**How diverse are coccoid cyanobacteria? A case study of terrestrial habitats from the Atlantic Rainforest (São Paulo, Brazil)**

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**Abstract**

The present study analyzed 267 samples from terrestrial habitats of different fragmented areas in the Atlantic Rainforest located in São Paulo State (southeastern Brazil), finding 61 taxa of coccoid cyanobacteria, of which 21 have only been possible to identify at the generic level. The samples were examined using light microscopy and populations were morphometrically separated and taxonomically identified. Among the identified taxa, we propose the change of *Chroococcus* *turgidus* var. *subviolaceus* to *Chroococcus subviolaceus* stat. nov*.* Due to the high species richness found, we assume that the Atlantic Rainforest is a large ‘hotspot’ of coccoid cyanobacterial diversity and should be better studied, as well as other tropical ecosystems and terrestrial habitats, which have been shown to be suitable places for cyanobacterial diversity establishment.

**Key words:** Brazilian forest, Chroococcales, cyanobacterial biodiversity, *status novus*.

**Introduction**

Coccoid cyanobacteria have historically been understood as presenting the ‘simplest’ morphology among the cyanobacteria, since they cannot form ‘true’ filaments or specialized cells (heterocytes and/or akinetes). However, this idea underestimates these organisms, whose complexity extends beyond simply spherical or elongated cells and colonies. Despite their inability to form true trichomes, these bacteria vary widely in colonial shape and theyalso have a complex process of cell division, such as asymmetrical and multiple and binary fission in different planes (Kováčik 1988, Komárek & Anagnostidis 1998). In addition, many taxa have a complex life cycle, each with different morphotypes, which can overlap in distinct genera/species, leading to misinterpretations (e.g*.* *Asterocapsa*/*Gloeocapsa*/*Gloeocapsopsis*) (Komárek 1993). This point, together with the difficulty in recognizing diacritical features, leads to difficulty in identifying coccoid cyanobacteria. Moreover, the greatest variability of shapes and morphotypes of coccoids are not found in aquatic sites, but mainly in terrestrial environments, which remain poorly investigated. This leads to a gap in the knowledge of these organisms, and makes reconstructing true biogeographic and systematic scenarios difficult.

In terrestrial environments, cyanobacteria are widespread and play a crucial role as primary producers and pioneers, preparing the environment for future colonization, and biofilm establishment (Gorbushina 2007). Coccoid cyanobacteria are frequently dominant, compressing and sedimenting particles, mainly due to their excessive mucilage production (Golubic & Abed 2010). However, there is still a paucity of studies on tropical biodiversity, since the majority of studies have been undertaken in temperate zones. In spite of this, over the past century researchers have demonstrated the great richness of coccoid species in the tropical zone (Fritsch 1907, Wille 1914, Printz 1921, Gardner 1927, Skuja 1949). Furthermore, a recent metagenomic study showed that unicellular and colonial cyanobacteria are abundant in tropical biofilms (Gaylarde *et al.* 2012), and they also tend to dominate these habitats in tropical Latin America more frequently than in continental Europe (Gaylarde & Gaylarde 2005).

Among tropical and subtropical zones, the Atlantic Rainforest is highlighted as one of the most diverse biomes on Earth, considered a hotspot for biodiversity and should be conserved (Myers *et al.* 2000). The great variability of distinct and particular landscapes in this ecosystem can explain the high number of endemic species found, which is true for microorganisms, including cyanobacteria. Twenty-two articles containing three new genera, 43 new species, and three new varieties indicate the endemicity of these bacteria from Atlantic Rainforest terrestrial habitats (Sant'Anna 1988, Sant'Anna & Silva 1988, Silva & Sant'Anna 1988, Azevedo 1991, Sant'Anna *et al*. 1991a, Sant'Anna *et al*. 1991b, Azevedo & Sant'Anna 1993, Azevedo & Sant'Anna 1994a, Azevedo & Sant'Anna 1994b, Branco *et al*. 1994, Azevedo & Kováčik 1996, Komárek 2003, Branco *et al*. 2006, Fiore *et al*. 2007, Sant'Anna *et al*. 2007, Sant'Anna *et al*. 2010, Lemes-da-Silva *et al*. 2010, Sant'Anna *et al*. 2011a, Sant'Anna *et al*. 2011c, Gama-Jr. *et al*. 2012, Komárek *et al*. 2013, Sant'Anna *et al*. 2013). Despite the high biodiversity, the majority of the new taxa described belong to heterocytous cyanobacteria (56%) with three new genera, while coccoids are the second most species-rich group (25%) (Sant’Anna *et al.* 2011b; Gama-Jr. *et al.* 2012; Komárek *et al.* 2013). Surely, coccoid richness is underestimated, since studies rarely focus on them, in comparison to other cyanobacterial groups. Thus, the aim of the present study is to report the large variability and diversity of coccoid cyanobacteria in terrestrial habitats from the Atlantic Rainforest, by discussing the main features and novelties in their taxonomy.

**Materials and Methods**

Localities and sampling: The sampling was carried out on soils, rocks, tree bark, concrete, and wood from six different Atlantic Rainforest conservation areas, all located in São Paulo state, southeastern Brazil. A total of 267 samples were collected and screened using a light microscope (Zeiss, Axioplan 2). We excluded from this study those samples that did not contain any coccoid cyanobacteria.

Sample processing: Samples were collected from the substrate with a spatula, and then dried over paper bags by exposure to sunlight. In the laboratory, the sampled pieces were rehydrated in Petri dishes with distilled water for a minimum of one day. Afterwards, they were analyzed with a light microscope, and a minimum of 30 individual cells of each population was measured using the AxioVs40 v 4.8.2.0 program. In the description, the measurements are listed as length × diameter (diam.), and the rare rates are given in parenthesis. Whenever necessary, China ink or 1% methylene blue solution was used to show the mucilage. The rehydrated samples were fixed in 4% formaldehyde, and deposited in the Herbarium of the Institute of Botany (SP), São Paulo, Brazil.

**Results**

The present studied reported a total of 61 coccoid cyanobacterial taxa, being 20 of them identified only at the generic level and one at family. We analyzed 60 samples from a total of 267, since only these had satisfactory populations for morphological study.

**Family Synechococcaceae Komárek & Anagnostidis (1986: 210).**

***Aphanothece saxicola*** Nägeli (1849: 60). (Fig. 1C–E)

Rounded up to irregular colonies, 8.3–80.3 µm diam. Sheath gelatinous, hyaline up to brownish, inconspicuous up to conspicuous. Cells sparsely disposed, oblong up to ellipsoidal, 2.7–4.2 × 1.5–2.6 µm, 1.5–2.4 times longer than wide. Cell content slightly granulated, blue-green.

**Habitat:**—Wet rocks.

**Studied material:**—BRAZIL. São Paulo: Peruíbe, Ecological Station “Juréia-Itatins”, 24°24.146'S, 47°03.648'W, 15 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427310); 24° 22.783'S, 47°01.287'W, 16 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427312); 24°23.737'S, 47°00.699'W, 16 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427320); 24° 23.708'S, 47°07.324'W, 17 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427330).

***Aphanothece* cf. *castagnei*** (Brébisson) Rabenhorst (1865: 64). (Fig. 1F–H)

**Basionym:** *Oncobyrsa castagnei* Brébisson in Kützing (1845: 9).

Rounded up to elongated, irregular colonies, 17.8–386.1 µm diam. Sheath gelatinous, hyaline up to brownish, inconspicuous up to conspicuous. Cells sparsely disposed, oblong up to ellipsoidal, 3.8–5.9 × 2.6–3.8 µm, 1.4–2.0 times longer than wide. Cell content slightly granulated, greyish green.

**Habitat:**—Wet rocks.

**Notes:**—Morphologically, the studied population is very similar to *Aphanothece* *castagnei* (Brébisson) Rabenhorst (1865: 64). However, ecologically they are distinct and, according to Rabenhorst (1865), *A. castagnei* was found growing among submersed mosses, not on wet rocks as the present material.

**Studied material:**—BRAZIL. São Paulo: Peruíbe, Ecological Station “Juréia-Itatins”, 24°24.146'S, 47°03.648'W, 15 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427310); 24° 23.708'S, 47°07.324'W, 17 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427330).

***Aphanothece* cf. *densa*** Lemes-da-Silva, L.H.Z. Branco & Necchi-Júnior (2010: 917).(Fig. 1I–J)

Rounded colonies, 20.1–48.8 µm diam. Sheath firm, hyaline to slightly brownish, conspicuous. Cells densely disposed, ellipsoidal, 3.6–4.6 × 2.6–3.7 µm, 1.3–1.6 times longer than wide. Cell content homogenous up to slightly granulated, blue-green.

**Habitat:**—Tree bark.

**Notes:**—The population found has a corticolous habitat; colonies and cell shapes, and the cell content color resembles *Aphanothece densa* Lemes-da-Silva *et al.* (2010: 917). This species was recently described based on a population found on the tree bark of a semi-deciduous forest, which is quite distinct from the Atlantic Rainforest. Besides, *A. densa* also has larger cell dimensions (4.0–7.0 × 4.0–5.0 μm) than the presently described population (Lemes-da-Silva *et al.* 2010).

**Studied material:**—BRAZIL. São Paulo: Peruíbe, Ecological Station “Juréia-Itatins”, 24°23.842'S, 47° 07.252'W, 17 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427328).

***Aphanothece* cf. *microscopica*** Nägeli (1849: 59). (Fig. 1A–B)

Rounded colonies, 24.6–77.8 µm diam., sub-colonies often present, 8.0–12.7 µm diam. Sheath firm, hyaline, conspicuous. Cells sparsely up to densely disposed, cylindrical, rarely ellipsoidal, 3.1–6.0(7.2) × 1.7–2.9 µm, 1.8–2.0 times longer than wide. Cell content slightly granulated, intense blue-green.

**Habitat:**—Waterlogged soil covered by vegetation.

**Notes:**—The studied specimens have a cell length smaller than what is proposed by Komárek & Anagnostidis (1998). Furthermore, the habitat of *Aphanothece microscopica* Nägeli (1849: 59) is a little different (moorland freshwater). However, Desikachary (1959) report the occurrence of *A. microscopica* in waterlogged soils from India, and Wille (1914) found this species among mosses.

**Studied material:**—BRAZIL. São Paulo: Cananéia, State Park of “Ilha do Cardoso” (Perequê), 25º04'08''S, 47º55'88''W, 29 June 2010, *W.A. Gama-Jr.* & *C.F.S. Malone* (SP 401439).

