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The genus *Pythium* Pringsheim from Brazilian cerrado areas, in the state of São Paulo, Brazil

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ABSTRACT – (The genus *Pythium* Pringsheim from Brazilian cerrado areas, in the state of São Paulo, Brazil). Water and soil samples were obtained from cerrado areas in the state of São Paulo, Brazil, from February, 1999 to February, 2001, brought to the laboratory and treated by the multiple baiting technique. Among the pythiaceous fungi isolated, nine species belonging to the genus *Pythium* Pringsheim: *Pythium echinulatum* Matthews, *P. graminicolum* Subramanian, *P. irregulare* Buisman, *P. rostratum* Butler, *P. spinosum* Sawada, *P. torulosum* Coker & Patterson, *P. ultimum* Trow var. *ultimum*, *P. undulatum* Petersen and *P. vexans* de Bary. *P. undulatum* is mentioned for the first time to Brazil.

Key words - biodiversity, Brazil, cerrado vegetation, *Pythium*

RESUMO – (O gênero *Pythium* Pringsheim de áreas de cerrado no Estado de São Paulo, Brasil). Foram coletadas amostras de água e solo em áreas de cerrado no Estado de São Paulo, Brasil, de fevereiro/1999 a fevereiro/2001. Estas amostras foram trazidas ao laboratório e tratadas segundo a técnica de iscagem múltipla. Dentre os fungos pitiáceos isolados, nove espécies pertencem ao gênero *Pythium* Pringsheim: *Pythium echinulatum* Matthews, *P. graminicolum* Subramanian, *P. irregulare* Buisman, *P. rostratum* Butler, *P. spinosum* Sawada, *P. torulosum* Coker & Patterson, *P. ultimum* Trow var. *ultimum*, *P. undulatum* Petersen e *P. vexans* de Bary. *P. undulatum* é mencionado pela primeira vez para o Brasil.

Palavras-chave - biodiversidade, Brasil, cerrado, *Pythium*

Introduction

The genus *Pythium* Pringsheim includes terrestrial and aquatic representatives, saprobe or parasite members, most of them cosmopolitan. According to Hawksworth *et al.* (1995), the genus includes 120 species, some of them phytopathogenic, causing fruit, root or stem rot, pre- or post-emergence damping-off of seedlings. *Pythium insidiosum* De Cock, Mendonza, Padhye, Ajello & Kaufman has been reported to cause pythiosis in humans in addition to dogs, cats and horses, as reported previously (Alexopoulos *et al.* 1996). Two cases of cutaneous pythiosis involving *P. insidiosum* have been recently diagnosed in calves from the Pantanal region, state of Mato Grosso, Brazil (Santurio *et al.* 1998).

This genus has been assigned to the Kingdom Stramenopila, Phylum Oomycota, Order Peronosporales and Family Pythiaceae (Alexopoulos *et al.* 1996). Dick (2001) proposed the name Straminipila instead of Stramenopila for this new kingdom.

The cerrado vegetation covers about 25% of the Brazilian territory, predominantly in the Center-West region. In the state of São Paulo it appears as fragmented areas and little is known about its biodiversity, mainly concerning zoosporic fungi (Kronka *et al.* 1998, Milanez *et al.* 1997). The first reference to the genus *Pythium* from Brazilian cerrado areas concerned the species *Pythium debaryanum* Hesse isolated from tubers of *Solanum tuberosum* L. and *Myrciaria* sp. fruits in the city of Campinas, state of São Paulo (Viégas & Teixeira 1943). Several biodiversity studies followed (Milanez 1968, 1970, Lyra & Milanez 1974, Pires-Zottarelli 1990, Pires-Zottarelli & Milanez 1993) which cited *Pythium debaryanum* Hesse, *P. diclinum* Tokunaga, *P. mamillatum* Meurs, *P. parvum*, M.S. Ali-Shtayeh, *P. pleroticum* T. Ito, *P. tardiscrescens* Vanterpool, *P. torulosum* Coker & Patterson, and *P. vexans* de Bary from the cerrado dominion.

Even fewer studies are available for other Brazilian cerrado areas. Gauch & Ribeiro (1998) obtained potential mycoparasitic species from soil in the state of Goiás: *P. acanthicum* Dreschler, *P. aphanidermatum* (Edson) Fitspatrick, *P. dictyosporum* Raciborski, *P. graminicolum* Subramaniam, *P. irregulare* Buisman, *P. myriotylum* Dreschler, *P. oligandrum* Drechler, *P. torulosum* and *P. ultimum* Trow var. *ultimum*, and

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some asexual isolates. Rocha *et al.* (2001) isolated ten different taxa from soil and water samples collected in cerrado areas of the "Parque Nacional de Sete Cidades", state of Piauí: *P. echinulatum* Matthews, *P. mamillatum* Meurs, *P. middletonii* Sparrow, *P. myriotylum* Drechsler, *P. palingenes* Drechsler, *P. periilum* Drechsler, *P. rostratum* Butler, *P. ultimum* Trow var. *ultimum*, *P. vexans* de Bary, and one asexual isolate (Group T).

