

Genus *Cosmarium* Corda from Thrissur Kole Lands, Kerala

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ABSTRACT

The present investigation deals with 68 taxa of *Cosmarium* Corda collected from the Kole lands of Thrissur, Kerala. The Kole lands constitute part of Vembanad-Kol, which is declared as one of the Ramsar sites of Kerala. All the taxa are systematically described with illustrations and their distribution in India. Of these, 6 taxa are the 1st time reported from India and 29 taxa are new additions to the algal flora of Kerala. *Cosmarium geminatum* Lund. var. *ornatum* Behre, *Cosmarium indentatum* Gronbl. var. *ellipticum* Scott and Gronbl., *Cosmarium pseudoconnatum* Nordst. var. *constrictum* West, *Cosmarium quadrifarium* Lund., *Cosmarium quadriverrucosum* West and West var. *undulatum* Scott and Prescott and *Cosmarium subturgidum* (Turn.) Schmidle are the new additions to the desmid flora of India.

KEY WORDS: *Cosmarium*, desmid, Kerala, Thrissur Kole lands, Vembanad-Kol

INTRODUCTION

The Kole lands form a unique aquatic ecosystem and are the rice granary of Thrissur and Malappuram districts, Kerala (Johnkutty and Venugopal, 1993). The Kole lands of Kerala constitute part of Vembanad-Kol, which is declared as one of the Ramsar sites of India in 2002 and got international importance (<http://www.ramsar.org>). The Kole lands geographically distributed in Mukundapuram, Chavakkad and Thrissur taluks of Thrissur district, Kerala are designated as "Thrissur Kole." The present manuscript deals with the systematic account, seasonal and spatial variation of *Cosmarium* Corda from the Kole lands of Thrissur, Kerala.

Cosmarium Corda comes under the family Desmidiaceae of the order Zygnematales and the class Chlorophyceae. The *Cosmarium* was reported from different parts of India and are distributed in Kerala (Jose and Francis, 2007; Maya *et al.*, 2000; Shaji *et al.*, 1988; Shaji *et al.*, 1989; Shaji and Patel, 1990; Shaji and Patel, 1991; Sheeba and Ramanujan, 2005; Sindhu and Panikkar, 1994; Sindhu and Panikkar, 1995; Suxena *et al.*, 1973), Andhra Pradesh (Suxena and Venkareswarlu, 1966), Bengal (Turner, 1892), Bihar (Das *et al.*, 1990; Saha and Choudhary, 1984), Chhattisgarh (Toppo and Suseela, 2009), Gujarat (Asokakumar and

Patel, 1988; Asokakumar and Patel, 1990), Karnataka (Gurudeva *et al.*, 1983; Hegde, 1986; Hegde and Isaacs, 1988), Maharashtra (Dhande and Jawale, 2009; Freitas and Kamat, 1979; Kamat, 1975a; Kamat, 1975b), Madhya Pradesh (Agarkar *et al.*, 1983; Agarkar *et al.*, 1979; Agarkar and Agarkar, 1977), Tamil Nadu (Perumal and Anand, 2008), and Uttar Pradesh (Chaturvedi *et al.*, 1987; Tiwari and Chauhan, 2007).

MATERIALS AND METHODS

The present paper is based on the collections of water samples from the Kole lands of Thrissur district, Kerala, during February 2005-January 2006. The study area lies between 10°20'28"-10°30'17" North latitudes and 76°06'31"-76°15'26" East longitudes. The surface water samples were collected monthly from 10 stations namely Pullur, Muriyad, Nambiankavu, Mapranam, Chemmanda, Cherpu, Palakkal, Chettupuzha, Anthikkad and Enamavu. The samples collected were preserved in 4% formalin solution. The *Cosmarium* taxa were identified with the help of monographs and research publications (Turner, 1892; Croasdale and Gronblad, 2007; Nurul and Irfanullah, 2006; Scott and Prescott, 1961; West and West, 1905; West and West, 1908; West and West, 1912). The Camera Lucida drawings of all taxa were prepared.

