Cyanobacteria from coastal lagoons of Southern Brazil: coccoid organisms

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ABSTRACT – (Cyanobacteria from coastal lagoons of Southern Brazil: coccoid organisms) Considering the great ecological importance of the cyanobacteria and the need for more detailed information about these organisms in Brazilian waters, this paper provides taxonomic information about the unicellular cyanobacteria flora in lagoon systems along the coastal plains of Rio Grande do Sul State. Sampling was performed in different freshwater bodies along the eastern (Casamento Lake area) and western (near the city of Tapes) banks of the Patos Lagoon (30°40' S-30°10' S and 50°30' W-51°30' W). The samples were collected once in the rainy season and once in the dry season (from May 2003 to December 2003) using a plankton net (25 µm mesh) in pelagic and littoral zones, and by squeezing the submerged parts of aquatic macrophytes. Thirty one species belonging to the families Synechoccocaceae (7 taxa), Merismopediaceae (12 taxa), Chamaesiphonaceae (1 taxon), Microcystaceae (4) and Chroococcaceae (7 taxa) were identified. Among these species, five are reported for the first time in Rio Grande do Sul State: Chamaesiphon amethystinus (Rostafinski) Lemmermann, Chroococcus minimus (Keissler) Lemmermann, Coelomoron pusillum (Van Goor) Komárek, Coelosphaerium kuetzingeanum Naegeli, and Cyanodictyon tubiforme Cronberg.

Key words - Casamento lake, Chroococcales, Patos Lagoon, Synechococcales

INTRODUCTION

Coastal lagoons are shallow aquatic environments that develop at the interface between coastal terrestrial and marine ecosystems and have high natural productivity as compared to oceanic or adjacent coastal ecosystems (Margalef 1969). Although lagoons are intricately connected to their surrounding environments, they have unique structural and functional mechanisms that result in specific biological productivities and carrying capacities (Terwilliger & Wolflin 2005).

Continental and marine environments influence coastal lagoons. Coastal regions have historically been prone to human habitation, and the resulting rural and urban landscapes reflect human orientations toward the use of the natural capital of lagoons. Lagoons are sensitive areas that play an important role among coastal ecosystems in providing suitable breeding areas for many species, but many lagoons are currently deteriorating because of overuse of their natural capital. Fisheries and aquaculture, tourism, and urban, industrial and agricultural developments are typical uses that are usually not well controlled, and lagoon resources are frequently overexploited – so that their present quality and future capability to sustain productivity is being seriously compromised (Göneng & Wolflin 2005).

There are important coastal lagoons systems along the southern Atlantic coast of South America that comprise a diversity of freshwater lakes not found anywhere else in the world. These aquatic systems are inserted with in a mosaic of heterogeneous terrestrial ecosystems – resulting in great biological diversity.

Cyanobacteria have important roles in aquatic systems and they make up part of the planktic, metaphytic, or benthic communities, representing the base of trophic chain; they are responsible for part of primary productivity of aquatic systems and are relevant in biogeochemical cycles (Wetzel 1983, Padisák 2003).

In Rio Grande do Sul State, southern Brazil, studies investigating phytoplankton community including cyanobacteria have been carried out by Callegaro et al. (1981), Torgan & Garcia (1989), Garcia & Vélez (1995), Torgan et al. (1995), Torgan (1997), and Cardoso & Motta-Marques (2003, 2004). A number of taxonomic studies concerning cyanobacteria have also been conducted by Torgan et al. (1981), Franceschini (1983, 1990), Werner (1984, 1988, 2002), Werner & Rosa (1992), Torgan & Paula (1994), Werner & Sant’Anna (1998, 2000, 2006), and Werner et al. (2008). The study by Werner (2002) was the most extensive study, as well as one of the most important, conducted to date in Rio Grande do Sul State.

The present study is part of a wider project examining the fauna and flora of coastal ecosystems of Rio Grande do Sul, Brazil.
MATERIAL AND METHODS

Samples were taken from different freshwater bodies on the eastern (Casamento lake area) and western (Tapes City area) banks of the Patos Lagoon (30°40’ S-30°10’ S and 50°30’ W-51°30’ W) (figure 1, table 1). The study area is dominated by wetland ecosystems, and the lagoons there are freshwater, shallow (Burger & Ramos 2007) and slightly acidic (Bicca 2007).

