

CLOSTERIUM IN PAKISTAN

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Twenty four species of *Closterium* have been described and illustrated from Pakistan. An identification key has also been given.

Key words: Taxonomy, *Closterium*, Pakistan

INTRODUCTION

Closterium belongs to the family Desmidiaceae of N.O. Zygnematales. A particular set of the species of *Closterium* is found in each locality. Since the desmid flora of Pakistan has not been explored so far, an attempt has been made to study *Closterium* intensively.

MATERIALS AND METHOD

Specimens were collected by a plankton-net, squeezing the aquatic vegetation and by scraping from pools, small ponds, streams and springs. Specimens were studied in fresh condition as far as possible, and then numbered and preserved in 3% formaline. All the drawings were made by camera lucida. The collection has been numbered by F.M. Sarim.

Characters of *closterium*. Nitzsch ex Ralf's Cells greatly elongated and always, usually markedly, attenuated; solitary, in most cases curved, rarely straight; without a median constriction; cell-wall colourless or yellow to brown in colour; smooth or with longitudinal striae that are usually ridged but may be series of granules; commonly with one or more transverse lines at middle of cell or at different points along the cell; cells with a single chloroplast in each semicell that is either entire or with longitudinal ridges radiating from a comparatively slender central axis; generally with a single axile row of pyrenoids, more rarely with pyrenoids scattered throughout chloroplast; cell apices hyaline in portion not occupied by chloroplasts and with a conspicuous vacuole that contains one or more granules that show a constant motion.

Key to the taxa

1. Cells straight 2
1. Cells slightly curved 3
1. Cells strongly curved 6

2. Cell 6-7 times longer than broad
. *Cl. lunula* (Mull.) Nitzsch ex Ralfs
2. Cell 25-36 times longer than broad
. *Cl. setaceum* Ehr. ex Ralfs
2. Cell 37-40 times longer than broad
. *Cl. gracile* Breb. ex Ralfs
2. Cell 85-95 times longer than broad
. *Cl. aciculare* Tuffen. West
3. Pyrenoids definite in number 4
3. Pyrenoids variable in number 5
4. Pyrenoids 5 in number cell 12-15.5 μ m broad
. *Cl. abruptum* W. West
4. Pyrenoids variable in number
. *Cl. littorale* Gay
4. Pyrenoids 6 in number cell 16-31 μ m broad
. *Cl. intermediam* Ralfs
4. Pyrenoids 6 in number cell 33-50 μ m broad
. *Cl. moniliferum* (Bory) Ehr. ex Ralfs
4. Pyrenoids 7 in number, cell 41.4-55 μ m broad
. *Cl. moniliferum* var. *concauum* Kleb's
4. Pyrenoids 8 in number, cell 14-18.5 μ m broad
. *Cl. strigosum* Breb.
4. Pyrenoids 8 in number, cell 35-45 μ m broad
. *Cl. attenuatum* Ehr ex Ralfs
4. Pyrenoids 16 in number, cell 72-137 μ m broad
. *Cl. ehrenbergii* Menegh. ex Ralfs
5. Pyrenoids 1-3 in number, cell wall colourless
. *Cl. tumidum* Johnson
5. Pyrenoids 4-5 in number, cell wall straw coloured
. *Cl. rostratum* Ehr. ex Ralfs
5. Pyrenoids 5-7 in number, cell wall brown
. *Cl. baillyanum* Breb.
5. Pyrenoids 5-7 in number, cell wall yellowish-brown
. *Cl. striolatum* Ehr. ex Ralfs

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5. Pyrenoids 6-7 in number, cell wall reddish-brown
..... *Cl. costatum* corda ex Ralfs
5. Pyrenoids 7-11 in number, cell wall colourless
..... *Cl. acerosum* (Schrank) Ehr. ex Ralfs
5. Pyrenoids 8-11 in number, cell wall yellowish-brown
..... *Cl. acerosum* var. *elongatum* Breb.
5. Pyrenoids 9-11 in number, cell wall reddish-brown
..... *Cl. lineatum* Ehr. ex Ralfs
5. Pyrenoids 15-30 in number, cell wall yellowish-brown
..... *Cl. turgidum* var. *giganteum* (Nordst.) De Toni
6. Cell 5-7 times longer than broad
..... *Cl. incurvum* Breb.
6. Cell 8-9 times longer than broad
..... *Cl. venus* Kg. ex Ralfs.
6. Cell 10 times longer than broad
..... *Cl. diana* var. *arcuatum* (Breb) Radenh.

