

Some freshwater algae from Bagh-Jhoda wetland, Morang: new for Nepal

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ABSTRACT

Present paper describes new and interesting algae reported during the exploration of algal flora of Bagh-Jhoda wetland, Morang. A total of 20 species of freshwater algae, excluding cyanobacteria, have been reported from this wetland as new for Nepal. They were *Ankistrodesmus spiralis*, *Botryococcus braunii*, *B. protuberans*, *Glaucocystis duplex*, *Gonium sociale*, *Kirchneriella contorta*, *Nephrocytium hydrophilum*, *N.obesum*, *Oocystis eremosphaeria*, *Sorastrum americanum*, *Staurostrum pseudosebaldi*, *S. striolatum* var. *divergens*, *S. subpolymorphum*, *Glenodinium borgei*, *Peridinium gatunense*, *Gomphonema lacustrankaloides*, *G.pseudoaugur*, *Nitzschia* cf. *pumila*, *Pinnularia amabilis* and *Ulnaria capitata*. This wetland area is rich in algal diversity including red algae and it needs further extensive exploration.

Keywords: algal flora, Chlorophyceae, diatom, east Nepal, *Gomphonema*

INTRODUCTION

Algae are a large heterogeneous group of simple, thalloid, photosynthetic and usually water dwelling plants (Prescott, 1969). They are characterized by presence of chlorophyll a, lack of true tissue, absence of multicellular gametangia and usually have water-dispersed spores. Their size varies greatly from unicellular 0.5 µm in diameter, colonial, palmelloid, filamentous to bushy plant like 30 m or more in length. Importance of algae is manifold as they act as primary producer in aquatic food chain and consume large amount of CO₂ from atmosphere. They are used as human food, biofertilizer, biodiesel, bioindicator, medicines, cosmetics, and tools for forensic science, nanotechnology and research activities.

The taxonomy and diversity of lower plants of Nepal have not been studied comprehensively in comparison to the higher plants. Studies on algal flora of Nepal are very few and that are mostly limited to the higher mountains and midhills of central Nepal. The Terai belt of Nepal, which is favourable for the luxuriant growth and diversity of algae due to hot and humid climate, still awaits detailed investigation on algal flora. Literature revealed that the major contribution in the algal flora of Nepal have been made by Hirano (1955, 1963, 1969, 1984), Suxena *et al.* (1972), Hickel (1973a, 1973b), Joshi (1979), Shrestha & Manandhar (1983), Komarek & Watanabe (1990, 1998), Nozaki (1990), Sahay *et al.* (1993), Baral (1995, 1996), Watanabe (1995), Prasad (1996), Habib and Chaturvedi (1997), Yoshimura *et al.* (2006), Takeuchi *et al.* (2009), Jüttner *et al.* (2010, 2011), Jha & Kargupta (2012), Rai *et al.* (2012), and Krstić *et al.* (2013). Baral (1999) has listed 687 algae, belonging to 150 genera and 50

families. Recent data showed that the total alga recorded from Nepal is 995 (Prasad, 2011).

Diatom (total 36 taxa, 20 taxa new to Nepal) and blue-green algae (total 51 taxa, 19 taxa new to Nepal) of eastern Nepal have been studied by Misra *et al.* (2009) and Rai & Misra (2010), respectively. Chlorophycean forms like Spirogyra (Rai & Misra, 2007), Oedogonium (Rai, 2012), Pediatrum (Rai & Misra, 2012a), Scenedesmus (Rai, 2013a) and desmids (Rai, 2014) were also enumerated from eastern Nepal. From the eastern Terai region, 17 diatoms have been enumerated out of which Navicula gastrum, Pinnularia viridis var. intermedia, Cymbella reinhardtii, Epithemia sorex and Hantzschia virgata were new record for Nepal (Rai, 2006a). Algae of Betana wetland (23 taxa, 6 diatoms new to Nepal) (Rai, 2011), Chimdi lake (total 6 taxa, Euastrum spinulosum var. bellum new to Nepal) (Rai & Rai, 2012), Koshi Tappu region (total 81 taxa, 22 taxa new to Nepal) (Rai, 2013b) and Itahari (total 52 taxa, 10 taxa new to Nepal) (Shrestha *et al.*, 2013) have also been studied. Diatoms (total 12 taxa, 5 taxa new to Nepal) (Rai & Rai, 2005) and Euglenophyceae algae (total 19 taxa, 9 taxa new to Nepal) (Rai & Rai, 2007) of Biratnagar have been studied. Similarly, 26 desmids have been reported from Koshi Tappu area out of which 11 taxa were new to Nepal (Rai & Misra, 2008).

