 2, Figs. 8-11]. Cells 90-300(470) µm long, 7-14(23) µm broad. S: 2; D: 2017-11-22 & S: 9; D: 2018-01-30.

21. ***Gonatozygon pilosum*** Wolle (Pl. 4, Fig. 3). Croasdale & Flint 1986, P. 42, Pl. 2, Figs. 12-13. Cells 250-250 µm long, 10-15 µm broad. S: 2; D: 2017-11-22 & S: 8; D: 2018-01-30.

Genus: ***Penium*** Brébisson ex Ralfs (1848)

22. ***Penium margaritaceum*** Brébisson (Pl. 4, Figs. 4-5). Croasdale & Flint 1986, P. 44, Pl. 3, Figs. 13-15; Das & Adhikary 2012, P. 43, Figs. 4h-j (as var. *margaritaceum* f. *margaritaceum*). Cells 90-200 µm long, 15-28 µm broad. S: 1, 4; D: 2018-01-30.

Genus: ***Closterium*** Nitzsch ex Ralfs (1848)

23. ***Closterium acerosum*** Ehrenberg ex Ralfs (Pl. 4, Fig. 6). Tiffany & Britton 1952, P. 169, Pl. 52, Fig. 550; Scott & Prescott 1961, P. 9, Pl. 3, Fig. 1; Nurul Islam 1970, P. 909, Pl. 6, Figs. 1-3, 11, 15; Nurul Islam & Yusuf Haroon 1980, P. 558, Pl. 1, Figs. 3-4; Prasad & Misra 1992, P. 97, Pl. 16, Fig. 15. Cells 146-568 µm long, 30-44 µm broad, ca 30-38° arc; apices 4.5-6 µm broad. S: 1; D: 2017-11-22 & S: 8; D: 2018-01-30.

24. ***Closterium dianae*** Ehrenberg ex Ralfs (Pl. 4, Figs. 7-10). Nurul Islam & Yusuf Haroon 1980, P. 558, Pl. 2, Figs. 29-30; Prasad & Misra 1992, P. 105, Pl. 16, Fig. 7; Opute 2000, P. 136, Pl. 2, Fig. 13. Cells 162-320 µm long, 12.5-26.5 µm broad, ca 108° arc; apices 2-3 µm broad, 140-315 µm distant; chloroplast with 6-8 pyrenoids. S: 1, 2; D: 2017-11-22 & S: 4, 7-10; D: 2018-01-30.

25. ***Closterium striolatum*** Ehrenberg ex Ralfs (Pl. 4, Figs. 11-12). Croasdale & Flint 1986, P. 69, Pl. 10, Figs. 1-2; Kouwets 1987, P. 207, Pl. 32: 7-11. Cells 215 µm long, 23 µm broad, 36-69° arc; chloroplast with 5-7 pyrenoids. S: 1; D: 2017-11-22 & S: 4; D: 2018-01-30.

Genus: ***Pleurotaenium*** Nägeli (1849)

26. ***Pleurotaenium trabecula*** Nägeli (Pl. 4, Figs. 13-14). Scott & Prescott 1961, P. 18, Pl. 3, Fig. 4; Nurul Islam & Yusuf Haroon 1980, P. 564, Pl. 4, Fig. 56; Kouwets 1987, P. 208, Pl. 6, Fig. 7. Cells 350-520 µm long, 27-40 µm broad; apices 20-22 µm broad; isthmus 25-30 µm wide. S: 10; D: 2018-01-30.

Genus: ***Euastrum*** Ehrenberg ex Ralfs (1848)

27. ***Euastrum acanthophorum*** Turner (Pl. 4, Fig. 15). Scott & Prescott 1961, P. 22, Pl. 13, Figs. 4-5; Nurul Islam 1970, P. 915, Pl. 16, Fig. 17; Nurul Islam & Yusuf Haroon 1980, P. 564, Pl. 6, Figs. 99-100. Cells 34-36 µm long (CSp), 24-29 µm broad; isthmus 6-7 µm wide. S: 1; D: 2017-11-22 & S: 5; D: 2018-01-30.

28. ***Euastrum denticulatum*** var. ***quadrifarium*** Krieger (Pl. 4, Fig. 16). Scott & Prescott 1961, P. 25, Pl. 13, Figs. 10-11; Croasdale & Flint 1986, P. 89, Pl. 22, Fig. 15. Cells 20-30 µm long, 14-23 µm broad; isthmus 5-6 µm wide. S: 3, 9; D: 2018-01-30.

29. ***Euastrum divergens*** var. ***ornatum*** Borge ex Schmidle (Pl. 5, Fig. 1). Scott & Prescott 1961, P. 26, Pl. 10, Fig. 7; Nurul Islam 1970, P. 916, Pl. 16, Fig. 22; Nurul Islam & Yusuf Haroon 1980, P. 566, Pl. 6, Fig. 101; Pl. 21, Fig. 346. Cells 42-56 µm long (SSp), 42-54 µm broad (SSp); isthmus 8-15 µm wide. S: 1, 2; D: 2017-11-22 & S: 4; D: 2018-01-30.

30. ***Euastrum elegans*** Ralfs (Pl. 5, Figs. 2-4). Scott & Prescott 1961, P. 26, Pl. 13, Fig. 17; Croasdale & Flint 1986, P. 90, Pl. 22, Figs. 6-7; Kouwets 1987, P. 215, Pl. 8, Figs. 7-8. Cells 26-37 µm long, 17-22 µm broad; isthmus 8 µm wide. S: 1, 2; D: 2017-11-22 & S: 5; D: 2018-01-30.

31. ***Euastrum spinulosum*** Delponte (Pl. 5, Figs. 5-6). Nurul Islam 1970, P. 917, Pl. 17, Fig. 3; Nurul Islam & Yusuf Haroon 1980, P. 568, Pl. 22, Fig. 356; Prasad & Misra 1992, P. 136, Pl. 19, Fig. 10. Cells 51-55 µm long, 47-48.5 µm broad; isthmus 11.5-13 µm wide; polar lobes 17-18 µm broad. S: 1; D: 2017-11-22 & S: 3, 4, 9, 10; D: 2018-01-30.

Genus: ***Micrasterias*** Agardh ex Ralfs (1848)

32. ***Micrasterias mahabuleshwarensis*** Hobson (Pl. 5, Figs. 7-9). Nurul Islam 1970, P. 920, Pl. 9, Fig. 3; Prasad & Misra 1992, P. 142, Pl. 20, Fig. 7. Cells 104 µm (SPr)-120 µm (CPr) long, 104 µm broad; isthmus 20-21 µm wide; apical lobes 32 µm (SPr)-52 µm (CPr) broad. S: 1, 2; D: 2017-11-22 & S: 9, 10; D: 2018-01-30.

33. ***Micrasterias pinnatifida*** Ralfs (Pl. 5, Figs. 10-11). Scott & Prescott 1961, P. 51, Pl. 12, Fig. 6; Pl. 14, Figs. 17-18; Nurul Islam & Yusuf Haroon 1980, P. 572, Pl. 14; Croasdale & Flint 1986, P. 106, Pl. 24, Figs. 1-2; Prasad & Misra 1992, P. 143, Pl. 20, Fig. 4. Cells 56-60 µm long, 55-60 µm broad; isthmus 10-11 µm wide; polar lobes 13-15 µm long, 35-38 µm broad; spines 4-5 µm long. S: 1; D: 2017-11-22 & S: 4, 8; D: 2018-01-30.

34. ***Micrasterias radians*** Turner (Pl. 5, Figs. 12-14). Scott & Prescott 1961, P. 51, Pl. 23, Fig. 1; Nurul Islam & Yusuf Haroon 1980, P. 572, Pl. 3, Figs. 48-49, 199; Prasad & Misra 1992, P. 144, Pl. 20, Fig. 2. Cells 103-110 µm long, 95-100 µm broad; isthmus 15-17 µm wide. S: 1, 7; D: 2017-11-22 & S: 10; D: 2018-01-30.

Genus: ***Actinotaenium*** (Nägeli) Teiling (1954)

35. ***Actinotaenium subglobosum*** (Nordstedt) Teiling (Pl. 5, Figs. 15-16). Croasdale & Flint 1988, P. 38, Pl. 28, Figs. 20-21; Stastny 2008, P. 890. Cells 32-48 µm long, 24-30 µm broad. S: 7; D: 2018-01-30 & S: 8; D: 2018-01-30.

36. ***Actinotaenium*** cf. ***turgidum*** (Brébisson ex Ralfs) Teiling (Pl. 6, Fig. 1). Coasdale & Flint 1988, P. 39, Pl. 28, Figs. 9-12. Cells 160-230 µm long, 61-106 µm broad. S: 4; D: 2017-11-22.

37. ***Actinotaenium*** cf. ***wollei*** (West et West) Teiling (Pl. 6, Figs. 2-3). Kouwets 1997, P. 39, Figs. 27-29. Cells 46-62 µm long, 40-43 µm broad. S: 7, 8; D: 2018-01-30.

Genus: ***Cosmarium*** Corda ex Ralfs (1848)

38. ***Cosmarium abbreviatum*** var. ***minus*** (West et West) Krieger et Gerloff (Pl. 6, Fig. 4). Nabeshima Aquino et al. 2016, P. 673, Figs 2a-b. Cell 10.7-11.5 µm long, 11.4-12.1 µm broad; isthmus 4.7-5.1 µm wide. S: 1, 2, 6; D: 2017-11-22 & S: 4, 8; D: 2018-01-30.

39. ***Cosmarium*** cf. ***angulare*** Johnson (Pl. 6, Fig. 5). Stastny 2010, P. 10, Figs. 113-115. Cells 30.5-35 µm long, 29-32 µm broad; isthmus 9-10 µm wide. S: 9; D: 2018-01-30.

40. ***Cosmarium auriculatum*** Reinsch (Pl. 6, Figs. 6-7). Scott & Prescott 1961, P. 54, Pl. 26, Fig. 4; Nurul Islam 1970, P. 923, Pl. 15, Figs. 13-15; Nurul Islam & Yusuf Haroon 1980, P. 574, Pl. 15, Figs. 208, 209; Bharati & Hegde 1982, P. 736, Pl. 3, Fig. 3; Prasad & Misra 1992, P. 153, Pl. 22, Fig. 14. Cells 45-48 µm long, 42-55 µm broad; isthmus 20-22 µm wide. S: 1; D: 2017-11-22; S: 9; D: 2018-01-30.

41. ***Cosmarium bengalense*** Turner (Pl. 6, Fig. 8). Scott & Prescott 1961, P. 54, Pl. 28, Fig. 1 (as *C. angulatum* f. *majus*); Bharati & Hegde 1982, P. 736, Pl. 5, Fig.6. Cells 68-70 µm long, 38-40.5 µm broad; isthmus 13-15 µm wide; apices 17.5-20 µm broad. S: 1; D: 2017-11-22 & S: 7, 9, 10; D: 2018-01-30.

