New records of *Cosmarium* Corda *ex* Ralfs in lotic environment, adjacent to the Iguaçu National Park, Paraná State, Brazil

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ABSTRACT - (New records of *Cosmarium* Corda *ex* Ralfs in lotic environment, area adjacent to the Iguaçu National Park, Paraná State, Brazil). This study aimed to document the *Cosmarium* (Desmiadiales, Zygnematophyceae) taxa at a subtropical stream located in an area adjacent to the Iguaçu National Park, an important environmental protection area in the further west of Paraná State. For this purpose, monthly samplings of periphytic material associated to *Eleocharis minima* Kunth were performed in the period of August 2012 to July 2013. This taxonomic inventory allowed the identification of 37 taxa at specific and infra-specific levels. There were 15 new records for Paraná State: *Cosmarium bipunctatum* Börgensen, *C. clepsydra* Nordstedt var. *bicardia* (Reinsch) Croasdale, *C. crenatum* var. *crenatum* Ralfs, *C. difficile* Lütkemüller var. *dilatatum* Borge, *C. isthmochondrum* var. *isthmochondrum* Nordstedt, *C.obsoletum* (Hantzsch) Reinsch var. *obsoletum*, *C. ordinatum* (Borge) West & West var. *ordinatum*, *C.ornatum* Ralfs var. *ornatum* f. *ornatum*, *C. pseudoconnatum* Nordstedt var. *pluriradians* Scott & Grönblad, *C. pseudoretusum* F. Ducell. var. *pseudoretusum* Krieger *et* Gerlof, *C. pyramidatum* var. borgei Krieger & Gerloff, *C. regnellii* var. *minimum* Eichler & Gutwinski, *C. repandum* var. *minus* (West & West) Krieger & Gerloff, *C. securiforme* Borge var. *brasiliense* Grönblad and *C. variolatum* var. *variolatum* Lundell.
Keywords: Biogeography, desmids, stream, taxonomy, Zygnematophyceae.

RESUMO - (Novos registros de *Cosmarium* Corda *ex* Ralfs em ambiente lótico, área adjacente ao Parque Nacional do Iguaçu, PR, Brasil). Este estudo objetivou documentar os táxons do gênero *Cosmarium* (Desmiadiales, Zygnematophyceae) em um riacho subtropical localizado em área adjacente ao Parque Nacional do Iguaçu, importante área de proteção ambiental no extremo oeste do Estado do Paraná. Para isso, foram realizadas amostragens mensais de material perifítico associado a *Eleocharis minima* Kunth no período de agosto de 2012 a julho de 2013. Este inventário taxonômico possibilitou a identificação de 37 táxons em nível específico e infra-específico. Foram 15 as novas ocorrências para o Estado do Paraná: *Cosmarium bipunctatum* Börgensen, *C. clepsidra* Nordstedt var. *bicardia* (Reinsch) Croasdale, *C. crenatum* var. *crenatum* Ralfs, *C. difficile* Lütkemüller var. *dilatatum* Borge, *C. isthmochondrum* var. *isthmochondrum* Nordstedt, *C.obsoletum* (Hantzsch) Reinsch var. *obsoletum*, *C. ordinatum* (Borge) West & West var. *ordinatum*, *C.ornatum* Ralfs var. *ornatum* f. *ornatum*, *C. pseudoconnatum* Nordstedt var. *pluriradians* Scott & Grönblad, *C. pseudoretusum* F. Ducell. var. *pseudoretusum* Krieger *et* Gerlof, *C. pyramidatum* var. *borgei* Krieger & Gerloff, *C. regnellii* var. *minimum* Eichler & Gutwinski, *C. repandum* var. *minus* (West & West) Krieger & Gerloff, *C. securiforme* Borge var. *brasiliense* Grönblad e *C. variolatum* var. *variolatum* Lundell.
Palavras-chave: Biogeografia, desmídias, riacho, taxonomia, Zygnematophyceae

Introduction

The Zygnematophyceae Class is the biggest and most diverse algae group of the Streptophyta lineage (Gontcharov & Melkonian 2005), encompassing organisms characterized by the absence of flagellated cells in its life cycle, besides presenting sexual reproduction through conjugation. It comprehends two Orders: Zygnematales and Desmidiales (Hoek *et al.*1995, Bicudo *et al.* 2014).

Desmidiales, popularly known as desmids, are microscopic green algae, which stand out mainly by its specific richness, distributed in a cosmopolitan way, so they can be found in plankton, periphyton or

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metaphyton (Coesel 1982, Margalef 1983, Felisberto & Rodrigues 2002, Felisberto & Rodrigues 2008, Menezes *et al.* 2011b). They comprehend a group of high morphological diversity and great ecological importance in the continental aquatic ecosystems, acting as biological indicators (Coesel 2001, Šťastný 2009). They present as mainly characteristics two identical semi cells formed by a median constriction and the isthmus, with cell wall morphologically diverse, rich in ornamentations, such as granules, spinules, pores or processes (Hoek *et al.* 1995). The *Cosmarium* Corda *ex* Ralfs genus is one of the oldest and largest in number of taxa described (ca. 1500 species) to the Desmidiales Order, its representatives having preference by environments with acid oligo- to eutrophic waters (Bicudo & Menezes 2006).

For the Paraná State 26 studies have contributed to the desmids knowledge until the present moment: Bittencourt-Oliveira (1993a, b), Bittencourt-Oliveira & Castro (1993), Cecy (1993), Bittencourt- Oliveira & Mecenas (1994), Cecy *et al.* (1997), Picelli-Vicentim (2001), Cetto *et al.* (2004), Silva & Cecy (2004), Biolo *et al.* (2008, 2013), Felisberto & Rodrigues (2007, 2008, 2010b, 2013, 2014), Moresco *et al.* (2009), Bortolini *et al.* (2008, 2009, 2010a,b), Menezes *et al*. (2011a, b, 2013), Aquino *et al.*(2014) and Carvalho *et al*. (2015). Among them, only four comprise exclusively the *Cosmarium* genus: Felisberto & Rodrigues (2010b), Menezes *et al.* (2011b), Biolo *et al.* (2013) and Carvalho *et al.* (2015).

Thus, due the importance of floristic studies about the Paranaense desmid flora, and the knowledge about the biogeographic distribution of the taxon in continental aquatic environments, besides the great species diversity within *Cosmarium*, this study aimed to taxonomically document the occurrence of the taxa belonging to this genus in a subtropical stream, area adjacent to the Iguaçu National Park, an important environmental protection area located in the further west of Paraná State.

Material and methods

The study was carried out in the Tenente João Gualberto stream, an important tributary of the lower Iguaçu River hydrographic basin, located at São Miguel do Iguaçu municipality (25º20'S and 54º14'W), further west of Paraná. This stream is situated in an area adjacent to the Iguaçu National Park Conservation Unit. This region has Cfa climate (humid temperate with hot summer), humid-mesothermal subtropical, with well-defined summer and winter periods, besides having rainfalls well distributed during the year (Álvares *et al*. 2014). The sampling station (figure 1) has a narrow stretch, approximately 3.4 m wide between margins, about 20 cm depth. The area presents approximately 2 m of riparian vegetation in its surroundings.

The biological material was collected in the period between August 2012 and July 2013, comprehending 12 samplings. The periphytic material was collected from the aquatic macrophyte *Eleocharis minima* Kunth, and removed with the help of a brush and distilled water jets. Samples were preserved in 1:1 *Transeau* solution, according to Bicudo & Menezes (2006). The biological material is deposited in the State University of West Paraná Herbarium, Cascavel campus (UNOP-Algae).

For the qualitative analysis, an average of 15 slides per sample were prepared. Morphometric and photographic analysis of microalgae were performed in a trinocular microscope with infinite correction optics, Olympus model CX31, with camera attached. Systematic and taxonomic framework for identified taxa was performed based in the classic literature (*e.g.*, Prescott *et al.* 1981), as well as in specialized scientific papers of the area.

The measures (in µm) are represented by the symbols L - length, W- width and I - isthmus. The geographic distribution for the Paraná State and morphometric data were recorded to all taxa. Descriptions were made just for the first taxa cited for the State. Comments were elaborated when deemed necessary.

Results and Discussion

The taxonomic assessment of the genus *Cosmarium* allowed the identification of 37 taxa. These, 15 taxa are new records for the State of Paraná.

Cosmarium Corda *ex* Ralfs

Artificial key to identify the *Cosmarium* taxa found in the analyzed samples. Cell size followed detail the categories proposed by Araújo & Bicudo (2006). Taxa with asterisk are new records.

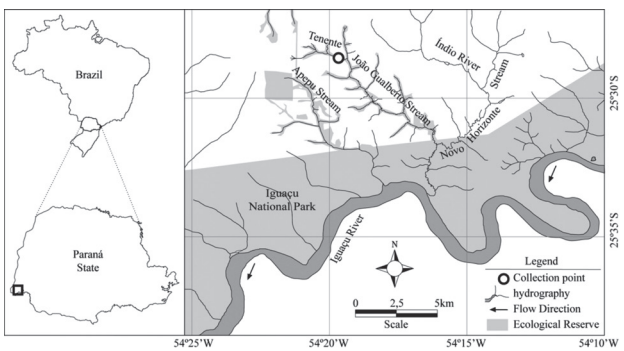

Figure 1. Location of the sampling station in the Tenente João Gualberto stream, Paraná, Brazil.

