

RESEARCH ARTICLE

Coccoid green algae genus *Coelastrum* and some desmids from coastal region of Odisha, India

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Abstract

In this study total of 08 species of *Coelastrum* and 22 species of desmids were recorded from different freshwater habitats of the coastal region of Odisha during 2019 to 2020. Of these 30 algal species, 10 algal species namely; *Coelastrum rugosum* (Rich) Tsarenko, *Coelastrum polychordum* (Kors.) Hind, *Cosmarium auriculatum* var. *bogoriense* C. Bernard, *Cosmarium depressum* var. *reniforme* West et G.S. West, *Cosmarium subcostatum* Nordstedt, *Cosmarium tumidum* P. Lundell, *Staurastrum gracile* var. *nanum* Wille, *Staurastrum indentatum* f. *minus* A.M. Scott & Prescott, *Staurastrum sebaldi* var. *ornatum* Nordstedt, and *Xanthidium subhastiferum* West were recorded for the first time from Odisha.

Keywords: Coccoid algae, *Coelastrum*, *Closterium*, *Cosmarium*

Introduction

The coccoid green algae have diverse morphological forms and phylogenetically they have been extended into a large taxonomic clade (Baudelet *et al.*, 2017). Further, they widely distributed around the world living in freshwater, seawater, subaerial habitats and they don't propagate sexually (Krienitz and Bock 2012). Most of the members of coccoid green algae belong to three classes namely, Prasinophyceae, Trebouxiophyceae, and Chlorophyceae in the Chlorophyta division (Krienitz 1990; Fawley *et al.*, 2000; Krienitz *et al.*, 2003; Jena *et al.*, 2014). The coccoid algal genus *Coelastrum* was kept in the order Chlorococcales by Komárek and Fott (1983) and this nomenclature was made basing on classical morphological characteristics (Pascher 1918). Presently most of the taxa which were usually considered as the members of the Chlorococcales have now been transferred to order Sphaeropleales (Lewis and McCourt 2004). The coccoid algal species morphologically related to the genus *Chlorococcum*

belong to the order Chlorococcales and other species belong to Sphaeropleales (Proschold and Leliaert 2007).

The desmids are special type of coccoid green algae belonging to Zygnematophyceae of the order Desmiales. The presence of symmetrical halves (Semi-cells) is the distinguishing morphological feature of these coccoid algae (Coesel and Krienitz 2007). These coccoid algae are conventionally considered as the members of division Chlorophyceae but presently desmids are placed in the class Charophyta as evidenced by the phylogenetic studies (Krienitz and Bock 2012). Furthermore, desmids (Zygnematophyceae) usually co-dominantly occurred in bog water microflora. These are also very sensitive to environmental changes; therefore, they are also considered bio-indicators (Coesel 2003). A number of freshwater bodies including lakes, reservoirs, rivers, and ponds are present in Odisha state which harbour many freshwater algal species (Adhikary *et al.*, 2009; Das and Adhikary 2014).

Although, substantial work has been done on freshwater and marine algal diversity of Odisha state (Jena *et al.*, 2005; Jena *et al.*, 2006a, Jena *et al.*, 2006b; Rath *et al.*, 2006; Rath *et al.*, 2007; Jena *et al.*, 2008; Jena *et al.*, 2014; Maharana *et al.*, 2019; Dash *et al.*, 2020; Behera *et al.*, 2020; Dash *et al.*, 2021; Behera *et al.*, 2021; Pradhan *et al.*, 2021) but the information on freshwater coccoid green algal species belonging to genus *Coelastrum* and desmids is still scanty (Jena *et al.*, 2006c, Jena and Adhikary 2007). Thus, we have studied the diversity of coccoid green algae with special reference to the genus *Coelastrum* and some coccoid desmids from different freshwater habitats of the coastal region of Odisha.