Samples were collected once during the rainy season and once during the dry season, from May 2003 to December 2003, using phytoplankton nets (25 µm mesh) in pelagic and littoral zones, and by squeezing the submerged parts of aquatic macrophytes.

Figure 1. Map of the Casamento Lake region and the area around the city of Tapes (on the coastal plain of Rio Grande do Sul State, Brazil) (modified from Burger & Ramos 2007).
Table 1. Locations of the collections and their respective samples. (M = margin; P = pelagic zone; UTM = Universal Transverse Mercator coordinate system (zone 22); HAS = Alarich Schultz Herbarium).

<table>
<thead>
<tr>
<th>Area</th>
<th>UTM</th>
<th>HAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Capivarai/Casamento wetland (M)</td>
<td>541830-6654326</td>
<td>HAS1043339</td>
</tr>
<tr>
<td>2 Capivarai lagoon (M)</td>
<td>542910-6655896</td>
<td>HAS104098, HAS104343</td>
</tr>
<tr>
<td>3 Casamento lagoon (M)</td>
<td>541607-6654229</td>
<td>HAS104103, HAS104117, HAS104348, HAS104356, HAS104369, HAS104370, HAS104396</td>
</tr>
<tr>
<td>4 Casamento lagoon (P)</td>
<td>541719-6654246</td>
<td>HAS104106, HAS104351, HAS104352</td>
</tr>
<tr>
<td>5 Gateados lagoon (M)</td>
<td>532524-6621750</td>
<td>HAS104171, HAS104172, HAS104174</td>
</tr>
<tr>
<td>6 Gateados wetland</td>
<td>531876-6628854</td>
<td>HAS104131, HAS104132, HAS104134</td>
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<tr>
<td>7 Spillway</td>
<td>532831-6631257</td>
<td>HAS104163, HAS104167, HAS104381</td>
</tr>
<tr>
<td>8 Gateados lagoon (M)</td>
<td>532053-6624520</td>
<td>HAS104142, HAS104147</td>
</tr>
<tr>
<td>9 Gateados lagoon (M)</td>
<td>532285-6624514</td>
<td>HAS104153, HAS104376</td>
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<td>10 Gateados lagoon (P)</td>
<td>533263-6624909</td>
<td>HAS104150, HAS104372, HAS104399</td>
</tr>
<tr>
<td>11 Rincão do Anastácio wetland</td>
<td>530749-6639690</td>
<td>HAS104118, HAS104119, HAS104124, HAS104362</td>
</tr>
<tr>
<td>12 Capivaras lagoon (M)</td>
<td>473595-6629067</td>
<td>HAS104436</td>
</tr>
<tr>
<td>13 Dunas lagoon</td>
<td>473435-6628655</td>
<td>HAS104230, HAS104442</td>
</tr>
<tr>
<td>14 Dunas wetland</td>
<td>473603-6628803</td>
<td>HAS104234, HAS104446</td>
</tr>
<tr>
<td>15 Charutão lagoon (M)</td>
<td>465956-6623899</td>
<td>HAS104195, HAS104416</td>
</tr>
<tr>
<td>16 Charutão lagoon (P)</td>
<td>465745-6623421</td>
<td>HAS104197, HAS104202, HAS104420, HAS104425, HAS104450, HAS104451</td>
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<tr>
<td>17 São Miguel lagoon (M)</td>
<td>464203-6623642</td>
<td>HAS104203, HAS104427</td>
</tr>
<tr>
<td>18 Redonda lagoon (M)</td>
<td>465503-6622735</td>
<td>HAS104235, HAS104240</td>
</tr>
<tr>
<td>19 Araçá (M)</td>
<td>461948-6626264</td>
<td>HAS104457</td>
</tr>
</tbody>
</table>

The materials were examined using Olympus BH2 and Leica DMLB bright field microscopes. The structures of the mucilaginous envelopes were observed using China ink. The classification proposed by Hoffmann et al. (2005) was adopted to reflect the systematic arrangement and families and lower taxonomic levels according to Komárek & Anagnostidis (1998).

Taxonomic descriptions, photomicrographs, and their occurrence in the aquatic environments studied were provided for all species. The abbreviation “diam.” for diameter was used in the species descriptions.

The studied samples were deposited in the Prof. Alarich Schultz Herbarium (HAS, Natural Sciences Museum, Zoobotanical Foundation, Porto Alegre, Rio Grande do Sul, Brazil). The record numbers together with the list of species and occurrences are presented in tables 1 and 2, followed by the identification keys and species descriptions.

