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The genera *Chara* and *Nitella* (Chlorophyta, Characeae) in the subtropical Itaipu Reservoir, Brazil

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ABSTRACT – (The genera *Chara* and *Nitella* (Chlorophyta, Characeae) in the subtropical Itaipu Reservoir, Brazil). The family Characeae, represented by two genera in Brazil, *Chara* and *Nitella*, is considered to include the closest living relatives of land plants, and its members play important ecological role in aquatic ecosystems. The present taxonomic survey of *Chara* and *Nitella* was performed in tributaries that join to form the Brazilian shore of the Itaipu Reservoir on the Paraná River. Thirteen species were recorded, illustrated, and described: *C. braunii* var. *brasiliensis* R.Bicudo*, C. guairensis* R.Bicudo*, N. acuminata* A.Braun ex Wallman*, N. furcata* (Roxburgh ex Bruzileus) C.Agardh, and *N. subglomerata* A.Braun, already cited for the reservoir, and *C. hydropitys* Reichenbach*, C. rusbyana* Howe*, N. axillaris* A.Braun*, N. glaziovii* G.Zeller*, N. gracilis* (Smith) C.Agardh*, N. hyalina* (DC.) C.Agardh*, N. inversa* Imahori, and *N. microcarpa* A.Braun that represent new occurrences for the Itaipu Reservoir and Paraná State. Among the species encountered, *C. guairensis, N. furcata,* and *N. glaziovii* are widely distributed, while *C. hydropitys* and *C. rusbyana* have more restricted distributions.

Key words - Charophyceae, macroalgae, submerged macrophyte, taxonomy

INTRODUCTION

Characeae is a unique family of algae characterized by the complexity of their morphological features, including the structure of their gametangia and their axis differentiated into nodes and internodes (Picelli-Vicentim et al. 2004). These algae are considered the closest living relatives of land plants (Karol et al. 2001). Characeans have important ecological role in aquatic ecosystems as their assemblages are positively correlated with water transparency, they are efficient nutrient sinks and important in nutrient cycling, and they influence zooplankton and phytoplankton biomasses (Coops 2002, Kufel & Kufel 2002, Schwarz et al. 2002, van Donk & van de Bund 2002, Rodrigo et al. 2007).

The genus *Chara* includes macroscopic algae, typically with erect corticated axes and a five-celled coronula at the apices of the female gametangia. The genus *Nitella* is represented by macroalgae with no cortication patterns on the axis, branches, or branchlets, and the coronula is composed of ten cells, divided into two rows of five cells each (Picelli-Vicentim et al. 2004).

The occurrence of *Chara* in the Itaipu Reservoir was previously reported by Thomaz et al. (1999, 2003), Meurer et al. (2008), Mormul et al. (2010), and more recently, Bueno et al. (2011), with records for *Chara* sp., *C. braunii* var. *brasiliensis*, *C. diaphana*, *C. guairensis*, and *C. kenoyeri*. Information regarding *Nitella* in the Itaipu Reservoir is sparse, with the following species having previously been reported: *N. acuminata* A.Braun ex Wallman, *N. furcata* (Roxburgh ex Bruzileus) C. Agardh*, N. furcata* subsp. *mucronata* (A.Braun) R.D.Wood, and *N. subglomerata* A.Braun (Thomaz et al. 1999, 2003, Mormul et al. 2010). Considering that most of the species reported here are cited for the first time in that reservoir, this work also expands their distribution in Brazil.

The present study was carried out on the Brazilian side of the Itaipu Reservoir. Considering the important role of Characeae and the importance of acquiring more information about the species diversity of this group in Brazil, the present study surveyed the species of *Chara* and *Nitella* in the large subtropical Itaipu Reservoir in Paraná State, Brazil. The present study also provides quantitative information on relevant morphological characteristics and morphometric variations in the specimens studied, and compares them with previous records for Brazil.

MATERIALS AND METHODS

Eight tributary rivers that supply the Itaipu Reservoir (Arroio Guaçu, São Francisco Verdadeiro, São Francisco Falso, São Vicente, São João, Ocoí, Pinto, and Passo Cuê) were extensively surveyed in 2001, 2002 and 2003. We examined a total of 126 specimens of charophytes. Samples were obtained along the Brazilian shore of the Itaipu Reservoir (24°05'-25°33' S; 54°00'-54°37' W) upstream from the dam across the Paraná River. The Characeae

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specimens were collected using a small rake. In terms of nutrient concentrations, the central body of the reservoir has oligotrophic characteristics, while the tributary rivers on the left bank (Brazil) are mesotrophic to eutrophic (Bini et al. 1999).

The samples were rinsed with fresh water and analyzed using a light microscope. The specimens were subsequently preserved in Transeau solution and deposited in the UNOP herbarium (Universidade Estadual do Oeste do Paraná, Cascavel, Paraná), with duplicate samples being sent to the SP herbarium (Instituto de Botânica, São Paulo). Examinations of the biological material followed the methodologies described by Bicudo (1974); morphometric characters used in the identifications were measured in each individual examined. The classification follows Krause (1997), and the following literature was consulted for species identification and discussion: Groves & Groves (1911), Wood & Imahori (1964, 1965), Proctor et al. (1971), Bicudo (1974, 1977, 1979), Moore (1986), Bueno et al. (1996, 2009, 2011), Vieira Júnior et al. (2003) and Picelli-Vicentim et al. (2004).

RESULTS AND DISCUSSION

Key to the species of *Chara* and *Nitella* in the Itaipu Reservoir

1. Coronula with five cells. Presence of a cortex and/or derived structures such as stipulodes, bract-cells, or bracteoles ..... (Genus *Chara*) 2
   2. Stipulodes in two rows 3
      3. Plants monoecious, basal segment of branchlet fertile ..... *C. guairensis*
      3. Plants dioecious, basal segment of branchlet sterile ..... *C. rusbyana*
   2. Stipulodes in one row 4
      4 Cortication irregular, not present on all branchlets ..... *C. hydropitys*
      4 Cortication absent ..... *C. braunii* var. *brasiliensis*
1. Coronula with 10 cells. Absence of cortex and derived structures such as stipulodes, bract-cells, or bracteoles. ..... (Genus *Nitella*) 5
   5 Dimorphic, one-furcated branchlet, fertile whorls reduced in heads 6
      6. One-celled dactyls ..... *N. subglomerata*
      6. Two-celled dactyls ..... *N. axillaris*
   5. Monomorphic, fertile and sterile branchlets similar 7
      7. One or more furcated branchlets, one-celled dactyls ..... *N. acuminata*
      7. Two or more furcated branchlets, two or more celled dactyls 8
         8. Accessory branchlets present, from non-furcated to bifurcated ..... *N. hyalina*
         8. Accessory branchlets absent 9
            9. Lateral oogonia and terminal antheridia 10
            9. Lateral antheridia and terminal oogonia (inverse positions) ..... *N. inversa*
               10. Two to four-furcated branchlets 11
                  11. Two to three-celled dactyls, oogonia from one to two at a node ..... *N. glaziovii*
                  11. Two to four-celled dactyls, oogonia from one to six at a node ..... *N. furcata*
               10. Two to three-furcated branchlets, two to three-celled dactyls 12
                  12. Dactyls predominantly elongated (1/3 of the branchlet length), oospore with granulate membrane, six to seven striae, one to two oogonia at a node ..... *N. gracilis*
                  12. Dactyls predominantly abbreviated [94-2393(-3510) µm long], oospore with reticulate membrane, five to six striae, two to three oogonia at a node ..... *N. microcarpa*

Taxonomic treatment

Chara braunii Gmelin var. *brasiliensis* R.Bicudo, Rickia 8: 20, pl. 2. 1979.
Figures 1-2

Plant monoecious. Stem: 20 cm tall. Axes: 416-750 µm diam., without incrustations. Cortex: absent. Internodes: 0.6-2.6 cm. Spine cells: absent. Stipulodes: in one tier, 291-541 µm long × 58-100 µm diam. Branchlets: 7-9(-11); 0.7-2.7 cm long, segments 5-6, ecorticated; end segment reduced, forming tiny terminal corona, 183-437 µm long × 62-104 µm diam. Bract-cells: 2-4, 167-702 µm long × 62-104 µm diam. Bracteoles: 2; 604-1300 µm long × 78-130 µm diam. Gametangia: at 1st-2nd lowest branchlet nodes. Oogonia: solitary, 541-1274 µm long × 374-702 µm diam., coronula 156-286 µm long × 191-291 µm diam.,

divergent, convolutions 10-11. Oospores: 600-754 µm long × 364-494 µm diam., membrane finely granulate, striae 7-9, fossa 51-82 µm across. Antheridia: 312-408 µm diam., octo-scutate, triangular scute.

