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**Taxonomic and nomenclatural notes on five taxa of *Cosmarium* (Desmidiaceae, Zygnematophyceae) from Brazil**

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Here we propose to update names of five taxa of *Cosmarium* based on specimens gathered at “Pantanal dos Marimbus”, an area with a rich biodiversity in the Chapada Diamantina region, north-eastern Brazil. Taxonomic remarks and some ecological information are provided.

***Cosmarium clepsydra* var. *sumatranum*** (A.M.Scott & Prescott) G.J.P.Ramos & C.W.N.Moura, *comb. nov.* (Figs 1-3)

Basionym: *Cosmarium protuberans* var. *sumatranum* A.M.Scott & Prescott, *Hydrobiologia* 17(1/2): 66, pl. 32: fig. 18, 1961.

Material examined: BRAZIL: Marimbus wetlands, Andaraí, Bahia State – (HUEFS 185390).

Cell dimensions: length 21 µm, breadth 19.5 µm, breadth of isthmus 5.5 µm.

Habitat: This variety was found associated with periphyton of *Utricularia foliosa* L. and *Eichhornia azurea* (Swartz) Kunth. Water temperature was 29°C.

Distribution: Brazil, Indonesia.

Notes: *Cosmarium protuberans* var. *sumatranum* is a very rare taxon, described by Scott & Prescott (1961) based on specimens from Sumatra (Indonesia). Scott & Prescott (1961) considered that this variety differs from the type variety in having cells about one-third less in size, with lateral margins that are slightly retuse and convergent upwards. Despite the morphological similarity of the lateral and apical views with *C. protuberans* var. *protuberans*, the frontal view of this latter species is different (subtrapeziform). We consider, however, that the taxon under discussion should be treated as a variety of *Cosmarium clepsydra* Delponte, which has a number of varieties with margins convergent into the apices at front view, and also having similar sizes and forms in the lateral and apical views. Of the varieties of *C. clepsydra*, the var. *sumatranum* should be compared with *C. clepsydra* var. *bicardia* (Reinsch) Croasdale, *C. clepsydra* var. *dissimile* (Raciborski) Willi Krieger & Gerloff, and *C. clepsydra* var. *alaskanum* Croasdale.

The following four taxa are raised to varietal status:

***Cosmarium commissulare* var. *cruciforme*** (Kurt Förster) G.J.P.Ramos & C.W.N.Moura, *stat. nov.* (Figs 4-6)

Basionym: *Cosmarium commissulare* f. *cruciforme* Kurt Förster, *Amazoniana* 2(1/2): 47, pl. 19: figs 6, 7, 1969 (‘var. *crassum* f. *cruciforme*’).

Material examined – BRAZIL. Marimbus wetlands, Andaraí, Bahia State – HUEFS 242474, HUEFS 242434.

Cell dimensions: length 24-28µm, breadth 25-32 µm, breadth of isthmus 9.5-10.5 µm.

Habitat: This variety was found associated to periphyton of *Utricularia foliosa*, and *Cabomba caroliniana* A.Gray. Conductivity 0.06 mS cm<sup>-1</sup>, dissolved oxygen 5.9 mg L<sup>-1</sup>, pH 6.9, total dissolved solids 0.03, water temperature 29.9°C, water transparency 0.76 m, PO<sub>4</sub>-P 0.04 mg L<sup>-1</sup>, NO<sub>2</sub>-N 0.01 mg L<sup>-1</sup>, NO<sub>3</sub> 0.052 mg L<sup>-1</sup>, N-NH<sub>4</sub> 0.1 mg L<sup>-1</sup>, orthosilicate 0.16 mg L<sup>-1</sup>.

Distribution: Brazil.

Notes: The forma *cruciforme* was proposed by Förster (1969) as a form of *C. commissurale* var. *crassum* Nordstedt, based on material from the Brazilian Amazon. This forma was previously noted by Borge (1925, 33, pl. 1: fig. 8) for specimens gathered in State of Mato Grosso, Brazil, but was not named by him. It differs from the var. *crassum* in having cells with larger middle tumors giving a cross-shaped aspect in apical view. Currently, the taxon is known only in Brazil from the following States: Bahia, Pará, Mato Grosso, and São Paulo.

***Cosmarium monomazum* var. *brasiliense*** (Kurt Förster & Eckert) G.J.P.Ramos & I.B.Oliveira, *stat. nov.* (Figs 7-12)

Basionym: *Cosmarium monomazum* f. *brasiliense* Kurt Förster & Eckert in Kurt Förster, *Hydrobiologia* 23: 396, pl. 22: fig. 24; pl. 47: fig. 18, 1964 ('var. *dimazum* f. *brasiliense*').