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Material and Methods

Algal samples were collected from different locations in Odisha from 2019 to 2020 and details of sites are given in Table 1 and fig. 1. Samples were collected by plankton net (Brand: Hydrobios, Mesh size: 25 µm) and preserved in 4% (V/V) formaldehyde. Each collected tube having preserved algal samples was assigned with one voucher and were worked out at the Department of Botany, Berhampur University. The temporary slides were prepared by placing the sample drop-wise on a glass slide and covered with a coverslip. Then prepared slides were observed using a phase-contrast microscope (Model: Olympus BX 53) and images of algal species were taken by an attached CCD camera (Model: Olympus, SC-180). The identification of algal species was done based on the observations of important morphological characteristics evident from the algal microphotographs. The taxonomic assignment to the algal species was given by following published papers and monographs (Komárek and Fott 1983, Hindak 1988, Adhikary *et al.*, 2009, Jena *et al.*, 2014, Das and Keshri 2016).

Results and Discussion

A total of 30 coccoid green algal species were recorded from the collections of seven sites. These algal species belong to eight genera, namely *Coelastrum*, *Hariotina*, *Closterium*, *Cosmarium*, *Euastrum*, *Staurastrum*, *Xanthidium*, *Stauradesmus* of three families Scenedesmaceae, Closteriaceae, and Desmidiaceae. During this study, 10 algal species were recorded for the first time from Odisha. Of these 10 species, two species were belonging to genus *Coelastrum*, four species belong to genus *Cosmarium*, three belong to *Staurastrum* and one species belongs to genus *Xanthidium*. The details list of algal species recorded in this study are given in Table 2 and their microphotographs are shown in Fig. 2a-n and 3a-p. The systematic account and taxonomic position, illustrations, of all algal species are given below:

Phylum: Chlorophyta,

Class: Chlorophyceae,

Order: Sphaeropleales,

Family: Scenedesmaceae

Genus: *Coelastrum* Nägeli 1849

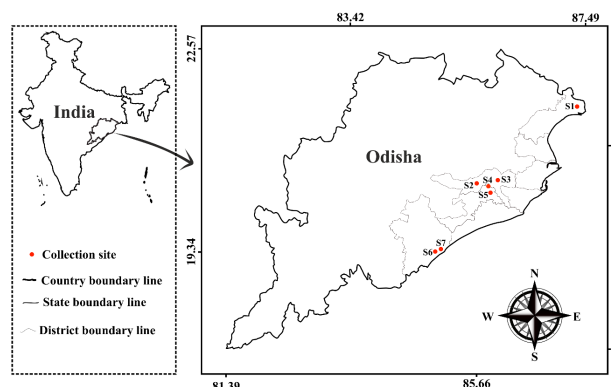


Fig. 1: Map showing different sites of coastal region of Odisha from algal samples were collected (details of sites are mentioned in table 1)

Coelastrum indicum W.B. Turner 1892. (Fig. 2a)

[Synonym: *Coelastrum pulchrum* var. *intermedium* Bohl. 1897; *C. pulchrum* var. *mamillatum* Bohl. 1897, *C. intermedium* (Bohl.) Kors. 1953]

Komárek and Fott 1983, p. 737, pl. 205, fig. 5

Coenobia spherical, mostly 16-32 celled, cells globose, broadly hexangular form the lateral poles, cell wall slightly thickened at the poles, openings between the cells triangular, cells 6-7 µm in diameter and the diameter of the coenobia about 15-19 µm.

Planktonic, Pond, Bhubaneswar, voucher no. BR10, date: 06.03.2019.

Coelastrum microporum Nägeli 1855. (Fig. 2b)

[Synonym: *Coelastrum robustum* Hantzsch 1868; *Pleurococcus regularis* Artari 1892; *Chlorella regularis* (Artari) Oltmanns 1904]

Komárek and Fott 1983, p. 725, pl. 202, fig. 1

Coenobia spherical, cells small, intercellular spaces within the coenobium, cells covered with thin gelatinous sheath, cells are interconnected with gelatinous processes, diameter of cells 3.5-5.1 µm and coenobium diameter 10.5-16 µm.

Planktonic, Pond, Cuttack, voucher no. CT6, date: 26.10.2019.