1. Cell wall smooth, finely or diminutively punctuate
   2. Circular, semicircular, elliptical, subelliptical or oval semicells
      3. Cells with different L:W ratio
         4. Cells wider than long
            5. Open or shallow median sinus, basal angles acute ending in a short bifurcation ..... *C. securiforme* var. *brasiliense**
            5. Median sinus closed, basal angles mamillately thickened ..... *C. obsoletum* var. *obsoletum**
         4. Cells longer than wide
            6. Median sinus open or shallow
               7. Cells of small (6-20 µm) to median size (21-35 µm) ..... *C. moniliforme* var. *moniliforme*
               7. Cells of large size (>35 µm)
                  8. Cells with parietal chloroplasts with 4 lobes in each semicell, one pyrenoid ..... *C. pseudoconnatum* var. *pseudoconnatum*
                  8. Cells with parietal chloroplasts with 6 lobes in each semicell, two to three pyrenoids ..... C. pseudoconnatum var. pluriradians*
            6. Median sinus closed
               9. Semicells with 1 pyrenoid
                  10. Cells of medium-sized (21-35 µm) with rounded apex and two large tuberculations on both sides ..... *C. mamilliferum* var. *mamilliferum*
                  10. Cells small (6-20 µm) with apex narrow, flattened and slightly retuse ..... *C. laeve* var. *leave*
               9. Semicells with 2 pyrenoids
                  11. Cells of large size (>35 µm) with thickened cell wall and visible pore canals ..... *C. pachydermum* var. *pachydermum*
                  11. Cells of medium size (21-35 µm) with undulate cell wall ..... *C. dispersum* f. *dispersum*
      3. Cells about as long as wide
         12. Cells with protrusion, median inflation ..... *C. clepsydra* var. *bicardia**
         12. Cells without protrusion, median inflation
            13. Cells of small size (6-20 µm), truncate apex, cell wall smooth, chloroplast with 1 pyrenoid ..... *C. abbreviatum* var. *minus*
            13. Cells of large size (>35 µm), truncate-rounded apex, wall finely punctate with two pyrenoids ..... *C. candianum* var. *candianum*
   2. Semicells shaped otherwise
      14. Pyramidal and trilobed semicells
         15. Cells of small (6-20 µm) to medium size (21-35 µm) ..... *C. granatum* var. *granatum*
         15. Cells of large size (>35 µm)
            16. Narrow and rounded apex, closed sinus, rounded angles
               17. Cells with conical protuberance in the median portion, wall diminutively punctate ..... *C. pyramidatum* var. *borgei**
               17. Cells without protuberance in the median portion, wall finely punctate ..... *C. pseudopyramidatum* var. *pseudopyramidatum*
            16. Broad apex, closed sinus, rounded angles
               18. Trilobed semicells with strong basal angles bearing a small papilla on both sides of the semicell ..... *C. pseudoretusum* var. *pseudoretusum**
               18. Trilobed semicells with basal lobes strongly projected, irregularly 3-ondulate, basal papilla absent ..... *C. pseudoretusum* var. *africanum*
      14. Trapeziform, subtrapeziform, rhomboid or quadrangular semicells
         19. Cells about as long as wide

20. Median sinus open, small cells (6-20 µm), subtrapeziform, small papilla in the superior angles of the semicell ..... *C. sphagnicolum* var. *sphagnicolum*
20. Median sinus closed, small hexagonal trapeziform cells (6-20 µm) ..... *C. regnelli* var. *minimum**
19. Cells with different L: W ratio
21. Rhomboid cells, closed sinus, semicell face with 3 transversal rows of visible pores ..... *C. difficile* var. *dilatatum**
21. Oblong-trapeziform cells, median sinus linear, truncate apex and divergent lateral margins ..... *C. repandum* var. *minus**

1. Ornamented cell wall
22. Semicircular, subsemicircular, elliptic, semielliptic or oval semicells
23. Median sinus open or shallow
24. Cells of small (6-20 µm) to medium size (21-35 µm), sinus very wide and shallow, isthmus elongated, cell wall granulate ..... *C. excavatum* var. *excavatum*
24. Cells of medium (21-35 µm) to large size (>35 µm)
25. Cells longer than wide, sinus with acute angle, opening outwards, margin granular-undulate, cell wall ornamented with verrucae ..... *C. ordinatum* var. *ordinatum**
25. Cells wider than long, sinus open and U-shaped within, margin granulate spine-like, midregion with prominent inflation ..... *C. lagoense* var. *amoebum*
23. Median sinus closed
26. Cells ornamented with tubercles, truncate apex, a pair of prominent granules within the apical margin, two pyrenoids per semicell ..... *C. isthmochondrum* var. isthmochondrum*
26. Cell wall densely scrobiculate, subretuse apex, one pyrenoid per semicell .... *C. variolatum* var. *variolatum**
22. Semicells shaped otherwise
27. Reniform and subretangular cells
28. Cells of medium size (21-35µm) with linear sinus, retuse and truncate apex, cell wall with marginal granules, median region with a prominent granulate inflation .... *C. ornatum* var. *ornatum**
28. Cell of large size (>35 µm)
29. Subretangular cells, about as long as wide, linear sinus, rounded angles, straight apex, cell wall densely granulate ..... *C. quadrum* var. *minus*
29. Subretangular cells with different C:L ratio (longer than wide)
30. Cells measuring approximately: 60-105 µm length, 56-82 µm width, isthmus 19-31 µm, linear sinus, truncate apex, cell wall uniformly granulate ……..... ..... *C. margaritatum* var. *margaritatum* f. *margaritatum*
30. Cells measuring approximately: 44-60 µm length, 38-51 µm width., isthmus 12-19 µm, linear sinus, truncate apex, cell wall uniformly granulates …….. ….....… *C. margaritatum* var. *margaritatum* f. *minor*
27. Cells shaped otherwise
31. Trilobular cells with linear sinus, dilated apex with rounded angles, granulate cell wall, semicell with a median region inflated ….....…… *C. protractum* var. *protractum*
31. Pyramidal and trapeziform cell
32. Trapeziform cells, about as long as wide, constriction deep, closed sinus, margin undulate, 2 granules, transversely disposed in the center of the semicell .... *C. bipunctatum* var. *bipunctatum**
32. Cells with different L:W ratio (longer than wide)
33. Trapeziform cells of small size (6-20 µm), closed sinus, truncate apex, 2 to 4-undulate, one large granule in the center of each semicell ..... *C. blyttii* var. *blyttii*
33. Cell of medium (21-35µm) to large size (>35µm)

34. Pyramidal cells of medium size (21-35 µm), truncate apex, lateral margin with 3 to 4-undulate, midregion without dilation ..... *C. crenatum* var. *crenatum**
34. Cells of medium size (21-35µm), truncate apex, lateral margins rounded without undulations, midregion without prominence ..... *C. punctulatum* var. *punctulatum*
35. Cells of large size (>35 µm), truncate apex, cell wall with 6 triangular scrobiculations disposed around each granule ..... *C. decoratum*
35. Cells of large size (>35 µm), truncate apex with approximately 4 crenulations, cell wall with rows of granules extending up to the dilated midregion ..... *C. subspeciosum* var. *subspeciosum*

Cosmarium abbreviatum Raciborski var. ***minus*** (West & West) Krieger & Gerloff, Gattung. *Cosmarium*: 3-4: 242. 1965; 2: pl. 42, fig. 18. 1965.
Figures 2a-b

Morphometric data: L: 10.7-11.5 µm, W: 11.4-12.1 µm, I: 4.7-5.1 µm.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 30-VII-2012, *L.C. Servat* (UNOP-Algae3930); Tenente João Gualberto stream, 29-X- 2012, *L.C. Servat.* (UNOP-Algae 3962).

Geographic distribution in the Paraná State: Felisberto & Rodrigues (2008, 2010b).

Cosmarium bipunctatum Börgensen, var. ***bipunctatum*** Vidensk. Medd. Naturh. Foren. Kjöbenhavn 1890: 40, pl. 4, fig. 33. 1890.
Figures 3a-c

Cells of small size, almost as long as wide. L: 15.9-19.8 µm, W: 14.8-18.5 µm, I: 5.1-7.3 µm. Median constriction deep, closed linear sinus, trapeziform semicells with convex lateral margins, apical margin broadly truncate, with two prominent granules disposed in the center of the semicell, in apical view circular, with one granule on either side of the midregion, in lateral view semicell elliptic, with one granule on either side of the midregion, cell wall granulate, chloroplastid with one central pyrenoid per semicell.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 30-VII-2012, *L.C. Servat* (UNOP-Algae3930); Tenente João Gualberto stream, 25-IX-2012, *L.C. Servat*. (UNOP-Algae3943); Tenente João Gualberto stream, 29-X-2012, *L.C. Servat* (UNOP-Algae3962); Tenente João Gualberto stream, 13-XI-2012, *L.C. Servat* (UNOP-Algae3976); Tenente João Gualberto stream, 18-XII-2012, *L.C. Servat* (UNOP-Algae4035); Tenente João Gualberto stream, 6-II-2013, *L.C. Servat* (UNOP-Algae4057); Tenente João Gualberto stream, 04-IV-2013, *L.C. Servat* (UNOP-Algae4093); Tenente João Gualberto stream, 6-VI-2013, *L.C. Servat* (UNOP-Algae4116).

Geographic distribution in the Paraná State: First record of the taxon.

According to Estrela *et al.* (2011), *Cosmarium bipunctatum* Börgensen may look like to *C. punctulatum* Brébisson and *C. orthosthicum* Lundell, although these not show a verrucae of considerable size in the midregion of the semicell, and also *C. spharelostichum* Nordstedt f. *bituberculatum* Förster, however this presents verrucae below the apex and not in the central region of the cell. The individuals found in the present study, have cell measures close to the ones found by Estrela *et al.* (2011), being a bit below the measures presented by Prescott *et al.* (1981) (L: 20-25 µm, W: 19-20 µm, I: 5-8 µm).

Cosmarium blyttii Wille var. ***blyttii***, Forh. Vidensk. Selsk. Christiania 11: 25, pl. 1, fig. 7. 1880.
Figures 4a-b

Morphometric data: L: 19.8 µm, W: 17 µm, I: 5.9 µm.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 4-IV-2013, *L.C. Servat* (UNOP-Algae4093).

Geographic distribution in the Paraná State: Felisberto & Rodrigues (2005a), Carvalho *et al.* (2015).

According to Oliveira *et al.* (2010), morphological changes can be found in *Cosmarium blyttii* var. *blyttii*, mainly associated to the number of undulations in the apical and lateral margins and the number of granules decorate the semicell face, can appear only a central granule or one ring.