Table 2. Cyanobacteria found in coastal lagoons. (WCC = wetlands between the Capivari and Casamento lagoons; CIL = Capivari lagoon; CML = Casamento lake; GL = Gateados lagoon; GW = Gateados wetland; SP = spillway; PAW = Pontal do Anastácio wetland; CAL = Capivaras lagoon; DL = Dunas lagoon; DW = Dunas wetland; CTL = Charutão lagoon; SML = São Miguel lagoon; RL = Redonda lagoon; AR = Araçá).

<table>
<thead>
<tr>
<th>Species</th>
<th>Casamento lagoon area</th>
<th>Tapes city area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aphanocapsa deliciatissima</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>A. elachista</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>A. holsatica</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>A. incerta</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>A. koordersii</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Aphanothece comasii</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>A. conglomerata</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>A. minutissima</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>A. smithii</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>A. stagnina</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Chamaesiphon amethystinus</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

continue
### RESULTS AND DISCUSSION

Thirty one species of coccoid cyanobacteria belonging to orders Synechococcales (20 species) and Chroococcales (11 species) were found in the aquatic environments sampled (table 2).

Order Synechococcales

1. Cells sessile ......................................................... *Chamaesiphon amethystinus* 2
2. Cells not sessile ............................................................... 3
3. Colonial arrangements ............................................... 4
4. Cells 1.0-1.4 µm diam. ................................................. *M. tenuissima* 5
5. Cells 2.5-3.5 µm diam. .................................................... *M. punctata* 6
6. Cells 3.5-6.5 µm diam. ..................................................... *M. glauca* 7
7. Cells peripherally arranged ............................................. *Snowella lacustris* 8
8. Cells distributed throughout the mucilage ....................... *Coelomoror pusillum* 9
9. Cells with central stalk system ................................. *Coelomoror pusillum* 10
10. Cells without central stalk system ............................... *Coelomoror pusillum* 11
11. Cells arranged in perpendicular rows ............................ *Coelomoror pusillum* 12
12. Cells greater than 2.5 µm diam. .................................... *Coelomoror pusillum* 13
13. Cells spherical or hemispherical ................................... *Coelomoror pusillum* 14
14. Cells spherical ......................................................... *Cyanodictyon reticulatum* 15
15. Cells spherical or elongated ....................................... *C. turgidus* 16

#### Table: Coccoid Cyanobacteria from coastal lagoons

<table>
<thead>
<tr>
<th>Species</th>
<th>Casamento lagoon area</th>
<th>Tapes city area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WCC      CIL  CML  GW  BG  SP  PAW</td>
<td>CAL  DL  DW  CTL  SML  RL  AR</td>
</tr>
<tr>
<td><em>Chroococcus dispersus</em></td>
<td>X        X        X</td>
<td>X</td>
</tr>
<tr>
<td><em>C. distans</em></td>
<td>X        X        X</td>
<td></td>
</tr>
<tr>
<td><em>C. limneticus</em></td>
<td>X        X        X</td>
<td></td>
</tr>
<tr>
<td><em>C. microscopicus</em></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><em>C. minimus</em></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><em>C. minutus</em></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><em>C. turgidus</em></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><em>Coelomoror pusillum</em></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><em>Coelosphaerium kuetzingianum</em></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><em>Cyanodictyon reticulatum</em></td>
<td>X        X        X</td>
<td></td>
</tr>
<tr>
<td><em>C. tubiforme</em></td>
<td>X        X        X</td>
<td></td>
</tr>
<tr>
<td><em>M. glauca</em></td>
<td>X        X        X</td>
<td></td>
</tr>
<tr>
<td><em>M. punctata</em></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><em>M. tenuissima</em></td>
<td>X        X        X</td>
<td></td>
</tr>
<tr>
<td><em>Microcrocis pulchella</em></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><em>Microcystis aeruginosa</em></td>
<td>X        X        X</td>
<td></td>
</tr>
<tr>
<td><em>M. protocystis</em></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><em>M. smithii</em></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><em>M. wesenbergii</em></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><em>Snowella lacustris</em></td>
<td>X        X        X</td>
<td></td>
</tr>
</tbody>
</table>
SYNECHOCOCACCINAE

Figures 2, 34

Colonies microscopic, spherical or oval, 20.0-37.0 µm diam., 30.0-49.0 µm long; cells densely and irregularly distributed in the central part of colony; mucilage homogenous, colorless, conspicuous margin; cells oval, 1.8-3.0 µm diam., 2.7-4.0 µm long; cell contents blue-green, homogenous or granulated.