Table 1: List of collection sites showing GPS location and habitat

Station no.	Name of the collection site	Latitude	Longitude	Habitat
S1	Bhograi, Balasore, Odisha	21° 54' 36.4" N	87° 21' 05.1" E	Pond
S2	Ansupa Lake, Athagarh, Cuttack, Odisha	20° 26' 28.4" N	85° 35' 56.7" E	Lake
S3	Near Kathajodi River, Cuttack, Odisha	20° 27' 28.1" N	85° 52' 46.6" E	Pond
S4	Kanjiahata Lake, Nandankanan, Bhubaneswar, Odisha	20° 23' 7.2" N	85° 48' 11.2" E	Lake
S5	Nicco park, Bhubaneswar, Odisha	20° 17' 7.1" N	85° 50' 3.9" E	Pond
S6	Tampara Lake, Chhatrapur, Ganjam, Odisha	19° 21' 9.9" N	85° 01' 20.6" E	Lake
S7	Laxmipur Pond, Huma, Ganjam, Odisha	19° 24' 4.4" N	85° 04' 16.1" E	Pond

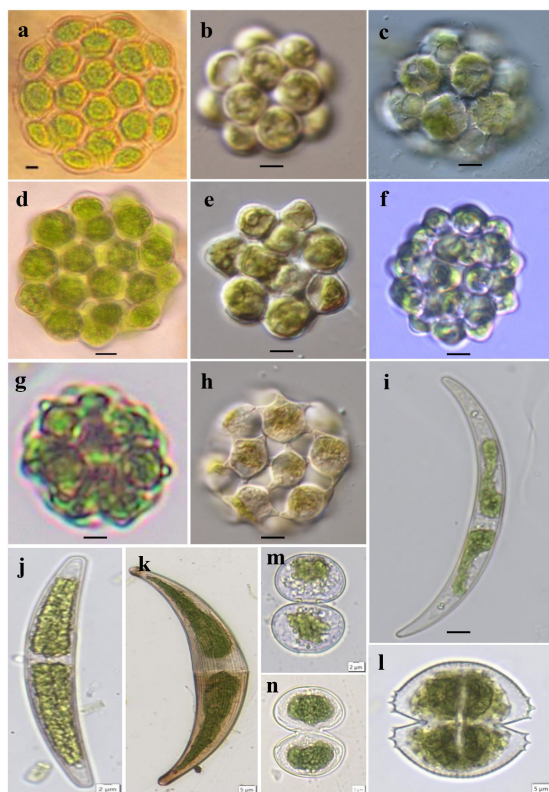


Fig. 2: a. *Coelastrum indicum* W.B. Turner, b. *Coelastrum microporum* Nägeli, c. *Coelastrum polychordum* (Kors.) Hind, d. *Coelastrum proboscideum* Bohlin in Wittrock, e. *Coelastrum pseudomicroporum* Korshikov, f. *Coelastrum rugosum* (Rich) Tsarenko, g. *Coelastrum sphaericum* Nägeli, h. *Hariotina reticulata* P.A. Dangeard, i. *Closterium ehrenbergii* Meneghini ex Ralfs, j. *Closterium jenneri* var. *robustum* G.S. West, k. *Closterium leibleinii* var. *angulatum* f. *minor* Turner, l. *Cosmarium auriculatum* var. *bogoriense* C. Bernard, m. *Cosmarium contractum* O. Kirchner, n. *Cosmarium depressum* var. *reniforme* West et G.S. West. (Scale bar: a to h = 10 µm; n, m, j, i = 2 µm; k, l = 5 µm)

***Coelastrum polychordum* (Kors.) Hind.1977. (Fig. 2c)**

[Synonym: *Coelastrum reticulatum* var. *polychordum* Korshikov 1953; *Coelastrum reticulatum* f. *duplex* Compère 1970]

Komárek and Fott 1983, p. 738, pl. 206, fig. 3

Coenobia globular, with (16) -32-64 cells. Cells spherical neighbouring cells connected by (1)- 2-3 narrow, subapical processes. After that, each cell has 10-15-(18) limbs. The outer cell wall is slightly wavy with gap between the cells. Chloroplast single, with a pyrenoid, diameter of cell 15 -19 µm and coenobia 100-120 µm (during reproduction up to 200 µm) in diameter.

