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# Some Desmids from Garhwal Region of Uttarakhand, India

**Pradeep Kumar Misra*, Purnima Misra, Madhulika Shukla and Jai Prakash**

*Department of Botany, University of Lucknow, Lucknow – 226007*

The present paper consists of 42 taxa belonging to 7 genera of desmids (green algae) collected from two districts of Garhwal region of Uttarakhand (Western Himalayas). The district Haridwar is located 29° 55' to 29° 59' N latitude and 68° 5' to 68° 30' E longitude covering about 2360 km$^2$ area and Dehradun district is situated between 77° 34' to 78° 18' E longitude and 29° 58' to 30° 58' N latitude. Seven genera of desmids are (with number of taxa in parenthesis): *Closterium* Nitzsch. (9), *Cosmarium* Corda ex Ralfs (25), *Euastrum* Ehr. (2), *Spondylosium* Breb. (1), *Micrasterias* Ag. (1), *Staurastrum* Meyen (3), *Arthrodesmus* Ehr. (1). All these taxa constitute new records for the area. The algal localities are relatively cleaner than those of majority of urban areas. A rich assemblage of desmids shows that water bodies of these hilly areas are still undisturbed and need protection for preservation of algal biodiversity.

**Key Words:** desmids, Garhwal region, India, Uttarakhand

## INTRODUCTION

Fresh water algae of India have been studied by several workers. Iyengar and Bai (1941) have studied desmids flora from Kodai Canal, South India. Venkateswarlu (1969, 1970) has described desmids new to Indian flora. Agarkar *et al.* (1979) have recorded desmids from Bandhagarh, M.P. Bharati and Hedge (1982) has studied desmids from Karnataka State and Goa. Prasad and Misra (1984, 1985) have reported a new species of *Closterium* Nitzsch. and 9 taxa of *Cosmarium* Corda ex Ralfs from India. Hedge and Bharati (1985) has recorded *Staurastrum agumbeyense* sp. nov. and *S. biwaensis* Hirano var. *sorabnum* var. nov. from Karnataka. Sindhu and Pannikar (1995) have enumerated two taxa of *Staurastrum* Meyen from Quilon, Kerala. Kant and Gupta (1998) have studied 166 taxa from Leh Kashmir out of which 3 species, 10 varieties and 2 forms were new to science. Habib *et al.* (1998) have reported some desmids flora from Kumaon Himalaya, U.P. Habib and Chaturvedi (2001) contributed to the knowledge of desmids of Kumaon Himalaya. Misra *et al.* (2007) has studied some desmids from Gorakhpur, Uttar Pradesh and further (2008) reported some desmids from district Mau, U.P. Shukla *et al.* (2008) studied desmids of foothills of Western Himalaya.

Major contributions in desmidiacean algae in abroad were made by Kim (1996) on Korea, Gonzalves *et al.* (1996) on Colombia, Gerrath and John (1988) on Ghana, Williamson (1998) on Peninsula Malaysia, Flint and Williamson (1999) on NewZealand, Coesal (2002) on Netherlands, Dingley (2002) on Australia, Gontcharov *et al.* (2002) on Canada, Sahin (2002, 2005) on Turkey. Similarly, Kanetsuna (2002) has described the desmids of Japan, Combodia, Malaysia and Thailand. Kostkeviciene *et al.* (2003) and Novakova (2003) have also studied the desmids from Hungary, Lithuania and Czech Republic respectively.

The district Haridwar is located 29° 55' to 29° 59' N latitude and 68° 5' to 68° 30' E longitude covering about 2360 km$^2$ area. Maximum temperature is 35°C and minimum temperature is 13.67°C. January is the coldest month when temperature goes down to 3°C. The district Dehradun which is situated between 77° 34' to 78° 18' E and 29° 58' to 30° 58' N. May and June are the hottest months (40-41°C) and December and January are the coldest when the temperature reaches the freezing point. Average rainfall of this area ranges from 2,000-2,125 mm.

## MATERIALS AND METHODS

Sample collection was made during January and June 2005 and March 2006. Collection was made with the help

*Corresponding author (misrapkm@yahoo.com)