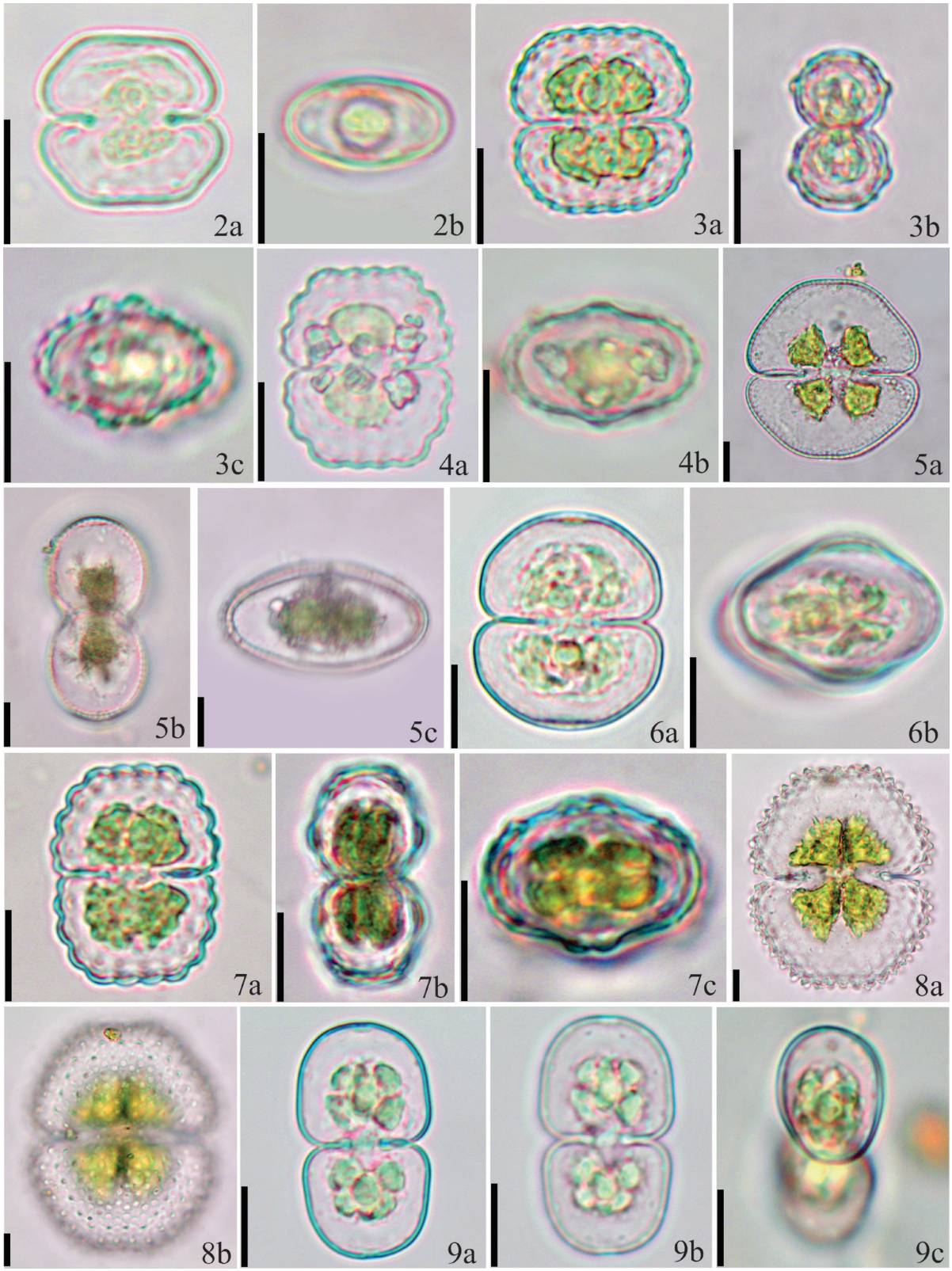

Figure 2a-9c. *Cosmarium* Corda *ex* Ralfs in lotic environment adjacent to the Iguaçu National Park**.** 2a-b. *Cosmarium abbreviatum* var. *minus* . 2b. Apical view. 3a-c. *C. bipunctatum* var. *bipunctatum*. 3b. Lateral view. 3c. Apical view. 4a-b. *C. blyttii* var. *blyttii.* 4b. Apical view. 5a-c. *C. candianum* var. *candianum.* 5b. Lateral view. 5c. Apical view. 6a-b. *C. clepsydra* var. *bicardia*. 6b. Apical view. 7a-c. *C. crenatum* var. *crenatum*. 7b. Lateral view. 7c. Apical view. 8a-b. *C. decoratum*. 8b. Detail of the wall ornamentation. 9a-c. *C. difficile* var. *dilatatum*. 9b. Detail of the punctate wall. 9c. Apical view. Scale = 10 µm.

Cosmarium candianum Delponte var. ***candianum***, Mém. R. Accad. Sc. Torino 28: 113, pl. 8, fig. 1-6. 1877.
Figures 5a-c

Morphometric data: L: 39.2-47.1 µm, W: 33.9-41.5 µm, I: 12.7-14.3 µm.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 29-X-2012, *L.C. Servat* (UNOP-Algae3962); Tenente João Gualberto stream, 13-XI-2012, *L.C. Servat* (UNOP-Algae3976); Tenente João Gualberto stream, 18-XII-2012, *L.C. Servat* (UNOP-Algae4035); Tenente João Gualberto stream, 15-I-2013, *L.C. Servat*. (UNOP-Algae4044); Tenente João Gualberto stream, 6-II-2013, *L.C. Servat* (UNOP-Algae4057); Tenente João Gualberto stream, 4-IV-2013, *L.C. Servat* (UNOP-Algae4093); Tenente João Gualberto stream, 9-V-2013, *L.C. Servat* (UNOP-Algae4102).

Geographic distribution in the Paraná State: Bortolini *et al.* (2010a), Menezes *et al.* (2013) and Aquino *et al.* (2014).

Cosmarium clepsydra Nordstedt var. ***bicardia*** (Reinsch) Croasdale, Trans. Am. Microsc. Soc., 75(1): 22, pl. 11. fig. 26. 1956.
Figures 6a-b

Cells of medium size, longer than wide. L: 24.4-27.2 µm, W: 21.1-22.9 µm, I: 6.1-7.7 µm. Median constriction deep, closed linear sinus, semicells subsemicircular or broadly subtriangular, with lateral margins slightly convex, apical margin rounded truncate, in apical view elliptic and in lateral view cuneate with rounded angles, cell wall finely punctate, chloroplastid with one pyrenoid per semicell.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 30-VIII-2012, *L.C. Servat* (UNOP-Algae3930); Tenente João Gualberto stream, 29-X-2012, *L.C. Servat* (UNOP-Algae3962); Tenente João Gualberto stream, 11-III-2013, *L.C. Servat* (UNOP-Algae4081).

Geographic distribution in the Paraná State: First record of the taxon.

According to Prescott *et al.* (1981), the variety *bicardia* (Reinsch) Croasdale differs from the species typical variety by showing cuneate lateral view with rounded angles and vertical view oval and tumid.

Cosmarium crenatum var. ***crenatum*** Ralfs, Brit. Desm, p.96. pl.15, fig.7.1848.
Figures 7a-c

Cells of medium size, longer than wide. L: 22-24.1 µm, W: 15-18.5 µm, I: 6-6.1µm. Median constriction deep and linear sinus, semicells pyramidal-quadrate, with rounded lateral margins, slightly retuse with four undulations, truncate apical margin with four crenulations, in apical view elliptic with the midregion inflated on both sides, cell wall with one to three small crenulations on each apical and lateral crenulation, chloroplastid with pyrenoids not observed.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 29-X-2012, *L.C. Servat* (UNOP-Algae3962).

Geographic distribution in the Paraná State: First record of the taxon.

Cosmarium decoratum West & West, Trans. Linn. Soc. London, Bot., II, 5(2): 61, pl.7, fig.21. 1895.
Figures 8a-b

Morphometric data: L: 68.5-69 µm, W: 55.4-56.1 µm, I: 23.8-24 µm.

Material Examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 29-X-2012, *L.C. Servat* (UNOP-Algae3962).

Geographic distribution in the Paraná State: Felisberto & Rodrigues (2010b), Biolo *et al.* (2013) and Aquino *et al.* (2014).

The individuals found in the present study showed cell measures a bit smaller than the ones presented by Prescott *et al.* (1981), such as L: 70-86 µm, W: 52-63 µm and I: 23-32.5 µm, although all the other characteristics are in accordance with the description.

Cosmarium difficile Lütkemüller, var. ***dilatatum*** Borge, Ark. f. Bot. 19 (17): 32, pl. 1, fig. 38. 1925.
Figures 9a-c

Cells of medium size, longer than wide. L: 26.2-28.3 µm, W: 14.8-15.8 µm, I: 4.5-4.6 µm. Median constriction deep, closed linear sinus, semicells with rounded lateral margins, diverging to a broadly rounded apex, apical and lateral view elliptic, cell wall smooth, showing three rows of pores or small conspicuous scrobiculations, cell wall finely punctate, chloroplastid with 1 pyrenoid per semicell.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 29-X-2012, *L.C. Servat* (UNOP-Algae3962); Tenente João Gualberto stream, 11-III-2013, *L.C. Servat* (UNOP-Algae4081).

Geographic distribution in the Paraná State: First record of the taxon.

According to Prescott *et al.* (1981), the variety *dilatatum* Borge differs from the typical by having more rhomboid semicells and more rounded apex.

Cosmarium dispersum L.N.Johnson f. ***dispersum*** L.N.Johnson, Bull. Torrey Bot. Club 22: 297, pl. 233, fig. 19. 1895.
Figure 10a-c

Morphometric data: L: 36.5-38.5 µm, W: 31.5-34.5 µm, I: 8.7-11.9 µm.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 29-X-2012, *L.C. Servat* (UNOP-Algae3962); Tenente João Gualberto stream, 18-XII-2012, *L.C. Servat* (UNOP-Algae4035); Tenente João Gualberto stream, 15-I-2013, *L.C. Servat* (UNOP-Algae4044); Tenente João Gualberto stream, 4-IV-2013, *L.C. Servat* (UNOP-Algae4093).