***Aphanothece* sp.** Nägeli (1949) (Fig. )

Rounded to elongated colonies, 29.2–78.9 µm diam. Sheath firm to gelatinous, hyaline, conspicuous. Cells densely to sparsely disposed, ellipsoidal, rarely cylindrical, 5.1–8.9 × 3.9–5.3 µm, 1.6–3.0 times longer than wide. Individual conspicuous sheaths cells can occur near colonies edge. Cell content granulated, pale purple.

**Habitat:**—Tree bark in the inner forest.

**Notes:**—The present population is distinct by its corticolous habitat, cell content color, dimensions and dispostion. Probably, this Atlantic Rainforest *Aphanothece* is a new morphospecies to science, and should be classified in the subgenus *Cyanogastrum* (Schiller) Komárek (1995: 82).

**Studied material:**—BRAZIL. São Paulo: Cananéia, State Park of “Ilha do Cardoso” (Perequê), 25º05‟08”S, 47º55‟30”W, 30 June 2010, *W.A. Gama-Jr.* & *C.F.S. Malone* (SP 401442, SP 401444).

***Gloeothece fuscolutea*** (Nägeli) Nägeli (1849: 57). (Fig. 2A–B)

**Basionym:** *Gloeocapsa fuscolutea*Nägeli ex Kützing (1849: 224).

Rounded to elliptical colonies, 10.7–24.0 µm diam. Sheath firm, hyaline to yellowish, conspicuous, not lamellate up to 1–4 lamellate, smooth. Cells oblong up to ellipsoidal, 6.7–11.1 × 3.9–5.6 µm, 1.9–2.1 times longer than wide. Cell content homogenous to slightly granulated, olive green.

**Habitat:**—Wet rocks and concrete wall.

**Studied material:**—BRAZIL. São Paulo: Peruíbe, Ecological Station “Juréia-Itatins”, 24° 22.783'S, 47°01.287'W, 16 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427312); 24°23.013'S, 47°04.836'W, 17 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427324); Cananéia, “Recanto do Mar” Inn, 25º01'16''S, 47º55'31''W, 30 November 2010, *W.A. Gama-Jr.* & *C.F.S. Malone* (SP 427337).

***Gloeothece interspersa*** Gardner (1927: 13). (Fig. 2C–D)

Rounded to oblong colonies, 9.5–19.2 µm diam. Sheath firm, hyaline, conspicuous, intensely lamellate, smooth. Cells oblong up to ellipsoidal, 4.2–6.9 × 3–3.9 µm, 1.3–1.7 times longer than wide. Cell content finely granulated, blue-green.

**Habitat:**—Concrete wall.

**Notes:**—The cell length in the Atlantic Rainforest population was smaller than Gardner’s description for *G. interspersa* Gardner (1927: 13)*,* which is 7–7.5µm diam., but all other morphological features correspond to this species, including the habitat.

**Studied material:**—BRAZIL. São Paulo: Peruíbe, Ecological Station “Juréia-Itatins”, 24°23.002’S, 47° 04.839’W, 17 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427325).

***Gloeothece rhodochlamys*** Skuja (1949: 18). (Fig. 2E–H)

Rounded to elliptical, irregular colonies, 16.0–70.0 µm diam. Sheath firm, hyaline (rare) to orange reddish, conspicuous, concentric lamellate, finely granulated. Cells oblong up to ellipsoidal, 4.5–6.0(6.7) × (1.8)2.6–3.6(4.8) µm, 1.3–1.6 times longer than wide. Cell content homogeneous up to finely granulated, olive green.

**Habitat:**—Rocky coast and dry rocks.

**Studied material:**—BRAZIL. São Paulo: São Luís do Paraitinga, State Park of “Serra do Mar”, Núcleo Santa Virgínia, 23º20'16''S, 45º09'0''W, 22 February 2010, *W.A. Gama-Jr.* (SP 401417); 23º20'35''S, 45º08'17''W, 24 February 2010, *W.A. Gama-Jr.* (SP 401428).

***Gloeothece* *samoensis*** Wille (1913: 144). (Fig. 2I)

Rounded, oblong up to elliptical colonies, 9.7–21.3 µm diam., with 2–4–8 cells, rarely more. Sheath firm to diffluent, hyaline, conspicuous, lamellate, smooth. Cells oblong up to ellipsoidal, 5.4–8.4 × 3.3–5.8 µm, 1.3–1.7 times longer than wide. Cell content granulated, blue-green to olive green.

**Habitat:**—Waterlogged soil covered by vegetation.

**Studied material:**—BRAZIL. São Paulo: Cananéia, State Park of “Ilha do Cardoso” (Perequê), 25º04'08''S, 47º55'88''W, 29 June 2010, *W.A. Gama-Jr.* & *C.F.S. Malone* (SP 401439); Peruíbe, Ecological Station “Juréia-Itatins”, 24°22.747'S, 47°04.729'W, 16 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427323).

***Gloeothece tepidariorum*** (A.Braun) Lagerheim (1883: 44). (Fig. 3A–B)

**Basionym:** *Gloeocapsa tepidariorum* A. Braun in Rabenhorst (1865: 38).

Rounded to oblong colonies, 18.9–45.7 µm diam. Sheath firm, hyaline, conspicuous, intensely lamellate, smooth finely up to granulated (rare). Cells oblong up to ellipsoidal, 6,1–11,1 × 4.4–5.5 µm, 1,7–2,2 times longer than wide. Cell content finely granulated, greyish green to olive green.

**Habitat:**—Concrete wall.

**Notes:**—*Gloeothece tepidariorum* (A.Braun) Lagerheim (1883: 44) was found together with populations of *Gloeothece interspersa* Gardner (1927: 13), both differing mainly by cell dimensions, being that *G. tepidariorum* is bigger than *G. interspersa*.

**Studied material:**—BRAZIL. São Paulo: Peruíbe, Ecological Station “Juréia-Itatins”, 24°23.002’S, 47° 04.839’W, 17 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427325).

***Lemmermanniella* *terrestris*** W.A. Gama-Jr. in Gama-Jr *et al.* (2012: 320). (Fig. 3C–D)

Hollow, rounded to elongated colonies, 43.7–243.7 µm diam., sub-colonies often present, 10.2–16.9 µm diam. Sheath gelatinous, hyaline, inconspicuous, following the colony outline. Cells ellipsoidal, 2.5–7.1(8.8) × 1.4–2.5 µm, 2.4–3.1 times longer than wide, ends acuminated or rounded (rare). Psedofilaments rarely found, 3–5 cells. Cell content granulated, pale blue-green to grey.

**Habitat:**—Dry soil.

**Studied material:**—BRAZIL. São Paulo: Cananéia, “Recanto do Mar” Inn, 25º01'16''S, 47º55'31''W, 30 June 2010,*W.A. Gama-Jr.* & *C.F.S. Malone* (SP 401446).

**Family Merismopediaceae Elenkin (1933: 19).**

***Aphanocapsa intertexta*** Gardner (1927: 4). (Fig. 3E–F)

Rounded to irregular colonies, 13.7–63.5 µm diam. Sheath gelatinous, hyaline, inconspicuous to conspicuous. Cells sparsely disposed, spherical, 2.4–3.0 µm diam. Cell content homogenous, can be slightly granulated, blue-green.

**Habitat:**—Wet rock.

**Notes:**—The colonies were always found mixed with other cyanobacteria, mainly trichomes of *Scytonema* Agardh ex Bornet & Flahault (1886: 85) and *Stigonema* Agardh ex Bornet & Flahault (1886: 62).

**Studied material:**—BRAZIL. São Paulo: Peruíbe, Ecological Station “Juréia-Itatins”, 24°26.162'S, 47°03.773'W, 15 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427307); 24°24.146'S, 47°03.648'W, 15 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427310).

***Aphanocapsa* cf. *intertexta*** Gardner (1927: 4). (Fig. 3G–H)

Rounded to irregular colonies, 9.1–15.2 µm diam. Sheath gelatinous, hyaline, inconspicuous. Cells sparsely disposed, spherical, 1.4–2.2 µm diam. Cell content homogenous, pale blue-green.

**Habitat:**—Tree bark from inner forest.

**Notes:**—This morphotype is different from *Aphanocapsa intertexta* Gardner (1927: 4) by smaller cell dimensions and the habitat, since the present population was found on tree bark, while *A.* *intertexta* is described from rocks, among filamentous cyanobacteria. .

**Studied material:**—BRAZIL. São Paulo: São Luís do Paraitinga, State Park of “Serra do Mar” (Santa Virgínia), 23º20'35''S, 45º08'17''W, 24 February 2010, *W.A. Gama-Jr.* (SP 401427).

***Aphanocapsa* sp.** Nägeli (1849: 52)(Fig. )

Rounded colonies, 33.0–82.1 µm diam. Sheath gelatinous, hyaline, inconspicuous to slightly conspicuous. Cells sparsely disposed, spherical, 3.0–3.6 µm diam. Cell content homogenous, pale brown.

**Habitat:**—Tree bark.

**Notes:**—This population was found among bryophytes and is distinct from other *Aphanocapsa* Nägeli (1849: 52)species mainly by the corticolous habitat and cell content color.

**Studied material:**—BRAZIL. São Paulo: Peruíbe, Ecological Station “Juréia-Itatins”, 24°23.842'S, 47° 07.252'W, 17 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427328).

***Coelosphaeriopsis* sp.** Lemmermann (1899: 352) (Fig.)

Hollow, rounded to elliptical colonies, 12.0–106.3 µm diam. Sheath firm, hyaline, conspicuous. Cells 2–4 grouped, elliptical to slightly polygonal, 2.3–3.8 µm diam., surrounded by individual hyaline sheaths. Cell content homogenous to granulated, blue-green to brown.

**Habitat:**—On rock covered by a water slide near a waterfall.

**Notes:**—*Coelosphaeriopsis* Lemmermann (1899: 352 ) is a rare and understudied genus, possessing only two species: *C. halophila* Lemmermann (1899: 352 ), described from saline environments, and *C. chlamydocystis* (Skuja) Komárek & Anagnostidis (1995: 17), found in a Swedish lake, both with habitats very different from the Altantic Rainforest population.

**Studied material:**—BRAZIL. São Paulo: São Luís do Paraitinga, State Park of “Serra do Mar” (Santa Virgínia), 23º20'16''S, 45º09'01''W, 22 February 2010, *W.A. Gama-Jr.* (SP 401419).