Recently, fresh water red algae viz., Nematolionopsis shawii has been reported from Sundar Dulari VDC, Morang as new to Nepal (Necchi *et al.*, 2016). This locality lies near to and more or less in the similar climatic zone of our study area. Rai has collected many algal samples from Bagh-Jhoda wetland during his Ph.D. work and described a total 7 species viz., *Ankistrodesmus spiralis*, *Coelastrum morus*, *Schizomeris liebleinii*, *Pithophora oedogonia*, *Micrasterias americana*, *Chara schweinitzii* and *Gomphonema lacus-rankala* (Rai, 2006b). In this study, a detail investigation was carried out identifying a total 74 algal species of 43 genera collected at the mentioned wetland site. Twenty taxa new to Nepal have been described in this paper.

MATERIALS AND METHODS

Study area

Bagh-Jhoda wetland (Lat. 26°40'38" N, Long. 87°23'52.3" E, Elevation ca 137 m) is a natural wetland situated at Koshi Haraicha Municipality of Morang district in eastern Nepal (figures 1-3). The wetland lies just at the southern margin of Charkoshe Jhadi, about few kilometers north from Khorsane, east west highway. It is more or less polygonal in shape, elongated from north to south, having narrow ends on both sides and widen at the middle. It covers ca 1 hectare area.