42. ***Cosmarium contractum*** Kirchner (Pl. 6, Fig. 9). Scott & Prescott 1961, P. 56, Pl. 27, Fig. 4 (as *C. contractum*); Croasdale & Flint 1988, P. 61, Pl. 33, Figs. 1-2. Cells 30-54 µm long, 17-34 µm broad; isthmus 8 µm wide. S: 4, 10; D: 2018-01-30.

43. ***Cosmarium granatum*** Brébisson ex Ralfs (Pl. 6, Figs. 10-11). Tiffany & Britton 1952, P. 186, Pl. 53, Fig. 565; Bharati & Hedge 1982, P. 742, Pl. 11, Fig. 1; Prasad & Misra 1992, P. 160, Pl. 21, Fig. 20. Cells 34.5-38.5 µm long, 25-27 µm broad; isthmus 7-7.5 µm wide; apices 8-9 µm broad. S: 1; D: 2017-11-22 & S: 5, 7, 8; D: 2018-01-30.

44. ***Cosmarium haynaldii*** Schaarschmidt (Pl. 6, Figs. 12-13). West & West 1902, P. 173; Guiry & Guiry 2018.Cells 32 µm long, 31 µm broad; isthmus 7.5 µm wide. S: 1; D: 2017-11-22 & S: 3, 4, 7, 10; D: 2018-01-30.

45. ***Cosmarium impressulum*** Elfving (Pl. 6, Figs. 14-15). Nurul Islam 1970, P. 924, Pl. 11, Figs. 6-8; Nurul Islam & Yusuf Haroon 1980, P. 576, Pl. 17, Figs. 146-147; Kouwets 1987, P. 225, Pl. 12, Figs. 36-42; Croasdale & Flint 1988, P. 71, Pl. 40, Figs. 16-19. Cells 20.5 µm long, 15 µm broad. S: 7, 10; D: 2018-01-30.

46. ***Cosmarium lundellii*** var. ***ellipticum*** West et West (Pl. 6, Fig. 16; Pl. 7, Fig. 1). Scott & Prescott 1961, P. 61, Pl. 25, Fig. 8; Croasdale & Flint 1988, P. 73, Pl. 29, Fig. 11; Prasad & Misra 1992, P. 164, pl 22, Fig. 23; Nurul Islam & Irfanullah 1999, P. 93, Pl. 1, Figs. 6-7. Cells 57-60 µm long, 42.5-43 µm broad; isthmus 16-17 µm wide. S: 1; D: 2017-11-22 & S: 3, 4, 8; D: 2018-01-30.

47. ***Cosmarium maculatiforme*** Schmidle (Pl. 7, Fig. 2). Nurul Islam 1970, P. 924, Pl. 14, Fig. 1. Cells 120 µm long, 62.5 µm broad; isthmus 42.5-45 µm wide. S: 1, 4; D: 2018-01-30.

48. ***Cosmarium margaritatum*** (Lundell) Roy et Bisset (Pl. 7, Fig. 3). Croasdale & Flint 1988, P. 74, Pl. 52, Figs. 7-8. Cells 60-105 µm long, 50-82 µm broad; isthmus 1.15-1.28 µm wide. S: 8; D: 2018-01-30.

49. ***Cosmarium meneghinii*** Brébisson ex Ralfs (Pl. 7, Fig. 4). Croasdale & Flint 1988, P. 75, Pl. 41, Figs. 12-14; http://www.digicodes.info/Cosmarium_meneghinii.html. Cells 13-30 µm long, 10-22 µm broad; isthmus 3-7 µm wide. S: 3, 9; D: 2018-01-30.

50. ***Cosmarium obsoletum*** (Hantzsch) Reinsch (Pl. 7, Fig. 5). Kouwets 1987, P. 226, Pl. 11, Fig. 15 (as *C. obsoletum*); Croasdale & Flint 1988, P. 80, Pl. 29, Fig. 1; Prasad & Misra 1992, P. 170, Pl. 22, Figs, 12, 16 (as *C. obsoletum*). Cells 23-56 µm long, 42-60 µm broad; isthmus 10-24 µm wide. S: 4, 8; D: 2018-01-30.

51. ***Cosmarium portianum*** Archer (Pl. 7, Figs. 6-7). Scott & Prescott 1961, P. 65, Pl. 28, Fig. 8. Cells 20 µm long, 18 µm broad; isthmus 16 µm wide. S: 1; D: 2017-11-22 & S: 4, 7, 8; D: 2018-01-30.

52. ***Cosmarium pseudoornatum*** Eichler et Gutwinski (Pl. 7, Fig. 8). Croasdale & Flint 1988, P. 90, Pl. 42, Figs. 3-5. Cells 25-37 µm long, 20-29 µm broad; isthmus 6-10 µm wide. S: 2; 2017-11-22 & S: 3, 7, 9; D: 2018-01-30.

53. ***Cosmarium pseudoretusum*** var. ***africanum*** (Fritsch) Krieger et Gerloff (Pl. 7, Fig. 9). Nabeshima Aquino et al. 2016, P. 681, Fig. 28a-b. Cells 19.9-23.3 µm long, 15.9-19 µm broad; isthmus 5.1-6.9 µm wide. S: 4, 8; D: 2018-01-30.

54. ***Cosmarium punctulatum*** Brébisson (Pl. 7, Fig. 10). Croasdale & Flint 1988, P. 90, Pl. 46, Figs. 8-10 (as var. *punctulatum*); Prasad & Misra 1992, P. 170, Pl. 22, Figs, 12, 16. Cells 22-40 µm long, 20-38 µm broad; isthmus 7-l4 µm wide. S: 3, 7, 8, 10; D: 2018-01-30.

55. ***Cosmarium quadrum*** Lundell (Pl. 7, Figs. 11-13). Tiffany & Britton 1952, P. 193, Pl. 53, Fig. 580; Croasdale & Flint 1988, P. 95, Pl. 54, Figs. 1-3 (as var. *quadrum*).; Prasad & Misra 1992, P. 178, Pl. 23, Figs. 1-2. Cells 60-90 µm long, 54-85 µm broad; isthmus 18-30 µm wide. S: 1; D: 2017-11-22 & S: 3, 5, 7, 8, 9; D: 2018-01-30.

56. ***Cosmarium ralfsii*** Brébisson ex Ralfs (Pl. 7, Figs. 14-15). Croasdale & Flint 1988, P. 96, Pl. 30, Figs. 6-7 (as var. *ralfsii*). Cells 88-124 µm long, 76-104 µm broad, 50-55 µm thick; isthmus 20-26 µm wide. S: 1, 2; D: 2017-11-22 & S: 3; D: 2018-01-30.

57. ***Cosmarium regnellii*** Wille (Pl. 7, Fig. 16; Pl. 8, Fig. 1). Croasdale & Flint 1988, P. 98, Pl. 41, Figs. 1-4, 9 (as var. *regnellii*); Nabeshima Aquino et al. 2016, P. 684, Figs 33a-b (as var. *minimum*). Cells (10)14-22 µm long, (8)15-22 µm broad, 6-11 µm thick; isthmus 4-5(8.5) µm wide. S: 1, 2; D: 2017-11-22 & S: 9; D: 2018-01-30.

58. ***Cosmarium regnesi*** Reinsch (Pl. 8, Fig. 2). Scott & Prescott 1961, P. 68, Pl. 32, Fig. 24; Bharati & Hedge 1982, P. 750, Pl. 11, Fig. 9; Croasdale & Flint 1988, P. 99, Pl. 37, Fig. 14 (as var. *regnesi*).

Cells 15 µm (CPr) and 10 µm (SPr) long, 15 µm (CPr) broad; isthmus 4.5 µm wide. S: 9; D: 2018-01-30.

59. ***Cosmarium sublatereundatum*** West et West (Pl. 8, Fig. 3). Nurul Islam & Yusuf Haroon 1980, P. 580, Pl. 22, Figs. 263-264; Bando et al. 1989, P. 21, Fig. 7e. Cells 42.5-46.2 µm long, 42.5-43 µm broad; isthmus 12.5-13.5 µm wide. S: 3, 4; D: 2018-01-30.

60. ***Cosmarium subspeciosum*** var. ***validius*** Nordstedt (Pl. 8, Figs. 4-7). Bharati & Hegde 1982, P. 752, Pl. 9, Fig. 1; Croasdale & Flint 1988, P. 106, Pl. 49, Figs. 11, 12 (as f. *validius*); Sahin 2005, P. 409, Fig. 14. Cells 45-50 µm long, 32.5-36.5 µm broad; isthmus 11-12 µm wide; apices 11-12.5µm broad. S: 1, 2; D: 2017-11-22 & S: 8; D: 2018-01-30.

61. ***Cosmarium venustum*** (Brébisson) Archer (Pl. 8, Fig. 8). Croasdale & Flint 1988, P. 112, Pl. 37, Figs. 3-5 (as var. *venustum*). Cells 30-48 µm long, 20-38 µm broad, 12-19 µm thick; isthmus 4-10 µm wide. S: 2; D: 2017-11-22 & S: 8; D: 2018-01-30.

Genus: ***Staurodesmus***Teiling (1948)

62. ***Staurodesmus convergens*** (Ehrenberg ex Ralfs) Lillieroth (Pl. 8, Fig. 9). Scott & Prescott 1961, P. 74, Pl. 34, Figs. 7-10 (As *Arthrodesmus convergens*); Croasdale et al. 1994, P. 41, Pl. 75, Figs. 1-8 (as var. *convergens*). Cells 34 µm long, 32-46 µm broad; isthmus 7.5-10 µm wide. S: 4, 8; D: 2018-01-30.

63. ***Staurodesmus unicornis*** (Turner) Coesel et Van Geest (Pl. 8, Figs. 10-14). Croasdale et al. 1994, P. 62, Pl. 68, Figs 1-5 (as var. *unicornis*). Cells 27-30 µm long, 25-35 µm broad; isthmus 6-8 µm wide. S: 1, 2; D: 2017-11-22 & S: 3; 9, 10; D: 2018-01-30.

Genus: ***Staurastrum*** Meyen ex Ralfs (1848)

64. ***Staurastrum avicula*** Brébisson (Pl. 8, Fig. 15). Nurul Islam & Yusuf Haroon 1980, P. 588, Pl. 4, Figs. 65-66; Kouwets 1987, P. 242, Pl. 18, Fig. 7; Croasdale et al. 1994, P. 85, Pl. 84, Figs. 1-9 (as var. *avicula*); Flint & Williamson 1998, P. 93, Pl. 9, Fig. 4. Cells 29-35 µm long (CSp), 35-42 µm broad (CSp); isthmus 9-11 µm wide. S: 8; D: 2018-01-30.

65. ***Staurastrum gutwinskii*** var. ***evolutum*** Scott et Prescott (Pl. 8, Fig. 16). Scott & Prescott 1961, P. 94, Pl. 43, Fig. 7. Cells 42 µm (CPr) and 30 µm (SPr) long, 57 µm (CPr) and 30 µm (SPr) broad; isthmus 16 µm wide. S: 8; D: 2018-01-30.

