

Phytoplankton flora of two rivers in Southeast Brazil – Paraibuna and Pomba Rivers, Minas Gerais

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ABSTRACT – (Phytoplankton flora of two rivers in Southeast Brazil – Paraibuna and Pomba Rivers, Minas Gerais). This work is a survey of the phytoplankton communities of the Paraibuna and Pomba Rivers. It aims to contribute to the existing albeit scarce knowledge of the phytoplankton of Minas Gerais and of lotic phytoplankton in general. The results are based on 32 samples collected from Paraibuna and Pomba Rivers, in Minas Gerais State, during the dry (July and August, 2001) and rainy seasons (February 2002). Forty-eight taxa were identified, 20 from Paraibuna River and 28 from Pomba River, thirty-eight of which are new records for Minas Gerais State. The phytoplankton community of Paraibuna River was strongly influenced by a reservoir close to its source, thus the occurrence of lentic species of cyanobacteria and desmids. However, the phytoplankton community of Pomba River was typical of lotic environments, with great number of diatoms and desmids.

Key words - potamoplankton, taxonomy, tropical rivers

RESUMO – (Flora fitoplanctônica de dois rios no Sudeste do Brasil – Rios Paraibuna e Pomba, Minas Gerais). É apresentada a composição fitoplanctônica dos Rios Paraibuna e Pomba, contribuindo para o escasso conhecimento do fitoplâncton de ambientes lóticos e também do Estado de Minas Gerais. Os resultados são baseados em 32 amostras coletadas nos Rios Paraibuna e Pomba, em Minas Gerais, durante a estação seca (agosto, julho/2001) e chuvosa (fevereiro/2002). Foram identificados 48 táxons, sendo 20 no Rio Paraibuna e 28 no Rio Pomba. Destes, 38 são primeira citação para o Estado de Minas Gerais. O fitoplâncton do Rio Paraibuna foi influenciado pela presença de um reservatório, favorecendo a ocorrência de cianobactérias de ambientes lênticos juntamente com desmídias. A composição do Rio Pomba foi tipicamente de ambientes lóticos, com maior número de diatomáceas e desmídias.

Palavras-chave - potamoplâncton, rios tropicais, taxonomia

Introduction

River phytoplankton has never received the same attention from phycologists or ecologists as phytoplankton from lakes (Reynolds & Descy 1996). According to Reynolds *et al.* (1994), the occurrence of phytoplankton in rivers is highly influenced by turbulence and low light intensity, which produces high richness of diatoms and green algae in rivers worldwide. In tropical rivers, where the variability of species is greater than in temperate rivers, desmids is another important group of phytoplankton (Rojo *et al.* 1994).

Potamoplankton also attracts scarce attention in Brazil. Despite the extensive Brazilian hydrographic system, the number of studies on phytoplankton community structure in lotic systems is much smaller than in lentic ones. In Brazil, pioneer studies were carried out in the Amazonian region rivers, such as Negro River, Tapajós River and Madeira River (Dickie 1881, Förster 1963,

1964, 1969, Scott *et al.* 1965, Thomasson 1971). Most of the taxonomic studies of river phytoplankton in Brazil are concentrated in the southern states. The diatom flora from rivers in Rio Grande do Sul State was described by Corte-Real & Aguiar (1972), Martau *et al.* (1977), Torgan & Aguiar (1978), Buselato & Aguiar (1979), Laudares-Silva (1987), Lobo & Torgan (1988), Callegaro *et al.* (1993) and Lobo *et al.* (1996). In Santa Catarina State by Rodrigues (1982, 1992) and Rodrigues & Moreira Filho (1990). In Paraná State Bittencourt-Oliveira (2002) described the phytoplankton community of River Tibagi. In the same state Contin (1990), Ludwig & Flôres (1995, 1997), Brassac *et al.* (1999), Brassac & Ludwig (2003), Brassac & Ludwig (2005) and Landucci & Ludwig (2005) carried out a survey of diatoms of various rivers. In the Southeast, Bicudo *et al.* (1992) and Bicudo *et al.* (1993) studied phytoplankton and diatoms, respectively, in Paranapanema River in a region to be dammed by Rosana Hydroelectric Power Plant. Necchi Júnior & Pascolato (1993), Necchi Júnior *et al.* (1994), Necchi Júnior & Moreira (1995), Branco & Necchi Júnior (1996, 1998), Branco *et al.* (1999) and Necchi Júnior *et al.* (2000) provided information of macroalgae distribution and composition in São Paulo State. The taxonomic studies in Minas Gerais

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State are scarce, even for lakes and reservoirs. Nordstedt (1870, 1877, 1878), Warming (1892), Wille (1884), Bicudo & Ventrice (1968), Bicudo (1969), Sormus (1991, 1993, 1996) and Oliveira (2001) described desmids from different environments, while Eterovick & Giani (1997) and Giani *et al.* (1999) surveyed the phytoplankton of the Pampulha Reservoir. Other taxonomic works include a study of the green algae from a pool located at the “Universidade Federal de Viçosa” (Lovo 1997), a work on diatoms from “Universidade Federal de Juiz de Fora” lake (Costa & Torgan 1991) and another survey on diatoms from Salto River, in “Parque Nacional do Ibitipoca” (Canani 2005).

The objective of this work is to improve the scarce knowledge of lotic phytoplankton, especially for Minas Gerais State, describing the flora of the Paraibuna and Pomba Rivers.

Material and methods

The Paraibuna and Pomba Rivers are the main tributaries of Paraíba do Sul River in Minas Gerais (figure 1). The climate is moderate wet subtropical (Cwa, Köppen), with annual

average precipitation from 1,200 to 1,600 mm and annual average temperature between 17.4 °C and 24.7 °C. The Paraibuna River is 176 km in length, with a 6,859 km² basin and flows into Paraíba do Sul River. Thirty-three kilometers away from the source, the river is dammed, to form the Chapéu D’Uvas Reservoir, with a surface area of 12 km², volume of 146 million cubic meters and maximum depth of 41 m. According to historical average values, the Paraibuna River flow is greatest in its lower stretches, where the gradient is steepest. The greatest flow rates occur during the months of January and February. The Pomba River runs for 265 km and flows into the Paraíba do Sul River. Its catchments area is 8,735 km² and the historical average flow rate is 130 m³s⁻¹ (Torres 1992).

The study of phytoplankton community was based on 32 samples collected at nine and seven stations in Paraibuna and Pomba Rivers, respectively, during dry (July, August, 2001) and rainy seasons (February, 2002) (table 1). Samples were collected by filling bottles directly in the water and fixed in acetic Lugol’s solution in 0.05% or with a 25 µm mesh net and fixed with Transeau’s solution. For diatoms study, slides were prepared according to Van Stoch (1970) using Naphrax. Samples were deposited at the Herbarium of the “Departamento de Botânica”, “Museu Nacional”, “Universidade Federal do Rio de Janeiro” (R).