The objective of the present paper was to contribute for knowledge of the diversity of *Pythium* species from Brazilian cerrado areas.

Material and methods

The studied cerrado areas are located in the state of São Paulo, Brazil ("Reserva Biológica de Moji-Guaçu"- 22º15' S and 47º09' W, "Estação Experimental de Luís Antônio", "Estação Ecológica de Jataí" - both located at 21º36' S and 46º47' W and "Estação Ecológica de Itirapina" - 22º13' S and 47º51' W). Water and soil samples from these areas were collected every three months from February, 1999 to February, 2001, and treated by the baiting technique with cellulosic substrates (*Sorghum* sp. seeds, onion epiderm and corn straw), prepared as described by Milanez (1989).

The isolates were purified in corn-meal-agar (CMA) plus penicillin, streptomycin and pimaricin - CMA + p.p.e. (Carvalho & Milanez 1989) and identified with the aid of specific literature (Middleton 1943, Frezzi 1956, Plaats-Niterink 1981). These isolates have been incorporated into the Fungal Culture Collection of the Botanical Institute of São Paulo (SPC).

Results and Discussion

Nine species of *Pythium* were identified and the descriptions of the genus and species are given below.

Pythium Pringsheim

Thallus monoecious or dioecious. Mycelium delicate, often with hyphal swellings. Zoosporangium generally present, filamentous, not differentiated from the vegetative hyphae, spherical, subspherical, ellipsoidal, rarely pyriform, occasionally proliferating or consisting of lobate or toruloid inflated elements. Zoospore, when present, completing its maturation in an evanescent vesicle formed at the apex of the zoosporangium discharge tube. Oogonium usually spherical or oval, with smooth or ornamented wall. Antheridia absent or present, of different origins. Oospore generally 1 per oogonium, plerotic or aplerotic (based on Sparrow 1960).

Key to *Pythium* species

1. Zoosporangia absent
   2. Oogonium wall normally smooth ..... *P. ultimum* var. *ultimum*
   2. Oogonium wall with digitate ornamentation ..... *P. spinosum*
1. Zoosporangia present
   3. Zoosporangia filamentous inflated
      4. Oogonia mostly 15-23 µm in diameter (average 20.5 µm); antheridial branches, 1-2 per oogonium ..... *P. torulosum*
      4. Oogonia mostly 17.5-29 µm in diameter (average 24.2 µm); antheridial branches, 1-5 per oogonium ..... *P. graminicolum*
   3. Zoosporangia spherical or ellipsoidal
      5. Sexual phase absent ..... *P. undulatum*
      5. Sexual phase present
         6. Oogonium wall smooth and/or with some papillae
            7. Oogonial wall sometimes papillate ..... *P. irregulare*
            7. Oogonial wall smooth
               8. Oogonia intercalary, usually in chains; antheridial cells tubular or clavate ..... *P. rostratum*
               8. Oogonia terminal, some sessile; antheridial cells typically bell-shaped ..... *P. vexans*
         6. Oogonium wall with conical ornamentations ..... *P. echinulatum*

Pythium echinulatum Matthews, Studies on the genus *Pythium*, p. 101. 1931.
Figures 1-3.

Colonies on CMA + p.p.e. showing no special pattern of growth. Hyphae 2-6 µm in diameter. Zoosporangia spherical, 17-25 µm in diameter (average 18.8 µm), some cylindrical; terminal ou intercalary. Encysted zoospores 3-5 µm in diameter (average 4.3 µm). Oogonia intercalary or terminal, spherical, 19-30 µm in diameter (average 22 µm) provided with conical ornamentations, 3-6 µm long (average 4.3 µm), some without ornamentation. Antheridia present; antheridial branches monoclinous or hypogynous, 1-2 per oogonium, usually 1; antheridial cells clavate making broad apical contact with the oogonium or tubular and laterally applied. Oospores aplerotic, spherical, 14-27 µm in diameter (average 18 µm), wall 1.9-2.5 µm thick.

Material examined: BRAZIL: São Paulo: Luís Antônio, Estação Ecológica de Jataí, soil samples, 25-XI-1999 and 4-VIII-2000, *C.L.A. Pires-Zottarelli* (SPC1892).

The characteristics of these specimens agree with the descriptions provided by Plaats-Niterink (1981) and Rocha *et al*. (2001). It was observed that at the beginning of development some oogonia are smooth, becoming ornamented with aging. This was mentioned for the first time in Brazil by Cavalcanti (2001) working with soil and water samples collected in the state of Pernambuco.