Representative specimens examined: BRAZIL, Paraná, Itaipu Reservoir: Passo Cuê River, 8-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP2918); São Francisco Falso River, 16-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP2037), 16-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP3003), 18-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1850), 11-II-2003, *SM Thomaz & TA Pagioro* (UNOP2995).

Geographic distribution in Brazil: in the states of Paraná (Meurer et al. 2008, Bueno et al. 2011), São Paulo (Bicudo 1979, Necchi Junior et al. 1994, 1997, 2000, Vieira Júnior et al. 2004, Picelli-Vicentim et al. 2004), and Rio Grande do Sul (Bueno et al. 2011).

Comments: *Chara braunii* var. *brasiliensis* resembles *C. socotrensis* Nordstedt emend. R.D.Wood due to the presence of gametangia on the basal segment of the branchlet, they differ because *C. braunii* has a crown of bract-cells on each branchlet apex, which are absent in *C. socotrensis*.

The var. *brasiliensis* was described by Bicudo (1979) and the sample specimens studied here are in accordance with the description presented in that study. Casanova (2005) notes that similar specimens sampled on different continents should eventually be considered different species, varieties, or taxonomical forms, as was pointed out by Proctor (1971), for this reason we decided to maintain the variety designation of Bicudo.

Chara guairensis R.Bicudo, Rickia 6: 145, pl. 4, fig. 1-11. 1974.
Figures 3-6

Plant monoecious. Stem: up to 40 cm tall. Axes: 460-1083 µm diam. Internodes: 0.7-7.3 cm long. Cortex: triplostichous. Spine cells: solitary, 31-396 µm long × 41-93 µm diam. Stipulodes: in two developed rows, upper row 423-1352 µm long × 75-150 µm diam., lower row (208-)333-1400 µm long × 74-133 µm diam. Branchlets: 9-13(-15); 0.9-5.5 cm long × 360-540 µm diam., basal segment ecorticated, 540-1290 µm long × 300-479 µm diam., intermediate segments 6-12, corticated, apical segment ecorticated, with bract-cells. Bract-cells: 5-6, verticilate, 155-1978 µm long × 62-180 µm diam. Bracteoles: 4; 580-1560 µm long × 80-250 µm diam. Gametangia: sejoined from 1st to 6th nodes. Oogonia: solitary, 725-1040 µm long × 396-568 µm diam., coronula 114-208 µm long × 192-291 µm diam., divergent, convolutions 11-12. Oospore: 441-666 µm long × 312-442 µm diam., membrane granulate, striae 9-11, fossa 40-78 µm across. Antheridia: 237-598 µm diam., octo-scutate, triangular scute.

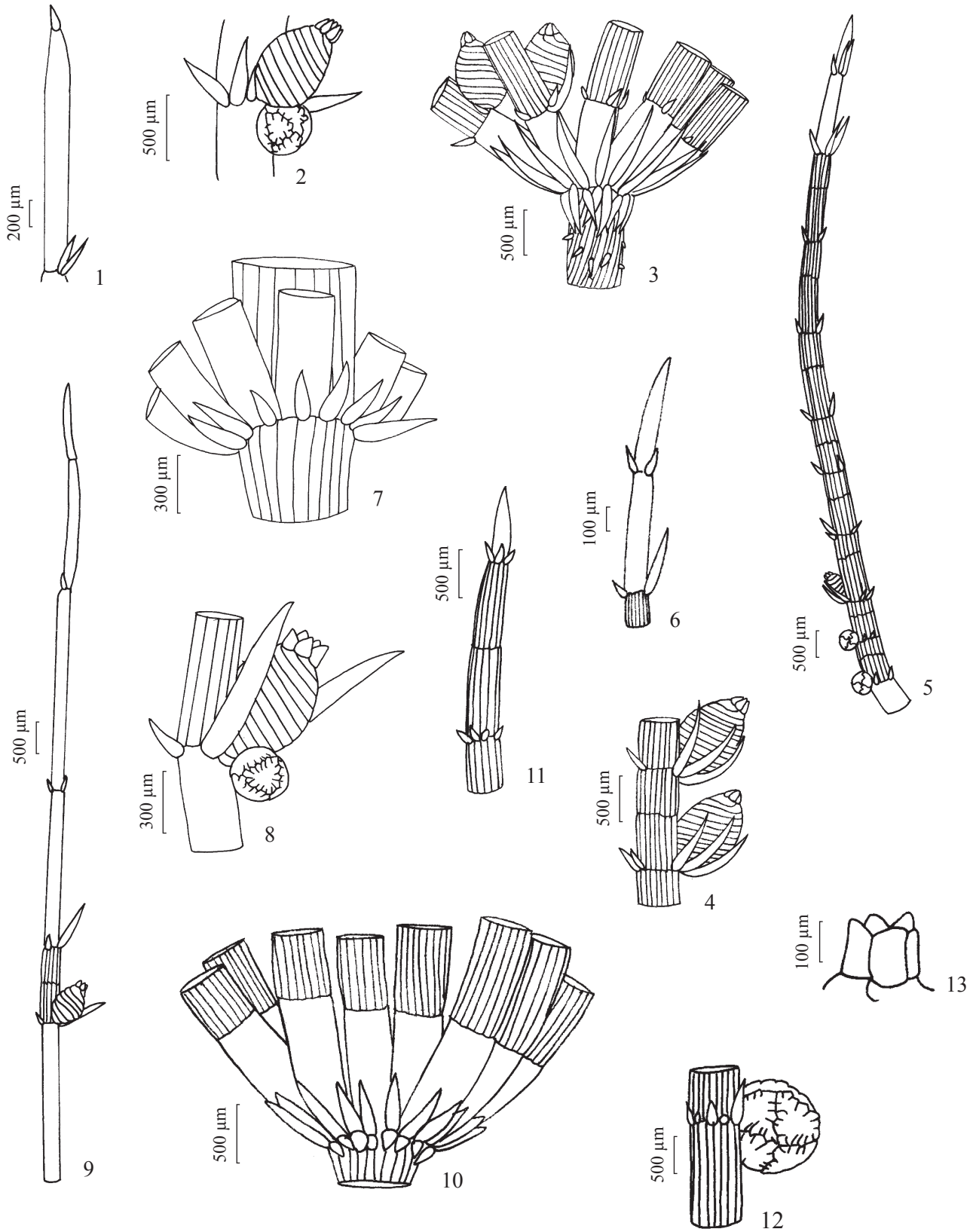
Representative specimens examined: BRAZIL, Paraná, Itaipu Reservoir: Passo Cuê River, 08-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP2073); Ocoí River, 14-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP2080); São João River, 12-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP2108), 12-VIII-2003, *SM Thomaz & TA Pagioro* (UNOP1843), 20-II-2003, *SM Thomaz & TA Pagioro* (UNOP2180); São Vicente River, 13-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP2922), 13-II-2003, *SM Thomaz & TA Pagioro* (UNOP1796, SP371087); Pinto River, 25-II-2003, *SM Thomaz & TA Pagioro* (UNOP1664, SP371093), 27-II-2003, *SM Thomaz & TA Pagioro* (UNOP2149), 27-II-2003, *SM Thomaz & TA Pagioro* (UNOP2152).