Material examined: BRAZIL. **RIO GRANDE DE SUL**:

Comments: Most of the population was formed by small colonies that had densely arranged within the central region of the colonial mucilage. The older cells of the colonies were sparsely arranged.

Figure 3

Colonies microscopic, elongated or irregular, 28.5-78.0 µm diam., 80.0-213.0 µm long; cells loosely and irregularly arranged within the colonial mucilage; mucilage, homogenous, colorless rarely lamellate, conspicuous margin (rarely inconspicuous); cells oval, 3.0-3.5 µm diam., 4.0-5.8 µm long; cell contents blue-green, with or without granules; with aerotopes.

Material examined: BRAZIL. **RIO GRANDE DO Sul**:

Comments: *Aphanothece pulverulenta* Bachman, *A. nebulosa* Skuja, and *A. minutissima* are very similar. According to Komářková-Legnerová & Cronberg...
(1994), these three species may belong to *A. minutissima*. However, Komárek & Anagnostidis (1998) consider *A. pulverulenta* and *A. minutissima* synonymous, with *A. nebulosa* being a distinct species because it has smaller cells.


Figures 5, 35

Colonies microscopic, spherical, oval, elongated, or irregular, 52.5-108.6 µm diam., 62.9-221.8 µm long; cells loosely and irregularly arranged within the colonial mucilage; mucilage homogenous, colorless, diffusent margin; cells oval to cylindrical with rounded ends, 1.2-2.0 µm diam., 1.7-2.9 µm long; cell contents blue-green, homogenous; rare and minute aerotopes.


Comments: The populations studied showed wider variations of their cell dimensions than the maximum specified by Komárková-Legnerová & Cronberg (1994). However, other features were according to the species diagnosis. Colony size and shape were variable, and the elongated colonies showed cells arranged in simple rows, like *Cyanodictyon tubiforme* Cronberg (figure 4).


Figures 6, 36

Colonies microscopic, spherical, elongated or irregular, 35.0-125.0 µm diam., 63.0-247.5 µm long; cells loosely and irregularly arranged within the colonial mucilage; mucilage homogenous, colorless, diffusent margin; cells oval to cylindrical with rounded ends, sometimes with their own colorless gelatinous envelopes, 4.0-6.0 µm diam., 6.0-9.0 µm long; cell contents blue-green, homogenous.


Comments: Although *A. stagnina* is known to be benthic and to form a macroscopic thallus, it can occasionally be found in the plankton; there are records (Komárková-Legnerová & Cronberg 1994, Werner 1988, 2002, Franceschini 1992, Joosten 2006) of this species forming microscopic thalli, as was observed in the present study. According to Komárek & Kastovsky (2003) and Komárek (2006), *A. stagnina* is phylogenetically distinct from Synechococcaceae and belongs to Cyanobacteriaceae (Hoffmann et al. 2005).


Figures 7, 37

Colonies microscopic, more or less spherical, or slightly elongated to irregular, 12.0-33.0 µm diam., 24.0-47.5 µm long; cells arranged in simple gelatinous rows, forming reticulate colonies; mucilage homogenous, colorless, conspicuous margin; cells spherical, 0.9-1.4 µm diam.; cell contents blue-green, homogenous.


Figures 8, 38-39

Colonies microscopic, elongated or irregular, sometimes clathrate, up to 326.0 µm long; cells arranged in multicellular rows in colony; mucilage homogenous, colorless, diffusent margin; cells oval, elongated, hemispherical after division, 2.0-2.4 µm diam., 2.0-2.9 µm long; cell contents blue-green, homogenous.

MERISMOPEDIACEAE


Figure 9

Colonies microscopic, spherical, oval or elongated, 13.6-78.7 µm diam., 29.6-168.7 µm long; cells loosely and irregularly arranged within the colonial mucilage; mucilage homogenous, fine, colorless, diffusent margin; cells spherical, hemispherical after division, 0.8-1.0 µm diam.; cell contents blue-green, homogenous.

Material examined: BRAZIL. RIO GRANDE DO SUL: Palmares do Sul, Gateados wetland, 7-V-2003, *VRWerner s.n.* (HAS104132); Casamento lagoon, 18-XI-2003, *LSCardoso s.n.* (HAS104352); Tapes, Redonda lagoon, 4-VI-2003, *VRWerner s.n.* (HAS104235).