66. ***Staurastrum leptocladum*** var. ***cornutum*** Wille (Pl. 9, Fig. 1). Nurul Islam & Yusuf Haroon 1980, P. 590, Pl. 17, Fig. 243; Therezien 1985, P. 552, Pl. 25, Fig. 3. Cells 36 µm (SSp) long, 10-15 µm (SPr) to 55-67 µm (CPr) broad; isthmus 7-7.5 µm wide; apical pair spines upto 3.5 µm long. S: 1, 2; D: 2017-11-22 & S: 3; D: 2018-01-30.

67. ***Staurastrum manfeldtii*** Delponte (Pl. 9, Figs. 2-3). Croasdaleet al. 1994, P. 112, Pl. 99, Figs. 1-3; Pl. 127, Figs. 1-8; Pl. 128, Figs. 1-10 (as var. *manfeldtii*); Flint & Williamson 1998, P. 93, Pl. 9, Fig. 5. Cells 37-58 µm long (CPr), 33-100 µm broad (CPr); isthmus 13-15 µm wide. S: 2; D: 2017-11-22 & S: 3, 8, 9; D: 2018-01-30.

68. ***Staurastrum*** cf. ***margaritaceum*** Meneghini ex Ralfs (Pl. 9, Figs. 4-5). Kouwets 1987, P. 246, Pl. 19, Fig. 8; Croasdale et al. 1994, P. 114, Pl. 104, Figs. 1-7. Cells 23-30 µm long (CPr), 15-48 µm broad (CPr); isthmus 6-11 µm wide. S: 1, 2; D: 2017-11-22 & S: 8; D: 2018-01-30.

69. ***Staurastrum sonthalianum*** Turner (Pl. 9, Figs. 6-12). Croasdale et al. 1994, P. 135, Pl. 124, Figs. 1-6. Cells 39-48 µm long (CPr), 53-77 µm broad (CPr); isthmus 12-13.5 µm wide. S: 1, 2; D: 2017-11-22 & S: 3, 5, 9; D: 2018-01-30.

70. ***Staurastrum striolatum*** (Nägeli) Archer (Pl. 9, Figs. 13-16). Croasdale et al. 1994, P. 136, Pl. 82, Figs 12-14 (as var. *striolatum*). Cells 19-28 µm long, 18-28 µm broad; isthmus 6-10 µm wide.S: 1, 2; D: 2017-11-22 & S: 7, 8; D: 2018-01-30.

71. ***Staurastrum tetracerum*** Ralfs ex Ralfs (Pl. 10, Fig. 1). Scott & Prescott 1961, P. 112, Pl. 57, Fig. 12; Croasdale et al. 1994, P. 141, Pl. 101, Figs. 1-7. Cells 7-10 µm long (SPr), 18-28 µm long (CPr) and 18-30 µm broad (CPr); isthmus 4-6 µm wide. S: 3, 4; D: 2018-01-30.

72. ***Staurastrum tohopekaligense*** var. ***tohopekaligense*** f. ***minus*** (Turner) Scott et Prescott (Pl. 10, Figs. 2-5). Scott & Prescott 1961, P. 114, Pl. 48, Figs. 4-6; Croasdale et al. 1994, P. 142, Pl. 88, Figs. 1-2; Pl. 115, Fig. 5 (as f. *tohopekaligense*); Flint & Williamson 1998, P. 95, Pl. 9, Fig. 2; Nurul Islam & Irfanullah 1999, P. 96, Pl. 3, Figs. 35-36. Cells 21 µm (SPr) to 35 µm (CPr) long, 16-17 µm (SPr) to 33.5-35 µm (CPr) broad; isthmus 10 µm wide; processes 10 µm long. S: 2; D: 2017-11-22 & S: 3, 5, 8; D: 2018-01-30.

Genus: ***Spondylosium*** Brébisson ex Kützing (1849)

73. ***Spondylosium nitens*** var. ***triangulare*** f. ***javanicum*** Gutwinski (Pl. 10, Figs. 6-8). Scott & Prescott 1961, P. 121, Pl. 60, Fig. 10; Nurul Islam 1970, P. 932, Pl. 3, Figs. 7, 11; Prasad & Misra 1992, P. 202, Pl. 26, Fig. 13. Cells 27.5 µm long, 25 µm broad; isthmus 6.3 µm wide. S: 1; D: 2017-11-22.

74. ***Spondylosium panduriforme*** var. ***panduriforme*** f. ***limneticum*** (West et West) Teiling (Pl. 10, Figs. 9-11). Croasdale et al. 1994, P. 165, Pl. 135, Figs 4-7. Cells 26-53 µm long, 10-30 µm broad; isthmus 10-18 µm wide. S: 1; D: 2017-11-22 & S: 4; D: 2018-01-30.

75. ***Spondylosium pulchrum*** (Bailey) Archer (Pl. 10, Fig. 12). Croasdale et al. 1994, P. 168, Pl. 134, Figs 1-3. Cells (20)31-58 µm long, (49)55-62(96) µm broad; apex 10-22 µm broad; isthmus 11-27 µm wide. S: 2; D: 2017-11-22.

Genus: ***Teilingia*** Bourrelly (1964)

76. ***Teilingia granulate*** (Roy et Bisset) Bourrelly (Pl. 10, Figs. 13-14). Nurul Islam & Yusuf Haroon 1980, P. 594, Pl. 1, Fig. 17; Kouwets 1987, P. 258, Pl. 21, Figs. 8-9; Croasdale et al. 1994, P. 169, Pl. 130, Figs. 5-8; Flint & Williamson 1998, P. 96, Pl. 10, Fig. 6. Cells 6-15 µm long, 7-17 µm broad; isthmus 3-7 µm wide. S: 1; D: 2017-11-22 & S: 8; D: 2018-01-30.

Table 2: Green algae reported from Barju Taal

Class	Order	Family	Algae
Trebouxiophyceae	Chlorellales	Oocystaceae	1. *Oocystis lacustris*
			2. *Nephrocytium agardhianum*
		Chlorellaceae	3. *Dictyosphaerium pulchellum*
	Trebouxiales	Botryococcaceae	4. *Botryococcus protuberans*
		Trebouxiophyceae	5. *Crucigenia crucifera*
Chlorophyceae	Chlamydomonadales	Volvocaceae	6. *Pandorina morum*
			7. *Eudorina elegans*
	Oedogoniales	Oedogoniaceae	8. *Bulbochaete varians*
	Chaetophorales	Chaetophoraceae	9. *Stigeoclonium fasciculare*
	Sphaeropleales	Hydrodictyaceae	10. *Pediastrum duplex* var. *subgranulatum*
			11. *P. tetras* var. *tetraodon*
			12. *Tetraëdron minimum*
		Selenastraceae	13. *Ankistrodesmus falcatus*
			14. *Kirchneriella contorta*
			15. *K. lunaris*
		Scenedesmaceae	16. *Coelastrum cambricum*
			17. *Scenedesmus acutiformis*
			18. *S. incrassatulus*
			19. *S. tropicus*
Conjugatophyceae	Desmidiales	Gonatozygaceae	20. *Gonatozygon monotaenium*
			21. *G. pilosum*
		Peniaceae	22. *Penium margaritaceum*
		Closteriaceae	23. *Closterium acerosum*
			24. *C.dianae*
			25. *C. striolatum*
		Desmidiaceae	26. *Pleurotaenium trabecula*
			27. *Euastrum acanthophorum*

Class	Order	Family	Algae
			28. *E. denticulatum* var. *quadrifarium* 29. *E. divergens* var. *ornatum* 30. *E. elegans* 31. *E. spinulosum*
			32. *Micrasterias mahabuleshwarensis* 33. *M. pinnatifida* 34. *M. radians*
			35. *Actinotaenium subglobosum* 36. *A.* cf. *turgidum* 37. *A.* cf. *wollei*
			38. *Cosmarium abbreviatum* var. *minus* 39. *C.* cf. *angulare* 40. *C. auriculatum* 41. *C. bengalense* 42. *C. contractum* 43. *C. granatum* 44. *C. haynaldii* 45. *C. impressulum* 46. *C. lundellii* var. *ellipticum* 47. *C. maculatiforme* 48. *C. margaritatum* 49. *C. meneghinii* 50. *C. obsoletum* 51. *C. portianum* 52. *C. pseudoornatum* 53. *C. pseudoretusum* var. *africanum* 54. *C. punctulatum* 55. *C. quadrum* 56. *C. ralfsii* 57. *C. regnellii* 58. *C. regnesi* 59. *C. sublatereundatum* 60. *C. subspeciosum* var. *validius* 61. *C. venustum*
			62. *Staurodesmus convergens* 63. *S. unicornis*
			64. *Staurastrum avicula* 65. *S. gutwinskii* var. *evolutum* 66. *S. leptocladum* var. *cornutum* 67. *S. manfeldtii* 68. *S. margaritaceum* 69. *S. sonthalianum* 70. *S. striolatum* 71. *S. tetracerum* 72. *S. tohopekaligense* var. *tohopekaligense* f. *minus*
			73. *Spondylosium nitens* var. *triangulare* f. *javanicum* 74. *S. panduriforme* var. *panduriforme* f. *limneticum* 75. *S. pulchrum*
			76. *Teilingia granulata*

Phylum: **Euglenozoa** (Euglenoids)

Genus: ***Monomorphina*** Mereschkowsky (1877)

1. ***Monomorphina pyrum*** (Ehrenberg) Mereschkowsky (Pl. 10, Fig. 15). Das & Adhikary 2012, P. 115, Pl. 2, Fig. 59. Cells 46.5 µm long, 16.4 µm broad. S: 1; D: 2017-11-22.

Genus: ***Phacus*** Dujardin (1841)

2. ***Phacus orbicularis*** Hübner (Pl. 10, Fig. 16). Prescott 1951, P. 401, Pl 87, Fig. 10. Cells 60-70-100 µm long, 39-46 µm broad. S: 1; D: 2017-11-22.

Table 3: Euglenoids reported from Barju Taal

Class	Order	Family	Algae
Euglenophyceae	Euglenales	Euglenaceae	1. *Monomorphina pyrum*
		Phacaceae	2. *Phacus orbicularis*

Phylum: **Bacillariophyta** (Diatoms)

Genus: ***Melosira*** Agardh (1824)

1. ***Melosira varians*** Agardh (Pl. 11, Fig. 1). Tiffany & Britton 1952, P. 221, Pl. 59, Fig. 673; Sinnu & Squires 1985, P. 298, Pl. 1, Fig. 1. Cells 15 µm in diameter; semicells 12 µm high. S: 2; D: 2017-11-22 & S: 3; D: 2018-01-30.

Genus: ***Eunotia*** Ehrenberg (1837)

2. ***Eunotia bilunaris*** (Ehrenberg) Schaarschmidt (Pl. 11, Fig. 2). Bey & Ector 2013, P. 300, Figs 1-21; Karthick et al. 2013, Pl. 33. Valves 66-86 µm long, 2-3 µm broad; striae 19-20 in 10 µm. S: 8; D: 2018-01-30.

3. ***Eunotia pectinalis*** (Kützing) Rabenhorst (Pl. 11, Fig. 3). Gandhi 1959, P. 310, Fig. 33; 1960, P. 97, Pl. 1, Fig. 8. Valves 82.5 µm long, 6.5-7.5 µm broad; striae 10-12 in 10 µm. S: 8; D: 2018-01-30.

