

Desmids from Bees-hazaar Lake, Chitwan, Nepal

S.K. Rai¹, R.K. Rai² and N. Paudel¹

¹Department of Botany, P.G. Campus, T.U., Biratnagar, Nepal

²Department of Botany, M.M.A.M. Campus, T.U., Biratnagar, Nepal

Received: 19.03.2008, Accepted: 04.07.2008

Abstract

A total 36 taxa belonging to 7 genera of desmids have been described and illustrated from Bees-hazaar lake of which 11 taxa are recorded for the first time for Nepal. This is a preliminary work on the desmids from this lake.

Key words: Algae, Bees-hazaar Lake, Desmids, Nepal.

Introduction

Bees-hazaar lake (Latitude 27°37'04.6"N, Longitude 84°26'11.3"E; altitude 286 m amsl; area ca 100 ha) is an oxbow lake (Ramsar site) situated in Tikauli-3, Gitanagar VDC, Chitwan, surrounded by Barandabhar Corridor Forest, an extension of the buffer zone of Chitwan National Park. The lake is connected with other six ponds, ghols and swamps towards its south-east end whereas it forms many finger-like projections towards the north. The rich in total nitrogen and orthophosphate and low in transparency level ranked the lake as hypereutrophic category.

The work on desmids of Nepal has been carried out by Hirano (1955, 1963, 1969, 1984), Förster (1965), Kusel-fetzmann (1969), Hickel (1973), Ichimura and Kasai (1982), Shrestha and Manandhar (1983), Nakanishi (1986), Bando *et al.* (1989), Habib and Chaturvedi (1995, 1997), Rai (2007), and Rai and Misra (2008). The literature revealed that the desmids flora of Nepal has not been explored so far extensively and further more, the terai plain is least studied. Here, an attempt has been made to study the desmids from Bees-hazaar Lake.

In this paper, taxonomy and morphology of 36 taxa of desmids belonging to 7 genera (*Closterium* 4, *Pleurotaenium* 1, *Euastrum* 5, *Micrasterias* 5, *Cosmarium* 16, *Arthrodesmus* 1, *Staurastrum* 4) has been described and illustrated. Out of these, 11 taxa viz., *Euastrum elegans* (Bréb.) Kütz., *Micrasterias mahabuleshwariensis* Hobs. var. *surculifera* Legerh., *M. tropica* Nordst., var. *polonica* Eichl. et Gutw. f. *evoluta* Scott et Prescott, *Cosmarium bioculatum* Bréb., *C. contractum* Kirchn. var. *pachydemum* Scott et Prescott, *C. cymatopleurum* Nordst. var. *subtropicum* Islam, *C. punctulatum* Bréb. var. *subpunctulatum* (Nordst.) Borges, *C. striolatum* Näg., *Arthrodesmus convergens* Ehr. var. *curtus* Turn., *Staurastrum* cf. *bifidum* Bréb. in Ralfs, and *St. javanicum* (Nordst.) Tum. var. *apiculiferum* (Turn.) Krieg. have been reported for the first time for Nepal. All the reports are new for the lake as no work has been done hitherto.

Materials and methods

Algal samples were collected from five

different sites of Bees-hazaar lake during the period of June to September, 2007. All the samples were taken by squeezing out the roots of *Eichhornia crassipes*, *Pistia stratiotes* and submerged aquatic macrophytes. Samples were tagged and labeled then preserved in 4% formaldehyde solution on the spot. Morpho-taxonomy of the desmids was studied in the Laboratory of Department of Botany, P.G. Campus by screening and camera-lucida drawings. Identification was done on the basis of illustration and dimension of the relevant literature and monographs mentioned below each taxon's name in the text.