Description of the plants

1. *Closterium abruptum* W. West, Alg. Eng. Lake Distr. p. 719, pl. 9, fig. 1. 1982.

Sarim & Faridi, 1976, p. 10, fig. 19, Parra & Gonzales, 1977, p. 16, fig. 48, Ruzicka, 1977, p. 222, pl. 33, figs. 20-24.

127-156 μm long, 12-15.5 μm broad, apices 6-7 μm broad.

Cells small, about 10 times longer than broad, slightly curved; outer margin about 55° of arc, median portion of cells almost straight, more curved towards the extremities, gradually but slightly attenuated towards the apices, which are broad and truncate; cell wall smooth, colourless or straw coloured; chloroplasts with about six ridges and containing a central row of 5 pyrenoids; terminal vacuole with one large moving granule. (pl. 1, fig. 8).

Local distribution. Akbarpura, Dist. Peshawar, Sarim No. 30, Sept. 25, 1976.

2. *Cl. acerosum* (Schrank) Ehr. ex Ralfs, Brit. Desm. p. 164, pl. 27, fig. 2. 1848.

Sarim & Faridi, 1976, p. 10, fig. 18, Chardard, 1977, p. 241, figs. 9, 10, Parra & Gonzales, 1977, p. 16, fig. 45.

300-460 μm long, 26-48 μm broad.

Cells large, 8-16 times longer than broad, slightly curved, narrowly fusiform; outer margin slightly curved, about 10° - 20° of arc, inner margin almost straight or slightly convex; semicells gradually tapering to the apices, which are narrow and rounded-truncate, often slightly thickened; cell wall colourless and smooth, in older individuals becoming yellowish-brown and very delicately striolate; chloroplasts ridged, with a median series of 7-11

pyrenoids; terminal vacuoles with a number of moving granules (Pl. 2, Fig. 7).

Local distribution. Azakhel water lodged pool, Dist. Peshawar, Sarim No. 156, March, 16, 1977.

3. *Cl. acerosum* (Schrank) Ehr. ex Ralfs var. *elongatum* Breb. Liste Desm. p. 152. 1856.

West & West, Vol. 1, 1904, p. 148, pl. 18, fig. 1, Taylor, 1934, p. 242, pl. 65, fig. 23, Hughes, 1951, p. 270, fig. 2a, 2b; Tibor, 1959, p. 513, fig. 38, 39; Forster, 1970, p. 279, pl. 2, fig. 19; Werner, 1977, p. 39, pl. 2, fig. 13-15; Ruzicka, 1977, p. 158, pl. 18, fig. 10.

525-790 μm long; 29-50 μm broad.

Cells large, relatively a little longer, and with the striolations of the cell wall more distinct; cell wall of yellowish-brown colour; chloroplast ridged with a median series of about 8-11 pyrenoids. (Pl. 1, fig. 11).

Local distribution. Madain, Dist. Swat, Sarim No. 190, Dec. 15, 1978.

4. *Cl. aciculare* Tuffen West, Rehm. Diat. Desm. p. 153, pl. 7, fig. 16, 1860. Scharf, 1979, p. 32, pl. 2, figs. 1-4.

440-590 μm long, 5-7 μm broad.

Cells very narrow and greatly elongated, 85-95 times longer than broad, almost straight for above half their length, very gradually attenuated from the middle to the apices, which are slightly incurved, acute or acutely rounded and very narrow; cell wall smooth and colourless; chloroplasts with from 6 to 8 pyrenoids; terminal vacuoles very long and containing one or two moving granules (pl. 2, fig. 5).

Local distribution. Islamabad, Sarim No. 150, March 11, 1977.

5. *Cl. attenuatum* Ehr. ex Ralfs, Brit. Desm. p. 169, pl. 29, fig. 5. 1848.

Lenzenweger, 1970, p. 258, pl. 12, fig. 10; Forster, 1970, p. 281, pl. 5, fig. 3.

432-428 μm long, 35-45 μm broad.

Cells large, 11-14 times longer than broad, slightly curved, outer margin 45° of arc, inner margin not tumid, gradually attenuated towards each extremity, near the apices rather suddenly narrowed into an obtuse cone; cell wall striated, from 17-24 striae visible across the cell, brown or reddish-brown in colour; chloroplast ridged with 7 pyrenoids in a central series; terminal vacuoles with a large number of moving granules. (pl. 1, fig. 6).