Planktonic, Pond, Cuttack, voucher no. CT12, date: 26.10.2019; Pond, Berhampur, Ganjam, voucher no. BR8, date: 22.06.2019.

***Coelastrum proboscideum* Bohlin in Wittrock, 1896. (Fig. 2d)**

Komárek and Fott 1983, p. 726, pl. 203, fig. 1

Coenobia slightly pyramidal, 4-6-16 cells, intercellular spaces generally large, polygonal. Cells conical in shape, truncate

and six-sided, cells lateral sides slightly concave. Cells poles thickened, cells 12-20 µm in diameter and coenobia 60-110 µm in diameter.

Planktonic, Tampara lake, Chhatrapur, Ganjam, Odisha, voucher no. TL7, date:10.02.2019.

***Coelastrum pseudomicroporum* Korshikov 1953. (Fig. 2e)**

Komárek and Fott 1983, p. 726, pl. 202, fig. 5

Coenobia spherical, 27-30 µm in diameter, 32 celled, cells surrounded by thin mucilage, cells are oblong, elliptical, 8-10 µm long and 6-8 µm broad.

Planktonic, Canal, Palasuni, Bhubaneswar, voucher no. BH1, date: 06.03.2019.

***Coelastrum rugosum* (Rich) Tsarenko 2011. (Fig. 2f)**

[Synonym: *Coelastrum astroideum* var. *rugosum* (Rich) Sodomková null; *C. cambricum* var. *rugosum* Rich 1932]

Jung et al., 2017, p. 290, fig. 1.

Coenobia 16 celled, cells oval, small intercellular spaces in coenobia, cells enclosed by a delicate gelatinous sheath and closely interconnected by gelatinous process, chloroplast cup shaped to diffuse with pyrenoid, cells 8-9 µm in diameter and coenobia 35-40 µm in diameter.

Planktonic, Ansuapa lake, Athagarh voucher no. AL3, date:05.02.2020; Boating Pond, Niccopark, Bhubaneswar, voucher no. BR5, date: 06.03.2019.

***Coelastrum sphaericum* Nägeli 1849. (Fig. 2g)**

[Synonym: *Coelastrum cubicum* Nägeli 1849; *C. verrucosum* (Reinsch) Reinsch 1875; *C. pseudocubicum* Schröder 1987; *C. irregulare* Schröder 1987; *C. giganteum* Cedergr.]

Philipose 1967, p. 231, fig. 140 a; Komárek and Fott 1983, p. 730, pl. 204, fig. 1

Coenobia spherical, 16 celled, cells angular globose with three or more truncate processes from the outer surfaces, cells 7.5-8.5 µm in diameter.

Planktonic, Tampara lake, Chhatrapur, Ganjam, voucher no. TL18, date: 10.02.2019.

Genus: *Hariotina* P.A. Dangeard 1899

***Hariotina reticulata* P.A. Dangeard 1899. (Fig. 2h)**

[Synonym: *Coelastrum reticulatum* (P.A.Dangeard) Senn, 1899]

Komárek and Fott 1983, p. 737, pl. 206, fig. 1

Coenobia spherical, 8-16-32 celled, 30-70 µm in diameter, cells spherical, enclosed by a gelatinous sheath, cells interconnected by 6-9 long gelatinous processes; chloroplast single, parietal, without pyrenoid; cells 7-15 µm in diameter.

Planktonic, Ansuapa lake, Athagarh, voucher no. AL 13, date: 10.05.2019.

Phylum: Charophyta

Class: Zygnematophyceae,

Order: Desmidiaceae,

Family: Closteriaceae

Genus: *Closterium* Nitzsch ex Ralfs, 1848

***Closterium ehrenbergii* Meneghini ex Ralfs, 1848. (Fig. 2i)**

[Synonym: *Closterium gigas* F.Gay null]

Prasad and Misra 1992, p. 116, pl. 26, fig. 5; Das and Adhikary 2014, p. 88, pl. 5, fig. 30.

