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Additional algae (excluding cyanobacteria) of Bagh-Jhoda wetland, Morang, Nepal

Ritu Rajopadhyaya and Shiva Kumar Rai*

Phycology Research Lab, Department of Botany, Post Graduate Campus, T.U., Biratnagar, Nepal

**E-mail: sk.khaling@gmail.com*

Abstract

In this paper, a total of 46 additional algae (excluding cyanobacteria) have been described from Bagh-Jhoda wetland, Morang. They belong to 7 classes, 13 orders, 21 families, and 28 genera. Algae were collected from 8 different peripheral localities of the wetland during winter, summer and rainy seasons, 2014. They were collected by squeezing submerged parts of macrophytes and by using plankton mesh net. *Cosmarium* was the largest genus as usual in the previous studies. The water in this wetland is maintained as it lies along the southern edge of Char-Koshe Jungle, hence harbor rich algal species.

Keywords: Bacillariophyta, charophyta, diatoms, freshwater algae

Introduction

Algae are the simplest aquatic plants capable to perform photosynthesis. They are the major producers in the aquatic food chain, upon which all biota depend directly and indirectly, and thus maintain the whole aquatic ecosystem.

Algal flora of Bagh-Jhoda wetland has been studied from time to time. Previously, 8 cyanobacteria including *Anabaena affinis* and *A. subcylindrica* as new to Nepal were described from Bagh-Jhoda wetland (Rajopadhyaya et al., 2017). Similarly, Rajopadhyaya and Rai (2016-18) have also reported 20 freshwater algae (excluding cyanobacteria) as new to Nepal from this wetland. The wetland is also a favourable place for *Chara* and freshwater red algae. The present paper endeavor to describe the additional algae from the Bagh-Jhoda wetland excluding cyanobacteria.

Materials and Methods

Study area

Bagh-Jhoda wetland (Lat. 26°40'38" N, Long. 87°23'52.3" E, Alt. ca 137m) is a natural wetland situated at Koshi Haraicha Municipality of Morang district in eastern Nepal (Fig. 1). It is elongated and more or less polygonal in shape expanding from north to south direction, covering ca 1 h area, having narrow ends on both sides and widen at the middle. The wetland lies just at the southern margin of Char-Koshe Jangal, about a few kilometers north of Khorsane.

The area has a hot and humid monsonic tropical climate. The wetland harbours many macrophytes like *Eichhornia crassipes, Pistia stratiotes, Potamogeton crispus, Hydrilla*

verticillata, *Utricularia gibba*, *Azolla* sp., *Polygonum* sp. *Blumea* sp., *Ranunculus* sp., duckweed, lotus, water fern etc. The northern side of the wetland is covered by dense *Shorea robust* forest of Char-Koshe Jangal. The wetland is popular for turtle habitat.

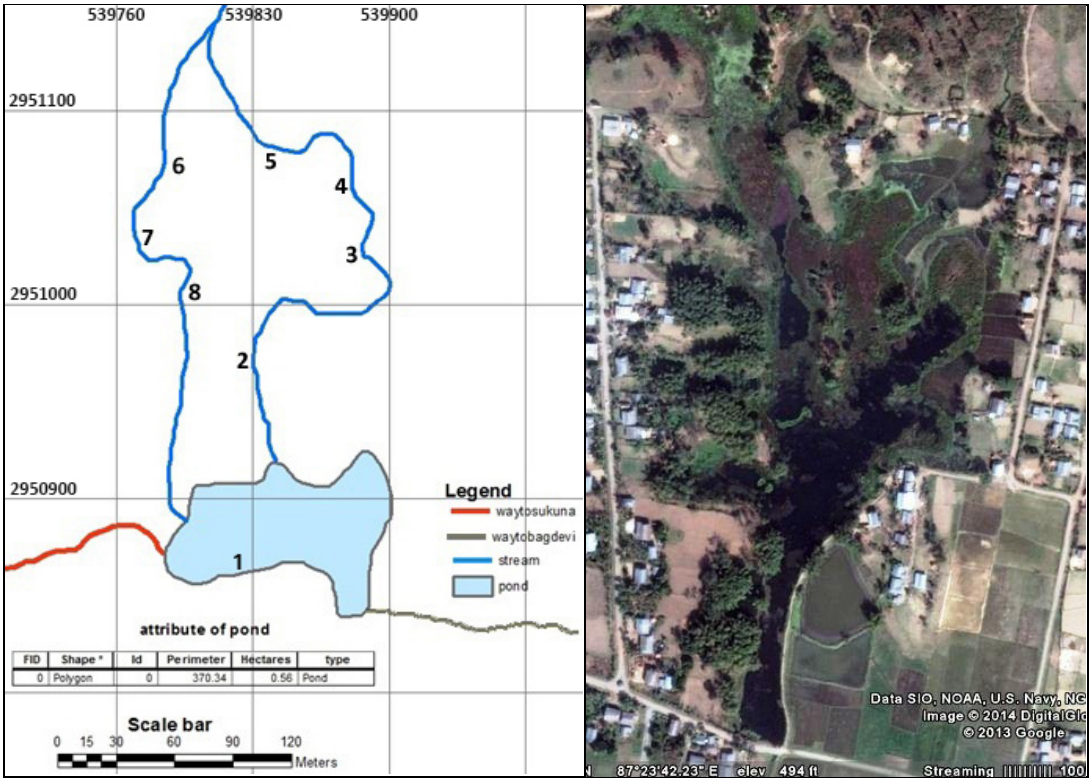


Figure 1. Bagh-Jhoda wetland showing algae sampling sites (1 to 8).

Algae collection and identification

Algal samples were collected from eight different sites in the periphery of the Bagh-Jhoda wetland (Table 1) in three different seasons, viz., winter, summer, and rainy in 2014. Planktonic forms were collected by using a plankton net (mesh size 10 µm) and epiphytic forms were by squeezing submerged parts of macrophytes specially of *Eichornia, Pistia, Hydrilla, Polygonum*, etc. They were preserved in 4% formaldehyde solution and labeling and tagging were done properly.

The latitude, longitude, and altitude were measured for every spot with the help of GPS Garmin etrex. Water temperature was measured with the help of a laboratory thermometer and pH with the help of pH meter and pH stripe paper. Information regarding collection and habitats was noted in the field diary. Photogtaphs of collection sites were taken with the help of Canon Powershot digital camera.

The temporary slides for each sample were prepared in glycerin mount (Sharma, 1992) and observed under a light microscope. Microphotography was done for each taxa under 40X and 100X objectives using Olympus Ch20i microscope and Canon Digital Power Shot

Camera. Taxa were identified consulting various articles, literatures and monographs. All the collected materials and slides have been deposited in the Phycology Research Lab, Department of Botany, P.G. Campus, Biratnagar.

Table 1. Sampling sites of Bagh-Jhoda wetland with water parameters.