Genus: ***Caloneis*** Cleve (1894)

4. ***Caloneis bacillum*** (Grunow) Cleve (Pl. 11, Fig. 4). Karthick et al. 2013, Pl. 3. Valve 16.5-33 µm long; 5-7 µm broad; stria 20-24 in 10 µm. S: 7; D: 2018-01-30.

Genus ***Gyrosigma*** Hassall (1845)

5. ***Gyrosigma acuminatum*** (Kützing) Rabenhorst (Pl. 11, Fig. 5). Wojtal 2009, P. 226, Pl. 87, Figs. 1-8; Pl. 88, Figs. 1-3. Valve 70-180 µm long, 12-24 µm wide; longitudinal striae 19-24 in 10 µm. S: 1; 2017-01-22 & S: 4; D: 2018-01-30.

Genus: ***Frustulia*** Rabenhorst (1853)

6. ***Frustulia rhomboides*** var. ***saxonica*** (Rabenhorst) Toni [***Frustulia saxonica*** Rabenhorst] (Pl. 11, Fig. 6). Tiffany & Britton 1952, P. 245, Pl. 66, Fig. 754. Valves 70-160 µm long, 15-30 µm broad; transverse striae 23-30 in 10 µm. S: 3, 7; D: 2018-01-30.

Genus: ***Neidium*** Pfitzer (1871)

7. ***Neidium affine*** (Ehrenberg) Pfitzer (Pl. 11, Fig. 7). Karthick et al.2013, Pl. 77. Valves 46-72 µm long, 8-9.5 µm broad; striae 10-13 in 10 µm. S: 4; D: 2018-01-30.

Genus: ***Pinnularia*** Ehrenberg (1843)

8. ***Pinnularia acrosphaeria*** Smith (Pl. 11, Fig. 8). Prasad & Srivastava 1992, P. 229; Pl. 30, Fig. 10; Karthick *et.al*. 2013, Pl. 74. Valves 43-65 µm long, 8.5-10.5 µm broad; striae 13 in 10 µm. S: 8; D: 2018-01-30.

9. ***Pinnularia amabilis*** Krammer (Pl. 11, Fig. 9). Karthick et al. 2013, Pl. 73. Valve 43.0-52.5 µm long, 7.0-8.5 µm broad; striae 8-10 in 10 µm. S: 8; D: 2018-01-30.

Genus: ***Gomphonema*** Ehrenberg (1832)

10. ***Gomphonema acidoclinatum*** Lange-Bertalot et Reichardt (Pl. 11, Fig. 10). Werum & Lange-Bertalot 2004, Pl. 92, Figs. 1-5, 6-11; Bey & Ector 2013, P. 880-81, Figs. 1-18. Valve 20-58 µm long, 6.6-8.5 µm broad; striae 12-15 in 10 µm. S: 3, 7, 8; D: 2018-01-30.

11. ***Gomphonema pseudoaugur*** Lange-Bertalot (Pl. 11, Fig. 11). Karthick et al. 2013, Pl. 78. Valves 41-60 µm long, 9.5-12 µm broad; striae 10-12 in 10 µm. S: 8; D: 2018-01-30.

12. ***Gomphonema sagitta*** Schumann [***Gomphonema subtile*** **var.** ***sagitta*** (Schumann) Grunow] (Pl. 11, Fig. 12). Lange-Bertalot 1996, P. 246, Pl. 64, Figs. 1-3. Valve 28-50 µm long, 6-9 µm broad; striae 8-17 in 10 µm. S: 7, 8; D: 2018-01-30.

Genus: ***Encyonema*** Kützing (1834)

13. ***Encyonema silesiacum*** (Bleisch) Mann (Pl. 11, Fig. 13). Bey & Ector 2013, P. 838, Figs. 1-22. Valves 16-42 µm long, 5-9 µm broad; striae 12 in 10 µm. S: 8; D: 2018-01-30.

Genus: ***Rhopalodia*** Müller (1895)

14. ***Rhopalodia gibba*** (Ehrenberg) Müller (Pl. 11, Fig. 14). Tiffany & Britton 1952, P. 282, Pl. 75, Fig. 884; Karthick et al. 2013, Pls. 106-107. Valves 36-200 µm long, 18-30 µm broad; costae 6-8 in 10 µm; striae 10-13 in 10 µm. S: 8, 10; D: 2018-01-30.

Genus: ***Nitzschia*** Hassall (1845)

15. ***Nitzschia palea*** (Kützing) Smith (Pl. 11, Fig. 15). Karthicket al. 2013, Pl. 118. Valve 27.5-47.5 µm long, 3.5-5 µm broad, stria more than 30 in 10 µm. S: 10; D: 2018-01-30.

Genus: ***Stenopterobia*** Brébisson ex Van Heurck (1896)

16. ***Stenopterobia intermedia*** (Lewis) Van Heurck ex Hanna (Pl. 11, Fig. 16). Spaulding & Edlund 2010, http://westerndiatoms.colorado.edu/taxa/genus/ stenopterobia. Valves 30-280 µm long, 3.5-9 µm broad. S: 8; D: 2018-01-30.

The largest phylum, i.e., chlorophyta, reported from Gajedi Lake is similar and support to the present work (Dhakal et al., 2020). The previous studies in Raja-Rani Wetland, Letang, Morang (Godar & Rai, 2018), Hasina Wetland, Sundar Haraicha, Morang (Rai & Rai, 2018), and Jagadishpur Taal, Kapilvastu (Rai & Paudel, 2019) showed that the maximum species found in the lentic water bodies in the Terai region of Nepal are of the genus *Cosmarium*, which also supports this work.

The common algae found in Barju Taal were *Dictyosphaerium pulchellum, Ankistrodesmus falcatus, Closterium dianae, Euastrum elegans, Actinotaenium subglobosum, Cosmarium quadrum, C. ralfsii, Staurodesmus unicornis, Staurastrum sonthalianum* and *S. striolatum* which were present in almost all collections. The scarcely collected algae were *Tetraedron minimum, Kirchneriella contorta, Gonatozygon monotaenium, Penium margaritaceum, Euastrum divergens* var. *ornatum, Cosmarium abbreviatum* var. *minus, C.* cf. *angulare, C. meneghinii, C. regnesi, Monomorphina pyrum, Gyrosigma acuminatum* and *Stenopterobia intermedia*. The algae, viz., *Gloeotrichia raciborskii* var. *kashiense, Melosira varians, Crucigenia crusifera* and *Eusrum spinulosm* reported from this lake previously by Rai & Rai (2012) are again reported this time.

Conclusion

The algal flora of Barju Taal is rich as it consists of 105 species of algae belonging to seven classes and 51 genera. The largest phylum was chlorophyta (72%), largest class was conjugatophyceae (54%) and largest genus was *Cosmarium* (22.85%). In comparison to the newly constructed lake, the occurrence of the species in terms of current status revealed that the algae in the old lake were abundant and diverse. The increasing human activities such as boating, swimming and picnic in and around the new lake may be one of the resons to this. Thus proper attention should be given for the conservation of Taal from the scientific point of view. Further studies are essential to document the variation of algal diversity in different seasons with respect to water quality in the Taal.

Table 4: Diatoms reported from Barju Taal

Class	Order	Family	Algae
Coscinodiscophyceae	Melosirales	Melosiraceae	1. *Melosira varians*
Bacillariophyceae	Eunotiales	Eunotiaceae	2. *Eunotia bilunaris* 3. *E. pectinalis*
	Naviculales	Naviculaceae	4. *Caloneis bacillum*
			5. *Gyrosigma acuminatum*
		Amphipleuraceae	6. *Frustulia rhomboides* var. *saxonica*
		Neidiaceae	7. *Neidium affine*
		Pinnulariaceae	8. *Pinnularia acrosphaeria* 9. *P. amabilis*
	Cymbellales	Gomphonema-taceae	10. *Gomphonema acidoclinatum* 11. *G. pseudoaugur* 12. *G. sagitta*
			13. *Encyonema silesiacum*
	Rhopalodiales	Rhopalodiaceae	14. *Rhopalodia gibba*
	Bacillariales	Bacillariaceae	15. *Nitzschia palea*
	Surirellales	Surirellaceae	16. *Stenopterobia intermedia*

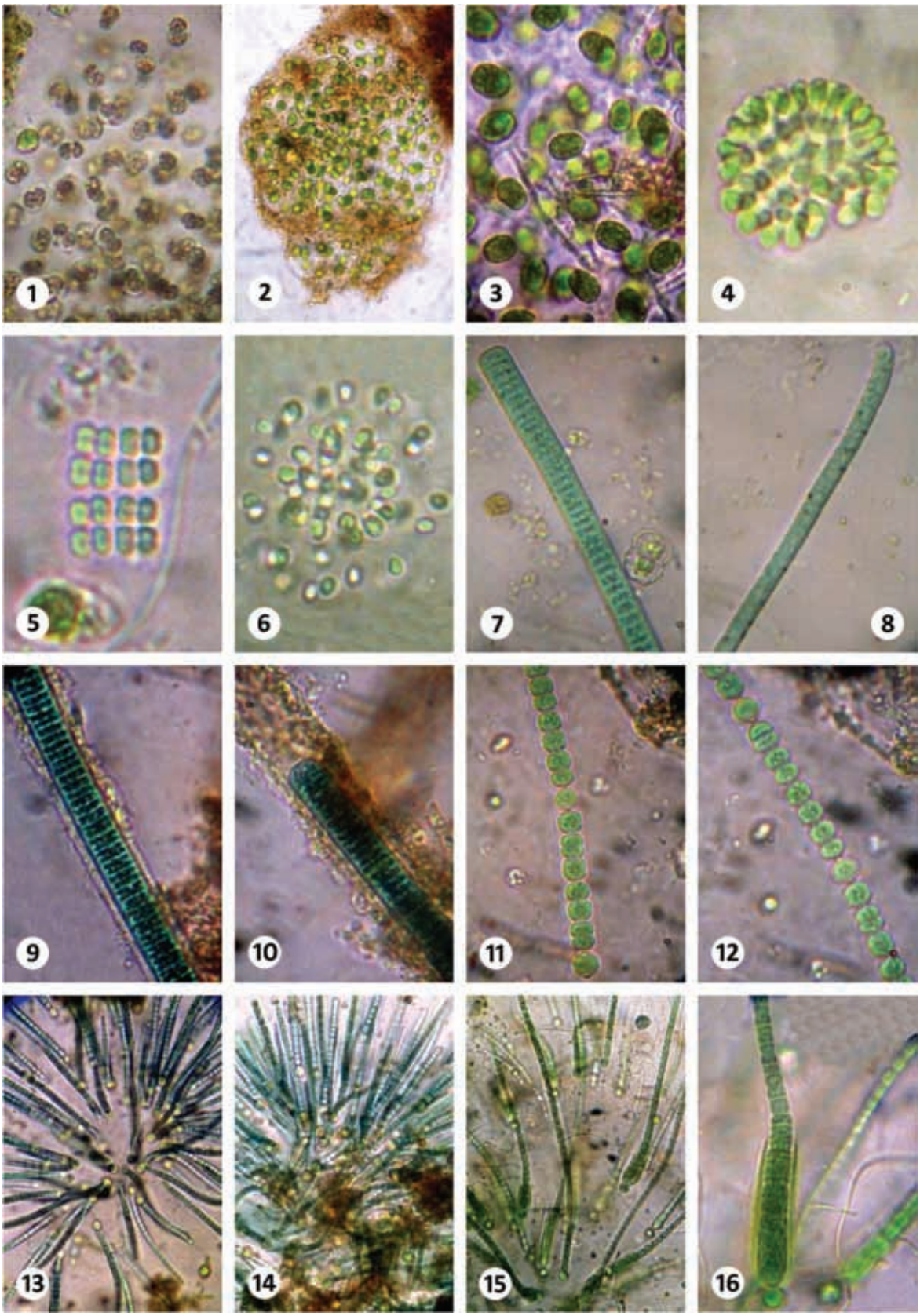

Plate 1. Figures: 1. *Microcystis aeruginosa,* **2-3.** *Aphanothece granulosa*, **4.** *Gomphosphaeria aponina,* **5.** *Merismopedia elegans*, **6.** *Snowella lacustris*, **7.** *Oscillatoria tenuis*, **8.** *Phormidium autumnale,* **9-10.** *Lyngbya hieronymusii*, **11-12.** *Anabaena affinis*, **13-14.** *Gloeotrichia echinulata*, **15-16.** *G. raciborskii* var. *kashiensis*