Explanation of symbols and abbreviations

L: Cell length

W: Cell diameter

MW: Median diameter

AW: Apical diameter

PW: Polar diameter

I: Isthmus diameter

CN: Sample number

D: Collection date

Taxonomic descriptions

1. *Closterium acerosum* (Schr.) Ehr. ex Ralfs (Pl. 1, Fig. 17)

Scott, A.M. and G.W. Prescott 1961, P. 9, Pl. 3, Fig. 1

L 474 µm, MW 42 µm, AW 4.5-6 µm; CN BH-18; D 27.8.2007

Distribution: Pangka, 4600 m; Longponga, 4650 m; Dudhpokhari, 4750 m (Watanabe, 1982); Mahendranagar (Habib and Chaturvedi, 1995; 1997); Koshi Tappu, 206 m (Rai and Misra, 2008)

2. *Closterium diana* Ehr. ex Ralfs var. *diana* (Pl. 1, Fig. 14)

Flint, E.A. and D.B. Williamson 1998, P. 75, Pl. 2, Fig. 7

L 203 µm, MW 17 µm, AW 2-3 µm; CN BH-4; D 25.6.2007

Distribution: Begnas lake, 960 m; Hetauda, 500 m (Watanabe, 1982); Koshi Tappu, 206 m (Rai and Misra, 2008)

3. *Closterium ehrenbergii* Menegh. ex Ralfs (Pl. 1, Fig. 15)

Nurul Islam, A.K.M. 1970, P. 910, Pl. 6, Fig. 14

L 374 µm, MW 64 µm, AW 8-10 µm; CN BH-5; D 25.6.2007

Distribution: Mugling, 500 m; Hetauda, 500 m (Watanabe, 1982); Baudha, Pashupatinath, Bansbari in Kathmandu; Dulari in Jhapa; Itahari; Birganj (Ichimura and Kasai, 1982); Chabahal in Kathmandu (Bando *et al.*, 1989); Mahendranagar (Habib and Chaturvedi, 1997); Koshi Tappu, 206 m (Rai and Misra, 2008)

4. *Closterium rostratum* Ehr. ex Ralfs (Pl. 1, Fig. 18)

Kouwets, F.A.C. 1987, P. 207, Pl. 5, Figs. 4-5

L 295 µm, MW 17 µm, AW 3-4 µm; CN BH- 13; D 24.7.2007

Distribution: Dole, 4100 m, Solu; Hetauda, 500 m (Watanabe, 1982); Mahendranagar (Habib and Chaturvedi, 1997)

5. *Pleurotaenium baculoides* (Roy et Biss.) Playf. (Pl. 1, Fig. 19)

Scott, A.M. and G.W. Prescott 1961, P. 14, Pl. 3, Fig. 5

L 370 µm, MW 30 µm, AW 18-20 µm, I 20 µm; CN BH-21; D 25.9.2007

Distribution: Taudaha, 1350 m, Kathmandu (Bando *et al.*, 1989)

6. *Euastrum ansatum* Ralfs var. *dideltiforme* Duce. (Pl. 2, Fig. 9)