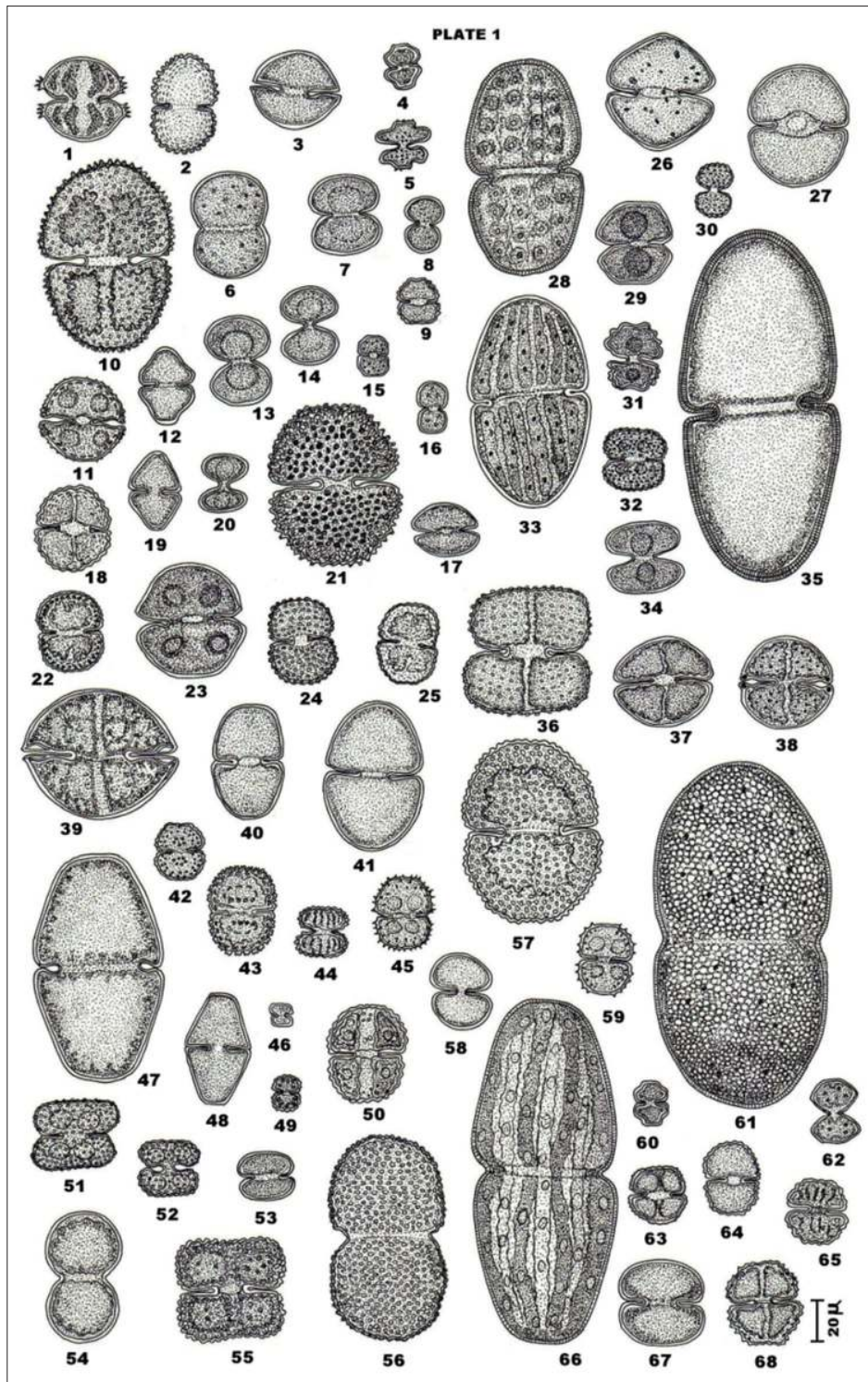


Plate 1 (Figs. 1-68): 1. *Cosmarium auriculatum* 2. *C. binum* 3. *C. circulare* 4. *C. clepsydra* var. *duplex* 5. *C. commissurale* 6. *C. connatum* 7. *C. contractum* var. *ellipsoideum* 8. *C. contractum* var. *minutum* 9. *C. impressulum* 10. *C. brebissonii* 11. *C. cuneatum* 12. *C. granatum* var. *nordstedtii* 13. *C. contractum* 14. *C. contractum* var. *incrassatum* 15. *C. meneghinii* 16. *C. exiguum* 17. *C. apertum* 18. *C. cyclicum* 19. *C. granatum* 20. *C. indentatum* var. *ellipticum* 21. *C. decoratum* var. *dentiferum* 22. *C. arnellii* 23. *C. lundellii* 24. *C. margaritatum* fa. *minor* 25. *C. manipurence* 26. *C. lundellii* var. *corruptum* 27. *C. lundellii* var. *ellipticum* 28. *C. javanicum* 29. *C. nitidulum* 30. *C. portianum* 31. *C. notabile* 32. *C. pseudobroomei* 33. *C. maculatiforme* 34. *C. pseudotoxicandrum* 35. *C. maculatum* 36. *C. margaritatum* var. *sublatum* 37. *C. obsoletum* 38. *C. nudum* 39. *C. obsoletum* var. *sitvense* 40. *C. pseudopyramidatum* var. *oculatum* 41. *C. pachydermum* 42. *C. punctulatum* var. *subpunctulatum* 43. *C. quadrifarium* 44. *C. geminatum* var. *ornatum* 45. *C. quadriverrucosum* var. *undulatum* 46. *C. pygmaeum* 47. *C. pyramidatum* 48. *C. pyramidatum* var. *stephanii* 49. *C. blyttii* 50. *C. speciosum* 51. *C. quadrum* 52. *C. reniforme* 53. *C. depressum* 54. *C. pseudoconnatum* var. *constrictum* 55. *C. scabrum* 56. *C. striolatum* 57. *C. subspeciosum* var. *validius* 58. *C. tumidum* 59. *C. trachypleurum* var. *nordstedtii* 60. *C. retusifforme* 61. *C. subturgidum* 62. *C. tjibenongense* fa. *minus* 63. *C. spinuliferum* 64. *C. subcrenatum* 65. *C. subcostatum* 66. *C. turgidum* 67. *C. taxichondrum* var. *nudum* 68. *C. vexatum*

RESULTS AND DISCUSSION

Cosmarium cells are longer than broad, constricted in the middle, semicells very variable in outline, elliptical, subcircular, semicircular, subquadrate, or truncate-pyramidate, apex rounded, truncate or subtruncate (West and West, 1905). During the present investigation, 68 taxa of *Cosmarium* have been identified from the Kole lands of Thrissur, Kerala and are described systematically with their distribution in India. Of these 6 taxa are new reports to India and 29 taxa are recorded for the 1st time from Kerala. The measurements of length (L) and breadth (B) of the taxa are given in microns (μm).