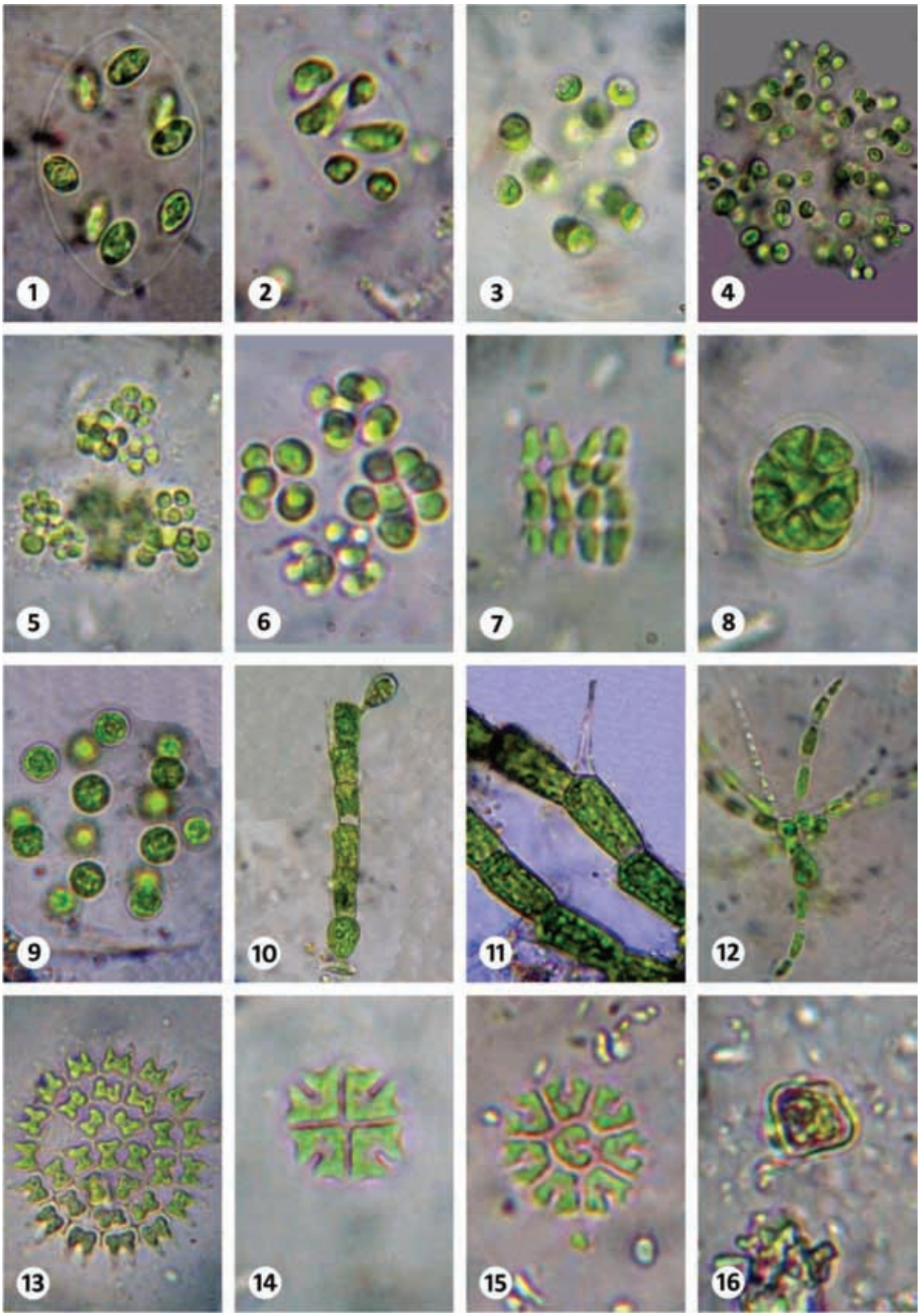

Plate 2. Figures: 1. *Oocystis lacustris,* **2.** *Nephrocytium agardhianum,* **3-4.** *Dictyosphaerium pulchellum,* **5-6.** *Botryococcus protuberans,* **7.** *Crucigenia crucifera,* **8.** *Pandorina morum,* **9.** *Eudorina elegans,* **10-11.** *Bulbochaete varians,* **12.** *Stigeoclonium fasciculare,* **13.** *Pediastrum duplex* var. *subgranulatum,* **14-15.** *P. tetras* var. *tetraodon,* **16.** *Tetraëdron minimum*

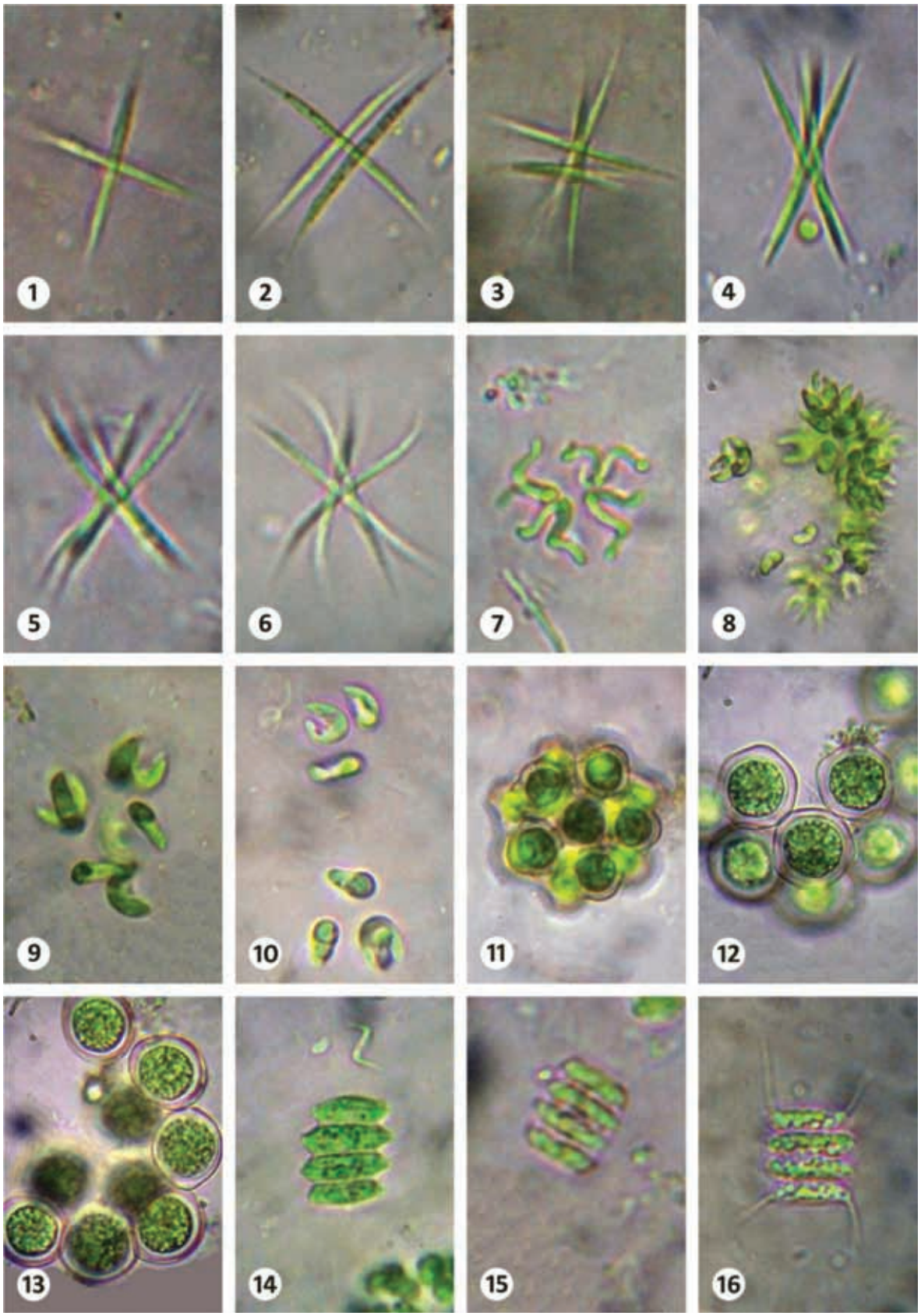

Plate 3. Figures: 1-6. *Ankistrodesmus falcatus*, **7.** *Kirchneriella contorta*, **8-10.** *K. lunaris*, **11-13.** *Coelastrum cambricum*, **14.** *Scenedesmus acutiformis*, **15.** *S. incrassatulus*, **16.** *S. tropicus*