- Nurul Islam, A.K.M. 1970, P. 916, Pl. 16, Fig. 6
L 85.8 µm, W 45 µm, PW 21 µm, I 11.6 µm; CN BH-10; D 25.6.2007
Distribution: Mewa valley (Hirano, 1984); Maipokhari lake, 2150 m, Ilam (Rai, 2008)
7. *Euastrum bidentatum* Näg. (Pl. 2, Fig. 14)
Capdevielle, P. and A. Coute' 1980, P. 880, Pl. 2, Fig. 20
L 48 µm, W 30.5 µm, PW 18 µm, I 10 µm; CN BH-10; D 25.6.2007
Distribution: Pheriche, 4200 m, Khumbu (Förster, 1965 as var. *speciosum*); Koshi Tappu, 206 m (Rai and Misra, 2008)
8. *Euastrum elegans* (Bréb.) Kütz. (Pl. 1, Fig. 3)
Kouwets, F.A.C. 1987, P. 215, Pl. 8, Figs. 7-8
L 36 µm, W 24 µm, PW 16 µm, I 6 µm; CN BH-8; D 25.6.2007
Distribution: New record for Nepal.
9. *Euastrum platycerum* Reinsch (Pl. 1, Fig. 10)
Scott, A.M. and G.W. Prescott 1961, P. 33, Pl. 60, Fig. 4
L 41 µm, W 35 µm, PW 12.5 µm, I 10 µm; CN BH-17; D 27.8.2007
Distribution: Koshi Tappu, 206 m (Rai and Misra, 2008)
10. *Euastrum spinulosum* DelP. (Pl. 1, Fig. 8)
Scott, A.M. and G.W. Prescott 1961, P. 40, Pl. 10, Fig. 3
L 45 µm, W 36 µm, PW 15 µm, I 11 µm; CN BH-13; D 24.7.2007
Distribution: Koshi Tappu, 206 m (Rai and Misra, 2008)
11. *Micrasterias foliacea* Bail. (Pl. 1, Fig. 13)
Scott, A.M. and G.W. Prescott 1961, P. 46, Pl. 20, Fig. 4
L 70 µm, W 75 µm, I 17 µm; CN BH-1; D 25.6.2007
Distribution: Koshi Tappu, 206 m (Rai and Misra, 2008)
12. *Micrasterias mahabuleshwarensis* Hobs. var. *surculifera* Lagerh. (Pl. 2, Fig. 6)
Scott, A.M. and G.W. Prescott 1961, P. 50, Pl. 16, Figs. 1-2
L 154 µm, W 134 µm, I 24 µm; CN BH-19; D 27.8.2007
Distribution: New record for Nepal.
13. *Micrasterias pinnatifida* (Kütz.) Ralfs (Pl. 2, Fig. 8)
Nurul Islam, A.K.M. 1970, P. 920, Pl. 10, Figs. 3-7
L 54 µm, W 62 µm, I 10 µm; CN BH-11; D 24.7.2007
Distribution: Luitel Bhanjyang, 770 m, Gorkha (Hirano 1955); Koshi Tappa, 206 m (Rai and Misra, 2008)
14. *Micrasterias radians* Tum. (Pl. 2, Fig. 7)
Scott, A.M. and G.W. Prescott 1961, P. 51, Pl. 23, Fig. 1
L 125 µm, W 115 µm, I 21 µm; CN BH-6; D 25.6.2007
Distribution: Tahachal, 1300 m, Kathmandu (Hirano, 1955)
15. *Micrasterias tropica* Nordst. var. *polonica* Eichl. et Gutw. f. *evoluta* Scott et Prescott (Pl. 2, Fig. 5)
Scott, A.M. and G.W. Prescott 1961, P. 53, Pl. 16, Fig. 7
L 133 µm, W 103 µm, I 17.5 µm; CN BH-19; D 27.8.2007

- Distribution: New record for Nepal. L 24 µm, W 16.5 µm, I 4 µm; CN BH-19; D 27.8.2007
16. *Cosmarium bioculatum* Bréb. (Pl. 1, Fig. 4) Distribution: Pheriche, 4200 m, Khumbu (Förster, 1965)