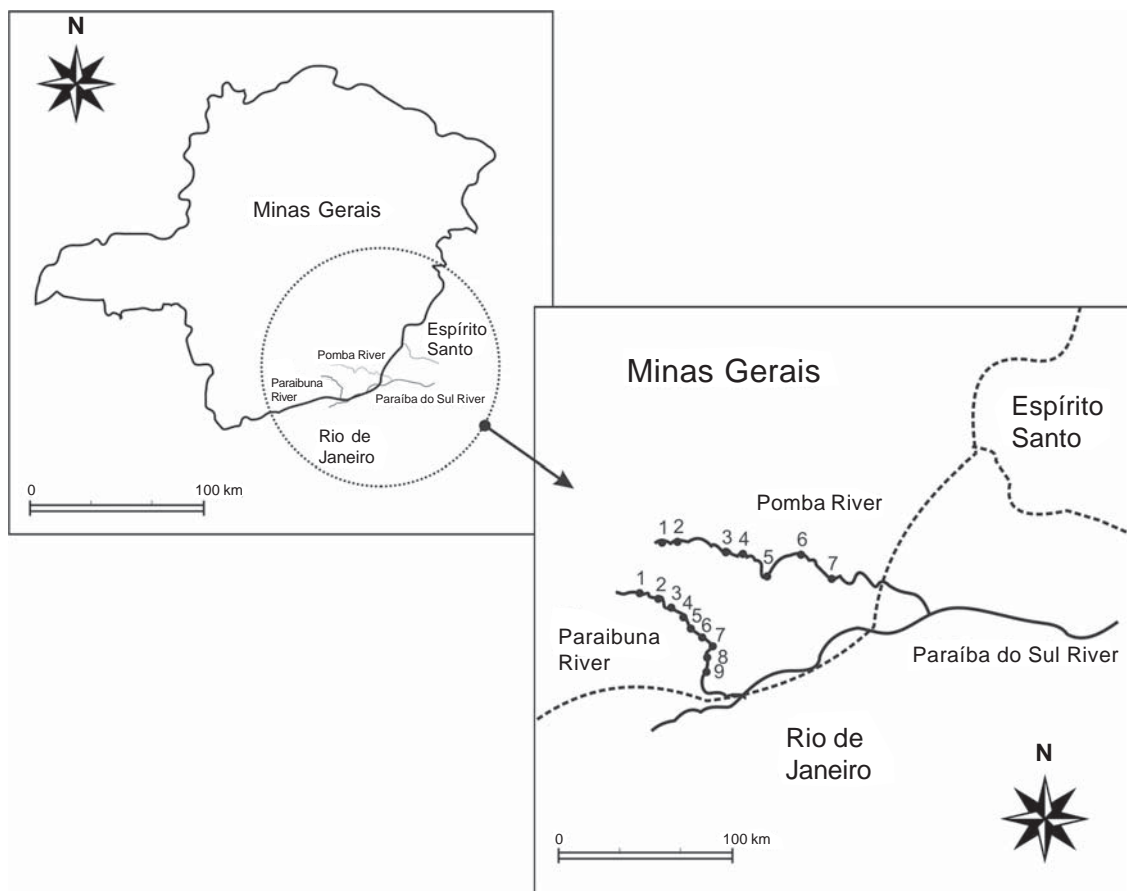


Figure 1. Map of Pomba and Paraibuna Rivers catchments showing the sample sites.

Table 1. Geographic coordinates (GC) of sampling sites (SS) in Paraibuna and Pomba Rivers and its herbarium number (R).

PARAIBUNA RIVER			POMBA RIVER		
GC	SS	Date/R	GC	SS	Date/R
21°30'14" S 43°38'27" W	1. Dores do Paraibuna	2-VII-01/205584 23-II-02/205593	21°16'05,9" S 43°38'04,3" W	1. Santa Bárbara do Tugúrio I	16-VIII-01/205567 24-II-02/205574
21°35'16,9" S 43°33'20,9" W	2. Chapéu D'Uvas Reservoir, Juiz de Fora	2-VII-01/205585 23-II-02/205594	21°14'58,2" S 43°34'03,9" W	2. Santa Bárbara do Tugúrio II	16-VIII-01/205568 24-II-02/205575
21°35'26,8" S 43°30'36,4" W	3. Chapéu D'Uvas, Juiz de Fora	2-VII-01/205586 23-II-02/205595	2°14'04,1" S 43°19'06,2" W	3. Mercês	16-VIII-01/205569 24-II-02/205576
21°38'44,3" S 43°26'14,6" W	4. Barreira, Juiz de Fora	2-VII-01/205587 23-II-02/205596	21°16'51,4" S 43°10'33,4" W	4. Rio Pomba	16-VIII-01/205570 24-II-02/205577
21°41'27,8" S 43°25'38,4" W	5. Distrito Industrial, Juiz de Fora	2-VII-01/205588 23-II-02/205597	21°18'54,4" S 42°51'41,8" W	5. Astolfo Dutra	16-VIII-01/205571 24-II-02/205578
21°43'54,2" S 43°23'19,7" W	6. Milho Branco, Juiz de Fora	2-VII-01/205589 23-II-02/205598	21°23'32,1" S 42°41'35,7" W	6. Cataguases	16-VIII-01/205572 24-II-02/205579
21°45'32,9" S 43°20'31,1" W	7. Halfeld, Juiz de Fora	2-VII-01/205590 23-II-02/205599	21°23'35,3" S 42°29'25,0" W	7. Laranjal	16-VIII-01/205573 24-II-02/205580
21°47'15,1" S 43°18'14,4" W	8. Marmelos I, Juiz de Fora	2-VII-01/205591 23-II-02/205600	21°27'27,2" S 42°21'01,0" W		
21°54'53,3" S 43°20'41,6" W	9. Cotegipe	2-VII-01/205592 23-II-02/205601			

The taxonomic classification for division and classes levels followed Van den Hoek *et al.* (1995), with exception of Bacillariophyta, which followed Round *et al.* (1990). The infra-classes hierarchy followed Anagnostidis & Komárek (1988) and Komárek & Anagnostidis (1989, 1999) for Cyanophyceae; Round *et al.* (1990) for Coscinodiscophyceae, Fragilariophyceae and Bacillariophyceae, Ettl (1978) for Xanthophyceae; Klaveness (1985) for Cryptophyceae; Tell & Conforti (1986) and Zákrys (1986) for Euglenophyceae; Ettl (1983) and Komárek & Fott (1983) for Chlorophyceae; and Ruzicka (1977, 1981) for Zygnematophyceae.

For the geographic distribution of species in Minas Gerais State, only descriptions with illustrations were considered.

Results and discussion

The 48 specific and infraspecific taxa identified were representative of eight taxonomic classes: Cyanophyceae (cyanobacteria), Coscinodiscophyceae, Fragilariophyceae, Bacillariophyceae (grouped as diatoms), Xanthophyceae, Euglenophyceae, Chlorophyceae (green algae) and Zygnematophyceae (desmids). Twenty of them were from the Paraibuna River and twenty-eight from the Pomba River. Cyanobacteria and desmids were the most important groups in Paraibuna River while diatoms and

desmids were the main groups in Pomba River (figure 2). Twenty-nine of the total specific and infraspecific taxa were identified to species level and 19 to infraspecific level. Thirty-eight were recorded for the first time to the Minas Gerais State. In general, the most important groups in terms of the number of species were cyanobacteria, diatoms and desmids (figure 2). Thirty-two taxa were exclusively from the dry period while six taxa were reported only in the rainy period and 10 were common during both periods (table 2). Flooding seems to be the most important event contributing to the decrease in taxa number during rainy period, especially in green algae and desmids. During this period some samples had no algae, especially those located downstream, where flow and turbidity were high. Chapéu D'Uvas Reservoir, near to the Paraibuna River source, influenced the phytoplankton composition, favoring the occurrence of lentic species of cyanobacteria (seven taxa) and desmids (seven taxa). From the 14 taxa registered in the reservoir, eight were exclusively found in this system, but others were also found downstream, especially in the dry period. *Cylindrospermopsis raciborskii* and *Cosmarium sphagnicolum* were found in the reservoir and were also distributed along the river. The higher number of

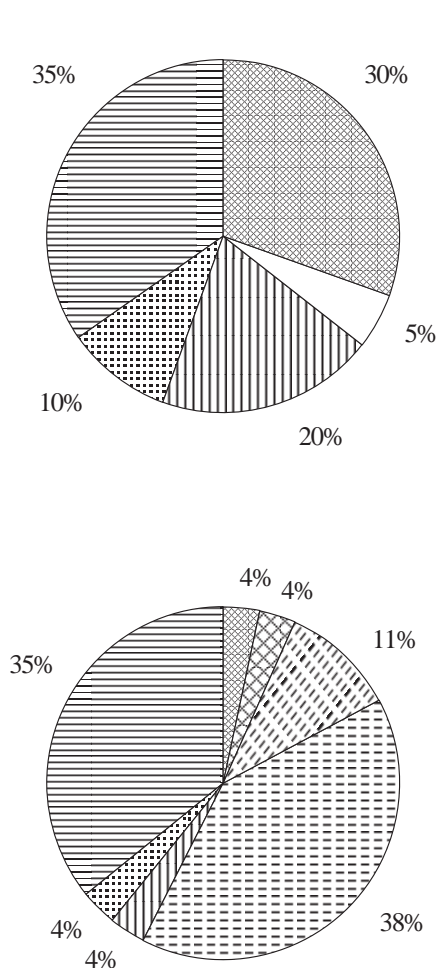
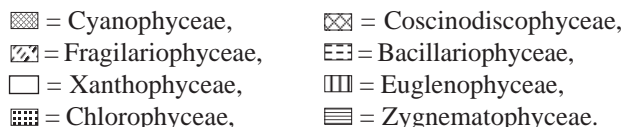


Figure 2: Phytoplankton composition in Paraibuna (A) and Pomba (B) rivers.



taxa in Paraibuna River was found in the reservoir and at the river's middle reaches (table 2). Pomba River composition was typical of lotic environment, with the greater number of taxa belonging to diatoms (16 taxa) and desmids (10 taxa) (figure 2). In the Pomba River, the highest number of species was found at the middle reaches (3-5), which provided 70% of total taxa from this river. In general each taxon was recorded only in few sites, with the exception of *Navicula cryptocephala*, which was found from station 3 to station 7 (table 2).

