
Additions to the Brazilian *Erysiphaceae*: *Ovulariopsis durantae* sp. nov. and *Streptopodium tabebuiae* sp. nov.

J.R. Liberato^{1,2} and R.W. Barreto^{1*}

¹Departamento de Fitopatologia, Universidade Federal de Viçosa, 36571-000, Viçosa-MG, Brazil

²Current address: Department of Primary Industries and Fisheries. Plant Pathology Building, 80 Meiers Road, Indooroopilly, Qld 4068, Australia

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Two new species of anamorphic powdery mildew from Brazil are described: *Ovulariopsis durantae* on *Duranta erecta* (*Verbenaceae*) and *Streptopodium tabebuiae* on *Tabebuia serratifolia* (*Bignoniaceae*). *Ovulariopsis durantae* is compared with and discriminated from other *Phyllactinia* anamorphs with sinuous to spirally twisted conidiophore foot-cells. The outer wall surface patterns of its conidia are different to those presented as typical for subfamily Phyllactinioideae. *Streptopodium tabebuiae* can be easily discriminated from the five species of *Pleochaeta* known to have *Streptopodium* anamorphs and also from the two strictly anamorphic species of *Streptopodium* by the combination of two features: very long conidiophores and straight conidiophore foot-cells.

Key words: anamorphs, new species, *Ovulariopsis durantae*, *Phyllactinioideae*, powdery mildew, *Streptopodium tabebuiae*.

Introduction

Little has been published concerning the powdery mildews belonging to the *Phyllactinioideae* that occur in Brazil and confusion regarding the usage of names of anamorphs of such fungi by Brazilian plant pathologists has often occurred. This paper aims at contributing to the knowledge of Brazilian *Phyllactinioideae*. Two fungi in this subfamily are described herein.

A powdery mildew common occurred on the native species *Tabebuia serratifolia* (Vahl) G. Nicholson (*Bignoniaceae*) in Viçosa (State of Minas Gerais, Brazil). The host for this fungus, *T. serratifolia* (yellow poui, local name: ipê-amarelo), is a very popular ornamental tree, which was loosely treated in the past as the Brazilian National Tree. It is widely cultivated as an ornamental in streets and parks throughout the country for its showy yellow

*Corresponding author: R.W. Barreto; e-mail: rbarreto@ufv.br

flowers produced during the winter. According to Ferreira (1989) this disease had been observed since the 1980s and was identified by him as caused by *Ovulariopsis* sp. Other reports of this disease in Brazil followed Ferreira's opinion (Schimitt and Veiga, 1987; Gianasi and Castro, 1993). Another Phyllactinioideae-caused powdery mildew disease was recently found in Viçosa on the ornamental shrub *Duranta erecta* L. (= *Duranta repens* L.) (*Verbenaceae*) (golden dewdrops, pigeon-berry, skyflower; local name: pingo-de-ouro).

Materials and methods

The specimen of *Ovulariopsis* sp. examined by Ferreira (1989) and deposited in his personal herbarium was re-examined, and fresh material was collected from the same site in Viçosa where Ferreira's collection was made. An additional specimen on *Tabebuia* sp. is from Campos dos Goitacazes (State of Rio de Janeiro, Brazil). Powdery mildew-infected *D. erecta* samples were all obtained from gardens within the campus of the Universidade Federal de Viçosa (Viçosa, State of Minas Gerais, Brazil).

In order to elucidate details of the origin of the conidiophores of these fungi, a diagnostic feature for the generic delimitation in this group, a whole leaf clearing and staining technique, developed by Bruzzese and Hasan (1983) for rust histopathological studies, was utilized.