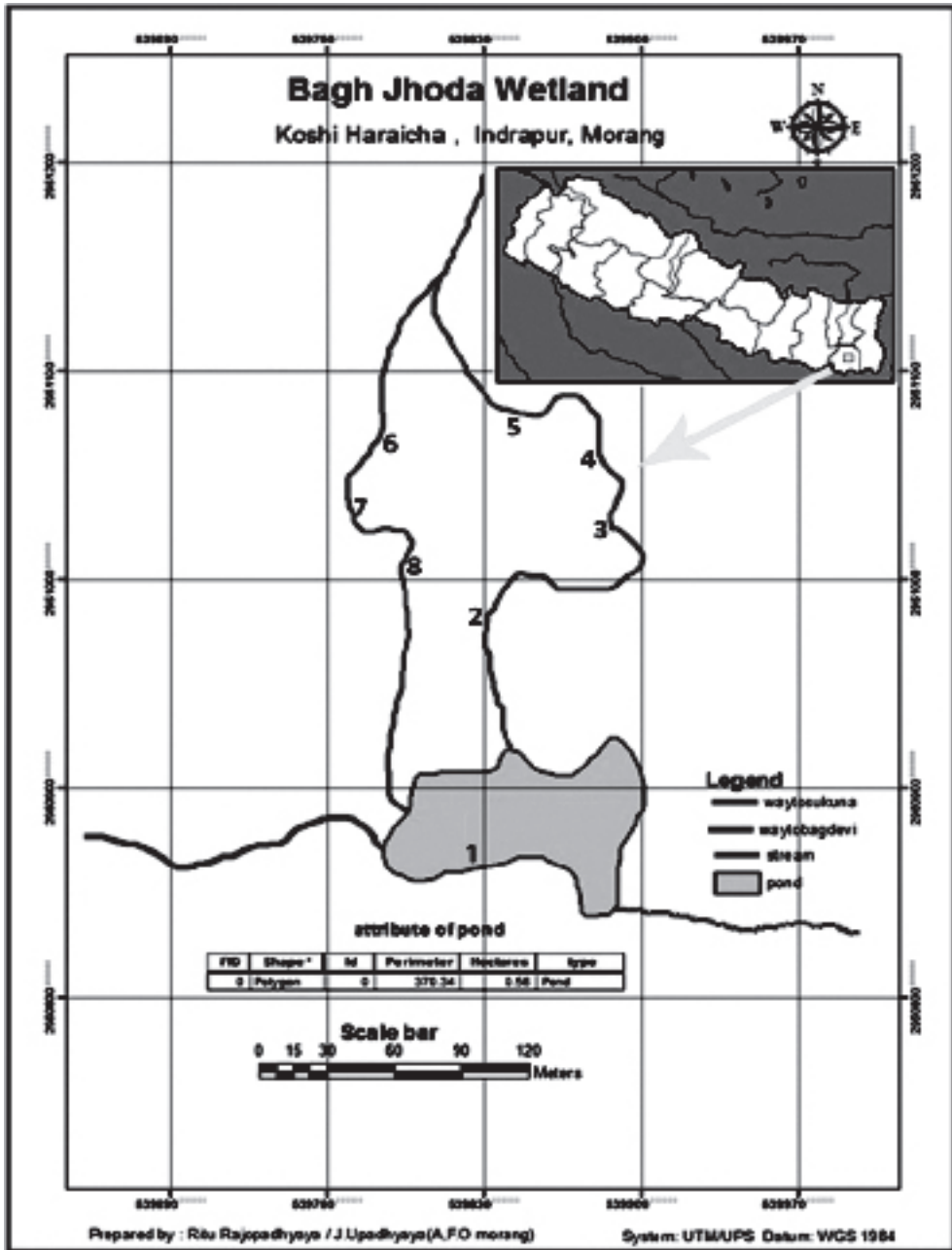


FIG. 1. Bagh-Jhoda wetland showing eight different sampling sites.



FIG. 2. Bagh-Jhoda wetland in winter season.



FIG. 3. Bagh-Jhoda wetland in rainy season.

Algae collection and identification

Algal samples were collected from eight different sites of Bagjhoda wetland (fig. 1) in three different season viz., winter, summer and rainy in 2014. Planktonic forms were collected by using plankton net (mesh size 10 μm) and epiphytic forms by squeezing submerged leaves and roots of aquatic macrophytes. They were preserved in 4% formaldehyde solution in air tight polythene bottles with proper tagging and labeling. The geographical positions for each spot were measured with the help of GPS Garmin e-trex. Water temperature was measured with the help of digital thermometer and pH with the help of Henna pH meter. The laboratory investigation of the sample was done in the Phycology Research Lab, Department of Botany, Post Graduate (P.G.) Campus, Biratnagar, east Nepal. The slides for each sample were prepared in glycerin mount (Sharma, 1992) and observed under light microscope in different magnifications. Microphotography for each taxa were done under 40X and 100X objectives using Olympus Ch20i Microscope and Canon Digital Power Shot Camera. Algae were identified consulting various articles, literatures and monographs (Prescott, 1951; Tiffany & Britton, 1952; Philipose, 1967; Croasdale *et al.*, 1994; Karthick *et al.*, 2013 etc.). All the collected materials and slides have been deposited in the Phycology Research Lab, Department of Botany, Post Graduate Campus.

RESULTS AND DISCUSSION

Bagh-Jhoda wetland is favourable habitat for growth of algae because the climate of this area is hot and humid and it has the permanent source of water that seeps continuously from Charkoshe Jungle. In this study, a total of twenty algae were reported as new to Nepal, described below.

Ankistrodesmus spiralis (Turner) Lemmermann (fig. 1,2)

Prescott 1951, p. 254, pl. 56, figs. 11-12; Philipose 1967, p. 210, fig.119a.