Material examined – BRAZIL. Marimbus wetlands, Andaraí, Bahia State – (HUEFS 241798, HUEFS 242484).

Cell dimensions: length 27-29 µm, breadth 33-34 µm, breadth of isthmus 10-12 µm.

Habitat: This variety was found associated to periphyton of *Utricularia foliosa* and *Cabomba caroliniana*. Conductivity 0.05 (± 0.03) mS cm<sup>-1</sup>, dissolved oxygen 6.7 (± 1.1) mg L<sup>-1</sup>, pH 6.8 (± 0.4), total dissolved solids 0.02 (± 0.01), water temperature 29.9 (± 2.7)°C, water transparency 0.51 (± 0.17) m, PO<sub>4</sub>-P 0.029 (± 0.018) mg L<sup>-1</sup>, NO<sub>2</sub>-N 0.014 (± 0.002) mg L<sup>-1</sup>, NO<sub>3</sub>-N 0.04 mg L<sup>-1</sup>, N-NH<sub>4</sub> 0.029 (± 0.031) mg L<sup>-1</sup>, orthosilicate 0.45 (± 0.53) mg L<sup>-1</sup>.

Distribution: Known only from Brazil.

Notes: *Cosmarium monomazum* var. *brasiliense* differs from the var. *dimazum* Willi Krieger by having an undulate sinus with convergent papillae at the ends. Förster (1964) considered that cell size was also a distinguishing feature of the taxa, but the specimens from the Marimbus have similar dimensions to var. *dimazum*, although slightly smaller. Both varieties are probably endemic to the Tropics. Currently, the var. *brasiliense* is known only for three states in Brazil: Tocantins (as "Conceição, Goyaz", type locality, Förster 1964), Bahia (present study, Oliveira *et al.* 2010), and São Paulo (Bicudo *et al.* 2019). There are some other similar taxa with two central verrucae that should be examined comparatively such as *C. dimaziforme* var. *floridanum* A.M.Scott & Grönblad, *C. dimaziforme* var. *undulatum* Kurt Förster & Eckert, *C. monomazum* var. *dimaziforme* Grönblad. All of these taxa were described based on specimens from the Americas, the latter two from Brazil.

***Cosmarium exiguum* var. *incrassatum*** (Scott & Grönblad) M.A.Santos & C.W.N.Moura, *stat. nov.* (Figs 13-15)

Basionym: *Cosmarium exiguum* f. *incrassatum* Scott & Grönblad, *Acta Societatis Scientiarum Fennicae, Nova Series B* 2(8): 17, pl. 8, figs 9, 10, 1957 ('var. *exiguum* f. *incrassatum*').

Material examined: BRAZIL. Marimbus wetlands, Andaraí, Bahia State – (HUEFS 253775).

Cell dimensions: length 20-21.5µm, breadth 11.5-12 µm, breadth of isthmus 4-6 µm.

Habitat: This variety was commonly found associated to periphyton of *Utricularia foliosa*, *Cabomba caroliniana* and *Nymphaea ampla* (Salisb.) DC Conductivity 0.05 (± 0.02) mS cm<sup>-1</sup>, dissolved oxygen 7.5 (± 1.8) mg L<sup>-1</sup>, pH 7.3 (± 0.9), total dissolved solids 0.02 (± 0.01), water temperature 29.5 (± 2)°C, water transparency 0.8 (± 0.16) m, PO<sub>4</sub>-P 0.014 (± 0.006) mg L<sup>-1</sup>,

NO<sub>2</sub>-N 0.014 (± 0.005) mg L<sup>-1</sup>, N-NH<sub>4</sub> 0.025 (± 0.014) mg L<sup>-1</sup>, orthosilicate 0.86 (± 0.52) mg L<sup>-1</sup>.