Patogenicity in Brazil: unknown.

Pythium graminicolum Subramaniam, Bull. Agric. Res. Inst. Pusa 177:5. 1928.
Figures 4-7.

Colonies on CMA + p.p.e. showing no special growth pattern. Hyphal swellings present. Apressoria present, subspherical or irregular. Zoosporangia filamentous inflated, simple or branched, terminal or intercalary. Encysted zoospores 7.5-10 µm in diameter (average 8.5 µm). Oogonia hyaline, sometimes yellowish, terminal or intercalary, spherical, 17.5-29 µm in diameter (average 24.2 µm); smooth walled. Antheridia present; antheridial branches monoclinous, some diclinous, 1-5 per oogonium, normally 2-3; antheridial cells crook-necked, sometimes irregular or tubular. Oospores plerotic, spherical, 19-22.5 µm in diameter (average 20.2 µm); smooth walled, 1-2.5 µm thick.

Material examined: BRAZIL: São Paulo: Moji-Guaçu, Reserva Biológica de Moji-Guaçu, soil sample, 19-II-2001; Itirapina, Estação Ecológica de Itirapina, soil sample, 19-II-2001; Luís Antônio, Estação Ecológica de Jataí, soil sample, 7-XI-2000, *C.L.A. Pires-Zottarelli* (SPC1920).

The characteristics of these specimens agree with those reported by Plaats-Niterink (1981), although she did not mention colored oogonia. Frezzi (1956) observed that some of the old oogonia were yellowish. The oogonia, oospheres and oospores of the studied material were often abortives, in agreement with Frezzi (1956) and Plaats-Niterink (1981), who respectively cited abortive oogonia and oospores. This species was mentioned for the first time in Brasil by Carvalho (1965) who isolated it from root rot of *Phaesolus vulgaris* L.

Patogenicity in Brasil: *Phaesolus vulgaris* (Carvalho 1965); *Ananas comosus* L., *Lycopersicon esculentum* P. Miller, and *Saccharum officinarum* L. (Mendes *et al.* 1998).

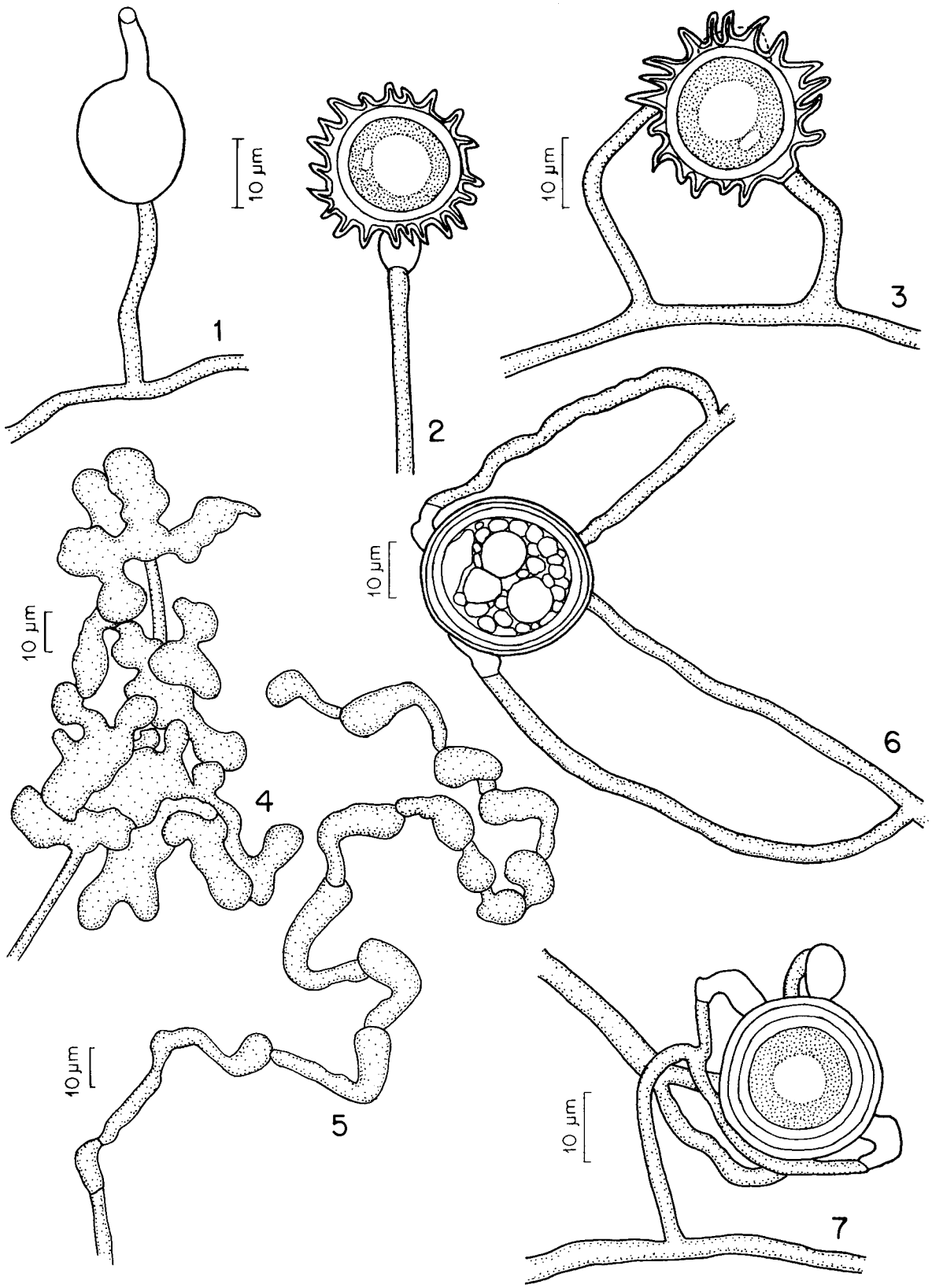
Pythium irregulare Buisman, Diss. Univ. Utrecht., p.38. 1927.
Figures 8-10.