Cells spindle-shaped, acicular with apices; spirally twisted round one another in the median region into bundles, but free at the ends; chloroplast a parietal plate without a pyrenoid.

Cells 2-3 μm in diameter, 25-35 μm long.

Sample No. and Date: BJ- 1, 18/02/2014.

Botryococcus braunii Kuetzing (fig. 25)

Tiffany and Britton 1952, p. 207, pl. 57, figs. 642, 643; Prasad and Srivastava 1992, p. 25, pl. 4, figs. 1,4.

Cells are ellipsoid, radiately arranged at the periphery of irregularly shaped, usually dark-colored masses of mucilage; free floating; colonial mucilage much folded and extended into tough, foamy strands, often forming colonial complexes by interconnecting strands of mucilage.

Cells 3-6 μm in diameter, 6-12 μm long.

Sample No. and Date: BJ- 1, 18/02/2014.

Botryococcus protuberans W.et G.S. West (fig. 11)

Prescott 1951, p. 232, pl. 52, figs. 4-5; Philipose, 1967, p. 197, fig. 197.

Cells ovoid, arranged in few-celled clusters which are connected by long tough, fibrous

strands, 4-16 such clusters involved to form multiple colonies; cells embedded in but not entirely surrounded by mucilage, one end protruding at the periphery.

Cells 5-6.5 μm in diameter, 8-9.5 μm long.

Sample No. and Date: BJ- 5, 04/05/2014.

Glaucocystis duplex Prescott (fig. 22, 23)

Prescott 1951, p. 474, pl. 108, fig. 1

Colony composed of 8-16 spherical cells enclosed by a much enlarged spherical mother cell wall; chromatophore-like bodies in the form of 2 stellate masses with long or short vermiform blue-green protoplasts radiating from two separate points.

Cells 40-44 μm in diameter, colony 150-170 μm in diameter.

Sample No. and Date: BJ- 1, 18/02/2014.

Gonium sociale Warming [Current accepted name: *Tetrabaena socialis* (Dujardin) H. Nozaki & M. Itoh] (fig. 3)

Prescott 1951, p. 75, pl. 1, fig. 22

Colony consists of 4 ovoid cells, all directed outwards, enclosed by colonial mucilage which has a central rectangular perforation.

Cells 10-15 μm in diameter, 12-20 μm long.

Sample No. and Date: BJ-1, 18/02/2014.

Kirchneriella contorta (Schmidle) Bohlin [Current accepted name: *Raphidocelis danubiana* (Hindak) Marvan, Komárek & Comas](fig. 5)

Prescott 1951, p. 258, pl. 57, figs. 7 and 8; Philipose 1967, p. 224, fig. 133.

Free-floating colonies; usually of 16 twisted, arcuate, cylindrical cells with broad, convex apices, lying irregularly scattered throughout the homogeneous, gelatinous envelope; chloroplast covering the entire wall of the cell.

Cells 1-2 μm in diameter, 5.8-10 μm long.

Sample No. and Date: BJ- 8, 18/02/2014.

Nephrocytium hydrophilum (Turner) Wille (fig. 4)

Philipose 1967, p. 190, fig. 105

Cells kidney-shaped or elongated with rounded ends which are often brown; usually in colonies of four or more cells enclosed by a colorless gelatinous envelope.

Cells 20-25 μm in diameter, 28-57 μm long.

Sample No. and Date: BJ- 6, 04/05/2014.

Nephrocytium obesum West & West [Current accepted name: *Oonephris obesa* (West & G.S. West) Fott] (fig.24)

Prescott 1951, p. 249, pl. 54, fig. 20; Philipose 1967, p. 191, fig. 106

Colonies broadly ovate; composed of 2-4 broadly ovate to hemispherical cells enclosed by a thick membranous integument; chloroplast massive somewhat reticulate and covering the entire wall.