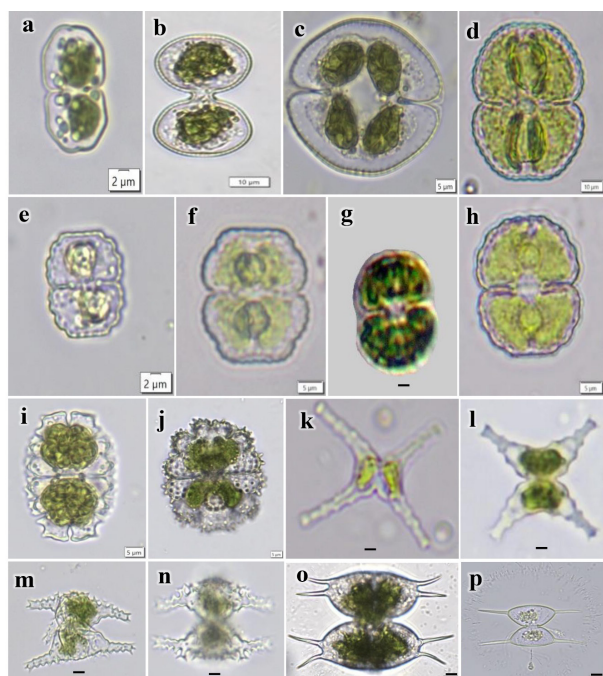


Fig. 3: a. *Cosmarium difficile* var. *sublaeve* Lükemüller, b. *Cosmarium moniliforme* Ralfs, c. *Cosmarium obsoletum* (Hantzsch) Reinsch, d. *Cosmarium radiosum* Wolle, e. *Cosmarium subcostatum* Nordstedt, f. *Cosmarium trilobulatum* var. *abscissum* (Schmidle) Willi Krieger & Gerloff, g. *Cosmarium tumidum* P. Lundell, h. *Cosmarium undulatum* var. *wollei* West, i. *Euastrum coralloides* var. *trigibberum* Lagerheim, j. *Euastrum spinulosum* Delponte, k. *Staurastrum bloklandiae* Coesel and Joosten, l. *Staurastrum gracile* var. *nanum* Wille, m. *Staurastrum indentatum* f. *minus* A.M. Scott & Prescott, n. *Staurastrum sebaldi* var. *ornatum* Nordstedt, o. *Xanthidium subhastiferum* West, p. *Staurodesmus convergens* (Ehrenberg ex Ralfs) S. Lillieroth. (Scale bar: a, e = 2 µm; b, d = 10 µm; c, f, g, h, i, j, k, l, m, n, o, p = 5 µm)

Cells solitary, green, moderately curved, inner margin concave, slightly bulged in the middle, attenuated at the apex, apex rounded, chloroplast with longitudinal 6-8 bands, pyrenoids many, at each apex one reddish polar nodule present, cells 26.4-35 µm long and 3-5 µm broad, pole is 5.4-6.3 µm broad.

Planktonic, Kanjiahata lake, Nandankanan, Bhubaneswar, voucher no. KL8., date 19.02.2020.

***Closterium jenneri* var. *robustum* G.S. West, 1899. (Fig. 2j)**
Adhikary and Jena 2012, p. 227, pl. 2, fig. 8.

Cells solitary, small, lunate slightly curved, dorsal side convex; slightly attenuated, towards apex obtuse; chloroplast axial with 2-3 ridges, granulated at the apex; cells longer than broad, 5-7 µm long and 14 µm broad.

Planktonic, collection site: Kanjiahata lake, Nandankanan, Bhubaneswar, voucher no. KL17, date: 19.02.2020; Tampara lake, Chhatrapur, Ganjam; voucher no. TL 13, date: 10.02.2019.

***Closterium leibleinii* var. *angulatum* f. *minor* Turner, 1978. (Fig. 2k)**

Das and Adhikary 2014, p. 89, pl. 6, fig. 1.

Cells solitary, longer than broad, cells 95-96 µm long and 22-23 µm broad, little curved, cells inner margin is inflated, obtuse apices,

Planktonic, Tampara lake, Chhatrapur, Ganjam, voucher no. TL19, date: 10.02.2019; Kanjiahata lake, Nandankanan, Bhubaneswar, voucher no. KL17, date: 19.02.2020.