Local distribution. Gandhi Garden, Karachi, Sarim No. 251, March 28, 1978.

6. *Cl. baillyanum* (Breb.) Breb. Liste Desm. p. 151. 1856.

Croasdale & Gronblad, 1964, p. 154, pl. 4, fig. 18, Scott, Gronblad & Croasdale 1965, p. 27, fig. 18, Eloranta, 1968, p. 64, fig. 67, Hinode, 1971, p. 103, pl. 3, figs. 3,4; Ruzicka, 1975, p. 201, figs. 11, 13, 17; Ruzicka, 1977, p. 179, pl. 23, figs. 1-6.

432-736 μm long, 42-48 μm broad; apex 26 μm broad.

Cells large, 10 times longer than broad, slightly curved, gradually attenuated at poles; poles wide and truncate-rounded; cell wall brown and punctuate, darker at each apex; each chloroplast with 5-7 pyrenoids, terminal vacuoles with several moving granules. (pl. 2, fig. 1).

Local distribution. Madain, Dist. Swat, Sarim No. 190, Dec. 15, 1978.

7. *Cl. costatum* Corda ex Ralfs, Brit. Desm. p. 170, pl. 29, fig. 1. 1848.

Parra & Gonzales, 1977, p. 16, fig. 66-69; Ruzicka, 1977, p. 195, pl. 27, fig. 1-6.

340-405 μm long, 48-66 μm broad.

Cells of medium size, 6-10 times longer than broad, slightly curved, outer margin from 90° to 98° of arc, gradually attenuated towards the apices which are rounded, truncately rounded or rounded conical; cell wall reddish-brown, costate, with 6-8 costae visible across the cell; each chloroplast with 6-7 pyrenoids in one axile series; terminal vacuoles with numerous moving granules (pl. 1, fig. 18).

Local distribution. Tangi, Charsadda, Sarim No. 28, Sept. 20, 1976.

8. *Cl. diana* Ehr. ex Ralfs var. *Arcuatum* (Breb.) Rabenh. Flor. Europ. Alg. p. 133. 1868.

Croasdale, 1965, p. 305, pl. 1, fig. 24; Forster, 1970, p. 282, pl. 3, fig. 14; Yacubson, 1974, p. 109, pl. 5, fig. 41; Whitford & Schumacher, 1973, p. 66, pl. 20, fig. 15; Ruzicka, 1977, p. 134, pl. 13, figs. 19-21.

129-290 μm long; 18-25 μm broad, apices 6-7 μm broad.

About 10 times longer than broad, slightly smaller and more strongly curved than the species; outer margin 140° - 152° of arc; cell wall of a pale yellow colour (pl. 2, fig. 4).

Local distribution. Pirbaba, Buner, Sarim No. 199, Dec. 30, 1978.

9. *Cl. ehrenbergii* Menegh. ex Ralfs, Brit. Desm. p. 166, pl. 28, fig. 2. 1848

Islam, 1970, p. 910, pl. 6, fig. 14; Forster, 1970, p. 283, pl. 4, fig. 12; Mix, 1973, p. 189, pl. 4, fig. 11; Whitford & Schumacher, 1973, p. 66, pl. 19, fig. 1; Stein, 1975, p. 137, fig. 92.

382-541 μm long; 72-137 μm broad, apices 12-18 μm broad.

Cells large, stout, 4-5½ times longer than broad, slightly curved, outer margin 110° - 120° of arc, inner margin concave but inflated in the median part, gradually attenuated towards the apices, which are obtusely rounded cell wall smooth and colourless; chloroplasts with eight to ten ridges, and containing about 16 pyrenoids; terminal vacuole with a cluster of small moving granules (pl. 1, fig. 3).

Local distribution. Gandhi Garden, Karachi, Sarim No. 251, March 28, 1978.

10. *Cl. gracile* Breb. ex Ralfs. Brit. Desm. p. 221. 1848.

Sarim & Faridi, 1976, p. 18, fig. 29; Hinode, 1971, p. 75; Parra & Gonzales, 1977, p. 17, figs. 46, 47; Ruzicka, 1977, p. 168, pl. 21, figs. 1-4.