Sites	Latitude	Longitude	Altitude	Water pH	Water Temperature (°C)		
					Winter	Summer	Rainy
1	26°40.487'N	087°23.809'	132m	7	20	27	31
2	26°40.558'N	087°23.857'	135m	7	18	27	32
3	26°40.637'N	087°23.886'	143m	6	21.5	28	32
4	26°40.681'N	087°23.841'	136m	6	22	29	31
5	26°40.725'N	087°23.832'	133m	7	23	28.5	34
6	26°40.704'N	087°23.811'	136m	6	23	31	34
7	26°40.663'N	087°23.826'	132m	6	23	26	32
8	26°40.647'N	087°23.834'	130m	7	23	28	32

Results and Discussion

Taxonomic Description

A total 46 additional algae (excluding cyanobacteria) belonging to 7 classes, 13 orders, 21 families, and 28 genera were reported from eight different sites of Bagh-Jhoda wetland, Morang (Table 2).

Table 2. Additional algae reported from Bagh-Jhoda wetland.

Phylum	Class	Order	Family	Algae
Chlorophyta	Chloro phyceae	Chlamydomonadales	Volvocaceae	1. *Pandorina morum*
		Sphaeropleales	Hydrodictyaceae	2. *Pediastrum tetras* var. *tetraodon*
			Selenastracea	3. *Kirchneriella lunaris*
			Scenedesmaceae	4. *Dimorphococcus lunatus*
				5. *Coelastrum cambricum*
				6. *C. proboscideum*
				7. *Scenedesmus acutiformis*
				8. *S. arcuatus*
				9. *S. bijuga* var. *alternans*
				10. *S. bijugatus* var. *graevenitzii*
			Cylindrocapsaceae	11. *Cylindrocapsa conferta*
		Chaetophorales	Chaetophoraceae	12. *Stigeoclonium farctum*
		Oedogoniales	Oedogoniaceae	13. *Oedogonium* sp.
	Trebouxio phyceae	Chlorellales	Oocystaceae	14. *Gloeotaenium loitlesbergerianum*
			Nephrocytiaceae	15. *Nephrocytium lunatum*
			Chlorellaceae	16. *Dictyosphaerium pulchellum*
Glauco phyta	Glauco phyceae	Glaucocystales	Glaucocystaceae	17. *Glaucocystis nostochinearum*

Charophyta	Zygnemato phyceae	Zygnematales	Zygnemataceae	18. *Mougeotia* sp.
				19. *Spirogyra* sp.
		Desmidiales	Closteriaceae	20. *Closterium dianae*
				21. *C. setaceum*
				22. *C. striolatum*
			Desmidiaceae	23. *Pleurotaenium trabecula*
				24. *Euastrum bidentatum*
				25. *Micrasterias pinnatifida*
				26. *M. radians*
				27. *M. tropica*
				28. *Cosmarium bipunctatum*
				29. *C. granatum*
				30. *C. lundellii*
				31. *C. maculatiforme*
				32. *C. pyramidatum*
				33. *C. quadrum*
				34. *C. regnellii*
				35. *C. sublateriundatum*
				36. *Staurastrum orbiculare*
Eugle nozoa	Eugleno phyceae	Euglenida	Phacidae	37. *Phacus birgei*
				38. *P. helikoides*
			Euglenidae	39. *Trachelomonas hispida* var. *coronata*
				40. *T.* cf. *kelloggii*
Bacillariophyta	Mediophyceae	Stephanodiscales	Stephanodiscaceae	41. *Cyclotella meneghiniana*
	Bacillario phyceae	Licmophorales	Ulnariaceae	42. *Ulnaria acus*
		Naviculales	Naviculaceae	43. *Navicula perrotetti*
			Pinnulariaceae	44. *Pinnularia acrospheria*
				45. *P. conica*
		Rhopalodiales	Rhopalodiaeae	46. *Rhopalodia gibba*

Phylum: Chlorophyta
Class: Chlorophyceae
Order: Chlamydomonadales
Family: Volvocaceae
Genus: ***Pandorina*** Bory (1826)

1. ***Pandorina morum*** (Müller) Bory (Fig. 2)
Prescott 1951, P. 75, Pl. 1, Fig. 23; Tiffany & Britton 1952, P. 16, Pl. 1, Fig. 13.
Colony usually distinctly ovate, 220µm in diameter; Cells pyriform, crowded, usually 16 in number, cells 12-17µm long, 10-15µm broad.
Collection no. & date: BJW 1; 2014.02.18
Distribution in Nepal: On the soil of a paddy field at Nagarkot, 1400m, Bhaktapur (Nozaki, 1988).

Order: Sphaeropleales
Family: Hydrodictyaceae
Genus: ***Pediastrum*** Meyen (1829)

2. ***Pediastrum tetras*** var. ***tetraodon*** (Corda) Hansgirg [*Stauridium tetras* var. *tetraodon* (Corda) Hall et Karol (2016)] (Fig. 3)
Prescott 1951, P. 227, Pl. 50, Fig. 7; Tiffany & Britton 1952, P. 112, Pl. 30, Fig. 294; Philipose 1967, p. 129, Fig. 45; Prasad & Misra 1992, P. 12, Pl. 1, Figs. 7, 10.
Colony composed of 4-8 celled, outer margin of peripheral cells with deep incisions; Cells 16-18µm long, 12-15µm broad.
Collection no. & date: BJW 6; 2014.05.04
Distribution in Nepal: Pond at Luitel Bhanjyang, Ankhu Khola, Gorkha (Hirano, 1955).

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

3. ***Kirchneriella lunaris*** (Kirchner) Möbius (Fig. 4)
Prescott 1951, P. 258, Pl. 58, Fig. 2; Philipose, 1967, P. 222, Fig. 131.
Colony composed of numerous cells arranged in groups of 4-16 within a close, gelatinous envelope, colonies 100-250µm in diameter; Cells flat, strongly curved, crescents with rather obtuse points, cells 6.5-13µm long, 3-5µm broad.
Collection no. & date: BJW 8; 2014.05.04
Distribution in Nepal: Pond at Tahachal, 1300m, Kathmandu (Hirano, 1963; Hickel, 1973); Pond near Indo-Nepal border, Mahendranagar, Kanchanpur (Chaturvedi & Habib, 1996).

Family: Scenedesmaceae
Genus: ***Dimorphococcus*** Braun (1855)

4. ***Dimorphococcus lunatus*** Braun (Fig. 5)
Prescott 1951, P. 252, Pl. 55, Fig. 8; Philipose 1967, P. 205, Figs. 115-117.
Cells in groups of 4, at the ends of fine, branched threads composed of the fragments of the mother cell wall, two inner cells are ovate or subcylindric and two outer cells are cordate, cells 10-25µm long, 4-15µm broad.
Collection no. & date: BJW 2; 2014.05.04
Distribution in Nepal: Pond at MMAM Campus, 72 m, Biratnagar, Morang (Rai, 2006).

Genus: ***Coelastrum*** Nägeli (1849)

5. ***Coelastrum cambricum*** Archer (Fig. 6)
Prescott 1951, P. 229, Pl. 53, Fig. 2; Philipose 1967, P. 231, Fig. 138b; Prasad & Misra 1992, P. 30, Pl. 4, Fig. 5
Coenobium spherical, usually composed of 32 globose cells, but number of cell ranges from 8 to 128, each cell adjoined to neighboring cells by 6 broad, short projections of the sheath leaving triangular intercellular spaces; outer free wall of the cells with a flattened, truncate projections, cells 10-20 µm in diameter.
Collection no. & date: BJW 7; 2014.02.18
Distribution in Nepal: Variety *intermedium* reported from Titrigachi pond, 206 m, Koshi Tappu, Kusaha, Sunsari (Rai, 2006).