Colonies on CMA + p.p.e. showing no special pattern of growth. Hyphae 5 µm in diameter, with limoniform swellings. Zoosporangia terminal or intercalary, of variable shape and size, ellipsoidal, pyriform, usually spherical, 12.5-25 µm in diameter (average 20 µm); discharge tubes persistent. Encysted zoospores 7.5-10 µm in diameter (average 8.8 µm). Oogonia intercalary, sometimes terminal and lateral, spherical, 15-27.5 µm in diameter (average 24 µm); wall with irregular contour, papillae infrequently present, 7.5 µm long. Antheridia present; antheridial branches monoclinous, sometimes hypogynous, 1-3 per oogonium; antheridial cells clavate or simple tubular; apically attached. Oospore aplerotic, 12.5-22.5 µm in diameter (average 18.5 µm); smooth walled, 2 µm thick.

Material examined: BRAZIL: São Paulo: Moji-Guaçu, Reserva Biológica de Moji-Guaçu, soil samples, 20-IX-1999 and 19-II-2001, *C.L.A. Pires-Zottarelli* (SPC1921).

The characteristics of these isolates agree with those mentioned by Frezzi (1956). The oogonia and oospores of the Brazilian material are larger than those mentioned by Plaats-Niterink (1981), who cited oogonia measuring 15-25 µm in diameter (average 18.5 µm) and oospores 14-20 µm in diameter (average 15.9 µm). This species was mentioned for the first time to Brazil by Carvalho (1965), who isolated it from root rot of *Chichorium endivia* L.

Patogenicity in Brazil: *Ananas comosus*, *Arachis hypogaea*, *Chichorium endivia*, *Myrciaria*



Figures 1-3. *Pythium echinulatum*. 1. Empty spherical zoosporangium with discharge tube. 2. Oogonium with conical ornamentation and hypogynous antheridium. 3. Ornamented lateral oogonium with monoclinous antheridium. Figures 4-7. *Pythium graminicolum*. 4. Zoosporangium. 5. Appressoria. 6. Intercalary oogonium with abortive oospore. 7. Oogonium with oospore and monoclinous and diclinous antheridia.

jaboticaba L., *Pinus* spp., *Saccharum officinarum*, and *Solanum tuberosum* L. (Mendes *et al.* 1998).

Pythium rostratum Butler, Memoirs of the Department of Agriculture 1:84. 1907.
Figures 11-12.

Colonies on CMA + p.p.e. showing a chrysanthemum-like growth pattern. Zoosporangia spherical, 10-25 µm in diameter (average 16 µm), sometimes pyriform; terminal or intercalary. Encysted zoospores 2.5-7.5 µm in diameter (average 5.1 µm). Oogonia hyaline or yellowish, spherical, 12.5-23 µm in diameter (average 20.1 µm), intercalary, often in chains, occasionally terminal; smooth walled. Antheridia present; antheridial branches monoclinous, sometimes diclinous or hypogynous; antheridial cells tubular, irregular ou clavate; with apical or lateral attraction. Oospores plerotic, rarely aplerotic, spherical, 12.5-17.5 µm in diameter (average 13.5 µm); smooth walled, 2 µm thick.

