Pak. J. Bot., 46(4): 1501-1506, 2014.

TAXONOMIC STUDIES ON THE GENUS *COSMARIUM* CORDA (DESMIDOPHYCEAE) FROM NORTH-EASTERN AREAS OF PAKISTAN

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Abstract

Forty-one species of the algal genus *Cosmarium* Corda *ex* Ralfs (phylum Volvophycota Shameel) were collected from various freshwater habitats in Azad Kashmir as well as provinces of the Punjab and Khyber Pakhtoonkhwa of Pakistan during January 2003 and December 2006. Out of these 11 species were taxonomically investigated and described here. Among them *C. pulchrum* Turner, *C. repandum* Nordstedt, *C. rugosum* Turner, *C. tetraophthalmum* Brébisson in Ralfs, *C. tumidum* P. Lundell are being reported for the first time from Pakistan.

Introduction

Algal communities play a significant role in any aquatic ecosystem, being initiators of food chain (Ali *et al.*, 2010a, b, 2011). Among them *Cosmarium* Corda *ex* Ralfs is a very common genus of placoderm desmids (family Desmidiaceae, order Desmidiales, class Desmidophyceae, phylum Volvophycota; *fide* Shameel, 2001, 2008, 2012). Its 41 species were collected from different freshwater habitats in the nortH-eastern areas of Pakistan, out of which 30 have been taxonomically described (Waqar-ul-Haq, 2010, 2011a, b). This is a continuation of these studies, here the remaining 11 species were taxonomically evaluated and are being presented.

Materials and Methods

The specimens were collected from various freshwater habitats at Gujranwala, Jauharabad, Jhang, Kasur, Lahore, Pasroor, Sheikupura and Sialkot districts of the Punjab Province, Attock and Swat in the province of Khyber Pakhtoonkhwa as well as Chenari and Neelam Valley of Azad Kashmir during January 2003 and December 2006. The methods used for their collection, preservation, microscopic examination and preparation of drawings were the same as have been described earlier (Waqar-ul-Haq *et al*., 2007). The specimens were identified up to species level with the help of authentic literature (*lit. cit.* at each species). The voucher specimens are kept in the Phycology & Phycochemistry Lab., MAH Qadri Biological Research Centre, University of Karachi.

Results and Discussion

The taxonomic evaluation of the collected specimens revealed the presence of 41 species of the placoderm desmid genus *Cosmarium.* The description of various taxa is presented below:

***Cosmarium* Corda 1839: 242 *ex* Ralfs 1848: 91:** It is one of the most common genera of the desmids, individuals are single celled, with a very obvious constriction in the center, two semi-cells are connected by a central part, the isthmus, containing the single nucleus. Each semi-cell has one or two chloroplasts, and with a prominent pyrenoid. There is much variation in shape, size of cell and wall surface. Sexual reproduction is by conjugation tube. In the present collection following 41 species were collected, which may be distinguished as follows:

1. Cells up to 53 µm long ……..... 2
   Cells more than 53 µm long ……..... 3
2. Cells more than 40 µm broad ……..... 4
   Cells less than 40 µm broad ……..…… 5
3. Cells more than 60 µm broad …… 6
   Cells less than 60 µm broad ……..... 7
4. Isthmus more than 14 µm broad ……..……..……..…… *C. rugosum (4)*
   Isthmus up to 14 µm broad …….. 8
5. Cells hemispherical ……..……. 9
   Cells otherwise ……..…… 10
6. Semi-cells rectangular ……..…..... *C. conspersum*
   Semi-cells hemispherical …… 11
7. Cells more than 45 µm broad ……..…….... 12
   Cells less than 45 µm broad …… 13
8. Cell-walls dentate ……..…..…… *C. formulosum*
   Cell-walls otherwise ……..…..... 14
9. Isthmus up to 10 µm broad ……..……... 15
   Isthmus more than 10 µm broad ……..... 16

