



Taxonomic Study of Some *Cosmarium* Species from North-Eastern Areas of Pakistan

Waqar-ul-Haq¹, Zarina Ali^{1*}, Masud-ul-Hasan² and Mustafa Shameel³

¹Department of Botany, Federal Urdu University of Arts, Science & Technology,
Gulshan-e-Iqbal Campus, Karachi-75300

²Department of Botany, Govt. College University, Katchehri Road, Lahore-54000

³Department of Botany, University of Karachi, Karachi-75270, Pakistan

Abstract: Ten species of the placoderm desmid, *Cosmarium* Corda ex Ralfs (phylum Volvophycota Shameel) were collected from various freshwater habitats in Azad Kashmir as well as provinces of Punjab and Khyber Pakhtoonkhwa of Pakistan during April 2004 and December 2006. They were taxonomically investigated and described. They appeared in winter, occurred predominantly in spring and summer, and disappeared in the autumn. Out of these, *C. ctenoideum*, *C. formulosum* Hoff in Nordstedt and *C. garrolense* Roy et Bisset are being reported for the first time from Pakistan.

Keywords: Freshwater algae, Volvophycota, desmids, *Cosmarium*, taxonomy, cytology, reproduction

1. INTRODUCTION

Cosmarium Corda ex Ralfs is a very common genus of placoderm desmids (family Desmidiaceae, order Desmidiales, class Desmidophyceae, phylum Volvophycota [1, 2]. It grows luxuriantly in freshwater habitats of Pakistan. Its 41 species were collected from different places in the north-eastern areas of Pakistan, out of which 31 species have been described earlier [3, 4]. The present investigation is a continuation of such studies, where 10 species were taxonomically evaluated and described.

2. MATERIALS AND METHODS

The material was collected from various freshwater habitats at Gujranwala, Jauharabad, Jhang, Lahore, Pasroor, Sheikhpura and Sialkot districts of the Punjab Province, Attock and Swat in the province of Khyber Pakhtoonkhwa as well as Chenari and

Neelam Valleies of Azad Kashmir during April 2004 and December 2006. The methods used for its collection, preservation, microscopic examination and preparation of drawings were the same as have been described earlier [5]. The specimens were identified up to species level with the help of authentic literature [6-30]. The voucher specimens are kept in the Phycology & Phycochemistry Lab. (Room No. 18), MAH Qadri Biological Research Centre, University of Karachi, where this research work was carried out.

3. RESULTS AND DISCUSSION

From collected material ten species of the genus *Cosmarium* Corda 1839: 242 ex Ralfs 1848: 91 were identified. Their microscopic examination revealed the following taxonomic characters, on the basis of which they may be distinguished as follows:

1. Cells more than 51 μm long2
Cells less than 51 μm long3
2. Cell-wall smooth *C. galeritum* (3)
Cell-wall otherwise.....4
3. Cells up to 20 μm broad5
Cells more than 20 μm broad6
4. Cells up to 42 μm broad *C. formulosum* (2)
Cells up to 46 μm
broad.....*C. margaritifera* (10)
5. Semi cells sub-circular *C. imressulum* (8)
Semi cells oblongo-elliptic *C. leave* (9)
6. Width of isthmus
more than 10 μm *C. hammeri* (7)
Width of isthmus up to 10 μm7
7. Cells more than
24 μm broad *C. garrolense* (4)
Cells up to 24 μm broad8
8. Semi cells truncate-
pyramidal.....*C. granatum* (6)
Semi cells otherwise9
9. Cell surface undulate
and flattened at apices.....*C. gibberulum* (5)
Cell surface otherwise *C. ctenoideum* (1)

1. *C. ctenoideum*

General Characters: Cells 26.4-28.0 μm long and 22-24 μm broad, isthmus 4-5 μm wide; cell-walls punctuate; semi-cells trapezoid in each cell, rare in medium (Fig. 1).

Locality: Lahore District: Ghulam Colony Village (22-6-2005).

Geographical Distribution: Worldwide.

Remarks: Specimens were collected in summer from rice fields. This is the first report of its occurrence in Pakistan.