Geographic distribution in the Paraná State: Aquino *et al.* (2014).

Cosmarium excavatum Nordst. var. ***excavatum*** Vidensk., Meddr Naturh. Foren. Kjöbenhavn 21: 214, pl. 3, fig. 25. 1870
Figures 11a-b

Morphometric data: L: 22.1 µm, W: 12.6 µm, I: 8.2 µm.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 15-I-2013, *L.C. Servat* (UNOP-Algae4044).

Geographic distribution in the Paraná State: Felisberto & Rodrigues (2010 a, b), Biolo *et al.* (2013) and Menezes *et al.* (2013).

The individuals found in the present work showed cell measures a bit bigger than the ones found by Prescott *et al.* (1981), such as L: 19-20 µm, W: 10-11.5 µm and I: 7.5-7.6 µm, although all the other characteristics are in accordance with the description.

Cosmarium granatum Bréb. *ex* Ralfs var. ***granatum***, Bréb. in litt. Cum ícone, 1846 Ralfs, Brit. Desmid. 96, pl. 32: fig. 6. 1848.
Figure 12

Morphometric data: L: 24.1-28.3 µm, W: 17.7-18.8 µm, I: 4.9-5.8 µm.

Material Examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 30-VIII-2012, *L.C. Servat* (UNOP-Algae3930); Tenente João Gualberto stream, 29-X-2012, *L.C. Servat* (UNOP-Algae3962).

Geographic distribution in the Paraná State: Cecy (1993), Picelli-Vicentim *et al.* (2001), Cetto *et al.* (2004), Silva & Cecy (2004), Felisberto & Rodrigues (2005a, b, 2010b, 2012), Bortolini *et al.* (2010b), Menezes *et al.* (2011b) and Aquino *et al.* (2014).

Cosmarium isthmochondrum var. ***isthmochondrum*** Nordstedt, Acta Univ.Lund. 9: 12. pl. 1, fig. 2. 1873.
Figures 13a-c

Cells of medium size, a bit longer than wide. L: 25.5-29.5 µm, W: 20.7-23.2 µm, I: 6.4-7.9 µm. Median constriction deep, closed linear sinus, semicircular semicells with rounded angles, lateral margins convex and crenulate, with a pair of more prominent crenulations on either side of the semicell, apical margin truncate with a marginal row of granules, the two central granules more prominent, apical view of the semicell elliptic, in lateral view oblong, cell wall granulate, chloroplastid with 2 pyrenoids per semicell.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 25-IX-2012, *L.C. Servat* (UNOP-Algae3943); Tenente João Gualberto stream, 29-X-2012, *L.C. Servat* (UNOP-Algae3962); Tenente João Gualberto stream, 13-XI-2012, *L.C. Servat* (UNOP-Algae3976); Tenente João Gualberto stream, 15-I-2013, *L.C. Servat* (UNOP-Algae4044); Tenente João Gualberto stream, 6-VI-2013, *L.C. Servat* (UNOP-Algae4116); Tenente João Gualberto stream, 16-VII-2013, *L.C. Servat* (UNOP-Algae4126).

Geographic distribution in the Paraná State: First record of the taxon.

Cosmarium isthmochondrum var. *isthmochondrum* Nordstedt resembles *Cosmarium polymorphum* Nordstedt var. *groenbladii* Förster, although *Cosmarium isthmochondrum* differs from the latter by showing granules close to isthmus (Estrela *et al.* 2011). The individuals found showed cell measurements a bit smaller than the ones recorded by Prescott *et al.* (1981), such as: L: 30-35 µm, W: 27-30 µm and I: 7.5-11 µm, however all the other characteristics are in accordance with the description.

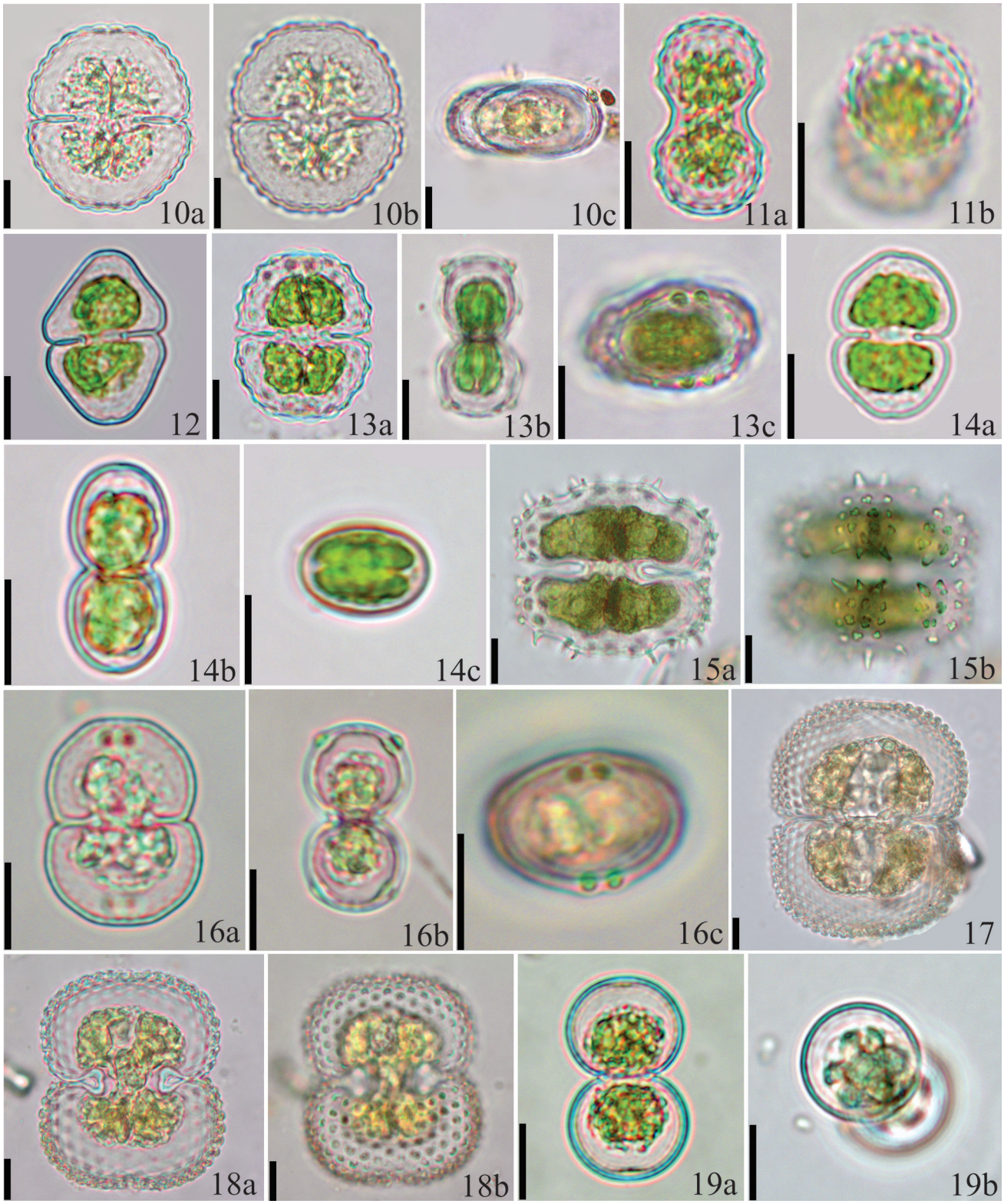

Figure 10a-19b. *Cosmarium* Corda *ex* Ralfs in lotic environment adjacent to the Iguaçu National Park**.** 10a-c. *Cosmarium dispersum* f. *dispersum*. 10b. Detail of the ornamentation. 10c.Apical view. 11a-b. *C. excavatum* var. *excavatum*. 11b. Apical view. 12. *C. granatum* var. *granatum*. 13a-c. *C. isthmochondrum* var. *isthmochondrum.* 13b. Lateral view. 13c. Apical view. 14a-c. *C. laeve* var. *laeve.* 14b. Lateral view. 14c. Apical view. 15a-b. *C. lagoense* var. *amoebum* 15b. Detail of the ornamentation. 16a-c. *C. mamilliferum* var. *mamilliferum*. 16b. Lateral view. 16c. Apical view. 17. *C. margaritatum* var. *margaritatum* f. *margaritatum.* 18a-b. *C. margaritatum* var. *margaritatum* f. *minor.* 18b. Detail of the punctate wall. 19a-b. *C. moniliforme* var. *moniliforme*. 19b. Apical view. Scale = 10 µm.

Cosmarium laeve Rabenhorst var. ***laeve***, Öfv. Kongl. Vet.-Akad. Förhandl., 6: 29, pl. 12, fig. 4. 1876.
Figures 14a-c

Morphometric data: L: 19-19.5 µm, W: 12.6-12.7 µm, I: 5.8-6.1 µm.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 18-XII-2012, *L.C. Servat* (UNOP-Algae4035); Tenente João Gualberto stream, 6-VI-2013, *L.C. Servat* (UNOP-Algae4116).

Geographic distribution in the Paraná State: Cetto *et al.* (2004), Silva & Cecy (2004), Felisberto & Rodrigues (2005a, b, 2008, 2010a, 2012), Algarte *et al.* (2006), Bortolini *et al.* (2010a) and Aquino *et al.* (2014).

Cosmarium lagoense Nordst. var. ***amoebum*** Förster & Eckert, in Förster, Hydrobiologia 23(3-4): 394, pl. 24, fig. 10-13. 1964.
Figures 15a-b

Morphometric data: L: 38.6 µm, W: 43.1 µm, I: 11.5 µm.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 29-X-2012, *L.C. Servat* (UNOP-Algae3962).

Geographic distribution in the Paraná State: Felisberto & Rodrigues (2005a, 2010b) and Menezes *et al.* (2011b, 2013).