**Family Chroococcaceae Nägeli (1849: 45).**

***Asterocapsa aerophytica*** Lederer (2000: 24). (Fig. 4A–C)

Rounded to elongated colonies, rarely irregular, 13.9–154.1 µm diam., isolated or in groups. Sheath firm, hyaline to reddish brown, conspicuous, rarely lamellate, granulated. Cells spherical to ellipsoidal, 4.3–5.4 µm diam. Spores dark reddish brown, solitary or in groups after releasing, 5.6–6.3 µm diam. Cell content granulated, green up to blue-green.

**Habitat:**—Dry wood.

**Notes:**—This species was found in a black mass growing on wood, and the colonies were epiphytic on *Scytonema* Bornet & Flahault (1886: 85) filaments, similar to the original habitat described by Lederer (2000).

**Studied material:**—BRAZIL. São Paulo: Peruíbe, Ecological Station “Juréia-Itatins”, 24°26.392'S, 47°04.536'W, 15 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427304).

***Asterocapsa* sp.1** Chu (1952: 97). (Fig.)

Rounded colonies, rarely irregular, 8.7–51.2 µm diam., isolated or in groups. Sheath firm, hyaline, conspicuous, non-lamellate, granulated. Cells ellipsoidal, 3.3–5.5 × 2.3–4.0 µm. Spores not observed. Cell content granulated, pale purple.

**Habitat:**—Tree bark in the inner forest.

**Notes:**—As diacritical features, *Asterocapsa* sp.1 has a corticolous habitat, elipsoidal cells, and hyaline and non-lamellate sheaths. *Asterocapsa hyalina* (Chu) Chu (1952: 100) and *Asterocapsa ocellata* H.X.Xiao (2000: 399) most resemble *A.* sp.1, differing by the epilithic habitat of both, and by sparks in the individual sheath of *A. hyalina* and dark and verrucous cells envelopes in *A. ocellata.*

**Studied material:**—BRAZIL. São Paulo: Cananéia, State Park of “Ilha do Cardoso” (Perequê), 25º05‟08”S, 47º55‟30”W, 30 June 2010, *W.A. Gama-Jr.* & *C.F.S. Malone* (SP 401442, SP 401444).

***Asterocapsa* sp.2** Chu (1952: 97) (Fig.)

Rounded, elongated to irregular colonies, 5.5–79.7 µm diam., isolated or in groups. Sheath firm, hyaline to reddish-brown and violet, conspicuous, rarely lamellate, smooth to granulated. Cells ellipsoidal to irregular, 3.8–5.7 × 2.5–3.9 µm. Spores dark reddish brown, solitary, 5.4–7.4 × 3.5–5.6 µm. Cell content granulated, green up to blue-green.

**Habitat:**—Dry concrete wall.

**Notes:**—*Asterocapsa* sp.2 is a peculiar morphotype since the granulation in its sheaths are rarely observed, possible to see only under immersion (1000x). Despite of this, the Atlantic Rainforest population has the typical life cycle described for *Asterocapsa* (Chu 1952: 97), and differs from others species by sheath color, elliptical shape, and cell dimensions.

**Studied material:**—BRAZIL. São Paulo: Peruíbe, Ecological Station “Juréia-Itatins”, 24°23.013'S, 47°04.836'W, 17 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427324); 24°22.739'S, 47°04.719'W, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427333); Cananéia, State Park of “Ilha do Cardoso” (Perequê), 25º04'08''S, 47º55'88''W, 29 June 2010, *W.A. Gama-Jr.* & *C.F.S. Malone* (SP 401440, SP 401438).

***Chroococcus subviolaceus*** (Wille) Gama-Jr., Laughinghouse IV & Sant’Anna*status novus* (Fig. 4D–F)

**Basionym: *Chroococcus turgidus* var. *subviolaceus*** Wille (1913: 144).

Elliptical to irregular colonies, 13.0–48.0 µm diam., 2–4–8–16 celled, rarely more. Sheath firm, hyaline, conspicuous, slightly or non-lamellate, smooth. Cells ellipsoidal, hemispherical to polygonal, (6.1)7.2–10.4(17.1) µm diam. Cell content homogeneous to granulated, brown-purple to purple.

**Habitat:**—Rocks near a waterfall and concrete.

**Notes:**—*Chroococcus turgidus* var. *subviolaceus* Wille (1913: 144) was first found growing on rocks, among *Plectonema* and *Tolypothrix* trichomes, in Samoa (Wille 1914). The features that make this variety different from *C. turgidus* (Kützing) Nägeli (1849: 46) are the purple cell content, the epiphytic habitat, the non-lamellated sheath, and the smaller cell diameter. However, these characteristics are substantial enough to classify *Chroococcus turgidus* var. *subviolaceus* as a separate species from *C. turgidus*. According to the Atlantic Rainforest material, we can say that *C. subviolaceus* (Wille) Gama-Jr., Laughinghouse IV & Sant’Anna *stat. nov.* may be very common in tropical terrestrial habitats of humid forests.

Komárek & Anagnostidis (1998) considered this variety as a synonym of *Chroococcus westii* Boye-Petersen (1923: 263). However, this species was first described in small Iceland lakes, and besides the habitat, Boye-Petersen (1923) mentioned that *C. westii* is quite different from *C. turgidus* var. *subviolaceus* by its bigger cell diameter and by the sheaths being distinctly lamellate. Thus, we also do not agree with the proposal by Komárek & Anagnostidis (1998) and propose the new status of this variety.

**Studied material:**—BRAZIL. São Paulo: Peruíbe, Ecological Station “Juréia-Itatins”, 24°23.737'S, 47°00.699'W, 16 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427320); 24°22.694'S, 47°04.793'W, 16 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427321); 24°22.685'S, 47°04.797'W, 16 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427322); 24°23.013'S, 47°04.836'W, 17 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427324); 24° 23.708'S, 47°07.324'W, 17 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427330); 24°22.739'S, 47°04.719'W, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427333).

***Chroococcus tenax*** (Kirchner) Hieronymus (1892: 483). (Fig. 4G–H)

**Basionym:** *Chroococcus turgidus* var. *tenax* Kirchner (1878: 262).

Rounded to elliptical colonies, 18.0–54.7 µm diam., 2–4(8–16) celled. Sheath firm, hyaline, conspicuous, intensely lamellate, smooth. Cells ellipsoidal to hemispherical after division, 12.7–20.7 µm diam. Cell content granulated, blue-green to olive green.

**Habitat:**—Waterlogged soil.

**Studied material:**—BRAZIL. São Paulo: Cananéia, State Park of “Ilha do Cardoso” (Perequê), 25º04'08''S, 47º55'88''W, 29 June 2010, *W.A. Gama-Jr.* & *C.F.S. Malone* (SP 401439).

***Chroococcus varius*** A. Braun in Rabenhorst (1876: 2451).(Fig. 4I)

Rounded, elliptical to irregular colonies, 8.8–12.2 µm diam., 2–4–8–16 celled. Sheath firm, hyaline to brown, conspicuous, non-lamellate, smooth. Cells spherical to hemispherical, 3.2–4.6(5.1) µm diam. Cell content homogeneous to slightly granulated, blue-green up to yellowish.

**Habitat:**—Wet rocks.

**Studied material:**—BRAZIL. São Paulo: Peruíbe, Ecological Station “Juréia-Itatins”, 24°24.146'S, 47°03.648'W, 15 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427310).

***Chroococcus* cf. *minor*** (Kützing) Nägeli (1849: 47). (Fig. 4J–K)

**Basionym:** *Protococcus minor* Kützing (1845: 144).

Irregular colonies, 8.6–24.2 µm diam., 2–4–8 celled. Sheath diffluent, hyaline, inconspicuous, homogeneous, smooth. Cells spherical to hemispherical, 2.8–3.4 µm diam. Cell content homogeneous to slightly granulated, blue-green.

**Habitat:**—Dry soil.

**Notes:**—*Chroococcus minor* (Kützing) Nägeli (1849: 47) is probably a polyphyletic species, since it is reported for distinct environments (Komárek & Anagnostidis 1998). Kützing (1845) predicted this variability when he described three different varieties for *C. minor*, separating them by habitat. Hence, the population found in the Atlantic Rainforest is similar to var. *mucosus*, since both grow on soils, a habitat not related to the typical *C. minor*. However, the utilization of varieties in cyanobacteria seems incongruent to the species concept, but the species concept is not well defined (Johansen & Casamatta 2005). Moreover, these varieties were never used, not cited by Nägeli (1849) or any other author.

**Studied material:**—BRAZIL. São Paulo: São Luís do Paraitinga, State Park of “Serra do Mar” (Santa Virgínia), 23º20'36''S, 45º07'44''W, 24 February 2010, *W.A. Gama-Jr.* (SP 401425); Cananéia, “Recanto do Mar” Inn, 25º01'16''S, 47º55'31''W, 30 June 2010,*W.A. Gama-Jr.* & *C.F.S. Malone* (SP 401446).

***Chroococcus* cf. *turgidus*** (Kützing) Nägeli (1849: 46). (Fig. 5A–C)

**Basionym:** *Protococcus turgidus* Kützing (1846: 5).

Elliptical colonies, 17.7–25.8 × 13.4–16.8 µm, 2–4 celled, rarely more. Sheath firm, hyaline, conspicuous, non-lamellate, smooth. Cells hemispherical, rarely elliptical, 7.8–14.1 µm diam. Cell content granulated, blue-green to olive green.

**Habitat:**—Dry soil.

**Notes:**—*Chroococcus turgidus* (Kützing) Nägeli (1849: 46) is a problematic species. Kützing (1846) described it with a wide cell diameter, 20.0–71.4 µm (1/100–1/28''', converted as proposed by Stearn (1992)), and did not indicate the habitat, only separating two varieties by color. Nowadays, there are many different species/varieties related and similar to *C. turgidus*, but none of them are typically terrestrial, which makes the Atlantic Rainforest population distinguishable from *C. turgidus* and its relatives.

**Studied material:**—BRAZIL. São Paulo: Cananéia, “Recanto do Mar” Inn, 25º01'16''S, 47º55'31''W, 30 June 2010, *W.A. Gama-Jr.* & *C.F.S. Malone* (SP 401446).

***Chroococcus* cf. *varius*** A. Braun in Rabenhorst (1876: 2451). (Fig. 5D–E)

Rounded, elliptical to irregular colonies, 8.8–17.4 µm diam., 2–4–8 celled, forming packets. Sheath firm, hyaline, conspicuous, distinctly lamellate to non-lamellate, smooth. Cells spherical to hemispherical, 2.5–4.2 µm diam. Cell content homogeneous to slightly granulated, olive green to yellowish.