2. *C. formulosum* Hoff in Nordstedt 1888: 194

References: Sherwood 2004: 10, Šťastný 2009: 143 [28-29].

General Characters: Cells 51-52 μm long and 40-42 μm broad; isthmus 13-14 μm wide; cell-walls

dentate; ends are not clear (Fig. 2).

Locality: Khyber Paktoonkhwa: Swat, Utrod river side in Kalam (13-8-2005).

Geographical Distribution: U. S. A., Denmark, Poland and Czech Rep.

Remarks: Collected during summer from the side of Utrod River. This is the first report of its occurrence in Pakistan.

3. *C. galeritum* Nordstedt 1870: 209

Synonymy: *Cosmarium pyramidatum* Brébisson in Bernard 1808: 107, *C. pyramidatum* Brébisson f. *subgranatum* Klebs 1879: 31.

References: Krieger & Gerloff 1962: 107, Duthie & Ostrofsky 1975: 262, Bando *et al.* 1989: 16, Masud-ul-Hasan & Yunus 1989: 114, Sahin & Akar 2007: 1824, Šťastný 2010: 12 [7, 9, 14, 21, 26, 30].

General Characters: Cells 51-53 μm long and 42-50 μm broad, isthmus 14-18 μm ; cells of moderate size, slightly longer than broad; deeply constricted, sinus narrowly linear with a dilated extremity; semi-cells pyramidal trapesiform, apex narrowly truncate and generally slightly convex; basal angle rounded, cell outline broadly elliptic; ends flat, side rounded; cell-walls smooth; chloroplast axial, each with two pyrenoids (Fig. 3).

Localities: Sheikhpura District: Mureedke and Narang Mundi (5-9-2005); Khyber Paktoonkhwa: Swat, Utrod river sides in Kalam (13-8-2005).

Geographical Distribution: Worldwide.

Remarks: Specimens were collected during summer and autumn from ponds and rice fields mixed with other free-floating algae.

4. *C. garrolense* Roy et Bisset 1894: 101

Synonymy: *Cosmarium alpinum* (Raciborski) De Toni var. *helveticum* Schmidle 1894: 89, *C. alpinum* (Raciborski) De Toni var. *garrolense* (Roy et Bisset) Schmidle 1897: 66, *C. latere-undatum* Roy et Bisset 1894: 101.

References: Krieger & Gerloff 1962: 43, Sahin & Akar 2005: 60, Šťastný 2010: 13 [1, 26, 30].

General Characters: Cells slightly longer than broad; semi-cells hemispherical in shape; flattened

at the apex, lateral undulations are five or six; length 29-38 μm and width 23-29 μm ; width of isthmus 7-10 μm (Fig. 4).

Localities: Lahore District: Ghulam Colony Village (18-7-2005); Pasroor District: Mutaik-e-Raypootan Village (4-3-2006).

Geographical Distribution: England, Germany, Switzerland, Turkey, Afghanistan and Brazil.

Remarks: Collected in spring and summer from stagnant water ponds and rice fields. This is the first report of its occurrence in Pakistan.

5. *C. gibberulum* Lütkemüller

References: Masud-ul-Hasan & Zeb-un-Nisa 1986: 242, Leghari *et al.* 2002: 76, Šťastný 2010: 13 [18, 19, 30].

General Characters: Cell surface undulate; flattened at apices; chloroplast one in each semi-cell, each with a pyrenoid; cell length 27-32 μm and breadth 20-24 μm , isthmus 1-9 μm broad (Fig. 5).

Localities: Azad Kashmir: Chenari (28-4-2004), Neelam Valley (5-4-2005).

Geographical Distribution: Czech Rep., Afghanistan and Pakistan.

Remarks: Collected in spring from river sides and stagnant water ponds.

6. *C. granatum* Brébisson in Ralfs 1848: 96

Synonymy: *Didymidium granatum* (Brébisson) Reinsch 1867: 109, *Euastrum granatum* (Brébisson) Gay 1884: 59, *Cosmarium pseudogranatum* Nordstedt in Gutwinski 1891: 47, *C. sexangulare* Lundell f. *minima* Nordstedt in Bohlin 1901: 70.