Geographic distribution in Brazil: in the states of Mato Grosso (Bueno et al. 2009), Mato Grosso do Sul (Bueno et al. 1996, 2009), Paraná (Bicudo 1974, Bueno et al. 2011), São Paulo (Vieira Júnior & Necchi Júnior 2002, Vieira Júnior et al. 2003, Picelli-Vicentim et al. 2004), and Rio Grande do Sul (Bueno et al. 2011).

Comments: *Chara guairensis* is characterized by having long bract-cells, sejoined gametangia, and a fertile basal segment. The species was recorded in the Itaipu Reservoir at different sampling stations. Our results extend the distribution of this species in the reservoir and contribute to a more accurate knowledge of *Chara* communities in the Itaipu River.

Chara hydropitys Reichenbach in Möessler's Handbuch der Gewächskunde 3: 1669. 1834.
Figures 7-9

Plant monoecious. Stem: 15 cm tall. Axes: 590-728 µm diam. Internodes: o correto é: 0.3-1 times the branchlet lenght. Cortex: triplostichous, isostichous. Spine cells: small to obscure, 31-33 µm long × 42 µm diam. Stipulodes: obscure, in one tier, 433-649 µm long × 62-82 µm diam. Branchlets: 9-12, intermediate segments (5-)6-7, 0-2-corticated; basal segment ecorticated; end segment ecorticated with bract-cells. Bract-cells: 4-6; (158-)1706 µm long × 50-156 µm diam. Bracteoles: 1040-1612 µm long × 50-156 µm diam. Gametangia: conjoined from 1st to 4th nodes. Oogonia: 716-837 µm long × 450-566 µm diam., coronula 100-108 µm long × 192-225 µm diam., divergent, convolutions 11-12. Oospores: 700 µm long × 300 µm diam., membrane smooth, striae 10-11. Antheridia: 312-338 µm diam., octo-scutate, scute triangular.



Figures 1-13. The genus *Chara* from the Itaipu Reservoir. 1-2. *Chara braunii* var. *brasiliensis*. 1. Branchlet apex. 2. Fertile node with conjoined gametangia. 3-6. *C. guairensis*. 3. Diplostephanous stipulodes. 4. Sejoined gametangia. 5. Fertile branchlet. 6. Branchlet apex. 7-9. *C. hydropitys*. 7. Haplostefanous stipulodes. 8. Conjoined gametangia. 9. Branchlet with one-corticated segment. 10-13. *C. rusbyana*. 10. Diplostephanous stipulodes. 11. Branchlet apex. 12. Antheridium. 13. Coronula.

Representative specimens examined: BRAZIL, Paraná, Itaipu Reservoir: São João River, 14-II-2002, *SM Thomaz & TA Pagioro* (UNOP1745).

Geographic distribution in Brazil: as *C. fibrosa* var. *hydropitys*: Bahia (Bicudo 1974), Maranhão (Bicudo 1974), Mato Grosso (Bueno et al. 2009), Mato Grosso do Sul (Bicudo 1974, Bueno et al. 1996, 2009), Rio Grande do Sul (Prado 2003, Bueno et al. 2011).

Comments: This is the first report of *Chara hydropitys* for Paraná State. An extensive discussion concerning the species can be found in the recent publication of Bueno et al. (2011). The specimens analyzed in this study had nine to 12 branchlets per whorl, with a maximum of two corticated segments, in accordance with the original description of the species. All other diagnostic characteristics for *C. hydropitys* fall within the morphometric limits presented for other specimens described in previous studies in Brazil.

Chara rusbyana Howe, Field Museum of Natural History 4(6): 160. 1929.
Figures 10-13

Plants dioecious. Axes: 650 µm diam. Internodes: 1-1.3 cm long. Cortex: triplostichous, isostichous. Spine cells: 134 µm long × 82 µm diam. Stipulodes: in two developed rows, upper row 728-754 µm long × up to 78 µm diam., lower row 312-433 µm long × 130-390 µm diam. Branchlets: 9-14; basal segment ecorticated, intermediate segments 6-12, corticated; apical segment 1-2, ecorticated, with bract-cells. Bract-cells: 5-8; 257 µm long × 82 µm diam. Bracteoles: 2; 910 µm long × 78 µm diam. Gametangia: sejoined at 2nd-5th branchlet nodes. Oogonia: solitary; 1014 µm long × 520 µm diam. Coronula: convergent or divergent, 130 µm long × 208 µm diam., convolutions 12. Oospores: 624 µm long × 442 µm diam., membrane homogeneous, striae 10. Antheridia: not seen.

Representative specimens examined: BRAZIL, Paraná, Itaipu Reservoir: Ocoí River, 14-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1599).

Geographic distribution in Brazil: in the states of Mato Grosso (Braun & Nordstedt 1883, Howe 1929, Bicudo 1974), Mato Grosso do Sul (Bueno et al. 1996, 2009), Minas Gerais, Pernambuco, Piauí, Santa Catarina (Braun & Nordstedt 1883, Bicudo 1974, Bueno et al. 2011), São Paulo (Braun & Nordstedt 1883, Bicudo 1974, Picelli-Vicentim et al. 2004), and Rio Grande do Sul (Bueno et al. 2011).

Comments: According to Proctor (1971), this species is restricted to South America. It resembles *Chara kenoyeri* Howe, from which it differs in having smaller bract cells and fewer segments in the branchlets. This is the first record of this species for Paraná State.

Nitella acuminata A.Braun ex Wallman, Försök till en systematisk uppställning af växfamiljen Characeae 35. 1853.
Figure 14

Plants monoecious. Stem: 15 cm tall. Axes: 416-676 µm diam. Internodes: 1-3.2 cm long. Branchlets: monomorphic, 6-8, 1-furcated, 1-2 cm long. Primary rays: 6-8, 6-7 mm long. Dactyls: 2-5, 1-celled, 2-7.8 mm long × 112-312 µm diam. Fertile heads: absent. Gametangia: conjoined, sessile, occasionally with a short stalk. Oogonia: one or two at a node, 330-453 µm long × 288-340 µm diam., convolutions 9-10, coronula 31-41 µm long × 41-51 µm diam. Oospore: 247-319 µm long × 196-227 µm diam., striae 7, fossa 42-55 µm across, membrane finely granulate. Antheridia: (154-)185-319 µm diam., octo-scutate, triangular scute.

Representative specimens examined: BRAZIL, Paraná, Itaipu Reservoir: São João River, 22-II-2002, *SM Thomaz & TA Pagioro* (UNOP1767); Ocoí River, 19-II-2003, *SM Thomaz & TA Pagioro* (UNOP2117); 11-I-2001, *SM Thomaz & TA Pagioro* (UNOP1643); Pinto River, 27-I-2002 (UNOP1305).

Geographic distribution in Brazil: in the states of Mato Grosso do Sul (Bueno & Bicudo 1997), Paraná (Thomaz et al. 2003), Rio de Janeiro (Bicudo 1969, Bicudo & Yamaoka 1978), São Paulo (Bicudo 1969, Bicudo & Yamaoka 1978, Picelli-Vicentim & Bicudo 1993, Picelli-Vicentim et al. 2004), and Rio Grande do Sul (Prado 2003).

