

Algal flora of Betana wetland, Morang, Nepal

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Abstract

In this paper, a total 23 epiphytic as well as planktonic taxa belonging to the classes cyanophyceae (6), chlorophyceae (1) and bacillariophyceae (16) have been enumerated from Betana wetland. Out of these, six diatom taxa viz., *Gomphonema constrictum* Ehr. var. *capitata*, *Gomphonema intricatum* Kütz. var. *vibrio*, *Gomphonema parvulum* (Kütz.) var. *lagenula* Hust., *Rhopalodia gibba* (Ehr.) O. Müll. var. *ventricosa*, *Nitzschia amphibia* Grun. and *Surirella tenera* Greg. var. *ambigua* Gandhi were the new records for the country.

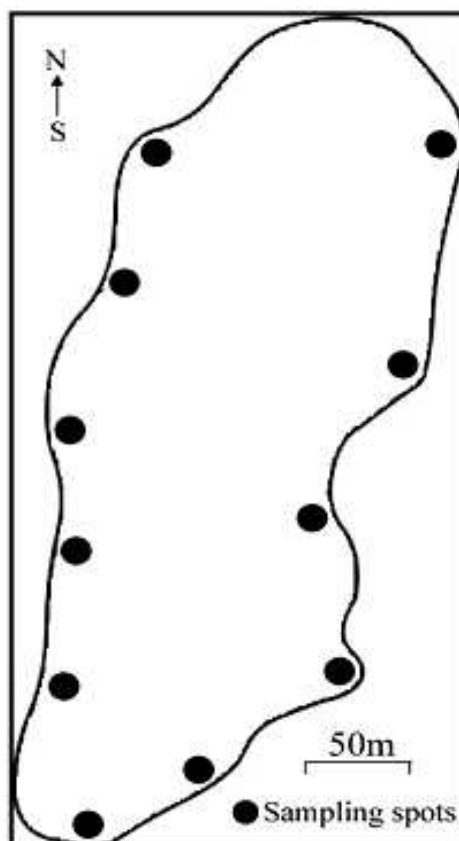
Key words: Algae, Betana, Diatoms, Nepal.

Introduction

Betana wetland is a freshwater ox-bow pond situated between 26°39'47.8" N to 87°26'02.8" E and 26°39'33.5" N to 87°26'02.9" E at an elevation of 123 m msl, covering ca 5.5 ha area in Belbari VDC, Morang (Map 1). The pond is surrounded by Sal forest of Char-Koshe-Jhadi from east, north and west sides whereas Mahendra Rajmarg lies adjacent on its south. The sources of its water are the water released from the surrounding forest and atmospheric precipitation. From its edge to the centre, water depth varies from 0.5 to 1.5 m in dry season and 1 to 2.5 m in monsoon season (Jha *et al.*, 2005). Generally, in rainy season when water level raises, over-water drained out through artificial outlets constructed at its southern bank. The area experiences tropical monsoonic climate having three distinct viz., winter (November-February), summer (March-June) and rainy (July-October) seasons in a year. Soil is alluvial type and the meteorological records are: average annual rainfall 1312 mm, average annual minimum and maximum temperatures 14.2°C and 30.6°C respectively.

The common macrophytes of this pond are *Azolla imbricata*, *Blyxa japonica*, *Ceratophyllum demersum*, *Eichhornia crassipes*, *Hydrilla verticillata*, *Ipomoea carnea*, *Pistia stratiotes* and *Potamogeton crispus*.

Phycological explorations in eastern Nepal have been carried out by various workers viz.,



Map 1. Betana wetland showing algal collection sites.

Rai (2005, 2006, 2009), Rai and Rai (2005, 2007), Rai and Misra (2007, 2008), Rai *et al.* (2008 a, 2008 b, 2010), Misra *et al.* (2009) and Subba *et al.* (2009). Only five algal species viz., *Lyngbya birgei*, *Lyngbya majuscula*, *Nostochopsis lobatus*, *Fragilaria construence* var. *construence* and *Eunotia tschirchiana* have been reported from this wetland before (Rai & Misra, 2010).