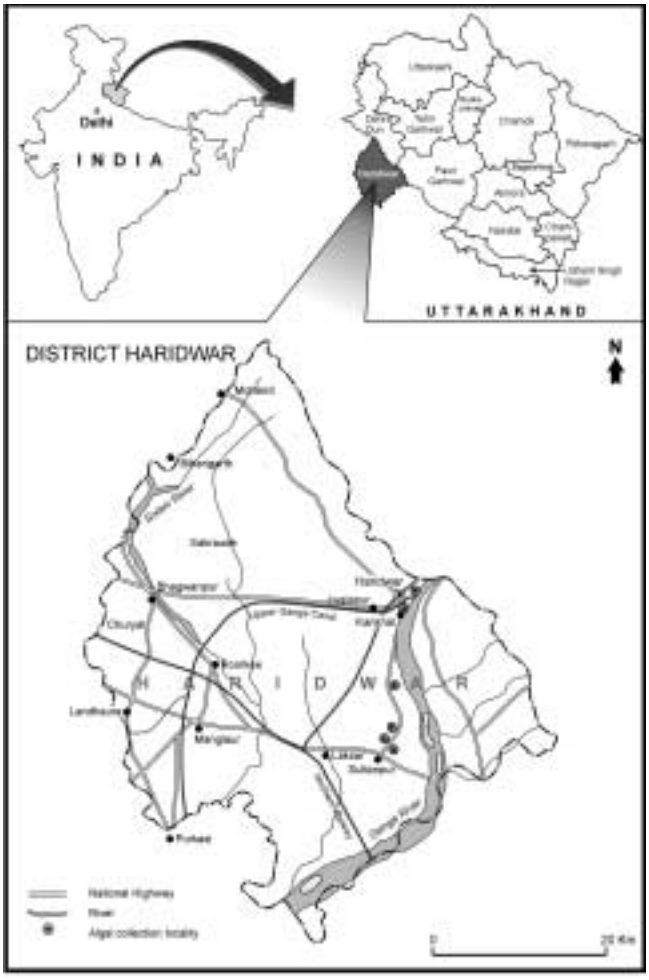


**Fig. 1.** Map of District-Haridwar, showing the sites of algal collection.

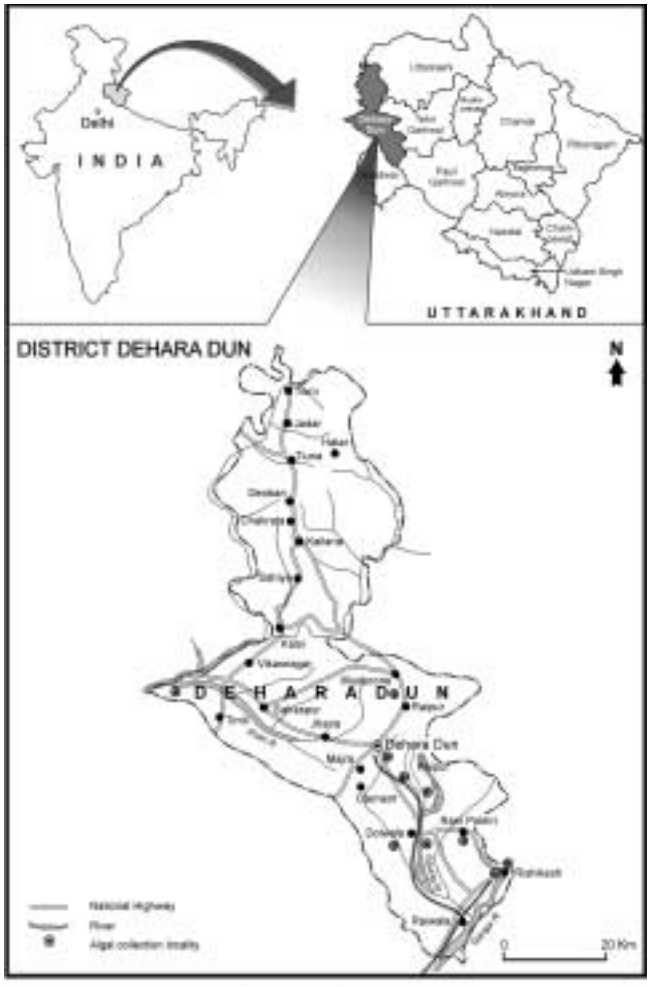


**Fig. 2.** Map of District-Dehradun, showing the sites of algal collection.

of planktonic mesh net and by squeezing the submerged vegetation harboring algae. Algal samples were preserved in 4% formalin. For the detailed study the chlorophycean algae were stained with Iodine and mounted in glycerine. The slides were examined under Labophot-II microscope with H-III photomicrographic attachment.

## RESULTS AND DISCUSSION

**Class: Chlorophyceae**
**Order: Zygnematales**
**Family: Desmidiaceae**

**Genus: *Cosmarium* Corda ex Ralfs, 1848**

**1. *Cosmarium angulosum* Breb. var. *concinnum* (Rao) West *et* West (Pl. 1, Fig. 1)**

Prasad and Misra 1992, p. 152, pl. 21, figs 5 and 8.

Cells small, deeply constricted, with entire margin, sinus narrow, linear, semi cells hexagonal with sharp angle in parallel sides, apex slightly retuse, straight cell wall smooth. Cells 18 $\mu$m long, 15 $\mu$m in diameter, isthmus 2 $\mu$m.

**Collection number, date and site: Garh./ut. 20, III; 22 June 2005; Asan Bairaj, Dehradun.**

**2. *Cosmarium angulatum* Rab. f. *majus* Grunow (Pl. 1, Fig. 2)**

Scott and Prescott 1961, p. 54, pl. 28, fig. 1.

Cells small, longer than broad, semicells with 5 ridges, ends flattened, cell wall smooth. Each semicell with one chloroplast, 2 pyrenoids. Isthmus narrow. Length of cell is 71 $\mu$m and breadth is 41 $\mu$m. Isthmus is 15 $\mu$m.

**Collection number, date and site: Garh./ ut. 4, III; 12 June 2005; Deopura Canal, Lachchhiwala, Dehradun.**

**3. *Cosmarium awadhense* Prasad *et* Mehrotra (Pl. 1, Fig. 3)**

Prasad and Mehrotra 1977a, p. 55, figs 35 and 81.

Prasad and Misra 1992, p. 153-154, pl. 21, fig. 17.