Comments: The specimens examined were in accordance with the diagnostic characteristics for *N. acuminata*, including one-celled dactyls, monomorphic whorls, and one-furcated branchlets (Bicudo 1969, Bicudo & Yamaoka 1978, Picelli-Vicentim et al. 2004). The morphometric variations of the observed structures were in accordance with previously published limits for the country. Sample UNOP1767 had the largest oogonia (up to 453 µm long) and antheridia (up to 319 µm diameter), while UNOP1305 had the largest oospores (up to 319 µm long).

Nitella axillaris A.Braun, Monatsbericht der deutschen Akademie der Wissenschaften zu Berlin 356. 1858.
Figures 15-16

Plants monoecious. Stem: 35-40 cm tall; without incrustations. Axes: 468-1092 µm diam. Internodes:

1-6.7 cm long. Branchlets: dimorphic, 1-furcated, fertile reduced. Sterile branchlets: 6-9, appearing simple, 1-furcated, 0.5-3 cm long × 260-1000 µm diam., primary rays 6-9, as long as branchlets, 0.4-2.7 cm long, dactyls 3-5, 2-celled, forming a mucro, 312-962 µm long × 78-260 µm diam. Fertile branchlets: 7-8; 1-furcated, 1290-1648 µm long, forming heads, dactyls 3-5, 2-celled, 286-650 µm long × 62-156 µm diam. Heads: axillary, 1-3 per whorl, occasionally with a stalk, 1-3 mm diam. Gametangia: conjoined. Oogonia: 1-3 at a node, 288-515 µm long × 247-381 µm diam., convolutions 8-9, coronula 31-51 µm long × 50-72 µm diam. Oospore: 247-330 µm long × 237-288 µm diam., membrane reticulate, striae 6-7, fossa 40-70 µm across. Antheridia: 154-598 µm diam., octo-scutate, triangular scute.

Representative specimens examined: BRAZIL, Paraná, Itaipu Reservoir: São Francisco Falso River, 25-IV-2002, *SM Thomaz & TA Pagioro* (UNOP1357); São Vicente River, 13-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP2921); 31-I-2002, *SM Thomaz & TA Pagioro* (UNOP1342); São João River, 20-II-2003, *SM Thomaz & TA Pagioro* (UNOP1750); 22-II-2003, *SM Thomaz & TA Pagioro* (UNOP2895); Ocoí River, 17-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1641); 23-I-2002, *SM Thomaz & TA Pagioro* (UNOP1304); 14-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1618); 14-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP2086); 19-III-2003, *SM Thomaz & TA Pagioro* (UNOP1621); 27-I-2002, *SM Thomaz & TA Pagioro* (UNOP1309); 14-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1632).

Geographic distribution in Brazil: [as *Nitella translucens* (Persoon) C.Agardh emend. R.D.Wood subsp. *translucens* var. *axillaris* (A.Braun) R.D.Wood f. *axillaris*] in the states of Mato Grosso do Sul (Bueno & Bicudo 1997), Pernambuco (Wood & Imahori 1965), São Paulo (Picelli-Vicentim & Bicudo 1993, Picelli-Vicentim et al. 2004), and Rio Grande do Sul (Prado 2003).

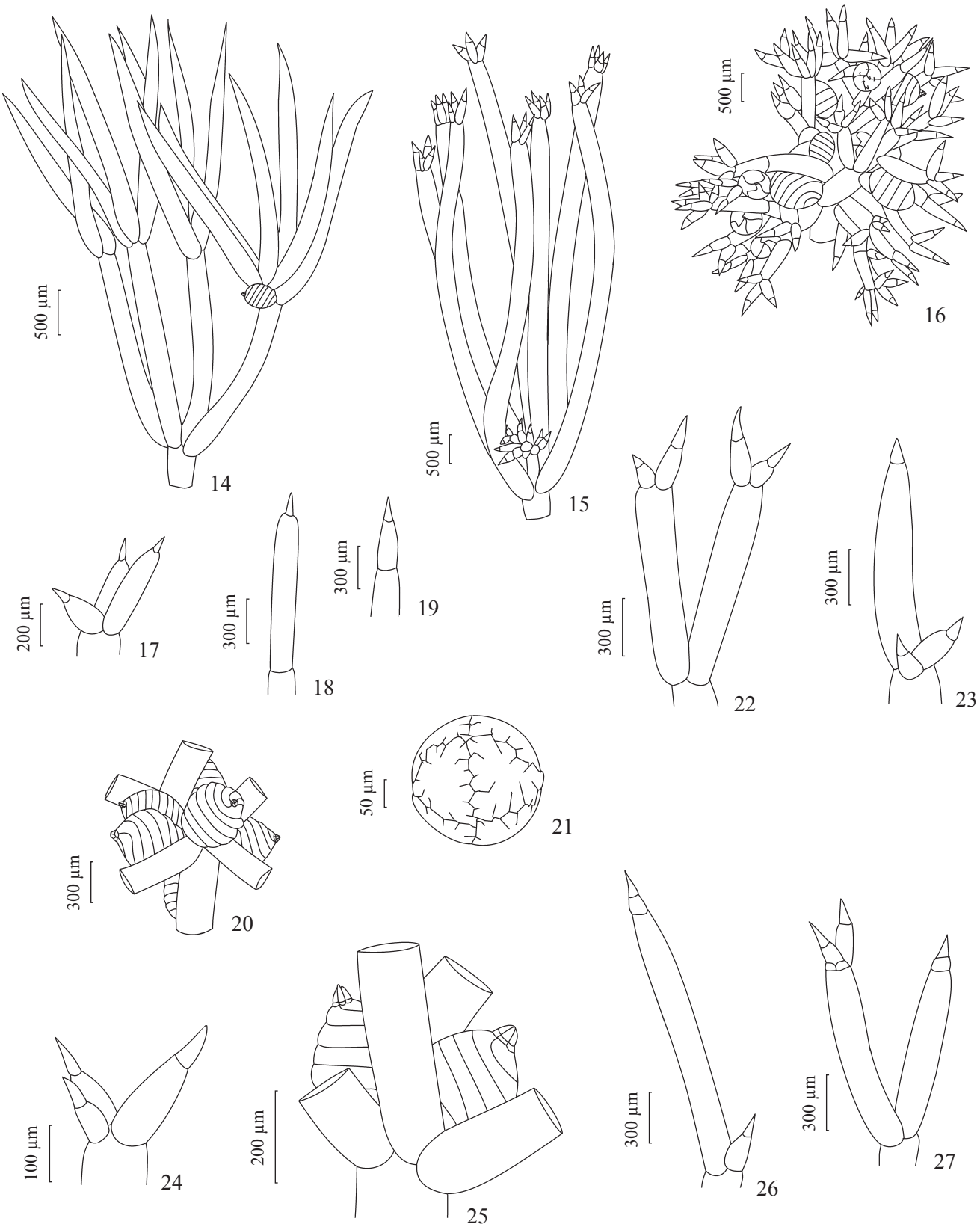
Comments: This is the first record of *Nitella axillaris* for the Itaipu Reservoir, and the first record of the species for Paraná State. The material analyzed here agreed with the descriptions given by Wood & Imahori (1964, 1965), Picelli-Vicentim & Bicudo (1993), and Bueno & Bicudo (1997). The upper morphometric limits of antheridia increased from 250 µm diameter (Prado 2003) to 598 µm (UNOP1357). Specimens from the Ocoí River had the largest oogonia and oospores (UNOP2086) as well as the smallest antheridia (UNOP2086) and oospores (UNOP1632). The largest antheridia were observed in material collected in the São Francisco Falso River (UNOP1357).