References: Krieger & Gerloff 1962: 111, Islam 1970: 924, Masud-ul-Hasan & Zeb-un-Nisa 1986: 242, Gontcharov *et al.* 2001: 99, Kopp 2006: 123, Gul *et al.* 2008: 201, Rai *et al.* 2008: 61, Sarim *et al.*, 2008: 39, Šťastný 2009: 143 [10, 11, 13, 14, 17, 19, 23, 27, 29].

General Characters: Cells 1-1 ½ times as long as broad, semi-cells truncate pyramidal; chloroplast one in each semi-cell with a pyrenoid; cell length 26-31 μm and breadth 19-23 μm , isthmus 4.9-7.0 μm wide; cell-walls smooth (Fig. 6).

Localities: Lahore District: Ghulam Colony Village (18-7-2004), Mari Village (23-7-2005); Sialkot District: Sambraal Road near Ravi Marals (6-4-2005); Azad Kashmir: Chenari (28-4-2006), Neelam Valley (15-12-2006).

Geographical Distribution: Worldwide: U.S.A., England, Germany, Switzerland, Czech Rep., South America, India, Pakistan and Afghanistan.

Remarks: Collected in winter, spring and summer from paddy fields, stagnant water ponds and river sides.

7. *C. hammeri* Reinsch 1867: 115

Synonymy: *Euastrum hammeri* (Reinsch 1867) Cohn 1879: 250.

References: Krieger & Gerloff 1962: 57, Gontcharov *et al.* 2001: 99, Husna *et al.* 2008: 106 [10, 12, 14].

General Characters: Cells about median size, deeply constricted; sinus narrowly linear, with a dilated extremity; semi-cells acute-pyramidal from a broad wavy base, angle rounded; cell-wall smooth wavy at apices; length of semi-cells 37-38 μm and width 20-21 μm ; width of isthmus 13.5-14.5 μm (Fig. 7).

Locality: Lahore District: Fountain of Shalimar Garden (20-5-2005).

Geographical Distribution: Cosmopolitan, all over the world.

Remarks: Collected in spring from fountain water (temperature 39.6 °C and pH 7).

8. *C. impressulum* Elfving 1881: 13

Synonymy: *Cosmarium meneghinii* Brébisson f. *latiuscula* Jacobsen 1876: 197, *C. meneghinii* Brébisson f. *octangularis* Wille 1879: 43, *C. meneghinii* var. *simplicissimum* Wille 1880: 30, *Euastrum impressulum* Gay 1884: 61, *C. meneghinii* f. *reinschii* Istvanfi 1886: 237, *C. crenulatum* (Nägeli) Schmidle 1893: 96, *C. crenulatum* (Nägeli) Schmidle var. *reinschii* (Istvanfi) Schmidle 1893: 96, *C. transiens* Gay f. *minor* Gutwinski 1909: 458, *C. undulatum* Corda var. *crenulatum* (Nägeli) Wittrock in Krieger 1932: 190, *C. undulatum* Corda f. *minima* Cosandey 1934: 451, *C. repandum*

Nordstedt f. *minor* Irénée-Marie 1938: 178.

References: Krieger & Gerloff 1965: 133, Islam 1970: 924, Masud-ul-Hasan & Batool 1987: 353, Masud-ul-Hasan & Yunus 1989: 114, Leghari *et al.*, 2002: 76, Novakovskaya & Patova 2008: 839, Rai *et al.* 2008: 61, Sterlyagova 2008: 917 [13, 15, 18, 20-23].

General Characters: Cells rather small, deeply constricted, sinus narrowly linear with slightly dilated apex; semi-cells sub-circular, margin regularly and markedly undulate, sometimes almost crenate; crenation two at the apex and two on each side of convex sides; cell-wall punctate; chloroplast axile with a central pyrenoid. Overall cell shape irregularly polygonal; semi-cells with a rounded perimeter of about eight small straight edges or undulation; length of cells is 20-30 μm and width is 15-20 μm ; isthmus 3.4-9.0 μm broad (Fig. 8).