Cells small, slightly longer than broad, constriction

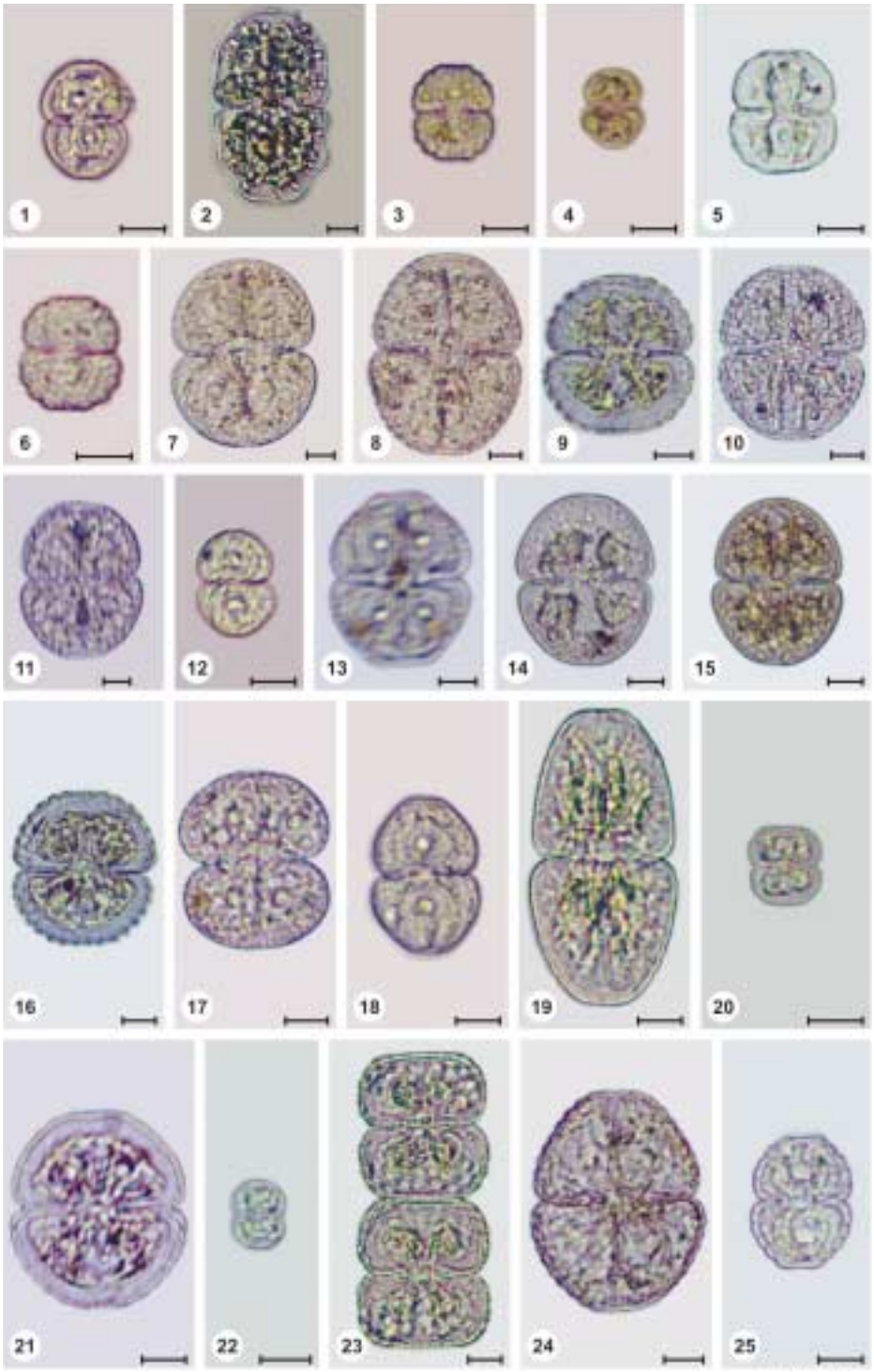


**Plate 1.** Fig. 1. *Cosmarium angulosum* Breb var. *concinnum* (Rao) West *et* West, Fig. 2. *Cosmarium angulatum* Rab. f. *majus* Grunow, Fig. 3. *Cosmarium awadhense* Prasad *et* Mehrotra, Fig. 4. *Cosmarium bidentatum* Turner, Fig. 5. *Cosmarium bipunctatum* Borges f. *subrectangularis* West *et* West, Fig. 6. *Cosmarium blytii* Wille var. *novae-sylvae* West *et* West, Fig. 7. *Cosmarium circulare* Reinsch var. *messikomeri* Krieger *et* Gerloff, Fig. 8. *Cosmarium decoratum* West *et* West, Fig. 9. *Cosmarium dispersum* Johnson, Fig. 10. *Cosmarium formosulum* Hoffman var. *narthorstii* (Boldt) West *et* West, Fig. 11. *Cosmarium formosulum* Hoffman, Fig. 12. *Cosmarium granatum* Brebisson, Fig. 13. *Cosmarium hammeri* Reinsch var. *homalodermum* (Nordst.) West *et* West, Fig. 14. *Cosmarium lundellii* Delp. var. *circulare* (Reinsch) Krieg., Fig. 15. *Cosmarium lundellii* Delp. var. *subellipticum* Prasad *et* Mehrotra, Fig. 16. *Cosmarium miscellum* Skuja, Fig. 17. *Cosmarium phaseolus* Breb. var. *omphalum* (Schaarschm.) Racib., Fig. 18. *Cosmarium pseudopyramidatum* Lund, Fig. 19. *Cosmarium pseudopyramidatum* Lund var. *occulatum* Krieger, Fig. 20. *Cosmarium pygmaeum* Archer, Fig. 21. *Cosmarium regnelli* Wille, Fig. 22. *Cosmarium scissum* Bruehl and Biswas, Fig. 23. *Cosmarium spinuliferum* West *et* West, Fig. 24. *Cosmarium speciosum* Lund, Fig. 25. *Cosmarium subalatum* West *et* West. Scale bars = 10 $\mu$m.

deep, sinus narrowly linear towards apex and slightly open outwards; semi cells sub semicircular, sides 4-5 crenate, apex truncate with more or less straight margin, cell wall smooth, each semicell with one massive chloroplast containing one pyrenoid. Long. cell 23 $\mu$m and lateral cell 19 $\mu$m and isthmus 5 $\mu$m.

**Collection number, date and site: Garh./ ut. 1, III; 11 June 2005; Sahasradhara, Dehradun.**

**4. *Cosmarium bidentatum* Turner (Pl. 1, Fig. 4)**

Turner 1892, p. 55, T. VIII, fig. 24.

Cells small, sub hexagonal in shape, more or less 1.5 times longer than broad, semi cells sub taperizoids, basal angle rounded and lateral side rotundate, sinus distinct, linear, deeply constricted, margin smooth, each semi cell with single pyrenoid, long. cell 28 $\mu$m lateral cell 10 $\mu$m and isthmus 5 $\mu$m.

**Collection number, date and site: Garh./ut. 19, III; 20 June 2005; Triveni Ghat, Rishikesh.**

**5. *Cosmarium bipunctatum* Borges f. *subrectangularis* West *et* West (Pl. 1, Fig. 5)**

Instant and Krieger 1936, p. 97, pl. V, fig. 7.

Cells small, semicells with undulated margins, flattened apices, isthmus broad, each semicell with one pyrenoid. Length of cell is 30 $\mu$m and breadth is 26 $\mu$m. Isthmus 8 $\mu$m.

**Collection number, date and site: Garh./ut. 13, II; 17 January 2005; Sahasradhara, Dehradun.**

**6. *Cosmarium blytii* Wille var. *novae-sylvae* West *et* West (Pl. 1, Fig. 6)**

Scott and Prescott 1961. p. 55, pl. 31, fig. 16.

Cells very small, slightly longer than broad, deeply constricted semicells trapazeform, semicircular, sides crenate. Cell wall granulate. 22 $\mu$m long, 20 $\mu$m width and isthums is 6 $\mu$m.