Nitella axillaris was treated as a variety of *Nitella translucens* by Wood & Imahori (1965). Moore (1986) reported that the oospores of *N. translucens* were longer, ovoid, and that its membrane ornamentation was finely reticulated, with five or six striae. Sakayama et al. (2002) reported that *N. axillaris* oospores were ovoid and had a membrane with a strongly reticulate ornamentation pattern, with six or seven striae. Molecular phylogenetic analyses have shown that *N. axillaris* and *N. translucens* are different species (Sakayama 2008).

Nitella furcata (Roxburgh ex Bruzileus) C.Agardh. Systema Algarum, p.124. 1824.
Figures 17-21

Plants monoecious. Stem: 21(-40) cm tall; without incrustations. Axes: 312-910 µm diam. Internodes: 0.6-5.7 cm long. Branchlets: monomorphic, 5-8, 2-3(-4)-furcated, 0.8-3.8 cm long. Primary rays: 5-8, 0.3-1.7 cm long. Secondary rays: 4-6. Tertiary rays: 3-5. Quaternary rays: 2-4. Dactyls: 2-3(-4), abbreviated, 2-3-celled, 113-3380 µm long × 52-208 µm diam., end cells conical, acuminate or acute. Heads: not formed. Gametangia: conjoined or sejoined, occasionally with a short stalk. Oogonia: 1-5(-6) at a node, 309-624 µm long × 237-443 µm diam., convolutions 6-9, coronula convergent, (31-)41-77 µm long × 50-93 µm diam. Oospore: 227-319 µm long × 175-330 µm diam., striae 5-7, fossa 40-82 µm across, membrane reticulate. Antheridia (144-)175-364 µm diam., octo-scutate, triangular scute.

Representative specimens examined: BRAZIL, Paraná, Itaipu Reservoir: São Francisco Falso River, 24-XII-2003, *SM Thomaz & TA Pagioro* (UNOP1728); 25-IV-2002, *SM Thomaz & TA Pagioro* (UNOP1351); 10-X-2002, *SM Thomaz & TA Pagioro* (UNOP1773); 12-XI-2002, *SM Thomaz & TA Pagioro* (UNOP1692); 24-II-2003, *SM Thomaz & TA Pagioro* (UNOP1691); 16-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1702); 26-II-2002, *SM Thomaz & TA Pagioro* (UNOP2902); 16-II-2002, *SM Thomaz & TA Pagioro* (UNOP1708); 26-VI-2001, *SM Thomaz & TA Pagioro* (UNOP1711); 11-II-2003, *SM Thomaz & TA Pagioro* (UNOP2129); 11-II-2003, *SM Thomaz & TA Pagioro* (UNOP1815); 11-II-2003, *SM Thomaz & TA Pagioro* (UNOP1718); 11-II-2003, *SM Thomaz & TA Pagioro* (UNOP1719); 11-II-2003, *SM Thomaz & TA Pagioro* (UNOP1724); 11-II-2003, *SM Thomaz & TA Pagioro* (UNOP1723); São Vicente River, 13-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1777); 13-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP3005); 13-II-2003, *SM Thomaz & TA Pagioro* (UNOP1788); 13-II-2003, *SM Thomaz & TA Pagioro*



Figures 14-27. The genus *Nitella* from the Itaipu Reservoir. 14. *Nitella acuminata*, fertile branchlet. 15-16. *N. axillaris.* 15. Branchlet. 16. Fertile head. 17-21. *N. furcata.* 17-19. Dactyls. 20. Node with six oogonia. 21. Antheridium. 22-27. *N. glaziovii.* 22-24. Two-celled dactyls. 25. Oogonium. 26-27. Two and three-celled dactyls.

(UNOP1790); 12-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1791); 13-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1799); 13-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1807); São João River, 12-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1733); 12-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1836); 20-II-2003, *SM Thomaz & TA Pagioro* (UNOP2187); 12-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP2105); 12-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP2108); 12-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1749); Ocoí River, 11-I-2001, *SM Thomaz & TA Pagioro* (UNOP1642); 14-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1613); 14-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1627); 14-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1603); 14-VIII-2002, S. M. Thomaz & T.A. Pagioro (UNOP1620); 14-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1623); 14-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1625); 14-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP2080); 14-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP2079); 14-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1630); 27-VIII-2001, *SM Thomaz & TA Pagioro* (UNOP1640); Pinto River, 09-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1661); 09-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1670); 27-II-2003, *SM Thomaz & TA Pagioro* (UNOP1672); 09-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1677); 09-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP2071); 09-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1673); 27-II-2003, *SM Thomaz & TA Pagioro* (UNOP2152); 27-II-2003, *SM Thomaz & TA Pagioro* (UNOP1676); 09-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1679); Passo Cuê River, 26-II-2002, *SM Thomaz & TA Pagioro* (UNOP1652); 26-II-2003, *SM Thomaz & TA Pagioro* (UNOP1656); 26-II-2003, *SM Thomaz & TA Pagioro* (UNOP1659).

Geographic distribution in Brazil: Paraná – Itaipu Reservoir (Thomaz et al. 1999), Rio Grande do Sul (Prado 2003).

Comments: *Nitella furcata* is a monoecious species, with homoclemous branchlets, absence of gametangia on basal furcation, with mucronate and predominantly abbreviated dactyls that form a cuspidate crown; fertile heads are rarely formed (Zaneveld 1940, Horn af Rantzien 1949, Wood & Imahori 1965). The samples identified as *Nitella furcata* had a reticulate ornamentation pattern of oospores, as reported by Mandal et al. (1995) and Sakayama et al. (2002).

The highest morphometric values for oogonia and oospores were recorded for UNOP1670 and UNOP1677 respectively. Sample UNOP1672, from the Pinto River, had the smallest antheridia. Compared to the morphometric values observed by Prado (2003), the present study expanded the upper morphometric limit of the dactyls from 1260 µm to 3380 µm long, the antheridia diameter from 310 µm to 364 µm, and the lower limit of the coronula from 52 µm to 31 µm long.

Nitella glaziovii G.Zeller, In Warming (ed.), Symbolae ad Floram Brasiliae Centralis Cognoscendam. Vidensk. Meddel. Naturhist. Foren. Kjøbenhavn 1876, 12 427-435. 1876.
Figures 22-27

Plants monoecious, without incrustations. Axes: 360-780 µm diam. Internodes: 1.4-4.5 cm long. Branchlets: monomorphic, 2-3-4 furcated, 1-2.7 cm long. Primary rays: 7-8, 0.2-1.4 mm long. Secondary rays: 4-5, one of which is occasionally central and reduced. Tertiary rays: 3-4. Quaternary rays: 2-3. Dactyls: 2-3, 2-3-celled, 130-2,548 µm long × 52-156 µm diam., predominantly abbreviated, conical end cell, acute apex. Heads: not formed. Gametangia: conjoined at all furcations. Oogonia: 1-2 at a node, (268-)309-566 µm long × 299-468 µm diam., convolutions 6-8, coronula 45-75 µm long × 60-80 µm diam. Oospore 225-309 µm long × 185-257 µm diam., striae 5-6, fossa 45-63 µm long, membrane reticulate. Antheridia: 165-312 µm diam., octo-scutate, triangular scute.