**Habitat:**—Dry wood and tree bark.

**Notes:**—The present population is different from *C. varius* A. Braun in Rabenhorst in relation to habitat, since it was found on wood and it is typically described from rocks (Komárek & Anagnostidis 1998).

**Studied material:**—BRAZIL. São Paulo: São Luís do Paraitinga, State Park of “Serra do Mar” (Santa Virgínia), 23º20'16''S, 45º09'01''W, 22 February 2010, *W.A. Gama-Jr.* (SP 401420); 23º20'12''S, 45º08'44''W, 23 February 2010, *W.A. Gama-Jr.* (SP 401421); Cananéia, State Park of “Ilha do Cardoso” (Perequê), 25º04'46''S, 47º55'18''W, 29 June 2010, *W.A. Gama-Jr.* & *C.F.S. Malone* (SP 401441).

***Cyanosarcina* sp.** Kováčik (1988: 175) (Fig.)

Irregular packed and rare colonies; isolated cells often present. Sheath firm to diffluent, hyaline to dark red, conspicuous to inconspicuous, non-lamellate, smooth. Cells spherical, hemispherical to irregular, (4.4)5.2–6.7 µm diam. Cell content homogeneous to slightly granulated, brownish purple.

**Habitat:**—Dry concrete wall.

**Notes:**—This morphotype resembles both the genera *Cyanosarcina* Kováčik (1988: 175) and *Chroococcus* Nägeli (1849: 45). With the first, it has the giant sarcinoid cells in common, formed by successive divisions. With the second, this population shares the isolated cell shape and the colored sheaths. In spite of this, we chose to keep this material identified as *Cyanosarcina* due to ‘giant cells’ (Fig. ), which are not described in *Chroococcus*. We judge this to be a more relevant character than the colored sheaths, because the envelopes are colored only in senescent stages. However, we do not discard the possibility that this population is a new genus, distinct from both.

**Studied material:**—BRAZIL. São Paulo: Cananéia, State Park of “Ilha do Cardoso” (Perequê), 25º04‟08”S, 47º55‟88”W, 29 June 2010, *W.A. Gama-Jr.* & *C.F.S. Malone* (SP 401439).

***Cyanostylon gelatinosus*** Azevedo & Sant’Anna (1994: 76). (Fig. 5F–H)

Dendroid up to irregular, dense gelatinous colonies, 3–50 celled, up to more. Mucilaginous stalks tubular, rounded to elliptical, branched, firm, hyaline, conspicuous, lamellate, 5.7–8.4 µm diam. Cells spherical, (1.2)1.5–2.7(3.2) µm diam., 1–2 disposed at stalk end. Cell content homogeneous, blue-green.

**Habitat:**—Cave wet walls.

**Studied material**:—BRAZIL. São Paulo: Ubatuba, “Sununga” Beach (Gruta-que-chora), 23°31'S, 45°08'W, 12 April 2003, *M.T. Fujii et al.* (SP 401448).

***Cyanostylon* cf. *gelatinosus*** Azevedo & Sant’Anna (1994: 76). (Fig. 5I)

Dendroid, dense gelatinous colonies, 3–30 celled, rarely more. Mucilaginous stalks tubular, rounded to elliptical, simple, firm, hyaline to slightly brown, conspicuous, lamellate, 3.1–7.5 µm diam. Cells spherical, 1.7–2.4 µm diam., 1–2 disposed at stalk end. Cell content homogeneous, pale blue-green.

**Habitat:**— Concrete wet walls.

**Notes:**—*Cyanostylon gelatinosus* Azevedo & Sant’Anna (1994: 76) was described from caves at the seafront, different from the habitat where the present population was found, which is on concrete directly exposed to sunlight near the forest. Despite the habitat, they are quite similar morphologically, except for stalk color, which can be brown in *C.* cf. *gelatinosus* and is always hyaline in *C. gelatinosus* (Azevedo & Sant’Anna 1994).

**Studied material**:—BRAZIL. São Paulo: São Luís do Paraitinga, State Park of “Serra do Mar” (Santa Virgínia), 23º20'36''S, 45º07'44''W, 24 February 2010, *W.A. Gama-Jr.* (SP 401423).

***Cyanostylon* sp.** Geitler (1928a: 441) (Fig.)

Dendroid, stratified, dense gelatinous colonies, 8–50 celled, often more. Mucilaginous stalks tubular, shorts, rounded to elliptical, simple, firm, hyaline to slightly brown and purple, conspicuous, lamellate, 8.0–9.5 × 3.1–7.5 µm. Cells spherical, (2.5)3.0–4.5 µm diam., 1–4 disposed at stalk end. Cell content homogeneous, pale olive-green.

**Habitat:**—Wet rocks near a waterfall.

**Notes:**—This population is similar to *Stilocapsa lilacina* Xiu & H.X. Xiao (2004: 206), mainly due to the coloration and structure of the colonies, and also the cell diameter. They differ in relation to the cell content and diameter of stalks, which are respectively granulated and wider in *S. lilacina* (15.0–26.0 µm diam.). However, this species is invalidly published since the authors did not designate a type (as well as a habitat). Since *Stilocapsa* Ley (1947: 77) is synonymous to *Cyanostylon*, we kept the Atlantic Rainforest population as *Cyanostylon* sp.

**Studied material:**—BRAZIL. São Paulo: Peruíbe, Ecological Station “Juréia-Itatins”,24° 23.708'S, 47°07.324'W, 17 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427330); 24° 23.703'S, 47° 07.330'W, 17 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427331).

***Endospora rubra*** Gardner (1927: 28). (Fig. 6A–B)

Sarcinoid to irregular colonies, 13.0–51.2 µm diam., sub-colonies paired with each other. Sheath firm, hyaline to rusty red, conspicuous, lamellate to non-lamellate, finely granulated. Cells polygonal, (4.4)6.5–9.5(16.3) µm diam. Cell content granulated, blue-green.

**Habitat:**—Wet rocks and dry roof.

**Notes:**—Bourrelly (1970) considered *Endospora rubra* Gardner (1927: 28) in the genus *Myxosarcina* Printz (1921: 35)*.* However, neither this author, nor Gardner (1927), described the typical baeocyte formation for this species, which is diacritical in *Myxosarcina*. Komárek & Anagnostidis (1998) suggested that *E. rubra* belonged to the genus *Cyanosarcina* Kováčik (1988: 175), since this species had the typical sarcinoid colonial arrangement. However, *Cyanosorcina* is not described as having colored envelopes, which is typical for *E. rubra*. The genus *Gloeocapsopsis* Geitler ex Komárek (1993: 23)has all these features: 1) the sarcinoid arrangement of colonies; 2) the colored sheaths; and 3) the formation of resistant cells by thickening of cell envelopes when they are inside the colony. Based on morphological features and due to baeocytes never being found in the Brazilian material, we suggest that *E. rubra* truly belongs to the genus *Gloeocapsopsis*. However, due to lack of information on the phylogenetic position of *Gloeocapsopsis* and its related genera like *Cyanosarcina* and *Asterocapsa* Chu (1952: 97)*,* we choose not to synonymize these taxa yet.

**Studied material:**—BRAZIL. São Paulo: São Luís do Paraitinga, State Park of “Serra do Mar” (Santa Virgínia), 23º20'16''S, 45º09'01''W, 22 February 2010, *W.A. Gama-Jr*. (SP 401418); 23º20'10''S, 45º08'44''W, 24 February 2010, *W.A. Gama-Jr.* (SP 401434).

***Gloeocapsopsis* *chroococcoides***(Nováček) Komárek (1993: 24). (Fig. 6C–D)

**Basionym:** *Gloeocapsa chroococcoides*Nováček (1934: 100, 139).

Sarcinoid, rounded to elongated colonies, rarely irregular, 15.5–50.0 µm diam., sub-colonies absent. Sheath firm, violet-rosy to dark violet, conspicuous, rarely lamellate, smooth to finely granulated. Cells ellipsoidal, hemispherical to polygonal, 10.1–16.8 µm diam. Cell content granulated, blue-green to olive green, a vacuole-like body frequently present.

**Habitat:**—Dry concrete wall.

**Studied material:**—BRAZIL. São Paulo: São Luís do Paraitinga, State Park of “Serra do Mar” (Santa Virgínia), 23º20'36''S, 45º07'44''W, 24 February 2010, *W.A. Gama-Jr.* (SP 401425); Cananéia, State Park of “Ilha do Cardoso” (Perequê), 25º04'08''S, 47º55'88''W, 29 June 2010, *W.A. Gama-Jr.* & *C.F.S. Malone* (SP 401438); 25º04'08''S, 47º55'88''W, 29 June 2010, *W.A. Gama-Jr.* & *C.F.S. Malone* (SP 401440); São Paulo, Institute of Botany, 23°38'32''S, 46°37'21''W, 29 November 2011, *W.A. Gama-Jr.* (SP 427335).

***Gloeocapsopsis dvorakii*** (Nováček) Komárek & Anagnostidis (1986: 191). (Fig. 6E–F)

**Basionym:** *Gloeocapsa dvorakii* Nováček (1929: 1).

Sarcinoid, rounded to irregular colonies, 11.0–134.4 µm diam., sub-colonies present, overlapped. Sheath firm, orange to rusty red, conspicuous, slightly lamellate, smooth to finely granulated. Cells ellipsoidal, hemispherical to polygonal, 3.5–9.2 µm diam. Cell content granulated, blue-green.

**Habitat:**—Dry rope and roof, and wet rocks.

**Studied material:**—BRAZIL. São Paulo: São Luís do Paraitinga, State Park of “Serra do Mar” (Santa Virgínia), 23º20'35''S, 45º08'17''W, 24 February 2010, *W.A. Gama-Jr.* (SP 401432); 23º20'10''S, 45º08'44''W, *W.A. Gama-Jr.* (SP 401433); 23º20'10''S, 45º08'44''W, 24 February 2010, *W.A. Gama-Jr.* (SP 401434); Cananéia, State Park of “Ilha do Cardoso” (Perequê), 25º04'12''S, 47º55'27''W, 26 June 2010, *W.A. Gama-Jr. & C.F.S. Malone* (SP 401436).

***Gloeocapsopsis* sp.1** Geitler ex Komárek (1993: 229) (Fig.).

Sarcinoid, rounded to irregular colonies, 14.6–159.4 µm diam., sub-colonies often present, overlapped. Sheath firm, hyaline to orange, rusty red, conspicuous, lamellate, finely granulated. Cells ellipsoidal, hemispherical to polygonal, 6.1–10.6 µm diam. Cell content granulated, blue-green to olive-green.