Leaf segments from fresh leaves of *T. serratifolia* and *D. erecta* were prepared for scanning electron microscopic observations (SEM) by immersion in 2% glutaraldehyde and 2% paraformaldehyde prepared in 0.05 M C₂H₆AsO₂Na buffer (pH 7.1) overnight. Samples were washed twice with cacodylate buffer for 15 min and then dehydrated by successive transfer in a graded alcohol solutions series (30, 50, 60, 70, 80, 95 e 100%) and left for 15 min in each solution. Samples were dried in a critical point dryer (BALZERS[®] model CPD 020) using CO₂ as transition fluid. After drying, the samples were coated with gold (30 nm thickness) in a sputter coater (BALZERS[®] model FDU 010) and examined using a Jeol[®] model TSM-200 scanning electron microscope (SEM).

Results and discussion

Only the anamorphic stages of the two fungi were found on diseased leaves. The specimens on *T. serratifolia* and on *D. erecta* showed hemiendophytic mycelium (partly external and partly internal). With a single exception [species belonging to *Cystotheca* (Braun, 1987)], this feature is

exclusive to the subfamily *Phyllactinioideae* Palla, which includes the genera: *Phyllactinia* Lév. (anamorph *Ovulariopsis* Pat. & Har.), *Leveillula* G. Arnaud (anamorph *Oidiopsis* Scalia) and *Pleochaeta* Sacc. & Spig. (anamorph *Streptopodium* R.Y. Zheng & G.Q. Chen emend Liberato & R.W. Barreto) (Braun, 1987; Braun *et al.*, 2002; Liberato *et al.*, 2004).

All specimens on the two hosts showed conidiophores arising from external mycelium, a feature what excludes the possibility of them belonging to *Leveillula* (*Oidiopsis*). The fungus on *D. erecta* was identified as an *Ovulariopsis* because it had monomorphic clavate conidia produced singly at apex of the conidiophores, and the species on *Tabebuia* was identified as *Streptopodium* because it had dimorphic conidia produced singly at the apex of the conidiophores.

Ovulariopsis on *D. erecta* and *Streptopodium* on *T. serratifolia* are described below.

***Ovulariopsis durantae* Liberato & R.W. Barreto, sp. nov.** (Figs. 1-6)

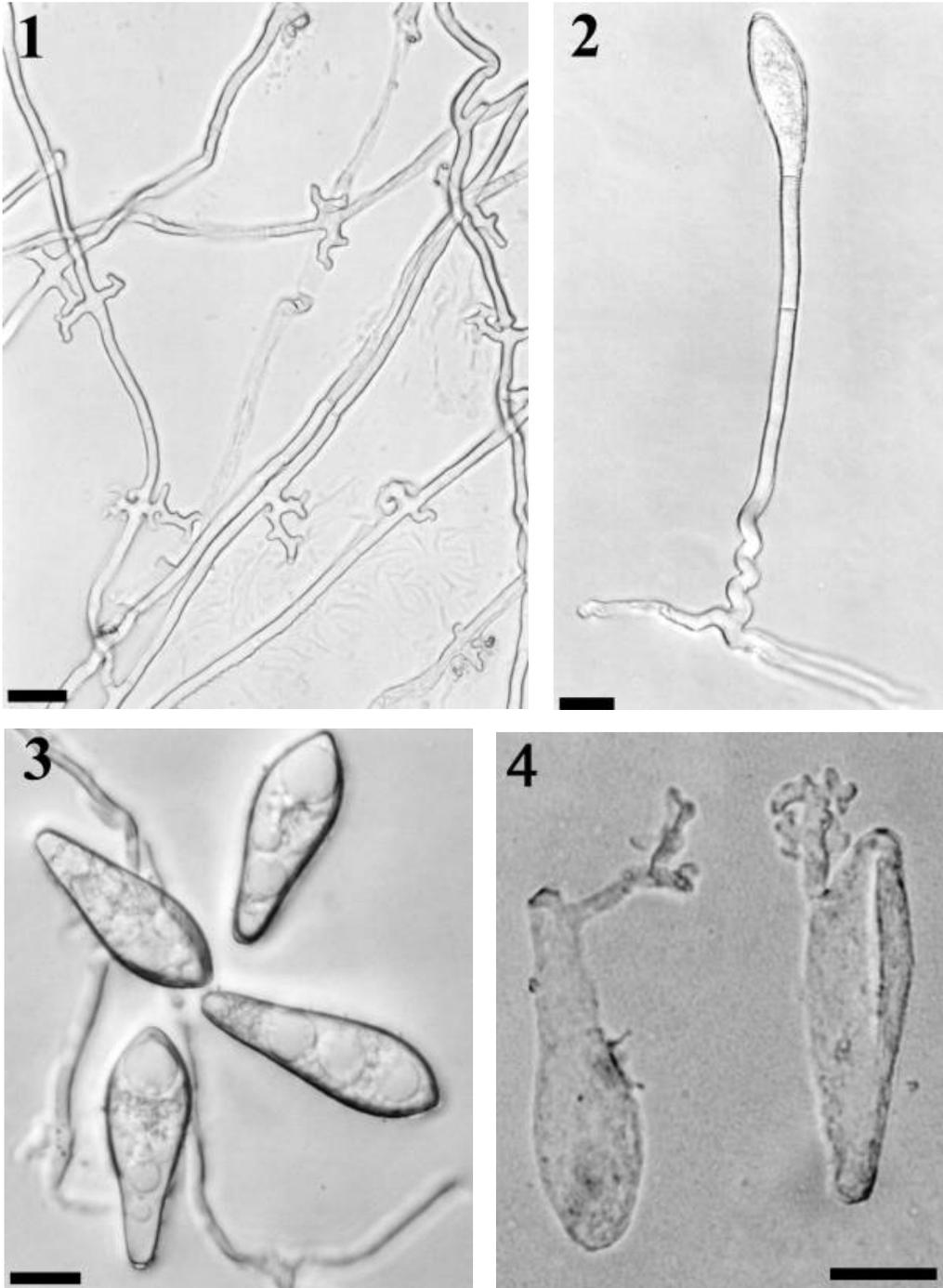
Etymology: from the host *Duranta erecta*.