**Collection number, date and site: Garh./ut. 7, III; 12 June 2005; Rispana River, Dehradun.**

**7. *Cosmarium circulare* Reinsch var. *messikomeri* Krieger *et* Gerloff (Pl. 1, Fig. 7)**

Prasad and Misra 1992, p. 156, pl. 22, fig. 8.

Semi cells more or less semicircular, sinus narrowly linear and close; cell wall distinctly punctate; chloroplast axile with ridges and two pyrenoids in each semicells.

**Collection number, date and site: Garh./ut. 20, III; 22 June 2005; Asan Bairaj, Dehradun.**

**8. *Cosmarium decoratum* West *et* West (Pl. 1, Fig. 8)**

Prasad and Misra 1992, p. 158, pl. 24, fig. 9.

Cells of medium size, slightly longer than broad, deeply constricted, sinus narrowly linear and bilipped; semicells semi-elliptic, apex flattened truncate with rounded angles, margin deeply crenate, crenations emarginated, 24-26, in number, margin followed by 4-5 concentric series of large granules, triangular pits surround granules in irregular fashion in the centre; semicell exhibits 2 chloroplast, each containing one pyrenoids. Long. cell 70 $\mu$m, lat. cell 52 $\mu$m, lat. isthmus 14 $\mu$m.

**Collection number, date and site: Garh./ut. 20, III; 22 June 2005; Asan Bairaj, Dehradun.**

**9. *Cosmarium dispersum* Johnson (Pl. 1, Fig. 9)**

West and West 1907, p. 202, pl. XV, fig. 17.

Cells more or less circular, isthmus narrow, semicells crenate margins, cell wall punctate, pyrenoid indistinct. 45 $\mu$m long cell, 41 $\mu$m width and isthmus 14 $\mu$m.

**Remark:** This specimen is 7 $\mu$m and 9 $\mu$m short.

**Collection number, date and site: Garh./ ut. 7, III; 12 June 2005; Rispana River, Dehradun.**

**10. *Cosmarium formosulum* Hoffman var. *nathorstii* (Boldt) West *et* West (Pl. 1, Fig. 10)**

Tiffany and Britton 1952, p. 189, pl. 54, fig. 590.

Cells 46 x 59 $\mu$m, isthmus 15 $\mu$m wide, with basal angles less rounded than in the species lateral margins with 3-6 bigranulate or emarginated crenations, the granules of central tumor stronger and more pronounced.

**Collection number, date and site: Garh./ut. 20, III; 22 June 2005; Asan Bairaj, Dehradun.**

**11. *Cosmarium formosulum* Hoffman (Pl. 1, Fig. 11)**

Tiffany and Britton 1952, p. 190, pl. 54, fig. 589.

Cells 46 x 59 $\mu$m, isthmus 15 $\mu$m, slightly longer than wide, deeply constricted, sinus linear, the apex slightly dilated; semicells trapeziform subsemicircular or subpyramidate in outline, basal angles rounded, sides convex and 6-7 crenate, the 3 upper crenations with 2 granules, lower crenations entire, apical singles obtuse or faintly bigranulate emarginate, apex truncate and 4 or rarely 6-7 crenate, minutely granulate within the margin, the granules in concentric and radiating series, binate except in the innermost series and near the basal angles, in the centre a broad tumor with 5-7 vertical series of granules; vertical view elliptic, poles rounded and minutely crenulate, with a broad 5-7 crenate tumor at the middle on each side, in the centre a small rectangular smooth area; lateral view of semicell broadly ovate, strongly granulate on the tumid margin near the base on each side; chromatophores axial; pyrenoids 2.

**Collection number, date and site: Garh./ut. 20, III; 22 June 2005; Asan Bairaj, Dehradun.**

**12. *Cosmarium granatum* Brebisson (Pl. 1, Fig. 12)**

Tiffany and Britton 1952, p. 186, pl. 53, fig. 565.

Cells 23 x 25 $\mu$m, isthmus 7 $\mu$m wide, longer than

wide, subrhomboid elliptic, deeply constricted, sinus linear, slightly dilated at the apex; semicells truncate pyramidate, basal angles rounded, sides straight, slightly convex, or rarely slightly concave, sub parallel at the base and converging toward the apex, upper angles obtuse, apex narrowly truncate and straight; vertical view elliptic; lateral view of semicell elliptic ovate; cell wall finely punctuate; chromatopores axial; pyrenoid single, central.

**Collection number, date and site: Garh./ut. 20, III; 22 June 2005; Asan Bairaj, Dehradun.**

**13. *Cosmarium hammeri* Reinsch var. *homalodermum* (Nordst.) West *et* West (Pl. 1, Fig. 13)**

West and West 1904, p. 182, pl. 62, figs 22 and 23.

Prasad and Misra 1992, p.161, pl. 21, fig. 4.

Cells of medium size about 1.5 times longer than broad, sub-hexagonal, deeply constricted, sinus narrowly linear with slightly dilated apex and opening outwards; semicells truncate pyramidate with rounded basal angles and faintly retuse sides converging to broadly truncate apex; cell wall thick and distinctly punctate; chloroplast axile with one pyrenoid. Cell 34 $\mu$m long, 30 $\mu$m wide, and isthmus 7 $\mu$m.

**Collection number, date and site: Garh./ut. 15, II; 19 January 2005; Deopura Canal, Lachchhiwala, Dehradun.**

**14. *Cosmarium lundellii* Delp. var. *circulare* (Reinsch) Krieg. (Pl.1, Fig. 14)**

Nurul Islam and Irfanullah 1999, p. 93, pl. 1, figs 4 and 5.

Cells of medium size, a little longer than broad, deeply contricted, sinus linear and open, semicells sub-semicircular. Cell 51 $\mu$m long and 40 $\mu$m broad. Isthmus 14 $\mu$m.

**Collection number, date and site: Garh./ut. 7, III; 12 June 2005; Rispana River, Dehradun.**

**15. *Cosmarium lundellii* Delp. var. *subellipticum* Prasad *et* Mehrotra (Pl. 1, Fig. 15)**

Prasad and Mehrotra 1977 a, p. 59, fig. 49

Prasad and Misra 1992, p. 165, pl. 22, fig. 9.