Bharati, S.G. and G.R. Hegde 1982, P. 736, Pl. 11, Fig. 12
L 19 µm, W 19 µm, I 5 µm; CN BH-1; D 25.6.2007
Distribution: New record for Nepal.
17. *Cosmarium contractum* Kirchn. var. *pachydermum* Scott et Prescott (Pl. 1, Fig. 2) Distribution: Luitel Bhanjyang, 770 m, Gorkha (Hirano, 1955); Taudaha, 1350 m, Kathmandu (Bando *et al.* 1989); Mahendranagar (Habib and Chaturvedi, 1995); Koshi Tappu, 206 m (Rai and Misra, 2008)
Scott, A.M. and G.W. Prescott 1961, P. 56, Pl. 27, Fig. 6
L 34 µm, W 27 µm, I 6 µm; CN BH-12; D 24.7.2007
Distribution: New record for Nepal.
18. *Cosmarium cymatopleurum* Nordst. var. *subtropicum* Islam (Pl. 1, Fig. 5) Distribution: Luitel Bhanjyang, 770 m, Gorkha; Pisang, 3100 m, Manang; Tukucha Moor, 2600 m, Mustang (Hirano, 1955; 1963); Mahendranagar (Habib and Chaturvedi, 1997)
Nurul Islam, A.K.M. 1970, P. 923, Pl. 11, Fig. 11
L 42 µm, W 29 µm, I 8.5 µm; CN BH-8; D 25.6.2007
Distribution: New record for Nepal.
19. *Cosmarium granatum* Bréb. (Pl. 1, Fig. 7) Distribution: Mewa valley (Hirano, 1984); Mahendranagar (Habib and Chaturvedi, 1997)
Tiffany, L.H. and M.E. Britton 1952, P. 186, Pl. 51, Fig. 565
L 33 µm, W 24 µm, I 6 µm; CN BH-12; D 24.7.2007
20. *Cosmarium impressulum* Elfv. f. *minus* Turm. (Pl. 1, Fig. 9) Distribution: Koshi Tappu, 206 m (Rai and Misra, 2008)
Bharati, S.G. and G.R. Hegde 1982, P. 742, Pl. 11, Fig. 3
21. *Cosmarium javanicum* Nordst. (Pl. 1, Fig. 6) Distribution: Luitel Bhanjyang, 770 m, Gorkha (Hirano, 1955); Taudaha, 1350 m, Kathmandu (Bando *et al.* 1989); Mahendranagar (Habib and Chaturvedi, 1995); Koshi Tappu, 206 m (Rai and Misra, 2008)
Nurul Islam, A.K.M. and A.K. Yusuf Haroon 1980, P. 576, Pl. 11, Figs. 156-157; Pl. 13, Fig. 179
L 155 µm, W 70 µm, I 32.5 µm; CN BH-1; D 25.6.2007
22. *Cosmarium lundellii* DelP. var. *circulare* (Reinsch) Krieg. (Pl. 2, Fig. 4) Distribution: Mewa valley (Hirano, 1984); Mahendranagar (Habib and Chaturvedi, 1997)
Bharati, S.G. and G.R. Hegde 1982, P. 744, Pl. 1, Fig. 2
L 55 µm, W 42 µm, I 16 µm; CN BH-13; D 24.7.2007
Remark: Present specimen has small dimension than the type.
23. *Cosmarium lundellii* DelP. var. *ellipticum* West et West f. *minus* Prescott (Pl. 1, Fig. 11) Distribution: Koshi Tappu, 206 m (Rai and Misra, 2008)
Bharati, S.G. and G.R. Hegde 1982, P. 744, Pl. 1, Fig. 6
L 43 µm, W 39 µm, I 15 µm; CN BH-12; D 27.7.2007
24. *Cosmarium maculatifforme* Schm. (Pl. 2, Fig. 12)