6. ***Coelastrum proboscideum*** Bohlin (Fig. 7)
Prescott 1951, P. 230, Pl. 53, Figs. 4, 5, 8; Prasad & Misra 1992, P. 31, Pl. 4, Fig. 7
Coenobium pyramidal or cubical, rarely polygonal, composed of 4-8-16-32 truncate cone-

shaped cells with the apex of the cone directed outward, the lower lateral walls of the cells adjoined about a large space in the center of the colony, four celled colony is about 35µm in diameter; Cells 8-15µm in diameter.
Collection no. & date: BJW 8; 2014.02.18
Distribution in Nepal: Birat Pokhari, 140 m, Anarmani, Jhapa (Rai, 2006).

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

7. ***Scenedesmus acutiformis*** Schröder [*Acutodesmus acutiformis* (Schröder) Tsarenko et John] (Figs. 8-9)
Prescott 1951, P. 275, Pl. 62, Figs. 6-7; Tiffany & Britton 1952, P.123, Pl. 35, Fig. 356; Prasad & Misra 1992, P.33-34, Pl. 5, Fig. 11.
Cells arranged in a single series of 4 (2-8); Cells fusiform-elliptic, with sharply pointed poles, outer cells with 2-4 longitudinal ridges, cells 16-22.5 µm long, 7-8 µm broad.
Collection no. & date: BJW 3; 2014.02.18
Distribution in Nepal: Godawari pond, Lalitpur (Nakano & Watanabe, 1988); Kara river, Hetauda (Sahay *et al*., 1993); Maipokhari, Ilam (Rai, 2009).

8. ***Scenedesmus arcuatus*** Lemm. (Lemm.) [*Comasiella arcuata* (Lemm.) Hegewald *et al*.] (Fig. 10)
Prescott 1951, P. 275, Pl. 62, Fig. 8.
Cell arranged to form a curved series of 4-16 oblong-ovate individuals with lateral walls; Cell wall without spines or teeth and cell with broadly rounded poles, cells 10-15-(17) µm long, 4-8-(9) µm broad.
Collection no. & date: BJW 6; 2014.02.18
Distribution in Nepal: Titrigachi pond, Koshi Tappu, 206m, Kusaha, Sunsari (Rai, 2006).

9. ***Scenedesmus bijuga*** var. ***alternans*** Hansgirg (Fig. 11)
Prescott 1951, P. 277, Pl. 63, Figs. 3, 4; Philipose 1967, P. 254, Fig. 164g; Prasad & Misra 1992, P. 36, Pl. 5, Fig. 8.
Cells ovate or elliptic, regularly arranged in two alternating series, cells 7-16µm long, 4-8µm broad.
Collection no. & date: BJW 7; 2014.05.04
Distribution in Nepal: Phewa, Rupa, and Begnas lakes, 967m, Kaski (Nakanishi, 1986).

10. ***Scenedesmus bijugatus*** var. ***graevenitzii*** (Bernard) Chodat [*Steinedesmus graevenitzii* (Bernard) Comas et Komarek] (Fig. 12)
Philipose 1967, P. 254, Figs. 164 a, b.
Colonies composed of 4 to 8 cells, arranged in alternate series with adjacent cells in contact only along a short portion of their length; Cells fusiform, ellipsoid, oblong-ellipsoid to ovoid, without teeth and spines and with obtuse apices, cells 11-16 µm long, 4.5-6.5 µm broad.
Collection no. & date: BJW 1; 2014.05.04
Distribution in Nepal: Triyuga river, 152m, Gaighat, Udayapur; Koshi Tappu Wildlife Reserve, Sunsari (Rai, 2013).

Family: Cylindrocapsaceae
Genus: ***Cylindrocapsa*** Reinsch (1867)

11. ***Cylindrocapsa conferta*** West (Fig. 13)
Prescott 1951, P. 110, Pl. 9, Figs. 5, 6.
Cells short, quadrate or quadrangular-ovate, enclosed by a wide sheath of lamellate mucilage, cells 20-26 µm long, 14-29 µm broad.
Collection no. & date: BJW 7; 2014.05.04
Distribution in Nepal: Maipokhari, 2150m, Ilam (Rai, 2009).

Order: Chaetophorales
Family: Chaetophoraceae
Genus: ***Stigeoclonium*** Kützing (1843)

12. ***Stigeoclonium farctum*** Berthold (Fig. 14)
Prasad & Misra 1992, P. 61, Pl. 9, Figs. 8-10.
Thallus attached to the substratum, with cushion-like prostrate system and erect filaments; Prostrate system more or less angular, compact and nearly isodiametric cells, cells 8-11 µm long, 7.5-9 µm broad; Erect filaments develop from basal cells, slightly constricted at septa, with cylindrical to somewhat barrel-shaped cells, apices usually blunt, rarely ending into a long pointed hair, cells 11-15 µm long, 8-10.5 µm broad.
Collection no. & date: BJW 8; 2014.02.18
Distribution in Nepal: Koshi River, 206m, Kusaha, Sunsari (Kargupta & Jha, 1997)

Order: Oedogoniales
Family: Oedogoniaceae
Genus: ***Oedogonium*** Link ex Hirn (1900)

13. ***Oedogonium*** sp. Link (Fig. 15)
Prasad & Misra 1992, P. 66; Tiffany & Britton 1952, P. 37.
Collection no. & date: BJW 8; 2014.02.18

Class: Trebouxiophyceae
Order: Chlorellales
Family: Oocystaceae
Genus: ***Gloeotaenium*** Hansgirg (1890)

14. ***Gloeotaenium loitlesbergerianum*** Hansgirg (Fig. 16)
Prescott 1951, P. 248, Pl. 54, Figs. 13, 14; Philipose 1967, P. 178, Fig. 88.
Colony free-floating, spherical or quadrangular-ovate composed of 2-8 cells, compactly and cruciately arranged in a persistent mother cell wall, eight celled colony up to 80 µm long, 70 µm broad; Cells globose or ellipsoid, cells 18-25-(30) µm in diameter.
Collection no. & date: BJW 1; 2014.02.18
Distribution in Nepal: Mechi Campus pond, 93m, Bhadrapur, Jhapa (Rai, 2006).

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

15. ***Nephrocytium lunatum*** West (Fig. 17)
Tiffany & Britton 1952, P. 116, Pl. 32, Fig. 316; Prescott 1951, P. 249, Pl. 54, Fig. 19; Philipose 1967, P. 189, Fig. 103.
Colony ovate, composed of 4-8 lunate, bluntly-pointed cells inclosed by a thin, hyaline membrane, cells arranged in such a way that their concave wall is directed toward the center of the colony; Cells 14-18 µm long, 4-5 µm in diameter.
Collection no. & date: BJW 2; 2014.05.04
Distribution in Nepal: Pond at Pisang, Manang (Hirano, 1955)

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

16. ***Dictyosphaerium pulchellum*** Wood [*Mucidosphaerium pulchellum* (Wood) Bock *et al.*] (Figs. 18-19)
Prescott 1951, P. 238, Pl. 51, Figs. 5, 7; Philipose, 1967, P. 199, Fig. 110.
Colony spherical or ovoid, composed of many as 32 spherical cells arranged in series of 4 on dichotomously branched threads, inclosed in mucilage; Cells 3-10 µm in diameter.
Collection no. & date: BJW 4; 2014.02.18
Distribution in Nepal: Phewa, Rupa, and Begnas Lakes, 967m, Kaski (Nakanishi, 1986).