Notes: *Cosmarium exiguum* f. *incrassatum* was proposed by Scott & Grönblad (1957) based on specimens from the Mississippi (USA). The authors considered the refractive thickening of the cell wall as the main distinguishing feature of the taxon. Although the cell outline was not mentioned at the protologue, the illustrations provided by the authors (Scott & Grönblad 1957: pl. VIII: figs 9, 10) indicate subpyriform semicells differing from the type variety, which are subquadrate. It is not always possible to see clearly the thickening at frontal view, especially when there are fragments of chloroplast, although it is visible at lateral and apical views, therefore the semicell shape is an additional feature to distinguish both varieties. Among the varieties of *C. exiguum*, the var. *incrassatum* most resembles var. *hexagonum* (Grönblad) Willi Krieger & Gerloff, but this latter differs by having semicells more or less hexagonal with obtuse basal corners, and not having the thickness at the cell wall. Other similar taxa should be also compared with var. *incrassatum* such as *Cosmarium plectrum* Reinsch, and *C. divergentiforme* Hirano. These two species differ mainly by having rounded apices, larger cells, and the thickness at the cell wall is absent.

***Cosmarium sphaerostichum* var. *bituberculatum*** (Kurt Förster & Eckert) G.J.P.Ramos & C.W.N.Moura, *stat. nov.* (Figs 16-20)

Basionym: *Cosmarium sphaerostichum* f. *bituberculatum* Kurt Förster & Eckert in Förster, *Revue Algologique* N.S. 7: 75, pl. 5: fig. 27, [photo] pl. 5, fig. 10, 1963.

Material examined: BRAZIL. Marimbus wetlands, Andaraí, Bahia State – HUEFS 241797, HUEFS 242434.

Cell dimensions: length 23-24 µm, breadth 19-20 µm, breadth of isthmus 7-8.5 µm.

Habitat: This variety was commonly found associated to periphyton of *Utricularia foliosa*, *Cabomba caroliniana*, and *Nymphaea ampla*. Conductivity 0.04 (± 0.02 mS cm<sup>-1</sup>), dissolved oxygen 7 (± 1.5) mg L<sup>-1</sup>, pH 7.3 (± 0.8), total dissolved solids 0.02 (± 0.01), water temperature 29.9 (± 2.3)°C, water transparency 0.72 (± 0.18) m, PO<sub>4</sub>-P 0.02 (± 0.013) mg L<sup>-1</sup>, NO<sub>2</sub>-N 0.014 (± 0.004) mg L<sup>-1</sup>, NO<sub>3</sub>-N 0.029 (± 0.018) mg L<sup>-1</sup>, N-NH<sub>4</sub> 0.025 (± 0.018) mg L<sup>-1</sup>, orthosilicate 0.59 (± 0.55) mg L<sup>-1</sup>.

Distribution: Brazil, French Guiana.