- Nurul Islam, A.K.M. 1970, P. 924, Pl. 14, Fig. 1
L 113 µm, W 62 µm, I 40 µm; CN BH-18; D 27.8.2007
Distribution: Luitel Bhanjyang, 770 m, Gorkha (Hirano, 1955 as var. *maior*)
25. *Cosmarium margaritatum* (Lund.) Roy et Biss. var. *sublatum* (Nordst.) Krieg. (Pl. 2, Fig. 10)
Scott, A.M. and G.W. Prescott 1961, P. 63, Pl. 29, Fig. 4
L 70 µm, W 64 µm, I 21 µm; CN BH-23; D 25.9.2007
Distribution: Ankhu Khola, 630 m, Gorkha (Hirano, 1955)
26. *Cosmarium obsoletum* (Hantz.) Reinsch (Pl. 2, Fig. 2)
Kouwets, F.A.C. 1987, P. 226, Pl. 11, Fig. 15
L 51 µm, W 55 µm, I 24 µm; CN BH-18; D 27.8.2007
Distribution: Luitel Bhanjyang, 770 m, Gorkha (Hirano, 1955); Koshi Tappu, 206 m (Rai and Misra, 2008)
27. *Cosmarium punctulatum* Bréb. var. *subpunctulatum* (Nordst.) Borges (Pl. 2, Fig. 3)
Scott, A.M. and G.W. Prescott 1961, P. 67, Pl. 31, Fig. 8
L 28 µm, W 25 µm, I 9 µm; CN BH-7; D 25.6.2007
Distribution: New record for Nepal.
28. *Cosmarium quadratum* Ralfs ex Ralfs var. *willei* (Schm.) Krieg. et Gerl. (Pl. 2, Fig. 13)
Kouwets, F.A.C. 1987, P. 231, Pl. 11, Figs. 8-10
L 78 µm, W 44 µm, I 18 µm; CN BH-14; D 24.7.2007
Distribution: Karyolung, 4300-4400 m, Khumbu (Förster, 1965)
29. *Cosmarium regnellii* Wille Fa. (Pl. 1, Fig. 1)
Prasad, B.N. and P.K. Misra 1992, P. 180, Pl. 21, Fig. 25
L 11.5 µm, W 10 µm, I 2.7 µm; CN BH-19; D 27.8.2007
Distribution: Pheriche, 4200 m, Khumbu (Förster, 1965); Taudaha, 1350 m, Kathmandu (Bando *et al.*, 1989); Rara lake, 3030 m, Mugu (Watanabe, 1995)
30. *Cosmarium striolatum* Näg. (Pl. 2, Fig. 11)
Bharati, S.G. and G.R. Hegde 1982, P. 752, Pl. 10, Fig. 4
L 108 µm, W 63 µm, I 51 µm; CN BH-4; D 25.6.2007
Distribution: New record for Nepal.
31. *Cosmarium sublateriundatum* West et West (Pl. 2, Fig. 1)
Nurul Islam, A.K.M. and A.K. Yusuf Haroon 1980, P. 580, Pl. 22, Figs. 263-264
L 41 µm, W 39 µm, I 13 µm; CN BH-22; D 25.9.2007
Distribution: Tukucha Moor, 2600 m, Mustang (Hirano, 1955); Pashupatinath, 1300 m (Bando *et al.*, 1989)
32. *Arthrodesmus convergens* Ehr. var. *curtus* Turn. (Pl. 1, Fig. 12)
Scott, A.M. and G.W. Prescott 1961, P. 74, Pl. 34, Fig. 5
L 57 µm, W 84 µm (with spines), I 20 µm; CN BH-1; D 25.6.2007
Distribution: New record for Nepal.