GENUS: *COSMARIUM* CORDA

Systematic Account

1. *Cosmarium apertum* Turn. (pl. 1, fig. 17)
Turner, 1892. p. 54, pl. 8, fig. 11.
L: 31-34 μm , B: 36-39 μm . Distribution: Gujarat (Asokakumar and Patel, 1988), East India (Turner, 1892); Tamil Nadu (Perumal and Anand, 2008).
2. *Cosmarium arnellii* Boldt. (pl. 1, fig. 22)
West and West, 1908. vol. 3, p. 205, pl. 84, fig. 11.
L: 39-50.6 μm , B: 35-40 μm . Distribution: East India (Turner, 1892), Tamil Nadu (Perumal and Anand, 2008).
3. *Cosmarium auriculatum* Reinsch (pl. 1, fig. 1)
Scott and Prescott, 1961. p. 54, pl. 26, fig. 4.
L: 46.7-50.6 μm , B: 48.6-54.5 μm . Distribution: Kerala (Shaji *et al.*, 1988; Sindhu and Panikkar, 1995); Bengal (Turner, 1892); Bihar (Saha and Choudhary, 1984); Gujarat (Asokakumar and Patel, 1990); Karnataka (Hegde and Isaacs, 1988); Maharashtra (Freitas and Kamat, 1979; Kamat, 1975b); Tamil Nadu (Perumal and Anand, 2008).
4. *Cosmarium binum* Nordst. (pl. 1, fig. 2)
West and West, 1908. vol. 3, p. 246, pl. 88, figs. 10-14.
L: 68-85.6 μm , B: 35-39 μm . Distribution: Kerala (Shaji *et al.*, 1988); Bihar (Das *et al.*, 1990); Gujarat (Asokakumar and Patel, 1988); Maharashtra (Freitas and Kamat, 1979; Kamat 1975a); Madhya Pradesh (Agarkar *et al.*, 1983; Agarkar and Agarkar, 1977); Tamil Nadu (Perumal and Anand, 2008).
5. *Cosmarium blyttii* Wille (pl. 1, fig. 49)
West and West, 1908. vol. 3, p. 225, pl. 86, figs. 1-4.
L: 11.7-18.5 μm , B: 8.8-15.6 μm . Distribution: Chhattisgarh (Toppo and Suseela, 2009); Tamil Nadu (Perumal and Anand, 2008).
6. *Cosmarium brebissonii* Menegh. (pl. 1, fig. 10)
West and West, 1908. vol. 3, p. 161, pl. 79, figs. 10, 11.
L: 65-97.3 μm , B: 49.6-70 μm . Distribution: Kerala (Sindhu and Panikkar, 1994); East India (Turner, 1892).
7. *Cosmarium circulare* Reinsch (pl. 1, fig. 3)
West and West, 1905. vol. 2, p. 136, pl. 56, figs. 11, 13, 14.
L: 35-46.7 μm , B: 39-46.7 μm . Distribution: Kerala (Shaji *et al.*, 1989; Sindhu and Panikkar, 1995); Bengal and Central India (Turner 1892); Gujarat (Asokakumar and Patel, 1988); Karnataka (Gurudeva *et al.*, 1983); Uttar Pradesh (Chaturvedi *et al.*, 1987).
8. *Cosmarium clepsydra* Nordst. var. *duplex* Prescott (pl. 1, fig. 4)
Shaji and Patel, 1990. pl. 1, fig. 6.
L: 23.3-25.3 μm , B: 17.5-18.5 μm . Distribution: Kerala (Shaji and Patel, 1990); Bihar (Das *et al.*, 1990).
9. *Cosmarium commissurale* Breb. (pl. 1, fig. 5)
West and West, 1908. vol. 3, p. 154, pl. 78, figs. 11-14.
L: 23.3-32 μm , B: 35-39 μm . Distribution: Kerala (Sindhu and Panikkar, 1994).
10. *Cosmarium connatum* Breb. (pl. 1, fig. 6)
West and West, 1908. vol. 3, p. 25, pl. 67, figs. 15-17.
L: 52.5-58.4 μm , B: 35-40 μm . Distribution: Kerala (Sheeba and Ramanujan, 2005; Sindhu and Panikkar, 1995); Gujarat (Asokakumar and Patel, 1988); Maharashtra (Freitas and Kamat, 1979; Kamat, 1975a; Kamat 1975b).
11. *Cosmarium contractum* Kirchner (pl. 1, fig. 13)
West and West, 1905. vol. 2, p. 170, pl. 61, figs. 23-25.
L: 38-42.8 μm , B: 25.3-27.2 μm . Distribution: Kerala (Sheeba and Ramanujan, 2005); Bengal and North India (Turner, 1892); Gujarat (Asokakumar and Patel, 1988); Maharashtra (Kamat, 1975a); Tamil Nadu (Perumal and Anand, 2008).
12. *Cosmarium contractum* Kirchner var. *ellipsoideum* (Elfv.)
West and West (pl. 1, fig. 7)
West and West, 1905. vol. 2, p. 172, pl. 61, figs. 28, 35.
L: 33-39 μm , B: 29-35 μm . Distribution: Kerala (Suxena *et al.*, 1973); Bihar (Das *et al.*, 1990); Chhattisgarh (Toppo and Suseela, 2009); Gujarat (Asokakumar and Patel, 1988); Maharashtra (Kamat, 1975a).
13. *Cosmarium contractum* Kirchner var. *incrassatum* Scott and Prescott (pl. 1, fig. 14)
Scott and Prescott, 1961. p. 56, pl. 27, fig. 5.
L: 33-42.8 μm , B: 21.4-27.2 μm . Distribution: Kerala (Sindhu and Panikkar, 1995); Karnataka (Hegde and Isaacs, 1988).
14. *Cosmarium contractum* Kirchner var. *minutum* (Delp.)
West and West (pl. 1, fig. 8)
Croasdale and Gronblad, 1964. p. 178, pl. 11, fig. 20.
L: 23.3-27.2 μm , B: 19.5-21.4 μm . Distribution:

- Kerala (Shaji *et al.*, 1989); Gujarat (Asokakumar and Patel, 1988); Karnataka (Gurudeva *et al.*, 1983); Maharashtra (Kamat, 1975a; Kamat, 1975b); Madhya Pradesh (Agarkar *et al.*, 1983).
15. *Cosmarium cuneatum* Joshua (pl. 1, fig. 11)
Scott and Prescott, 1961. p. 57, pl. 30, fig. 3.
L: 35-41.8 μm , B: 38-47.7 μm . Distribution: Karnataka (Gurudeva *et al.*, 1983); Madhya Pradesh (Agarkar *et al.*, 1983).
 16. *Cosmarium cyclicum* Lund. (pl. 1, fig. 18)
West and West, 1905. vol. 2, p. 145, pl. 58, figs. 8, 9.
L: 46.7-50.6 μm , B: 42.8-48.6 μm . Distribution: Bihar (Das *et al.*, 1990).
 17. *Cosmarium decoratum* West et West var. *dentiferum* West et West (pl. 1, fig. 21)
Shaji *et al.*, 1989. pl. 3, fig. 5.
L: 77.8-85.6 μm , B: 66-70 μm . Distribution: Kerala (Shaji *et al.*, 1989).
 18. *Cosmarium depressum* (Nag.) Lund. (pl. 1, fig. 53)
West and West, 1905. vol. 2, p. 176, pl. 62, figs. 2-5
L: 17-25.2 μm , B: 19.5-29.2 μm . Distribution: East India (Turner, 1892); Tamil Nadu (Perumal and Anand, 2008).
 19. *Cosmarium exiguum* Arch. (pl. 1, fig. 16)
West and West, 1908. vol. 3, p. 63, pl. 70, figs. 17-19.
L: 20.4-31 μm , B: 12.6-16.5 μm . Distribution: Kerala (Sindhu and Panikkar, 1994); Andhra Pradesh (Suxena and Venkareswarlu, 1966); East India (Turner, 1892); Maharashtra (Kamat, 1975a); Tamil Nadu (Perumal and Anand, 2008).
 20. *Cosmarium geminatum* Lund. var. *ornatum* Behre (pl. 1, fig. 44)
Scott and Prescott, 1961. p. 59, pl. 31, fig. 9.
L: 22.4-25.3 μm , B: 21.4-24.3 μm .
 21. *Cosmarium granatum* Breb. (pl. 1, fig. 19)
West and West, 1905. vol. 2, p. 186, pl. 63, figs. 1-3.
L: 31-39 μm , B: 23.3-27.2 μm . Distribution: Kerala (Maya *et al.*, 2000); Andhra Pradesh (Suxena and Venkareswarlu, 1966); Bengal (Turner, 1892); Bihar (Das *et al.*, 1990; Saha and Choudhary, 1984); Gujarat (Asokakumar and Patel, 1988); Maharashtra (Dhande and Jawale, 2009; Freitas and Kamat, 1979; Kamat, 1975a); Madhya Pradesh (Agarkar and Agarkar, 1977); Tamil Nadu (Perumal and Anand, 2008); Uttar Pradesh (Chaturvedi *et al.*, 1987).
 22. *Cosmarium granatum* Breb. var. *nordstedtii* Hansg. (pl. 1, fig. 12)
Suxena *et al.*, 1973. p. 326, figs. 45a, b.
L: 31-39 μm , B: 23.3-27.2 μm . Distribution: Kerala (Suxena *et al.*, 1973).
 23. *Cosmarium impressulum* Elfv. (pl. 1, fig. 9)
West and West, 1908. vol. 3, p. 86, pl. 72, figs. 14-18.
L: 23.3-27.2 μm , B: 17.5-19.5 μm . Distribution: Kerala (Sindhu and Panikkar, 1995); Andhra Pradesh (Suxena and Venkareswarlu, 1966); East India (Turner, 1892); Gujarat (Asokakumar and Patel, 1988); Maharashtra (Dhande and Jawale, 2009; Kamat, 1975a); Uttar Pradesh (Chaturvedi *et al.*, 1987).
 24. *Cosmarium indentatum* Gronbl. var. *ellipticum* Scott and Gronbl. (pl. 1, fig. 20)
Scott and Prescott, 1961. p. 59, pl. 27, fig. 7.
L: 29.2-31 μm , B: 19.5-23.3 μm .
 25. *Cosmarium javanicum* Nordst. (pl. 1, fig. 28)
Suxena and Venkareswarlu, 1966. p. 57, pl. 2, fig. 34.
L: 105-124.5 μm , B: 60.3-67 μm . Distribution: Kerala (Shaji *et al.*, 1988; Suxena *et al.*, 1973); Andhra Pradesh (Suxena and Venkareswarlu, 1966); Madhya Pradesh (Agarkar and Agarkar, 1977); Uttar Pradesh (Chaturvedi *et al.*, 1987).
 26. *Cosmarium lundellii* Delp. (pl. 1, fig. 23)
Scott and Prescott, 1961. p. 60, pl. 25, fig. 6.
L: 54.5-77.8 μm , B: 58.4-68 μm . Distribution: Kerala (Shaji *et al.*, 1988); Andhra Pradesh (Suxena and Venkareswarlu, 1966); Gujarat (Asokakumar and Patel, 1988); Karnataka (Isaacs and Hegde, 1986); Tamil Nadu (Perumal and Anand, 2008); Uttar Pradesh (Chaturvedi *et al.*, 1987).
 27. *Cosmarium lundellii* Delp. var. *corruptum* (Turn.) West and West (pl. 1, fig. 26)
Scott and Prescott, 1961. p. 61, pl. 25, fig. 9.
L: 42.8-66 μm , B: 39-58.4 μm . Distribution: Kerala (Shaji and Patel, 1990); Gujarat (Asokakumar and Patel, 1988); Maharashtra (Kamat, 1975a); Madhya Pradesh (Agarkar and Agarkar, 1977); Uttar Pradesh (Tiwari and Chauhan, 2007).
 28. *Cosmarium lundellii* Delp. var. *ellipticum* West (pl. 1, fig. 27)
Scott and Prescott, 1961. p. 61, pl. 25, fig. 8.
L: 59.3-68 μm , B: 47.7-53.5 μm . Distribution: Andhra Pradesh (Suxena and Venkareswarlu, 1966); Gujarat (Asokakumar and Patel, 1988); Maharashtra (Kamat, 1975a); Uttar Pradesh (Chaturvedi *et al.*, 1987).
 29. *Cosmarium maculatiforme* Schmidle (pl. 1, fig. 33)
Shaji and Patel, 1990. fig. 2/1.
L: 109-120.6 μm , B: 62.2-66 μm . Distribution: Kerala (Shaji and Patel, 1990); Gujarat (Asokakumar and Patel, 1990).
 30. *Cosmarium maculatum* Turn. (pl. 1, fig. 35)
Scott and Prescott, 1961. p. 61, pl. 24, fig. 2.
L: 171-190.6 μm , B: 74-81.7 μm . Distribution: East India (Turner, 1892); Maharashtra (Kamat, 1975a); Tamil Nadu (Perumal and Anand, 2008).
 31. *Cosmarium manipurence* Bruhl et Biswas (pl. 1, fig. 25)
Sindhu and Panikkar, 1995. fig. 4/4.