Cells 14-16 μm in diameter, 30-33 μm long.

Sample No. and Date: BJ- 1, 18/02/2014.

Oocystis eremosphaeria G.M. Smith [Current accepted name: *Eremoshaeraeremosphaeria* (Smith) Smith & Bold] (fig. 12)

Prescott 1951, p. 244, pl. 51, fig. 12

Plants are unicellular; usually solitary, sometimes in a group of 2 or 4 within the old mother cell wall; larger specimens found in the habitats where is rich mixture of algae in shallow, warm water.

Cells 20-25 μm diameter, 35-45 μm long.

Sample No. and Date: BJ- 8, 23/07/2014.

Sorastrum americanum Schmidle (fig.21)

Prescott 1951, p. 228, pl. 50, fig. 8

A free-floating spherical colony of 16-128 heart-shaped or sub-pyramidal cells; cells narrowed toward the base and attached to the center of colony by a short, cylindrical stalk and form a central hollow sphere.

Cells 7-20 μm in diameter, 5-20 μm long; spines 10-15 μm long.

Sample No. and Date: BJ- 1, 18/02/2014

Staurastrum pseudosebaldi Wille [Current accepted name: *Staurastrum manfeldtii* var. *pseudosebaldi* (Wille) Coesel & Meesters] (fig.20)

Croasdale *et al.* 1994, p. 126, pl. 110, figs 4-6; pl. 111, fig. 1.

Cells about 1.2 times wider than long; sinus an acute notch; body triangular with a swollen base, upper angles extending into stout, horizontal processes that end in 3-4 spines; apex with a row of bifurcate spines; process rough with several rings of granules.

Cells 60-71 μm wide, 45-51 μm long; isthmus 12-13 μm wide.

Sample No. and Date: BJ- 5, 23/07/2014.

1. ***Staurastrum striolatum*** var. ***divergens*** West & West (fig. 6-8)

Croasdale *et al.* 1994, p. 136, pl. 82, fig. 15

Cells having angles that are cylindrical, broadly rounded, and slightly divergent, resulting in a concave apex; fine granulation on the wall which is mostly limited to the angles; deeply constricted; sinus widely open and rather obtuse internally.

Cells about as long as broad, 18-28 μm broad, 19-28 μm long; isthmus 6-10 μm wide.

Sample No. and Date: BJ- 2, 04/05/2014.

2. ***Staurastrum subpolymorphum*** Borge (Pl. 7, fig. 6-8) (fig. 18,19)

Croasdale *et al.* 1994, p. 140, pl. 105, fig. 8, 9

Sinus wide angled and deep; apex slightly convex; body sub-elliptic to cup-shaped; processes short horizontal, ending in 3 short teeth; body smooth, apex smooth except for a pair of teeth on dorsal margin; semi-cells radiate, concave sides each with 2 intra-marginal teeth.

Cells 36-39 μm broad with processes, (26)32-33 μm long without processes; isthmus 11-12 μm wide.

Sample No. and Date: BJ- 3, 23/07/2014.

3. ***Glenodinium borgei*** Schiller [Current accepted name: *Peridiniopsis borgei* Lemmermann] (fig. 9)

Prescott 1951, p. 428, pl. 90, fig. 8, 9

Cells broadly ovoid to sub-globose; epicone high and shortly apiculate; epitheca with 1 apical, 2 intercalary, and 6 precingular plates; apical plate on the dorsal side not extending to the apex; hypotheca with 5 postcingular and 2 antapical plates.

Cells 30-40 μm in diameter, 40-46 μm long.

Sample No. and Date: BJ- 2, 18/02/2014.

4. ***Peridinium gatunense*** Nygaard (Willie) (fig. 10)

Prescott 1951, p. 433, pl. 90, fig. 25, 26

Cells are globose to elliptic, with angulations at the marginal sutures, the poles broadly rounded; transverse furrow spiral with a wide border; plates with wide, striated sutures between them, coarsely reticulate; epitheca with 13 plates; hypotheca with 2 large antapicals and 5 postsingular plates.