Comments: *Aphanocapsa delicatissima* is very similar to *A. elachista* W. West et G. S. West, although *A. elachista* has larger cells than *A. delicatissima*.


Figure 10, 40

Colonies microscopic, spherical, oval, elongated or irregular, 55.0-97.5 µm diam., 60.0-350.0 µm long; cells loosely and irregularly arranged within the colonial mucilage; mucilage homogenous, fine, colorless, diffusent margin; cells spherical, hemispherical after division, 1.5-2.0 µm diam.; cell contents blue-green, homogenous.

Material examined: BRAZIL. RIO GRANDE DO SUL: Palmares do Sul, Gateados wetland, 7-V-2003, *VRWerner s.n.* (HAS104132); Casamento lagoon, 18-XI-2003, *LSCardoso s.n.* (HAS104352); Tapes, Redonda lagoon, 4-VI-2003, *VRWerner s.n.* (HAS104235).

Comments: The taxonomy of planktic *Aphanocapsa* species is unclear. The morphologies of the species are very simple, differing by their cell dimensions, and by the cell organization in the colony. *Aphanocapsa elachista* is very similar to *A. koordersii* as both develop microscopic colonies with more or less sparsely distributed cells within a fine and colorless slime. As *A. elachista* has smaller cells than *A. koordersii* (Komárková-Legnerová & Cronberg 1994, Komárek & Anagnostidis 1998), these two species can be separated by cell size.


Figure 11

Colonies microscopic, elongated or irregular, 42.3-53.8 µm diam., 55.0-215.6 µm long; cells densely and irregularly arranged within the colonial mucilage; mucilage homogenous, fine, colorless, diffusent margin; cells spherical, 0.8-1.0 µm diam.; cell contents blue-green, homogenous.

Material examined: BRAZIL. RIO GRANDE DO SUL: Palmares do Sul, Casamento lagoon, 7-V-2003, *LCTorgan s.n.* (HAS104106); Spillway, 7-V-2003, *LCTorgan s.n.* (HAS104163).


Figure 12, 41

Colonies microscopic, spherical or oval, 40.0-52.0 µm diam., 42.0-64.5 µm long; cells densely and irregularly arranged in the central area of the colonial mucilage; mucilage homogenous, fine, colorless, diffusent margin; cells spherical, 1.0-1.5 µm diam.; cell contents blue-green, homogenous.


Comments: *Aphanocapsa incerta* is very similar to *A. delicatissima* and to *A. holsatica*, and all three species have small cells. They can be separate by colony morphology or by cell arrangement, with *A. incerta* having spherical colonies and cells densely arranged in central area, *A. delicatissima* has cells sparsely arranged in the colonial mucilage, and *A. holsatica* forms elongated or irregular colonies.


Figures 13, 42

Colonies microscopic, spherical or oval, 49.0-219.0 µm diam., 68.7-254.2 µm long; cells loosely and irregularly arranged within the colonial mucilage; mucilage homogenous, fine, colorless, diffusent margin; cells spherical, hemispherical after division, 2.0-3.0 µm diam.; cell contents blue-green, homogenous.

Material examined: BRAZIL. RIO GRANDE DO SUL: Palmares do Sul, Rincão do Anastácio wetland, 7-V-2003, *VRWerner s.n.* (HAS104118, HAS104124); Capivari lagoon, 18-XI-2003, *LSCardoso s.n.* (HAS104352); Tapes, Charutão lagoon, 3-VI-2003, *VRWerner s.n.* (HAS104202), 2-XII-2003, *LSCardoso s.n.* (HAS104420); São Miguel lagoon,
4-VI-2003, *LCTorgan* s.n. (HAS104203); Dunas lagoon, 3-XII-2003, *LSCardoso* s.n. (HAS104442).

Comments: Cells remain close after cell division, with tetrads frequently being observed. *Aphanocapsa koordersii* is similar to *A. elachista* and to *A. planctonica* G. M. Smith. It differs from *A. elachista* only in cell size. The difference between *A. koordersii* and *A. planctonica* is that the former is known from tropical and subtropical regions, while the latter is only known from temperate zones.


Figures 14

Colonies microscopic, spherical or slightly oval, 14.5-18.8 μm diam.; cells more or less radially arranged along the periphery of the colonial mucilage; mucilage homogenous, colorless, and diffluent; cells oval, 2.2-4.0 μm diam., 3.2-4.5 μm long; cell contents blue-green, homogenous.