- L: 39-50.6 μm , B: 27.2-35 μm . Distribution: Kerala (Sindhu and Panikkar, 1995); Uttar Pradesh (Tiwari and Chauhan, 2007).
32. *Cosmarium margaritatum* (Lund.) Roy and Biss. fa. *minor* (Boldt) W. and G.S. West (pl. 1, fig. 24) West and West, 1912. vol. 4, p. 18, pl. 99, fig. 9. L: 46.7-54.5 μm , B: 34-41 μm . Distribution: Maharashtra (Kamat, 1975a).
33. *Cosmarium margaritatum* (Lund.) Roy and Biss. var. *sublatum* (Nordst.) Krieg. (pl. 1, fig. 36) Scott and Prescott, 1961. p. 63, pl. 29, fig. 4. L: 60.3-67 μm , B: 58.4-62.2 μm . Distribution: Gujarat (Asokakumar and Patel, 1988); Karnataka (Isaacs and Hegde, 1986).
34. *Cosmarium meneghinii* Breb. (pl. 1, fig. 15) West and West, 1908. vol. 3, p. 90, pl. 72, figs. 29-32. L: 16.5-18.5 μm , B: 9.7-12.6 μm . Distribution: Kerala (Sindhu and Panikkar, 1994; Suxena *et al.*, 1973); Andhra Pradesh (Suxena and Venkareswarlu, 1966); Bihar (Saha and Choudhary, 1984); Gujarat (Asokakumar and Patel, 1990); Maharashtra (Freitas and Kamat, 1979; Kamat, 1975b); Uttar Pradesh (Chaturvedi *et al.*, 1987).
35. *Cosmarium nitidulum* De Not (pl. 1, fig. 29) West and West, 1905. vol. 2, p. 197, pl. 64, figs. 1-3. L: 35-42.8 μm , B: 25.3-39 μm . Distribution: Kerala (Suxena *et al.*, 1973); Gujarat (Asokakumar and Patel, 1988); Maharashtra (Kamat, 1975b); Tamil Nadu (Perumal and Anand, 2008).
36. *Cosmarium notabile* Breb. (pl. 1, fig. 31) West and West, 1908. vol. 3, p. 15, pl. 66, figs. 15-16. L: 23.3-31 μm , B: 19.5-24.3 μm . Distribution: Kerala (Sindhu and Panikkar, 1994).
37. *Cosmarium nudum* (Turn.) Gutw. (pl. 1, fig. 38) Scott and Prescott, 1961. p. 63, pl. 30, figs. 1, 2. L: 46.7-48.6 μm , B: 43.8-45.7 μm . Distribution: Kerala (Shaji and Patel, 1990); Uttar Pradesh (Chaturvedi *et al.*, 1987).
38. *Cosmarium obsoletum* (Hantzsch) Reinsch (pl. 1, fig. 37) Scott and Prescott, 1961. p. 63, pl. 26, fig. 1. L: 52.5-66 μm , B: 53.5-58.4 μm . Distribution: Kerala (Jose and Francis, 2007); East India (Turner, 1892); Karnataka (Isaacs and Hegde, 1986); M.P. (Agarkar *et al.*, 1983); Tamil Nadu (Perumal and Anand, 2008); Uttar Pradesh (Tiwari and Chauhan, 2007).
39. *Cosmarium obsoletum* (Hantzsch) Reinsch var. *sitvense* Gutw. (pl. 1, fig. 39) Scott and Prescott, 1961. p. 63, pl. 25, fig. 11 and pl. 26, fig. 2. L: 62.2-66 μm , B: 64.2-77.8 μm . Distribution: Kerala (Sindhu and Panikkar, 1995; Suxena *et al.*, 1973); Bihar (Das *et al.*, 1990; Saha and Choudhary, 1984); Chhattisgarh (Toppo and Suseela, 2009); Maharashtra (Kamat, 1975a); Karnataka (Hegde and Isaacs, 1988); Madhya Pradesh (Agarkar *et al.*, 1979).
40. *Cosmarium pachydermum* Lund. (pl. 1, fig. 41) Scott and Prescott, 1961. p. 64, pl. 25, fig. 5. L: 70-85.6 μm , B: 50.6-66 μm . Distribution: Kerala (Sindhu and Panikkar, 1994).
41. *Cosmarium portianum* Arch. (pl. 1, fig. 30) Scott and Prescott, 1961. p. 65, pl. 28, fig. 8. L: 23.3-27.2 μm , B: 17.5-19.5 μm . Distribution: Kerala (Jose and Francis, 2007, Shaji and Patel, 1991); East India (Turner, 1892); Bihar (Das *et al.*, 1990); Gujarat (Asokakumar and Patel, 1988); Maharashtra (Freitas and Kamat, 1979; Kamat, 1975a; Kamat, 1975b); Madhya Pradesh (Agarkar *et al.*, 1983); Tamil Nadu (Perumal and Anand, 2008).
42. *Cosmarium pseudobroomei* Wolle (pl. 1, fig. 32) West and West, 1912. vol. 4, p. 22, pl. 100, figs. 7, 8. L: 31-35 μm , B: 30-32 μm . Distribution: Kerala (Shaji and Patel, 1990); Andhra Pradesh (Suxena and Venkareswarlu, 1966); East India (Turner, 1892); Maharashtra (Kamat, 1975b); Tamil Nadu (Perumal and Anand, 2008).
43. *Cosmarium pseudoconnatum* Nordst. var. *constrictum* West (pl. 1, fig. 54) West and West, 1908. vol. 3, p. 29, pl. 67, figs. 23. L: 60.3-72 μm , B: 40-48.6 μm .
44. *Cosmarium pseudopyramidatum* Lund. var. *oculatum* Krieg. (pl. 1, fig. 40) Scott and Prescott, 1961. p. 67, pl. 27, figs. 2, 3. L: 54.5-61.2 μm , B: 34-37 μm . Distribution: Kerala (Sindhu and Panikkar, 1995); Andhra Pradesh (Suxena and Venkareswarlu, 1966); Madhya Pradesh (Agarkar *et al.*, 1983).
45. *Cosmarium pseudotoxicandrum* Nordst. (pl. 1, fig. 34) Croasdale and Gronblad, 1964. p. 184, pl. 13, fig. 20. L: 33-39 μm , B: 36-39 μm . Distribution: Tamil Nadu (Perumal and Anand 2008).
46. *Cosmarium punctulatum* Breb. var. *subpunctulatum* (Nordst.) Borg. (pl. 1, fig. 42) West and West, 1908. vol. 3, p. 209, pl. 84, figs. 15-20 and pl. 85, figs. 1-3. L: 31-39 μm , B: 27.2-33 μm . Distribution: Kerala (Shaji *et al.*, 1988); Gujarat (Asokakumar and Patel, 1988); Madhya Pradesh (Das *et al.*, 1990; Saha and Choudhary, 1984).
47. *Cosmarium pygmaeum* Arch. (pl. 1, fig. 46) West and West, 1908. vol. 3, p. 73, pl. 71, figs. 22-31. L: 7.8-11.7 μm , B: 9.7-13.6 μm . Distribution: Kerala (Sindhu and Panikkar, 1994); Gujarat (Asokakumar and Patel, 1988).
48. *Cosmarium pyramidatum* Breb. (pl. 1, fig. 47)