The individuals found presented lower size than the ones cited by Prescott *et al.* (1981), such as: L: 40-46 µm, W: 43-52 µm and I: 13-29 µm. The measurements found are similar to the ones found by Camargo *et al.* (2009), L: 36-38 µm, W: 34-43 µm and I: 11-13 µm.

Cosmarium mamilliferum var. ***mamilliferum*** Nordstedt, Vidensk. Medd. Naturh. Foren. Kjöbenhavn 1869 (14-15): 212, pl. 3, fig. 22. 1870.
Figures 16a-c

Morphometric data: L: 22-23.3 µm, W: 17.1-18µm, I: 5-5.6 µm.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 13-XI-2012, *L.C. Servat* (UNOP-Algae3976); Tenente João Gualberto stream, 18-XII-2012, *L.C. Servat* (UNOP-Algae4035).

Geographic distribution in the Paraná State: Felisberto & Rodrigues (2010b).

Cosmarium margaritatum var. ***margaritatum*** f. ***margaritatum*** (Lund.) Roy & Bisset, Jd. Bot., v. 27, n. 1, p. 194. 1886.
Figure 17

Morphometric data: L: 69.1 µm, W: 56.1 µm, I: 15.6 µm.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 15-I-2013, *L.C. Servat* (UNOP-Algae4044).

Geographic distribution in the Paraná State: Lozovei & Luz (1976), Lozovei & Hohmann (1977), Cecy *et al.* (1997), Cetto *et al.* (2004), Bortolini *et al.* (2010a), Menezes *et al.* (2011b) and Aquino *et al.* (2014).

Cosmarium margaritatum (Lund.) Roy & Bisset var. ***margaritatum*** f. ***minor*** (Boldt) West & West, Welw. Afric. Freshw. Alg.: 121. 1897.
Figures 18a-b

Morphometric data: L: 45-51.6 µm, W: 35.2-43.6 µm, I: 13.3-15.9 µm.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 30-VII-2012, *L.C. Servat* (UNOP-Algae3930); Tenente João Gualberto stream, 13-XII-2012, *L.C. Servat* (UNOP-Algae3976); Tenente João Gualberto stream, 15-I-2013, *L.C. Servat* (UNOP-Algae4044).

Geographic distribution in the Paraná State: Silva & Cecy (2004), Felisberto & Rodrigues (2005a, b, 2010a,b), Bortolini *et al.* (2010b), Menezes *et al.* (2011b, 2013) and Aquino *et al.* (2014).

Cosmarium moniliforme var. ***moniliforme*** (Turpin) Ralfs, Brit. Desmid., 107, pl. 17, fig. 6. 1848.
Figures 19a-b

Morphometric data: L: 25.2-26.2 µm, W: 14.8-15.6 µm, I: 5.2-5.4 µm.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 29-X-2012, *L.C. Servat* (UNOP-Algae3962); Tenente João Gualberto stream, 18-XII-2012, *L.C. Servat* (UNOP-Algae4035); Tenente João Gualberto stream, 6-II-2013, *L.C. Servat* (UNOP-Algae4057); Tenente João Gualberto stream, 11-III-2013, *L.C. Servat* (UNOP-Algae4081).

Geographic distribution in the Paraná State: Bittencourt-Oliveira (1993), Silva & Cecy (2004), Biolo *et al.* (2013), Menezes *et al.* (2013) and Aquino *et al.* (2014).

Cosmarium obsoletum (Hantzsch) Reinsch var. ***obsoletum***, Acta Soc. Senckenberg 6: 142, pl. 22D1, fig. 1-4. 1867. 1862.
Figure 20

Cells of large size, broader than long. L: 38.8 µm, W: 46.1 µm, I: 15.1 µm. Median constriction deep, closed linear sinus, slightly open at extremities, semicircular semicells with smooth and rounded margins, apical margin slightly truncate, in apical view semicells elliptic and in lateral view semicells globose, cell wall finely punctate, chloroplastid with 2 pyrenoids per semicell.

Material Examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 29-X-2012, *L.C. Servat* (UNOP-Algae3962).

Geographic distribution in the Paraná State: First record of the taxon.

According to Ramos *et al*. (2011), *C. obsoletum* (Hantzsch) Reinsch var. *obsoletum*, has great morphological similarity with *C. ralfsii* Breb., differing only because of its lower cell size, and by having an apical margin retuse and strongly rounded.

Cosmarium ordinatum (Borge) West & West var. ***ordinatum*** f. ***ordinatum*****,** Trans. Linn. Soc. London, Bot., II, 5(5): 251, pl. 15, fig. 14. 1896a.
Figures 21a-c

Cells of medium size, a little longer than broad. L: 24-24.9 µm, W: 20.6-25.8 µm, I: 6.7-8.9 µm. Median constriction deep, open sinus, semicells semicircular-elliptic, lateral margins convex, apical margin rounded, in apical view elliptic, in lateral view subcircular, cell wall ornamented with approximately 5 to 6 series of emarginated verrucae, margin granular-undulate, chloroplastid with 1 pyrenoid per semicell.

Material Examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 30-VIII-2012, *L.C. Servat* (UNOP-Algae 930); Tenente João Gualberto stream, 15-I-2013, *L.C. Servat* (UNOP-Algae4044); Tenente João Gualberto stream, 6-II-2013, *L.C. Servat* (UNOP-Algae4057).

Geographic distribution in the Paraná State: First record of the taxon.

Cosmarium ornatum Ralfs var. ***ornatum*** f. ***ornatum***, Brit. Desmidieae: 104, pl. 17, fig. 7. 1848.
Figures 22a-b

Cells of medium size, about as long as broad. L: 24.6-25.9 µm, W: 23.8-27 µm, I: 8-10.2 µm. Median constriction deep, closed linear sinus, reniform semicells showing granulated protuberance in the midregion, lateral margin with 7 to 9 prominent and rounded granules, in apical view semicells elliptic-oblong with an inflation in the midregion on either side, in lateral view subcircular, cell wall granulate, chloroplastid with 2 pyrenoids per semicell.

Material Examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 25-IX-2012, *L.C. Servat* (UNOP-Algae3943); Tenente João Gualberto stream, 29-X-2012, *L.C. Servat* (UNOP-Algae3962); Tenente João Gualberto stream, 11-III-2013, *L.C. Servat* (UNOP-Algae4081); Tenente João Gualberto stream, 6-VI-2013, *L.C. Servat* (UNOP-Algae4116).

Geographic distribution in the Paraná State: First record of the taxon.

The individuals found showed lower size than the ones cited by Prescott *et al.* (1981), such as: L: 32-41 µm, W: 30-41 µm and I: 9-13 µm. Although all the other characteristics are in accordance with the description.

Cosmarium pachydermum Lundell var. ***pachydermum*** f. ***pachydermum***, Nova Acta R. Soc. Scient. Upsal. 3, 8(2): 39, pl. 2, fig. 15. 1871.
Figure 23

Morphometric data: L: 109.9-114.1µm, W: 83.2-88.7 µm, I: 36-39.5 µm.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 29-X-2012, *L.C. Servat* (UNOP-Algae3962); Tenente João Gualberto stream, 18-XII-2012, *L.C. Servat* (UNOP-Algae4035).

Geographic distribution in the Paraná State: Bittencourt-Oliveira (1993), Bortolini *et al.* (2010b), Felisberto & Rodrigues (2010b) and Menezes *et al.* (2011b).

Cosmarium protractum (Nägeli) De Bary var. ***protractum***, Untersuch. Conjugaten: 72. 1858. G. West & W. West, Monogr. III, p. 181, pl. 82, fig. 8, pl. 94, figs. 4-5.
Figure 24a-c

Morphometric data: L: 26.4-31.9 µm, W: 26.1-35.4 µm, I: 9.3-10.8 µm.