10. Cells up to 30 µm long 17
    Cells more than 30 µm long 18
11. Cell outline circular ..... *C. subcirculare (6)*
    Cell outline otherwise ..... *C. pachydermum*
12. Isthmus up to 20 µm broad 19
    Isthmus less than than 20 µm broad 20
13. Cell outline circular ..... *C. circulare*
    Cell outline cunate 21
14. Semi-cells trapezoidal in shape ..... *C. nymannianum*
    Semi-cells oblongo-rectangular in shape ..... *C. pulchellum (1)*
15. Cells up to 35 µm long ..... *C. subtumidum (9)*
    Cells more than 35 µm long ..... *C. garrolense*
16. Cells up to 39 µm long ..... *C. canadense*
    Cells less than 39 µm long 22
17. Semi-cells laterally flattened ..... *C. polygonum*
    Semi-cells laterally otherwise 23
18. Isthmus up to 7 µm broad 24
    Isthmus more than 7 µm broad 25
19. Semi-cells oval in shape ..... *C. margasitatium*
    Semi-cells triangular ..... *C. obtusatum*
20. Cell outline wavy ..... *C. botrytis*
    Cell outline otherwise 26
21. Cells up to 42 µm broad ..... *C. scotii (5)*
    Cells more than 42 µm broad ..... *C. tetraophthalmum (10)*
22. Semi-cells compressed ..... *C. phaseolus*
    Semi-cells otherwise 27
23. Chloroplast contains many pyrenoids ..... *C. subcostatum (7)*
    Chloroplast contains a central pyrenoid 28
24. Semi-cells trapezoidal in shape 29
    Semi-cells otherwise in shape 30
25. Semi-cells up to 21 µm broad 31
    Semi-cells more than 21 µm broad 32
26. Chloroplast contains one pyrenoid ..... *C. margaritiferum*
    Chloroplast contains two pyrenoids ..... *C. galeritum*
27. Cells up to 31 µm long ..... *C. biloculatum*
    Cells less than 31 µm long ..... *C. baileyi*
28. Cell surface flattened at apices ..... *C. gibberulum*
    Cell surface otherwise at apices ..... *C. impressulum*
29. Apices of cells slightly curved ..... *C. pseudomeneghinii*
    Apices of cells otherwise ..... *C. ctenoideum*
30. Semi-cells up to 10 µm long ..... *C. repandum (3)*
    Semi-cells more than 10 µm long 33
31. Cell surface wavy 34
    Cell surface otherwise 35
32. Isthmus up to 8 µm broad 36
    Isthmus more than 8 µm broad 37
33. Apices of semi-cells flattened ..... *C. alatum*
    Apices of semi-cells otherwise ..... *C. hammeri*
34. Cel-walls smooth ..... *C. leave*
    Cel-walls not smooth ..... *C. sublateriundatum (8)*
35. Cell-walls smooth 38
    Cell-walls otherwise 39
36. Cell outline circular 40
    Cell outline otherwise ..... *C. concentricum*
37. Semi-cells elliptical to sub-elliptical in shape ..... *C. contractum*
    Semi-cells truncato-pyramidal in shape ..... *C. granatum*
38. Semi-cells broadly oval ..... *C. pulchrum (2)*
    Semi-cells oblong-oval ..... *C. tumidum (11)*
39. Sinus narrow, isthmus up to 29 µm broad ..... *C. pluvial*
    Sinus narrow, isthmus less than 29 µm broad ..... *C. orthogonum*
40. Semi-cells hexangular to octangular, with sharp basal angles ..... *C. angular*
    Semi-cells pyramidal, basal angles otherwise ..... *C. pericymatium*

Out of the above mentioned species 30 have been taxonomically described earlier (Waqar-ul-Haq *et al.,* 2010, 2011a, b). The remaining 11 species are being described as follows.

1. *C. pulchellum* Turner

Reference: Masud-ul-Hasan & Zeb-un-Nisa, 1986: 242.

General characters: Cells dumbel-shaped, semi-cells oblong rectangular; sinus narrowly linear, deeply constricted; cell-wall finely granulated, granules small and solid; each semi-cells has two chloroplasts, each with a prominent pyrenoid; cell length 45-52 µm and breadth 38-46 µm; isthmus 13-14 µm wide (Fig. 1).