Maculae in foliis vivis, amphigenae, irregulares. *Mycelium* hypophyllum, effusum vel densum, hemiendophyticum. *Hyphae superficiales* hyalinae, flexuosae, ramosae, rami ad angulum 90° patentes, 3.5-6 µm latae, septatae, laeves, per stoma emergentiae. Appressoria oblonga vel uncinata, 3.5-27 µm longa. *Conidiophora* ex hyphis superficialibus oriunda, non ramosa, cylindrica, 153-292.5 × 5-7.5 µm, 1-3 septata, hyalina, laevia, cellulis pedibus cylindraceutis, 68.5-106.5 × 5-7.5 µm, ad basim flexuosis vel spiralter tortuosis, septis basalibus 6-21 µm dissitis. *Conidia* solitaria, clavata interdum ellipsoidea vel subcylindraceuta 52-99 × 15-24.5 µm, hyalina, laevia, tubis germinativis plerumque brevibus, non ramosis, appressoriis lobatis vel leniter uncinatis. Status teleomorphosis absens.

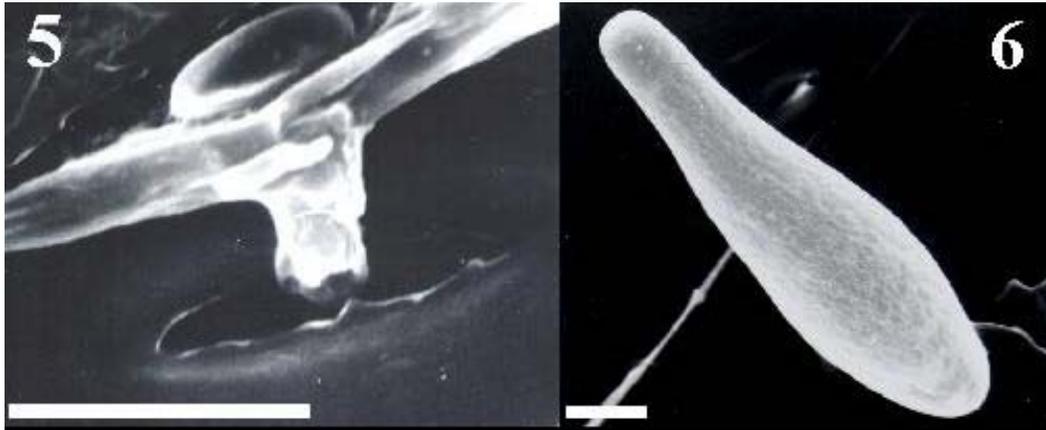
Habitat: in foliis vivis *Duranta erecta* L.