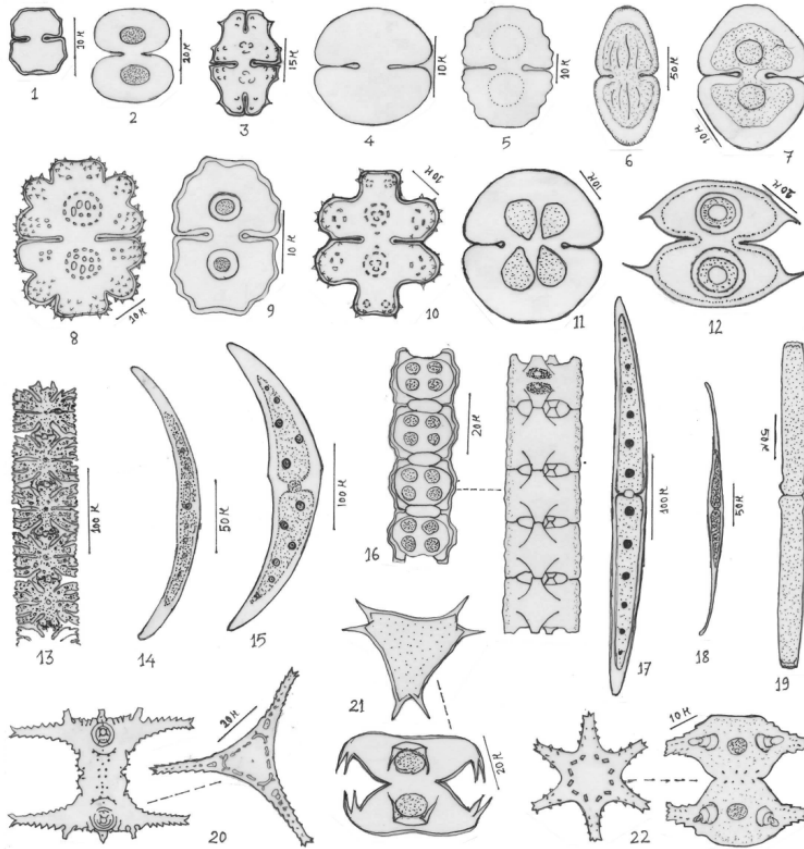


Plate 1

Fig.1 *Cosmarium regnellii* Wille Fa., **Fig. 2** *C. contractum* Kirchn. var. *pachylemum* Scott et Prescott, **Fig. 3** *Euastrum elegans* (Bréb.) Kütz., **Fig. 4** *Cosmarium bioculatum* Bréb., **Fig. 5** *C. cymatopleurum* Nordst. var. *subtropicum* Islam, **Fig. 6** *C. javanicum* Nordst., **Fig. 7** *C. granatum* Bréb., **Fig. 8** *Euastrum spinulosum* DelP., **Fig. 9** *Cosmarium impressulum* Elfv. f. *minus* Tum., **Fig. 10** *Euastrum platycerum* Reinsch, **Fig. 11** *Cosmarium lundellii* DelP. var. *ellipticum* West et West f. *minus* Prescott, **Fig. 12** *Arthrodesmus convergens* Ehr. var. *curtus* Turn., **Fig. 13** *Micrasterias foliacea* Bail., **Fig. 14** *Closterium diana* Ehr. ex Ralfs var. *Diana*, **Fig. 15** *Cl. ehrenbergii* Menegh. ex Ralfs, **Fig. 16** *Desmidium baileyi* (Ralfs) Nordst. var. *baileyi* f. *tetragonum* Nordst., **Fig. 17** *Closterium acerosum* (Schr.) Ehr. ex Ralfs, **Fig. 18** *Cl. rostratum* Ehr. ex Ralfs, **Fig. 19** *Pleurotaenium baculoides* (Roy et Biss.) Playf., **Fig. 20** *Staurastrum javanicum* (Nordst.) Turn. var. *apiculiferum* (Turn.) Krieg., **Fig. 21** *St. cf. bifidum* Bréb. in Ralfs, **Fig. 22** *St. sexcostatum* Bréb. ex Ralfs var. *productum* (W. West) G.S. West.

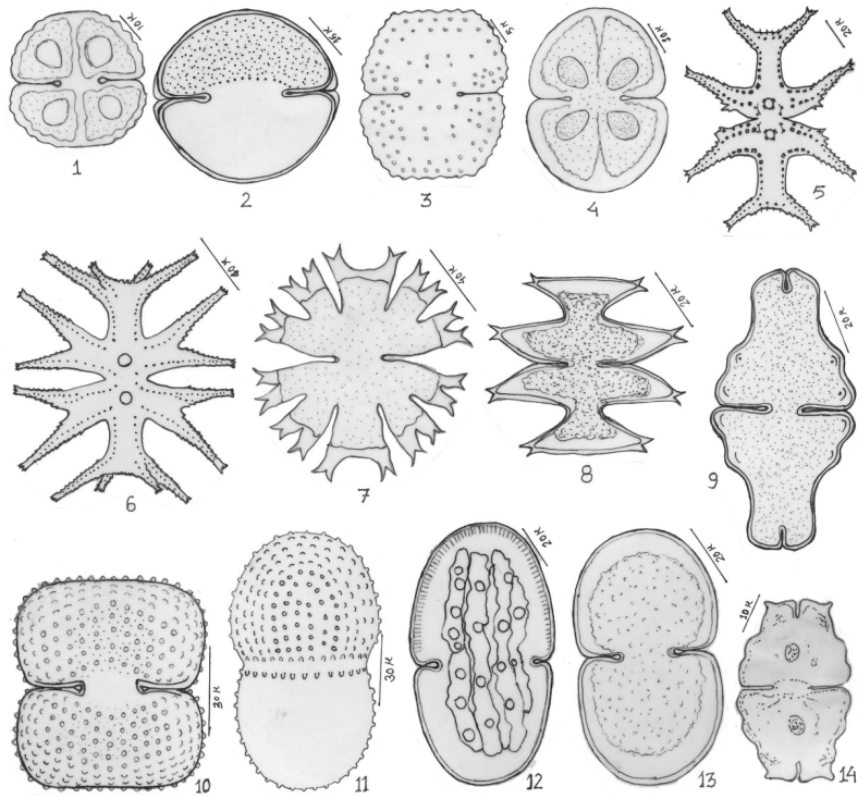


Plate 2

Fig.1 *Cosmarium sublateriundatum* West et West, **Fig.2** *C. obsoletum* (Hantz.) Reinsch, **Fig.3** *C. punctulatum* Bréb. var. *subpunctulatum* (Nordst.) Borges, **Fig.4** *C. lundellii* DelP. var. *circularis* (Reinsch) Krieg, **Fig.5** *Micrasterias tropica* Nordst. var. *polonica* Eichl. et Gutw. f. *evoluta* Scott et Prescott, **Fig.6** *M. mahabuleshwariensis* Hobs. var. *surculifera* Lagerh, **Fig.7** *M. radians* Turn, **Fig.8** *M. pinnatifida* (Kütz.) Ralfs, **Fig.9** *Euastrum ansatum* Ralfs var. *dideltiforme* Duce, **Fig.10** *Cosmarium margaritatum* (Lund.) Roy et Biss. var. *sublatum* (Nordst.) Krieg, **Fig.11** *C. striolatum* Näg, **Fig.12** *C. maculiforme* Schm, **Fig.13** *C. quadratum* Ralfs ex Ralfs var. *willei* (Schm.) Krieg. et Gerl, **Fig.14** *Euastrum bidentatum* Näg.