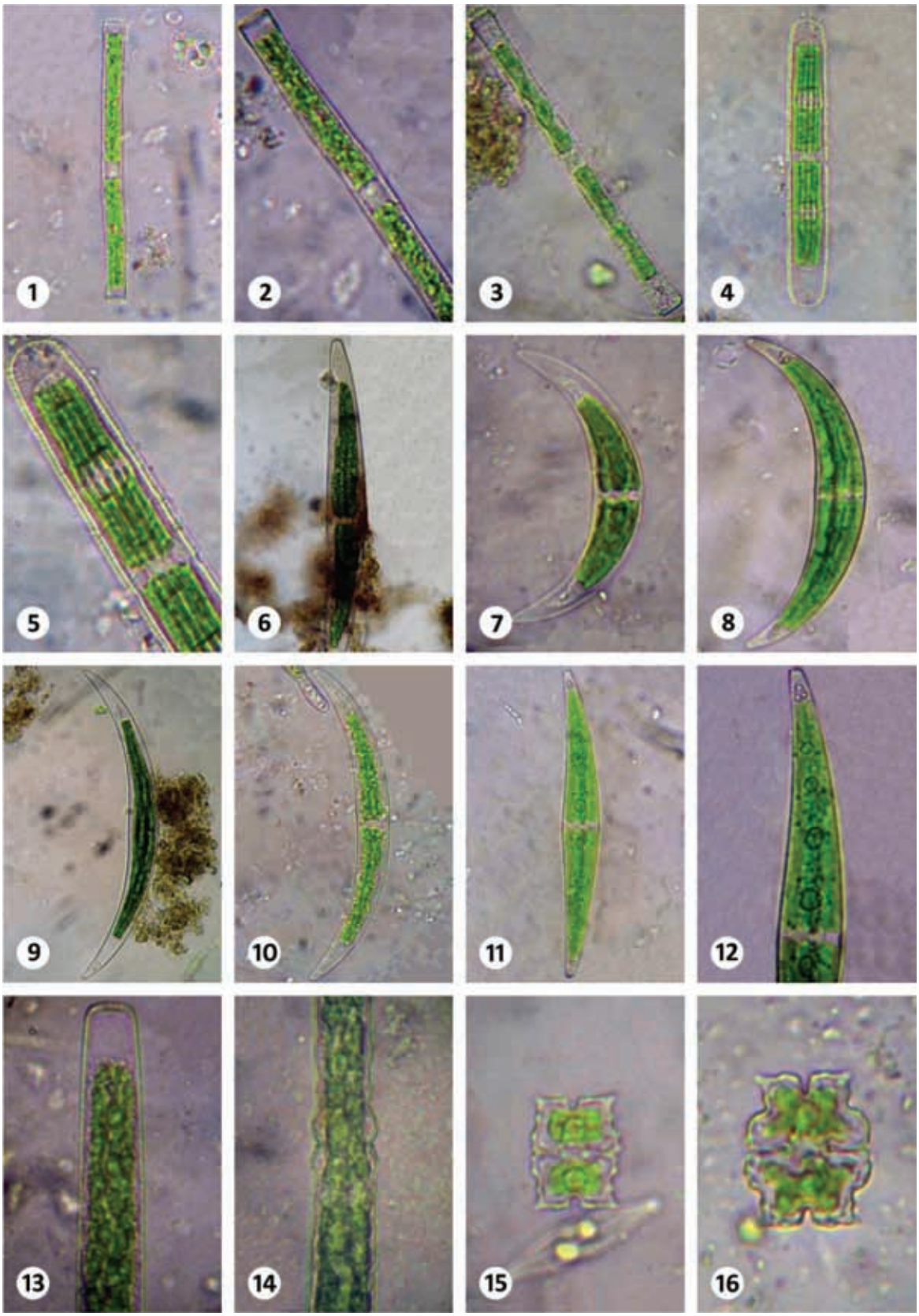

Plate 4. Figures: 1-2. *Gonatozygon monotaenium*, **3.** *G. pilosum*, **4-5.** *Penium margaritaceum*, **6.** *Closterium acerosum*, **7-10.** *C. dianae*, **11-12.** *C. striolatum*, **13-14.** *Pleurotaenium trabecula*, **15.** *Euastrum acanthophorum*, **16.** *E. denticulatum* var. *quadrifarium*

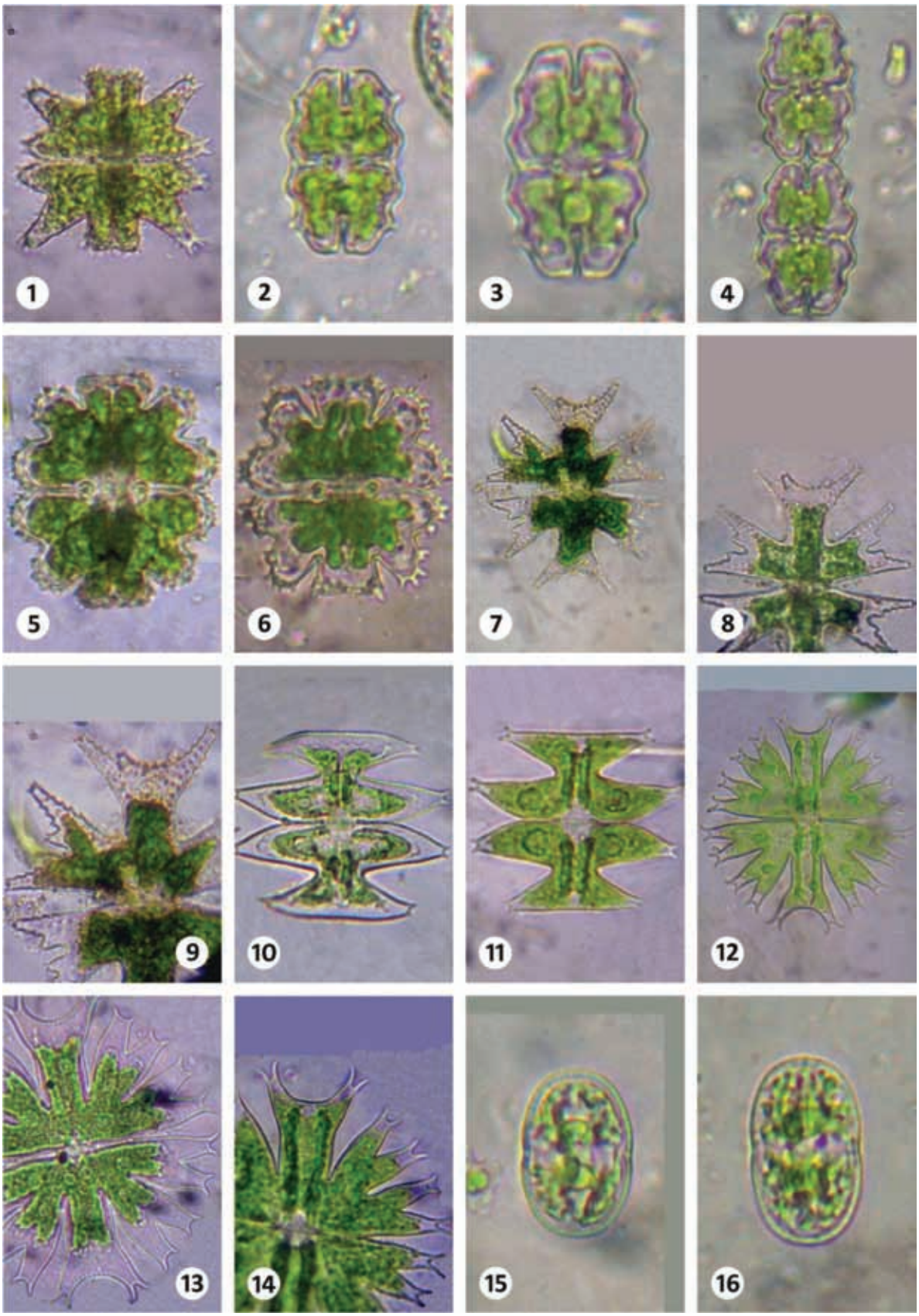

Plate 5. Figures: 1. *Euastrum divergens* var. *ornatum*, **2-4.** *E. elegans*, **5-6.** *E. spinulosum*, **7-9.** *Micrasterias mahabuleshwarensis*, **10-11.** *M. pinnatifida*, **12-14.** *M. radians*, **15-16.** *Actinotaenium subglobosum*

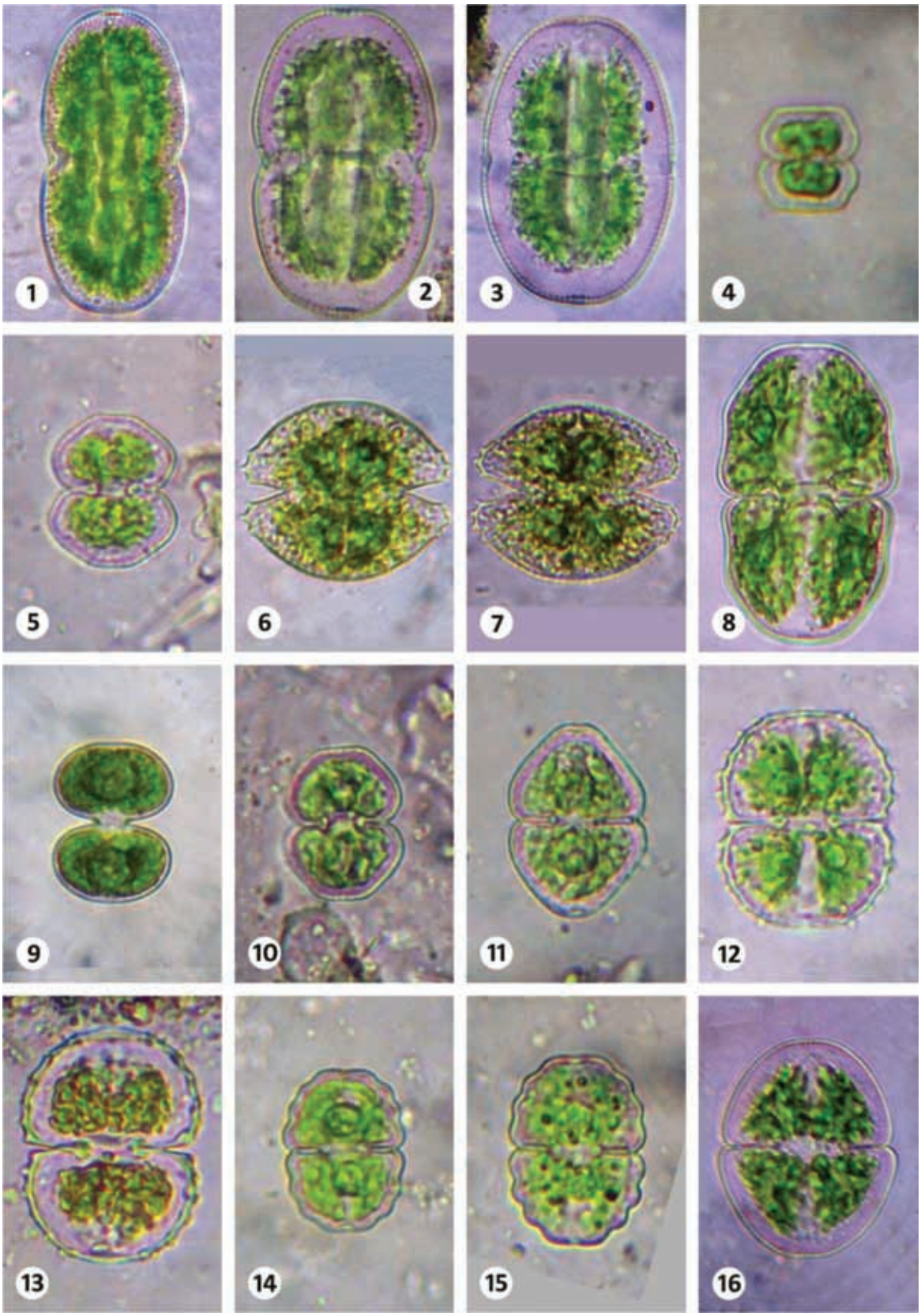

Plate 6. Figures: 1. *Actinotaenium* cf. *turgidum*, **2-3.** *A.* cf. *wollei*, **4.** *Cosmarium abbreviatum* var. *minus*, **5.** *C.* cf. *angulare*, **6-7.** *C. auriculatum*, **8.** *C. bengalense*, **9.** *C. contractum*, **10-11.** *C. granatum*, **12-13.** *C. haynaldii*, **14-15.** *C. impressulum*, **16.** *C. lundellii* var. *ellipticum*