Materials and Methods

Planktonic forms were collected with the help of mesh net (pore size 5 μm) whereas epiphytic forms by squeezing submerged macrophytes, from 11 peripheral spots of the wetland (Map 1). Few algae especially diatoms were also collected by brushing the slimy surface of the pebbles. All the samples were preserved in 4% (final concentration) formaldehyde solution. Further study viz. measurement, identification, microphotography etc. were carried out in the laboratory, Department of Botany, P.G. Campus, Biratnagar. For better viewing and identification, diatom frustules were washed with saturated solution of chromic acid (potassium dichromate dissolved in conc. H_2SO_4). The slides thus prepared were observed and took microphotography using Carl Zeiss Axiostar plus microscope and Canon digital camera (8 mega pixel). Taxonomic identification have been made up to the species and variety level following standard literature and monographs viz., Geitler (1932), Deshikachary (1959), Prasad and Srivastava (1992), Rai *et al.* (2010), Rai and Misra (2010) etc.

Taxonomic Description

Cyanophyceae

1. *Merismopedia elegans* A. Braun in Kützing (Fig. 1)

Desikachary 1959, p. 156, pl. 29, fig. 9; Rath & Adhikary 2005, p. 44, pl. 6, fig. 3; pl. 15, fig. 110.

Whole colony 98.7 μm long, 78.5 μm broad; cells 8.2 μm long, 5.8 μm broad.

Distribution in Nepal: Phewa lake, 967 m, Pokhara, Kaski (Ishida, 1986); Chandi river, Chandranigahpur and Rapti river, Hetauda (Sahay *et al.*, 1993); Lamphengwa, Pheyong and Deumai rivers, Gajurmukhi, Ilam (Rai *et al.*, 2008a); Paddy field and damp soil around a tap, Hongchur, 850 m, Khotang (Rai & Misra, 2010).

2. *Oscillatoria princeps* Vauch. ex Gom. (Fig. 2)

Desikachary 1959, p. 210, pl. 37, figs. 1, 10-11, 13-14; Sant'anna & Azevedo 1995, p. 42, fig. 88.

Trichomes 28.5-38 μm broad; cells 5-5.5 μm long.

Distribution in Nepal: A pond at Patan Dhoka, 1,300 m, Lalitpur (Hirano, 1963); Narayani river, Narayanghat, Chitwan (Upadhyaya, 1979); Kara river at Hetauda and Malangwa (Sahay *et al.*, 1993); Main dam of Khageri Khola at Tikauli, Chitwan, and Jayshree Khola at Gaindakot, Nawalparasi (Das & Verma, 1996); Paddy and Sugarcane field, Birganj, Parsa (Prasad, 1996); Roadside pools, Mahendranagar, Kanchanpur (Habib, 1997); Kusaha, Haripur, and Madhubani of Sunsari, Eastern Nepal (Jha & Kargupta, 2001); Malaya roadside ditches, 72 m, Biratnagar (Rai & Misra, 2010).

3. *Lyngbya birgei* G.M. Smith (Fig. 3)

Desikachary 1959, p. 296, pl. 50, figs. 7-8; Prasad & Srivastava 1992, p. 89, pl. 10, fig. 9.

Filaments 22-25.5 μm broad; sheath 1-1.6 μm thick; trichomes 19-20.5 μm broad; cells 3.5-4 μm long.

Remarks: The present specimen has slightly longer cells.

Distribution in Nepal: Sundarijal, 1,300 m, Kathmandu; Patan, 1,300 m, Lalitpur; Thimi, 1,300 m, Bhaktapur (Shrestha, 1982; Shrestha & Manandhar, 1983); Betana wetland, Morang (Rai & Misra, 2010).

4. *Lyngbya majuscula* (Dillwyn) Harv. ex Gom. (Fig. 4)

Desikachary 1959, p. 313, pl. 48, fig. 7; pl. 49, fig. 12; pl. 52, fig. 10; Prasad & Srivastava 1992, p. 93, pl. 11, fig. 2.

Filaments 13.5-16 μm broad; sheath 1.4-3.2 μm thick; trichomes 10.5-11.4 μm broad; cells 2.3-3 μm long.

Distribution in Nepal: Betana wetland, Morang (Rai & Misra, 2010)

5. *Anabaena iyengarii* Bharadwaja (Fig. 5)

Desikachary 1959, p. 406, pl. 78, fig. 2.