130-190 μm long, 3-4-6 μm broad, apices 1.2-2.4 μm broad, than broad, almost straight for more than half their length, margins parallel, gradually narrowed and gracefully curved towards the apices, which are obtuse; cell wall smooth and colourless; chloroplast sometimes subundulate, with five to seven pyrenoids, terminal vacuoles with one to several moving granules. (pl. 1, fig. 15 and pl. 2, fig. 2).

Local distribution. New Bus Stand, Peshawar, Sarim No. 154, March 3, 1977.

11. *Cl. incurvum* Breb. Liste Desm. p. 150, pl. 2, fig. 47. 1856.

Sarim & Faridi, 1976, p. 18, fig. 41; Ruzicka, 1977, p. 118, pl. 10, fig. 35-42.

42-64 μm long, 10.5-14 μm broad.

Cells very small, 5-7 times longer than broad, strongly curved, outer margin about 180° of arc, inner margin not tumid, strongly attenuated towards the apices, which are acute; cell wall smooth and colourless; chloroplast with several small pyrenoids in one series; terminal vacuoles with several small moving granules (pl. 1, fig. 14)

Local distribution; Ali Masjid Bridge, Khyber Agency, Sarim No. 135, Jan. 20, 1977.

12. *Cl. intermedium* Ralfs, Brit. Desm. p. 171, pl. 29, fig. 3. 1848.

Hinode, 1970, p. 75, fig. 2; Parra & Gonzales, 1977, p. 17, fig. 16; Ruzicka, 1977, p. 215, pl. 32, fig. 1-5.

234-465 μm long; 16-31 μm broad, apices 10-11.5 μm broad.

Cells of medium size, 12-15 times longer than broad, slightly curved, outer margin from 36° to 45° of arc, inner margin slightly concave, not tumid but sometimes straight in the median portion, gradually attenuated towards the apices, which are truncate with rounded angles; cell wall pale yellow or yellowish-brown in colour, strongly

striated, with 8-10 striae visible across the cell; each chloroplast with 6 pyrenoids; terminal vacuoles with one large moving granule or a few smaller ones (pl. 1, fig. 16).

Local distribution. Bannu, Sarim No. 231, Feb. 1, 1978.

13. *Cl. lineatum* Ehr. ex Ralfs, Brit. Desm. p. 1, 30, fig. 1. 1848.

Werner, 1977, p. 42, pl. 3, fig. 4; Ruzicka, 1977, p. 184, pl. 24, Fig. 1-3.

415-760 μm long, 17-35 μm broad; apices 7-10 μm broad.

Cells large, long and narrow, 16-24 times longer than broad, slightly curved, median portion of the cell fairly straight and cylindrical, inner margin faintly and widely tumid and gradually attenuated towards the apices, which are broad and truncately rounded, cell wall striated, striae rather variable, from 10 to 20 visible across the cell wall reddish-brown in colour; chloroplasts with about six ridges and a median row of nine to eleven pyrenoids; terminal vacuoles with a close cluster of several moving granules. (pl. 1, fig. 7).

Local distribution. Saidu Sharif, Swat, Sarim No. 164, March 23, 1977.

14. *Cl. litorale* Gay. Monogr. Ioc. Conj. p. 75, pl. 2, fig. 17. 1884.

Hirano, 1977, p. 212; Ichimura & Watanabe, 1978, p. 1; Ichimura & Watanabe, 1978a, p. 11.

150-220 μm long, 17.5-22.5 μm broad.

Cells of medium size, about 10 times longer than broad; slightly curved, outer margin 35° - 40° of arc, inner margin a little concave, and slightly but widely tumid in the middle, gradually attenuated to the apices, which are obtusely rounded; cell wall smooth and colourless; chloroplast with 8 ridges and a central series of 5 pyrenoids; terminal vacuoles with a number of moving granules (pl. 1, fig. 2).

Local distribution. Govt. College Abbottabad, Sarim No. 232, Feb. 8, 1978.

15. *Cl. lunula* (Mull.) Nitzsch ex Ralfs, Brit. Desm. p. 163, pl. 27, fig. 1. 1848.

Hinode, 1977, p. 76, fig. 3; Ruzicka, 1977, p. 145, pl. 16 fig. 1-3.

478-680 μm long; 76-116 μm broad, apices 19-23 μm broad.