The 48 specific and infraspecific taxa recorded during this study are the follow:

CYANOPHYCEAE

CHROOCOCCALES

SYNECHOCOCCACEAE

Aphanothece stagnina (Spreng.) A. Braun in Rabernhorst, Decades 57-58:1572. 1863.

Figure 3

Colonies spherical or irregularly elongate, 15-50 x 20-40 μm ; mucilage colourless; cells oblong, 5-6 x 3-4 μm , with pale blue green, granular content.

Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 16-VIII-2001, *M.C.S. Soares s.n.* (R205567).

Distribution in Minas Gerais State: new record.

Cyanogranis ferruginea (Wawrik) Hindák, Algolog. Stud. 32:244. 1982.

Figure 39

Colonies spherical or irregular, 8-15 μm diameter; cells sometimes enveloped by ferric, blackish precipitates, which are occasionally aggregated on the periphery of cell groups; mucilage very fine; cells spherical to slightly oval, 1.0-1.5 x 0.6-1.0 μm , with pale blue green content. Specimens examined: BRAZIL: MINAS GERAIS: Paraibuna River, 2-VII-2001, *M.C.S. Soares s.n.* (R205585, R205586, R205587, R205588); 23-II-2002, *M.C.S. Soares s.n.* (R205594).

Distribution in Minas Gerais State: new record.

CHROOCOCCACEAE

Chroococcus dispersus (Keissl.) Lemmerm., Ark. Bot. 2:102. 1904.

Figure 4

Colonies spherical or irregular, 8-10 μm diameter; mucilage clearly delimited; cells spherical or hemispherical, 3-4 μm diameter, content homogeneous.

Specimens examined: BRAZIL: MINAS GERAIS: Paraibuna River, 2-VII-2001, *M.C.S. Soares s.n.* (R205584).

Distribution in Minas Gerais State: new record.

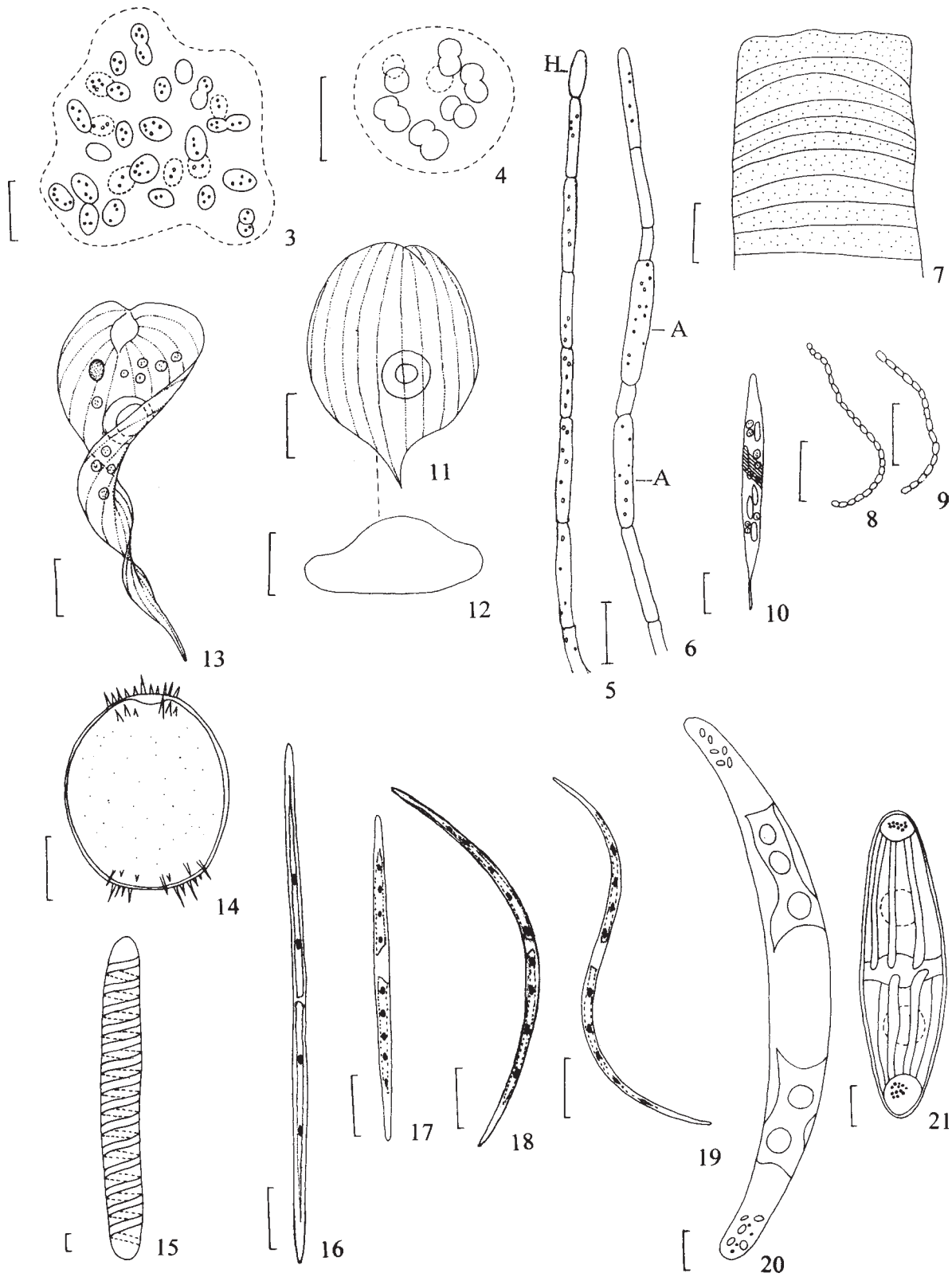
NOSTOCALES

NOSTOCACEAE

Cylindrospermopsis raciborskii (Wolosz.) Seenaya & Subba Raju, in Desikachary, Taxonomy and Biology of Blue-green Algae 52:57. 1972.

Figures 5-6

Trichomes solitary, 24-240 μm long, straight or slightly curved, constricted; cells cylindrical, 5-9 x 1-2 μm , with aerotopes; heterocytes conical, terminal, 4-8 x 1-2 μm ; akinetes cylindrical, distant from the heterocyte by few cells, 8-9 x 2-3 μm .



Figures 3-21. Cyanophyceae, Euglenophyceae and Zygnematophyceae from Paraibuna and Pomba rivers. 3. *Aphanothece stagnina*. 4. *Chroococcus disperses*. 5-6. *Cylindrospermopsis raciborskii* (A) akinete (H) heterocyte. 7. *Oscillatoria princeps*. 8-9. *Romeria*. 10. *Euglena acus* var. *acus*. 11-12. *Phacus denisii*. 11. Frontal view. 12. Vertical view. 13. *P. longicauda* var. *tortus*. 14. *Trachelomonas armata* var. *armata*. 15. *Spirotaenia condensata*. 16. *Closterium acutum* var. *acutum*. 17. *C. acutum* var. *linea*. 18-19. *C. acutum* var. *variabile*, morphological expressions. 20. *C. leibleinii* var. *leibleinii*. 21. *C. navicula* var. *navicula*. Bars = 10 μ m.