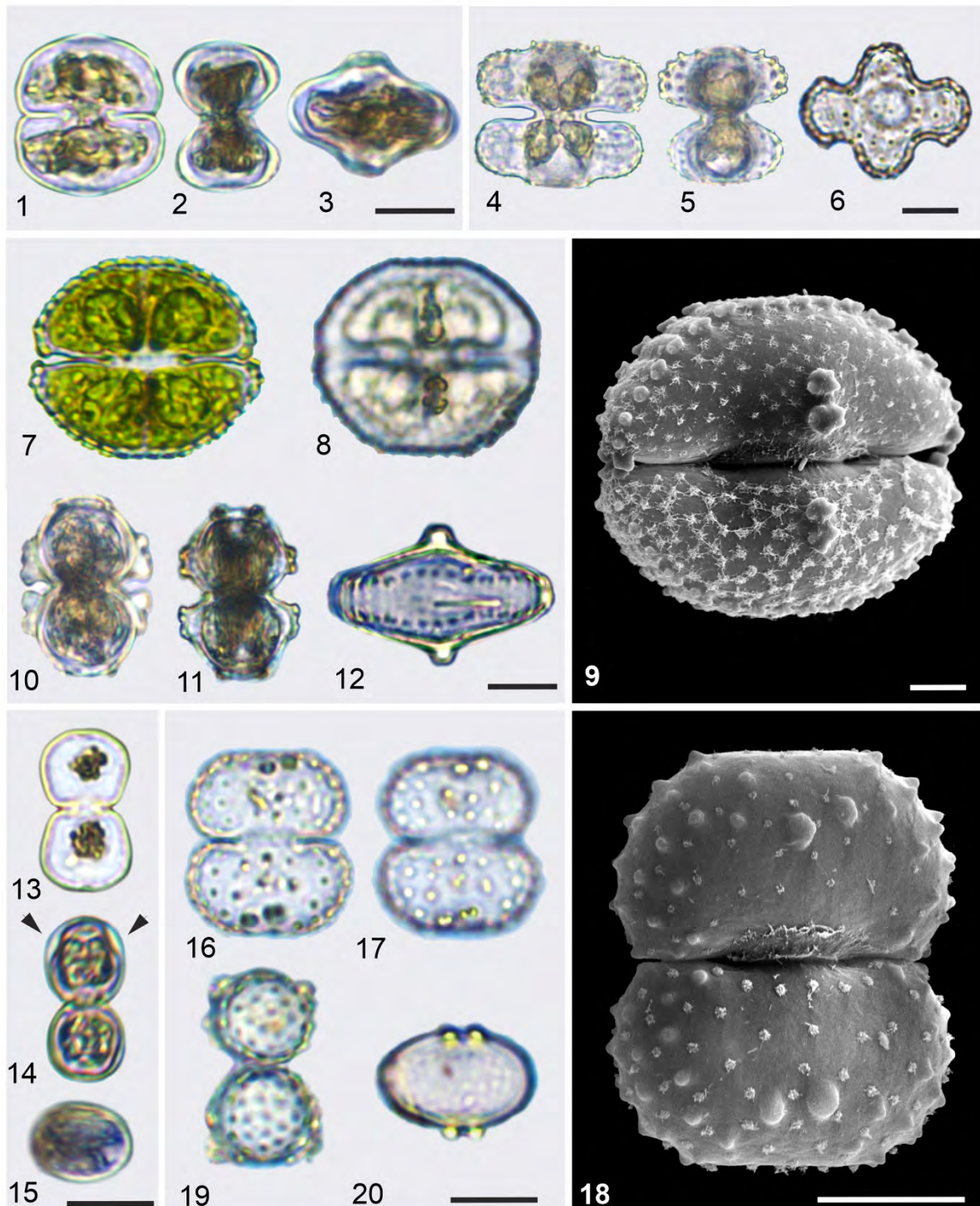
Notes: *Cosmarium sphaerostichum* var. *bituberculatum* differs from the type variety in having no granules at the isthmus region, and cell wall having punctate-rows spaced between the two subapical granules and the isthmus. The var. *bituberculatum* is a rare taxon, known only for South America: Brazil (Förster 1963, Oliveira et al. 2010), and French Guiana (Bourrelly & Couté 1982). Bicudo & Ventrice (1968) suggested that this taxon should be regarded as synonymous with *C. dichondrum* West & G.S.West due the numerous intermediate forms that differ only by arrangement of granulations. Despite the morphological similarity, we disagree, because *C. dichondrum*, described by West & G.S.West (1895) from Madagascar, has a subampliate sinus, a densely granulate cell wall, irregularly arranged (not concentric like the specimens described by Bicudo & Ventrice 1968, and Borge 1903), whereas *Cosmarium sphaerostichum* var. *bituberculatum* has a closed sinus, cells sparsely ornamented (two larger subapical granules, intramarginal series of minor granules, and mid-region coarsely punctate). It is important to highlight that this “punctate” pattern, seen under LM (Figs 16-17), actually refers to hardened pore exudates, resulting from mucilage remains, which are better seen under SEM (Fig.18).

This study was financed partly by the “Coordenação de Aperfeiçoamento Pessoal de Nível Superior – Brasil (CAPES)” – Finance Code 001. Authors are also grateful to Professor Michael D. Guiry and an anonymous reviewer for their valuable suggestions and corrections leading to an

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improvement of the manuscript; to Projeto Flora da Bahia (483909/2012-2), to “Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq)” for financial support of the “Projeto Ecológico de Longa Duração” (PELD — Chapada Diamantina, MCT/CNPq nº 59/2009) and for the fellowships granted to GJPR (150380/2019-4) and MAS (141734/2017-5).

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**Figs 1–20.** *Cosmarium* from Brazil. **Figs 1–3.** *Cosmarium clepsydra* var. *sumatranum*: frontal view (1), lateral view (2), apical view (3). **Figs 4–6.** *Cosmarium commissulare* var. *cruciforme*: frontal view (4), lateral view (5), apical view (6). **Figs 7–12.** *Cosmarium monomazum* var. *brasiliense*: LM (7–8, 10–12), SEM (9), frontal view (7–9), lateral view (10, 11), apical view (12). **Figs 13–15.** *Cosmarium exiguum* var. *incrassatum*: frontal view (13), lateral view, thickening (arrowheads) (14), apical view (15). **Figs 16–20.** *Cosmarium sphaerostichum* var. *bituberculatum*: LM (16–17, 19–20), SEM (18), frontal view (16–18), lateral view (19), apical view (20). Scale bars = 10 µm (LM), 5 µm (SEM).