**Habitat:**—Dry tree bark.

**Notes:**—The studied population is morphologically similar to *Gloeocapsopsis dvorakii* (Nováček) Komárek & Anagnostidis (1986: 191) and *G. magma* (Brébisson) Komárek & Anagnostidis (1986: 191). However, these species usually do not have lamellated sheaths and the coloration pattern found in *Gloeocapsopsis* sp.1 is different. These features were constantly observed in all three populations found in the Atlantic Rainforest. Except for *G. ferruginea* Komárek & Watanabe (1998: 123), which was found as an epiphyte on filamentous algae in a lake, all *Gloeocapsopsis* species are described to rocks, a different habitat from the analyzed material.

**Studied material:**—BRAZIL. São Paulo: São Luís do Paraitinga, State Park of “Serra do Mar” (Santa Virgínia), 23º20'36''S, 45º07'44''W, 24 February 2010, *W.A. Gama-Jr.* (SP 401424); 23º20'36''S, 45º08'17''W, 24 February 2010, *W.A. Gama-Jr.* (SP 401429); Peruíbe, Ecological Station “Juréia-Itatins”, 24°23.018'S, 47°04.847'W, 17 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427326).

***Gloeocapsopsis* sp.2** Geitler ex Komárek (1993: 229) (Fig.).

Sarcinoid, rounded, elongated to irregular colonies, 71.7–123.2 µm diam., sub-colonies present, overlapped. Sheath firm, hyaline (rare) to dark-brown, conspicuous, non-lamellate, smooth. Cells irregularly spherical, ellipsoidal, hemispherical, 6.7–10.6 µm diam. Cell content hardly granulated, olive-green.

**Habitat:**—Wet rocks.

**Notes:**—The population herein present is distinguishable from others *Gloeocapsopsis* species by the colonies arrange, shape of cells and sheath color. Moreover, the cells were not polygonal and their content is intensely granulated, what is not observed in the other types of *Gloeocapsopsis*.

**Studied material:**—BRAZIL. São Paulo: Cananéia, State Park of “Ilha do Cardoso” (Perequê), 25º04'12''S, 47º55'27''W, 26 June 2010, *W.A. Gama-Jr.* & *C.F.S. Malone* (SP 427336).

***Nephrococcus shilinensis*** Tian in Tian *et al.* (2001: 280). (Fig. 6G–I)

Sarcinoid, rounded to elongated colonies up to irregular, 25.4–340.0 µm diam., sub-colonies present, 2–4–8–16 celled, overlapping. Sheath firm, orange to red, more intense in inner layers, conspicuous, lamellate, finely granulated. Cells reniform to ellipsoidal, (3.3)8.1–10.4(15.5) µm diam. Cell content finely granulated, blue-green to olive green.

**Habitat:**—Wet rocks.

**Studied material:**—BRAZIL. São Paulo: São Luís do Paraitinga, State Park of “Serra do Mar” (Santa Virgínia), 23º20'16''S, 45º09'01''W, 22 February 2010, *W.A. Gama-Jr.* (SP 401418).

***Pseudocapsa dubia*** Ercegović (1925: 95). (Fig. 6J–K)

Rounded to irregular colonies, 8.0–33.0 µm diam., sub-colonies present. Sheath firm, hyaline to brown, conspicuous, non-lamellate, smooth. Cells spherical, hemispherical to irregular, 2.0–4.0 µm diam., radially arranged in mature colonies. Cell content homogeneous, blue-green to yellow.

**Habitat:**—Wet walls in a cave.

**Studied material:**—BRAZIL. São Paulo: Ubatuba, “Sununga” Beach (Gruta-que-chora), 23°31'S, 45°08'W, 12 April 2003, *M.T. Fujii et al.* (SP 401448).

***Pseudocapsa* sp.** Ercegović (1925: 95) (Fig.)

Isolated or composed colonies formed by rounded to irregular sub-colonies, 6.4–12.5 µm diam. Sheath firm, hyaline to dark brown, conspicuous, non-lamellate, smooth. Cells hemispherical to irregular, 2.7–3.8 µm diam. without sheath; 2.9–4.4 µm diam. with sheath, radially arranged in mature colonies. Cell content homogeneous, pale blue-green.

**Habitat:**—Dry wood.

**Notes:**—This population resembles *Pseudocapsa dubia* Ercegović (1925: 95) differing mainly by habitat, which is wet cave wall for *P. dubia* and dry wood for *Pseudocapsa* sp.

**Studied material:**—BRAZIL. São Paulo: São Luís do Paraitinga, State Park of “Serra do Mar” (Santa Virgínia), 23º20'12''S, 45º08'44''W, 23 February 2010, *W.A. Gama-Jr.* (SP 401421).

**Family Microcystaceae Elenkin (1933: 19).**

***Chondrocystis* *dermochroa*** (Nägeli) Komárek & Anagnostidis (1995: 17). (Fig. 7A)

**Basionym:** *Gloeocapsa dermochroa* Nägeli (1849: 51).

Sarcinoid colonies up to irregular, 26.5–64.3 µm diam., sub-colonies densely packed. Sheath firm, hyaline, conspicuous, homogeneous, smooth. Cells spherical to hemispherical, 1.8–2.4 µm diam. Cell content homogeneous, blue-green.

**Habitat:**—Rocks covered by a water slide near a waterfall.

**Studied material:**—BRAZIL. São Paulo: São Luís do Paraitinga, State Park of “Serra do Mar” (Santa Virgínia), 23º20'16''S, 45º09'01''W, 22 February 2010, *W.A. Gama-Jr.* (SP 401419).

***Gloeocapsa compacta*** Kützing (1845: 24). (Fig. 7B–C)

Rounded, elliptical to irregular colonies, 7.3–168.8 µm diam., 2–4–8 celled, rarely more. Sheath firm in outer layer, diffluent in inner, brown to purple, conspicuous, rarely lamellate, smooth to slightly granulated. Cells spherical to hemispherical, 4.3–5.4 µm diam. Cell content homogenous to sparsely granulated, blue-green. Spores dark orange, solitary or in groups after releasing, 3.3–4.0 µm diam.

**Habitat:**—Tree bark and dry rocks.

**Studied material:**—BRAZIL. São Paulo: Cananéia, “Recanto do Mar” Inn, 25º01'16''S, 47º55'31''W, 30 June 2010, *W.A. Gama-Jr.* & *C.F.S. Malone* (SP 401447); Peruíbe, Ecological Station “Juréia-Itatins”, 24°23.018'S, 47°04.847'W, 17 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427326).

***Gloeocapsa* *nigrescens*** Nägeli in Rabenhorst (1857: 629). (Fig. 7D–G)

Rounded colonies, rarely elongated, 7.3–44.8 µm diam., 2–4–8–16 celled, rarely more. Sheath firm, hyaline to bluish or blackish, conspicuous, rarely lamellate, granulated. Cells spherical to slightly elongated, 3.2–5.4 µm diam. Cell content homogenous to sparsely granulated, blue-green to olive green. Spores elongated to irregular, dark-grey, roughly granulated, solitary or in pairs, 5.8–7.7 µm diam.

**Habitat:**—Dry and wet concrete walls.

**Studied material:**—BRAZIL. São Paulo: São Luís do Paraitinga, State Park of “Serra do Mar” (Santa Virgínia), 23º20'36''S, 45º07'44''W, 24 February 2010, *W.A. Gama-Jr.* (SP 401425); 23º20'10''S, 45º08'44''W, 24 February 2010 *W.A. Gama-Jr.* (SP 401435); Cananéia, State Park of “Ilha do Cardoso” (Perequê), 25º04'08''S, 47º55'88''W, 29 June 2010, *W.A. Gama-Jr.* & *C.F.S. Malone* (SP 401438); 25º04'08''S, 47º55'88''W, 29 June 2010, *W.A. Gama-Jr.* & *C.F.S. Malone* (SP 401437); 25º04'08''S, 47º55'88''W, 29 June 2010, *W.A. Gama-Jr.* & *C.F.S. Malone* (SP 401440) 25º05'08''S, 47º55'30''W, 29 June 2010, *W.A. Gama-Jr.* & *C.F.S. Malone* (SP 401445); Peruíbe, Ecological Station “Juréia-Itatins”, 24°26.420'S, 47°04.588'W, 15 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427305); 24°23.013'S, 47°04.836'W, 17 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427324) 24°22.739'S, 47°04.719'W, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427333).

***Gloeocapsa* *novacekii*** Komárek & Anagnostidis (1995: 19). (Fig. 7H; 8A–C)

Rounded colonies, rarely elongated, 9.6–174.4 µm diam. Sheath firm, hyaline to rosy or dark red, conspicuous, lamellate or non-lamellate, finely granulated. Cells spherical to slightly elongated, 2.7–5.2(6.4) µm diam. Cell content granulated, blue-green up to pale blue-green. Spores elongated to irregular, dark red, roughly granulated, solitary or pairs, 4.6–5.8 µm diam.

**Habitat:**—Dry and wet concrete walls.

**Studied material:**—BRAZIL. São Paulo: São Luís do Paraitinga, State Park of “Serra do Mar” (Santa Virgínia), 23º20'16''S, 45º09'01''W, 22 February 2010, *W.A. Gama-Jr.* (SP 401418); 23º20'10''S, 45º08'44''W, 24 February 2010*W.A. Gama-Jr.* (SP 401435); Cananéia, State Park of “Ilha do Cardoso” (Perequê), 25º04'08''S, 47º55'88''W, 29 June 2010, *W.A. Gama-Jr.* & *C.F.S. Malone* (SP 401438); 25º04'08''S, 47º55'88''W, 29 June 2010, *W.A. Gama-Jr.* & *C.F.S. Malone* (SP 401440); Peruíbe, Ecological Station “Juréia-Itatins”, (24°26.420'S, 47°04.588'W, 15 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427305); 24°24.146'S, 47°03.648'W, 15 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427310); 24°23.013'S, 47°04.836'W, 17 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427324); 24°22.739'S, 47°04.719'W, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427333).

***Gloeocapsa punctata*** Nägeli (1849: 51). (Fig. 8D–E)

Rounded, elliptical to irregular colonies, 3.8–13.8 µm diam., 2–4–8 celled, rarely more. Sheath firm to diffluent, hyaline, conspicuous, rarely lamellate, smooth. Cells spherical to hemispherical, 1.4–2.2 µm diam. Cell content homogenous, blue-green. Spores not observed.

**Habitat:**—Dry concrete wall.

**Studied material:**—BRAZIL. São Paulo: Peruíbe, Ecological Station “Juréia-Itatins”, 24°23.013'S, 47°04.836'W, 17 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427324).