Trichomes 6 μm broad; heterocysts 9.5 μm long, 7.5 μm broad; akinets 15-25 μm long, 8-11 μm broad.

Distribution in Nepal: Chandi river at Chandranigahpur (Sahay *et al.*, 1993); a pond near Sharada dam, Mahendranagar, Kanchanpur (Habib, 1997); Kusaha and Haripur of Sunsari, Eastern Nepal (Jha & Kargupta, 2001); Titrigachi pond, Koshi Tappu, Kusaha, 206 m, Sunsari (Rai & Misra, 2010).

6. *Nostochopsis lobatus* Wood em. Geitler (Fig. 6)

Geitler 1932, p. 475, figs. 28, 285-286; Desikachary 1959, p. 570, pl. 120, figs. 1-8.

Thallus up to 4 cm in diameter; cells 4-10 μm long, up to 5 μm broad; heterocysts 6-7.5 μm long, 5.5-6.5 μm broad.

Distribution in Nepal: A pond at Godawari, 1,400 m, Lalitpur (Shrestha, 1982; Shrestha & Manandhar, 1983; Watanabe & Komarek, 1988); Betana wetland, Morang (Rai & Misra, 2010).

Chlorophyceae

7. *Cosmarium maculatiforme* Schm. (Fig. 7)

Turner 1892, P. 49, pl. 8, fig. 68 (as *C. maculatum* forma); Nurul Islam 1970, p. 924, pl. 14, fig. 1.

Cells 120 μm long, 62.5 μm broad; isthmus 42.5-45 μm wide.

Distribution in Nepal: Variety *maior* reported from a pond at Luitel Bhanjyang, 770 m, Gorkha (Hirano, 1955); Bees hazaar lake, Chitwan (Rai *et al.*, 2008b).

Bacillariophyceae

8. *Melosira varians* Ag. (Fig. 8)

Hadi *et al.* 1984, p. 518, pl. 1, fig. 21; pl. 8, fig. 131; Sinnu & Squires 1985, p. 298, pl. 1, fig. 1.

Frustule 15 μm in diameter; semicell 12 μm high.

Distribution in Nepal: A pond at Ankhu Khola, 640 m and Luitel Bhanjyang, 770 m, Gorkha (Hirano, 1955); Pitchhra pond, 72 m, Biratnagar (Rai & Rai, 2005); Lamphengwa, Pheyong and Deumai rivers, Gajurmukhi, Ilam (Rai *et al.*, 2008a); Muga river, 1850 m, Pakhribas, Dhankuta; Hongchur river, 900 m, Khotang; Chimdi lake, 73 m, Sunsari (Misra *et al.*, 2009).

9. *Fragilaria construence* (Ehr.) Grun. var. *construence* (Fig. 9)

Kobayasi 1968, p. 96, pl. 1, figs. 10-11; Foged 1982, p. 350, pl. 1, fig. 9; pl. 4, fig. 10 (as *Fragilaria construence*).

Valves 14 µm long, 5 µm broad; girdles 14 µm long, 4.9 µm broad.

Distribution in Nepal: Betana wetland, 123 m, Belbari, Morang (Misra *et al.*, 2009).

10. *Eunotia tschirchiana* Müll. (Fig. 11)

Hustedt 1938, p. 173-174, pl. 12, fig. 29; Gandhi 1999, p. 26, pl. 1, fig. 37; p. 92, pl. 1, fig. 23; p. 153, pl. 2, fig. 61.

Valves 53-62.5 µm long, 8.5-10 µm broad; striae 8-13 in 10 µm.

Distribution in Nepal: A stream at Mewa valley, Eastern Nepal (Hirano, 1984); Muga river, 1850 m, Pakhribas, Dhankuta; Pond inside Birendra Sabha Griha compound, 72 m, Biratnagar, Morang; Betana wetland, 123 m, Belbari, Morang (Misra *et al.*, 2009).

11. *Cocconeis placentula* Ehr. var. *euglypta* (Ehr.) Cl. (Fig. 14)

Hadi *et al.* 1984, p. 526, pl. 9, fig. 158; Sinu & Squires 1985, p. 301, pl. 5, figs. 37-40.

Valves 35.5 µm long, 19.5 µm broad; striae 18-19 in 10 µm.