On living leaves. *Mycelium* hypophyllum, inconspicuous to conspicuous and dense, hemiendophytic (partly external and partly internal), superficial hyphae emerging through stomata, 3.5-6 µm wide, septate, branched predominantly at right angles, hyaline, smooth, mycelial appressoria elongated, hooked, 3.5-27 µm long. *Conidiophores* produced from the external mycelium, unbranched, cylindrical, 153-292.5 × 5-7.5 µm, 1-3-septate, hyaline, smooth; foot-cells cylindrical, either straight or having a sinuous to spirally twisted base, 68.5-106.5 × 5-7.5 µm, basal septum 6-21 µm displaced from the branching point of the mycelium. *Conidia* produced singly at the apex of the conidiophores, monomorphic, predominantly clavate, sometimes ellipsoidal or subcylindrical, 52-99 × 15-24.5 µm, apex rounded, l/w ratio 2.4-5.1, aseptate, hyaline, smooth; germ tubes usually short to very short (mostly shorter than the length of the conidium), appressoria lobed to somewhat hooked, sometimes crowded along the length of the germ tube.

Teleomorph: absent.



Figs. 1-4. *Ovulariopsis durantae*. **1.** Hyphal appressoria. **2.** Conidiophore and conidium. **3.** Conidia. **4.** Germ tubes of conidia. Bar = 20 μ m.



Figs. 5, 6. *Ovulariopsis durantae* under SEM: **5.** Hyphae penetrating a stoma of *Duranta erecta*. **6.** Conidium. Bar = 10 μ m.

Habitat: On living leaves of *Duranta erecta* in gardens

Holotype (designated here): BRAZIL: Viçosa, Minas Gerais, on *Duranta erecta* L., 5 June 2003, J.R. Liberato (VIC 26557).

Notes: A distinctive and somewhat unusual character of *O. durantae* is the formation of sinuous to spirally twisted conidiophore foot-cells. In Braun's (1987) monograph of the *Erysiphaceae*, 25 species of the genus *Phyllactinia* and four species of *Ovulariopsis* were recognized. Since 1987, the following additional species were described: *Ovulariopsis ellipsospora* G.J.M. Gorter (Gorter, 1989), *Ovulariopsis lawsoniae* Bagyan., U. Braun & Hosag. (Bagyanarayana *et al.*, 1988), *Phyllactinia aceris* H.D. Shin & Y.J. La (Shin, 2000), *Phyllactinia adesmiae* Havryl. (Havrylenko, 1995), *Phyllactinia ampulliformis* Havryl. (Havrylenko, 1995), *Phyllactinia cassiae* G.J.M. Gorter & Eicker (Gorter and Eicker, 1987), *Phyllactinia coriariae* D.Z. Xie (Xie, 1990), *Phyllactinia corni* H.D. Shin & Y.J. La (Shin, 2000), *Phyllactinia evodiae* S.R. Yu (Yu, 1993), *Phyllactinia gmelinae* Bagyan. & U. Braun (Bagyanarayana and Braun, 1999), *Phyllactinia gorteri* Eicker (Eicker, 1988), *Phyllactinia lianyungangensis* S.J. Gu, Y.S. Zhang & S.R. Yu (Gu *et al.*, 1998), *Phyllactinia miracula* Y.S. Paul (Paul, 1997), *Phyllactinia phaseolina* N. Ahmad, D.K. Agarwal & A.K. Sarbhoy (Ahmad *et al.*, 1987), *Phyllactinia pistaciae* H.D. Shin & Choi (Shin and Choi, 2003), *Phyllactinia pyri-communis* K.C. Puzari & A.K. Sarbhoy (Puzari and Sarbhoy, 1996), *Phyllactinia rhododendri* H.D. Shin & Y.J. La (Shin, 2000) and *Phyllactinia verruculosa* D.Z. Xie (Xie, 1992). Among these 47 species, only *O. lawsoniae* and the anamorphs of *Phyllactinia dalbergiae* Piroz. (Pirozynski, 1965), *P. ampulliformis*, *P. pistaciae* and *P. aceris* have sinuous to spirally twisted foot-cells of conidiophores. However, *O. durantae* differs from these five species in