Localities: Gujranwala: Nandipur (4-4-2004); Jhang District: near Riwarz Chund Bridge, Chenab (22-1-2005); Lahore District: Ghulam Colony Village (18-7-2005); Sheikhpura District: Mureedke and Narang Mundi (12-9-2006); Khyber Paktoonkhwa: Attock (12-1-2005).

Geographical Distribution: U. S. A. Canada, Europe, Pakistan and Afghanistan.

Remarks: Collected from paddy fields, river water, canal side ponds and stagnant ponds mixed with other free-floating algae.

9. *C. leave* Rabenhorst 1868: 161

Synonymy: *Cosmarium leiodermum* (Gay) Hansgirg 1888: 194, *C. gerstenbergim* Richter f. *typica* Richter 1895: 23, *C. gerstenbergim* Richter f. *subreniformis* Richter 1895: 23, *C. leiodermum* (Gay) Hansgirg var. *maius* Gutwinski 1898: 145, *C. leiodermum* (Gay) Hansgirg f. *maior* Borge 1901: 24, *C. granatum* Brébisson var. *subgranatum* Nordstedt f. *crassa* Roller 1925: 147, *C. meneghinii* f. *octangularis* Wille.

References: Krieger & Gerloff 1969: 259, Ahmed *et al.* 1983: 426, Bando *et al.* 1989: 16, Kitner *et al.* 2004: 49, Sahin & Akar 2007: 1824, Celewicz-Gołdyn & Kuczyńska-Kippen 2008: 17, Husna *et al.* 2008: 106 [6-8, 12, 16, 24, 25].

General Characters: Cells small, very deeply

constricted; sinus narrowly linear with dilated apex, depressive at apex; semi-cells oblongo-elliptic, with basal angles slightly rounded; apex narrowly truncate and retuse; cell-walls smooth, chloroplast axile with a central pyrenoid, rare in median; length of semi-cell is 25.5-26.5 μm and width 19-20 μm ; width of isthmus 13-14 μm (Fig. 9).

Locality: Lahore District: Fountain of Shalimar Garden (20-4-2005).

Geographical Distribution: Cosmopoliton, found all over the world.

Remarks: Collected from fountain water of historical place (temperature 35.1 °C and pH 7).

10. *C. margaritifera* Meneghini ex Ralfs 1848: 100

Synonymy: *Cosmarium confusum* var. *regularis* Nordstedt.

References: Masud-ul-Hasan & Zeb-un-Nisa 1986: 243, Gul *et al.* 2008: 202, Štátný 2009: 143 [11, 19, 29].

General Characters: Cell-wall punctate and granulated; semi-cells pyramidal truncate, basal and upper angles rounded; sides slightly convex, apex broad and straight; sinus deep, narrowly linear, dilated at the extremity; chloroplasts two in a semi-cell, each with a pyrenoid; cell length 49-58 μm and breadth 39-46 μm ; isthmus 13-17 μm wide (Fig. 10).

Localities: Jauharabad (16-2-2005); Sialkot District: Ravi Marala Link, Sambraal Road (6-4-2005); Azad Kashmir: Chenari (28-4-2006).

Geographical Distribution: U. S. A., Denmark, Poland, Czech Rep., Pakistan and New Zealand.

Remarks: Collected from three different places from stagnant water pools.

The collected species of *Cosmarium* were observed to appear in the winter season; they occurred predominantly in spring and summer, and gradually disappeared in the autumn.

4 CONCLUSIONS

The species were identified mainly on the basis of cellular morphology and cell dimensions, but future