Semi cells sub-elliptic with rounded to sub truncate apices. Long. cell 50 $\mu$m, lateral cell 40 $\mu$m, isthmus 12 $\mu$m.

**Collection number, date and site: Garh./ut. 20, III; 22 June 2005; Asan Bairaj, Dehradun.**

**16. *Cosmarium miscellum* Skuja (Pl. 1, Fig. 16)**

Prasad and Misra 1992, p. 167, pl. 24, fig. 5.

Cell large, slightly longer and broad, sides converging upwards from the broad base to somewhat narrow and flattened apex, apical angle sub-acute basal angles rounded, isthmus bilipped, narrow linear semicell compressed, semicircular with 23-26 marginal crenulations followed by 5-6 regular, radial and concentric rings of crenulate, central tumour with 7-8 vertical and one basal series of granules; each semicell with 2 axile chloroplasts containing two pyrenoids, long. cell 47 $\mu$m, lat. cell 45 $\mu$m, lat. isthmus 11 $\mu$m.

**Collection number, date and site: Garh./ut. 8, III; 06 March 2006; Triveni Ghat, Rishikesh.**

**17. *Cosmarium phaseolus* Breb. var. *omphalum* (Schaarschm.) Racib. (Pl. 1, Fig. 17)**

Scott and Prescott 1961, p. 65, pl. 31, fig. 17.

Prasad and Mehrotra 1977b, p. 68, pl. 1, fig. 22.

Cells small, nearly as long as broad, semicells with swollen apices; each semicell with the one chloroplast and one pyrenoid, cell wall smooth. Cells 36 $\mu$m diameter, 44 $\mu$m long, 16 $\mu$m isthmus.

**Collection number, date and site: Garh./ut. 1, IV; 06 March 2006; Saung River, Doiwala, Dehradun.**

**18. *Cosmarium pseudopyramidatum* Lund (Pl. 1, Fig. 18)**

Taylor, W.R. 1934, p. 261, pl. L, fig. 7.

Cells small, semicells broadly truncate, apices slightly flattened-truncate. Cell wall minutely punctate. Each semicells with 1 chloroplast and one pyrenoid. Length is 37 $\mu$m, width is 25 $\mu$m and isthmus is 8 $\mu$m.

**Collection number, date and site: Garh./ut. 4, III; 12 June 2005; Deopura canal, Lachchhiwala, Dehradun**

**19. *Cosmarium pseudopyramidatum* Lund var. *occulatum* Krieger (Pl. 1, Fig. 19)**

Prasad and Misra 1992, p. 175, pl. 23, fig. 14.

Cells of medium size 1.8-1.9 times longer than broad deeply constricted sinus narrowly linear and close; semicell ovate, truncate, base broad, and converging upwards to truncately rounded apices, side almost straight or faintly convex; cell wall finely granulate and exhibits a faint protuberance in the middle of each semicells. Long. cell 69 $\mu$m, lat. cell 34 $\mu$m, isthmus is 13 $\mu$m.

**Collection number, date and site: Garh./ut. 4, III; 12 June 2005; Deopura canal, Lachchhiwala, Dehradun**

**20. *Cosmarium pygmaeum* Archer (Pl. 1, Fig. 20)**

Prasad and Misra 1992, p. 177, pl. 21, fig. 10.

Cells very small, a little longer than broad, deeply constricted, sinus narrowly linear; semicells oblong hexagonal, basal and apical angles sharp, apex widely truncate with straight margin, centre of each semicell with a faint protuberance; cell wall smooth. Long. cell 15 $\mu$m, lat. Cell 13 $\mu$m, isthmus 3.5 $\mu$m.

**Collection number, date and site: Garh./ut. 20, III; 22 June 2005; Asan Bairaj, Dehradun.**

**21. *Cosmarium regnelli* Wille (Pl. 1, Fig. 21)**

Prasad and Misra 1992, p. 180, pl. 24, fig. 25.

Cells rather small, a little longer than broad deeply constricted, sinus narrow with slightly dilated extremity; semicells sub hexagonal, basal angles more or less sub rectangular, sides parallel, upper angles broad and oblique apex truncate and straight; cell wall smooth; each semicell with an axile chloroplast and one pyrenoid. Long. cell 13 $\mu$m, lat. cell 10 $\mu$m lat., isthmus 1-2 $\mu$m.

**Collection number, date and site: Garh./ut. 1, IV; 06 March 2006; Saung River, Doiwala, Dehradun.**

**22. *Cosmarium scissum* Bruehl *et* Biswas (Pl. 1, Fig. 22)**

Bruehl and Biswas 1926, p. 297, pl. X, figs. 100a-b.

Cells large, deeply constricted, semicells with slightly undulate margins, cells wall indistinct. Each semicell with one chloroplast and 2 pyrenoid. Cell is 50 $\mu$m x 44 $\mu$m and isthmus is 12 $\mu$m.

**Collection number, date and site: Garh./ut. 10, I; 06 March 2006; Suswa River, Bullawala, Dehradun.**

**23. *Cosmarium spinuliferum* West *et* West (Pl. 1, Fig. 23)**

Scott and Prescott 1961. p. 69, pl. 29, fig. 6.

Cells as long as broad, cell wall with spine like projection, isthmus narrow, each semicell with 2 chloroplast each with one pyrenoid. Length of cell is 48 $\mu$m and breadth is 40 $\mu$m. Isthmus 12 $\mu$m.

**Collection number, date and site: Garh./ut. 9, II; 15 January 2005; Laxmanjhoola, Rishikesh.**

**24. *Cosmarium speciosum* Lund (Pl. 1, Fig. 24)**

Prasad and Misra 1992, p. 183, pl. 24, fig. 14.

Cells of medium size, about 1.5 times longer than broad, moderately constricted, sinus narrowly linear, semi cells sub rectangular or sub pyramidate with rounded angles, sides slightly convex and very gradually attenuated upwards to broadly truncate apex, margin with 4 apical and 7 lateral crenation; cell wall granulate, granules in regular, radial and concentric series, each showing 3-4 granules, space across the base and just above the isthmus exhibits 5-6 vertical series of 6-7 granules; chloroplast axile with two pyrenoids in each semi cell; long. cell 59 $\mu$m lat. cell 45 $\mu$m and isthmus 7 $\mu$m.