Distribution in Nepal: Rawa Khola (river), 720 m, Manglabare, Khotang (Misra *et al.*, 2009).

12. *Navicula viridula* (Kütz.) Ehr. (Fig. 21)

Tiffany & Britton 1952, p. 255, pl. 67, fig. 785; Gandhi 1999, p. 54, pl. 3, fig. 124.

Valves 56.5-77 µm long, 13-15 µm broad; striae 6-7 (middle) to 9-10 (pole) in 10 µm.

Distribution in Nepal: A pond at Ankhukhola, Gorkha, 640 m. (Hirano, 1955); Punyamati river, Kavrepalanchowk (Aryal & Lacoul, 1996); Kathmandu, Likhu khola and Arun valley (Jüttner *et al.*, 1996).

13. *Stauroneis javanica* (Grun.) Cl. (Fig. 10)

Hustedt 1959, p. 813-817, fig. 1159.

Valves 98 µm long, 20.5 µm broad.

Distribution in Nepal: *S. javanica* (Grun.) Cl. var. *oblonga* Ostr. was reported from a stream at Mewa valley, eastern Nepal (Hirano, 1984).

14. *Pinnularia braunii* (Grun.) Cl. var. *amphicephala* (A. Mayer) Hust. (Fig. 12)

Foged 1980, p. 660, pl. 8, fig. 8; Prasad & Srivastava 1992, p. 230, pl. 30, fig. 13.

Valves 47.5-58 µm long, 9.5-10.5 µm broad; striae 10-12 in 10 µm.

Distribution in Nepal: A stream at Mewa valley, Eastern Nepal (Hirano, 1984); Sarouchia pond, 72 m, Biratnagar (Rai & Rai, 2005); Lamphengwa, Pheyong and Deumai rivers, Gajurmukhi, Ilam (Rai *et al.*, 2008a).

15. *Gyrosigma scalproides* (Rabenh.) Cl. (Fig. 19)

Tiffany & Britton 1952, p. 269, pl. 66, fig. 762; Prasad & Srivastava 1992, p. 241, pl. 31, fig. 9.

Valves 52 µm long, 8.5 µm broad; transverse striae 24 in 10 µm.

Distribution in Nepal: Kathmandu valley, Likhu Khola, and Arun valley (Eastern Nepal) (Jüttner *et al.*, 1996).

16. *Gomphonema cf. constrictum* Ehr. var. *capitata* (Ehr.) Cl. (Fig. 16)

Tiffany & Britton 1952, p. 271, pl. 72, fig. 840; Foged 1986, p. 562, pl. 6, figs. 7 & 12.

Valves 39 µm long, 10.5 µm broad; transverse striae 11 in 10 µm.

Distribution in Nepal: New record for Nepal.

17. *Gomphonema cf. intricatum* Kütz. var. *vibrio* (Ehr.) Cl. (Fig. 20)

Tiffany & Britton 1952, p. 271, pl. 72, fig. 837; Gandhi 1959, p. 325, fig. 46.

Valves 99.5 µm long, 10.5 µm broad; transverse striae 7-8 in 10 µm.

Distribution in Nepal: New record for Nepal.

18. *Gomphonema cf. parvulum* (Kütz.) var. *lagenula* Hust. (Fig. 17)

Carter & Denny 1987, p. 244, pl. 3, fig. 7.

Valves 52 µm long, 16 µm broad; auger shaped, transverse striae 9-11 in 10 µm.

Distribution in Nepal: New record for Nepal.

19. *Gomphonema sphaerophorum* Ehr. (Fig. 15)

Tiffany & Britton 1952, p. 272, pl. 72, fig. 847; Prasad & Srivastava 1992, p. 257, pl. 33, fig. 10.

Valves 43.5 µm long, 9 µm broad; striae 10-12 in 10 µm.

Distribution in Nepal: A pond near Phewa lake, 967 m, Pokhara, Kaski (Hirano, 1955); a pond near Police Station, Mahendranagar, Kanchanpur (Habib, 1997); Triyuga river, 152 m, Udayapur (Rai, 2006).

20. *Cymbella cymbiformis* (Ag.) Kütz. var. *nonpunctata* Font. (Fig. 13)

Hadi *et al.* 1984, p. 534, pl. 5, fig. 75; pl. 11, fig. 193.