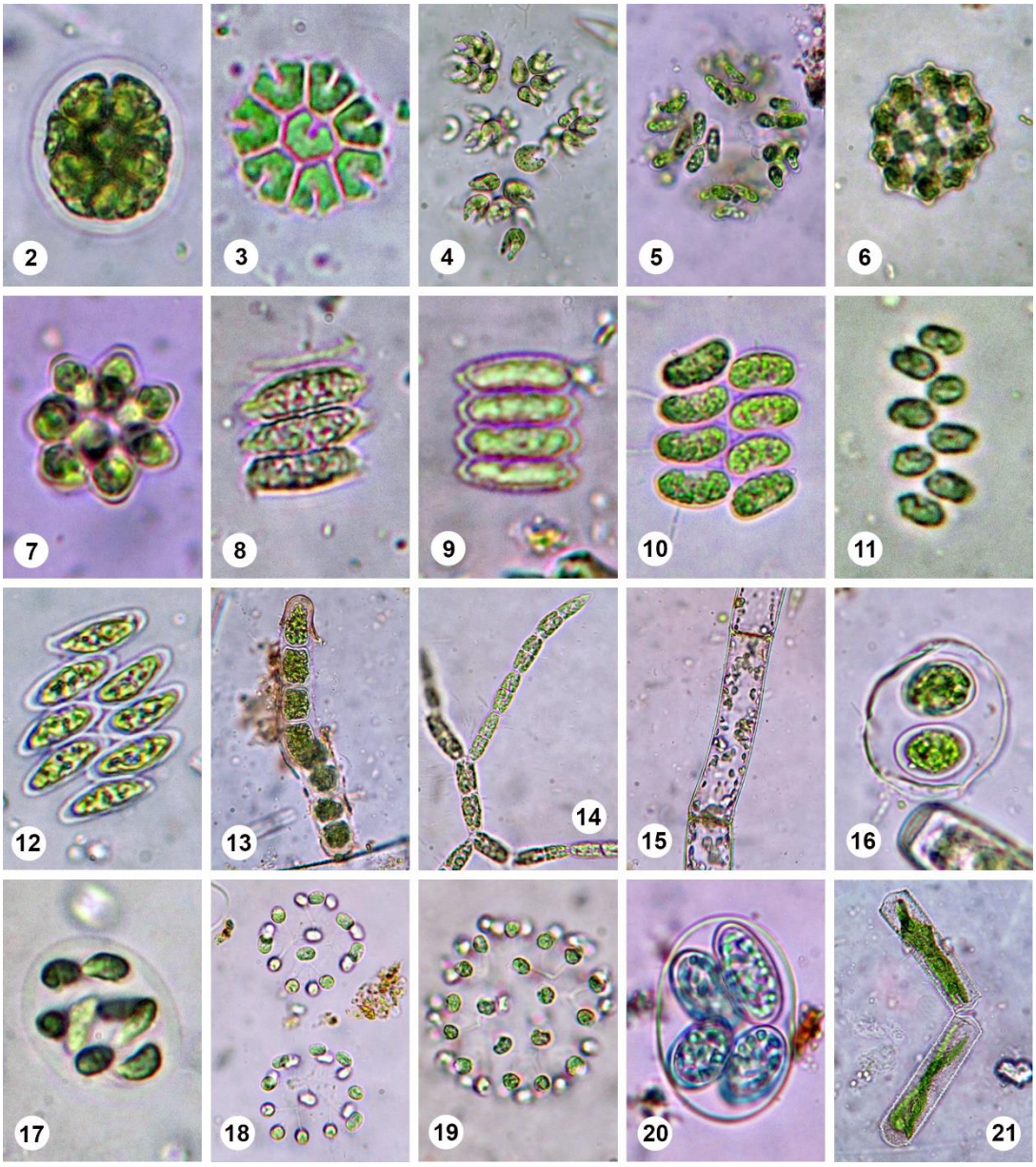
Phylum: Glaucophyta
Class: Glaucophyceae
Order: Glaucocystales
Family: Glaucocystaceae
Genus: ***Glaucocystis*** Itzigzohn (1866)

17. ***Glaucocystis nostochinearum*** Itzigsohn (Fig. 20)
Prescott 1951, P. 474, Pl. 108, Fig. 2; Philipose 1967, P. 188, Fig. 101, 102; Prasad & Misra 1992, P. 21, Pl.2, Figs. 9, 13.
Colony free-floating composed of 4-8 elliptical cells enclosed by an old mother cell wall, four-celled colony up to 50 µm long; Chromatophores axial and stellate in arrangement, bright blue-green; Cells 18-23.4-(28) µm long, 10-18 µm broad.
Collection no. & date: BJW 1; 2014.02.18
Distribution in Nepal: MMAM Campus pond and Birendra Sabha Griha pond, 72 m, Biratnagar, Morang; Titrigachi pond, 206 m, Koshi Tappu, Kusaha, Sunsari (Rai, 2006)

Phylum: Charophyta
Class: Zygnematophyceae
Order: Zygnematales
Family: Zygnemataceae
Genus: ***Mougeotia*** Agardh (1824)

18. ***Mougeotia*** sp. (Fig. 21)
Prescott 1951, P. 297; Tiffany & Britton 1952, P. 126.
Filaments with cylindrical cells without basal-distal differentiation, forming entangled cottony masses, floating or caught among aquatic plants; Conjugation usually scalariform, zygospore in the tube between the gametangia; Cells 200-250 µm long, 35 µm broad.

Collection no. & date: BJW 3; 2014.02.18
Distribution in Nepal: *Mougeotia viridis* reported from Sundarijal, 1500m, Kathmandu (Shrestha & Manandhar, 1983).



Figures: 2. *Pandorina morum* 3. *Pediastrum tetras* var. *tetraodon* 4. *Kirchneriella lunaris* 5. *Dimorphococcus lunatus* 6. *Coelastrum cambricum* 7. *C. proboscideum* 8-9. *Scenedesmus acutiformis* 10. *S. arcuatus* 11. *S. bijuga* var. *alternans* 12. *S. bijugatus* var. *graevenitzii* 13. *Cylindrocapsa conferta* 14. *Stigeoclonium farctum* 15. *Oedogonium* sp. 16. *Gloeotaenium loitlesbergerianum* 17. *Nephrocytium lunatum* 18-19. *Dictyosphaerium pulchellum* 20. *Glaucocystis nostochinearum* 21. *Mougeotia* sp.