continuation

TAXA	PARAIBUNAR RIVER																		POMBA RIVER													
	Dry Period									Rainy Period									Dry Period							Rainy Period						
	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	1	2	3	4	5	6	7
samples	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	1	2	3	4	5	6	7
XANTHOPHYCEAE																																
<i>Isthmochlorum gracile</i>									x																							
EUGLENOPHYCEAE																																
<i>Euglena acus</i> var. <i>acus</i>																																
<i>Phacus denisii</i>									x																							
<i>P. longicauda</i> var. <i>tortus</i>									x																							
<i>Trachelomonas armata</i> var. <i>armata</i>																																
<i>T. reticulata</i>									x																							
CHLOROPHYCEAE																																
<i>Hydrodictyon reticulatum</i>																																
<i>Pediastrum tetras</i>									x																							
<i>Coelastrum pulchrum</i> var. <i>pulchrum</i>																																
ZYGNEMATOPHYCEAE																																
<i>Closterium acutum</i> var. <i>acutum</i>									x																							
<i>C. acutum</i> var. <i>linea</i>									x																							
<i>C. acutum</i> var. <i>variable</i>									x																							
<i>C. leibleinii</i> var. <i>leibleinii</i>																																
<i>C. navicula</i> var. <i>navicula</i>																																
<i>Cosmarium contractum</i> var. <i>minutissimum</i> .									x																							
<i>C. formulosum</i> var. <i>formulosum</i>																																
<i>C. pseudoretusum</i> var. <i>africanum</i>																																
<i>C. sphagnicolum</i> var. <i>sphagnicolum</i>																																
<i>C. vexatum</i> var. <i>vexatum</i>																																
<i>Spirotaenia condensata</i>																																
<i>Staurastrum leave</i>																																
<i>S. rotula</i>									x																							
<i>S. tetracerum</i>									x																							
<i>S. trifidum</i> var. <i>inflexum</i>																																
<i>Staurodesmus dejectus</i> var. <i>dejectus</i>																																
<i>S. mamillatus</i>																																

Specimens examined: BRAZIL: MINAS GERAIS: Paraibuna River, 2-VII-2001, *M.C.S. Soares s.n.* (R205585, R205586, R205587, R205588, R205589, R205590, R205591, R205592); 23-II-2002, *M.C.S. Soares s.n.* (R205594, R205595, R205600, R205601).

Distribution in Minas Gerais State: new record.

OSCILLATORIALES

PSEUDANABAENACEAE

Leptolyngbya perelegans (Lemmerm.) Anagn. & Komárek, Algolog. Stud. 53:392. 1988.

Figure 40

Filaments solitary, 1.0-1.2 µm wide, straight, with thin colourless sheaths; trichomes not constricted; cells content blue green, homogeneous; cross-walls with two granules on either side; end-cell rounded, without thickened outer membrane.

Specimens examined: BRAZIL: MINAS GERAIS: Paraibuna River, 2-VII-2001, *M.C.S. Soares s.n.* (R205590, R205591); 23-II-2002, *M.C.S. Soares s.n.* (R205598, R205599).

Distribution in Minas Gerais State: new record.

Oscillatoria princeps Vaucher ex Gomont, Ann. Sci. Nat. Bot. 16:206. 1892.

Figure 7

Trichomes straight or slightly curved, not attenuated, not constricted 35-37 µm diameter; cell 2-4 µm, contents pale blue green, granulated; apical cells capitated, with thickened outer membrane.

Specimens examined: BRAZIL: MINAS GERAIS: Paraibuna River, 23-II-2002, *M.C.S. Soares s.n.* (R205592).

Distribution in Minas Gerais State: new record.

Romeria victoria Komárek & Cronberg., Nova Hedwigia 73(1-2):141. 2001.

Figure 8-9

Trichomes solitary, slightly arcuated or irregularly waved, constricted; cells rod-shaped, 0.8-1.6 µm wide, contents pale blue green.

Specimens examined: BRAZIL: MINAS GERAIS: Paraibuna River, 2-VII-2001, *M.C.S. Soares s.n.* (R205590); 23-II-2002, *M.C.S. Soares s.n.* (R205600, R205601).

Distribution in Minas Gerais State: new record.

COSCINODISCOPHYCEAE

MELOSIRALES

MELOSIRACEAE

Melosira varians C. Agardh, Bot. Zeitung (Berlin) p.628.1827.

Figure 41

Valves cylindrical in pleural view, on filamentous straight chains; lacking sulco. Diameter 15-30 µm, length 20-30 µm length.

Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 24-II-2002, *M.C.S. Soares s.n.* (R205577).

Distribution in Minas Gerais State: new record.

FRAGILARIOPHYCEAE

FRAGILARIALES

FRAGILARIACEAE

Fragilaria capucina Desm. var. *fragilarioides* (Grunow) T. Ludwig & Flôres, Hoehnea 24(1):55. 1997.

Figure 42

Valves linear-lanceolate; apices capitated to sub-capitated; axial area narrow; central area rectangular, bilaterally intumescend; parallel striae. Apical axis: 82-86 µm; transapical axis: 8-12 µm; 5-6 striae in 10 µm.

Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 16-VIII-2001, *M.C.S. Soares s.n.* (R205570).

Distribution in Minas Gerais State: new record.

Fragilaria capucina Desm. var. *vaucheriae* (Kütz.) Lange-Bert., Hedwigia 33:747. 1980.

Figure 43

Valves lanceolate to linear-lanceolate; apices sub-capitated to rostrate; axial area lanceolate to linear; central area rectangular; parallel striae. Apical axis: 13-15 µm; transapical axis: 2-3 µm; 13-15 striae in 10 µm.

Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 24-II-2002, *M.C.S. Soares s.n.* (R205576, R205577, R205578).

Distribution in Minas Gerais State: new record.

Ulnaria ulna (Nitzsch) Compère in Jahn *et al.*, Studies on diatoms 97. 2001.

Figure 44

Valves linear to linear-lanceolate, without median constriction; apices rostrate to subcapitate; axial area linear; central area rectangular; parallel striae. Apical axis: 82-90 µm; transapical axis: 6-7 µm; 10-11 striae in 10 µm.

Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 16-VIII-2001, *M.C.S. Soares s.n.* (R205569, R205570, R205571).

Distribution in Minas Gerais State: new record.

BACILLARIOPHYCEAE

CYMBELLALES

CYMBELLACEAE

Encyonema minutum (Hilse) D.G. Mann in Round *et al.*, Diatoms 667. 1990.

Figure 45

Valves dorsiventral and symmetrical to the transapical axis, dorsal margin arched, ventral margin straight or slightly biarcuate; apices rounded to rostrate; raphe

more-or-less straight with central endings deflected dorsally and apical ends deflected ventrally. Apical axis: 14-17 μm ; transapical axis: 4-6 μm ; 13 striae in 10 μm . Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 16-VIII-2001, *M.C.S. Soares s.n.* (R205570, R205571, R205573).

Distribution in Minas Gerais State: new record.

Encyonema silesiacum (Bleisch) Mann in Round *et al.*, Diatoms 667. 1990.

Figure 46

Valves dorsiventral and symmetrical to the transapical axis, dorsal margin arched, ventral margin straight or slightly biarcuate, slightly enlarged on median region; apices rounded to rostrate; raphe more-or-less straight with central endings deflected dorsally and apical ends deflected ventrally. Apical axis: 25-38 μm ; transapical axis: 9-10 μm ; 10-15 striae in 10 μm .

Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 16-VIII-2001, *M.C.S. Soares s.n.* (R205570, R205571, R205572, R205573); 24-II-2002, *M.C.S. Soares s.n.* (R205580).

Distribution in Minas Gerais State: Juiz de Fora (Costa & Torgan 1991, as *Cymbella sylesiaca*).

GOMPHONEMATACEAE

Gomphonema clevei Fricke, Atlas des Diatomaceenkundi 249-256. 1902.

Figure 47

Valves slightly asymmetrical to transapical axis (heteropolar), symmetrical to apical axis, lanceolate in outline; apices rounded; a single stigma is present on one side of the central area. Apical axis: 43-45 μm ; transapical axis: 8-9 μm ; 16 striae in 10 μm .

Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 16-VIII-2001, *M.C.S. Soares s.n.* (R205570, R205571, R205572, R205573).

Distribution in Minas Gerais State: new record.

Gomphonema parvulum (Kütz.) Kütz., Sp. Alg. 65.1849.

Figure 48

Valves slightly asymmetrical to transapical axis (heteropolar), symmetrical to apical axis, appear lanceolate in outline, wedge-shaped in girdle view with pseudosepta visible; apices narrowly rounded to narrowly sub-rostrate; raphe often slightly sinuous; striae are coarse and punctate. Apical axis: 17-27 μm ; transapical axis: 4-7 μm ; 10-11 striae in 10 μm .

Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 16-VIII-2001, *M.C.S. Soares s.n.* (R205568, R205571); 24-II-2002, *M.C.S. Soares s.n.* (R205576).

Distribution in Minas Gerais State: Juiz de Fora (Costa & Torgan 1991).

ACHNANTHALES

ACHNANTHIDIACEAE

Achnantheidium exiguum (Grunow) Czarn., Proc. Int. Diatom Symp. 11:157. 1994.

Figure 49

Valves linear, apices capitate-rostrate, rafe only in one valve. Apical axis: 12-14 μm ; transapical axis: 4-5 μm ; 16 striae in 10 μm .

Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 24-II-2002, *M.C.S. Soares s.n.* (R205578, 205579).

Distribution in Minas Gerais State: new record.

NAVICULALES

PINNULARIACEAE

Pinnularia microstauron (Ehrenb.) Cleve, Acta Soc. Fauna Fl. Fenn. 8(2):28. 1891.

Figure 50

Valves linear-lanceolate, apices subcapitate-rounded; axial area lanceolate; central area transverse; rafe linear reflected to the sides; transapical striae radiate in central area and convergent in the extremes. Apical axis: 35-60 μm ; transapical axis: 8-13 μm ; 12 striae in 10 μm .

Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 16-VIII-2001, *M.C.S. Soares s.n.* (R205568, R205569, R205571).

Distribution in Minas Gerais State: new record.

Pinnularia viridis (Nitzsch) Ehrenb., Ber. Bekanntm. Verh. Königl. Preuss. Akad. Wissensch. 139-144. 1841.

Figure 51

Valves linear with rounded apices; apices convergent; axial area narrow near poles, widening gradually to the round or elliptical central area; striae transverse or slightly radiate at centre. Apical axis: 61-64 μm ; transapical axis: 9-12 μm ; 9-11 striae in 10 μm .

Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 16-VIII-2001, *M.C.S. Soares s.n.* (R205568); 24-II-2002, *M.C.S. Soares s.n.* (R205574).

Distribution in Minas Gerais State: Juiz de Fora (Costa & Torgan 1991).

NAVICULACEAE

Navicula cryptocephala Kütz., Die kieselschaligen Bacillarien oder Diatomeen 152, 1844.

Figure 52

Valves narrowly lanceolate; apices slightly sub-capitate; striae fine and radiate throughout the valves, transverse or slightly convergent at the apices; raphe lies in slightly thickened rib, slightly broader at centre but not markedly asymmetrical. Apical axis: 23-29 μm ; transapical axis: 5-7 μm ; 14 striae in 10 μm .

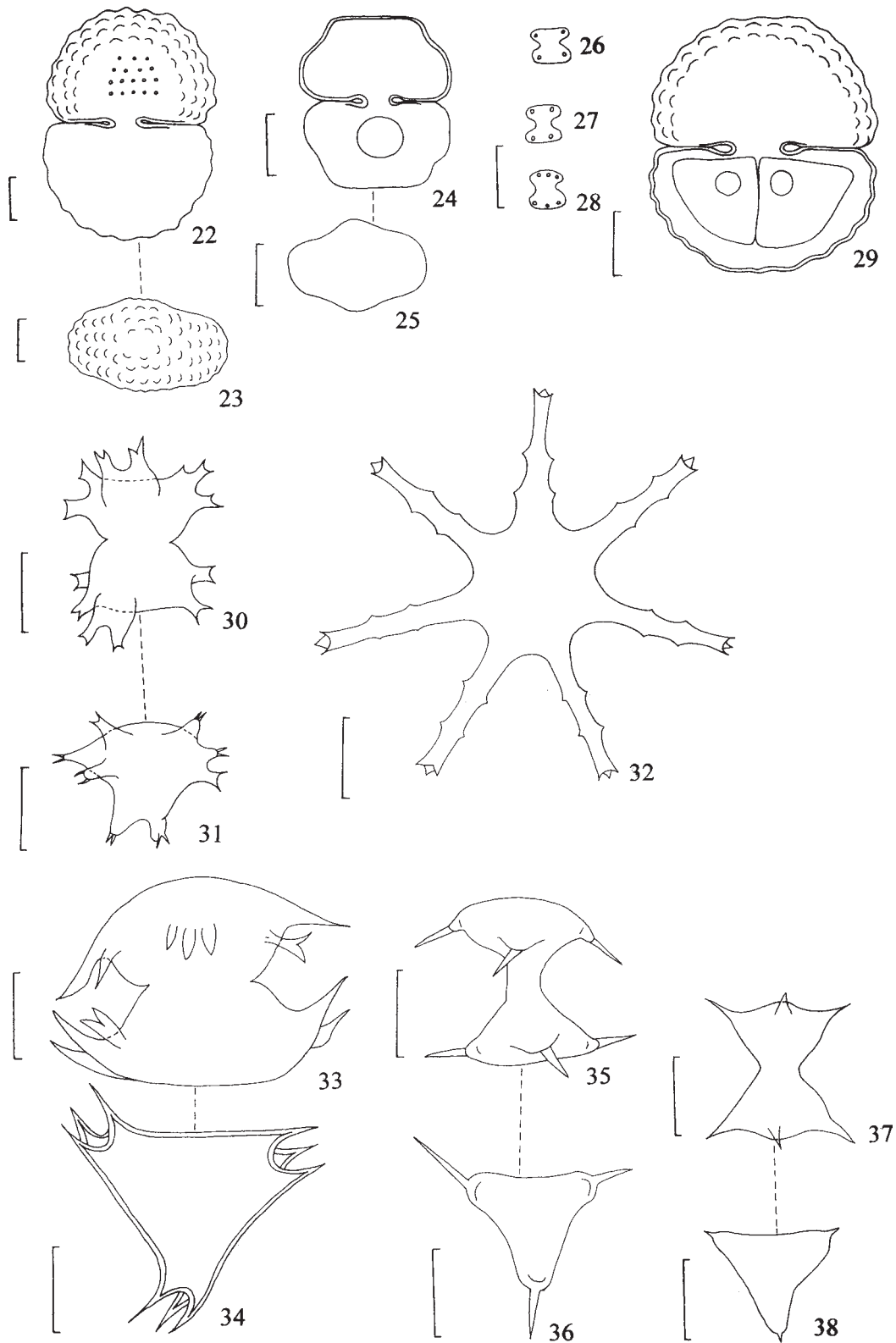


Figure 22-38. Zygnetophyceae from Paraibuna and Pomba rivers. 22-23. *Cosmarium formulosum* var. *formulosum*. 22. Frontal view. 23. Vertical view. 24-25. *C. pseudoretusum* var. *africanum*. 24. Frontal view. 25. Vertical view. 26-28. *C. sphagnicolum* var. *sphagnicolum*, morphological expressions. 29. *C. vexatum* var. *vexatum*. 30-31. *Staurastrum leave*. 30. Frontal view. 31. Vertical view. 32. *S. rotula*, vertical view. 33-34. *S. trifidum* var. *inflexum*. 33. Frontal view. 34. Vertical view. 35-36. *Staurodesmus dejectus* var. *dejectus*. 35. Frontal view. 36. Vertical view. 37-38. *S. mamillatus*. 37. Frontal view. 38. Vertical view. Bars = 10 μ m.

Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 16-VIII-2001, *M.C.S. Soares s.n.* (R205569, R205570, R205571, R205572, R205573, R205574, R205575); 24-II-2002, *M.C.S. Soares s.n.* (R205579). Distribution in Minas Gerais State: Juiz de Fora (Costa & Torgan 1991).

Navicula viridula (Kütz.) Ehrenb. var. *rostellata* (Kütz.) Cleve, Avenska VetenskAkad. Handdl. 27(3):15. 1895. Figure 53

Valves lanceolate; apices subrostrate; striae clearly lineate, radiate over most of the valve, but convergent at the poles; raphe fissures hooked over the apices, slightly expanded and deflected to one side at the centre. Apical axis: 70-89 µm; transapical axis: 10-15 µm; 10-11 striae in 10 µm. Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 16-VIII-2001, *M.C.S. Soares s.n.* (R205569). Distribution in Minas Gerais State: new record.