***Gloeocapsa stegophila*** (Itzigsohn) Rabenhorst (1863: 72). (Fig. 8F–G)

**Basionym:** *Monocapsa stegophila* Itzigsohn in Rabenhorst (1853: 263a).

Rounded to elongated colonies, 7.2–32.8(57.7) µm diam., 2–4–8 celled, rarely more. Sheath firm, hyaline to dark orange, conspicuous, rarely lamellate, smooth to slightly granulated. Cells spherical to hemispherical, (2.8)3.2–3.9(4.2) µm diam. Cell content homogenous to sparsely granulated, blue-green. Spores not observed.

**Habitat:**—Tree bark and dry rocks.

**Notes:**—This species differs from *Gloeocapsa rupicola* Kützing (1849: 221) by the pattern of colonial coloration, which is dark reddish in the inner part and almost hyaline at the edge of the colonies (Komárek & Anagnostidis 1998). The cell diameter is also smaller in *G. rupicola*.

**Studied material:**—BRAZIL. São Paulo: Cananéia, “Recanto do Mar” Inn, 25º01'16''S, 47º55'31''W, 30 June 2010, *W.A. Gama-Jr.* & *C.F.S. Malone* (SP 401447); Peruíbe, Ecological Station “Juréia-Itatins”, 24°23.018'S, 47°04.847'W, 17 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427326).

***Gloeocapsa* sp.1** (Kützing 1843: 173). (Fig.).

Rounded, elliptical to irregular colonies, 3.7–18.3(107.8) µm diam., 2–4–8 celled, rarely more. Sheath firm, hyaline to slightly navy-blue, conspicuous, lamellate or not, smooth. Cells spherical to hemispherical, elongated after division, 1.2–2.2 µm diam. Cell content homogenous, olive-green. Spores not observed.

**Habitat:**—Tree bark.

**Notes:**—The studied population from the Altantic Rainforest is similar to *Gloeocapsa punctata* Nägeli (1849: 51), mainly due to the morphometry of colonies and cells. However, they differ to the habitat of *G. punctata* (rocks/concrete) and also by the cell content color and that the sheaths are always hyaline. *Gloeocapsa atrata* Kützing (1843: 174) is another morphologically similar species, in which *Gloeocapsa* sp.1 differs by having smaller cells and a different habitat, since *G. atrata* occurs on wet rocks (Komárek & Anagnostidis 1998).

**Studied material:**—BRAZIL. São Paulo: Cananéia, State Park of “Ilha do Cardoso” (Perequê), 25º05‟08”S, 47º55‟30”W, 30 November 2010, *W.A. Gama-Jr.* & *C.F.S. Malone* (SP 401442).

***Gloeocapsa* sp.2** (Kützing 1843: 173). (Fig.).

Elliptical to irregular colonies, 7.8–73.2 µm diam., 2–4 celled, rarely more. Sheath firm to diffluent, hyaline to brown and purple, conspicuous, lamellate or not, smooth to slightly granulated. Cells spherical to hemispherical, elongated after division, (2.6)3.1–3.8 µm diam. Cell content homogenous or with disperse little granules, blue-green. Spores not observed.

**Habitat:**—Tree bark.

**Notes:**—*Gloeocapsa* sp. 2 most resembles *Gloeocapsa lignicola* Rabenhorst (1865: 41) and *Gloeocapsa compacta* Kützing (1847: 24), differing by the bluish color of colonies in the former, and the smaller cell diameter in the latter.

**Studied material:**—BRAZIL. São Paulo: São Luís do Paraitinga, State Park of “Serra do Mar” (Santa Virgínia), 23º20'35''S, 45º08'17''W, 24 February 2010, *W.A. Gama-Jr.* (SP 401426).

**Family Entophysalidaceae Geitler (1925: 235).**

***Chlorogloea* cf. *novacekii*** Komárek & Montejano (1994: 6). (Fig. 8H–I)

Polarized, elongated colonies, 58.3–95.0 µm length. Sheath firm up to diffluent, hyaline, conspicuous, non-lamellate, smooth. Cells spherical, 2.6–3.2 µm diam., up to cylindrical 1.3–1.9 × 2.7–3.3 µm, arranged in rows. Cell content homogenous or 2–4 granules per cell, pale blue-green.

**Habitat:**—Wet rocks.

**Notes:**—*Chlorogloea novacekii* Komárek & Montejano (1994: 6) was described from a wet cave with a mean temperature lower than 20°C (Komárek & Montejano 1994), different than the environmental conditions found in the Atlantic Rainforest.

**Studied material:**—BRAZIL. São Paulo: São Luís do Paraitinga, State Park of “Serra do Mar” (Santa Virgínia), 23º20'16''S, 45º09'01''W, 22 February 2010, *W.A. Gama-Jr.* (SP 401418).

***Chlorogloea* sp.1** Wille (1900: 5). Fig. ()

Polarized, elongated colonies, 27.0–83.0 µm length. Sheath firm to diffluent, hyaline, conspicuous, non-lamellate, smooth. Cells spherical to elongated, 1.7–2.6 µm diam., arranged in rows, without individual envelopes. Cell content homogenous, pale blue-green.

**Habitat:**—Tree bark.

**Notes:**—The corticulous habitat, cell content color, cell dimensions, and the absence of individual cell envelopes are the diacritical features that distinguish this morphotype from other *Chlorogloea*Wille (1900: 5) species.

**Studied material:**—BRAZIL. São Paulo: São Luís do Paraitinga, State Park of “Serra do Mar” (Santa Virgínia), 23º20'35''S, 45º08'17''W, 24 February 2010, *W.A. Gama-Jr.* (SP 401427).

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***Chlorogloea* sp.2** Wille (1900: 5). Fig. ()

Polarized, rounded to elongated colonies, 19.1–154.4 µm length. Sheath firm to diffluent, hyaline, conspicuous, non-lamellate, smooth. Cells spherical to elliptical, 1.0–1.9(2.8) µm diam., arranged in rows, without individual envelopes. Cell content homogenous, pale purple.

**Habitat:**—Tree bark.

**Notes:**—The color of the cell content is one of the diagnostic features of *Chlorogloea* sp.2, where it resembles *Chlorogloea purpurea* Geitler (1928b: 98). However this species is described as benthic on rocks in alpine lakes, a distinct habitat from the Altantic Rainofest population.

**Studied material:**—BRAZIL. São Paulo: Cananéia, State Park of “Ilha do Cardoso” (Perequê), 25º05'08''S, 47º55'30''W, 30 June 2010, *W.A. Gama-Jr.* & *C.F.S. Malone* (SP 401443).

***Chlorogloea* sp.3** Wille (1900: 5). Fig. ()

Polarized, rounded to elongated colonies, 16.4–133.2 µm length. Sheath firm, hyaline to reddish, conspicuous, lamellate, and finely granulated. Cells spherical to elliptical, 3.0–4.6 µm diam., arranged in rows, with individual envelopes. Cell content homogenous to slightly granulated, blue-green.

**Habitat:**—Dry rope and roof.

**Notes:**—*Chlorogloea* sp.3 is morphometricaly similar to *Aphanocasa richteriana* var. *major* Gardner (1927: 4), differing by the honey color of sheaths and presence of envelopes only in peripheral cells. In spite of *Aphanocapsa* being distinct from *Chlorogloea*, this variety has cells surrounded by individual and colored sheath, not typical in *Aphanocapsa.* Besides, Komárek & Komárková-Legnerová (2007) comment on the relationship of *A. richteriana* var. *major* with *Chlorogloea* species.

**Studied material:**—BRAZIL. São Paulo: São Luís do Paraitinga, State Park of “Serra do Mar” (Santa Virgínia), 23º20'10''S, 45º08'44''W, *W.A. Gama-Jr.* (SP 401433); 23º20'10''S, 45º08'44''W, 24 February 2010, *W.A. Gama-Jr.* (SP 401434).

***Cyanoarbor* aff. *himalayensis*** M.Watanabe & Komárek in Branco *et al.* (2006: 373). (Fig. 9A–B)

Polarized, elongated and lobed colonies, 79.8–157.6 µm diam. Sheath firm, hyaline to brown, conspicuous, non-lamellate, smooth. Cells spherical to slightly elongated, 2.3–3.2 µm diam., arranged in rows. Cell content homogenous, blue-green.

**Habitat:**—Dry concrete wall.

**Notes:**—The genus *Cyanoarbor* Wang (1989: 129)was rediscovered and revised by Branco *et al.* (2006), 17 years after its original description. In this paper, the authors also published the species *Cyanoarbor* *himalayensis* M.Watanabe & Komárek in Branco *et al.* (2006: 373), which resembles the Atlantic Rainforest population by the similar color of the colonies and cell dimensions. However, *C. himalayensis* was described for mountains in Nepal, growing on wet rocks, and only rarely has cells organized in rows (Branco *et al.* 2006). Our population was found on a dry wall surrounded by a preserved Atlantic Rainforest area, with cells always organized in a linear fashion.

**Studied material:**—BRAZIL. São Paulo: São Paulo, Institute of Botany, 23°38'32''S, 46°37'21''W, 29 November 2011, *W.A. Gama-Jr.* (SP 427335).

***Entophysalis arboriformis*** Kaštovský, Fučíková, Hauer & Bohunická (2011: 174). (Fig. 9C–E)

Polarized, arboriform colonies, 11.0–134.4 µm diam., composed by sub-colonies. Sheath firm, hyaline to intensely rusty red, conspicuous, lamellate, smooth. Cells spherical up to polygonal, 3.2–7.1(11.9) µm diam. Cell content granulated, blue-green.

**Habitat:**—Dry rocks.

**Studied material:**—BRAZIL. São Paulo: São Luís do Paraitinga, State Park of “Serra do Mar” (Santa Virgínia), 23º20'35''S, 45º08'17''W, 24 February 2010, *W.A. Gama-Jr.* (SP 401430).

***Entophysalis granulosa*** Kützing (1843: 177). (Fig. 9F–G; 10A)

Polarized, arboriform to irregular colonies, 29.5–118.7 µm length. Sheath firm, hyaline to red-brownish or purple-brownish, conspicuous, lamellate, smooth to finely granulated. Cells spherical, hemispherical to ellipsoidal, 2.1–3.7(4.2) µm diam. Cell content granulated, blue-green.

**Habitat:**—Rocks in tidal zone.

**Studied material:**—BRAZIL. São Paulo: Peruíbe, Ecological Station “Juréia-Itatins”, 24°24.146'S, 47°03.648'W, 15 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427310); 24° 22.783'S, 47°01.287'W, 16 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427312); 24°22.796'S, 47°01.231'W, 16 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427313).