33. Remark: *Staurostrum* cf *bifidum* Bréb. in Ralfs (Pl. 1, Fig. 21)

Scott, A.M. and G.W. Prescott 1961, P. 86, Pl. 54, Fig. 5

L 37 µm, W 54 µm (with spines), I 16 µm; CN BH-23; D 25.9.2007

Present specimen has more or less similar dimension with the type but spines are

abruptly bent and outer surface distinctly concave.

Distribution: New record for Nepal.

34. *Staurastrum javanicum* (Nordst.) Turn. var. *apiculiferum* (Tum.) Krieg. (Pl. 1, Fig. 20)

Scott, A.M. and G.W. Prescott 1961, P. 97, Pl. 44, Fig. 6

L 51 µm, W 70 µm, I 14 µm; CN BH-15; D 24.7.2007

Distribution: New record for Nepal.

35. *Staurastrum sexcostatum* Bréb. ex Ralfs var. *productum* (W. West) G.S. West (Pl. 1, Fig. 22)

Kouwets, F.A.C. 1987, P. 251, Pl. 19, Fig. 7 L 42 µm, W 45 µm, I 14 µm; CN BH-1; D 25.6.2007

Distribution: Luitel Bhanjyang, 770 m, Gorkha (Hirano, 1955); Koshi Tappu, 206 m (Rai and Misra, 2008)

36. *Desmidium baileyi* (Ralfs) Nordst. var. *baileyi* f. *tetragonum* Nordst. (Pl. 1, Fig. 16) Nurul Islam, A.K.M. and H.M. Irfanullah 1999, P. 120, Pl. 1, Fig. 1

L 17 µm, W 24 µm, I 23 µm; CN BH-1; D 25.6.2007

Distribution: Koshi Tappu, 206 m (Rai and Misra, 2008)

Conclusion

Present investigation shows that the desmids flora of Bees-hazaar lake is rich and diverse. Among the genera, *Cosmarium* has the maximum taxa representing by 16 out of 36 whereas *Pleurotaenium* and *Arthrodesmus* have monotypes. Here, one specimen (*Staurastrum* cf. *bifidum*) we have has similar dimensions and morphology of spines with *Staurastrum bifidum* described by Scott and Prescott (1961) but it has

distinctly concave outer surface as in *Staurodesmus triangularis* (Lagerh.) Teil. described by Kouwets (1987) and abruptly bent down spines. Therefore, it needs further study to be confirmed. For a complete documentation of the specimens, regular seasonal explorations of the lake will be essential.

Acknowledgements

Authors are grateful to the Chairman, Department of Botany, P.G. Campus, Biratnagar for the laboratory facilities.

References

- Bando, T., T. Nakano and M. Watanabe 1989. The desmid flora of Kathmandu, Nepal. *Bull. Natn. Sci. Mus., Ser. B*, Tokyo. **15**: 1-25.
- Bharati, S.G. and G.R. Hegde 1982. Desmids from Karnataka state and Goa, Part III. Genus *Cosmarium* Corda. *Nova Hedwigia* **36**: 733-757.
- Capdevielle, P. and A. Coute' 1980. Quelques *Staurastrum* Meyen (Chlorophycées, Desmidiacées) rare ou nouveaux pour la France. *Nova Hedwigia* **33**: 859-882.
- Flint, E.A. and D.B. Williamson 1998. Desmids (Chlorophyta) in two ponds in Central Canterbury, New Zealand. *Algological Studies* **91**: 71-100.
- Förster, K. 1965. Beitrag zur kenntais der Desmidiaceen-flora von Nepal. *Erg. Forschunturm Nepal Himalaya. Khumbu Himal* **1**, 2: 25-58.
- Habib, I. and U.K. Chaturvedi 1995. On some desmids from Nepal. *J. Ind. Bot. Soc.* **74(1-4)**: 277-282.
- Habib, I. and U.K. Chaturvedi 1997. Contribution to the knowledge of desmids from Nepal. *Phykos* **36(1-2)**: 27-36.
- Hickel, B. 1973. Limnological investigations in lakes of Pokhara valley, Nepal. *Int. Rev. ges Hydrobiol.* **58(5)**: 659-672.
- Hirano, M. 1955. Fresh water algae. In *Fauna and flora of Nepal Himalaya* (Ed. H. Kihara). *Fauna and Flora Research Society*, Kyoto, Japan. pp. 5-42.
- Hirano, M. 1963. Fresh water algae from the Nepal Himalaya, collected by a member of the Japanese