Cells 55-80 μm broad, 45-80 μm long.

Sample No. and Date: BJ- 7, 18/02/2014.

5. ***Gomphonema lacustrankaloides*** Karthick and Kociolek (fig. 14)

Karthick *et al.* 2013, pl. 84

Valves lanceolate-clavate; head-pole protracted to acute; axial area narrow; central area indistinct, with one round stigma opening; raphe lateral, undulate, with proximal raphe ends dilated, raphe ends deflected onto the mantle; striae punctuate, parallel near center, radiate near apices.

Valves 11-15 μm broad, 62.0-90.5 μm long; striae 8-11/10 μm .

Sample No. and Date: BJ- 2, 04/05/2014.

6. ***Gomphonema pseudoaugur*** Krammer (fig. 13)

Karthick *et al.* 2013, pl. 78

Valves strongly heteropolar, oval to lanceolate club shaped; head-pole strongly protracted, foot-pole rounded; central area small formed by shortening of central striae, stigmata associated with the end of one central stria; striae weakly radial throughout, indistinctly punctate.

Valves 9.5-12 µm broad, 41-60 µm long; striae 10-12/10 µm.

Sample No. and Date: BJ- 3, 18/02/2014.

7. ***Nitzschia* cf. *pumila*** Hustedt (fig. 15)

Karthick *et al.* 2013, pl. 127

Valves narrow lanceolate with attenuated ends; apices capitate or acutely rounded; marginal keel supported by very small fibulae, equidistant in the middle. Present specimen is quite different in shape and size.

Valve 2.5-5.0 µm broad, 56-60 µm long; fibula 13-15/10 µm; striae >40/10 µm.

Sample No. and Date: BJ- 5, 18/02/2014.

8. ***Pinnularia amabilis*** Krammer (fig. 17)

Karthick *et al.* 2013, pl. 73

Valves linear, with straight sides and protracted (sometime capitate ends); axial area narrow and linear, broadly expanding into the central area; central area forms a broad fascia; raphe lateral with drop-like proximal ends; striae radiate in the middle, convergent to slightly sinuous near the poles.

Valves 7.0-8.5 µm broad, 43.0-52.5 µm long; striae 8-10/10 µm.

Sample No. and Date: BJ- 3, 18/02/2014

9. ***Ulnaria capitata*** (Ehrenberg) Compère (fig. 16)

Tiffany & Britton 1952, p. 236, pl. 63, Fig. 722; Foged 1982, p. 357, pl. 4, fig. 12

Valves solitary, conspicuously linear with nearly parallel edges and cuneate ends; broadly linear in girdle view; pseudo-raphe narrowly linear; central area usually not evident.

Valves 7.0-10.5 µm broad, 125-500 µm long; striae 8-11/10 µm.

Sample No. and Date: BJ- 8, 18/02/2014.

In the present study, *Ankistrodesmus spiralis* (Turner) Lemm. reported earlier by Rai (2006b) as new to Nepal was again observed. Diatom species *Gomphonema lacus-rankala* var. *chandolensis* reported by Rai (2006b) as new to Nepal was not observed now but quite similar but elongated species *Gomphonema lacus-rankaloides* Karthick and Kociolek was observed. Similarly, algae like *Pithophora oedogonia* (Mont.) Wittrock, *Micrasterias americana* (Ehr.) ex Ralfs, and *Chara schweinitzii* A. Braun observed previously by Rai (2006b) were also not reported now. The area is also favourable for fresh water red algae (Necchi *et al.*, 2016) but not observed due to unfavourable season during collection period. Further exploration is needed for documenting complete algal flora of this region.

Bagh-Jhoda wetland is being destroyed day by day due to the human encroachment and over- population of *Eichornia cracipes*. This wetland needs quick and special conservation strategy from local and Government levels. Thus, many interesting aquatic biodiversity hidden in this wetland can be conserve properly.