***Entophysalis* cf. *samoensis*** Wille (1913: 144).(Fig. 10B–C)

Polarized, fasciculate colonies, 21.0–115.3 × 8.4–85.1 µm. Sheath firm, hyaline to slightly yellow, conspicuous, non-lamellate, smooth. Cells elliptical, hemispherical, rarely spherical, 2.4–3.4 × 1.0–2.5 µm. Cell content homogenous to granulated, intensely blue-green.

**Habitat:**—Dry concrete.

**Notes:**—*Entophysalis samoensis* Wille (1913: 144) and the material found in the Atlantic Rainforest are similar in color and in the ‘coral shape’ of colonies. However, they differ by a larger cell diameter (3–4 µm) and presence of lamellate sheaths in *E. samoensis*.

**Studied material:**—BRAZIL. São Paulo: Cananéia, State Park of “Ilha do Cardoso” (Perequê), 25º04'08''S, 47º55'88''W, 29 June 2010, *W.A. Gama-Jr.* & *C.F.S. Malone* (SP 401437).

***Entophysalis* sp.1** Kützing (1843: 177). (Fig.).

Polarized, arboriform to irregular colonies, 57.8–125.2 µm length. Sheath firm, hyaline, conspicuous, homogeneous, smooth, with holes. Cells spherical, hemispherical to polygonal, 3.2–8.0 µm diam. Cell content granulated, gray.

**Habitat:**—Wet rock.

**Notes:**—A presence of empty holes throughout the mucilage was found. The cell dimensions and the color content also differs this morphotype from the other *Entophysalis* species.

**Studied material:**—BRAZIL. São Paulo: Peruíbe, Ecological Station “Juréia-Itatins”, 24° 23.311'S, 47° 00.940'W, 16 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427316).

***Entophysalis* sp.2** Kützing (1843: 177). (Fig.)

Polarized, lobate to irregular dense colonies, 38.6–125.4 µm length. Sheath firm, hyaline to yellowish, conspicuous, homogeneous, smooth. Cells spherical, hemispherical to polygonal, 3.6–7.6 µm diam. Cell content granulated, vacuole-like, green to olive green.

**Habitat:**—Wet concrete covered with plants.

**Notes:**—This morphotype is distinguishable by its dense celled colonies, surrounded by a rigid and wide sheath, in addition to the cell content color and vacuole-like structures.

**Studied material:**—BRAZIL. São Paulo: São Luís do Paraitinga, State Park of “Serra do Mar” (Santa Virgínia), 23º20'36''S, 45º07'44''W, 24 February 2010, *W.A. Gama-Jr.* (SP 401422, SP 401423).

**Entophysalidaceae unidentified** (Fig.)

Polarized, arboriform, lobed, rounded to irregular colonies, 43.4–277 µm length, with cells agglomerated in the periphery (lobes) and sparse in the inner. Sheath firm, hyaline in inner colonies to intensely violet to orange brown in colonies at the edge, conspicuous, lamellate, smooth to finely granulated, with holes. Cells spherical, hemispherical to ellipsoidal, 3.4–6.1 µm diam. Cell content granulated, vacuole-like, green to blue-green.

**Habitat:**—Wet rocks.

**Notes:**—The morphotype found has a colonial structure very similar to that found in *Placoma regulare* Broady & Ingerfeld (1991: 548). This species was described for New Zealand and despite being in the genus *Placoma* Schousboe ex Bornet & Thuret (1876: 4), it differs substantially from *P. vesiculosum* Schousboe in Bornet & Thuret (1876: 4), the type-species of the genus. We believe that *P. regulare* and the Atlantic Rainforest population are a putative new genus, characterized by the lobed colonies with cells disposed mainly in the periphery, being surrounded by firm and holed sheaths. According to the erect thalli, this new genus should belong to the family Entophysalidaceae.

**Studied material:**—BRAZIL. São Paulo: São Luís do Paraitinga, State Park of “Serra do Mar” (Santa Virgínia), 23º20'35''S, 45º08'17''W, 24 February 2010, *W.A. Gama-Jr.* (SP 401431), Peruíbe, Ecological Station “Juréia-Itatins”, 24° 22.783'S, 47°01.287'W, 16 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427312).

**Family Chamaesiphonaceae Borzì (1878: 238).**

***Chamaesiphon* *stratosus*** Sant’Anna, Gama-Jr., Azevedo & Komárek (2011: 26). (Fig. 10D–E)

Colonies shrub–like, fan–shaped. Cells club–shaped, rounded at both ends, organized in one layer or at most two, 9.3–20.6(26.8) × 2.3–4(6.5) μm. Sheath U-shaped, distinct, colorless to intensely yellowish-green or brownish, slightly lamellate and frayed when old. Exocytes 1.5–2.6 μm diam., singularly liberated or forming variable number of rows and layers. Cell content brownish or olive-green, slightly granular.

**Habitat:**—Rocks near a river splash zone.

**Studied material:**—BRAZIL. São Paulo: Campos do Jordão, Horto Florestal, 22°41'26.3''S, 45°28'51.4''W, 8 November 2002, *C.L. Sant’Anna, M.T.P. Azevedo & J. Komárek* (SP 400963).

**Family Hyellaceae Borzì (1914: 359).**

***Hyella* cf. *caespitosa* var. *arbuscula*** Al-Thukair & Golubić (1996: 84). (Fig. 10F–G)

Main thallus with polygonal cells, 4.4–5.2 µm diam. Pseudofilaments radiating into substrate, 30.8–78.0 µm length, branched, uniseriate. Sheath firm, hyaline, conspicuous, non-lamellate, smooth. Middle cells of pseudofilaments quadratic to rectangular, 1.9–3.6 × 3.3–9.0 µm. Apical cells of pseudofilaments tortuous, rounded ends, 1.9–2.8 × 10.6–17.0 µm. Baeocytes produced by the main thallus, more than 20 per cell, 1.2–1.6 µm diam. Cell content homogenous, rosy to purple-brown.

**Habitat:**—Rocks in tidal zone.

**Notes:**—The habitat and morphology of the colonies and cells of the Brazilian population are similar to those described for *Hyella caespitosa* var. *arbuscula* Al-Thukair & Golubić (1996: 84). However, the dimensions of all structures were smaller.

**Studied material:**—BRAZIL. São Paulo: Peruíbe, Ecological Station “Juréia-Itatins”, 24°23.368'S, 47°00.671'W, 16 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427318).

***Pleurocapsa* cf. *aurantiaca*** Geitler (1932: 354). (Fig. 10H–J)

Polarized, fasciculate colonies, with cells densely packed. Cells hemispherical to elliptical 3.8–6.8 µm diam. Pseudofilaments dichotomous, biseriate, 5–17 celled, 20.2–59.2 × 8.4–13.4 µm. Sheath firm, yellow to dark brown, conspicuous, non-lamellate, smooth. Baeocytes not observed. Cell content homogenous, blue-green to green brownish.

**Habitat:**—Rocks covered by a water slide.

**Notes:**—Despite baeocytes not being found, colonial arrangement was typical of *Pleurocapsa.* The population described resembles *Pleurocapsa aurantiaca* Geitler (1932: 354) in relation to habitat and colonial morphology. However, this species has larger cell diameter and orange/red sheaths.

**Studied material:**—BRAZIL. São Paulo: Peruíbe, Ecological Station “Juréia-Itatins”, 24° 22.783'S, 47°01.287'W, 16 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427312).

***Pleurocapsa* sp.** Thuret in Hauck (1885: 555). (Fig. ).

Rounded, elliptical, club-shaped cells, 4.1–22.4 µm diam., isolated or forming dense colonies. Pseudofilaments simple or dichotomous, uniseriate, 3–8 celled, 20.2–59.2 × 6.4–8.7 µm. Sheath firm, hyaline to blackish, conspicuous, non-lamellate, smooth. Baeocytes (many, >20 per cell) spherical, 2.4–2.8 µm diam. Cell content homogenous, green brownish to brown-purplish.

**Habitat:**—Dry concrete covered by dry soil.

**Notes:**—The morphological analyses showed that this population has the same life cycle of *Pleurocapsa* group I described by Waterbury & Stanier (1978). In relation to species, most of *Pleurocapsa* are originally described to marine environments, being *Pleurocapsa muralis* Lagerheim in Wittrock & Nordstedt (1893: 195) the only species described to a terrestrial environment. However, we could not access the original description of this species to confirm the resembles from it to the Atlantic Rainforest population.

**Studied material:**—BRAZIL. São Paulo: São Luís do Paraitinga, State Park of “Serra do Mar” (Santa Virgínia), 23º20'36''S, 45º07'44''W, 24 February 2010, *W.A. Gama-Jr.* (SP 427340).

**Família Xenococcaceae** Ercegović (1932).

***Chroococcidiopsis* sp.** Geitler (1933: 625). (Fig. )

Rounded, elliptical, elongated cells, (3.5)4.6–13.7 µm diam., isolated or forming colonies. Sheath firm, hyaline, conspicuous, non-lamellate, smooth. Baeocytes (many, >15 per cell) spherical to irregular, 2.0–2.9 µm diam. Cell content homogenous to slightly granulated, green brownish to brown-purplish.

**Habitat:**—Wet concrete.

**Notes:**— Cell content color, cell dimensions, including baeocytes, and the habitat, cause this morphotype to be different from other *Chroococcidiopsis* species.

**Studied material:**—BRAZIL. São Paulo: São Luís do Paraitinga, State Park of “Serra do Mar” (Santa Virgínia), 23º20'10''S, 45º08'44''W, 24 February 2010*W.A. Gama-Jr.* (SP 427348).

***Myxosarcina* sp.** Printz (1921: 35). (Fig.).

Sarcinoid colonies, 20.3–48.4 µm diam., isolated or agglomerated. Sheath firm, hyaline, conspicuous, non-lamellate, smooth. Cells spherical, elliptical to polygonal, 6.3–13.0 µm diam. Baeocytes (many, >20 per cell) spherical to irregular, 2.7–3.7 µm diam. Cell content granulated, dark green to olive-green.

**Habitat:**—Wet rocks and concrete covered with plants.

**Notes:**—The studied population is similar to *Myxosarcina decolorata* (Varma & Mitra) Komárek & Anagnostidis (1995: 21). However they differ by of *M. decolorata* having rounded cells, wider and wrinkled sheaths, and the number of beocytes (1–8).