Geissleria aikenensis (Patrick) Torgan & Oliveira, Proc. Int. Diatom Symp. 16:115. 2001.

Figure 54

Valves linear to linear-elliptic; apices rostrate; axial area narrow, linear; central area transapically expanded; striae moderately radiate. Apical axis: 21 µm; transapical axis: 7 µm; 13-15 striae in 10 µm.

Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 16-VIII-2001, *M.C.S. Soares s.n.* (R205572, 205573). Distribution in Minas Gerais State: new record.

PLEUROSIGMATACEAE

Gyrosigma nodiferum (Grunow) Reimer, Diat. United States 320. 1966.

Figure 55

Valves slightly sigmoid, linear; apices attenuated, rounded; axial area narrow; central area oblique; raphe slightly sigmoid, strongly inclined and rounded; striae longitudinal. Apical axis: 65-70 µm; transapical axis: 12 µm; 20 striae in 10 µm. Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 24-II-2002, *M.C.S. Soares s.n.* (R205578).

Distribution in Minas Gerais State: new record.

XANTHOPHYCEAE

MISCHOCOCCALES

PLEUROCHLORIDACEAE

Isthmochloron gracile (Reinsch) Skuja, Nova Acta Regia Soc. Sci. Upsal, ser. 4, 14(5):173. 1949.

Figure 56

Cells solitary, with 4 angles, each angle with 1 bifurcated process ending in spines, 31 x 38 µm, several discoidal chloroplasts.

Specimens examined: BRAZIL: MINAS GERAIS: Paraibuna River, 2-VII-2001, *M.C.S. Soares s.n.* (R205585).

Distribution in Minas Gerais State: new record.

EUGLENOPHYCEAE

EUGLENALES

EUGLENACEAE

Euglena acus Ehrenb. var. *acus*, Infus. 112. 1838.

Figure 10

Cells elongate, fusiform, 77-95 x 6 µm, posterior end gradually attenuated in caudal process; striae clearly visible, running almost parallel to the body; several discoidal chloroplasts; 4 to several rod-shaped paramylon grains. Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 16-VIII-2001, *M.C.S. Soares s.n.* (R205570). Distribution in Minas Gerais State: new record.

Phacus denisii Allorge & Lefèvre, Bull. Soc. Bot. France 72:127. 1925.

Figures 11-12

Cells orbicular to broadly ovate, 21 x 14 µm, with a prominent, bluntly-angled, dorsal keel reaching the posterior end of the cell; pellicle longitudinally striated; 1 discoid paramylon grain. Specimens examined: BRAZIL: MINAS GERAIS: Paraibuna River, 2-VII-2001, *M.C.S. Soares s.n.* (R205584). Distribution in Minas Gerais State: new record.

Phacus longicauda (Ehrenb.) Dujard. var. *tortus* Lemmerm., Kryptogamenfl. Mark. Brandenburg 3:511. 1910.

Figure 13

Cells broadly ovate to ovate-elliptic, twisted, 63-76 x 21-37 µm, posterior end gradually attenuated in caudal process, 18-28 µm; pellicle longitudinally striated; several chloroplasts, discoids; 1 discoid paramylon grain.

Specimens examined: BRAZIL: MINAS GERAIS: Paraibuna River, 2-VII-2001, *M.C.S. Soares s.n.* (R205584). Distribution in Minas Gerais State: new record.

Trachelomonas armata (Ehrenb.) F. Stein var. *armata*, Infus. 3. 1878.

Figure 14

Lorica elliptical to ovoid, 33-34 x 28-29 µm; wall reddish-brown, with several spines, 3-7 µm.

Specimens examined: BRAZIL: MINAS GERAIS: Paraibuna River, 7-VII-2001, *M.C.S. Soares s.n.* (R205585).

Distribution in Minas Gerais State: Belo Horizonte (Giani *et al.* 1999, as *Trachelomonas armata*).

Trachelomonas recticollis (Playfair) Deflandre, Ehr. Rev. gen. Bot. 38:703. 1926.

Figure 57

Lorica spherical, 20-21 µm, with cylindrical collar, 4 µm; wall smooth, reddish-brown.

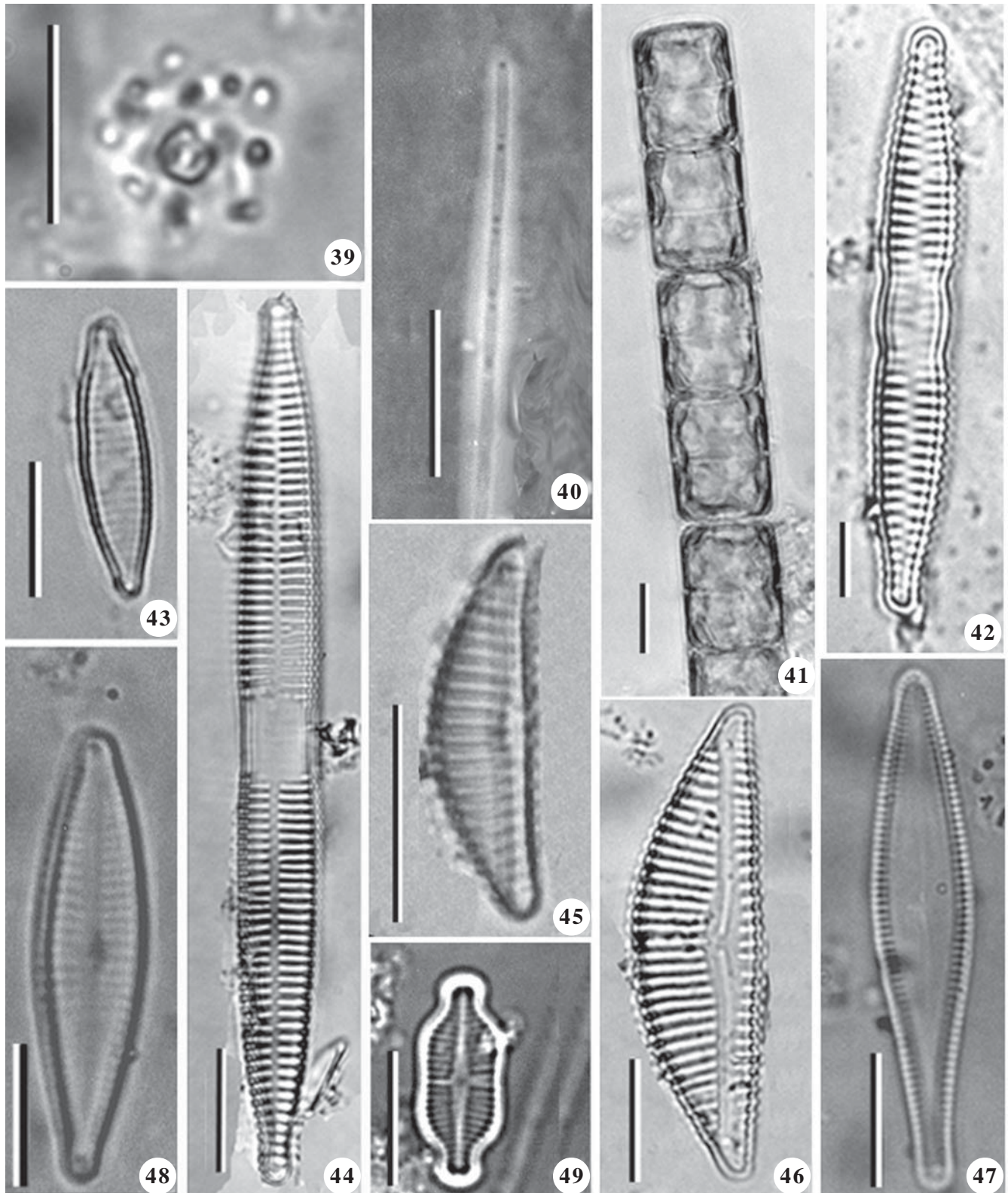


Figure 39-49. Cyanobacteria, Coscinodiscophyceae, Fragilariophyceae and Bacillariophyceae from Paraibuna and Pomba Rivers. 39. *Cyanogranis ferruginea*. 40. *Leptolyngbya perelegans*. 41. *Melosira varians*. 42. *Fragilaria capucina* var. *fragilarioides*. 43. *F. capucina* var. *vaucheria*. 44. *Ulnaria ulna*. 45. *Encyonema minutum*. 46. *E. silesiacum*. 47. *Gomphonema clevei*. 48. *G. parvulum*. 49. *Achnanthydium exiguum*. Bars = 10 μ m.