Comments: *Coelomoron pusillum* was originally described as belonging to the genus *Coelosphaerium*, but was later transferred to *Coelomoron* by Komárek & Hindák (1988) based on cell shape. This species is widely distributed. *Coelomoron tropicale* Senna, Peres & Komárek and *C. microcystoides* Komárek are similar to *C. pusillum*, but differ in terms of colony sizes and by cell distributions. *Coelomoron tropicale* has cells densely and radially gathered in the colonial mucilage, while the cells of *C. pusillum* are slightly distant and not oriented with respect to one another. *Coelomoron microcystoides* forms larger colonies than *C. pusillum* (Senna et al. 1998). Probably the first citation for Rio Grande do Sul since no prior reference was found.


Figure 15

Colonies microscopic, spherical, 50.0-61.5 μm diam.; cells loosely and irregularly arranged near the colony surface; mucilage homogenous, fine, colorless, diffluent margin; cells spherical, hemispherical after division, 2.3-2.9 μm diam.; cell contents blue-green, homogenous or granular.


Comments: *Coelosphaerium kuetzingianum* and *C. aerugineum* Lemmermann are very similar and commonly misidentified. *Coelosphaerium kuetzingianum* probably has cosmopolitan occurrence (but very frequent mainly in tropical regions), while *C. aerugineum* is known from temperate zones (Komárek & Anagnostidis 1998). Probably the first citation for Rio Grande do Sul since no prior reference was found.


Figures 16, 43

Colonies microscopic, flat, tabular, rectangular, composed of 8-192 cells disposed more or less loosely in perpendicular rows within the colonial mucilage, 20.0-110.0 μm diam., 30.0-165.5 μm long; mucilage homogenous, fine, colorless, diffluent margin; cells spherical, widely oval, hemispherical after division, 3.5-6.5 μm diam.; cell contents blue-green, homogenous.


Comments: The features of the populations observed are consistent with the species diagnosis, except in terms of their cell sizes, which are larger than the maximum value cited by Komárek & Anagnostidis (1998).


Figure 17

Colonies microscopic, flat, tabular, rectangular, composed by 16-64 cells disposed more or less loosely in perpendicular rows, 15.0-35.0 μm diam., 20.0-53.0 μm long; mucilage homogenous, fine, colorless, diffluent margin; cells spherical, hemispherical after division, 2.5-3.5 μm diam.; cell contents blue-green, homogenous.

Material examined: BRAZIL. RIO GRANDE DO SUL: Tapes, Charutão lagoon, 3-VI-2003, *VRWerner*
Merismopedia punctata is a common species and very similar to M. glauca and M. hyalina (Ehrenberg) Kützing. It differs from M. glauca in terms of cell size. Merismopedia punctata can be distinguished from M. hyalina by the smaller numbers of cells in its colonies and by the somewhat irregular cell arrangement in M. hyalina.


Order Chroococcales

1. Cells with aerotopes ................................................................................................................................. 2
2. Cells without aerotopes ............................................................................................................................. 5
3. Cells up to 4.5 µm diam. ............................................................................................................................ 6
4. Cells broader than 4.5 µm diam. .................................................................................................................. 3
5. Colonies enveloped by a distinctly delimited mucilage, usually slightly refractive on the margins, lobate colonies .............................................................................................................................. M. wesenbergii
6. Colonies enveloped by diffusent, sometimes indistinct slime, colonies not lobate ........................................ 4
7. Cells solitary or in small groups (2-4 cells) ................................................................................................... 2
8. Cells broader than 4.5 µm diam. .................................................................................................................. 7
9. Cells up to 7.5 µm diam. ............................................................................................................................ 6
10. Cells up to 1.1 µm diam. ........................................................................................................................... 7
11. Cells more than 1.1 µm diam. ..................................................................................................................... 8
12. Cells up to 4.5 µm diam. ............................................................................................................................ 9
13. Cells larger than 5.3 µm diam. .................................................................................................................... 10
14. Cells remain in groups after division, irregularly distributed, cells 3.0-4.5 µm diam. ................................. C. dispersus
15. Cells separate after division, usually distant one from another, cells 2.4-3.0 µm diam. ......................... C. minimus
16. Cells 5.3-7.5 µm diam., without individual envelopes around cells ....................................................... C. distans
17. Cells 6.0-10.5 µm diam., with narrow individual envelopes around cells ................................................ C. limneticus

MICROCYSTACEAE

Microcystis aeruginosa (Kützing) Kützing, Tab. Phycol. 1: 6, 1846.
Figures 23, 46

Colonies mucilaginous, microscopic, irregular, usually elongated, lobate, sometimes clathrate, 45.0-127.0 µm diam., 68.0-335.0 µm long; irregularly and densely arranged cells in the central part of the colonial mucilage; mucilage colorless, structureless, diffusent, sometimes forming a wide margin; cells spherical, sometimes slightly elongated, 4.5-6.5 µm diam.; cell contents blue-green; with aerotopes.