Cells large, stout, 6-7 times longer than broad, almost straight, outer margin 40° - 45° of arc, inner margin generally straight, and very slightly tumid in the median part, gradually and gently narrowed to the apices which are slightly recurved and obtusely rounded; cell wall smooth and colourless, chloroplasts with about 10 to 12 ridges and

numerous scattered pyrenoids; terminal vacuoles with a large cluster of moving granules (pl. 1, fig. 1).

Local distribution. Bannu, Sarim No. 231, Feb. 1, 1978.

16. *Cl. moniliferum* (Bory) Ehr. ex Ralfs, Brit. Desm. p. 166, pl. 28, fig. 3. 1848.

Parra & Gonzales, 1977, p. 18, fig. 25, 27; Ruzicka, 1977, p. 137, pl. 14, fig. 3-6; Hirano, 1977, p. 212, Dubois-Tylski, 1978, p. 211, pl. 1.

222-370 μm long; 33-50 μm broad, apices 8-11 μm broad.

Cells of medium size, stout, 6-8 times longer than broad, slightly curved, outer margin 100° - 110° of arc, inner margin with a distinct inflation in the middle, uniformly narrowed to the apices, which are obtusely founded, cell wall smooth and colourless, chloroplasts with distinct ridges, about 6 in number and with a single series of 6 pyrenoids; terminal vacuoles with numerous moving granules (pl. 1, fig. 4).

Local distribution. Gujrat, Punjab, Sarim No. 285, Feb. 1, 1978.

17. *Cl. moiliferum* (Bory) Ehr. ex Ralfs var. *conca-
vum* Klebs, in Krieger Krypt. Flor. p. 13, pl. 1, Fig. 201, 1935.

Forster 1969, p. 22, pl. 2, fig. 30; Forster, 1970, p. 287, pl. 4, fig. 10, 11; Werner, 1977, p. 43, pl. 4, fig. 12; pl. 17, fig. 3; Parra & Gonzales, 1977, p. 18, fig. 28; Ruzicka, 1977, p. 140, pl. 14, fig. 7-9.

200-245 μm long, 41.4-55 μm broad.

Cells of medium size, curved more than the species; cell wall colourless without a median girdle, smooth; terminal vacuoles conspicuous; chloroplast with a median series of 7 pyrenoids (pl. 1, fig. 5).

Local distribution. Gandhi Garden Karachi, Sarim No. 251, March 28, 1978

18. *Cl. rostratum* Ehr. ex Ralf, Brit. Desm. p. 175, pl. 30, fig. 3. 1848.

Watanabe, 1974, p. 222, pl. 3, fig. m; Steir, 1975, p. 137, fig. 93; Ruzicka 1977, p. 209, pl. 31, fig. 1-6.

246-530 μm long, 19-30 μm broad, apices 3.4-5 μm broad.

Cells curved, median part of cell fusiform-lanceolate, inner margin more convex than the outer extremities prolonged into long, colourless processes which are slightly incurved, apex obtuse and slightly dilated; cell wall straw coloured, finely striated, 25-27 striae visible across the cell; chloroplasts with four or five pyrenoids; terminal vacuoles large, situated within the base of the apical processes and containing from 12 to 15 moving granules (pl. 2, fig. 6).

Local distribution. Irum Cold Storage, Peshawar, Peshawar, Sarim No. 154, March 13, 1977.

19. *Cl. setaceum* Ehr. ex Ralfs, Brit. Desm. p. 176. pl. 30, fig. 4. 1848.

Whitford & Schumacher, 1973, p. 67, pl. 20, fig. 21; Ruzicka, 1977, p. 205, fig. 1-3.

227-450 μm long; 7.5-12.5 μm broad, apices 0.7-1.5 μm broad.

Cells small, very slender, almost straight, 25-36 times longer than broad, median portion of cell small, fusiform lanceolate, both margins equally convex, extremities prolonged into slender, setaceous, colourless processes, which are slightly incurved and obtuse at the apices; each apical process about three-eighths the length of the cell; cell wall colourless or pale straw-coloured, finely striated, about 13 fine striations visible across the cell; chloroplasts with two pyrenoids; terminal vacuoles within the base of the apical processes, with three or four moving granules (pl. 1, fig. 10).

Local distribution. Rawal Dam Canal, Rawalpindi, Sarim No. 23, Sept. 15, 1976.