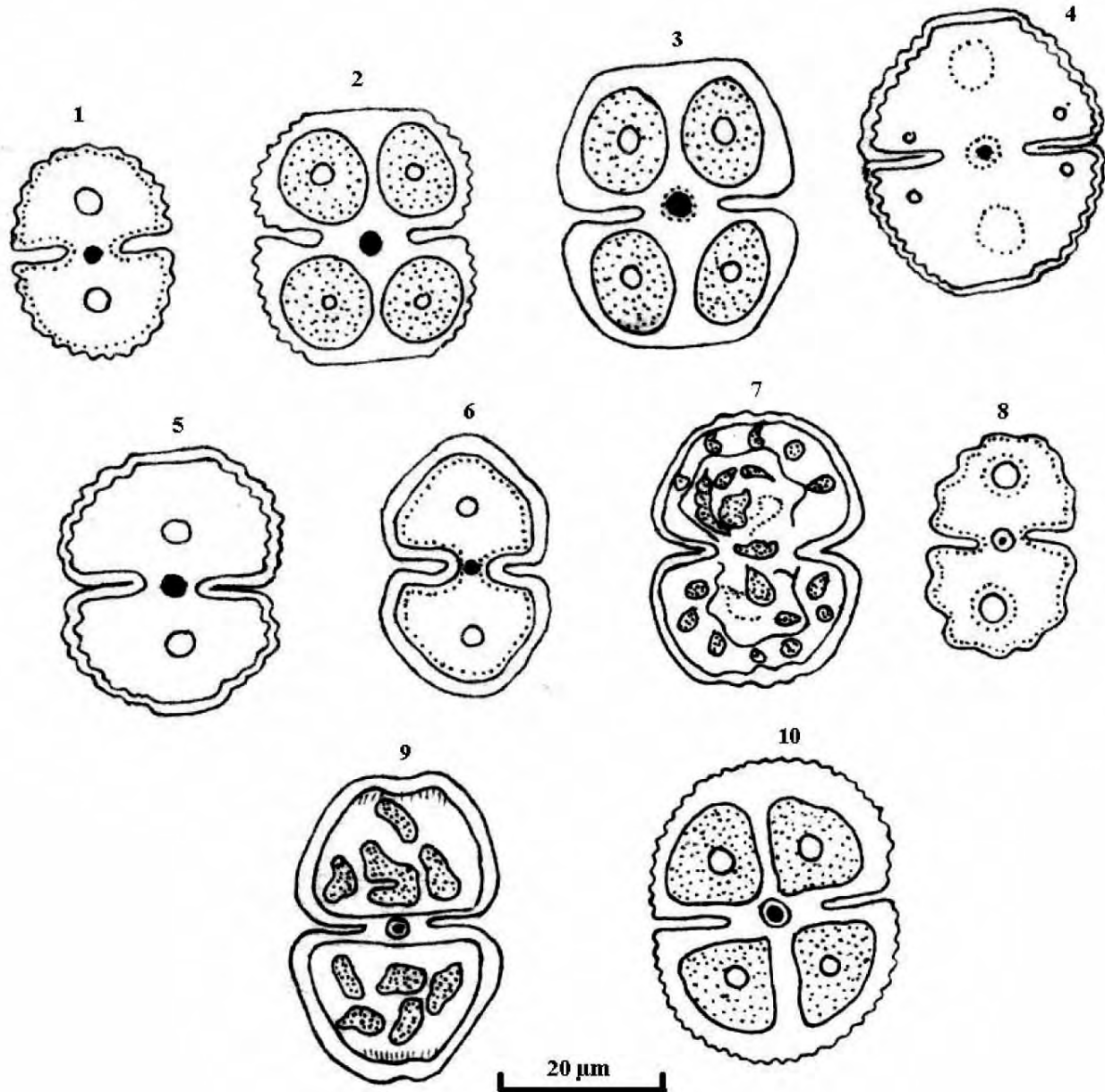


Fig. 1-10. Species of *Cosmarium* from Pakistan: 1. *C. ctenoideum*, 2. *C. formulosum*, 3. *C. galeritum*, 4. *C. garrolense*, 5. *C. gibberulum*, 6. *C. granatum*, 7. *C. hammeri*, 8. *C. impressulum*, 9. *C. leave*, 10. *C. margaritifera*.

studies, like molecular analysis using *rbcL* and mitochondrial *COX3* genes as molecular markers, may confirm their identification. The investigated species appeared in winter, occurred predominantly in spring and summer, and gradually disappeared during autumn. The frequency of their occurrence during autumn season was extremely low. This may be attributed to poor availability of nutrients which are usually exhausted up to the end of summer season by blooming algae. This tendency was repeatedly observed over three years.

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