Representative specimens examined: BRAZIL, Paraná, Itaipu Reservoir: Arroio Guaçu river, 10-II-2003, *SM Thomaz & TA Pagioro* (UNOP1584); São Francisco Falso River, 24-II-2003, *SM Thomaz & TA Pagioro* (UNOP1694); 16-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1700); 12-XI-2002, *SM Thomaz & TA Pagioro* (UNOP1690); São Vicente River, 13-II-2003, *SM Thomaz & TA Pagioro* (UNOP2171, UNOP1808); São João River, 20-II-2003, *SM Thomaz & TA Pagioro* (UNOP1817); Ocoí River, 25-II-2003, *SM Thomaz & TA Pagioro* (UNOP1633); Pinto River, 27-II-2003, *SM Thomaz & TA Pagioro* (UNOP2149); 25-II-2003, *SM Thomaz & TA Pagioro* (UNOP1662); Passo Cuê River, 08-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1649); 08-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1651); *SM Thomaz & TA Pagioro* (UNOP2075).

Geographic distribution in Brazil: Rio de Janeiro (Wood & Imahori 1964, 1965 [= *Nitella furcata* (Roxb. ex Bruz.) Ag. emend. R.D.Wood var. *sieberi* (A.Braun) R.D.Wood f. *glaziovii*]).

Comments: This is the first record of this species in the Itaipu Reservoir and also the first record of this species for Paraná State. Wood & Imahori (1964, 1965) mentioned its occurrence in Rio de Janeiro state. The citation of *N. glaziovii* by Bicudo (1969) was later

corrected by the author, and was then identified as *N. furcata* subsp. *furcata* var. *sieberi* f. *japonica.*

N. glaziovii has one or two oogonia at each furcation, branchlets have up to four furcations, and the oospore ornamentation pattern is similar to the reticulate pattern described by Wood & Imahori (1965) and Sakayama (2008). *N. glaziovii* resembles *N. gracilens* in terms of their numbers of gametangia and the presence of predominantly abbreviated dactyls. However, *N. gracilens,* which has only been recorded in Japan, has up to three furcations on each branchlet and the ornamentation of oospore membrane is finely granulated – characteristics not observed in the samples from the Itaipu Reservoir.

Nitella gracilis (Smith) C.Agardh, Systema Algarum, p.125. 1824.
Figures 28-31

Plants monoecious, without incrustations. Axes: 234-650 µm diam. Internodes: 1.1-1.8 cm long. Branchlets: monomorphic, 5-7, 2-3-furcated, 1.2-3.2 cm long. Primary rays: 5-7, 0.4-1.3 cm long. Secondary rays: 3-5. Tertiary rays: 3-4. Dactyls: 2-3, 2-3-celled, 156-5,590 µm long × 78-130 µm diam., predominantly elongated, slender, occasionally abbreviated, penultimate cell cylindrical, end cell conical to acute. Heads: not formed, upper whorls occasionally compacted, no mucus. Gametangia: conjoined or sejoined at all furcations, occasionally absent at first. Oogonia: 1(-2) at a node, 350-463 µm long × 300-371 µm diam., convolutions 8-10, coronula 38-52 µm long × 51-65 µm diam. Oospore: 299-319 µm long × 185-288 µm diam., striae 6-7, fossa 43-63 µm across. Antheridia: 227-338 µm diam., octo-scutate, triangular scute.

Representative specimens examined: BRAZIL, Paraná, Itaipu Reservoir: São Francisco Falso River, 11-II-2003, *SM Thomaz & TA Pagioro* (UNOP1717); 11-II-2003, *SM Thomaz & TA Pagioro* (UNOP1719); São Vicente River, 13-II-2003, *SM Thomaz & TA Pagioro* (UNOP1779); 13-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1797); 13-II-2003, *SM Thomaz & TA Pagioro* (UNOP1814); Ocoí River, 19-II-2003, *SM Thomaz & TA Pagioro* (UNOP1624); Passo Cuê River, 08-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1646); 08-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1647).

Geographic distribution in Brazil: Rio Grande do Sul (Astorino 1983, Prado 2003).

Comments: *N. gracilis* Smith [=*N. gracilis* (Smith) C.Agardh emend. R.D.Wood subsp. *gracilis* var. *gracilis* f. *gracilis*] is monoecious, has branchlets with two to three furcations, two- to three-celled dactyls, oospore with a finely granulated ornamentation pattern, with six to seven striae (Schubert & Blindow 2004). The first record for Brazil was reported by Astorino (1983) in Rio Grande do Sul State. This is the first record of *N. gracilis* for the Itaipu Reservoir, and constitutes the first record of this species for Paraná State.

Some of the morphological structures differed in size as compared with those reported by Astorino (1983) and Prado (2003). The specimens from the São Vicente River (UNOP1814) had the largest and smallest oogonia, the specimens from the São Francisco Falso River (UNOP1717) had the smallest antheridia, and the specimens from the Ocoí River (UNOP1624) had the smallest oospores.

Nitella hyalina (DC.) C.Agardh, Systema Algarum, p.126. 1824.
Figures 32-34

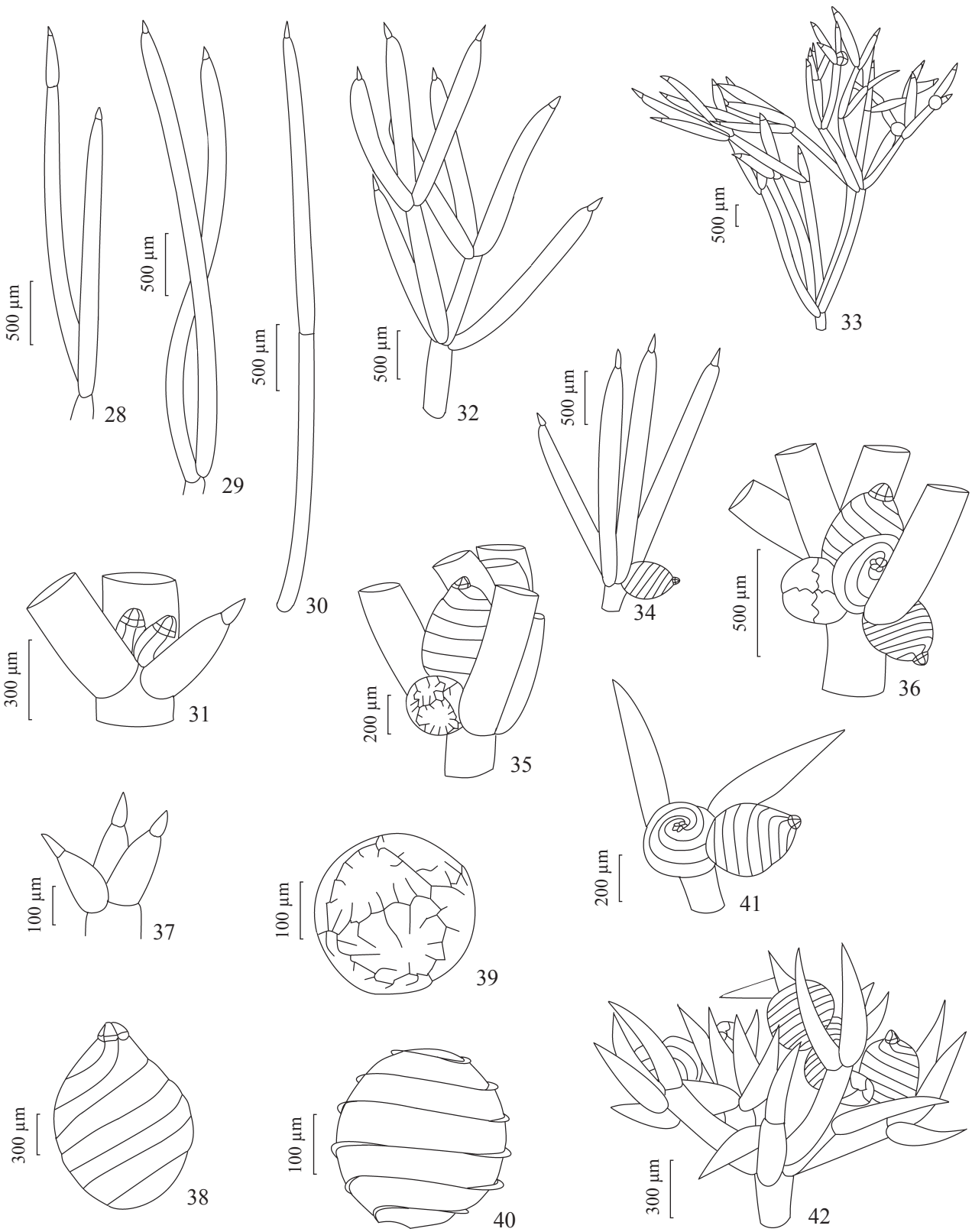
Plants monoecious, delicate, with occasional carbonate incrustations. Axes: 234-390 µm diam. Internodes: 1 cm long, up to 9 X the branchlet length. Branchlets: heteroclemous, 5-7, 1-2(-3)-furcated, 6-14 mm long. Primary rays: 5-7, 2-5 mm long × 156-260 µm diam. Secondary rays: 2-5. Tertiary rays: 3. Dactyls: (2-)3(-4), 2-celled, 676-4,420 µm long × 78-156 µm diam. Accessory branchlets: in two whorls, 4-6, (0-)1-2-furcated, ½ as long as primary rays. Gametangia: sejoined, with a short stalk, with mucus. Oogonia: solitary, 391-484 µm long × 319-381 µm diam., convolutions 7-9, coronula 32-50 µm long, 50-65 µm diam. Oospore: 268-309 µm long × 185-278 µm diam.; striae 6-7(-8), fossa 47-65 µm across, membrane fibrous. Antheridia: 234-268 µm diam., octo-scutate, triangular scute.