Localities: Gujranwala District: Nandipur (4-4-2004); Jauharabad District: Jauharabad (16-2-2004); Azad Kashmir: Chenari (28-4-2006), Neelam Valley (15-12-2005);

Geographical distribution: U. S. A., Europe, Afghanistan, India and Pakistan.

Remarks: Collected from stagnant water ponds, pools, freshwater ponds and river sides.

2. *C. pulchrum* Turner

General characters: Over all shape broadly oval, wall undulated; cells 45-46 µm long and 30-31 µm broad, isthmus 7.5-8.0 µm wide (Fig. 2).

Locality: Jhang District: Chenab near Riwaz Chund Bridge (22-1-2005).

Geographical distribution: Previously reported from U. S. A.

Remarks: Collected from river side pond. This is the first report of its occurrence in Pakistan.

3. *C. repandum* Nordstedt 1887: 162

References: Maskell, 1888: 16; West & West, 1908: 53; Chapman *et al.,* 1956: 718; Krieger & Gerloff, 1965: 233.

Synonymy: *Cosmarium rectangulare* Grunow var. *repandum* (Nordstedt) Playfair 1910.

General characters: Cells 9-10 µm long and 5-7 µm broad, isthmus 1.4-1.6 µm wide; semi-cells hexagonal or sinuses very narrow and deep. It is smaller than the type specimen (Fig. 3).

Locality: Sialkot District: Langarwal Village (25-5-2004).

Geographical distribution: Previously reported from U. S. A., England, Germany and New Zealand.

Remarks: Collected from roadside puddle. This is the first report of its occurrence in Pakistan.

4. *C. rugosum* Turner

General characters: Cells 47-48 µm broad and 60-62 µm long, isthmus 17-1 8 µm wide; semi-cells sub-circular, sinus deeply constricted, cell-wall granulated (Fig. 4).

Locality: Gujranwala District: Nandipur (4-4-2005).

Geographical distribution: Previously reported from India.

Remarks: Collected from freshwater pond. This is the first report of its occurrence in Pakistan.

5. *C. scotii* Croasdale *in* Grönblad *et al.,* 1964: 24

References: Krieger & Gerloff, 1969: 335; Gul *et al.,* 2008: 202.

General characters: Cell outline smooth, much longer than broad, sinus wide; 2 chloroplasts in each semi-cell; cells 60-63 µm long and 30-42 µm; broad isthmus 20-23 µm wide (Fig. 5).

Locality: Sialkot District: Head Marala (17-8-2005).

Geographical distribution: Previously reported from Germany and Uganda.

Remarks: The material was collected from stagnant water ponds during summer.

6. *C. subcirculare* Turner

Reference: Gul *et al.,* 2008: 202.

General characters: Cells outline circular, each semi-cell hemispherical, side view circular; sinus deep, narrowly linear, dilated at the extremity; cell length 68-70 µm and breadth 60-62 µm; isthmus 27-29 µm wide (Fig. 6).

Locality: Sialkot District: Head Marala (17-8-2005).