Class: Zygnematophyceae,

Order: Desmidiaceae,

Family: Desmidiaceae

Genus: *Cosmarium* Corda ex Ralfs, 1848

***Cosmarium auriculatum* var. *bogoriense* C. Bernard, 1908. (Fig. 2 l)**

Misra and Srivastava 2003, p. 87, pl. 1, fig. 86.

Cells small with narrow constriction, sinus opens outwards, semi-cells sub-elliptical, apex rounded having small truncation; cell wall punctate, constricted cell wall near to sinus having five undulations with sharp and pointed ridges; chloroplast axial; cells 43 µm long and 45 µm broad; isthmus 18-20 µm broad.

Planktonic, Kanjiahata lake, Nandankanan, Bhubaneswar, voucher no. KL 14, date: 19.02.2020.

***Cosmarium contractum* O. Kirchner, 1878. (Fig. 2m)**

Jena et al., 2006c, p. 24, pl. 2, fig. 3.

Cells solitary, longer than broad; sinus acutely constricted, broadly open; semi-cells circular, distinct central pyrenoids, cell wall smooth; cells 25-28 µm long and 16-19 µm broad; isthmus 4-5 µm broad.

Planktonic, Kanjiahata lake, Nandankanan, Bhubaneswar, voucher no. KL7, date: 19.02.2020

***Cosmarium depressum* var. *reniforme* West et G.S. West, 1905. (Fig. 2n)**

Das and Keshri 2016, p.103, pl. VII, Fig. 214.

Cells small, little broader than long, constriction deep at middle, sinus linear, open; semi-cells reniform, apex rounded; chloroplast axial having single pyrenoid. 18-20 µm long and 21-24 µm broad; isthmus; 6-8 µm.

Planktonic, Kanjiahata lake, Nandankanan, Bhubaneswar, voucher no. KL19; date: 19.02.2020.

***Cosmarium difficile* var. *sublaeve* Lütkenmüller, 1893. (Fig. 3a)**

Jena et al., 2006c, p. 25, pl. 2, fig. 8.

Cells solitary, ectangular, longer than broad, sinus slightly constricted, closed; semi-cells sub-quadrangular, outer wall plain, basal angles broadly rounded; apex flattened; cell wall smooth; cells 25-34 µm long and 11-15 µm broad; isthmus 3-4 µm broad.

Planktonic, Kanjiahata lake, Nandankanan, Bhubaneswar, voucher no. K94, date: 12.02.2019.

***Cosmarium moniliforme* Ralfs, 1848. (Fig. 3b)**

Das and Adhikary 2014, p. 114, pl. 8, fig. 26.

Cells longer than broad, deeply constricted, sinus broadly open, semi-cells spherical with extensively rounded apex, cell wall smooth, semi-cells 40-43 µm long and 16-22 µm broad and isthmus 7-9 µm broad.

Planktonic, collection site: Kanjiahata lake, Nandankanan, Bhubaneswar, voucher no. KL8, date: 19.02.2020; Tampara

lake, Chhatrapur, Ganjam, voucher no. TL18, date: 19.02.2020.
***Cosmarium obsoletum* (Hantzsch) Reinsch, 1867. (Fig. 3c)**
 Adhikary and Jena 2012, p. 228, pl. 2, fig. 15.

Cells solitary, diagonally elliptic, nearly as long as broad; sinus acutely constricted, narrow, open outwards; semicells semi-circular and depressed; chloroplast axial; cell wall smooth; cells 30-32 μm long and 28-35 μm broad; isthmus 30-35 μm wide.

Planktonic, Kanjiahata lake, Nandankanan, Bhubaneswar, voucher no. KL4, date: 19.02.2020.

***Cosmarium radiosum* Wolle, 1884. (Fig. 3d)**

Das and Adhikary 2014, p. 117, pl. 8, fig. 36.

Cells longer than broad, intensely constricted; sinus linear, narrow, slightly opened; semi-cells sub-semicircular, sides strongly convex, apex rounded, semi-cells 60-70 μm long, 45-52 μm broad.

Planktonic, Tampara lake, Chhatrapur, Ganjam, voucher no. TL13, date: 10.02.2019.