Valves 63.5 µm long, 12.5 µm broad; striae 9 in 10 µm.

Distribution in Nepal: A stream at Kungbachen, 4150 m. (Hirano, 1984)

21. *Rhopalodia gibba* (Ehr.) O. Müll. var. *ventricosa* (Ehr.) Grun. (Fig. 22)

Foged 1980, p. 661, pl. 11, figs. 2-4; Gandhi 1999, p. 229, pl. 8, fig. 293.

Valves 65-91 µm long, 10-16 µm broad; costae 1-4 in 10 µm; striae 9 in 10 µm, 2-9 striae between two costae.

Distribution in Nepal: New record for Nepal.

22. *Nitzschia amphibia* Grun. (Fig. 18)

Prasad & Srivastava 1992, p. 285, pl. 36, fig. 16; Gandhi 1999, p. 56, pl. 3, fig. 125.

Valves 24.5 µm long, 4.5 µm broad; keel punctae 8-9 in 10 µm; striae 17 in 10 µm.

Distribution in Nepal: New record for Nepal.

23. *Surirella tenera* Greg. var. *ambigua* Gandhi (Fig. 23)

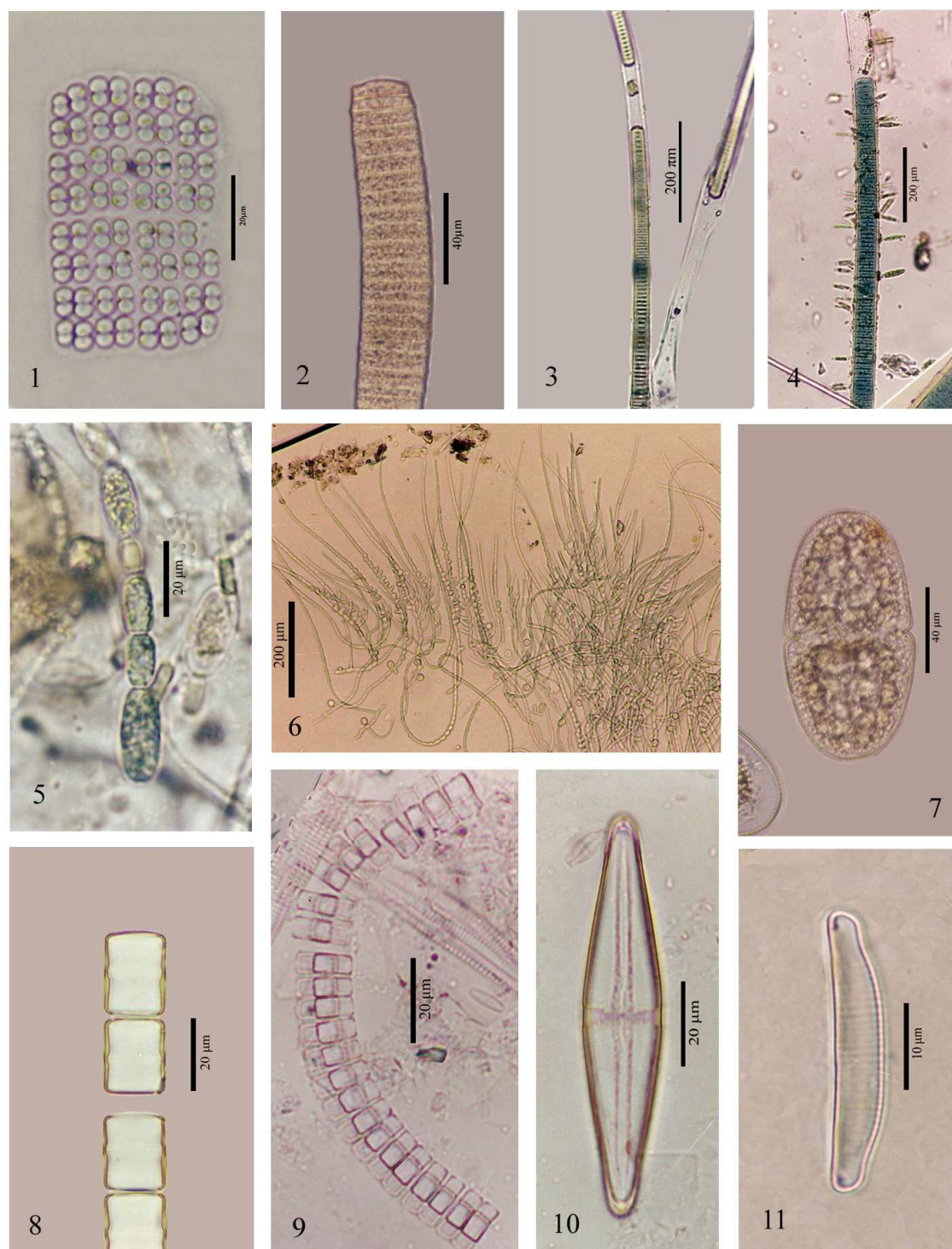
Gandhi 1957, p. 54, pl. 13, fig. 21; Gandhi 1999, p. 79, pl. 4, figs. 194-195.