Material examined: BRAZIL: SÃO PAULO: Moji-Guaçu, Reserva Biológica de Moji-Guaçu, soil samples, 25-XI-1999 and 19-V-2000; Luís Antônio, Estação Ecológica de Jataí, soil samples, 4-VIII-2000 and 7-XI-2000, *C.L.A. Pires-Zottarelli* (SPC1891).

The specimens studied showed zoosporangia and oogonia smaller than those mentioned by Plaats-Niterink (1981), who cited zoosporangia measuring 17-32 µm in diameter (average 25 µm) and oogonia 17-26 µm in diameter (average 21.5 µm). Rocha *et al.* (2001) cited larger oospores than those reported here, 14-20 µm in diameter (average 18.5 µm) This species was mentioned for the first time to Brazil by Upadyhay (1967), who isolated it from soil samples in Caruaru municipality, state of Pernambuco, identified as *Pythium diamenson*, a synonym of *P. rostratum*. Some yellowish oogonia were present, as also observed by Frezzi (1956).

Patogenicity in Brazil: *Chrysanthemum* sp. (Silva *et al.* 1989), and *Saccharum officinarum* (Valdebenito-Sanhueza *et al.* 1984).

Pythium spinosum Sawada, Trans. Nat. Hist. Soc. Formosa 16:199. 1926.
Figures 13-16.

Colonies on CMA + p.p.e. showing aerial mycelium and no special pattern. Zoosporangia and zoopores absent. Apressoria not observed. Hyphal swellings present, terminal or intercalary, globose or limoniform; thin and smooth wall, but occasionally with digitate ornamentations. Oogonia terminal or intercalary, spherical, 12.5-20 µm in diameter (average 17.5 µm), some fusiform when intercalary; with digitate ornamentations, 3-8 × 1-2 µm. Antheridia present; antheridial branches monoclinous, occasionally diclinous, 1 per oogonium, sometimes 2; antheridial cells clavate. Oospore plerotic, spherical, 12-17.5 µm in diameter (average 14.5 µm); thin walled.

Material examined: BRAZIL: SÃO PAULO: Luís Antônio, Estação Experimental de Luís Antônio, soil samples, 19-V-2000 and 4-VIII-2000, *C.L.A. Pires-Zottarelli* (SPC1950).

The characteristics of the specimens examined agree with those mentioned by Plaats-Niterink (1981); however, apressoria were not observed. Middleton (1943) and Frezzi (1956) mentioned the presence of zoosporangia in their cultures of this species, absent in the Brazilian material. *P. spinosum* was cited from Brazil for the first time by Pires-Zottarelli *et al.* (1995), isolated from soil samples collected in the "Parque Estadual das Fontes do Ipiranga", São Paulo city.

Patogenicity in Brazil: *Zingiber* sp.

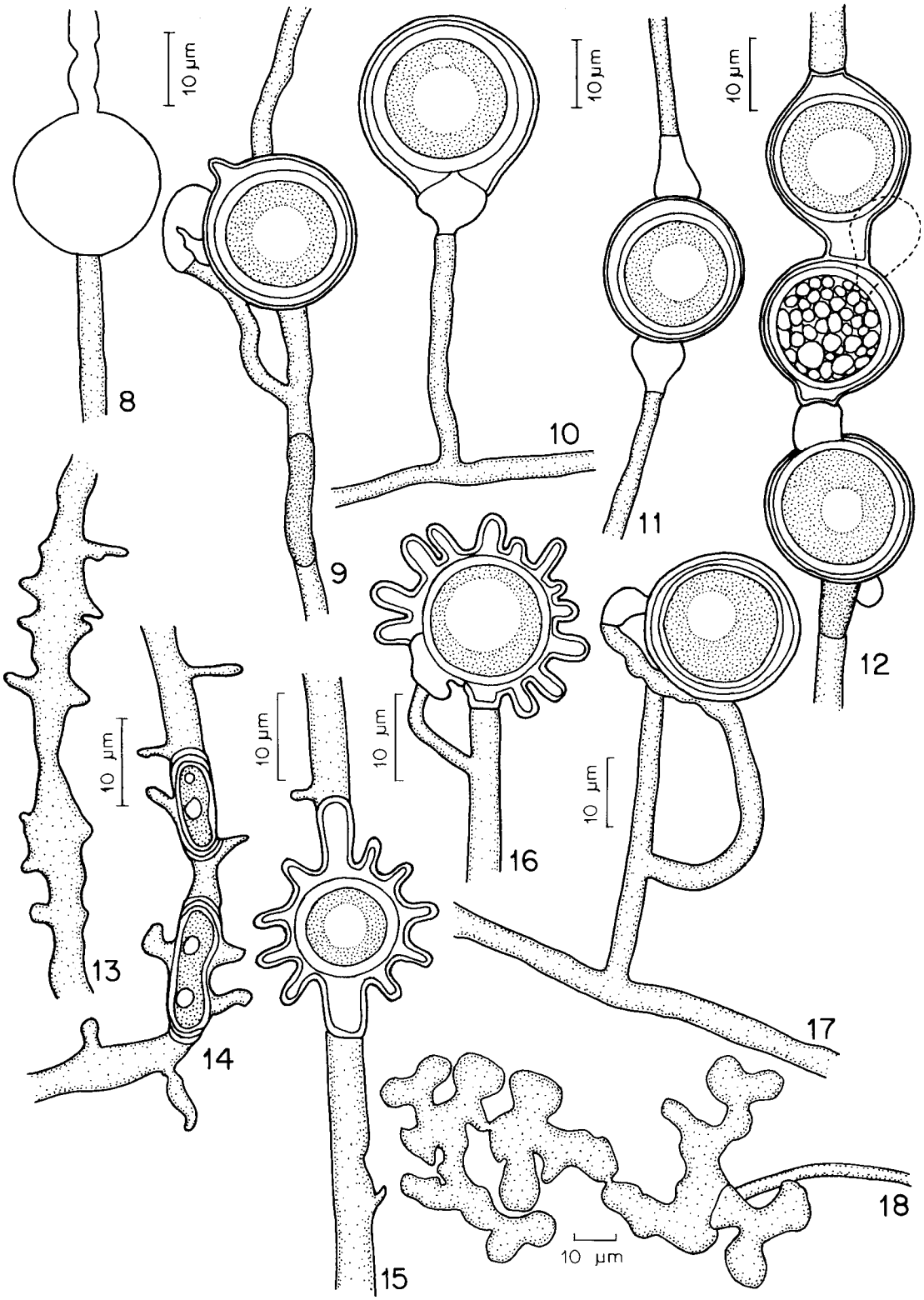
Pythium torulosum Coker & Patterson, J. Elisha Mitchell Sci. Soc. 42:247. 1927.
Figures 17-18.