**Collection number,date and site: Garh./ut. 4, III; 12 June 2005; Deopura canal, Lachchhiwala, Dehradun.**

**25. *Cosmarium subalatum* West et West (Pl. 1, Fig. 25)**

Prasad and Misra 1992, p. 185, pl. 24, fig. 22.

Cells small, slightly longer than broad, deeply constricted sinus narrowly linear, semi cells widely truncate to pyramidate, sides tricrenate, angles rounded apex with two small creations (excluding apical angles), crenations bigranulate, central tumour rounded with 7 granules arranged in circular fashion; top view elliptic; chloroplast axile with two pyrenoid in each semi cell; long. cell 30 $\mu$m lateral cell 24 $\mu$m and isthmus 6 $\mu$m.

**Collection number, date and site: Garh./ut. 12, II; 19 January 2005; Rei River, Lachchhiwala, Dehradun.**

**Genus: *Closterium* Nitzsch 1817**

**1. *Closterium littorale* Gay (Pl. 2, Fig. 26)**

Tiffany and Britton 1952, p. 173, pl. 51, fig. 544.

Cells 280 x 30 $\mu$m (apices 12 $\mu$m), slightly curved, outer margin 35-55 degrees of arc, inner margin a little concave and slightly but widely tumid in the middle, gradually attenuated to the acute to obtusely rounded apices, cell wall smooth, colorless.

**Collection number, date and site: Garh./ut. 5, III; 12 June 2005; Ranipokhari, Dehradun.**

**2. *Closterium parvulum* Naeg. var. *cornutum* Krieg. (Pl. 2, Fig. 27)**

Scott and Prescott 1961, p. 13, pl. 2, fig. 9.

Cells 20-25 $\mu$m x 125-130 $\mu$m, apices 7 $\mu$m wide, strongly curved, gradually attenuated to the acutely rounded apices, cell-wall smooth.

**Collection number, date and site: Garh./ut. 2, II; 14 January 2005; Brahmakund, Haridwar.**

**3. *Closterium pritchardianum* Arch. (Pl. 2, Fig. 28)**

Tiffany and Britton 1952, p. 170, pl. 52, fig. 554.

Taylor 1934, p. 244, pl. XLV, fig. 24.

Cells 20 $\mu$m x 370 $\mu$m, (apices 9-10 $\mu$m wide), very slightly curved, 12-17 times longer than wide, outer margin 24-43 degrees of arc, inner margin straight or very slightly concave, gradually attenuated to the narrow, truncate, and slightly recurved apices, 5-6 ridges, pyrenoids 7-10 in a median series.

**Collection number, date and site: Garh./ut. 12, II; 19 January 2005; Rei River, Lachchhiwala, Dehradun.**

**4. *Closterium rectimarginatum* Scott et Prescott (Pl. 2, Fig. 29)**

Scott and Prescott 1961, p. 13, pl. 1, figs 27 and 28.

Cells large, 10-11 times longer than broad, spindle shaped lateral margins almost straight and converging from center to narrowly rounded apices, cells wall smooth, chloroplast with four ridges, containing 6-7 pyrenoids. Cells 38 $\mu$m diameter, 280 $\mu$m long, apex 8 $\mu$m.