Genus: ***Spirogyra*** Link (1820)

19. ***Spirogyra*** sp. Link (Fig. 22)
Prescott 1951, P. 307, Tiffany & Brittton 1952, P. 144.
Filaments long, unbranched, usually without basal-distal differentiation; Chloroplast 1-16 per cell, parietal band or ribbon, spirally twisted ½ to 3 (rarely 8) turns; Conjugation is either lateral or scalariform, usually by the formation of tubes, rarely by geniculate bendings of the filament so that conjugation cells are brought into juxaposition.
Collection no. & date: BJW 4; 2014.02.18
Distribution in Nepal: *Spirogyra communis* reported from Koshi River, Bhantabari, 162m, Sunsari (Rai & Mishra, 2007).

Order: Desmidiales
Family: Closteriaceae
Genus: ***Closterium*** Nitzsch ex Ralfs (1848)

20. ***Closterium dianae*** Ehrenberg ex Ralfs (Figs. 23-24)
Tiffany & Britton 1952, P. 169, Pl. 52, Fig. 548; Prasad & Misra 1992, P. 105, Pl. 16, Fig. 7; Rai & Misra 2008, P. 49, Pl. 2, Fig. 5'
Outer margins curved with 108° arc, inner slightly tumid or inflated in the middle, gradually tapering towards the obtusely rounded ends; Cell walls smooth; Chloroplast 3-4 ridged with 6-8 pyrenoids in a median series in each semi-cell; Cells 330µm long, 26.5µm broad; Apices 2-3µm.
Collection no. & date: BJW 5; 2014.05.04
Distribution in Nepal: Variety *dianae* reported from Begnas Lake, 960m, Kaski (Watanabe, 1982); Rice field, Hetauda, 500m, Makawanpur (Watanabe 1982); Koshi Barrage resorvoir, 206m, Sunsari (Rai & Mishra, 2008); Bees-hazar Lake, 286m, Tikauli, Chitwan (Rai *et al*., 2008).

21. ***Closterium setaceum*** Ehrenberg ex Ralfs (Figs. 25-26)
Scott & Prescott 1961, P. 13, Pl. 1, Fig. 21; Kouwets 1987, P. 207, Pl. 5, Figs. 2, 3; Rai & Misra 2008, P. 50, Pl. 1, Fig. 10.
Cells almost straight, median part fusiform-lanceolate with convex margins, tapering into long setaceous processes with rounded ends, apices 2-3µm broad; Cell wall longitudinally striated; Chloroplast with 4-5 pyrenoids in a median series.
Collection no. & date: BJW 3; 2014.07.23
Distribution in Nepal: A pond at Dillibazar, 1300m, Kathmandu (Hirano, 1963); Rara Lake, 3030m, Mugu (Watanabe, 1995); Koshi Barrage reservoir, 206m, Sunsari (Rai & Misra, 2008).

22. ***Closterium striolatum*** Ehrenberg ex Ralfs (Fig. 27)
Rai 2009, P. 4, Fig. 3; Kouwets 1987, P. 207, Pl. 32: 7-11.
Cells moderately curved, outer margin convex, 36-69° arc, inner margin concave or sometimes mediately straight, gradually attenuated towards broad, rounded to truncate ends; Cells moderately curved, generally 8-12 times longer than broad, 215µm long, 23µm broad; Cell wall yellowish or yellowish-brown with a median girdle; Chloroplast with 5-6 ridges, with 5-7 pyrenoids in a median series.

Collection no. & date: BJW 8; 2014.05.04
Distribution in Nepal: Variety *striolatum* reported from Maipokhari Lake, 2150m, Ilam (Rai, 2009).

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

23. ***Pleurotaenium trabecula*** Nägeli (Figs. 28-29)
Scott & Prescott 1961, P. 18, Pl. 3, Fig. 4; Prasad & Misra 1992, P. 130, Pl. 18, Fig. 13.
Cells medium-sized, more or less straight, 11-12 times longer than broad, 261-275 µm long; Semicells with more or less straight lateral margins, gradually attenuated to rotundo-truncate apices without tubercles; Cell wall smooth.
Collection no. & date: BJW 8; 2014.05.04
Distribution in Nepal: Pond at Ankhu Khola, Luitel Bhanjyang, Gorkha; Pisang, Manang (Hirano, 1955).

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

24. ***Euastrum bidentatum*** Nägeli (Fig. 30)
Capdevielle & Coute' 1980, P. 880, Pl. 2, Fig. 20; Rai & Misra 2008, P. 49, Pl. 2, Fig. 4.
Cells deeply constricted, sinus slightly dilated at the extremity; Semi-cells 3-lobed; Polar lobe with deep median incision, apical angles with a short spine; Lateral lobes bilated, marginal spines not distinct; Semi-cells with 5 protuberances, one large just above isthmus, one on each lateral lobe, and one on each side of apical notch in the polar lobe; Cells 44µm long, 30µm broad; Isthmus narrow, 6-7µm wide.
Collection no. & date: BJW 1; 2014.02.18
Distribution in Nepal: Bees-hazar Lake, 286m, Tikauli, Chitwan (Rai *et al*., 2008).

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

25. ***Micrasterias pinnatifida*** Ralfs (Figs. 31-32)
Scott & Prescott 1961, P. 51, Pl. 12, Fig. 6; Pl. 14, Figs. 17, 18; Nurul Islam 1970, P. 920, Pl. 10, Figs. 3-7.
Species common and variable; cell wall smooth or finely punctate; Cell 52 µm long, 49-52 µm broad; Apex 31-33.8 µm broad; Isthmus 10.5 µm wide.
Collection no. & date: BJW 3; 2014.02.18
Distribution in Nepal: Pond at Luitel Bhanjyang, 770m, Gorkha (Hirano, 1955); Koshi River, Koshi Tappu, 206m, Sunsari (Rai & Misra, 2008); Bees-hazar Lake, 286m, Tikauli, Chitwan (Rai *et al*., 2008).

26. ***Micrasterias radians*** Turner (Fig. 33)
Scott & Prescott 1961, P. 51, Pl. 23, Fig. 1; Prasad & Srivastava 1992, P. 144, Pl. 20, Fig. 2.
Cells medium-sized, sub-circular, very deeply constricted, sinus with apical portion linear and outer open; Semi-cells 5-lobed with deep, radial and widely open, polar lobe with sub-parallel sides showing retusely emarginate and somewhat expanded apex with furcate-acuminate extremity, each lateral lobe divided into two lobules by incision as deep as between polar and lateral lobes; Lobules with furcate-acuminate extremities; Cell wall

smooth; Cells 104.5-110 µm long, 96-101 µm broad; Isthmus 15-17.5 µm wide.
Collection no. & date: BJW 5; 2014.07.23
Distribution in Nepal: Moist soil at Tahachal, 1300m, Kathmandu (Hirano, 1955); Bees-hazar Lake, 286m, Tikauli, Chitwan (Rai *et al*., 2008); Betana pond, 164m, Belbari, Morang (Shrestha *et al.*, 2013).