the characters given in Table 1. Additionally the hosts of these species all belong to different plant families (Table 1).

Ovulariopsis durantae has conidiophores that are longer than those of *P. dalbergiae* and the mycelial appressoria in *P. ampulliformis* are different (inconspicuous in *P. ampulliformis* as compared with conspicuous – lobed to hooked in *O. durantae*). It differs from *O. lawsoniae* in shape and length of mycelial appressoria. Another contrasting feature between these two species is the shape of the germ tubes: those of *O. lawsoniae* are twisted, whereas those of *O. durantae* are very short with appressoria lobed to somewhat hooked, sometimes crowded along the length of the germ tube. *Ovulariopsis durantae* and the anamorph of *P. aceris* are similar, but the conidia of *O. durantae* are narrower and contain few big oil droplets, whereas the anamorph of *P. aceris* contains many small oil droplets, and they have different germ tubes. Additionally, the pattern of the outer wall surface of turgid conidia in *O. durantae*, examined by SEM (Fig. 6), is different from all species of the *Phyllactinioideae* presented by Cook *et al.* (1997) and Braun *et al.* (2002). *Ovulariopsis durantae* differs from *P. pistaciae* in shape and length of germ tube and in conidia size.

This is the first report of an *Ovulariopsis* on *Duranta*. There is only one other species of the *Phyllactinioideae* reported on *D. erecta*, viz., the anamorphic stage of *Leveillula taurica* (Lév.) G. Arnaud [*Oidiopsis haplophylli* (Magnus) Rulamort] in India (Reddy and Reddi, 1981).

***Streptopodium tabebuiae* Liberato & R.W. Barreto, sp. nov.** (Figs. 7-15)

Etymology: from the host *Tabebuia serratifolia*

Maculae in foliis vivis, amphigenae, irregulares, in epiphyllis flavidae, in hypophyllo brunneae. *Mycelium* hypophyllum, effusum vel densus, hemiendophyticum. *Hyphae superficiales* hyalinae, flexuosae, ramosae, cylindricae, septatae, laeves, per stoma emergentiae. Appressoria lobata. *Conidiophora* ex hyphis superficialibus oriunda, non ramosa, cylindrica, 160.5-555.5 × 3.5-6 µm, 2-4-septata, hyalina, laevia, cellulis pedibus cylindratis, rectis, 123.5-261.5 × 5-6 µm, ad basim rectis, septis basalibus 12.5-27 µm dissitis. *Conidia* solitaria, dimorpha: conidia primaria lanceolata, apice acuminato, basi rotundata, 45-74 × 15-27 µm; conidia secundaria clavata vel ellipsoidea vel ovoidea, ad apicem et basim rotundata, 36-69 × 15-29.5 µm, hyalina, laevia, tubis germinativis cum appressoriis inconspicuis.

Status teleomorphosis: absens.