**Collection number, date and site: Garh./ut.2, 3, III; 12 June 2005; Deopura canal, Lachchhiwala, Dehradun.**

**5. *Closterium ehrenbergii* Meneghini (Pl. 2, Fig. 30)**

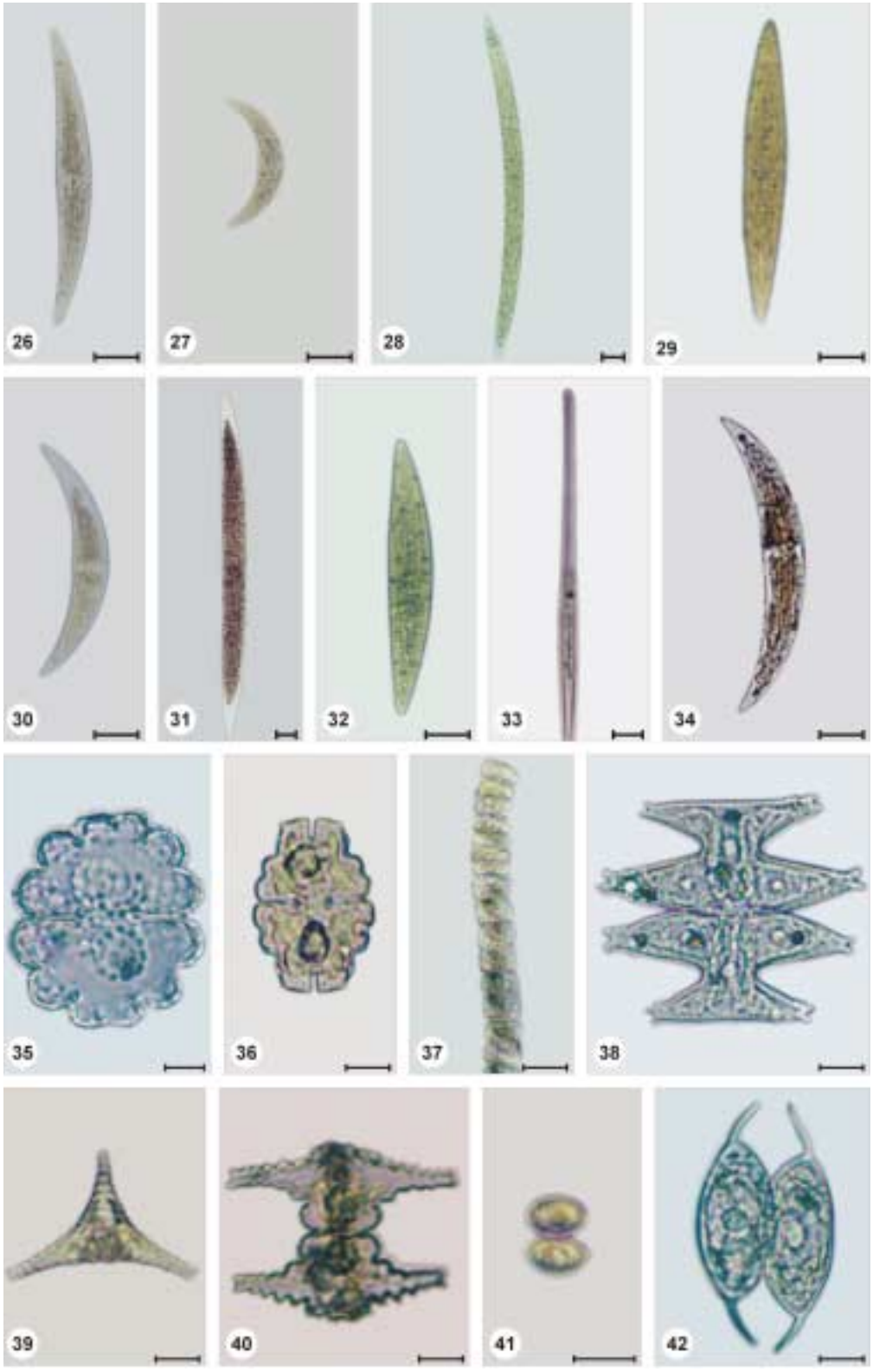


**Plate 2.** Fig. 26. *Closterium littorale* Gay, Fig. 27. *Closterium parvulum* Naeg. var. *cornutum* Krieg., Fig. 28. *Closterium pritchardianum* Arch., Fig. 29. *Closterium rectimarginatum* Scott *et* Prescott, Fig. 30. *Closterium ehrenbergii* Meneghini, Fig. 31. *Closterium acerosum* Ehr. var. *elongatum* Breb., Fig. 32. *Closterium moniliferum* (Bory) Ehr., Fig. 33. *Closterium kuetzingii* Breb., Fig. 34. *Closterium venus* Kuetz., Fig. 35. *Euastrum spinulosum* Delp. var. *inermius* Nordstedt, Fig. 36. *Euastrum sinuosum* Lenorm var. *reductum* West *et* West, Fig. 37. *Spondylosium pygmaeum* (Cooke) W. West, Fig. 38. *Micrasterias pinnatifida* (Kuetz.) Ralfs, Fig. 39. *Staurastrum gracile* Ralfs var. *coronulatum* Boldt., Fig. 40. *Staurastrum recurvatum* Turner, Fig. 41. *Staurastrum punctulatum* Brebisson, Fig. 42. *Arthrodesmus convergens* Ehrenberg. Scale bars = 10 $\mu$m.

Tiffany and Britton 1952, p. 172, pl. 52, fig. 558.

Cells 35 $\mu$m x 220 $\mu$m (apices 11 $\mu$m wide), moderately curved, outer margin 92-140 degrees of arc, inner margin concave but inflated in the middle, gradually attenuated to the obtusely rounded apices; cell wall smooth, colourless, pyrenoids numerous, scattered; terminal vacuoles containing a cluster of small moving granules.

**Remark:** This sp. is 20 $\mu$m shorter.

**Collection number, date and site: Garh./ut. 11 II; 16 January 2005; Mussoorie Lake, Dehradun.**

**6. *Closterium acerosum* Ehr. var. *elongatum* Breb. (Pl. 2, Fig. 31)**

West and West 1904, p. 148, pl. 18, fig. 1.

Tiffany and Britton 1952, p. 169, pl. 52, fig. 551.

Cells narrowly fusiform, outer margin curved inner margin gradually tapering to the narrow and often slightly thickened, with rounded truncate apices, cell wall smooth, colourless, with or without a median girdle, chloroplast without ridges, pyrenoids 3-4 in a medium series. Cells 200 $\mu$m long; 13 $\mu$m in diameter; apices 4 $\mu$m broad.

**Collection number, date and site: Garh./ut. 14, II; 19 January 2005; Saung River, Doiwala, Dehradun.**

**7. *Closterium moniliferum* (Bory) Ehr. (Pl. 2, Fig. 32)**

Tiffany and Britton 1952, p. 172, pl. 52, fig. 549.

Cells 45 $\mu$m x 260 $\mu$m, apices 6 $\mu$m wide, shout, 6-8 times longer than wide, moderately curved, outer margin 100-130 degrees of arc, inner margin inflated in the middle, uniformly narrowed to the obtusely rounded apices, cell wall smooth, colorless; pyrenoids present.

**Collection number, date and site: Garh./ut. 1, II; 13 January 2005; Kanakhal, Haridwar.**

**8. *Closterium kuetzingii* Breb. (Pl. 2, Fig. 33)**

Prasad and Misra 1992, p. 107, pl. 16, fig. 21.

Cells of medium size, 20 times longer than broad, almost straight, median part fusiform lanceolate with convex margins, cell tapering towards each extremity and ending in long setaceous processes with parallel sides and rounded apices; cell wall longitudinally striated, striae delicate, 18-20 visible across the cell; chloroplast with 4-5 pyrenoids arranged in a row. Long. cell 425 $\mu$m broad 20 $\mu$m and apex 2 $\mu$m.

**Collection number, date and site: Garh./ut. 20, III; 22 June 2005; Asan Bairaj, Dehradun.**

**9. *Closterium venus* Kuetz (Pl. 2, Fig. 34)**

Tiffany and Britton 1952, p. 173, pl. 51, fig. 542.

Cells 9 $\mu$m x 70 $\mu$m, apices 3 $\mu$m wide, 8-9 times longer than wide, strongly curved, outer margin 150-180 degrees of arc, inner margin not tumid, gradually attenuated to the acute or acutely rounded apices, cell wall smooth pyrenoids present.

**Remark:** This species varies in length about 7 $\mu$m more i.e. 63 $\mu$m.

**Collection number, date and site: Garh./ut. 20, III; 22 June 2005; Asan Bairaj, Dehradun.**

**Genus: *Euastrum* Ehrenberg, 1832**

**1. *Euastrum spinulosum* Delp. var. *inermius* Nordstedt (Pl. 2, Fig. 35)**

Prasad and Misra 1992, p. 137, pl. 19, fig. 11.