Specimens examined: BRAZIL: MINAS GERAIS: Paraibuna River, 2-VII-2001, *M.C.S. Soares s.n.* (R205585).
Distribution in Minas Gerais State: new record.

CHLOROPHYCEAE

CHLOROCOCCALES

HYDRODICTYACEAE

Hydrodictyon reticulatum (L.) Lagerh., Öfvers. Förh. Kongl. Svenska Vetensk.-Akad. 40(2):71. 1883.

Figure 58

Cenobia macroscopic, saccate reticulum consisting of several cylindrical cells adjoined at their ends to form 5- or 6-side meshes, which are organized into a network; cells cylindrical 15-20 x 6 µm.

Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 16-VIII-2001, *M.C.S. Soares s.n.* (R205570).
Distribution in Minas Gerais State: new record.

Pediastrum tetras (Ehrenb.) Ralfs, Ann. Nat. Hist. 14: 469. 1844.

Figure 59

Cenobia rounded, 4-8 polygonal cells, outer margin with 2 bifurcate processes; cell 12 x 7 µm.

Specimens examined: BRAZIL: MINAS GERAIS: Paraibuna River, 2-VII-2001, *M.C.S. Soares s.n.* (R205585).

Distribution in Minas Gerais State: Caldas, Lagoa Santa (Wille, 1884); Parque Nacional do Itatiaia (Bicudo & Ventrice 1968); Viçosa (Lovo 1997).

COELASTRACEAE

Coelastrum pulchrum Schmidle var. *pulchrum*, Ber. Deutsch. Bot. Ges. 10:206. 1892.

Figure 60

Cenobia spherical, 8-16 cells; cells sub-ovate in lateral view, spherical in vertical view, 8-12 x 8-15 µm, outer pole with conical-rounded projection; 5-6 interconnecting processes, uniting a neighboring cell.

Specimens examined: BRAZIL: MINAS GERAIS: Paraibuna River, 2-VII-2001, *M.C.S. Soares s.n.* (R205585, R205586).
Distribution in Minas Gerais State: new record.

ZYGNEMATOPHYCEAE

ZYGNEMATALES

MESOTAENIACEAE

Spirotaenia condensata Bréb. in Ralfs, Brit. Desm. p.179. 1848.

Figure 15

Cells 6-10 times longer than broad, 173-193 x 17-28 µm, cylindric, rounded apex; chloroplast a broad parietal band, making 10-12 close turns.

Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 16-VIII-2001, *M.C.S. Soares s.n.* (R205573).
Distribution in Minas Gerais State: new record.

DESMIDIALES

CLOSTERIACEAE

Closterium acutum (Lyngb.) Bréb. ex Ralfs var. *acutum*, Brit. Desm. p.177. 1848.

Figure 16

Cells 15 times longer than broad, 30-45 x 2-3 µm, straight to moderately and uniformly curved; apex acutely rounded, 1 µm.

Specimens examined: BRAZIL: MINAS GERAIS: Paraibuna River, 16-VIII-2001, *M.C.S. Soares s.n.* (R205585).
Distribution in Minas Gerais State: new record.

Closterium acutum var. *linea* (Perty) W. West & G.S. West, Bot. Trans. Yorkshire Naturalists Union 5:57. 1900.

Figure 17

Cells 16-25 times longer than broad, 50-100 x 3-4 µm, mostly straighter and relatively longer than the typical, apex rounded, 2 µm.

Specimens examined: BRAZIL: MINAS GERAIS: Paraibuna River, 16-VIII-2001, *M.C.S. Soares s.n.* (R205585).
Distribution in Minas Gerais State: new record.

Closterium acutum var. *variabile* (Lemmerm.) Krieg. in Rabenhorst, Kryptogamen-Flora 13(1/2):262. 1937.

Figures 18-19

Cells thin 25-30 times longer than broad, 50-90 x 2-3 µm, strongly curved, sometimes irregularly curved, apex rounded, 2 µm.

Specimens examined: BRAZIL: Minas Gerais: Paraibuna River, 2-VII-2001, *M.C.S. Soares s.n.* (R205585, R205587); 23-II-2002, *M.C.S. Soares s.n.* (R205596).

Distribution in Minas Gerais State: new record.

Closterium leibleinii Kütz. ex Ralfs var. *leibleinii*, Brit. Desm. 167. 1848.

Figure 20

Cells 7-9 times longer than broad, 125-136 x 15-18 µm, strongly curved, ventral margin concave but tumid in median part; narrow, acutely rounded apex, 3-4 µm; wall smooth.

Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 16-VIII-2001, *M.C.S. Soares s.n.* (R205570).

Distribution in Minas Gerais State: Lavras (Oliveira 2001).

Closterium navicula (Bréb.) Lütkem. var. *navicula* Cohn's Beitr. Biol. Pflanzen. 8:395. 1902.

Figure 21

Cell 3-4 times longer than broad, 67-78 x 14-24 µm, broadly fusiform to ellipsoid; apices broadly rounded, 5-8 µm; cell wall smooth.

Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 16-VIII-2001, *M.C.S. Soares s.n.* (R205569, R205570).

Distribution in Minas Gerais State: new record.

DESMIDIACEAE

Cosmarium contractum Kirchn. var. *minutissimum* Grönblad, Commentat. Biol. 15(12): 26. 1956.

Figure 61

Cell 10-11 x 9 µm, isthmus 6-7 µm, sinus very widely open; semicells elliptic.

Specimens examined: BRAZIL: MINAS GERAIS: Paraibuna River, 2-VII-2001, *M.C.S. Soares s.n.* (R205585).

Distribution in Minas Gerais State: new record.

Cosmarium formulosum Hoff var. *formulosum*, in Nordstedt, Vidensk. Meddel. Dansk. Naturhist. Foren. Kjöbenhavn. 194. 1888.

Figures 22-23

Cell 52-54 x 36-39 µm, isthmus 8-10 µm; semicells trapeziform-subsemicircular with a central tumor, sides evenly convex, 5-6 crenate; vertical view narrowly elliptic with a median tumor in both lateral margins.

Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 16-VIII-2001, *M.C.S. Soares s.n.* (R205570).

Distribution in Minas Gerais State: new record.

Cosmarium pseudoretusum Duceillier var. *africanum* (Fritsch) Krieg. & Gerloff, Die Gattung *Cosmarium* 1. 97. 1962.

Figures 24-25

Cell 30-33 x 25-28 µm, isthmus 8-10 µm; semicells in lateral view broadly elliptic, vertical view elliptic with a median tumor in both lateral margins.

Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 16-VIII-2001, *M.C.S. Soares s.n.* (R205569).

Distribution in Minas Gerais State: new record.

Cosmarium sphagnicolum W. West & G.S. West var. *sphagnicolum*, J. Roy. Microscop. Soc. London. 1897: 486. 1897.

Figures 26-28

Cell 5-7 x 4-6 µm, isthmus 3-4 µm; semicells transversely oblong-rectangular; widely open sinus, 2-3 marginal papillas.

Specimens examined: BRAZIL: MINAS GERAIS: Paraibuna River, 2-VII-2001, *M.C.S. Soares s.n.* (R205585, R205587, R205588, R205589, R205590, R205591, R205592); 23-II-2002, *M.C.S. Soares s.n.* (R205594, R205596, R205598, R205600, R205601).

Distribution in Minas Gerais State: new record.

This taxon showed a great morphological variation in the populational samples (figure 26-28). Prescott *et al.* (1981)

showed on plate 258, figure 3, a very similar taxon, but identified as *C. regnesi*. The same author informs that the Brazilian *C. regnesi* taxon has reduced, rounded lateral margins, making the Brazilian species similar to *C. sphagnicolum*. Due to the great material variability in the samples, the taxon is still identified as *Cosmarium sphagnicolum*.

Cosmarium vexatum W. West var. *vexatum*, J. Roy. Microsc. Soc. London. 1892: 727. 1892.

Figure 29

Cells 41-44 x 36-39 µm, at isthmus 11-13 µm; median constriction deep; semicells pyramidal-truncate, lateral margins convex, undulate, apex truncate.

Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 16-VIII-2001, *M.C.S. Soares s.n.* (R205569).

Distribution in Minas Gerais State: new record.

Staurastrum leave Ralfs, Brit. Desm. 131. 1848.

Figures 30-31

Cells 15-18 x 12-14 µm (without processes) at isthmus 6-9 µm, deeply constricted; semicell elliptic, apex and sides convex; each angle extended into a pair of process, slightly divergent, terminating in 2 teeth, one above the other; cell wall smooth.

Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 16-VIII-2001, *M.C.S. Soares s.n.* (R205569, R205570).

Distribution in Minas Gerais State: new record.

Staurastrum rotula Nordst., Vidensk. Meddel. Dansk. Naturhist. Foren. Kjöbenhavn. 227. 1869.

Figures 32, 62

Cells 32-35 x 51-54 µm (with processes) at isthmus 9-10 µm; median constriction deep semicell subhexagonal, 7 processes arising midway between apex and isthmus, long, horizontal or slightly divergent.

Specimens examined: BRAZIL: MINAS GERAIS: Paraibuna River, 16-VIII-2001, *M.C.S. Soares s.n.* (R205585).

Distribution in Minas Gerais State: Caldas (Nordstedt, 1870; 1877); Lagoa Santa (Wille 1884; Warming 1892); Lavras (Oliveira 2001).

Staurastrum tetracerum Ralfs, Ann. Mag. Nat. Hist. 15:150. 1845.

Figure 63

Cells 7-9 x 5-7 µm (without processes), 23-26 x 20-24 µm (with processes), isthmus 3-5 µm, sinus narrow to open; semicell triangular, long processes, divergent; vertical view birradiate.

Specimens examined: BRAZIL: MINAS GERAIS: Paraibuna River, 2-VII-2001, *M.C.S. Soares s.n.* (R205585); 23-II-2002, *M.C.S. Soares s.n.* (R205596, R205601).

Distribution in Minas Gerais State: new record.

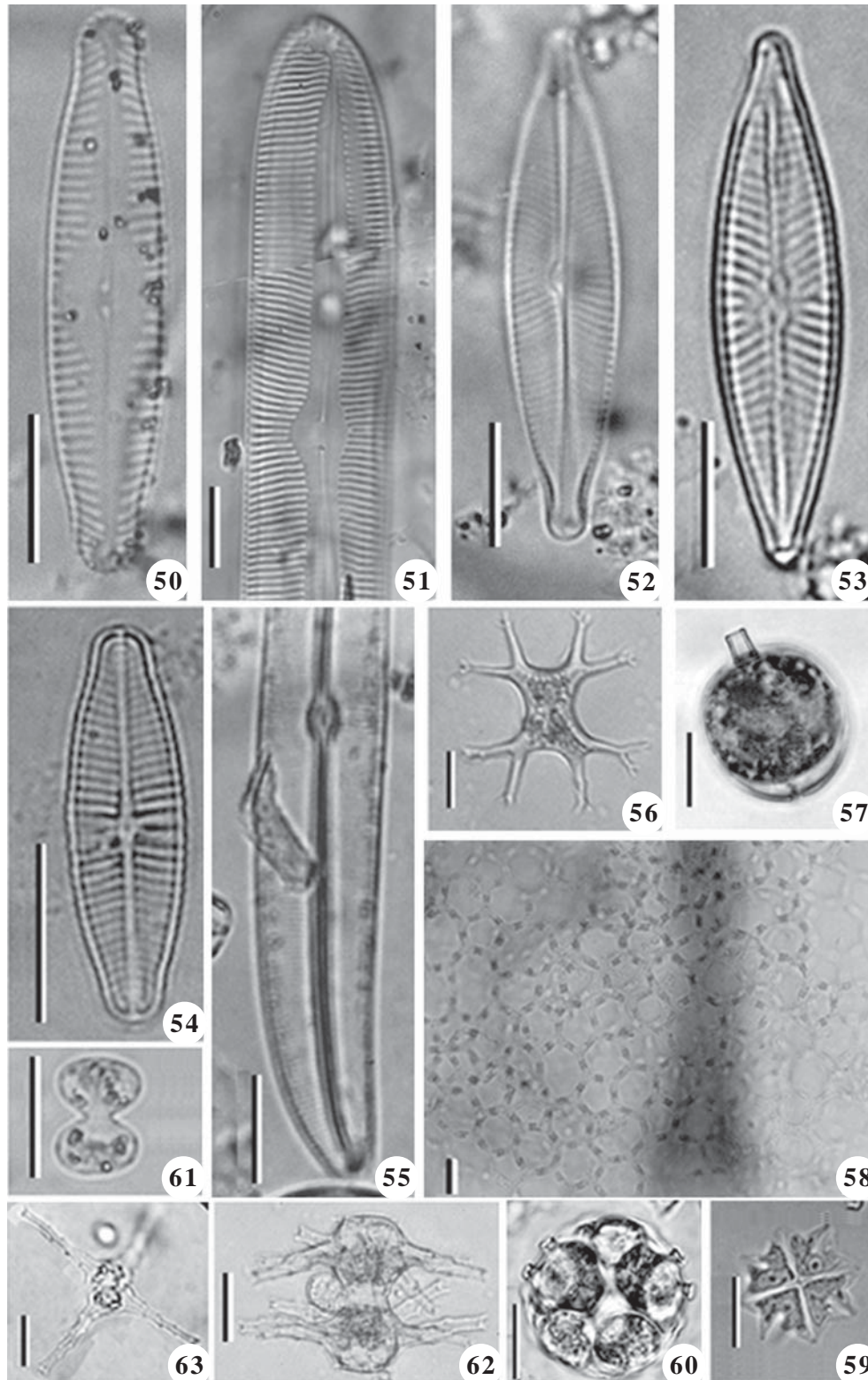


Figure 50-63. Bacillariophyceae, Xanthophyceae, Euglenophyceae, Chlorophyceae and Zygnematophyceae from Paraibuna and Pomba rivers. 50. *Pinnularia microstauron*. 51. *P. viridis*. 52. *Navicula cryptocephala*. 53. *N. viridula* var. *rostellata*. 54. *Geissleria aikenensis*. 55. *Gyrosigma nodiferum*. 56. *Isthmochlorum gracile*. 57. *Trachelomonas reticollis*. 58. *Hydrodictyon reticulatum*. 59. *Pediastrum tetras*. 60. *Coelastrum pulchrum* var. *pulchrum*. 61. *Cosmarium contractum* var. *minutissimum*. 62. *Staurastrum rotula*, frontal view. 63. *S. tetracerum*, frontal view. Bars = 10 μ m.

Staurastrum trifidum Nordstedt var. *inflexum* W. West & G.S. West, Trans. Linn. Soc. London, Bot. ser. 2, 5(5): 258. 1869.

Figures 33-34

Cells 25-28 x 22-25 µm (without processes), 35-38 µm (with processes), isthmus 11-13 µm; median constriction deep; semicells subcuneate, apical margin truncate; spines at the apical angles sometimes recurved.

Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 2-VII-2001, *M.C.S. Soares s.n.* (R205570).

Distribution in Minas Gerais State: Caldas (Nordstedt 1870, as *S. trifidum*).

Staurodesmus dejectus (Bréb. ex Ralfs) Teiling var. *dejectus*, Ark. Bot. 6(11):529. 1967.

Figures 35-36

Cells 17-20 x 14-16 µm, isthmus 4-5 µm; semicell cup-shaped somewhat elongated, with short, divergent spines.

Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 16-VIII-2001, *M.C.S. Soares s.n.* (R205571).

Distribution in Minas Gerais State: Parque Nacional do Itatiaia (Bicudo & Ventrice 1968); Lavras (Oliveira 2001 as *S. dejectus*).

Staurodesmus mamillatus (Nordst.) Teiling, Ark. Bot. 6(11):531. 1967.

Figures 37-38

Cells 18-30 x 25-35 µm, isthmus 3-5 µm; semicell triangular, apex margin convex, angles inflated, each cell with 1 long spine, parallel, triangular in apical view.

Specimens examined: BRAZIL: MINAS GERAIS: Pomba River, 16-VIII-2001, *M.C.S. Soares s.n.* (R205569, R205570).

Distribution in Minas Gerais State: new record.

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