***Cosmarium subcostatum* Nordstedt, 1876. (Fig. 3e)**

John et al., 2002, p. 546, pl. 135, fig. C.

Cells 6.5-10 μm long, 4-6 μm wide; sinus deep, linear, dilated internally; semi-cells sub trapeziform reinform, lateral margins convex with 2 crenation above basal angles, 4 longer crenations, semi-cell face minutely granulated, radially and concentrically disposed, with central tumor having granules in 4-5 vertical series.

Planktonic, Kanjiahata lake, Nandankanan, Bhubaneswar, voucher no. KL17, date: 19.02.2020.

***Cosmarium trilobulatum* var. *abscissum* (Schmidle) Willi Krieger & Gerloff, 1962. (Fig. 3f)**

Das and Adhikary 2014, p. 118, pl. 9, fig. 2.

Cells small, semi-cells pyramidal, lateral angles rounded, truncated towards the pole, apices flattened; sinus narrow, linear, cell wall smooth, cells 20-26 μm long and 17-20 μm broad; Planktonic, Tampara lake, Chhatrapur, Ganjam, voucher no. TL7, date: 10.02.2019.

***Cosmarium tumidum* P. Lundell, 1871. (Fig. 3g)**

Scott and Prescott, 1961, p. 72, pl. 27, fig. 16.

Cells small, longer than broad, isthmus present, sinus closed, constriction deep; semi-cells semi-circular to trapezoid, apex truncate, cells are 30-32 μm long and 22-26 μm broad, isthmus is 5-7 μm long.

Planktonic, Kanjiahata lake, Nandankanan, Bhubaneswar, voucher no. KL15, date: 19.02.2020; Ansupa lake, Athagarh, voucher no. AL8, date: 05.02.2020.

***Cosmarium undulatum* var. *wollei* West, 1892. (Fig. 3h)**

Das and Adhikary 2014, p. 118, pl. 9, fig. 3.

Cells solitary, elongated, acutely constricted; sinus in lines; semicells curved, margin crenate, semi-cells 22-25 μm long and 28-32 μm broad.

Planktonic, Tampara lake, Chhatrapur, Ganjam, voucher no. TL 10, date: 10.02.2019.

Genus: *Euastrum* Eherenberg ex Ralfs, 1848

***Euastrum coralloides* var. *trigibberum* Lagerheim, 1888. (Fig. 3i)**

Das and Adhikary 2014, p. 94, pl. 6, fig. 13.

Cells small with deep constriction: semi-cells three lobed, polar lobe short and broad with deep median incision, apical angle with short spines, lateral lobes bi-lobulate, each lobule truncate, emarginated with a small spine in the furrow, each semi-cell with 5 tumours, two small and lateral in position, one large just above sinus and one on each side of the apical notch in polar lobe, cells 24-30 μm long, 10-15 μm broad and isthmus is 5-6 μm broad.

Planktonic, Kanjiahata lake, Nandankanan, Bhubaneswar, voucher no. KL 14, date: 19.02.2020.

***Euastrum spinulosum* Delponte, 1876. (Fig. 3j)**

Das and Keshri 2016, p. 139, pl. XXVIII, fig. 467.

Cells solitary, yellowish green, sinus constricted, rounded to flattened, polar tube trapezoid; cell wall granulated, arranged like a circular fission; cells 50-55 μm long and 45-50 μm broad, isthmus 7-9 μm .

Planktonic, Kanjiahata lake, Nandankanan, Bhubaneswar, voucher no. KL11, date: 19.02.2020; Ansupa lake, Athagarh, voucher no. AL16, date: 05.02.2020; Tampara lake, Chhatrapur, Ganjam, voucher no. TL 19, date: 10.02.2019.

Genus: *Staurostrum* Meyen ex Ralfs, 1848

***Staurostrum bloklandiae* Coesel and Joosten, 1996. (Fig. 3k)**

Das and Adhikary 2014, p. 96, pl. 06, fig. 22.

Cell with 4 diverging, robustly dentated processes terminating in two stout divergent spines: semi-cells sub-triangular, two marginal dents at the apex, notch like sinus, open widely, cells 27-31 μm long and 15-18 μm broad.