- Climbing Expedition. *Contr. Biol. Lab.*, Kyoto Univ., Japan. **16**: 1-23.
- Hirano, M. 1969. Fresh water algae from Langtang Himal, Nepal Himalaya. *Contr. Biol. Lab.*, Kyoto Univ., Japan. **22**: 1-42.
- Hirano, M. 1984. Fresh water algae from east Nepal. Study reported of *Baika Junior College* **32**: 197-215.
- Ichimura, T. and F. Kasai 1982. New mating groups, group H and group I of *Closterium ehrenbergii* Meneghini from Kathmandu valley and terai plains of Nepal. In *Reports on the cryptogamic study in Nepal* (Ed. Y. Otani). National Science Museum, Tokyo, Japan. pp. 61-73.
- Kouwets, F.A.C. 1987. Desmids from the Auvergne (France). *Hydrobiol.* **146**: 193-263.
- Kusel-fetzmann, E. 1969. Einige Algen aus Nepal. *Khumbu Himal* **1(6)**: 37-56.
- Nakanishi, M. 1986. Limnological study in Phewa, Begnas and Rupa lakes. In *Studies on distribution, adaptation and evolution of microorganisms in Nepal Himalayas* (Ed. Y. Ishida). Ministry of Education, Science and Culture, Kyoto, Japan. pp. 3-13.
- Nunul Islam, A.K.M. 1970. Contributions to the knowledge of desmids of East Pakistan, Part I. *Nova Hedwigia* **20**: 903-983.
- Nunul Islam, A.K.M. and A.K. Yusuf Haroon 1980. Desmids of Bangladesh. *Int. Rev. ges Hydrobiol.* **65(4)**: 551-604.
- Nunul Islam, A.K.M. and H.M. Irfanullah 1999. New records of desmids for Bangladesh- II. Thirteen taxa. *Bangladesh J. Bot.* **28(2)**: 117-123.
- Prasad, B.N. and P.K. Misra 1992. *Fresh water algal flora of Andaman and Nicobar Islands*. Vol. II. B. Singh and M.P. Singh Publ., Dehradun, India.
- Rai, S.K. 2008. Some chlorophycean algae from Maipokhari lake, Ilam. *J. Nat. Hist. Mus.*, Nepal. (Communicated)
- Rai, S.K. and P.K. Misra 2008. On some desmids from Koshi Tappu Wildlife Reserve, Nepal. *Ecoprint* (Communicated)
- Scott, A.M. and G.W. Prescott 1961. Indonesian desmids. *Hydrobiologia* **17(1-2)**: 1-132.
- Shrestha, B. and J.D. Manandhar 1983. Contribution to the algal flora of Kathmandu valley. *J. Inst. Sci. Techn.* **6**: 1-6.
- Tiffany, L.H. and M.E. Britton 1952. *The algae of Illinois*. Hafner Publ. Co., New York. 405p.
- Watanabe, M. 1982. Observation on the genus *Closterium* from Nepal. In *Reports on the cryptogamic study in Nepal* (Compiled Y. Otani). National Science Museum, Tokyo, Japan. pp. 47-59.
- Watanabe, M. 1995. Algae from lake Rara and its vicinities, Nepal Himalayas. In *Cryptogams of the Himalayas*, Vol. 3, *Nepal and Pakistan* (Eds. M. Watanabe and H. Hagiwara). National Science Museum, Tsukuba, Japan. pp. 1-17.