Colonies on CMA + p.p.e. showing a radiate growth pattern. Zoosporangia filamentous, inflated, forming toruloid complexes. Hyphal swellings of various sizes and shapes. Encysted zoospores 8-9 µm in diameter; discharge tubes long. Oogonia terminal, lateral, spherical, 15-23 µm in diameter (average 20.5 µm); smooth walled. Antheridia present; antheridial branches monoclinous, some diclinous, 1-2 per oogonium; antheridial cells clavate. Oospores plerotic, spherical 14-19 µm in diameter (average 18 µm); smooth walled, 2 µm thick.

Material examined: BRAZIL: SÃO PAULO: Itirapina, Estação Ecológica de Itirapina, soil samples, 20-IX-1999, 7-XI-2000 and 19-II-2001; Luís Antônio, Estação Experimental de Luís Antônio, soil sample, 25-XI-1999, *C.L.A. Pires-Zottarelli* (SPC1896).

The characteristics of the specimens agree with those mentioned by Frezzi (1956), Plaats-Niterink (1981), and Pires-Zottarelli (1999). The species was mentioned for the first time to Brazil by Pires-Zottarelli & Milanez (1993), who isolated it from water samples collected in the "Represa do Lobo ("Broa")", Brotas-Itirapina municipalities, São Paulo state.

Patogenicity in Brazil: *Ananas comosus* (Mendes *et al.* 1998).



Figures 8-10. *Pythium irregulare*. 8. Empty spherical zoosporangium with discharge tube. 9. Intercalary oogonium with monoclinous antheridia. 10. Oogonium with aplerotic oospore and hypogynous antheridium. Figures 11-12. *Pythium rostratum.* 11. Spherical intercalary oogonium. 12. Oogonia in chains. Figures 13-16. *Pythium spinosum*. 13. Hypha with digitate ornamentations. 14. Oogonia inside a hypha. 15. Ornamented intercalary oogonium. 16. Ornamented oogonium with monoclinous antheridium. Figures 17-18. *Pythium torulosum.* 17. Oogonium with oospore and monoclinous antheridium. 18. Zoosporangium.

Pythium ultimum Trow var. *ultimum*, Ann. Bot. 15:269. 1901.
Figures 19-20.

Colonies on CMA + p.p.e. showing a radiate growth pattern and aerial mycelia. Sporangia and zoopore absent. Oogonia terminal or intercalary, spherical, 16-22 µm in diameter (average 18.3 µm); smooth walled, rarely with papillae. Antheridia present; antheridial branches monoclinous or hypogynous, 1-2 per oogonium, some sessile; antheridial cells clavate, tubular or irregular, with lateral and apical attachment to the oogonium. Oospores aplerotic, spherical, 12-18 µm in diameter (average 14.4 µm).