**Studied material:**—BRAZIL. São Paulo: São Luís do Paraitinga, State Park of “Serra do Mar” (Santa Virgínia), 23º20'36''S, 45º07'44''W, 24 February 2010, *W.A. Gama-Jr.* (SP 427338); Peruíbe, Ecological Station “Juréia-Itatins”, 24° 23.311'S, 47° 00.940'W, 16 August 2011, *W.A. Gama-Jr.*, *G.S. Hentschke*, *C.F.S. Malone &* C*.L. Sant’Anna* (SP 427303).

**Discussion**

In regards to new citations, the present study found seven species which are putative first reports for South America (i.e. *Asterocapsa aerophytica* Lederer 2000: 24, *Chroococcus subviolaceus* Gama-Jr., Laughinghouse IV & Sant’Anna *stat. nov.*, *Gloeocapsopsis chroococcoides* (Nováček) Komárek 1993: 24, *Nephrococcus shilinensis* Tian in Tian *et al.* 2001: 280, *Chondrocystis dermochroa* (Nägeli) Komárek & Anagnostidis 1995: 17, *Gloeocapsa novacekii* Komárek & Anagnostidis 1995: 19, and *G. stegophila* (Itzigsohn) Rabenhorst 1863: 72).The majority have been described for a long time, but have never been found in South America. We believe this is associated to the focus of previous studies, which were scarcely concentrated on the floristics of tropical terrestrial habitats. In addition to these new occurrences, four species currently reported were never found after their original descriptions: 1) *Nephrococcus shilinensis* was the second species described to *Nephrococcus* Li (1984: 191), and until now this genus has only been found in China (Tian *et al.* 2001); 2) *Entophysalis arboriformis* Kaštovský, Fučíková, Hauer & Bohunická (2011: 174) was described from Mt. Roraima (Venezuela) as endemic (Kaštovský *et al.* 2011); 3) *Asterocapsa aerophytica* is the only species of this genus described from Europe (Lederer 2000); however, we have found all its life cycle, which together with the habitat confirms the identification of the Atlantic Rainforest population; and 4) *Endospora rubra* Gardner (1927: 29), which is a morphologically complex species (see *E. rubra* notes herein showed), but was also found in the Atlantic Rainforest after being described and reported only from Puerto Rico (USA). Recording these species is important for understanding their geographical distribution, and better characterizing their morphology, which contributes to the systematic knowledge by recovering these rarely cited species that will facilitate identifying them in future studies.

We found that the species of cyanobacteria were more associated to habitat conditions than to geographical distance. This is related in literature (Bahl *et al*. 2011), and is herein exampled by the report of species found in continental Europe (e.g. *Gloeocapsopsis dvorakii* (Nováček) Komárek & Anagnostidis 1986: 191, *G. chroococcoides (*Nováček) Komárek 1993: 24, *Asterocapsa aerophytica* Lederer 2000: 24). All material found in the Atlantic Rainforest matched with these species in their morphological and ecological features, and probably they respond to the microclimate found in each substrate, what justify their occurrence in a tropical region, even being described to a temperate one.

Specific floristic studies on tropical coccoid cyanobacteria are rare, but large species diversity is a common theme among those undertaken in this habitat. McGreggor (2013) recently published the flora of freshwater coccoid cyanobacteria from northeastern Australia, and found 112 taxa, with 25 identified to generic level. These results attest that these organisms are not well known in tropical/subtropical zones, even in aquatic environments. As terrestrial cyanobacteria are mostly unexplored, studies on their biodiversity show a very promising field for new discoveries.

Nabout *et al.* (2013) estimates that 3,582 species of cyanobacteria (57% of the total estimated number) worldwide have yet to be described, demonstrating how their diversity is still undiscovered. These authors used different statistical models to achieve this number and pointed this elevated value as a consequence to the lack of biodiversity studies, mainly those related to poorly known environments, such as tropical/subtropical and terrestrial.

The present study is a great example of these assumptions, since it reported 40 taxa of coccoid cyanobacteria in the terrestrial habitats of the Atlantic Rainforest. Moreover, 21 unidentified coccoid taxa were also found in this environment, which probably represent one new genus, and 20 new species, with two already described (*Chamaesiphon stratosus* Sant’Anna *et al.* 2011b: 26, and *Lemmermanniella terrestris* Gama-Jr. in Gama-Jr *et al.* 2012: 320). Considering all data, 61 taxa of coccoid cyanobacteria were found in the Atlantic Rainforest, 34.4% probably correspond to new taxa. These numbers are much higher than those found in cyanobacterial inventory studies (floras) on terrestrial habitats from this ecosystem, which found 14, 12, and six coccoid species (Branco *et al.* 1996, 2009; Büdel *et al.* 2002) respectively, reinforcing the idea that studies with specific taxonomic groups always enhance the possibility of discovering new or little known taxa. Thus, the results herein confirm a high biodiversity of coccoids in the terrestrial environments from the Atlantic Rainforest, and also highlight the great importance to study this group of cyanobacteria.

**Conclusions**

Due to the high number of coccoid cyanobacterial species, we find that this group needs large floristic studies, and the diversity is surely much higher than previously believed. Directing studies to unknown environments, focused on this specific cyanobacterial group and terrestrial habitats from tropical/subtropical zones, the knowledge of their biodiversity will most likely increase. We think Brazil's Atlantic Rainforest possesses a great part of this cyanobacterial richness, since it has a huge variability of habitats, which enhances the possibilities for different species to survive. However, due to the scarcity of studies in this biome and to its large deforested areas, this diversity is substantially and continuously threatened.

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**Captions**

**Figure 1**

**A**–**B:** *Aphanothece microscopica.* A: general colony aspect. B: colonies with cylindrical cells and visible chromatoplasm (arrow). **C–E:** *Aphanothece saxicola.* C-D: general colony aspect with cells in an individual envelope (arrow). E: colony’s cells with visible chromatoplasm (arrow). **F–H:** *Aphanothece* cf. *castagnei.* F**–**G: general colony aspect, with yellow-brown sheaths. H: colony showing cells with individual envelope (arrow). **F–G:** *Aphanothece* cf. *densa*. F: general colonies aspect and detail of an elliptic cell (arrow). Scale bar: 10μm.

**Figure 2**

**A**–**B:**  *Gloeothece fuscolutea*. A: general colony aspect. B: colony detail showing the yellow sheath. **C–D:** *Gloeothece interspersa*. C: general colony aspect and detail of concentrically lamellate sheaths (arrow)*.* **E**–**H:** *Gloeothece rhodochlamys*.E: general colony aspect with granular orange red sheaths. F: general colony aspect with colorless sheaths. G: resistant spores; H: detail showing a cell with concentrically lamellate sheaths. **I:** *Gloeothece samoensis*: different colonies view*.* Scale bar: 10μm.

**Figure 3**

**A**–**B:**  *Gloeothece tepidariorum*: general colony aspect and detail of concentrically lamellate sheaths (arrow)*.* **C–D:** *Lemmermanniella terrestris*. C: general colony aspect, showing cells disposed in one layer only. D: detail of cell morphology. **C–D:** *Aphanocapsa intertexta.* C: general aspect of a colony without conspicuous mucilage. D: conspicuous mucilage colony forming subcolonies (arrows). **E–F:** *Aphanocapsa* cf. *intertexta*: detail of cells showing visible chromatoplasm (arrows). Scale bar: 10μm.

**Figure 4**

**A**–**C:** *Asterocapsa aerophytica.* A: general colonial aspect. B: released spores. C: colonies growing on *Scytonema*’s filament. **D**–**F:** *Chroococcus subviolaceus.* D: isolated cells. E: general colony aspect. C: cells in tetrad arrangement. **G–H:** *Chroococcus tenax*. G: general colony aspect highlighting the lamellated sheaths. H: desiccated cell showing concentrically lamellate sheaths and blue color. **I:** *Chroococcus varius*. **J–K:** *Chroococcus* cf. *minor*. K: colonies’ sheath highlighted by China ink. Scale bar: 10μm.

**Figure 5**

**A–C:** *Chroococcus* cf. *turgidus*. A: isolated cell showing non-lamellate sheath. C: colonies showing cells of different dimensions. **D–E:** *Chroococcus* cf. *varius.* D: general colonies aspect. E: colony’s lamellate sheath highlighted by metilene blue solution. **F–H:** *Cyanostylon gelatinosus*. G: cells detail. H. mucilage stalk detail. **I:** *Cyanostylon* cf. *gelatinosus*: general colony aspect with detail of mucilage stalks (arrows). Scale bar: 10μm.

**Figure 6**

**A–B:** *Endospora rubra:* general colony aspect with cell packets showing individual envelopes (arrows)*.* **C–D:** *Gloeocapsopsis chroococcoides.* D: colonies showing vacuole-like structures (arrow).

**C–D:** *Gloeocapsopsis dvorakii*. C: colony collected from a rope. D: colony collected from a roof. **G–I:** *Nephrococcus shilinensis*. G**–**H: general colony aspect. I: detail of reniform cells (arrows). **J–K:** *Pseudocapsa dubia.* J**–**K: general colony aspect with colonies showing brown sheaths (arrow)*.* Scale bar: 10μm.

**Figure 7**

**A:** *Chondrocystis dermochroa*: general colony aspect with densely aggregated colonies. **B–C:** *Gloeocapsa compacta*. **D–G:** *Gloeocapsa nigrescens***.** D**–**E: general mature colony aspect. F: spores inside the colony. G: released spores. **H:** *Gloeocapsa novacekii*. Scale bar: 10μm.

**Figure 8**

**A–C:** *Gloeocapsa novacekii*. A**–**B: variability of colonial morphology. C: released spores**. D–E:** *Gloeocapsa punctata.* **F–G:** *Gloeocapsa stegophila.* F: general aspect of colonies found on rocks. G: general aspect of colonies found on tree barks. **H–I:** *Chlorogloea* cf. *novacekii*: general colony aspect showing cells with individual envelopes (arrow). Scale bar: 10μm.

**Figure 9**

**A–B:** *Cyanoarbor* aff. *himalayensis.* A: lobate colony aspect. B: detail of a colonial lobe. **C–E:** *Entophysalis arboriformis*.C–D: general colony aspect. E: detail of cell morphology. **F–G:** *Entophysalis granulosa.* Scale bar: 10μm.

**Figure 10**

**A:** *Entophysalis granulosa*. **B–C:** *Entophysalis* cf. *samoensis*. **D–E:** *Chamaesiphon stratosus*: cell arrangement and initial stage after exospore germination (arrow). **F–G:** *Hyella* cf. *caespitosa* var. *arbuscula.* F: detail of baeocytes in mothers’ sheath (arrow) G: general thallus aspect. **H–J:** *Pleurocapsa* cf. *aurantiaca.*