- West and West, 1905. vol. 2, p. 199, pl. 64, figs. 5-7.
L: 97.3-116.7 μm , B: 52.5-58.4 μm . Distribution: Bihar (Das *et al.*, 1990); Maharashtra (Kamat, 1975a); Madhya Pradesh (Agarkar *et al.*, 1979; Agarkar and Agarkar, 1977).
49. *Cosmarium pyramidatum* Breb. var. *stephanii* (Irene-Marie) Krieg. et Gerloff (pl. 1, fig. 48)
Shaji *et al.*, 1989. pl. 2, fig. 7.
L: 60.3-66 μm , B: 36-40.8 μm . Distribution: Kerala (Shaji *et al.*, 1989); Karnataka (Gurudeva *et al.*, 1983).
50. *Cosmarium quadrifarium* Lund. (pl. 1, fig. 43)
West and West, 1908. vol. 3, p. 141, pl. 76, figs. 15-17 and pl. 77, figs. 1-3.
L: 40-42.8 μm , B: 30-33 μm .
51. *Cosmarium quadri verrucosum* West and West var. *undulatum* Scott and Prescott (pl. 1, fig. 45)
Scott and Prescott, 1961. p. 67, pl. 30, fig. 7.
L: 24.3-35 μm , B: 19.5-24.3 μm .
52. *Cosmarium quadrum* Lund. (pl. 1, fig. 51)
West and West, 1912. vol. 4, p. 20, pl. 100, figs. 3-6.
L: 46.7-54.5 μm , B: 55.4-59.3 μm . Distribution: Kerala (Shaji *et al.*, 1988; Sindhu and Panikar, 1994); Bihar (Das *et al.*, 1990); Maharashtra (Kamat, 1975a); M.P. (Agarkar and Agarkar, 1977); T.N. (Perumal and Anand, 2008); U.P. (Chaturvedi *et al.*, 1987).
53. *Cosmarium reniforme* (Ralfs) Arch. (pl. 1, fig. 52)
West and West, 1908. vol. 3, p. 157, pl. 79, figs. 1-2.
L: 35-48.6 μm , B: 33-44.7 μm . Distribution: Bihar (Das *et al.*, 1990; Saha and Choudhary, 1984); Maharashtra (Dhande and Jawale, 2009; Kamat, 1975a); Tamil Nadu (Perumal and Anand, 2008); Uttar Pradesh (Tiwari and Chauhan, 2007).
54. *Cosmarium retusiforme* (Wille) Gutw. (pl. 1, fig. 60)
Scott and Prescott, 1961. p. 68, pl. 32, fig. 15.
L: 23.3-25.3 μm , B: 19.5-23.3 μm . Distribution: Kerala (Shaji and Patel, 1990); Gujarat (Asokakumar and Patel, 1988); Karnataka (Isaacs and Hegde, 1986); Tamil Nadu (Perumal and Anand, 2008).
55. *Cosmarium scabrum* Turn. (pl. 1, fig. 55)
Scott and Prescott, 1961. p. 68, pl. 29, fig. 3.
L: 46.7-51.5 μm , B: 47.7-53.5 μm . Distribution: East India (Turner, 1892); Karnataka (Gurudeva *et al.*, 1983); Uttar Pradesh (Chaturvedi *et al.*, 1987).
56. *Cosmarium speciosum* Lund. (pl. 1, fig. 50)
West and West, 1908. vol. 3, p. 247, pl. 89, figs. 1-3.
L: 48.6-62.2 μm , B: 31-40 μm . Distribution: Tamil Nadu (Perumal and Anand, 2008); Uttar Pradesh (Tiwari and Chauhan, 2007).
57. *Cosmarium spinuliferum* West and West (pl. 1, fig. 63)
Scott and Prescott, 1961. p. 69, pl. 29, figs. 6, 7.
L: 31-34 μm , B: 32-35 μm . Distribution: Maharashtra (Kamat, 1975b).
58. *Cosmarium striolatum* Nag. (pl. 1, fig. 56)
Scott and Prescott, 1961. p. 70, pl. 25, figs. 2, 3.
L: 93.4-112.8 μm , B: 54.5-62.2 μm . Distribution: Maharashtra (Kamat, 1975a); Madhya Pradesh (Agarkar *et al.*, 1983).
59. *Cosmarium subcostatum* Nordst. (pl. 1, fig. 65)
West and West, 1908. vol. 3, p. 236, pl. 87, figs. 3-5.
L: 27.2-35 μm , B: 24.3-27.2 μm . Distribution: Kerala (Shaji *et al.*, 1989); Uttar Pradesh (Chaturvedi *et al.*, 1987).
60. *Cosmarium subcrenatum* Hantzsch (pl. 1, fig. 64)
West and West, 1908. vol. 3, p. 228, pl. 86, figs. 10-14.
L: 26.3-39 μm , B: 22.4-31 μm . Distribution: Chhattisgarh (Toppo and Suseela, 2009); Maharashtra (Freitas and Kamat, 1979); Tamil Nadu (Perumal and Anand, 2008); Uttar Pradesh (Chaturvedi *et al.*, 1987).
61. *Cosmarium subspeciosum* Nordst. var. *validius* Nordst. (pl. 1, fig. 57)
West and West, 1908. vol. 3, p. 253, pl. 89, figs. 12, 13.
L: 81.7-93.4 μm , B: 60.3-66 μm . Distribution: Kerala: (Sindhu and Panikkar, 1995); Bihar (Saha and Choudhary, 1984); Chhattisgarh (Toppo and Suseela, 2009); Karnataka (Isaacs and Hegde, 1986); Maharashtra (Kamat, 1975b); U.P. (Chaturvedi *et al.*, 1987).
62. *Cosmarium suburgidum* (Turn.) Schmidle (pl. 1, fig. 61)
West and West, 1908. vol. 3, p. 116, pl. 75, fig. 5.
L: 175-182.8 μm , B: 85.6-97.3 μm .
63. *Cosmarium taxichondrum* Lund. var. *nudum* Turn. (pl. 1, fig. 67)
Turner, 1892. p. 60, pl. 8, fig. 64.
L: 39-41.8 μm , B: 42.8-44.7 μm . Distribution: East India (Turner 1892).
64. *Cosmarium tjibenongense* Gutw. fa. *minus* G.S. West (pl. 1, fig. 62)
Scott and Prescott, 1961. p. 72, pl. 27, fig. 8.
L: 31-34 μm , B: 20.4-22.4 μm . Distribution: Karnataka (Hegde, 1986; Hegde and Isaacs, 1988).
65. *Cosmarium trachypleurum* Lund. var. *nordstedtii* Gutw. (pl. 1, fig. 59)
Scott and Prescott, 1961. p. 72, pl. 31, fig. 6.
L: 31-36 μm , B: 27.2-31 μm . Distribution: Kerala (Shaji *et al.*, 1989); Karnataka (20); Maharashtra (Kamat, 1975a).
66. *Cosmarium tumidum* Lund. (pl. 1, fig. 58)
Scott and Prescott, 1961. p. 72, pl. 27, fig. 16.
L: 31-34 μm , B: 24.3-27.2 μm . Distribution: Maharashtra (Kamat, 1975a).
67. *Cosmarium turgidum* Breb. (pl. 1, fig. 66)
West and West, 1908. vol. 3, p. 115, pl. 75, figs. 1-3.
L: 171-210 μm , B: 77.8-81.7 μm . Distribution:

Table 1: Seasonal and spatial variation of genus *Cosmarium* Corda in the Kole lands of Thrissur, Kerala

Serial number	Name of taxa	Seasons			Stations									
		S i	S ii	S iii	1	2	3	4	5	6	7	8	9	10
1	<i>C. apertum</i>	-	-	+	+	-	-	-	-	-	-	-	-	-
2	<i>C. arnellii</i>	+	+	-	-	+	-	-	+	-	-	+	-	-
3	<i>C. auriculatum</i>	+	+	+	-	+	+	+	+	+	+	+	+	+
4	<i>C. binum</i>	+	-	+	-	-	-	-	-	+	-	-	+	+
5	<i>C. blyttii</i>	+	+	+	-	+	-	-	+	-	+	-	-	+
6	<i>C. brebissonii</i>	+	-	-	+	-	-	-	-	-	-	-	-	+
7	<i>C. circulare</i>	+	+	+	+	+	+	+	-	-	-	+	-	-
8	<i>C. clepsydra</i> var. <i>duplex</i>	+	-	+	+	-	+	-	-	-	-	-	-	-
9	<i>C. commissurale</i>	+	-	-	-	-	-	+	-	-	-	-	-	-
10	<i>C. connatum</i>	+	+	+	+	+	+	+	+	-	-	+	+	-
11	<i>C. contractum</i>	+	+	+	+	+	-	-	+	+	-	-	-	-
12	<i>C. contractum</i> var. <i>ellipsoideum</i>	+	+	+	+	+	+	-	+	-	-	-	-	-
13	<i>C. contractum</i> var. <i>incrassatum</i>	-	+	+	-	-	-	+	-	-	-	+	+	-
14	<i>C. contractum</i> var. <i>minutum</i>	+	+	+	+	+	+	+	+	-	-	-	-	+
15	<i>C. cuneatum</i>	+	+	+	+	+	+	+	+	+	+	+	-	+
16	<i>C. cyclicum</i>	+	+	-	+	-	-	+	-	-	+	-	-	-
17	<i>C. decoratum</i> var. <i>dentiferum</i>	+	+	+	-	+	-	-	+	-	-	-	+	-
18	<i>C. depressum</i>	-	+	-	-	-	-	+	+	-	+	-	-	-
19	<i>C. exiguum</i>	+	+	+	+	+	-	-	-	-	-	-	-	-
20	<i>C. geminatum</i> var. <i>ornatum</i>	-	+	+	+	+	-	+	-	-	+	-	-	-
21	<i>C. granatum</i>	+	+	+	+	+	-	+	+	+	-	+	+	+
22	<i>C. granatum</i> var. <i>nordstedtii</i>	+	+	+	+	-	+	-	+	-	+	+	-	-
23	<i>C. impressulum</i>	+	+	+	+	+	-	+	+	-	-	-	-	-
24	<i>C. indentatum</i> var. <i>ellipticum</i>	+	+	+	+	-	+	-	+	-	+	-	-	-
25	<i>C. javanicum</i>	-	-	+	-	+	-	-	-	-	-	-	-	-
26	<i>C. lundellii</i>	+	+	+	+	+	+	+	+	+	+	+	-	+
27	<i>C. lundellii</i> var. <i>corruptum</i>	+	+	+	+	+	+	+	-	-	-	-	+	-
28	<i>C. lundellii</i> var. <i>ellipticum</i>	-	+	+	+	+	-	-	+	-	+	-	+	+
29	<i>C. maculatifforme</i>	+	+	+	-	-	+	-	+	-	-	-	-	-
30	<i>C. maculatum</i>	+	+	+	+	-	+	-	+	-	+	-	-	-
31	<i>C. manipurence</i>	+	+	+	-	+	-	-	-	-	+	-	-	+
32	<i>C. margaritatum</i> fa. <i>minor</i>	+	+	+	-	-	-	+	+	-	-	+	-	+
33	<i>C. margaritatum</i> var. <i>sublatum</i>	+	+	+	+	-	-	-	+	-	-	-	-	+
34	<i>C. meneghinii</i>	-	+	-	-	-	-	+	-	-	-	-	-	-
35	<i>C. nitidulum</i>	-	+	-	-	-	-	-	+	-	-	-	-	-
36	<i>C. notabile</i>	+	-	-	-	-	+	-	-	-	-	-	-	-
37	<i>C. nudum</i>	-	+	+	-	-	-	-	+	-	+	-	-	-
38	<i>C. obsoletum</i>	-	+	-	-	-	-	-	+	-	-	-	-	-
39	<i>C. obs oletum</i> var. <i>sitvense</i>	-	-	+	-	-	-	-	-	-	-	+	-	-
40	<i>C. pachydermum</i>	+	-	-	-	-	-	-	+	-	-	-	-	-
41	<i>C. portianum</i>	+	+	-	+	-	-	-	-	-	+	-	+	-
42	<i>C. pseudobroomei</i>	-	+	+	+	-	-	-	-	+	-	+	+	+
43	<i>C. pseudoconnatum</i> var. <i>constrictum</i>	-	-	+	-	-	-	-	-	-	-	-	-	+
44	<i>C. pseudopyramidatum</i> var. <i>oculatum</i>	+	-	-	-	-	-	-	+	-	-	-	-	+
45	<i>C. pseudotoxicandrum</i>	-	-	+	-	-	-	+	-	-	-	-	-	-
46	<i>C. punctulatum</i> var. <i>subpunctulatum</i>	+	+	+	+	+	+	+	+	+	-	-	+	+
47	<i>C. pygmaeum</i>	+	+	+	+	+	+	+	-	-	-	-	-	-
48	<i>C. pyramidatum</i>	-	-	+	+	-	-	-	-	-	-	-	-	-