Material examined: BRAZIL: São Paulo: Itirapina, Estação Ecológica de Itirapina, soil sample, 19-V-2000; Luís Antônio, Estação Experimental de Luís Antônio, soil sample, 2-II-2000, *C.L.A. Pires-Zottarelli* (SPC1893).

The characteristics of the specimens agree with those mentioned by Plaats-Niterink (1981), and Rocha *et al.* (2001). This variety was mentioned for the first time in Brazil by Pires-Zottarelli *et al.* (1995), who isolated it from soil samples collected in the "Parque Estadual das Fontes do Ipiranga", in the city of São Paulo.

Patogenicity in Brazil: *Arachis hypogaea, Cicer arietinum* L., *Lactuca sativa* L. *Phaseolus lunatus* L., *Pisum sativum* L., *Poinsettia* sp., *Saccharum officinarum, Solanum gilo* L., *Solanum melogena* L., and *Lycopersicon esculentum* (Mendes *et al.* 1998). The above references are related to *Pythium ultimum* without identification of the variety, but the literature shows that *P. ultimum* var. *ultimum* is the most common taxon with extensive reports of its pathogenicity (Plaats-Niterink 1981).

Pythium undulatum H.E. Petersen, Bot. Tidsskr. 29:394. 1909.
Figures 21-23.

Colonies on CMA + p.p.e. showing no special growth pattern. Zoosporangia ellipsoidal, terminal and intercalary, 45-113 (average 80 µm) × 22-38 µm (average 29 µm), proliferating internally. Discharge tubes with variable length. Encysted zoospores 10-12.5 µm in diameter (average 11 µm). Chlamydospores spherical, 20-50 µm in diameter (average 38 µm), terminal ou intercalary, amber. Sexual phase absent.

Material examined: BRAZIL: São Paulo: Moji-Guaçu, Reserva Biológica de Moji-Guaçu, water samples, 21-V-1999, 2-II-2000 and 4-VIII-2000 and soil samples, 25-XI-1999, 19-II-2001; Luís Antônio, Estação Ecológica de Jataí, soil sample, 20-IX-1999; Itirapina, Estação Ecológica de Itirapina, water sample, 2-II-2000 and soil sample, 19-II-2001, *C.L.A. Pires-Zottarelli* (SPC1894).

The specimens studied agree with the ones cited by Plaats-Niterink (1981). This species was originally isolated from *Nymphaea alba* L. leaves and *Nuphar luteum* L. in Denmark (Plaats-Niterink 1981). This is the first report of the species to Brazil.

Patogenicity in Brazil: unknown.

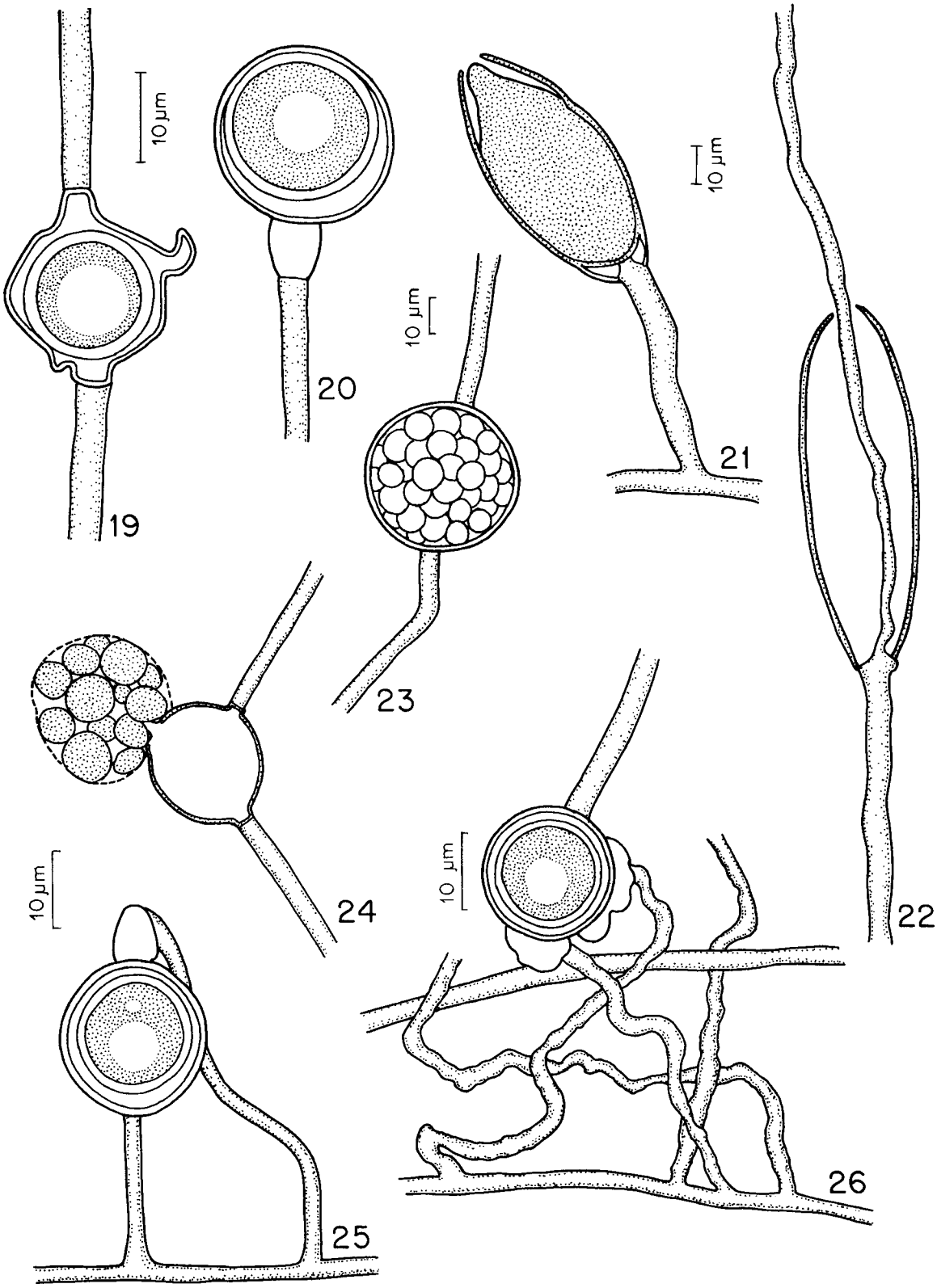
Pythium vexans de Bary, Journal de Botanique Paris 14:105. 1876
Figures 24-26.