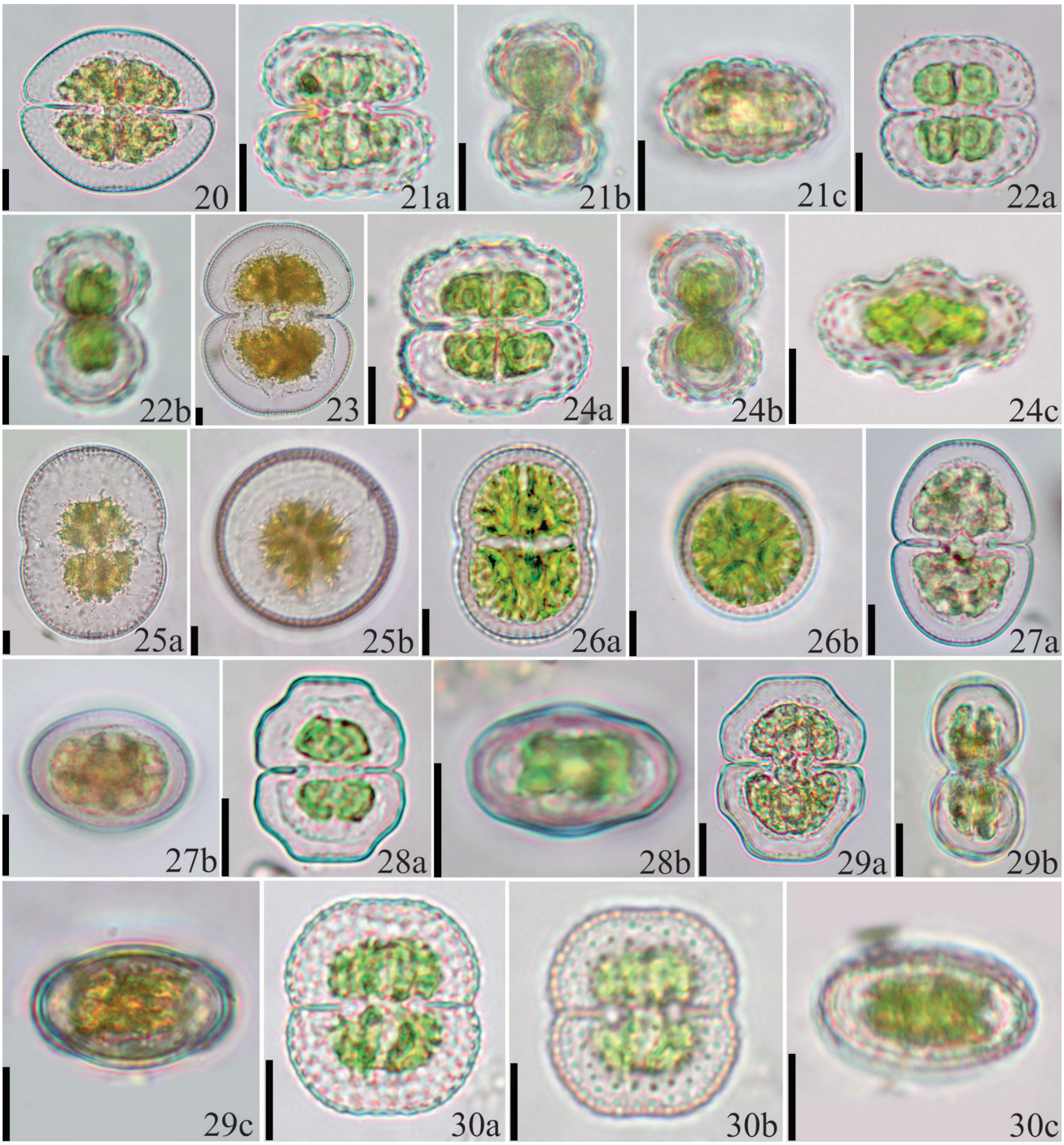

Figure 20-30c. *Cosmarium* Corda ex Ralfs in lotic environment adjacent to the Iguaçu National Park**.** 20. *Cosmarium obsoletum* var. *obsoletum*. 21a-c. *C. ordinatum* var. *ordinatum* f. *ordinatum*. 21b. Lateral view. 21c. Apical view. 22a-b. *C. ornatum* var. *ornatum* f. *ornatum*. 22b. Lateral view. 23. *C. pachydermum* var. *pachydermum* f. *pachydermum*.24a-c. *Cosmarium protractum* var. *protractum*. 24b. Lateral view. 24c. Apical view. 25a-b. *C. pseudoconnatum* var. *pluriradians* 25b. Apical view. 26a-b. *C. pseudoconnatum* var. *pseudoconnatum* 26b. Apical view. 27a-b. *C. pseudopyramidatum* var. *pseudopyramidatum*. 27b. Apical view. 28a-b. *C. pseudoretusum* var. *africanum*. 28b. Apical view. 29a-c. *C. pseudoretusum* var. *pseudoretusum*. 29b. Lateral view. 29c. Apical view. 30a-c. *C. punctulatum* var. *punctulatum*. 30b. Detail of the punctuations. 30c. Apical view. Scale = 10 µm.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 25-IX-2012, *L.C. Servat* (UNOP-Algae3943); Tenente João Gualberto stream, 29-X-2012, *L.C. Servat* (UNOP-Algae3962); Tenente João Gualberto stream, 16-VII-2013, *L.C. Servat* (UNOP-Algae4126).

Geographic distribution in the Paraná State: Cecy *et al.* (1997), Felisberto & Rodrigues (2005a, 2010a, b), Bortolini *et al.* (2010a), Biolo *et al.* (2013) and Menezes *et al.* (2013).

The individuals found showed lower size than the ones cited by Prescott *et al*. (1981), being closest to the cell measures found by Moresco *et al.* (2015), such as: L: 24.6-35 µm, W: 24.6-37 µm and I: 7.4-10.4 µm.

Cosmarium pseudoconnatum Nordstedt var. ***pluriradians*** Scott & Grönblad, Acta Soc. Sci. Fennicae, II, B, 2(8): 20, pl. 6, figs. 12-14. 1957.
Figures 25a-b

Cells of large size, longer than wide. L: 82.1-92.4 µm, W: 60.7-63.3 µm, I: 58.1-60.6 µm. Median constriction very slight, sinus very broad and shallow, semielliptic semicells, apical and lateral margins rounded, apical view circular, lateral view almost the same as the frontal view, cell wall punctate, chloroplastid with 2 to 3 pyrenoids.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 29-X-2012, *L.C.* (UNOP-Algae3962).

Geographic distribution in the Paraná State: First record of the taxon.

According to Prescott *et al.* (1981), *Cosmarium pseudoconnatum* Nordstedt var. *pluriradians* differs from the typical variety by showing a superior cell seize, measuring: L: 40-49 µm, W: 29-48 µm and I: 26-46 µm and by presenting a large chloroplast.

Cosmarium pseudoconnatum Nordst. var. ***pseudoconnatum*** Vidensk., Medd. Naturh. Foren. Kjöbenhavn 21: 214, pl. 3, fig. 17. 1870.
Figures 26a-b

Morphometric data: L: 33.6-52.4 µm, W: 26.9-40.4 µm, I: 24.2-37.4 µm.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 30-VIII-2012, *L.C. Servat* (UNOP-Algae3930); Tenente João Gualberto stream, 29-X-2012, *L.C. Servat* (UNOP-Algae3962); Tenente João Gualberto stream, 13-XI-2012, *L.C. Servat* (UNOP-Algae3976); Tenente João Gualberto stream, 18-XII-2012, *L.C. Servat* (UNOP-Algae4035); Tenente João Gualberto stream, 15-I-2013, *L.C. Servat* (UNOP-Algae4044); Tenente João Gualberto stream, 6-II-2013, *L.C. Servat* (UNOP-Algae4057); Tenente João Gualberto stream, 11-III-2013, *L.C. Servat* (UNOP-Algae4081); Tenente João Gualberto stream, 4-IV-2013, *L.C. Servat* (UNOP-Algae4093); Tenente João Gualberto stream, 6-VI-2013, *L.C. Servat* (UNOP-Algae4116); Tenente João Gualberto stream, 16-VII-2013, *L.C. Servat* (UNOP-Algae4126).

Geographic distribution in the Paraná State: Bittencourt-Oliveira (1993), Cecy *et al.* (1997), Silva & Cecy (2004), Picelli-Vicentim *et al.* (2001), Felisberto & Rodrigues (2005a,b, 2008, 2010a, b), Bortolini *et al.* (2010a), Menezes *et al.* (2011b, 2013) and Aquino *et al.* (2014).

Cosmarium pseudopyramidatum Lund. var. ***pseudopyramidatum***, Nova Acta Reg. Soc. Sci. Upsal., ser. 3, 8(2): 41, pl. 2, fig. 18. 1871.
Figures 27a-b

Morphometric data: L: 38.5-62.9 µm, W: 27.3-39.7 µm, I: 9.2-14 µm.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 29-X-2012, *L.C. Servat* (UNOP-Algae3962); Tenente João Gualberto stream, 13-XI-2012, *L.C. Servat* (UNOP-Algae3976); Tenente João Gualberto stream, 18-XII-2012, *L.C. Servat* (UNOP-Algae4035); Tenente João Gualberto stream, 15-I-2013, *L.C. Servat* (UNOP-Algae4044); Tenente João Gualberto stream, 6-II-2013, *L.C. Servat* (UNOP-Algae4057); Tenente João Gualberto stream, 4-IV-2013, *L.C. Servat* (UNOP-Algae4093); Tenente João Gualberto stream, 6-VI-2013, *L.C. Servat* (UNOP-Algae4116); Tenente João Gualberto stream, 16-VII-2013, *L.C. Servat* (UNOP-Algae4126).

Geographic distribution in the Paraná State: Cetto *et al.* (2004), Bortolini *et al.* (2010b), Ferreira *et al.* (2011) and Menezes *et al.* (2013).

Cosmarium pseudoretusum F. Ducell. var. ***africanum*** (Fritsch) West & G. S.West, Gatt. 97. 1962.
Figures 28a-b

Morphometric data: L: 19.9-23.3 µm, W: 15.9-19 µm, I: 5.1-6.9 µm.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 30-VII-2012, *L.C. Servat* (UNOP-Algae3930); Tenente João Gualberto stream, 25-IX-2012, *L.C. Servat* (UNOP-Algae3943); Tenente João Gualberto stream, 29-X-2012, *L.C. Servat* (UNOP-Algae3962); Tenente João Gualberto stream, 13-XI-2012, *L.C. Servat* (UNOP-Algae3976); Tenente João Gualberto stream, 18-XII-2012, *L.C. Servat* (UNOP-Algae4035); Tenente João Gualberto stream, 15-I-2013, *L.C. Servat* (UNOP-Algae4044); Tenente João Gualberto stream, 6-II-2013, *L.C. Servat* (UNOP-Algae4057); Tenente João Gualberto stream, 11-III-2013, *L.C. Servat* (UNOP-Algae4081); Tenente João Gualberto stream, 4-IV-2013, *L.C. Servat* (UNOP-Algae4093); Tenente João Gualberto stream, 9-V-2013, *L.C. Servat* (UNOP-Algae4102); Tenente João Gualberto stream, 6-VI-2013, *L.C. Servat* (UNOP-Algae4116); Tenente João Gualberto stream, 16-VII-2013, *L.C. Servat* (UNOP-Algae4126).

Geographic distribution in the Paraná State: Aquino *et al.* (2014).

Cosmarium pseudoretusum F. Ducell. var. ***pseudoretusum*** Krieger et Gerlof, Bull. Soc. Bot. Genève, II, 10: 99. 1918
Figures 29a-c

Cells of medium size, longer than wide. L: 32.2-34.5 µm, W: 26.1-27.8 µm, I: 8-12 µm. Median constriction deep, closed linear sinus, semicells slightly diverging and slightly retuse from the sinus, lateral margins rounded and basal margins strongly elliptic bearing a small papilla on either side, in apical and lateral view elliptic with a slight median swelling, cell wall punctate, the puncta stronger near the base, chloroplastid with 1 pyrenoid per semicell.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 29-X-2012, *L.C. Servat* (UNOP-Algae3962); Tenente João Gualberto stream, 18-XII- 2012, *L.C. Servat* (UNOP-Algae4035); Tenente João Gualberto stream, 15-I-2013, *L.C. Servat* (UNOP-Algae4044); Tenente João Gualberto stream, 11-III-2013, *L.C. Servat* (UNOP-Algae4081); Tenente João Gualberto stream, 16-VII-2013, *L.C. Servat* (UNOP-Algae4126).