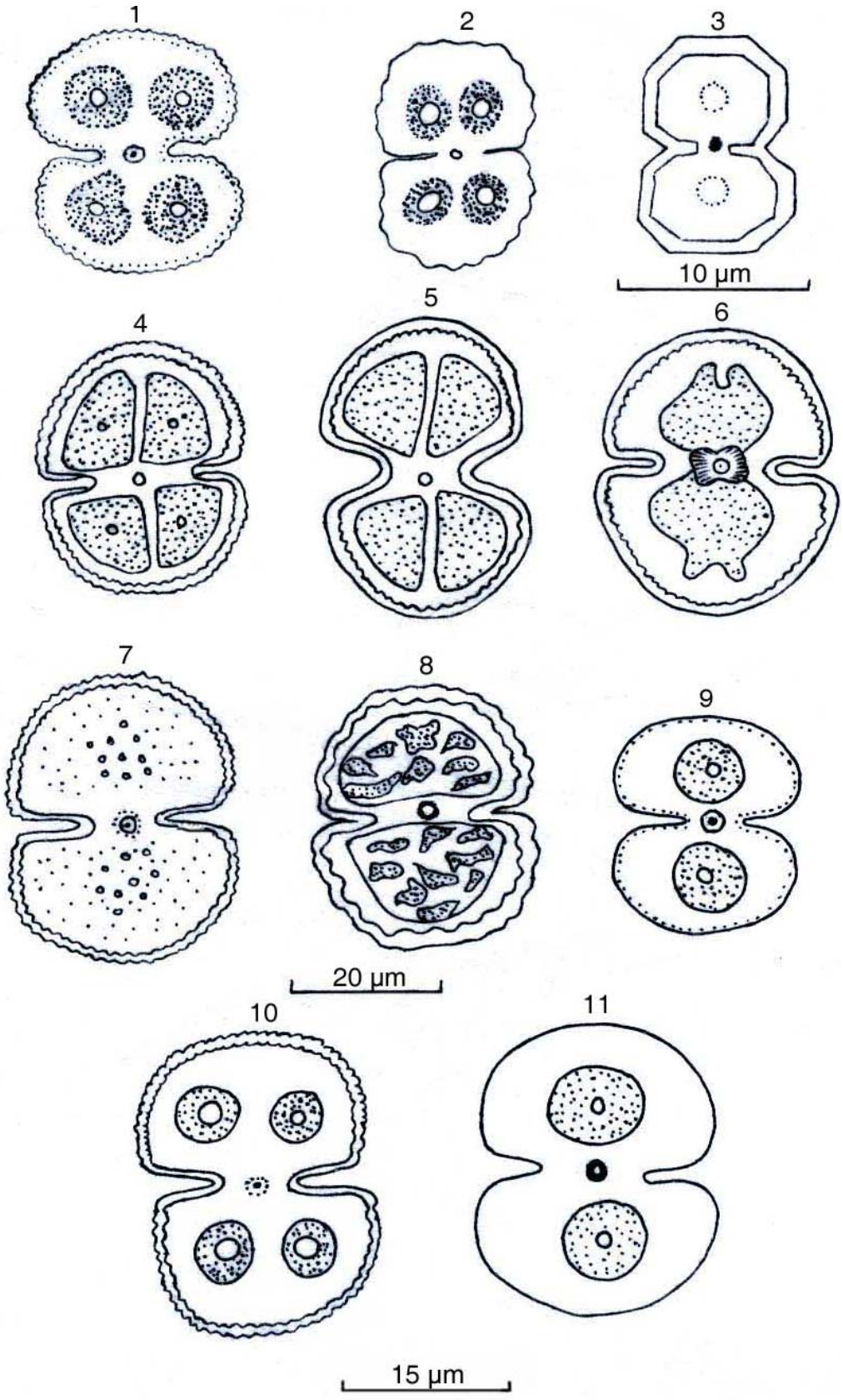
Geographical distribution: Previously reported from India and Pakistan.

Remarks: Collected from stagnant water channels.

7. *C. subcostatum* Nordstedt 1876

References: Børgesen, 1901: 226; West, 1904:168; Whitton & Donaldson, 1977: 6; Bando *et al.,* 1989: 21; Sahin & Akar, 2007: 1826; Husna *et al.,* 2008: 109; Rai *et al.,* 2008: 80; ŠŤastný, 2009: 143.

General characters: Semi-cells sub-circular, obovate; cell-wall finely punctate; chloroplast axile with many pyrenoids in each semi-cell, rare median; length of semi-cell is 23.5-24.0 µm and width 20.5-22.5 µm; width of isthmus 7.5-9.5 µm (Fig. 7).



Figs. 1-11. Species of *Cosmarium*: **1.** *C. pulchellum*, **2.** *C. pulchrum*, **3.** *C. repandum*, **4.** *C. rugosum*, **5.** *C. scotii*, **6.** *C. subcirculare*, **7.** *C. subcostatum*, **8.** *C. sublateriundatum*, **9.** *C. subtumidum*, **10.** *C. tetraophthalmum*, **11.** *C. tumidum*.

Locality: Lahore District: Fountain of zoo (20-7-2005).

Geographical distribution: Previously reported from Denmark, Czech, England, Turkey and Nepal.

Remarks: Collected from fountain water of zoo (temprature 32.8 ºC and pH 7.5).