Valves 89.5 µm long, 30 µm broad; costae 5 in 20 µm.

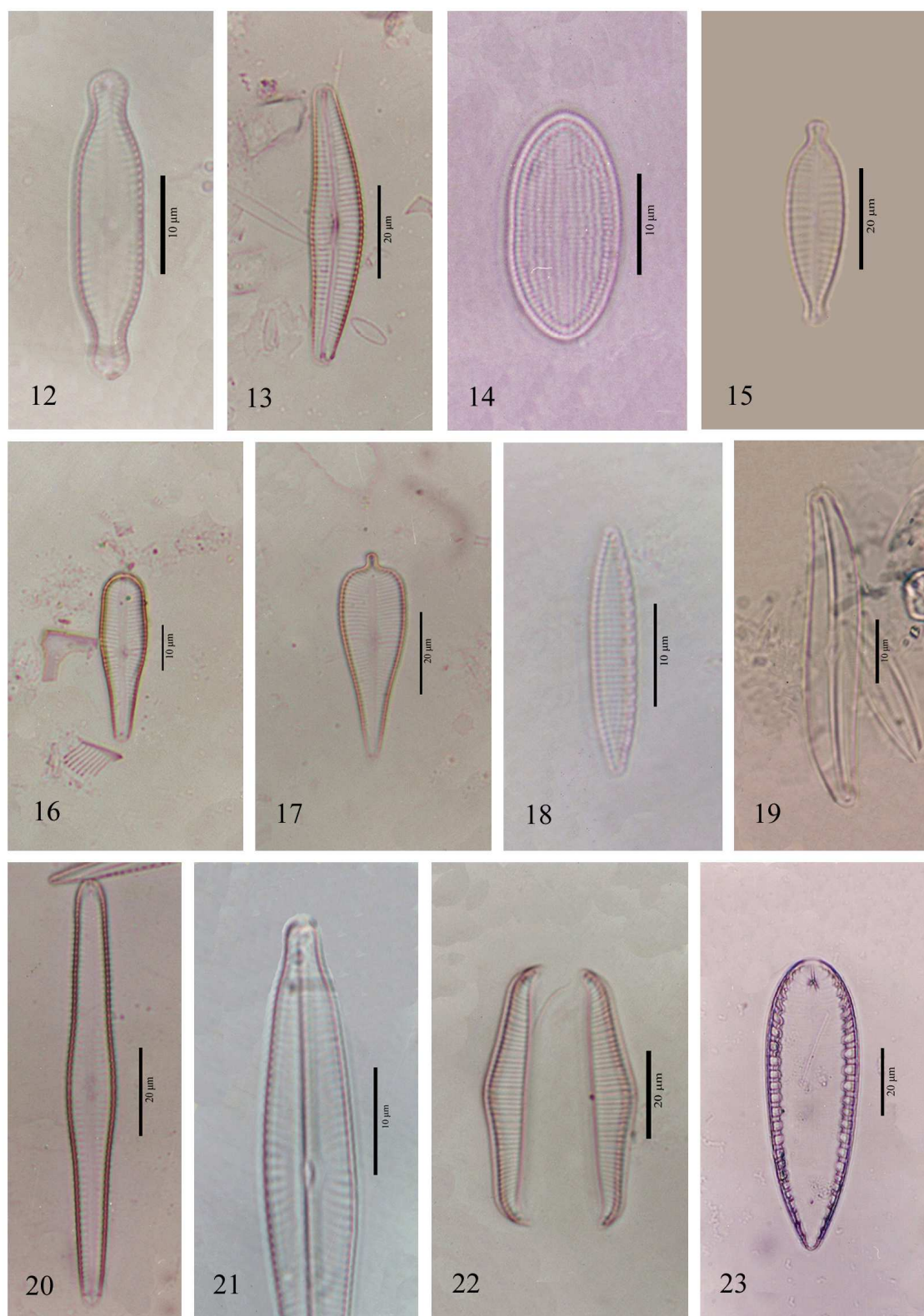
Distribution in Nepal: New record for Nepal.