Habitat: in foliis vivis *Tabebuia serratifolia* (Vahl) G. Nicholson

Lesions on living leaves, chlorotic, irregular, becoming yellow with age; soaked areas corresponding to areas with white to grayish powdery mildew fungal growth abaxially. *Mycelium* hypophyllum, hemiendophytic (partly external and partly internal), inconspicuous to conspicuous and dense. Superficial *hyphae* emerging through stomata, septate, branched, hyaline, smooth, mycelial appressoria lobed. *Conidiophores* produced from the external

Table 1. Hosts and morphological characters of *Ovulariopsis durantae* and *Phyllactinia* with spirally twisted conidiophore foot-cells.

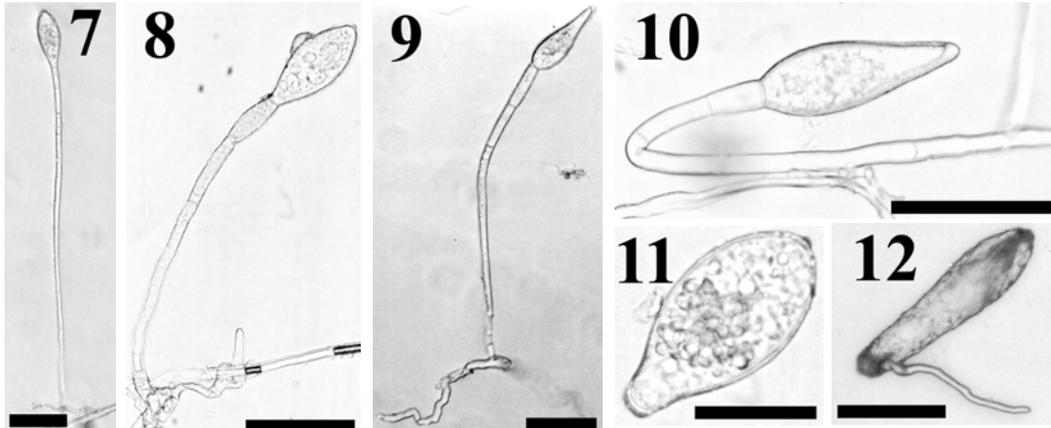
Fungal species	Host	Mycelial appressoria	Conidiophore	foot-cells	conidia	Germ tube
<i>Ovulariopsis durantae</i>	<i>Duranta erecta</i> L. (Verbenaceae)	Elongated, hooked, 3.5-27 μ m	153-292.5 x 5-7.5 μ m	Straight, or sinuous to spirally twisted; 68.5-106.5 x 5-7.5 μ m	52-99 x 15-24.5 μ m; apex rounded;	Appressoria lobed to somewhat hooked, sometimes crowded along the length of the germ tube
<i>Ovulariopsis lawsoniae</i> ¹	<i>Lawsonia inermis</i> L. (Lythraceae)	Nipple-shaped, curved or irregularly lobed, 2-5 μ m	(100-)120-200 (-250) x 5-10 μ m	Undulate to helically twisted, very long;	50-120 x 16-23 μ m; apex obtuse or occasionally subacute;	Simple, twisted, with inconspicuous appressorium
<i>Phyllactinia aceris</i> ²	<i>Acer mandshuricum</i> Maxim. (Aceraceae)	Rod- to hook-shaped, branched to coral-shaped	160-270 x 6-8 μ m,	Twisted or flexuous at the base, very occasionally straight, (up to 170 μ m*)	60-85 x 22-30 μ m, clavate, non-papillate at apex, sometimes narrowed and papilla-like on the end	Substraight to somewhat wavy, inconspicuous to conspicuous appressorium*
<i>Phyllactinia ampulliformis</i> ³	<i>Discaria chacaye</i> (G. Don) Tortosa (Rhamnaceae)	Nipple-shaped to multi-lobed	Not described	Frequently twisted; up to 72 μ m long	61-81 x 14-22 μ m; with an apiculus,	Simple, with inconspicuous appressorium*

Table 1 continued.