Geographic distribution in the Paraná State: First record of the taxon.

Cosmarium pseudoretusum Ducellier is very similar to *C.trilobulatum* Reinsch, differing solely because of its less flattened apex and tumid ventral view (Prescott *et al.* 1981).

Cosmarium punctulatum Bréb. var. ***punctulatum*** Mém. Soc. Imp. Sci. Nat. Cherboug 4: 129,pl.1, fig. 16. 1856.
Figures 30a-c

Morphometric data: L: 15.0-28.1 µm, W: 21.0-25.6 µm, I: 7.0-8.4 µm.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 16-VII-2013, *L.C. Servat* (UNOP-Algae4126).

Geographic distribution in the Paraná State: Lozovei & Luz (1976); Cecy *et al.* (1997); Cetto *et al.* (2004); Silva & Cecy (2004); Felisberto & Rodrigues (2005b, 2008, 2010b, 2012); Algarte *et al.* (2006); Bortolini *et al.* (2010a) e Aquino *et al.* (2014).

Cosmarium pyramidatum var. ***borgei*** Krieger & Gerloff, Gatt. Cosmarium: 123, pl 25, fig. 5. 1965.
Figures 31a-d

Cells of large size, longer than wide. L: 73.5 µm, W: 45.6 µm, I: 15.5 µm. Median constriction deep, closed linear sinus, pyramidal semicells with apical and basal margins rounded, bearing a conical protuberance on either side of the middle portion, lateral margins convex, in apical view elliptic, in lateral view elliptic-oblong, both with a swelling on either side of the semicell, cell wall diminutively punctate, chloroplastid with 1 to 5 pyrenoids.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 11-III-2013, *L.C. Servat* (UNOP-Algae4081).

Geographic distribution in the Paraná State: First record of the taxon.

According to Prescott *et al.* (1981) the variety *borgei* Krieger & Gerloff, Gatt. differs from the typical variety by presenting a more rounded apex and by its conical protuberance in the middle portion of the semicell.

Cosmarium quadrum Lundell var. ***minus*** Nordst., Lund. Univ. Arsskr. 9(10): 11. 1873.
Figure 32

Morphometric data: L: 28.5-38.3 µm, W: 28.9-38.3 µm, I: 9.2-12.2 µm.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 25-IX-2012,

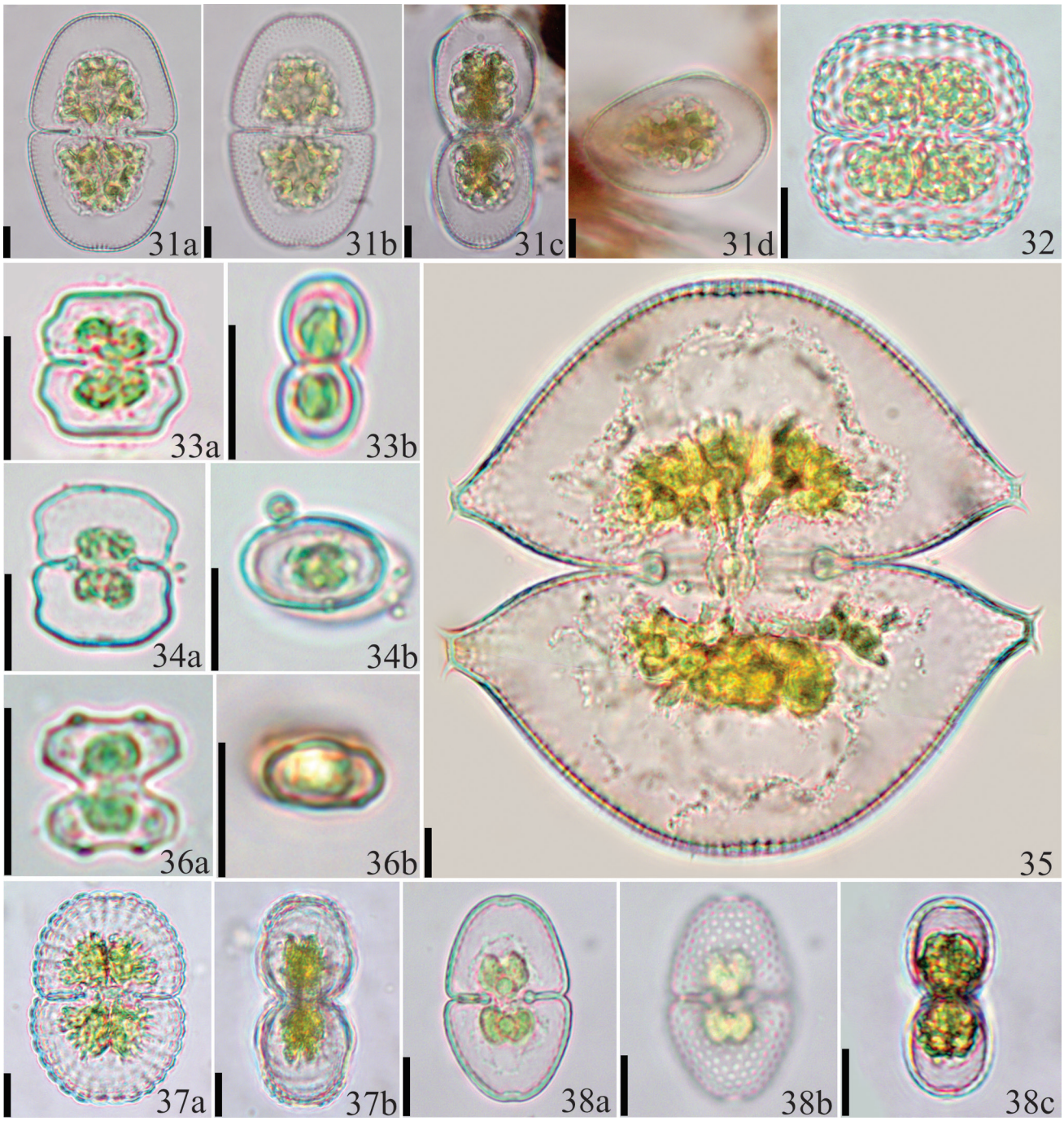

Figure 31a-38c. *Cosmarium* Corda ex Ralfs in lotic environment adjacent to the Iguaçu National Park**.** 31a-d. *C. pyramidatum* var. *borgei*. 31b. Detail of the punctuations. 31c. Lateral view. 31d. Apical view. 32. *Cosmarium quadrum* var. *minus*. 33a-b. *C. regnellii* var. *minimum*. 33b. Lateral view. 34a-b. *C. repandum* var. *minus*. 34b. Apical view. 35. *C. securiforme* var. *brasiliense*. 36a-b. *C. sphagnicolum* var. *sphagnicolum*. 36b. Apical view. 37a-b. *C. subspeciosum* var. *subspeciosum*. 37b. Lateral view. 38a-c. *C. variolatum* var. *variolatum*. 38b. Detail of the punctuations. 38c. Lateral view. Scale = 10 µm.

L.C. Servat (UNOP-Algae3943); Tenente João Gualberto stream, 29-X-2012, *L.C. Servat* (UNOP-Algae3962); Tenente João Gualberto stream, 13-XI-2012, *L.C. Servat* (UNOP-Algae3976); Tenente João Gualberto stream, 18-XII-2012, *L.C. Servat* (UNOP-Algae4035); Tenente João Gualberto stream, 15-I-2013, *L.C. Servat* (UNOP-Algae4044); Tenente João Gualberto stream, 6-II-2013, *L.C. Servat* (UNOP-Algae4057); Tenente João Gualberto stream, 11-III-2013, *L.C. Servat* (UNOP-Algae4081); Tenente João Gualberto stream, 9-V-2013, *L.C. Servat* (UNOP-Algae4102); Tenente João Gualberto stream, 6-VI-2013, *L.C. Servat* (UNOP-Algae4116).

Geographic distribution in the Paraná State: Felisberto & Rodrigues (2005a, b), Bortolini *et al.* (2010b), Menezes *et al.* (2011b) and Aquino *et al.* (2014).

Cosmarium regnellii var. ***minimum*** Eichler & Gutwinski, 164, pl. IV [4], fig. 6. 1894.
Figures 33a-b

Cells of small to medium size, longer than wide. L: 11.6-12 µm, W: 9.1-10.7 µm, I: 2.9-4 µm. Median constriction deep, closed linear sinus, trapeziform to hexagonal semicells, lateral margins slightly diverging, smooth, with basal, lateral and apical angles rounded, apical margin broadly truncate, in apical view elliptic, in lateral view oval, cell wall smooth, chloroplastid with 1 pyrenoid per semicell.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 30-VIII-2012, *L.C. Servat* (UNOP-Algae3930); Tenente João Gualberto stream, 29-X-2012, *L.C. Servat* (UNOP-Algae3962); Tenente João Gualberto stream, 06-II-2013, *L.C. Servat* (UNOP-Algae4057).

Geographic distribution in the Paraná State: First record of the taxon.

Cosmarium regnellii var. *minimum* Eichler & Gutwinski differs by having lateral lobes shorter and less apparent when compared to the typical variety, besides showing smaller cells and a small swelling in the midregion of the semicells.

Cosmarium repandum var. ***minus*** (West & West) Krieger & Gerloff, nov. stat. Gatt. *Cosmarium*: 234.1965.
Figures 34a-b

Cells of small size, longer than wider. L: 16.5-16.6 µm, W: 14.5-14.9 µm, I: 5.9-6.1 µm. Median constriction deep, narrow linear sinus, semicells transversally oblong-trapeziform, lateral margins distinctly diverging, apical margin slightly truncate and with rounded angles, in apical view cell elliptic, in lateral view semicell subcircular, smooth cell wall, chloroplastid with pyrenoids not observed.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 30-VII-2012, *L.C. Servat* (UNOP-Algae3930); Tenente João Gualberto stream, 09-V-2013, *L.C. Servat* (UNOP-Algae4102).