8. *C. sublateriundatum* West *et* West 1895: 60

References: Krieger & Gerloff, 1962: 48; Bando *et al.,* 1989: 21; Husna *et al.,* 2008: 109.

General characters: Over all cell outline broadly elliptical; semi-cells flattened, surface of semi-cell punctate; sinus linear, with dialated extremity; apex narrowly truncate; cell-wall not smooth; cell length 32-33 µm and width 19-20 µm; width of isthmus 13-14 µm (Fig. 8).

Locality: Lahore District: fountain of Shalimar Garden (20-3-2005).

Geographical distribution: Previously reported from Germany, Madagascar, Nepal and Myanmar.

Remarks: Specimens were collected from fountain water (temprature 32 ºC and pH 7).

9. *C. subtumidum* Nordstedt 1878 *in* Wittrock *ex* Nordstedt 1889: 44

References

Børgesen, 1901: 223; West, 1904: 168; West & West, 1905: 192; Carter, 1926: 269; Messikommer, 1942: 105; Skuja, 1949: 66; Croasdale, 1956: 55; Wasylik, 1961: 278; Krieger & Gerloff, 1965: 162; Biswas, 1975: 571; Duthie & Ostrofsky, 1975: 262; Whitford, 1979: 42; Ahmed *et al.,* 1983: 426; Masud-ul-Hasan & Yunus, 1989: 115; Gontcharov *et al.,* 2001: 99; Leghari *et al.,* 2002: 76; Sterlyagova, 2008: 917; ŠŤastný, 2010: 19; Özer *et al.,* 2012: 758.

Synonymy: *Cosmarium subtumidum* Nordstedt var. *minus* Sampaio 1944: 345, *C. subtumidum* Nordstedt f. *punctata* Nygaard 1949: 68, *C. granatum* Brébisson var. *depressum* Ström 1920: 7, *C. nitidulum* De Notaris *in* Elfving 1887: 12.

General characters: Semi-cells hemispherical with slightly flattened poles; equatorial angles somewhat rounded; surface smooth, length 32-35 µm and width 25-28 µm; isthmus 7.0-8.25 µm wide (Fig. 9).

Localities: Lahore District: Ghulam Colony Village (18-7-2003); Sheikhupura District: Mureedke and Narang Mundi (12-9-2004).

Geographical distribution: Worldwide.

Remarks: Collected from rice fields at two different places.

10. *C. tetraophthalmum* Brébisson *in* Ralfs 1848

References: Maskel, 1888: 6; Børgesen, 1901: 228; Chapman *et al.*, 1956: 718; Hirano, 1964: 218; Kitner *et al.,* 2004: 50; ŠŤastný, 2009: 143.

General characters: Semi-cells are hemispherical in shape, margins are cuneate; 2 pyrenoids in each semi-cell; length 68.3-70.3 µm and width 50-54 µm, isthmus 13.8-15.8 µm wide (Fig. 10).

Locality: Lahore District: Hadira Village (17-8-2006).

Geographical distribution: China, Czech, Germany, France, India and New Zealand.

Remarks: Collected from freshwater pond. This is the first report of its occurrence in Pakistan.

11. *C. tumidum* P. Lundell 1871: 45

References: Wolle, 1892: 67; West & West, 1905: 160; Irénée-Marie, 1939: 162; Krieger & Gerloff, 1962: 57.

Synonymy: *Cosmarium pseudonitidulum* Nordstedt var. *maius* Reinsch 1875: 88, *C. tumidum* Lundell f. *genuinum* Kirchner 1878: 47, *C. tumidum* Lundell f. *typica* Schmidle 1898: 24, *C. tumidum* Lundell f. *ventricosa* Heimerl 1891: 597.

General characters: Semi-cells oblong-oval; cells 37-38 µm broad and 32-33 µm long, isthmus 6.8-8.0 µm wide (Fig. 11).

Locality: Sialkot District: near Trimmu Head Works (22-1-2005).

Geographical distribution: Previously reported from England, Canada and U. S. A.

Remarks: Collected from a pond mixed with other free-floating algae. This is the first report of its occurrence in Pakistan.

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(Received for publication 6 March 2013)