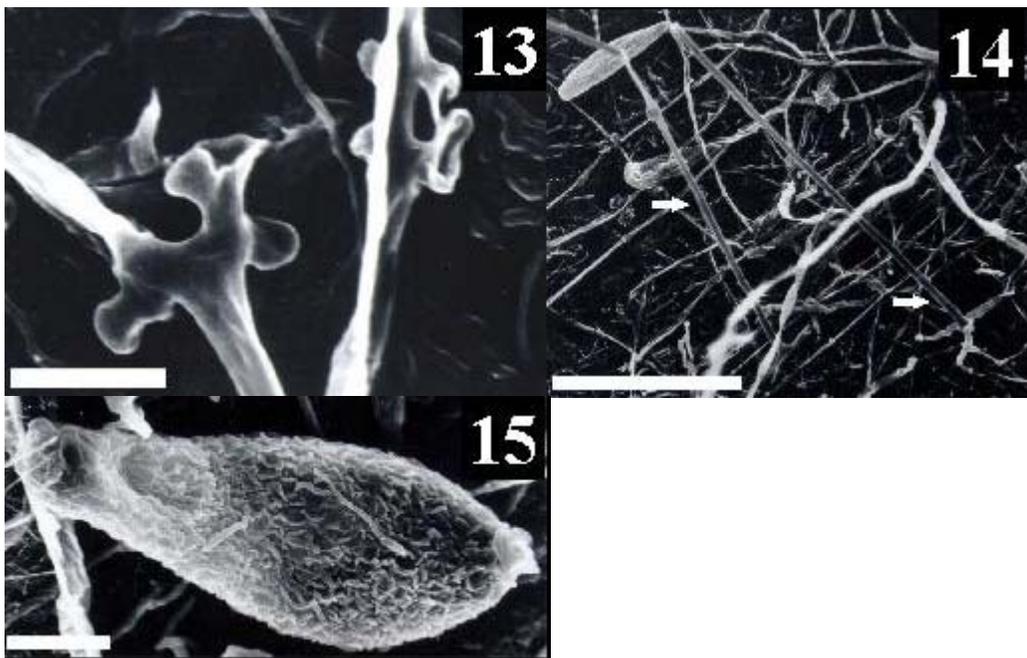
Fungal species	Host	Mycelial appressoria	Conidiophore	foot-cells	conidia	Germ tube
<i>Phyllactinia dalbergiae</i> ⁴	<i>Campylotropis polyantha</i> (Franch.) Schindl. (<i>Fabaceae</i>), <i>Senna obtusifolia</i> (L.) H.S.Irwin & Barneby (<i>Fabaceae</i>), <i>Dalbergia lanceolaria</i> L.f. (<i>Fabaceae</i>), <i>D. sissoo</i> Roxb. ex DC., <i>D. volubilis</i> Roxb. (<i>Erythrina crista-galli</i> L. (<i>Fabaceae</i>), <i>E. dominguezii</i> Hassl., <i>Pueraria peduncularis</i> (Graham ex Benth.) Benth. (<i>Fabaceae</i>)	Not described	120-180 µm	Spirally twisted; 40-65 µm ⁵	52-105 × 14-28, apex rounded or with a protusion ^{5,6} ;	Short with inconspicuous appressorium or slightly unlobed appressorium ⁷
<i>Phyllactinia pistaciae</i> ⁸	<i>Pistacia vera</i> L. (<i>Anacardiaceae</i>)	Hook- to rod-shaped	110-240 × 5-7 µm,	Not described	52-72(-80) × 17.5-25µm	At randomly located sites, with inconspicuous appressorium

*information drawn from of the published illustration of the fungus

References: ¹Bagyanarayana *et al.* (1988), ²Shin (2000), ³Havrylenko (1995), ⁴Pirozynski (1965), ⁵Boesewinkel (1980), ⁶Zheng and Chen (1978), ⁷Braun (1987) and ⁸Shin and Choi (2003).



Figs. 7-12. *Streptopodium tabebuiae*. 7-8. Conidiophore and secondary conidium. 9-10. Conidiophore and primary conidium. 11-12. Conidia. Bars: 7-10 = 50 μm ; 11-12 = 30 μm .