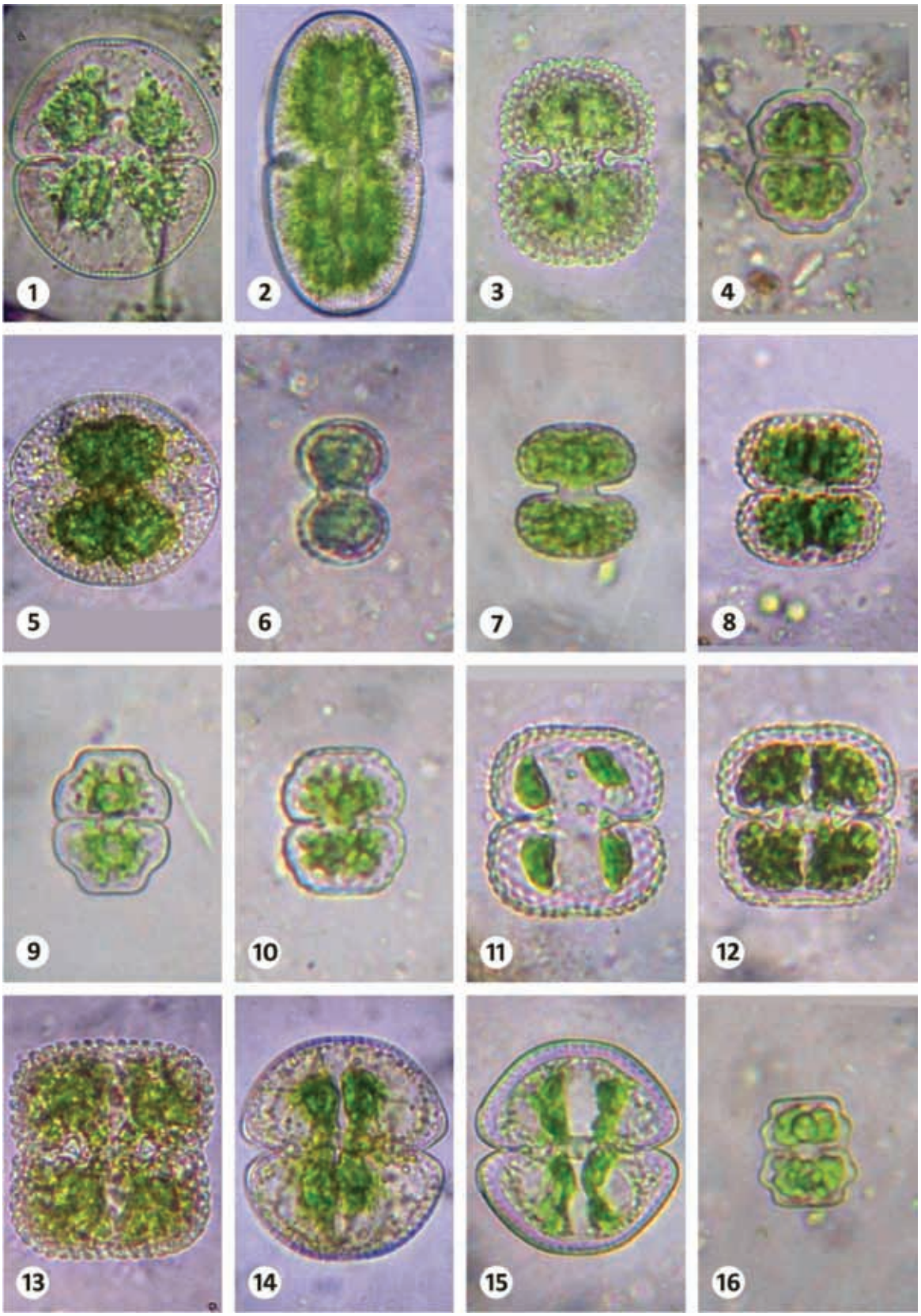

Plate 7. Figures: 1. *Cosmarium lundellii* var. *ellipticum*, **2.** *C. maculatiforme*, **3.** *C. margaritatum*, **4.** *C. meneghinii*, **5.** *C. obsoletum*, **6-7.** *C. portianum*, **8.** *C. pseudoornatum*, **9.** *C. pseudoretusum* var. *africanum*, **10.** *C. punctulatum*, **11-13.** *C. quadrum*, **14-15.** *C. ralfsii*, **16.** *C. regnellii*

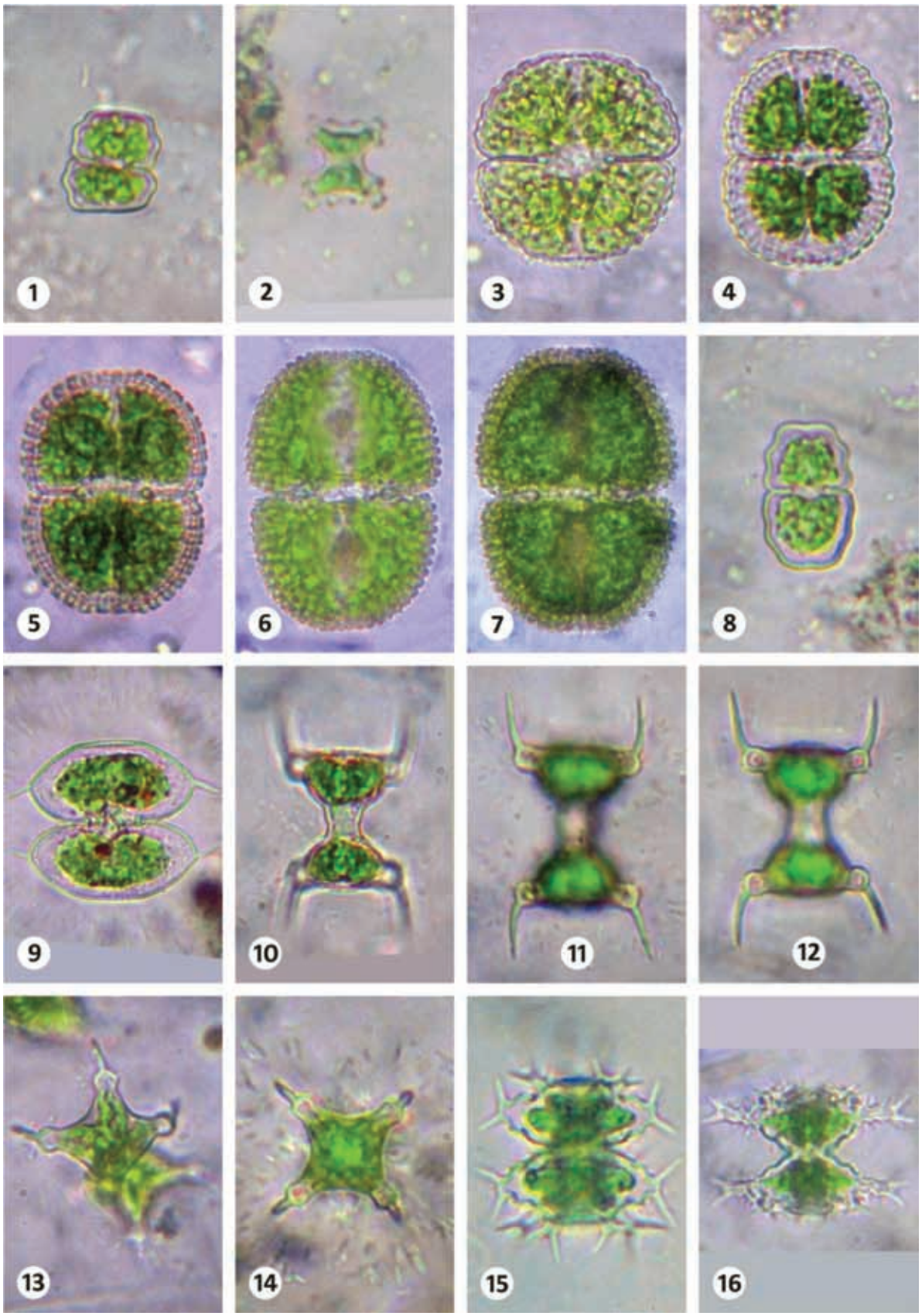

Plate 8. Figures: 1. *Cosmarium regnellii*, **2.** *C. regnesi*, **3.** *C. sublatereundatum*, **4-7.** *C. subspeciosum* var. *validius*, **8.** *C. venustum*, **9.** *Staurodesmus convergens*, **10-14.** *S. unicornis*, **15.** *Staurastrum avicula*, **16.** *S. gutwinskii* var. *evolutum*