Geographic distribution in the Paraná State: First record of the taxon.

The variety *minus* (West & West) Krieger & Gerloff differs from the typical variety of the species by presenting smaller measures. The measures of the typical species are: L: 40-56 µm, W: 35-45 µm and I: 12-21 µm (Prescott *et al.* 1981).

Cosmarium securiforme Borge var. ***brasiliense*** Grönblad, Acta Soc. Sci. Fenn., sér. B, 2(6): 21, fig. 140. 1945.

Figure 35

Cells of large size, wider than long. L: 113.7-127.6 µm, W: 117.3-132.2 µm, I: 30.3-30.9 µm. Median constriction deep, angular median sinus, open, semicells oval-acuminated with lateral margins slightly convex and rounded apical margins, acute basal angles ending in a small bifurcation facing upwards, in apical view fusiform, cell wall finely punctate, eight chloroplastids with several scattered pyrenoids.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 29-X-2012, *L.C. Servat* (UNOP-Algae3962).

Geographic distribution in the Paraná State: First record of the taxon.

According to Grönblad (1945) *apud* Oliveira *et al.* (2010) the *brasiliense* variety differs from the typical by having two to three spines in the lateral angles.

Cosmarium sphagnicolum var. ***sphagnicolum*** West & G.S.West, Alg. S. England, p. 4S6, t. 6, f. 13-14. 1897.
Figures 36a-b

Morphometric data: L: 6.8-7.4 µm, W: 6.1-8.3 µm, I: 3.1-3.6 µm.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 30-VIII-2012,

Table 1. Distribution of the *Cosmarium* taxa at the Tenente João Gualberto stream, Paraná, Brazil. Emphasizing the presence (●) or absence (-) of taxa.

Taxa	2012					2013						
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jul	Jun
Cosmarium abbreviatum var. *minus*	●	-	●	-	-	-	-	-	-	-	-	-
C. bipunctatum	●	●	●	●	●	-	●	-	●	-	●	-
C. blyttii var. *blyttii*	-	-	-	-	-	-	-	-	●	-	-	-
C. candianum var. *candianum*	-	-	●	●	●	●	●	-	●	●	-	-
C. clepsydra var. *bicardia*	●	●	-	-	-	-	-	●	-	-	-	-
C. crenatum var. *crenatum*	-	-	●	-	-	-	-	-	-	-	-	-
C. decoratum	-	-	●	-	-	-	-	-	-	-	-	-
C. difficile var. *dilatatum*	-	-	●	-	-	-	-	●	-	-	-	-
C. dispersum f. *dispersum*	-	-	●	-	●	●	-	-	●	-	-	-
C. excavatum var. *excavatum*	-	-	-	-	-	●	-	-	-	-	-	-
C. granatum var. *granatum*	●	-	●	-	-	-	-	-	-	-	-	-
C. isthmochondrum var. *isthmochondrum*	-	●	●	●	-	●	-	●	-	-	●	●
C. laeve var. *laeve*	-	-	-	-	●	-	-	-	-	-	●	-
C. lagoense var. *amoebum*	-	-	●	-	-	-	-	-	-	-	-	-
C. mamilliferum var. *mamilliferum*	-	-	-	●	●	-	-	-	-	-	-	-
C. margaritatum var. *margaritatum* f. *margaritatum*	-	-	-	-	-	●	-	-	-	-	-	-
C. margaritatum var. *margaritatum* f. *minor*	●	-	-	●	-	●	-	-	-	-	-	-
C. moniliforme var. *moniliforme*	-	-	●	-	●	-	●	●	-	-	-	-
C. obsoletum var. *obsoletum*	-	-	●	-	-	-	-	-	-	-	-	-
C. ordinatum var. *ordinatum* f. *ordinatum*	●	-	-	-	-	●	●	-	-	-	-	-
C. ornatum var. *ornatum* f. *ornatum*	-	●	●	-	-	-	-	●	-	-	●	-
C. pachydermum var. *pachydermum* f. *pachydermum*	-	-	●	-	●	-	-	-	-	-	-	-
C. protractum var. *protractum*	-	●	●	-	-	-	-	-	-	-	-	●
C. pseudoconnatum var. *pluriradians*	-	-	●	-	-	-	-	-	-	-	-	-
C. pseudoconnatum var. *pseudoconnatum*	●	-	●	●	●	●	●	●	●	-	●	●
C. pseudopyramidatum var. *pseudopyramidatum*	-	-	●	●	●	●	●	-	●	-	●	●
C. pseudoretusum var. *africanum*	●	●	●	●	●	●	●	●	●	●	●	●
C. pseudoretusum var. *pseudoretusum*	-	-	●	-	●	●	-	●	-	-	-	●
C. punctulatum var. *punctulatum*	-	-	-	-	-	-	-	-	-	-	-	●
C. pyramidatum var. *borgei*	-	-	-	-	-	-	-	●	-	-	-	-
C. quadrum var. *minus*	-	●	●	●	●	●	●	●	-	●	●	-
C. regnellii var. *minimum*	●	-	●	-	-	-	●	-	-	-	-	-
C. repandum var. *minus*	●	-	-	-	-	-	-	-	-	●	-	-
C. securiforme var. *brasiliense*	-	-	●	-	-	-	-	-	-	-	-	-
C. sphagnicolum var. *sphagnicolum*	●	●	-	-	-	-	-	-	-	-	-	-
C. subspeciosum var. *subspeciosum*	-	-	●	-	-	-	-	●	-	-	-	-
C. variolatum var. *variolatum*	-	-	●	-	-	-	-	-	-	-	-	-

L.C. Servat (UNOP-Algae3930); Tenente João Gualberto stream, 25-IX-2012, *L.C. Servat* (UNOP-Algae3943).

Geographic distribution in the Paraná State: Aquino *et al.* (2014).

Cosmarium subspeciosum var. ***subspeciosum*** Nordst., Ofvers. K. [Svenska] Vet.-Akad. Förh. 32(6): 22, pl. VI, fig. 13. 1875.
Figures 37a-b

Morphometric data: L: 47 µm, W: 34.3 µm, I: 11.3 µm.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 29-X-2012, *L.C. Servat* (UNOP-Algae 3962); Tenente João Gualberto stream, 11-III-2013, *L.C. Servat* (UNOP-Algae4081).

Geographic distribution in the Paraná State: Felisberto & Rodrigues (2005a, 2008); Bortolini *et al.* (2010b); Menezes *et al.* (2011b) and Aquino *et al.* (2014).

Cosmarium variolatum var. ***variolatum*** Lundell, Nova Acta R. Soc. Sc.Upsal., 3,8(2): 41, pl. 2, fig. 19. 1871.
Figures 38a-c

Cells of medium size, longer than wide. L: 29.2-34.3 µm, W: 19.7-21 µm, I: 5.8-6.3 µm. Median constriction deep, closed sinus except at the extremities, semielliptic semicells with basal angles slightly rounded, lateral margins convex, apical margin truncate, in apical and lateral view elliptics, cell wall densely scrobiculated, chloroplastid with 1 pyrenoid per semicell.

Material examined: BRAZIL. Paraná: São Miguel do Iguaçu, Tenente João Gualberto stream, 29-X-2012, *L.C. Servat* (UNOP-Algae3962).

Geographic distribution in the Paraná State: First record of the taxon.

This species is characterized mainly by the cell walls which have dense and rough scrobiculations (Prescott *et al.* 1981).

Of the 37 specific and infraspecific taxa of *Cosmarium* identified in this study, 15 constitute new records for the Paraná State: *Cosmarium bipunctatum*, *C. clepsidra* var. *bicardia*, *C. crenatum* var. *crenatum*, *C. difficile* var. *dilatatum*, *C. isthmochondrum* var. *isthmochondrum*, *C.obsoletum* var. *obsoletum*, *C. ordinatum* var. *ordinatum*, *C.ornatum* var. *ornatum* f. *ornatum*, *C. pseudoconnatum* var. *pluriradians*, *C. pseudoretusum* var. *pseudoretusum*, *C. pyramidatum* var. *borgei*, *C.regnellii* var. *minimum*, *C. repandum* var. *minus*, *C. securiforme* var. *brasiliense* and *C. variolatum* var. *variolatum*.

The taxa with highest frequency of occurrence were: *Cosmarium pseudoretusum* var. *africanum* (100%), *C. pseudoconnatum* var. *pseudoconnatum* (83%), *C. quadrum* var. *minus* (75%), *C. bipunctatum* (66%), *C. pseudopyramidatum* var. *pseudopyramidatum* (66%) and *Cosmarium istmochondrum* var. *istmochondrum* (50%). Regarding the months of study, October 2012 presented the greatest number of taxa (25 taxa), while May 2013 presented the lower number (4 taxa) (table 1).

The number of *Cosmarium* taxa found was considered intermediate in comparison with other periphytic studies to Paraná. Among the taxonomic studies, stand out: Felisberto & Rodrigues (2008) presenting 17 species to Salto do Vau Reservoir; Felisberto & Rodrigues (2010b) with 48 species to Rosana Reservoir; Biolo & Rodrigues (2011) with 4 taxa to Ressaco do Pau Véio and Menezes *et al.* (2013) with 13 taxa to Iguaçu National Park. In ecological studies we can mention: Cetto *et al.* (2004) that list 11 taxa to Irai Reservoir; Felisberto & Rodrigues (2005a) with 57 taxa to Rosana and Salto do Vau Reservoir; Felisberto & Rodrigues (2005b) with 22 taxa also to Rosana and Salto do Vau Reservoir; Felisberto & Rodrigues (2010a) with 49 taxa to Corvo Stream and Felisberto & Rodrigues (2012) with 26 species to Corvo River.

This study, although of qualitative character, highlights the importance of the knowledge regarding the phycological flora of Paraná, due the high number of taxa recorded. Such findings emphasize the need to know the taxa biogeography, in order to serve as a comparative base for ecological studies in continental aquatic environments, as well as to proposed preservation and biological conservation measures.

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