Planktonic, Tampara lake, Chhatrapur, Ganjam, voucher no. TL9, date: 10.02.2019.

***Staurostrum gracile* var. *nanum* Wille, 1880. (Fig. 3l)**

Lee 2015, p. 61, fig. 60.

Cells solitary, small, apical margin of the semi-cells nearly straight or slightly convex. In vertical view cell is 4-rayed. Cells are 8-12 μm long and 3-5 μm broad.

Planktonic, Tampara lake, Chhatrapur, Ganjam, voucher no. TL6, date: 10.02.2019.

***Staurostrum indentatum* f. *minus* A.M. Scott & Prescott, 1961. (Fig. 3m)**

Santra and Pal 2006, p. 470, pl. XXII, fig. 8.

Cells are solitary, processes horizontal, denticulated, long, terminating in 2-3 spines; many short bifurcate verrucae on the apices and lateral margin of the semi-cell. Cells are 4-13 μm long and 8-10 μm broad.

Planktonic, Kanjiahata lake, Nandankanan, Bhubaneswar, voucher no. KL4, date: 19.02.2020.

***Staurostrum sebaldi* var. *ornatum* Nordstedt, 1873. (Fig. 3n)**

Thomasson 1967, p. 295, figs. 2 (4-5)

Cells are solitary, symmetrical, middle constricted, acute

incised sinus, isthmus long, prolong horns at both side, cells 70-94 µm long and 81-90 µm broad

Planktonic, Kanjiahata lake, Nandankanan, Bhubaneswar, voucher no. KL17; date: 19.02.2020, Ansupa lake, Athagarh, voucher no. AL8, date: 05.02.2020.

Genus: *Xanthidium* Ehrenberg ex Ralfs, 1848

***Xanthidium subhastiferum* West, 1892. (Fig. 3 o)**

John et al., 2002, p. 585, pl. 142, fig. F.

Cells with spines, 10-20 µm long; sinus acutely constricted, intensely angled, open; isthmus 13-19 µm wide; semi-cells oblong-elliptical, sometimes flattened at base and apex; each lateral margin with 2 simple diverging spines in same vertical plane; face of semi-cell with a central, small, rounded thickened area, cells 12-14 µm wide.

Free floating, Kanjiahata lake, Nandankanan, Bhubaneswar, voucher no. KL9, date: 10.02.2020.

Genus: *Staurodesmus* Teiling, 1948

***Staurodesmus convergens* (Ehrenberg ex Ralfs) S. Lillieroth, 1950. (Fig. 3 p)**

Das and Adhikary 2014, p. 122, pl. 9, fig. 7.

Cells longer than broad, deep constriction at the middle; sinus opening widely outwards from narrow linear extremity, semi-cells transversely elliptic, apical margin slightly more convex than the basal, lateral angles rounded conical and furnished with rather stout and slightly incurved spine, cell wall smooth, chloroplast axile with 1-2 pyrenoids in each semi-cell.

Planktonic, Kanjiahata lake, Nandankanan, Bhubaneswar, voucher no. KL18, date: 19.02.2020.

Conclusions

Coccal green algae belonging to the genus *Coelastrum* showed more morphological ambiguity with coenobium arrangements. The overlapping morphological complexity between two species *Coelastrum microporum* and *Coelastrum rogosum* and between *Hariotina reticulata* and *Coelastrum polychordum* was observed and molecular identification is needed for taxonomic conclusion. The important finding of the present investigation was recording of 10 coccoid green algae i.e. *Coelastrum rugosum* (Rich) Tsarenko, *Coelastrum polychordum* (Kors.) Hind, *Cosmarium auriculatum* var. *bogoriense* C. Bernard, *Cosmarium depressum* var. *reniforme* West et G.S. West, *Cosmarium subcostatum* Nordstedt, *Cosmarium tumidum* P. Lundell, *Staurostrum gracile* var. *nanum* Wille, *Staurostrum indentatum* f. *minus* A.M. Scott & Prescott, *Staurostrum sebaldi* var. *ornatum* Nordstedt, and *Xanthidium subhastiferum* West from coastal region of Odisha for the first time.

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