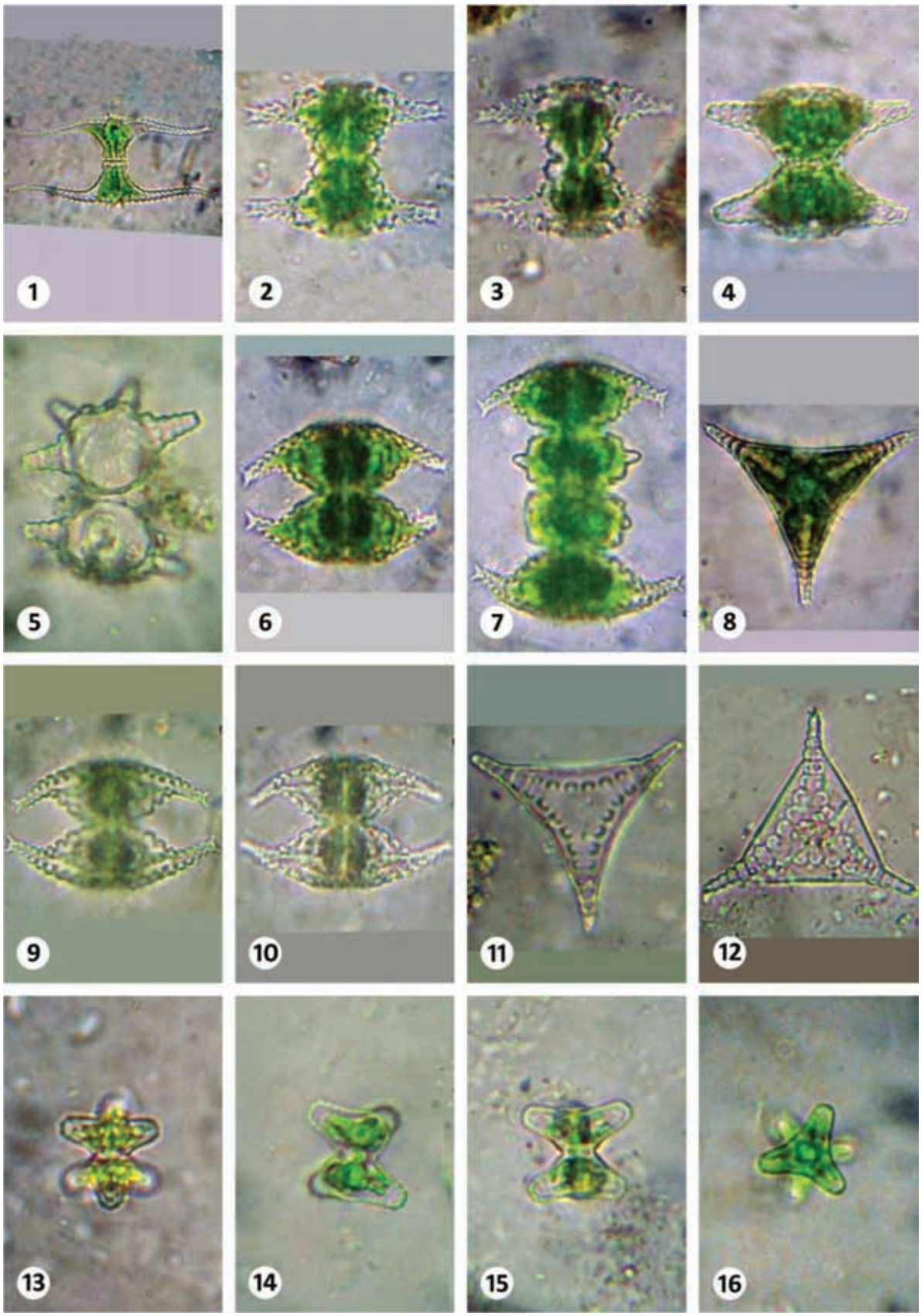

Plate 9. Figures: 1. *Staurastrum leptocladum* var. *cornutum*, **2-3.** *S. manfeldtii*, **4-5.** *S.* cf. *margaritaceum*, **6-12.** *S.sonthalianum*, **13-16.** *S. striolatum*

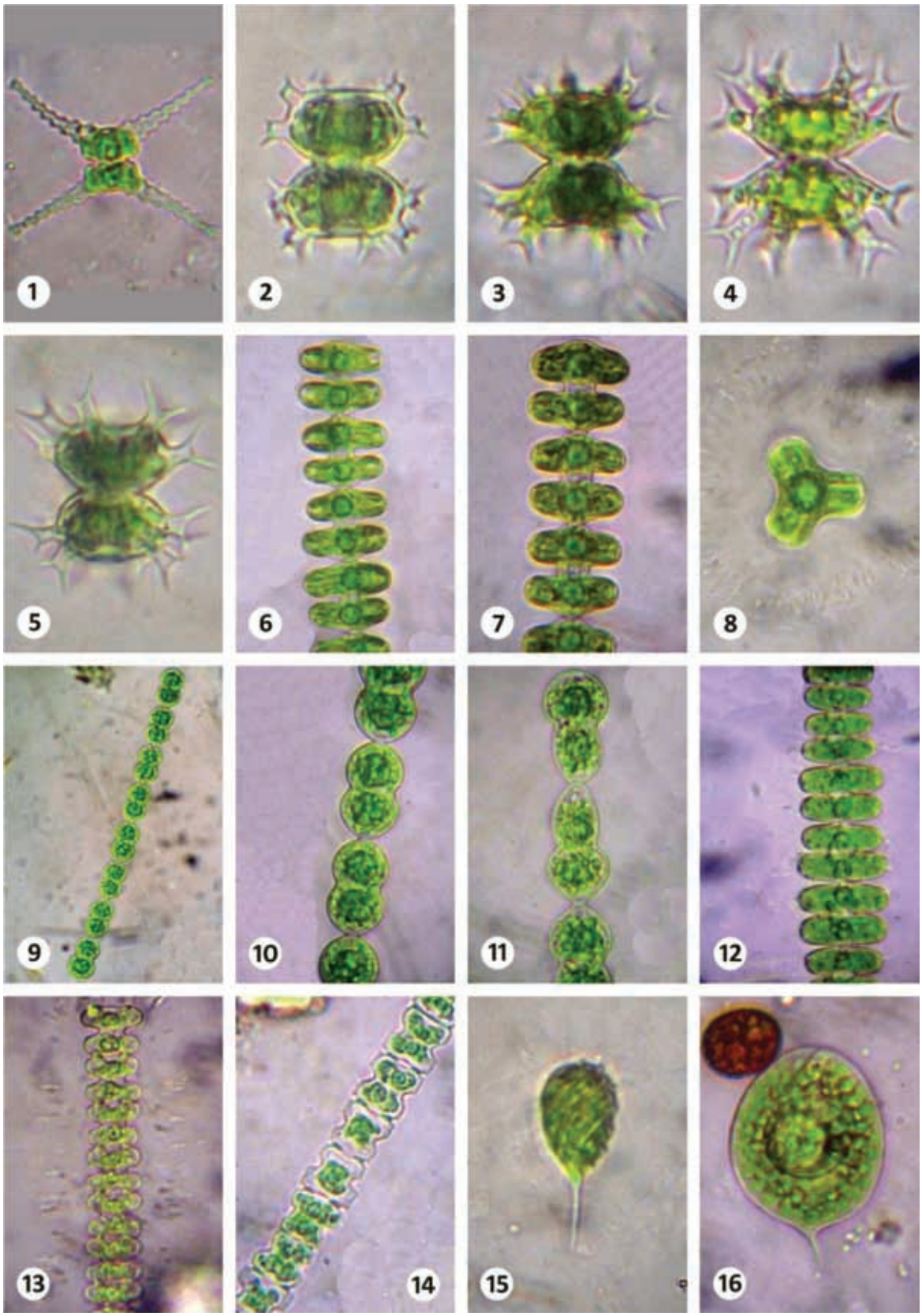

Plate 10. Figures: 1. *Staurastrum tetracerum*, **2-5.** *S. tohopekaligense* var. *tohopekaligense* f. *minus*, **6-8.** *Spondylosium nitens* var. *triangulare* f. *javanicum*, **9-11.** *S. panduriforme* var. *panduriforme* f. *limneticum*, **12.** *S. pulchrum*, **13-14.** *Teilingia granulata*, **15.** *Monomorphina pyrum*, **16.** *Phacus orbicularis*

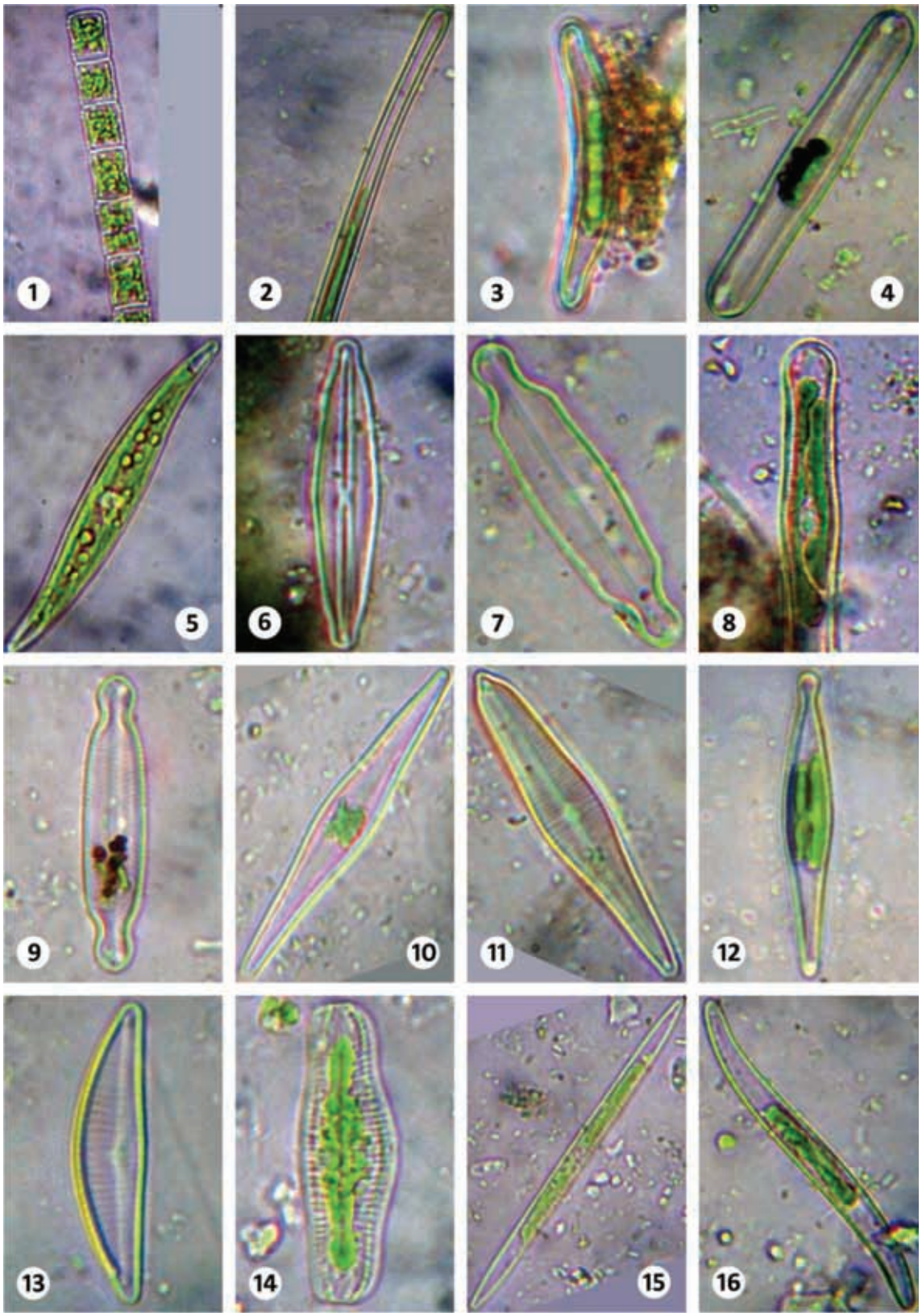

Plate 11. Figures: 1. *Melosira varians,* **2.** *Eunotia bilunaris,* **3.** *E. pectinalis,* **4.** *Caloneis bacillum,* **5.** *Gyrosigma acuminatum,* **6.** *Frustulia rhomboids* var. *saxonica,* **7.** *Neidium affine,* **8.** *Pinnularia acrosphaeria,* **9.** *P. amabilis,* **10.** *Gomphonema acidoclinatum,* **11.** *G. pseudoaugur,* **12.** *G. sagitta,* **13.** *Encyonema silesiacum,* **14.** *Rhopalodia gibba,* **15.** *Nitzschia palea,* **16.** *Stenopterobia intermedia*

Author Contributions

L. Chaudhary and S.K. Rai collected and identified algae, S.K. Rai analysed data and prepared manuscript, and N.P. Ghimire and S. Dhakal edited and reviewed the manuscript. S.K. Rai, as a corresponding author, is the guarantor for this article.

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