20. *Cl. strigosum* Breb. Liste Desm. p. 153, pl. 2, fig. 43, 1856.

Tiffany & Britton, 1952, p. 174, pl. 51, fig. 545; Yacubson, 1974, p. 109, pl. 5, fig. 43; Ichimura & Watanabe, 1976, p. 123; Ruzicka, 1976, p. 8, fig. 141, 146, Ruzicka, 1977, p. 173, pl. 21, fig. 18-36; Ichimura & Watanabe, 1978, p. 1.

254-358 μm long, 14-18.5 μm broad.

Cells of moderate size, 16-20 times longer than broad, slightly curved, median portion of cell straight, towards the extremities incurved, gradually attenuated to the apices which are somewhat incurved and subacute, cell wall smooth and colourless; chloroplasts with a central row of 8 pyrenoids; terminal vacuoles with several moving granules (pl. 1, fig. 17).

Local distribution. Cadet College, Hasanabdal, Sarim No. 227, Feb. 2, 1978.

21. *Cl. striolatum* Ehr. ex Ralfs, Brit. Desm. p. 170, pl. 29, fig. 29. 1848.

Watanabe, 1974, p. 222, pl. 3, fig. 1; Ruzicka, 1976, p. 10; Sarim & Faridi, 1976, p. 25, fig. 23; Hinode, 1977, p. 76, fig. 2; Parra & Gonzales, 1977, p. 19, fig. 61; Ruzicka, 1977, p. 15, pl. 32, fig. 7-13.

235-478 μm long; 22-53 μm broad, apices 10-14 μm broad.

Cells of medium size, 8-12 times longer than broad slightly curved, outer margin from 39 to 69° of arc, inner margin concave, never tumid, but sometimes straight in the middle, gradually attenuated to the apices, which are

broad and truncate with rounded angles; cell wall yellowish-brown in colour, striated, with 141-21 striae visible across the cell; each chloroplast having 6 ridges and an axile row of 5-7 pyrenoids; terminal vacuoles with many moving granules (pl. 1, fig. 9).

Local distribution. Waste water channel of Packages Ltd. Lahore, Sarim No. 14, Oct. 21, 1976.

22. *Cl. tumidum* Johnson, Rare Desm. p. 291, pl. 239, pl. 4, 1895. West & West, vol. 1, 1904, p. 156, pl. 19, fig. 15.

59-139 μm long; 7.7-18 μm broad; apices 2.5-5.5 μm broad.

Cells rather small, 8-9 times longer than broad, slightly curved; outer margin 28-58° of arc; inner margin of the cell broadly tumid in the middle, faintly concave towards the extremities, gradually attenuated towards the apices, which are truncately rounded and of somewhat variable width; cell wall smooth and colourless; chloroplast with four or six ridges; and 1-3 pyrenoids; terminal vacuoles with only one moving granule (pl. 1, fig. 12).

Local distribution. Sasnamana (Ziarat) Baluchistan, leg. Khial Badshah; Sarim No. 130, Jan. 15, 1977.

23. *Cl. turgidum* Ehr. ex ralfs var. *giganteum* (Nordst.) De Toni, Syll. Alg. p. 828. 1889.

West & West, vol. 1, 1904, p. 171; Whitford & Schumacher, 1973, p. 67, pl. 19, fig. 17; Ruzicka, 1977, p. 168, pl. 19, fig. 15.

600-900 μm long, 55-100 μm broad.

Cells large, slightly curved, outer margin about 40° of arc, gradually attenuated towards the extremities; cell wall yellowish-brown in colour; chloroplasts with about 15-30 pyrenoids; terminal vacuoles with many granules (pl. 2, fig. 3).

Local distribution. Pabbi, Dist. Peshawar, Sarim No. 48, Oct. 22, 1976, Nathiagal, Sarim No. 203, March 20, 1977.

24. *Cl. venus* Kg. ex Ralfs, Brit. Desm. p. 220, pl. 36, fig. 12. 1848.

Parra & Gonzales, 1977, p. 19, fig. 38; Ruzicka, 1977, p. 119, pl. 11, fig. 1-7; Hirano, 1977, p. 212.

51-81 μm long, 7-10 μm broad.

Cells small, 8-9 times longer than broad, strongly curved, outer margin 150-160° of arc, inner margin not tumid, gradually attenuated to the apices, which are acute or acutely rounded; cell wall smooth, colourless, or more rarely yellowish-brown; chloroplasts ridged, with two pyrenoids, rarely only one; terminal vacuoles large with a number of moving granules (pl. 1, fig. 13).