Representative specimens examined: BRAZIL, Paraná, Itaipu Reservoir: Arroio Guaçu river, 11-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP2904); São Francisco Verdadeiro River, 17-II-2003, *SM Thomaz & TA Pagioro* (UNOP2197); São Vicente River, 13-II-2003, *SM Thomaz & TA Pagioro* (UNOP1783).

Geographic distribution in Brazil: Rio Grande do Sul (Prado & Baptista 2005).

Comments: *N. hyalina* is monoecious and has two-celled dactyls and a solitary oogonia. The primary branchlets are long and have from two to four furcations, while the accessory short branchlets have from one to two furcations (Schubert & Blindow 2004).

Some measurements of the specimens differed from those reported by Prado & Baptista (2005). The upper morphometric limit for the dactyl length increased



Figures 28-42. The genus *Nitella* from the Itaipu Reservoir. 28-31. *Nitella gracilis*. 28-30. Two and three-celled dactyls. 31. Fertile node. 32-34. *N. hyaline*. 32-33. Branchlets. 34. Fertile branchlet. 35-36. *N. inversa*, fertile nodes. 37-40. *N. microcarpa*. 37. Two-celled dactyls. 38. Oogonium. 39. Antheridium. 40. Oospore. 41-42. *N. subglomerata*. 41. Oogonium. 42. Fertile head.

from 1350 µm to 4420 µm, the lower limit of oogonia length decreased from 680 µm to 484 µm, the lower limit of oospores decreased from 370 µm to 286 µm, and the lower limits of antheridia from 330 µm to 234 µm diameter. The highest values for oogonia, coronula, oospores and dactyls were measured on specimens from sample UNOP1783, and the lowest values for antheridia, oospores, and dactyls were recorded on UNOP2197, both from the São Francisco River, while the specimens from the Arroio Guaçu River (UNOP2904) showed the lowest values for the oogonia, and the highest for the antheridia. This is the first record of *N. hyalina* in Paraná.

Nitella inversa Imahori, Japanese Charophyta. p. 125, pl.31, fig.44. 1954.
Figures 35-36

Plants monoecious. Stem: 13 cm tall; without incrustations. Axes: 442-728 µm diam. Internodes: 1-3.6 cm long. Branchlets: monomorphic, 0.8-3.5 cm long, (2-)3-4-furcated. Primary rays: 6-8, 4-15 mm long. Secondary rays: 4-7. Tertiary rays: 3-4. Quaternary rays: 2-3. Dactyls: 2-3, 2-3-celled, 208-1560 µm long × 78-156 µm diam., predominantly abbreviated, penultimate cell cylindrical, end cell conical, apex acute. Heads: not formed. Gametangia: conjoined and sejoined at all furcations, occasionally with a short stalk. Oogonia: 1-3 per node, terminal, 443-567 µm long × 319-402 µm diam., convolutions 8-9, coronula 42.5-82 µm long × 60-93 µm diam. Oospore: 278-330 µm long × 337-288 µm diam., striae 6-7, fossa 50-55 µm across, membrane reticulate. Antheridia: terminal or lateral, 237-329 µm diam., octo-scutate, triangular scute.

Representative specimens examined: BRAZIL, Paraná, Itaipu Reservoir: São Vicente River, 13-II-2003, *SM Thomaz & TA Pagioro* (UNOP1786); Ocoí River, 15-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1616); 14-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1629); Passo Cuê River, 08-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1657).

Geographic distribution in Brazil: [as *Nitella furcata* f. *inversa* R.D.Wood] São Paulo (Picelli-Vicentim et al. 2004) and Rio Grande do Sul (Prado 2003).

Comments: This is the first record of *N. inversa* Imahori [sin. *Nitella furcata* (Roxburgh ex Bruzelius) C.Agardh emend. R.D.Wood subsp. *furcata* var. *sieberi* (A.Braun) R.D.Wood f. *inversa* (Imahori) R.D.Wood] in the Itaipu Reservoir, and is also the first report of this species in Paraná State. *Nitella inversa* has terminal oogonia, terminal or lateral antheridia (Picelli-Vicentim et al. 2004), two- and three-celled dactyls, and ornamentation of the oospore membrane varying from papillate to reticular (Sakayama 2008).

Compared to the specimens observed by Prado (2003), the material analyzed here showed differences in the morphometric limits of the oospores (from 320 µm to 278 µm long) and antheridia (from 310 µm to 329 µm diameter). The highest and the lowest morphometric values for the oogonia and lowest value of the antheridia were recorded in the sample from the São Vicente River (UNOP1786). The specimens from the Ocoí River showed the smallest measurements for oospores (UNOP1616 and UNOP1629) and the largest measurements for antheridia (UNOP1629).

Nitella microcarpa A.Braun. Monatsbericht der deutschen Akademie der Wissenschaften zu Berlin 357. 1858.
Figures 37-40

Plants monoecious. Stem: 10 cm tall, without incrustations. Axes: 390-702 µm diam. Internodes: 1.6-4.2 cm long. Branchlets: monomorphic, 7-8, 2-3 furcated, 1.2-2.7 cm long. Primary rays: 7-8, 0.4-1 cm long. Secondary rays: 4-5, 1 of which is occasionally central and reduced. Tertiary rays: 3-4. Quaternary rays: 2-3. Dactyls: 2-3, 2-3-celled, 94-2,392(-3,510) µm long × 41-182 µm diam., predominantly abbreviated, penultimate cell cylindrical, end cell conical, acute apex. Heads: not formed. Gametangia: conjoined at all furcations. Oogonia: 2-3 at a node, 412-525 µm long × 268-443 µm diam., convolutions 7-8, coronula 45-65 µm long × 62-82 µm diam. Oospore: 288-309 µm long × 247-299 µm diam., striae 5-6, fossa 50-57 µm across, membrane reticulate. Antheridia: 227-494 µm diam., octo-scutate, triangular scute.