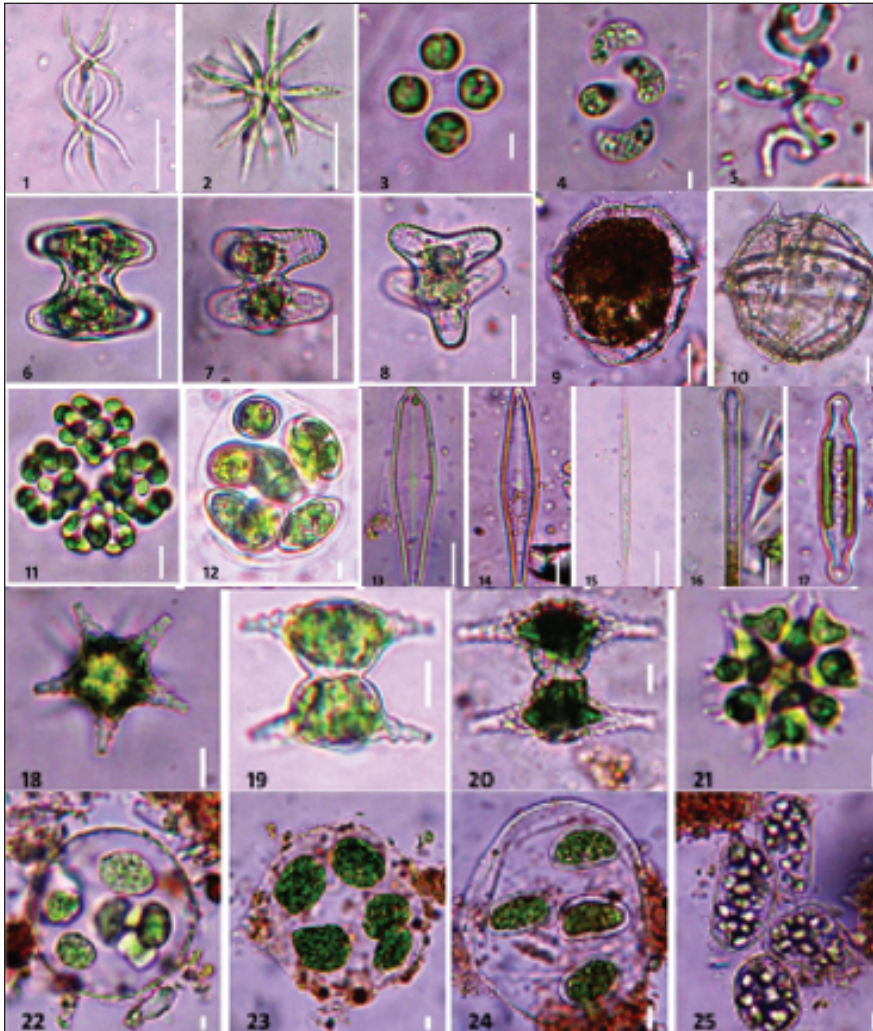


FIG. 1-2. *Ankistrodesmus spiralis* 3. *Gonium sociale* 4. *Nephrocytium hydrophyllum* 5. *Kirchneriella contorta* 6-8. *Staurastrum striolatum* var. *divergens* 9. *Glenodinium borgei* 10. *Peridinium getunense* 11. *Botryococcus protuberance* 12. *Oocystiseremo sphaeria* 13. *Gomphonema pseudoaugar* 14. *G. lacustrankaloids* 15. *Nitzschia cf pumila* 16. *Ulnaria capitata* 17. *Pinnularia amabilis* 18-19. *Staurastrum subpolymorphum* 20. *S. pseudosebaldi* 21. *Sorastrum americanum* 22-23. *Glaucocystis duplex* 24. *Nephrocytium obesum* 25. *Botryococcus braunii* (All scales are 10 μ m long).

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