Local distribution. Kund Attock, Sarim No. 131, Jan. 16, 1977.

CONCLUSION

The present study deals with the desmid genus *Closterium* in Pakistan based upon the collections made by the present authors themselves. The total number of species described in the present study is 24. All these 24 species are new additions to the Pakistani Desmid flora.

It is difficult to explain the state of distribution of desmids, based upon the difference in the chemical compositions of inland waters of Pakistan. A low content of calcium in the waters is said to be generally beneficial to desmids. It should not be beyond 10 mg per litre. But a number of species in waters of various parts of the country is not always rich in desmids.

Some species in the present study are rare species of the world but these are not truly rare species. These species will probably have their names removed from the rare rank through further investigations in the neighbouring countries.

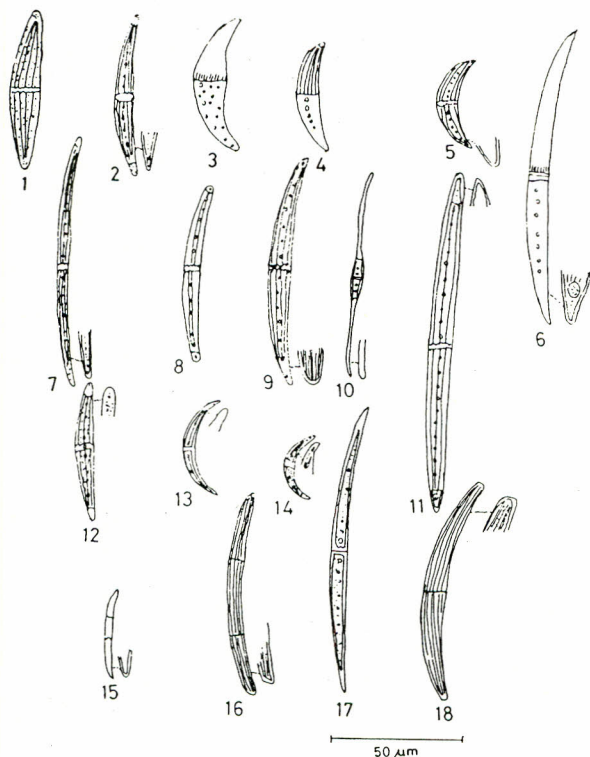


Plate 1. 1. *Closterium lunula*; 2. *Cl. littorale*; 3. *Cl. ehrenbergii*; 4. *Cl. moniliferum*; 5. *Cl. moniliferum* var. *concauum*; 6. *Cl. attenuatum*; 7. *Cl. lineatum*; 8. *Cl. abruptum*; 9. *Cl. striolatum*; 10. *Cl. setaceum*; 11. *Cl. acerosum* var. *elongatum*; 12. *Cl. tumidum*; 13. *Cl. venus*; 14. *Cl. incurvum*; 15. *Cl. gracile*; 16. *Cl. intermedium*; 17. *Cl. strigosum*; 18. *Cl. costatum*.

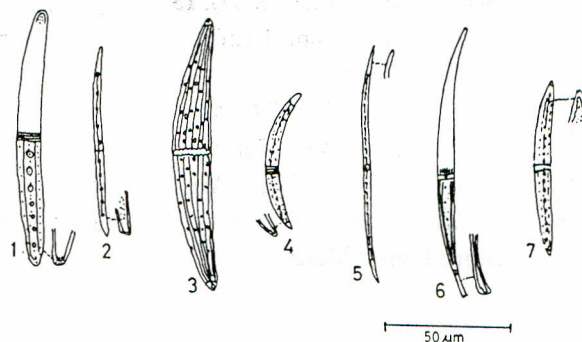


Plate 2. 1. *Closterium baillyanum*; 2. *Cl. gracile*; 3. *Cl. turgidum* var. *giganteum*; 4. *Cl. diana* var. *arcuatum*; 5. *Cl. aciculare*; 6. *Cl. rostratum*; 7. *Cl. acerosum*.

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is not always taken in deserts
 Some species in the present study are rare species in
 the world but these are not truly rare species. These
 species will probably have their names removed from the
 rare rank through further investigation in the neighboring
 countries