Colonies on CMA + p.p.e. showing a radiate growth pattern. Zoosporangia spherical, 15-20 µm in diameter (average 17.5 µm), lateral, terminal ou intercalary, not proliferating. Encysted zoopores 6.25-10 µm in diameter (average 7.75 µm). Oogonia spherical, 12.5-25 µm in diameter (average 19.6 µm), terminal, some of them sessile; oogonial wall sometimes with some papillae. Antheridia present; antheridial branches monoclinous, rarelly diclinous, 1 per oogonium, occasionally 2; antheridial cells typically bell-shaped, clavate, lobed, rarely irregular, apically or laterally attached to the oogonium. Oopores aplerotic, ocasionally plerotic, spherical, 12-16 µm in diameter (average 14 µm).

Material examined: BRAZIL: São Paulo: Luís Antônio, Estação Experimental de Luís Antônio, soil sample, 25-XI-1999; Moji-Guaçu, Reserva Biológica de Moji-Guaçu, soil sample, 19-II-2001, *C.L.A. Pires-Zottarelli* (SPC1895).

The characteristics of the specimens agree with the description of Frezzi (1956), and Pires-Zottarelli (1999). The oospores mentioned by Plaats-Niterink (1981) are a little larger, 14-20 µm in diameter (average 17.3 µm). Rocha *et al.* (2001) observed pyriform and oval zoosporangia, shapes not observed in the specimens studied here. Milanez (1970) also mentioned the presence of pyriform zoosporangia (18-36 × 30-36 µm) and spherical zoosporangia 15-36 µm in diameter, generally 20-30 µm, and oospore 16-22 µm in diameter, generally 18-20 µm; these are larger than the ones studied here. The first mention of this species in this country was made by Carvalho (1965), who obtained it from root rot of *Strelitzia* sp.

Patogenicity in Brazil: *Strelitzia* sp. (Carvalho1965), *Saccharum officinarum* (Valdebenito-Sanhueza *et al.* 1984), *Solanum melongena* L., and *Solanum gilo* (Zambolim *et al.* 1996).



Figures 19-20. *Pythium ultimum* var. *ultimum*. 19. Intercalary oogonium with some papillae. 20. Smooth spherical oogonium with hypogynous antheridia. Figures 21-23. *Pythium undulatum*. 21-22. Ellipsoidal zoosporangium with internal proliferation. 23. Chlamydospore. Figures 24-26. *Pythium vexans*. 24. Spherical zoosporangium liberating zoospores. 25. Lateral oogonium with monoclinous antheridia and bell-shaped antheridial cells. 26. Spherical oogonium with diclinous antheridia and irregular antheridial cells.

The cerrado areas have been used in recent years for the expansion of the frontiers of agriculture. They have been transformed into agricultural lands for crops such as sugar cane, soybean, cotton, and wheat. This study reveals that the cerrado soils contains a diversity of *Pythium* species with phytopathogenic potential that should not be overlooked. Knowledge of this diversity will help to build up an integrated plan for pathogen control.

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