27. ***Micrasterias tropica*** Nordstedt (Fig. 34)
Nurul Islam 1970, P. 921, Pl. 9, Figs. 7, 8.
Cells in end view angularly fusiform, longer than broad, 90-125 µm long, 75-100 µm broad, 25-30 µm thick; Lateral lobes conical, typically undivided extending horizontally; Polar lobe with an erect, parallel-sided lower portion and two widely diverging apical processes, about half as long as lateral lobes; Inframarginal spines small, stout on body and processes, with marginal spines also on processes.
Collection no. & date: BJW 8; 2014.02.18
Distribution in Nepal: Variety *polonica* f. *evoluta* reported from Bees-hazar Lake, 286m, Tikauli, Chitwan (Rai *et al*., 2008).

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

28. ***Cosmarium bipunctatum*** Børgesen [*Cosmarium vogesiacum* var. *bipunctatum* (Børgesen) Förster] (Fig. 35)
Bharati & Hedge 1982, P. 736, Pl. 7, Fig. 2.
Cells small, 30µm long, 26µm broad; Semi-cells with undulated margins, flattened apices, with one pyrenoid; Isthmus broad, 8µm wide.
Collection no. & date: BJW 2; 2014.05.04
Distribution in Nepal: Pond at Tahachal, 1300m, Kathmandu (Hirano, 1963); A pond south of Rara Lake, 3030m, Mugu (Watanabe, 1995).

29. ***Cosmarium granatum*** Brébisson ex Ralfs (Figs. 36-37)
Prasad & Misra 1992, P. 160, Pl. 21, Fig. 20; Tiffany & Britton 1952, P. 186, Pl. 53, Fig. 565; Nurul Islam 1970, P. 924, Pl. 15, Fig. 11.
Cells small, slightly longer than broad, 21-26 µm long, 15.5-18 µm broad, sub-rhomboid to elliptic, deeply constricted; Semi-cells truncate pyramidate, basal angles rounded, apical angles obtuse; Chloroplast axile with single pyrenoid; Isthmus 4.5-5 µm wide.
Collection no. & date: BJW 1; 2014.05.04
Distribution in Nepal: Luitel Bhanjyang, 770m, Gorkha; Stream at Tukucha Moor, 2600m, Mustang; Pond at Pisang, 3100m, Manang (Hirano, 1955); Moist soil at Mahendranagar, 198m, Kanchanpur (Habib & Chaturvedi, 1997); Bees-hazar Lake, 286m, Tikauli, Chitwan (Rai *et al*., 2008).

30. ***Cosmarium lundellii*** var. ***circulare*** (Reinch) Krieger [*Cosmarium circulare* Reinsch] (Fig. 41)
Scott & Prescott 1961, P. 60, Pl. 25, Fig. 7; Bharati & Hedge 1982, P. 744, Pl. 1, Fig. 2; Nurul Islam & Irfanullah 1999, P. 93, Pl. 1, Figs. 4, 5.
Cells circular in outline, deeply constricted, sinus linear, somewhat dilated at the apex, isthmus narrow; Semi-cells semicircular, basal angles rounded; Cell wall minutely

punctuate; Pyrenoids 2 in each semi-cell; Cells 51µm long, 40µm broad; Isthmus 14µm wide.
Collection no. & date: BJW 1; 2014.05.04
Distribution in Nepal: Stream at Mewa valley, 4150m, Taplejung (Hirano, 1984); Moist soil at Mahendranagar, 198m, Kanchanpur (Habib & Chaturvedi, 1997); Bees-hazar Lake, 286m, Tikauli, Chitwan (Rai *et al*., 2008).

31. ***Cosmarium maculatiforme*** Schmidle (Fig. 42)
Nurul Islam 1970, P. 924, Pl. 14, Fig. 1.
Cells twice or longer than wide, 45-100 µm long, 40-49µm broad, deeply constricted, sinus linear, apex rounded and slightly dilated; Semi-cells semielliptic or widely truncate ovate, basal angles rounded, apex rounded or slightly truncate; Cell wall smooth; Several pyrenoids; Isthmus 19-39µm wide.
Collection no. & date: BJW 2; 2014.05.04
Distribution in Nepal: Pond at Luitel Bhanjyang, 770m, Gorkha as var. *major* (Hirano, 1963); Bees-Hazar Lake, 286m, Tikauli, Chitwan (Rai *et al*., 2008).

32. ***Cosmarium pyramidatum*** Brébisson ex Ralfs (Fig. 43)
Prasad & Misra 1992, P. 177, Pl. 22, Fig. 18; Scott & Prescott 1961, P. 67, Pl. 27, Fig. 1.
Cells medium-sized, about 1.2 times longer than broad, 45.5-53 µm long, truncate-elliptic in outline, deeply constricted, sinus narrow and dilated towards the apex; Semicells truncate pyramidate, basal angles rounded, sides convex and converging upwards to narrowly truncate and flattened apex showing obtuse angles; Isthmus 16-18 µm wide.
Collection no. & date: BJW 8; 2014.02.18
Distribution in Nepal: Stream at Mewa valley, 4150m, Taplejung, (Hirano, 1984).

33. ***Cosmarium quadrum*** Lundell (Fig. 44)
Tiffany & Britton 1952, P.193, Pl. 53, Fig. 580; Prasad & Misra 1992, P. 178, Pl. 23, Figs. 1, 2.
Cells as long as wide or slightly longer, 64 µm long, 57 µm broad, quadrate in outline, deeply constricted, sinus linear and slightly dilated at the apex; lateral view of semi-cells sub-circular; vertical view oblong-elliptic; Chloroplast axial, 2 pyrenoids in each cell; Isthmus 20 µm wide.
Collection no. & date: BJW 5; 2014.07.23
Distribution in Nepal: Pond at Tahachal, 1300m, Kathmandu, (Hirano, 1963; Bando *et al*., 1989).

34. ***Cosmarium regnellii*** var. ***regnellii*** Wille (Figs. 38-39)
Croasdale & Flint 1986, P. 98, Pl. 41, Figs. 1-4, 9.
Sinus very narrowly linear; Semi-cells subhexagonal, the angles extending as upwardly projecting knoblike protuberances above the middle of semi-cell, the margin below the projection slightly retuse, and above it more strongly retuse, apex broad and flat or somewhat retuse; Semi-cells in side view rouded-ovate, in end view oblong-elliptic; Cells 11.5 µm long, 10 µm broad; Isthmus 2.75 µm wide.
Collection no. & date: BJW 5; 2014.07.23
Distribution in Nepal: *Cosmarium regnelli* reported from a pond at Luitel Bhanjyang, 770m, Gorkha (Hirano, 1955).

35. ***Cosmarium sublatereundatum*** West et West (Fig. 45)
Nurul Islam & Yusuf Haroon 1980, P. 580, Pl. 22, Figs. 263, 264; Bando *et al*. 1989, P. 21, Fig. 7e.
Cells slightly longer than wide, deeply constricted, sinus linear, apex slightly dilated; Semi-cells trapeziform subsemi-circular or subpyramidate in outline, basal angles rounded, sides convex with 6-7 crenates, apex truncate, minutely granulate margin, pyranoids 2; Cells 42.5-46.2 µm long, 42.5-43 µm broad; Isthmus 12.5-13.5 µm wide.
Collection no. & date: BJW 2; 2014.05.04
Distribution in Nepal: Stream at Tukucha Moor, 2600m, Mustang (Hirano, 1955); Bagmati river at Pashupatinath, 1300m, Kathmandu (Bando *et al.*, 1989); Sarouchia pond and Malaya Roadside ditches, 72m, Biratnagar, Morang (Rai, 2006); Bees-hazar Lake, 286m, Tikauli, Chitwan (Rai *et al*., 2008).