Figs. 13-15. *Streptopodium tabebuiae* under SEM: 13. Hyphal appressoria. 14. Conidiophore and conidium. 15. Conidium. Bars: 13, 15 = 10 μm ; 14 = 100 μm .

mycelium, unbranched, cylindrical, $160.5-555.5 \times 3.5-6 \mu\text{m}$, 2-4-septate, hyaline, smooth; foot-cells cylindrical, straight, $123.5-261.5 \times 5-6 \mu\text{m}$, basal septum $12.5-27 \mu\text{m}$ displaced from the branching point of the mycelium. *Conidia* produced singly at the apex of the conidiophores, dimorphic: primary

conidia lanceolate, apically pointed, base rounded, $45-74 \times 15-27 \mu\text{m}$, l/w ratio 2.3-3.5, secondary conidia clavate, ellipsoid to ovoid, $36-69 \times 15-29.5 \mu\text{m}$, with rounded to truncate ends, l/w ratio 1.7-3.4, aseptate, hyaline, smooth, germ tubes predominantly formed laterally, short (0.5-2 times as long as the conidium), simple, appressoria inconspicuous.

Teleomorph: absent.

Holotype (designated here): BRAZIL: Viçosa, Minas Gerais, on *Tabebuia serratifolia* Nichols., 30 April 2003, Robert W. Barreto (VIC 26551).

Paratype: BRAZIL: Campos dos Goytacazes, Rio de Janeiro, on *Tabebuia* sp., 4 July 2003, Silvaldo F. da Silveira (VIC 26559).

Habitat: On living leaves of *Tabebuia serratifolia*.

Notes: The specimen of this fungus in Ferreira's personal herbarium was re-examined, but unfortunately the condition of this collection was rather poor. It was nevertheless possible to observe the presence of dimorphic conidia, typical for *Streptopodium* and *Oidiopsis*. Ferreira's (1989) publication included a micrograph taken from this specimen clearly showing conidiophores arising from external mycelium. Therefore, the powdery mildew on *T. serratifolia*, identified as *Ovulariopsis* sp. by Ferreira (1989), belongs to *Streptopodium* and agrees well with the new collections.

Braun (1987, 1995) recognized three species of *Pleochaeta* with known *Streptopodium* anamorphic states: *Pleochaeta turbinata* (Viégas & Cardoso) U. Braun (Braun, 1982) [= *Queirozia turbinata* Viégas & Cardoso (Viégas and Cardoso, 1944; Cardoso and Viégas, 1945)], *Pleochaeta shiraiana* (Henn.) Kimbr. & Korf (Kimbrough, 1963; Zheng and Chen, 1978; Gorter and Eicker, 1983), *Pleochaeta polychaeta* (Berk. & M.A. Curtis in Berk.) Kimbr. & Korf (Kimbrough, 1963; Zheng and Chen, 1978). These species plus *Pleochaeta indica* N. Ahmad, A.K. Sarbhoy & Kamal (Ahmad *et al.*, 1995), and *Streptopodium diospyri* G.J.M. Gorter (Gorter, 1988) have spirally twisted foot-cells of conidiophores. *Streptopodium tabebuiae* differs from these five species in having straight foot-cells and, in addition, very long conidiophores (160.5-555.5 μm). The conidiophore length is also a relevant feature for separating *S. tabebuiae* from *Streptopodium caricae* Liberato & R.W. Barreto (Liberato *et al.*, 2004), a species without spirally twisted foot-cells, which has shorter conidiophores ranging from 90 to 181 μm . Finally there is an additional species of *Pleochaeta* with a known *Streptopodium* anamorph, viz., *Pleochaeta prosopidis* (Speg.) U. Braun (Braun, 1982). There is no information about the morphology of foot-cells available in the literature for this species, but conidia of this species germinate at an end whereas conidia on *S. tabebuiae* germinate laterally. The two species can therefore be treated as separate taxa.

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