Variety differs from species in broadly rounded to flattened lateral lobes and somewhat trapezoid polar lobes; cell wall with relatively bigger granules, arranged in more or less circular fashion, central protuberance with 10 big peripheral and 4 large internal granules. Long. cell 59 $\mu$m, lat. cell 51 $\mu$m, lat. isthmus 11 $\mu$m.

**Collection number, date and site: Garh./ut. 20, III; 22 June 2005; Asan Bairaj, Dehradun.**

**2. *Euastrum sinuosum* Lenorm var. *reductum* West *et* West (Pl. 2, Fig. 36)**

Prasad and Misra 1992, p. 135, pl. 19, fig. 2.

Cells small, 1.7 times longer than broad, deeply constricted, sinus narrowly linear with dilated extremity, semicells 3 lobed, lateral lobes bilobulate and less prominent, polar lobe quadrate oblong with deep median incision, semicell with 3 protuberances in the centre and 2 above them on lateral sides, punctation on cell wall not seen. Long. cell 43 $\mu$m, lat. cell 28 $\mu$m, lat. isthmus 8 $\mu$m.

**Collection number, date and site: Garh./ut. 11, II; 16 January 2005; Mussoorie Lake, Dehradun.**

**Genus: *Spondylosium* Brebisson, 1844**

**1. *Spondylosium pygmaeum* (Cooke) W. West (Pl. 2, Fig. 37)**

Tiffany and Britton 1952, p. 202, pl. 56, fig. 626.

Cells 5 $\mu$m x 10 $\mu$m (isthmus 2-3 wide) about as long as wide or slightly wider, deeply constricted, sinus acute, almost linear for part of its length; semi cells elliptic united by a relatively small surface of their apices into long filaments frequently embedded in a gelatinous sheath, cell wall smooth.

**Collection number, date and site: Garh./ut. 7, IV; 06 March 2006; Ranipokhari, Dehradun.**

**Genus: *Micrasterias* C.A. Agardh, 1827**

**1. *Micrasterias pinnatifida* (Kuetz.) Ralfs (Pl. 2, Fig. 38)**

Scott and Prescott 1961, p. 51, pl. 12, fig. 6.

Prasad and Misra 1992, p. 143-144, pl. 20, fig. 4

Cells 5 $\mu$m in diameter, 58 $\mu$m in length, sinus linear slightly open outwards, semi cells 3 lobed, interlobular incision deep and broadly rounded, lateral lobes horizontal, semifusiform with minutely bifid apices exhibiting acuminate ends, polar lobes with basal portion subrectangular and apical portion with extremities like lateral lobes' but relatively shorter in length, cell wall minutely punctate. Isthmus 11 $\mu$m in diameter.

**Collection number, date and site: Garh./ut. 20, III; 22 June 2005; Asan Bairaj, Dehradun.**

**Genus: *Staurastrum* Meyen, 1829**

**1. *Staurastrum gracile* Ralfs var. *coronulatum* Boldt. (Pl. 2, Fig. 39)**

Prasad and Misra 1992, p. 196, pl. 25, figs 7 and 11.

Cells of medium size about 2.3 times longer than broad, depressed, constriction shallow with an acute notch; semicells somewhat broadening towards the slightly convex apex, apices showing undulate margins and relatively shorter and emerginate processes tipped with 2-3 minute spines and showing 4-5 concentric rows of dentations; top view triangular with dentation within the lateral margins. Long. cell 43 $\mu$m, lat. cell with processes 55 $\mu$m. isthmus 10 $\mu$m.

**Collection number, date and site: Garh./ut. 12, II; 19 January 2005; Rei River, Lachchhiwala, Dehradun.**

**2. *Staurastrum recurvatum* Turner (Pl. 2, Fig. 40)**

Prasad and Misra 1992, p. 199, pl. 29, figs 13 and 17.

Cells small, slightly broader than long, deeply constricted with open sinus; semicells fusiform with dorsal margin convex undulate and ventral slightly tumid, angles produced into short, stout and recurved processes, each tipped with 3-4 spines and provided with 5-6 concentric rings of denticulations; top view triangular; each semicell with an axile chloroplast containing one pyrenoid. Long. cell 20 $\mu$m, wide without arm 17 $\mu$m.

**Collection number, date and site: Garh./ut. 10, IV; 07 March 2006; Sheetlakheda, Haridwar.**

**3. *Staurastrum punctulatum* Brebisson (Pl. 2, Fig. 41)**

Tiffany and Britton 1952, p. 198, pl. 54, fig. 603.

Cells 38 $\mu$m x 50 $\mu$m isthmus 10 $\mu$m wide, some longer than wide, deeply constricted, sinus acute and widely open semicells angularly elliptic or rhomboidal with dorsal and ventral margins equally convex, angles acutely rounded; vertical view triangular, cell wall with flattened granules arranged in regular series around the angles.

**Collection number, date and site: Garh./ut. 20, III; 22 June 2005; Asan Bairaj, Dehradun.**

**Genus: *Arthrodesmus* Ehrenberg, 1838**

**1. *Arthrodesmus convergens* Ehrenberg (Pl. 2, Fig. 42)**

Scott and Prescott 1961, p. 74, pl. 34, fig. 9

Prasad and Misra 1992, p. 190, pl. 25, fig. 5

Cell of medium size median constriction deep, sinus open widely out words from narrowly linear extremity semicell more or less transversely elliptic, apical margin slightly more concave than the basal lateral angles rounded-conical and furnished with rather stout and slightly curved spine, cell wall smooth chloroplast axile with 1-2 pyrenoid in each semicell . Long. cell 33 $\mu$m, lat. cell with spine 59 $\mu$m, without spine 37 $\mu$m, isthmus 9 $\mu$m.

**Collection number, date and site: Garh./ut. 20, III; 22 June 2005; Asan Bairaj, Dehradun.**

The algal localities of Haridwar and Rishikesh areas also inhibit some members of Cyanophyceae and Bacillariophyceae. However, the members of class Chlorophyceae are dominant which is indicative of clean water of hilly regions. Large perennial water bodies of western Himalayan Region need conservation which will not only protect natural habitats supporting algal biodiversity but also be good source of algal material for experimental and economic researches.

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