Results and Discussion

In the present study, a total 23 algae have been reported from Betana wetland among which 6 taxa *viz.* *Gomphonema constrictum* Ehr. var. *capitata*, *Gomphonema intricatum* Kütz. var. *vibrio*, *Gomphonema parvulum* (Kütz.) var. *lagenula* Hust., *Rhopalodia gibba* (Ehr.) O. Müll. var. *ventricosa*, *Nitzschia amphibia* Grun. and *Surirella tenera* Greg. var. *ambigua* Gandhi were the new records for Nepal. Diatoms were the most dominant algae, representing by 16 taxa whereas green algae were the least, representing by only one taxa i.e. *Cosmarium maculatiforme*. More green algae present in the samples were still unidentified. Among the taxa, the dominancy was found as follows *Oscillatoria princeps* > *Cymbella cymbiformis* var. *nonpunctata* > *Gomphonema sphaerophorum* > *Pinnularia braunii* var. *amphicephala* > *Lyngbya majuscula* > *Cosmarium maculatiforme* > *Melosira varians* and so on. Fleishy gelatinous balls of *Nostochopsis lobatus* were found to be attached on the submerged walls of the outlet canal. Similarly, pure mucilaginous mass of *Lyngbya* species were found as floating on the edge of wetland. Further extensive algal exploration of the wetland periodically as well as seasonally and their relationship with water chemistry are essential and to be carried out in the future.



Figures 1. *Merismopedia elegans* **2.** *Oscillatoria princeps* **3.** *Lyngbya birgei* **4.** *Lyngbya majuscula* **5.** *Anabaena iyengarii* **6.** *Nostochopsis lobatus* **7.** *Cosmarium maculatiforme* **8.** *Melosira varians* **9.** *Fragilaria construence* var. *construence* **10.** *Stauroneis javanica* **11.** *Eunotia tschirchiana*.



Figures 12. *Pinnularia braunii* var. *amphicephala* **13.** *Cymbella cymbiformis* var. *nonpunctata* **14.** *Cocconeis placentula* var. *euglypta* **15.** *Gomphonema sphaerophorum* **16.** *Gomphonema* cf. *parvulum* var. *lagenula* **17.** *Gomphonema* cf. *constrictum* var. *capitata* **18.** *Nitzschia amphibia* **19.** *Gyrosigma scalproides* **20.** *Gomphonema* cf. *intricatum* var. *vibrio* **21.** *Navicula viridula* **22.** *Rhopalodia gibba* var. *ventricosa* **23.** *Surirella tenera* var. *ambigua*.

The history of Nepalese phycology showed poor and sporadic explorations and have only countable reports in comparison to the neighbouring countries. Though, Nepal is rich in algal diversity due to its diverse climate and rich lotic and lentic habitats, this branch has given least priority from the beginning. Recently, as the world has focused on the modern algal nanotechnology, biotechnology, genetics, bio-fuel, super food, natural health medicines, climate change, bio-indicator, pollution control, bio-fertilizer etc., interest has been increasing on this micro-flora to some extent.

A complete record and database by extensive explorations throughout the country is essential and should be carry out soon and then the practice to sustainable use of algae by promoting its farming for agriculture, food, medicine etc. that uplift economy of the nation should be started. Betana pond would be an appropriate natural habitat for mass cultivation of algae in the future to supply the need of industrial production.

Acknowledgement

I would like to acknowledge the Head, Department of Botany, P.G. Campus, Biratnagar for laboratory facilities. Thanks also due to University Grants Commission (UGC), Nepal for financial assistance.

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