Representative specimens examined: BRAZIL, Paraná, Itaipu Reservoir: São João River, 12-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1739); 12-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1772); Ocoí River, 14-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1611); 24-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP2081); 14-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP2917); Pinto River, 09-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP2062); Passo Cuê River, 09-VIII-2002, *SM Thomaz & TA Pagioro* (UNOP1650).

Geographic distribution in Brazil: [as *Nitella furcata* f. *microcarpa* (A.Braun) R.D.Wood] Mato Grosso do Sul (Bueno & Bicudo 1997) and São Paulo State (Necchi Júnior et al. 2000, Picelli-Vicentim et al. 2004).

Comments: Braun (1858) first reported the occurrence of this species in Brazil. *Nitella microcarpa* has two to three oogonia at a single node, predominantly abbreviated

dactyls with two and three cells, and the axis up to 1 mm in diameter. The material analyzed here increased the upper limit for dactyl length from 2600 µm (Picelli-Vicentim et al. 2004) to 3510 µm, oospore morphometric limits increased from 292 µm long × 260 µm diameter (Bueno & Bicudo 1997) to 309 µm long × 299 µm diam., and the morphometric limits of the antheridia increased from 290 µm (Bueno & Bicudo 1997) to 300 µm diameter.

Nitella subglomerata A.Braun 1858. Monatsbericht der deutschen Akademie der Wissenschaften zu Berlin 356. 1858.
Figures 41-42

Plants monoecious, without incrustations. Axes: 468-832 µm diam. Internodes: 1.3-2 cm long. Branchlets: dimorphic. Sterile branchlets: 6-10, 0.9-2.3 cm long, 1-furcated, primary rays 6-10, 0.8-1.7 cm long, dactyls 2-5, 1-celled, acuminate apex, 1300-9000 µm long × 117-312 µm diam. Fertile branchlets: reduced, forming heads, 7-10, 453-3952 µm long × 72-104 µm diam., 1-furcated, dactyls 3-4, elongated, curved, acuminate apex, 1-celled, 463-858 µm long × 72-104 µm diam. Heads: stipitate, numerous, 1-3 per whorl, semi-spherical to conical, lax, occasionally forming whorls with axillary ramifications, 0.1-2 mm diam. Gametangia: conjoined or sejoined. Oogonia: 1-3 at a node, 309-433 µm long × 268-309 µm diam., convolutions 8-9, coronula 28-42 µm long × 41-50 µm diam. Oospore: 206-278 µm long × 237-546 µm diam., striae 6-7, fossa 42-45 µm across, membrane granulate. Antheridia: 237-278 µm diam., octo-scutate, triangular scute.

Representative specimens examined: BRAZIL, Paraná, Itaipu Reservoir: São Francisco Falso River, 25-IV-2002, *SM Thomaz & TA Pagioro* (UNOP1354); São João River, 20-II-2003, *SM Thomaz & TA Pagioro* (UNOP2916); 20-II-2003, *SM Thomaz & TA Pagioro* (UNOP2176); Ocoí River, 28-I-2002, *SM Thomaz & TA Pagioro* (UNOP1312); Pinto River, 23-I-2002, *SM Thomaz & TA Pagioro* (UNOP2897).

Geographic distribution in Brazil: in the states of Mato Grosso (Braun & Nordstedt 1883, Bicudo & Yamaoka 1978), Mato Grosso do Sul (Bicudo & Yamaoka 1978, Bueno & Bicudo 1997), Minas Gerais (Braun & Nordstedt 1883, Bicudo 1969, Bicudo & Yamaoka 1978), Paraná (Bicudo & Yamaoka 1978), Rio Grande do Sul (Astorino 1983, Prado 2003), and São Paulo (Braun & Nordstedt 1883, Wood & Imahori 1965, Bicudo & Yamaoka 1978, Picelli-Vicentim & Bicudo 1993, Necchi Junior et al. 2000, Vieira Júnior et al. 2002, Picelli-Vicentim et al. 2004).

Comments: *N. subglomerata* is cosmopolitan and widely recorded in Brazil. The material analyzed here was similar to that reported by Bicudo & Yamaoka (1978), Astorino (1983), Bueno & Bicudo (1997), Picelli-Vicentim & Bicudo (1993), and Picelli-Vicentim et al. (2004). The species has fertile branchlets reduced into heads, one-celled dactyls, and one-furcated dimorphic branchlets. The presence of fertile heads distinguishes *N. subglomerata* from *N. acuminata*, and a monoecious condition separates it from the dioecious species *N. blankinshipii* T.F.Allen. Specimen UNOP2176 showed the lowest and highest morphometric values for antheridia, and UNOP2916 the lowest values for oogonia and oospores.

General comments

Information regarding the occurrence of the genera *Chara* and *Nitella* in Paraná State is still relatively scarce. *Chara guairensis* was described by Bicudo (1972, 1974) for the Guaíra region, *N. subglomerata* was recorded for the mid-western region of the state (Branco et al. 2009), the genus *Nitella* was recorded for the mid-southern region (Krupek et al. 2008), and *N. furcata* recorded for the Upper Paraná river floodplain (Thomaz et al. 2009). Species recorded for the Itaipu Reservoir include *C. braunii, C. guairensis, Chara* sp., *Nitella* sp., *N. acuminata, N. furcata, N. furcata* subsp. *mucronata,* and *N. subglomerata* (Thomaz et al. 1999, 2003, Mormul et al. 2010). Recently, Bueno et al. (2011) contributed with records of *C. diaphana* and *C. kenoyeri* as new citations for the reservoir.

Nine species of *Nitella* were recorded. The Ocoí River contained the highest species richness (seven), followed by the São João and São Vicente rivers with six species each. These areas, located in the lacustrine zone of the reservoir, are mesotrophic to oligotrophic (Bini et al. 1999) and favorable environments for the development of submerged algae. The Arroio Guaçu and São Francisco Verdadeiro rivers, located in the transition and fluvial zones of the reservoir respectively, contained one and two species respectively. These regions have eutrophic characteristics (Bini et al. 1999), with frequent phytoplankton blooms that make the environment less favorable to the development of submerged species such as the Characeae. The differences in Characeae richness seen among the different tributaries of the fluvial, transition, and lacustrine zones are in accordance with the results of Pagioro & Thomaz (2002) who found a gradient of sedimentation rates in the reservoir, where water

transparency gradually increased from the fluvial zone to the lacustrine zone, allowing greater colonization by submerged plants in the clearer water.

The species *Chara hydropitys*, *C. rusbyana*, *Nitella axillaris*, *N. glaziovii*, *N. gracilis*, *N. hyalina*, *N. inversa*, and *N. microcarpa* are new records for the Itaipu Reservoir and Paraná State. We believe that the differences in richness between the present study and those reported by Thomaz et al. (1999, 2003), Mormul et al. (2010), and Bueno et al. (2011) were due to different criteria for sampling and for identification, and to the taxonomic resolutions used in the different studies.

The morphometric differences seen between the specimens analyzed and those previously described in the studies of Bicudo (1972, 1974), Astorino (1983), Bueno et al. (1996), Prado (2003), Vieira Júnior et al. (2003, 2003), Picelli-Vicentim et al. (2004), and Bueno et al. (2009, 2011) could represent variation due to phenotypic plasticity, corresponding to the different environmental conditions to which these plants were subjected (Asaeda et al. 2007, Blindow & Schütte 2007), although further investigations are necessary to confirm this hypothesis.

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