Comments: Microcystis aeruginosa is the most widespread species in Brazil (Sant’Anna & Azevedo 2000), but misidentifications have probably contributed to its presumed distribution (Sant’Anna et al. 2004).

Figures 24, 47

Colonies mucilaginous, microscopic, irregular, spherical or elongated, 125.0-305.0 µm diam., 150.0-434.0 µm long; cells irregularly and sparsely arranged within the colonial mucilage; mucilage colorless, structureless, diffusent; cells spherical, sometimes with their own colorless gelatinous envelopes, 4.5-6.5 µm diam.; cell contents blue-green; with aerotopes.

Material examined: BRAZIL, RIO GRANDE DO SUL: Palmares do Sul, Casamento lagoon, 5-V-2003, LCTorgan s.n. (HAS104106), 19-XI-2003, LSCardoso s.n. (HAS104369); Tapes, Charutão lagoon, 3-XII-2003, LSCardoso s.n. (HAS104451).

Comments: a mucilaginous envelope around each cell makes Microcystis protocystis distinct from other Microcystis species, although not all colonies had cells with individual envelopes. Cell sizes of M. protocystis and M. aeruginosa are similar, but these species can be distinguished by the different arrangements of the cells within their colonies.
Figures 25, 48-49

Colonies mucilaginous, microscopic, spherical, oval or elongated, 80.0-150.0 µm diam., 93.0-357.0 µm long; cells irregularly and sparsely arranged within the colonial mucilage; mucilage colorless, structureless, diffuent; cells spherical, single or in pairs after division, 3.5-4.5 µm diam.; cell contents blue-green, with one or several aerotopes in each cell.

Material examined: BRAZIL. RIO GRANDE DO SUL: Tapes, Charutão lagoon, 3-VI-2003, VRWerner s.n. (HAS104195).

Comments: As many cells are arranged in pairs within the colonial mucilage, *M. smithii* appears similar to *Aphanocapsa* species. Nevertheless, the presence of aerotopes in the cells allows differentiation and correct classification of the *Microcystis* genus.

Microcystis wesenbergii (Komáré) Komáré In Kondrateva, Cvetenie vody, 32, 1968.
Figures 26, 50

Colonies microscopic, 20.0-69.0 µm diam., 35.0-157.0 µm long, spherical, elongated, lobate, irregular, clathrate, sometimes composed of subcolonies; cells irregularly arranged within the colonial mucilage; mucilage colorless, structureless, with distinctly delimited, firm, continuous, with refractive outline; cells spherical, 5.0-8.0 µm diam.; cell contents blue-green; with aerotopes.


Comments: As many cells are arranged in pairs within the colonial mucilage, *M. smithii* appears similar to *Aphanocapsa* species. Nevertheless, the presence of aerotopes in the cells allows differentiation and correct classification of the *Microcystis* genus.

CHROOCOCCACEAE

Figure 27

Colonies free floating, microscopic, elongated or irregular, 62.5-71.7 µm diam., 80.3-89.7 µm long; cells irregularly arranged, sometimes in groups, which are distant from one other within the colonial mucilage; mucilage colorless, firm, diffuent; cells spherical or hemispherical after division, 3.0-4.5 µm diam.; cell contents blue-green, homogenous.

Material examined: BRAZIL. RIO GRANDE DO SUL: Palmares do Sul, Capivari lagoon, 18-XI-2003, LSCardoso s.n. (HAS104343); Tapes, Charutão lagoon, 3-XII-2003, LSCardoso s.n. (HAS104451).

Comments: *Chroococcus dispersus* belongs to the group of planktic *Chroococcus* species. The main distinguishing feature of this species is that the cells are distributed in small groups that remain distant from one another within this the colonial mucilage. It differs from *Limonococcus limneticus* (Lemmermann) Komárková et al. by its smaller cell dimensions and by having colonies with greater numbers of cells.