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

36. ***Staurastrum orbiculare*** var. ***orbiculare*** Ralfs (Figs. 40, 46-47)
Kauwets 1987, P. 248, Pl. 16; Croasdale *et al*. 1994, P. 119, Pl. 79, Figs. 1, 2.
Cells little longer than broad, almost circular, deeply constricted, sinus closed or nearly so; Semicells sub-semi-circular; Apex slightly depressed, basal angels rounded; Wall punctate; Cells 54-58 µm long, 46-19 µm broad; Isthmus 11-12.5 µm wide.
Collection no. & date: BJW 4; 2014.02.18
Distribution in Nepal: Variety *depressum* reported from a pond near Ankhu Khola, 640m, Gorkha, (Hirano, 1955).

Phylum: Euglenozoa
Class: Euglenophyceae
Order; Euglenida
Family: Phacidae
Genus: ***Phacus*** Dujardin (1841)

37. ***Phacus birgei*** Prescott (Fig. 48)
Prescott 1951, P. 398, Pl. 87, Fig. 11.
Cells broadly ovoid, produced posteriorly to form a long tapering caudus which is oblique to the longitudinal axis of the cell; Periplast very finely striated; Margins of the cell sharply notched with 4 small indentations on either side; Paramylon bodies 1 large and numerous small circular plates; Chloroplasts many ovoid discs; Pigment-spot; Cell 70-80 µm long, 50-60 µm broad.
Collection no. & date: BJW 7; 2014.07.23
Distribution in Nepal: Pond at P.G. Campus, 72m, Biratnagar, Morang (Rai & Rai, 2007).

38. ***Phacus helikoides*** Pochmann (Fig. 49)
Prescott 1951, P. 400, Pl. 87, Fig. 9.
Cells fusiform or elongate fusiform-pyriform, twisted throughout their entire length, briefly narrowed anteriorly and bilobed, tapering posteriorly to a spirally twisted, long, straight caudus which is about ½ the cell body; Cells 70-120µm long; 39-54µm broad.
Collection no. & date: BJW 6; 2014.02.18
Distribution in Nepal: Pond at P.G. Campus, 72m, Biratnagar, Morang (Rai & Rai, 2007).

Family: Euglenidae
Genus: ***Trachelomonas*** Ehrenberg (1834)

39. ***Trachelomonas hispida*** var. ***coronata*** Lemmermamm (Fig. 50)
Prescott 1951, P. 414, Pl. 83, Fig. 30.
Test oblong-oval; Flagellum aperature surrounded by a short collar with the margin bearing a circle of spines; Test 29-32µm long, 20µm broad.
Collection no. & date: BJW 7; 2014.02.18
Distribution in Nepal: Pond at Swoyambhu, 1300m, Kathmandu (Ioriya, 1988).

40. ***Trachelomonas*** cf. ***kelloggii*** Skvortzov (Fig. 51)
Prescott 1951, P. 415, Pl. 83, Figs. 16, 17.
Test broadly elliptic to spherical; Flagellum aperture without a collar but occasionally with an annular thickening; Wall brown, punctate and roughened with conical granulations which usually are more pronounced around the poles; Test 35-39 µm long, 31-34 µm broad.
Collection no. & date: BJW 5; 2014.02.18
Distribution in Nepal: Budhi Khola, Tandi, Chitwan (Das & Verma, 1996).

Phylum: Bacillariophyta
Class: Mediophyceae
Order: Stephanodiscales
Family: Stephanodiscaceae
Genus: ***Cyclotella*** (Kützing) Brébisson (1838)

41. ***Cyclotella meneghiniana*** Kutzing (Fig. 52)
Tiffany & Britton 1952, P. 218, Pl. 58, Fig. 660; Gandhi 1955, P. 308, Fig. 1; Kobayasi 1968, P. 96, Pl. 1, Fig. 8; Florin 1970, P. 698, Pl. 10, Figs. d, e; Sinnu & Squires 1985, P. 298, Pl. 1, Figs. 4-6; Karthick *et al*. 2013, Pl. 5.
Frustules drum-shaped with tangential undulations or flat valve face; Marginal zone with strongly radial striae, broader at the margin and tapering towards the center; Valve 10.0-34.5µm in diameter; Striae 6-8 in 10µm.
Collection no. & date: BJW 2; 2014.05.04
Distribution in Nepal: Pond at Dillibazar, 1300m, Kathmandu (Hirano, 1963); Pond at Birendra Sabhagriha, Biratnagar, 72m, Morang (Rai & Rai, 2005).

Class: Bacillariophyceae
Order: Licmophorales
Family: Ulnariaceae
Genus: ***Ulnaria*** (Kützing) Compère (2001)

42. ***Ulnaria acus*** (Kützing) Aboal
Karthick *et.al*. 2013, Pl. 17.
Valves linear with sub-capitat apices; Hyaline area present at the centre of the valve, reaching one valve margin only; Striae parallel and ghost striae may be visible in the hyaline area; Single labiate process located near the apex of one end of the valve; Valves 90-166 µm long, 3-6 µm broad; Striae 13-14 in 10 µm.

Collection no. & date: BJW 2; 2014.05.04
Distribution in Nepal: As *Synedra acus* reported from Phewa, Rupa and Begnas Lakes, 967m, Kaski (Nakanishi, 1986).

Order: Naviculales
Family: Naviculaceae
Genus: ***Navicula*** Bory (1822)