49	<i>C. pyramidatum</i> var. <i>stephanii</i>	-	+	-	+	-	-	-	-	-	-	-	-	-
50	<i>C. quadrifarium</i>	+	+	+	+	-	+	+	-	-	+	+	-	-
51	<i>C. quadriverrucosum</i> var. <i>undulatum</i>	-	-	+	-	-	+	-	-	-	-	-	-	-
52	<i>C. quadrum</i>	+	+	+	+	+	+	+	+	-	+	+	+	-
53	<i>C. reniforme</i>	+	+	-	-	-	-	-	-	+	-	-	-	+
54	<i>C. retusiforme</i>	-	+	+	+	+	+	+	+	-	+	-	-	-
55	<i>C. scabrum</i>	-	+	+	-	+	-	+	+	-	-	-	-	-
56	<i>C. speciosum</i>	+	-	-	-	-	-	-	-	-	-	+	-	-
57	<i>C. spinuliferum</i>	-	+	+	-	-	+	-	-	-	-	-	-	-
58	<i>C. striolatum</i>	-	+	+	+	+	-	-	-	-	-	-	-	-
59	<i>C. subcostatum</i>	-	+	-	-	-	-	-	-	-	+	-	+	-
60	<i>C. subcrenatum</i>	+	+	+	+	-	+	+	+	-	+	-	+	-
61	<i>C. subspeciosum</i> var. <i>validius</i>	-	+	-	-	-	-	+	-	-	-	-	-	-
62	<i>C. subturgidum</i>	-	+	+	+	+	-	-	-	-	-	-	-	+
63	<i>C. taxichondrum</i> var. <i>nudum</i>	+	-	+	-	-	-	-	+	-	-	-	-	+
64	<i>C. tjiibenongense</i> fa. <i>minus</i>	+	-	+	+	+	-	-	-	-	-	+	-	-
65	<i>C. trachyleurum</i> var. <i>nordstedtii</i>	+	+	+	+	+	+	+	+	-	+	+	-	-
66	<i>C. tumidum</i>	-	+	+	+	-	-	-	-	-	+	-	-	-
67	<i>C. turgidum</i>	+	+	+	-	-	+	+	-	-	-	-	-	-
68	<i>C. vexatum</i>	+	+	+	+	-	-	-	-	-	-	-	-	-

+: Present, -: Absent, S i: Pre-monsoon season (Feb-May), S ii: Monsoon season (Jun-Sep), S iii: Post-monsoon season (Oct-Jan). Stations: (1) Pullur, (2) Muriyad, (3) Nambiankavu, (4) Mapranam, (5) Chemmanda, (6) Cherpu, (7) Palakkal, (8) Chettupuzha, (9) Anthikkad, (10) Enamavu

Maharashtra (Freitas and Kamat, 1979); T.N. (Perumal and Anand, 2008).

68. *Cosmarium vexatum* West (pl. 1, fig. 68)

West and West, 1908. vol. 3, p. 187, pl. 92, fig. 4.

L: 40-44.7 µm, B: 35-39 µm. Distribution: Maharashtra (Dhande and Jawale, 2009; Freitas and Kamat, 1979).

Seasonal and spatial variation of genus *Cosmarium* Corda in Thrissur Kole lands, Kerala were given in Table 1. The seasonal analysis of *Cosmarium* at different stations revealed that 29 taxa were observed throughout the year irrespective of the seasonal changes, 43 taxa were found during pre-monsoon (Feb-May), 51 taxa during monsoon (Jun-Sep) and 51 taxa during post-monsoon (Oct-Jan) seasons in the study area (Table 1). More diversity of *Cosmarium* was observed in station 1 (Pullur) with 37 taxa followed by station 5 (Chemmanda) with 30 taxa.

In Thrissur Kole ecosystem, the periods of cultivation are well-defined, the soils are comparatively fertile and productive, and the microclimate is favorable. The variations in rainfall and the physicochemical parameters are responsible for the fluctuations in the quality and quantity of algae in water bodies.

C. geminatum Lund. var. *ornatum* Behre, *C. indentatum* Gronbl. var. *ellipticum* Scott and Gronbl., *C. pseudoconnatum* Nordst. var. *constrictum* West, *C. quadrifarium* Lund., *C. quadriverrucosum* West and West var. *undulatum* Scott and Prescott and *C. suburgidum* (Turn.) Schmidle are new additions to the desmid flora of India.

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