Figures 28, 51

Colonies microscopic, elongated or irregular, 55.5-70.8 µm in diameter, 67.3-121.8 µm long; cells irregularly and sparsely arranged within the colonial mucilage; mucilage colorless, firm, homogenous, diffuent; cells 5.3-7.5 µm in diameter, spherical or hemispherical after division, individual envelops lacking; cell contents blue-green, homogenous.


Comments: The cell characteristics of *Chroococcus distans* and *Limonococcus limneticus* are similar, but the species can be distinguished by their colony sizes and by the arrangements of the cells within the colonial mucilage. *Chroococcus distans* forms larger colonies and the cells of older colonies are more distant one from the other.

Figure 29

Colonies free floating, microscopic, irregular, 5.5-18.5 µm diam., 6.5-30.0 µm long; cells forming groups, which are irregularly arranged within the colonial mucilage; mucilage colorless, firm, homogenous, diffuent; cells spherical, 0.8-1.1 µm diam.; cell contents blue-green, homogenous.


Comments: *Chroococcus microscopicus* and *C. aphanocapsoides* Skuja are similar, both having small cells. These two species can be distinguished by their
cell and colony sizes, where *C. aphanocapsoides* has larger colonies and large cells distributed within a common colonial mucilage, while *C. microscopicus* has smaller cells that are united into small groups, with each cell being surrounded by an individual mucilaginous sheath.  

*Chroococcus minimus* (Keissler) Lemmermann, Ark. F. Bot. 2: 102, 1904.  
Figures 30, 52.

Colonies free floating, microscopic, oval, irregular, 30.5-48.3 µm diam., 50.3-63.8 µm long; cells more or
less regularly arranged within the colonial mucilage; mucilage colorless, firm, homogenous, diffluent; cells spherical or hemispherical after division, sometimes with individual envelope around cells, 2.4-3.0 µm diam.; cell contents blue-green, homogenous.

Material examined: BRAZIL. RIO GRANDE DO SUL: Palmares do Sul, Spillway, 7-V-2003, LCTorgan s.n. (HAS104163); Tapes, Charutão lagoon, 2-XII-2003, SMAIves-da-Silva s.n. (HAS104416).

Comments: Reported for the first time in Rio Grande do Sul.

Chroococcus minutus (Kützing) Nägeli, Gatt. Einz. Algen. 46, 1849. Figure 31

Colonies with few cells (2-4); cells solitary or microscopic, oval, elongated; mucilage colorless, firm, homogenous, sometimes lamellate, delimited; cells spherical or hemispherical after division, 5.0-7.5 µm diam.; cell contents blue-green, homogenous.

Material examined: BRAZIL. RIO GRANDE DO SUL: Palmares do Sul, Casamento lagoon, 18-XI-2003,

LSCardoso s.n. (HAS104352), 19-XI-2003, LSCardoso s.n. (HAS104356).

Comments: This species is widely reported from various biotopes throughout the world including mangrove swamps, aerophytic, and metaphytic habitats, thermal springs, and alkaline subtropical and tropical swamps, springs, creeks, and lakes. In this study it was observed in plankton.


Microscopic few-celled colonies (2-4 cells) that are oval, elliptic; mucilage colorless, firm, homogenous or lamellate, delimited; cells spherical or hemispherical after division, 8.0-12.5 µm diam.; cell contents blue-green, homogenous or finely granular.

Material examined: BRAZIL. RIO GRANDE DO SUL: Tapes, Charutão lagoon, 3-VI-2003, VRWerner s.n. (HAS104202), 3-XII-2003, LSCardoso s.n. (HAS104451); Dunas wetland, 4/6/2003, VRWerner s.n. (HAS104234); Redonda lagoon, 4-VI-2003, VRWerner s.n. (HAS104235); Palmares do Sul, Capivari lagoon, 18-XI-2003, LSCardoso s.n. (HAS104343).

Comments: This species is widely distributed and has been reported from a great variety of habitats. Numerous taxonomic varieties have been described and probably represent a collective species.


Colonies microscopic, oval, elongated or irregular, 40.0-60.0 µm diam., 60.3-85.5 µm long; cells irregularly arranged within the colonial mucilage, sometimes in indistinct groups (2-6 cells); mucilage colorless, firm, homogenous, diffusent; cells spherical or hemispherical after division, usually with individual envelope, 6.0-10.5 µm diam.; cell contents blue-green, homogenous.


**REFERENCES**