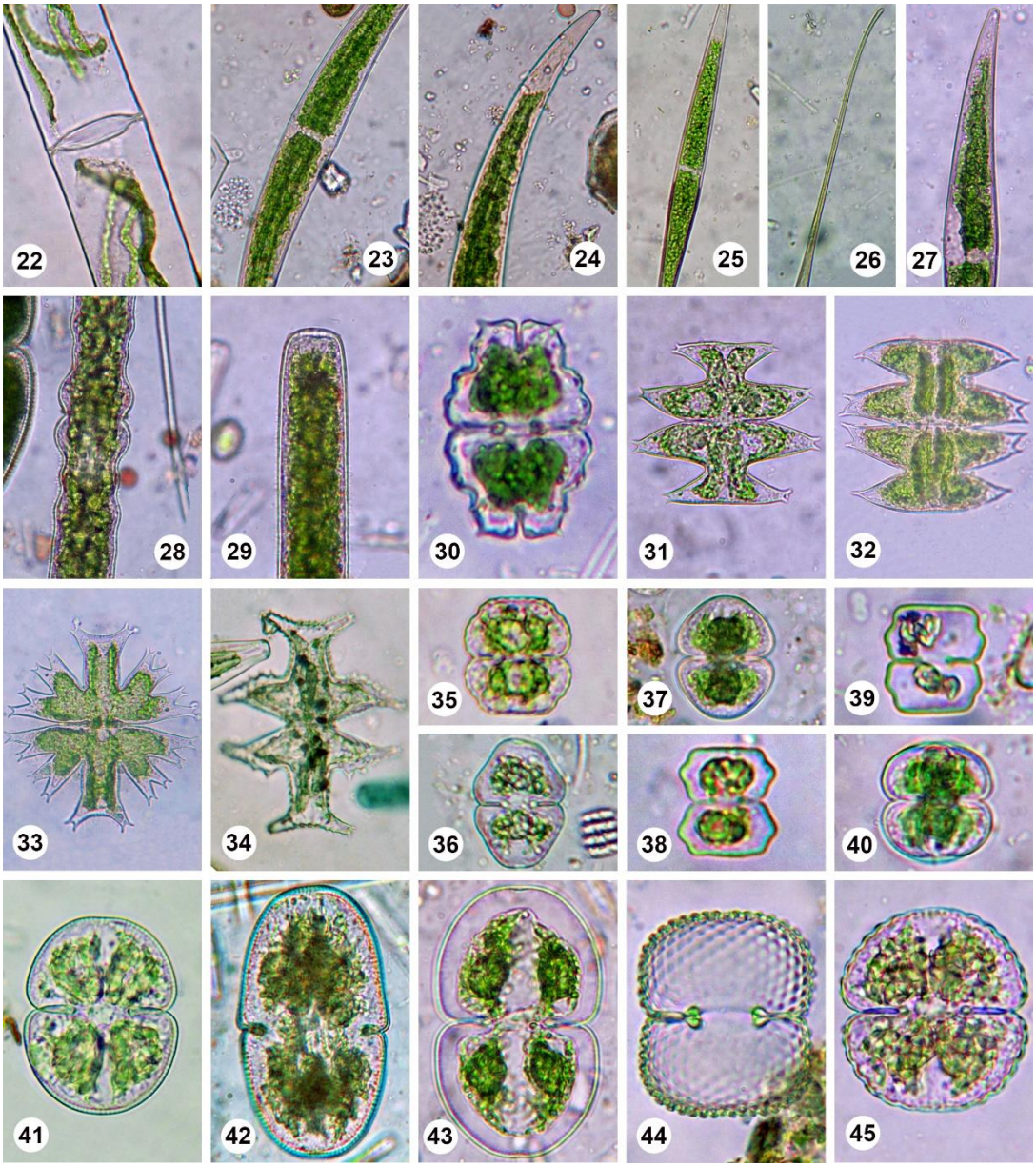
43. ***Navicula perrotettii*** (Grunow) Cleve [*Craticula perrotettii* Grunow] (Fig. 53)
Foged 1980, P. 652, Pl. 8, Figs. 1, 2; Rai & Rai 2005, P. 73, Fig. 9.
Valves broadly lanceolate or somewhat rhombo-lanceolate, 84 µm long, 21.5 µm broad, with constricted; Raphe straight, median with slightly unilaterally bent central nodules and swollen terminal fissures; Axial area narrow, linear, central area moderately wide and longitudinally elongated; Transverse striae fine, 12-13 in 10 µm, lineate, parallel; Longitudinal striae parallel to axial area.
Collection no. & date: BJW 1; 2014.02.18
Distribution in Nepal: Roadside ditch at Biratnagar, 72m, Morang (Rai & Rai, 2005); Triyuga river, 152m, Gaighat, Udaypur (Rai, 2006).

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

44. ***Pinnularia acrosphaeria*** Smith (Fig. 54)
Prasad & Misra 1992, P. 229, Pl. 30, Fig. 10; Gandhi 1999, P. 128, Pl. 3, Fig. 91; P. 224, Pl. 7, Fig. 285; Karthick *et.al*. 2013, Pl. 74.
Valves outline linear, margins straight, slightly convex, swollen in the middle, with broadly rounded ends or sometimes capitate; Axial area broad, linear, slightly widened near the central area; Terminal fissures very large, sickle-shaped but differing in the different varieties; Both axial and central area have a characteristic irregular surface structure; Valves 38-54µm long, 8-12 µm broad; Striae 12-16 in 10 µm.
Collection no. & date: BJW 2; 2014.05.04
Distribution in Nepal: Variety *minor* reported from a pond at Patan Dhoka, 1300m, Lalitpur (Hirano, 1963).

45. ***Pinnularia conica*** Gandhi (Figs. 55-56)
Karthick *et al*. 2013, Pl. 75.
Valves broad, linear-lanceolate with constricted and slightly capitate-cuneate ends; Raphe thin with drop-shaped curved proximal ends; Axial area narrow, ¼ of valve breadth, expanding broadly into central area; Terminal fissures large, sickle-shaped; Striae strongly radiate in the middle, convergent at the ends; Valves 52.0-55.5 µm long, 9-10 µm broad; Striae 9-12 in 10 µm.
Collection no. & date: BJW 5; 2014.02.18
Distribution in Nepal: Maipokhari, 2150m, Ilam (Rai, 2005).

Order: Rhopalodiales
Family: Rhopalodiaeae
Genus: ***Rhopalodia*** Müller (1895)



Figures: 22. *Spirogyra* sp. 23-24. *Closterium dianae* 25-26. *C. setaceum* 27. *C. striolatum* 28-29. *Pleurotaenium trabecula* 30. *Euastrum bidentatum* 31-32. *Micrasterias pinnatifida* 33. *M. radians* 34. *M. tropica* 35. *Cosmarium bipunctatum* 36-37. *C. granatum* 38-39. *C. regnellii* var. *regnellii* 40. *Staurastrum orbiculare* var. *orbiculare* 41. *Cosmarium lundellii* var. *circulare* 42. *C. maculatiforme* 43. *C. pyramidatum* 44. *C. quadrum* 45. *C. sublateriundatum*

46. ***Rhopalodia gibba*** (Ehrenberg) Müller (Fig. 57)

Tiffany & Britton 1952, P. 282, Pl. 75, Fig. 884; Foged 1982, Pl. 3, Fig. 7; Karthick *et al*. 2013, Pl. 107.

Valves strongly dorsiventral, claw-like in shape, dorsal margin strongly convex with a

slight but noticeable indentation in the middle, margins more or less straight; Apices narrow rounded ventrally deflected; Raphe canal follows the dorsal margin, raphe supported by fibulae, round or oval holes known as portulae lie between the fibulae; Costae prominent, extend across the valve face; Valves 42.0-96.5 µm long, 20-26 µm broad; Striae 8-10 in 10 µm; Fibula 6-8 in 10 µm.

Collection no. & date: BJW 6; 2014.07.23

Distribution in Nepal: Pond at Ankhu Khola, 630m, Gorkha; Pond at Pisang, 3100m, Manang; Stream at Tukucha Moor, 2600m, Manang (Hirano, 1955); Stream at Upper Mustang (Subba *et al*., 2009).

Figures: 46-47. *Staurastrum orbiculare* var. *orbiculare* 48. *Phacus birgei* 49. *P. helikoides* 50. *Trachelomonas hispida* var. *coronate* 51. *T.* cf. *kelloggii* 52. *Cyclotella meneghiniana* 53. *Navicula perrotettii* 54. *Pinnularia acrosphaeria* 55-56. *P. conica* 57. *Rhopalodia gibba*

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